Start with a top-to-bottom equipment inspection and save year after year.

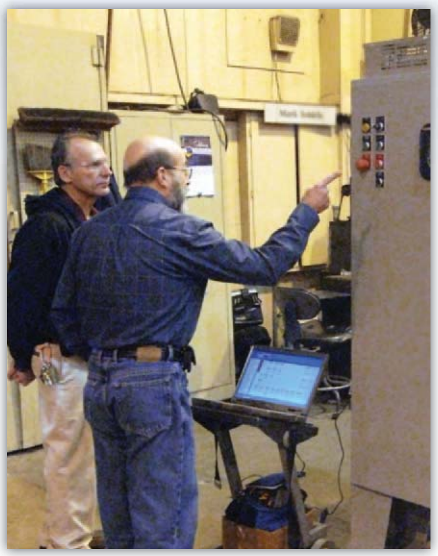
Proactively prevent component failures, major repairs and unplanned downtime.

Initial inspection puts you back on track. Your Hapman equipment was robustly engineered to run trouble-free for years. But you must properly maintain it to reap the savings – and it's too easy to fall behind. To keep maintenance on track, start with a top-to-bottom inspection of your Hapman equipment. One of our skilled technicians will conduct the 4-8 hour inspection. You'll get a detailed report with early warnings of part wear and/or impending component failures. We'll also evaluate your maintenance program and provide a 30-minute consultation so you can learn how to make cost-saving improvements. Fee: only $600 plus expenses.

Customized Managed Maintenance Program (MMP) minimizes "surprise" expenses. Included in your initial inspection will be a no-obligation MMP based on the level of maintenance assistance you want:

- Regularly scheduled equipment inspections by a Hapman technician
- Shared maintenance responsibilities between Hapman and your staff, or
- Full maintenance performed by Hapman

All three levels will improve your machine uptime, reliability, performance and longevity. And that's how you'll keep saving year after year.



YOUR INITIAL INSPECTION INCLUDES:

- Maintenance baseline for your Hapman equipment.
- Detailed inspection report pinpointing maintenance/repair needs.
- One-on-one consultation on how to maximize equipment longevity.
- No-obligation MMP to safeguard your equipment investment.

EXCLUSIVE SAVINGS

When you sign on for the Hapman MMP:

- Save 10% on Hapman service call rates.
- Save 10% on list price of all MMP-covered parts purchases.

TO LEARN MORE WAYS TO SAVE WITH MMP OR TO SCHEDULE AN INSPECTION, CONTACT US TODAY:

800-427-6260 (US/Can) or 269-343-1675
fax 269-382-8266

HAPMAN®
Ideas that move™

www.hapman.com

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MANUFACTURER INSTALLATION OPERATION AND MAINTENANCE MANUAL

AMARUQ WTP – NUNAVUT

VEOLIA PROJECT: 5000 218 009

KOFLO

MODEL 1.5-40C-4-6-2, STATIC MIXER
MODEL 2-40C-4-6-2, STATIC MIXER

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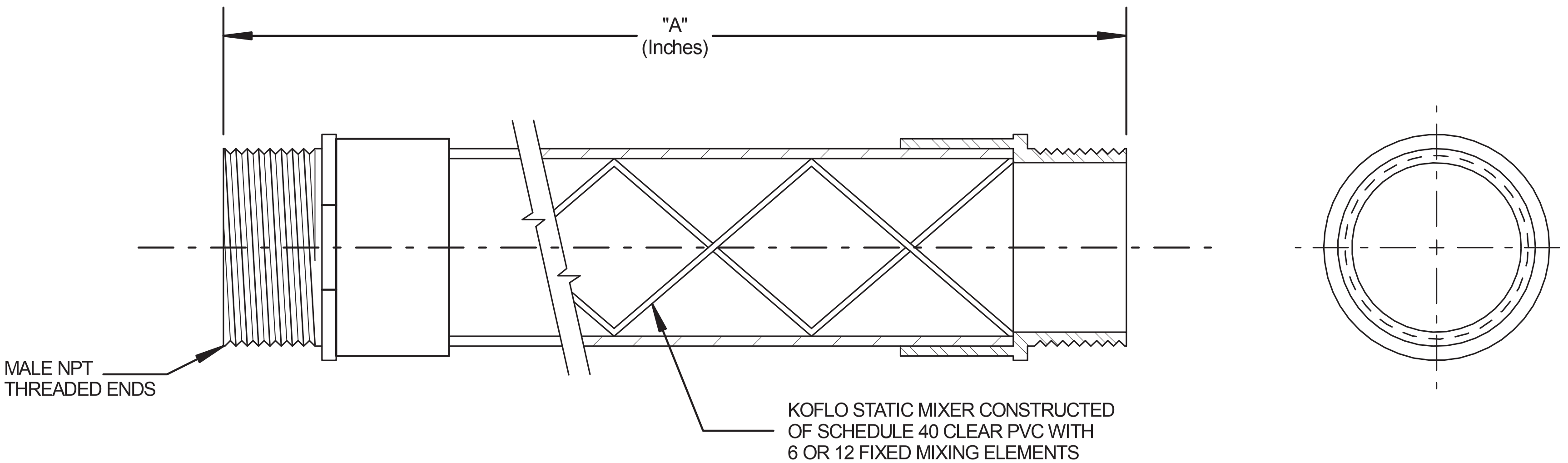

Size	6 Element Model Number	"A" 6 Element	12 Element Model Number	"A" 12 Element
3/8"	3/8-40C-4-6-2	6-1/2	3/8-40C-4-12-2	11
1/2"	1/2-40C-4-6-2	7	1/2-40C-4-12-2	12
3/4"	3/4-40C-4-6-2	9	3/4-40C-4-12-2	15
1"	1-40C-4-6-2	11	1-40C-4-12-2	18
1-1/4"	1.25-40C-4-6-2	14	1.25-40C-4-12-2	25
1-1/2"	1.5-40C-4-6-2	15	1.5-40C-4-12-2	28
2"	2-40C-4-6-2	19	2-40C-4-12-2	35

Koflo Corporation
309 CARY POINT DR.
CARY, IL 60013

SCALE: NONE	APPROVED BY JLF	DRAWN BY NJF
DATE: 1/18/94		REVISED 10/15/01
CUSTOMER:		REVISED 5/22/08
		REVISED 6/12/09
MODEL NO: CLEAR PVC SCHEDULE 40 MIXER		DRAWING NUMBER: KD-993

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Mc LANAHAN

MODEL M3H-CR 3/3, MICROSAND RECIRCULATION PUMP (P2-011/012/021/022)

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585 Airport Road, Gallatin, TN 37066 USA Tel: +1 (615) 451 4440 Fax: +1 (615) 451 4461 mclanahan.com

May 11, 2018
VEOLIA WATER TECHNOLOGIES
3901 RUE SARTELON
VILLE ST LAURENT QC H4S 2A6
CANADA

Thank you for your recent purchase of the following McLanahan equipment with your Purchase Order 18000630 HD referencing our Sales Order 113957.

This document contains important information regarding the installation & operations of your new equipment. Having recommended spare parts at your plant will assure minimum down time in order to perform periodic maintenance and will also eliminate the expense of air freight of critical parts. They are available for immediate shipment from our inventory.

When ordering parts, you will be required to provide the equipment's serial number.

- (4) 3X3 DG NITRILE PUMP ASM W/ 15 HP DRIVE
  S/N: **20182093- 20182096**

We suggest you become familiar with the enclosed literature to ensure the proper installation of this equipment.

Should you have any questions regarding the installation and/or operation of the equipment you have purchased, please contact our Process Equipment Department at (615) 451-4440.

Sincerely,

McLanahan Corporation

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INSTALLATION, OPERATION & MAINTENANCE MANUAL

(4) 3X3 DG NITRILE PUMP ASM W/ 15 HP DRIVE

PROJECT ID #20182093- 20182096

McLanahan®

WORLD HEADQUARTERS	200 Wall Street, Hollidaysburg, PA 16648 USA	Ph: +1 (814) 695 9807	Fax: +1 (814) 695 6684
TENNESSEE	585 Airport Road, Gallatin, TN 37066 USA	Ph: +1 (615) 451 4440	Fax: +1 (615) 451 4461
FLORIDA	6550 New Tampa Highway, Lakeland, FL 33815 USA	Ph: +1 (863) 667 2090	Fax: +1 (863) 667 0449
IOWA	800 First Avenue N.W., Cedar Rapids, IA 52405 USA	Ph: +1 (319) 365 0441	Fax: +1 (319) 369 5440
AUSTRALIA	16 Callistemon Close, Warabrook, NSW 2304 Australia	Ph: +02 49 248 248	Fax: +02 4926 2514
UNITED KINGDOM	Unit 15, Newman Lane, Alton, Hampshire, GU34 2QR, UK	Ph: +44 (0) 1420 542489	

mclanahan.com

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INSTALLATION, OPERATION & MAINTENANCE MANUAL

PUMP ASSEMBLY MANUAL

TAG INFO: ITEM #1 P2-011 PID 20182093

TAG ITEM #2 P2-012 20182094

TAG ITEM #3 P2-021 20182095

TAG ITEM #4 P2-022 20182096

WORLD HEADQUARTERS 200 Wall Street, Hollidaysburg, PA 16648 USA Tel: +1 814-695-9807 Fax: +1 814-695-6684

TENNESSEE 585 Airport Road, Gallatin, TN 37066 USA Tel: +1 615-451-4440 Fax: +1 615-451-4461

FLORIDA 2920 Barneys Pumps Place, Lakeland, FL 33812 USA Tel: +1 863-667-2090 Fax: +1 863-667-0449

IOWA 800 First Avenue N.W., Cedar Rapids, IA 52405 USA Tel: +1 319-365-0441 Fax: +1 319-369-5440

AUSTRALIA 16 Callistemon Close, Warabrook, NSW 2304 Australia Tel: +02 49 248 248 Fax: +02 4926 2514

UNITED KINGDOM 11 Warren Rise, Frimley, Surrey, GU16 8SH UK Tel: +44 (0)7407 344757

mclanahan.com

Table of Contents

Safety Precautions

Overview

<u>READ THIS MANUAL IN ITS ENTIRETY BEFORE BEGINNING OPERATION.</u>

- **DO NOT** install, operate or service this equipment (or any portion thereof) without fully understanding the information contained herein.
- **DO NOT** operate this equipment in any manner other than that for which it has been designed or approved.

NOTE: A copy of this manual **must** be provided to the operator of this equipment and **must** be kept with the equipment at all times.

The safety instructions presented throughout this manual do not supersede any other directives or practices associated with this equipment or its operation. Rather, they are to be used in addition to any other applicable guidelines set forth by governing bodies (ANSI, ISO, OSHA, MSHA, etc.), plant administrators, signs, tags or placards, etc. (Refer to the **TAGS** section of this manual for information regarding safety and instructional tags provided with the equipment.) In the event of conflicting information, **<u>always use the guidelines providing the highest degree of protection/safety.</u>**

The safety instructions used throughout this manual and on the equipment contain a "signal word" (CAUTION, WARNING or DANGER) that indicates the seriousness of the hazard as described below.

DANGER *indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.*

WARNING *indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.*

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

CAUTION *(used without the safety alert symbol) indicates a potentially hazardous situation, which, if not avoided, may result in property damage.*

McLanahan

The safety instructions listed below are general guidelines. Additional safety instructions are listed throughout this manual as required. **<u>All</u>** safety instructions **<u>must</u>** be followed at all times to ensure personal safety and to prevent equipment damage.

DANGER — **Verify that all personnel are clear of any/all moving or rotating parts** (or parts that are subject to movement or rotation) before installing, operating or servicing this equipment or any portion thereof.

WARNING — **Verify that all guards and safety devices are in place, secured and functional** before operating this equipment or any portion of it. **DO NOT** circumvent or disable any safety devices.

WARNING — **Lockout/Tagout all controls and secure all applicable components to prevent unexpected movement** before performing any maintenance, repairs or adjustments on this equipment or any portion thereof.

WARNING — **Lockout/Tagout power at the source** before accessing any electrical panels or devices on this equipment or before performing any maintenance or repairs to the power line(s) feeding this equipment.

CAUTION — Wear appropriate personal protective equipment at all times.

CAUTION — **Obey all safety tags and signs** and replace any that are illegible or missing.

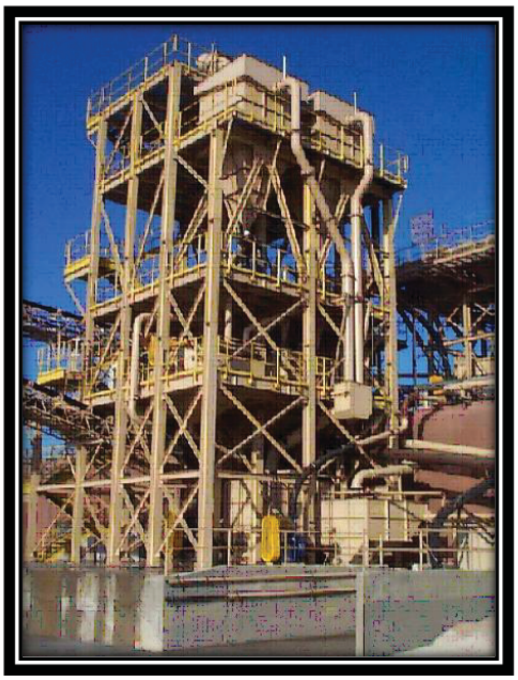
If any questions arise concerning the safe operation of this equipment, or if clarification of any information is required, cease operation and contact **McLanahan Corporation** immediately.

The McLanahan Pump

Introduction

The Aggregate Processing Division of McLanahan is a major manufacturer of process plants for the minerals industry. The McLanahan Model lllr is the latest generation of successful abrasion/corrosion-resistant slurry handling pumps.

This manual should be carefully read before attempting to install or operate this McLanahan Model lllr Pump.



Service, Selection and Support

Total Service

From design to installation and beyond, McLanahan engineers are available to give advice on your slurry pumping needs and solutions for your problems.

The McLanahan Model lllr range has been designed to offer a wide choice of pump sizes to suit most slurry pumping applications. A standard questionnaire is available to ensure that the most complex installation, as well as the more straightforward pumping application, receives individual consideration.

McLanahan can also advise on the ancillary components within the pumping system. The provision of low head loss valves, gland feed pumps, priming devices and flexible bends, all incorporating application specific linings for trouble-free life, are an important aspect of ensuring a totally successful pump installation.

Design Specifications and Options

The McLanahan Model lllr standard casing is designed for a maximum working pressure of 88psi (6 bar). A high pressure casing is available, rated at 272psi (18.5 bar). Please contact McLanahan for pressures higher than this.

The pump units in the McLanahan Model lllr range are designated by the size of suction and discharge ports. Units up to 4” (100mm) have equal size suction and discharge; above this, the Model lllr has a larger suction than discharge. Size is given in inches i.e. 8”/6” (200/150mm) Model lllr has an 8” (200mm) suction port and a 6” (150mm) discharge port.

Suction and discharge flanges are universal and, as a standard, are available in ASA150 drilling patterns. Other drilling patterns (metric & BS4504) are available to special order. Orientation of discharge to 4 positions according to installation requirements.

The McLanahan Model lllr pump components are designed and manufactured in accordance with appropriate International Quality Standards, such as ISO9000.

"Pumptec" Computer Software

Many complex calculations are needed in order to

- Size a pump
- Establish the optimum pipeline carrying velocity
- De-rate the pump for a slurry duty
- Calculate pipeline friction head losses
- Calculate power absorbed
- Analyze the system head

McLanahan Corporation uses unique software, **Pumptec,** to perform these calculations.

The pump is able to adapt to a change of V-belt sheave ratios and different speeds. However, it is **crucial** to recalculate duty parameters and check motor and drives to guarantee that they are not overloaded under any normal operating condition.

Please consult McLanahan Corporation before making any changes to your pump system to ensure the correct combination of speed and power is selected.

Input criteria required:

- Volume to be pumped
- Percent solids
- Gradation of solids (top size & 50% passing size)
- Specific Gravity of Solids
- Specific Gravity of Liquid
- Temperature of Liquid
- Elevation above sea level
- Height of liquid level in tank (**if negative suction**, height from liquid surface to center line of pump inlet)
- Vertical height from pump inlet to discharge point
- Pressure required at delivery point
- Pipe diameter (inside diameter important)
- Pipe material
- Pipe fittings – type and quantity

Pumptec: Computer Aided Support

To complement and facilitate optimum selection of your slurry system, McLanahan uses **Pumptec.**

This unique computer program:

- Analyzes the effects of changing slurry density
- Calculates the P_{50} particle size from a sieve analysis
- Calculates settling velocities and select pump sizes
- Calculates pipeline frictional losses in various pipe materials and pipe fittings
- Calculates the pump duty and selects a pump and drive based on input parameters
- Prints full application and selection data including NPSH, BEP, RPM, HP, etc.

Troubleshooting is made easier using **Pumptec** Software to evaluate different scenarios.

Maska Pulleys Inc.
180, Boul. Gagnon, Ste-Claire
,Qc, Canada G0R 2V0
Tel:(418)883-3322 Fax:(418)883-5015
www.maskapulleys.com

Selection Parameters

Family: Classic & Narrow belts drives

Shaft diameter Driver: 1-5/8 Inch
Shaft diameter Driven: 45MM
Service Factor: 1.2
Driver power: 15 hp
Rpm Driver: 1760
Rpm Driven: 1318 **Tolerance:** -3% +3%
Center distance : Minimum: 16.5 Inch
Maximum: 18 Inch
Belts: BX,5V,5VX

Max. Hub Load: 9999
Rim Speed min.: 900 FPM
Rim Speed max.: 6500 FPM
Nbr of Grooves min.: 2
Nbr of Grooves max.: 15

Pitch Diameter (Inch)

	Min.	Max.
Driver	0.50	71.00
Driven	0.50	71.00

Actual Drive Values

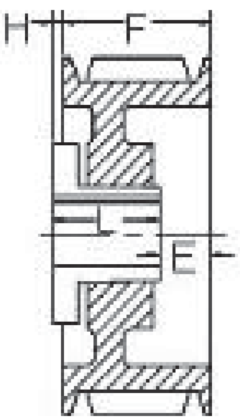
Maximum number of results: 20

Rpm: 1326
Service Factor: 1.54
BeltSpeed (fpm): 3384
List Price: 298.32

Center distance (Inch): 17.0
Power/Belt (hp): 11.5

Deflection (inch): 0.26
Deflection Force (lbs): 5.0
Hub Loads (lbs): 263

Driver Sheave: 2B70

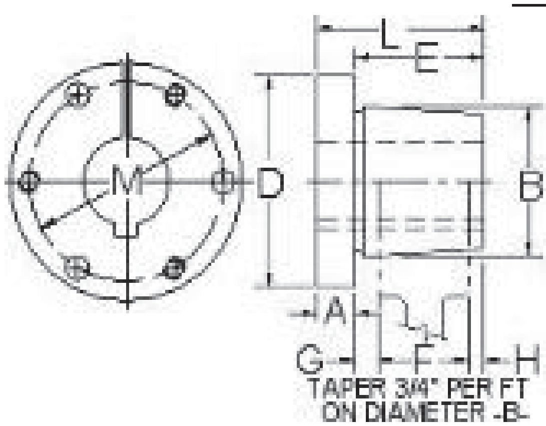


List Price: 72.00
Weight: 9.30 lbs

Constuction type: Web

D.D. A or 4L Belt: 6.60"
D.D. B or 5L Belt: 7.00"
E: 1/4"
F: 1 3/4"
H: 3/8"
L: 1 7/8"
O.D.: 7.35"

Driver Bushing: SKX1-5/8

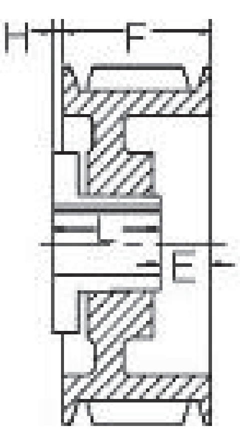


List Price: 26.80
Weight: 2.75 lbs

Product specifications: Standard with set screw over keyway.
Set screw - Dimensions: 1/4-20 UNC x 1/4
Hex bolt: 3=5/16-18UNC X 2

A: 1/2"
B: 2 13/16"
D: 3 7/8"
E: 1 3/8"
F: 1 1/4"
G: 5/16"
H: 3/16"
Keyseat: 3/8 x 3/16"
L: 1 7/8"
M: 3 5/16"

Driven Sheave: 2B94

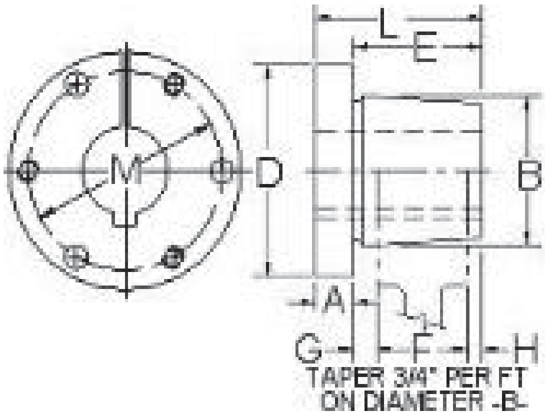


List Price: 78.00
Weight: 13.30 lbs

Constuction type: Arms

D.D. A or 4L Belt: 9.00"
D.D. B or 5L Belt: 9.40"
E: 1/4"
F: 1 3/4"
H: 3/8"
L: 1 7/8"
O.D.: 9.75"

Driven Bushing: SKX45MM

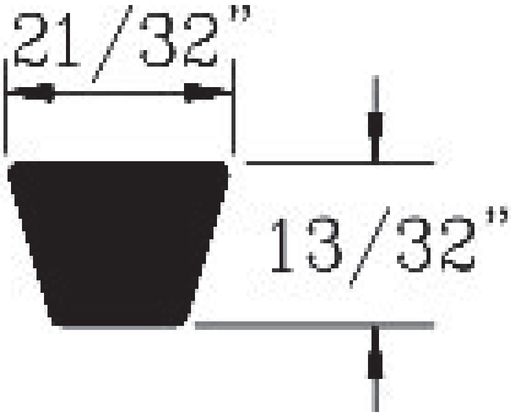


List Price: 26.80
Weight: 2.55 lbs

A: 1/2"
B: 2 13/16"
D: 3 7/8"
E: 1 3/8"
F: 1 1/4"
G: 5/16"
H: 3/16"
Key: 14 x 9"
L: 1 7/8"
M: 3 5/16"

Product specifications: Standard with set screw over keyway.
Hex bolt: 3=5/16-18UNC X 2
Set screw - Dimensions: 1/4-20 UNC x 1/4

Belts: VBBX58 (Qty:2)



List Price: 47.36
Weight: 0.64 lbs

Recommended Drive Selections are designed for use with Maska components (sheaves, bushings and V-belts) which meet or exceed MPTA & RMA standards. The use of lesser quality products could affect life expectancy of drive.Selections and Pricing are as accurate as possible; Maska is not responsible for ANY pricing or design errors.Price shown are for standard products only. For non-standard products or products that need dynamic balancing, contact Maska for pricing.

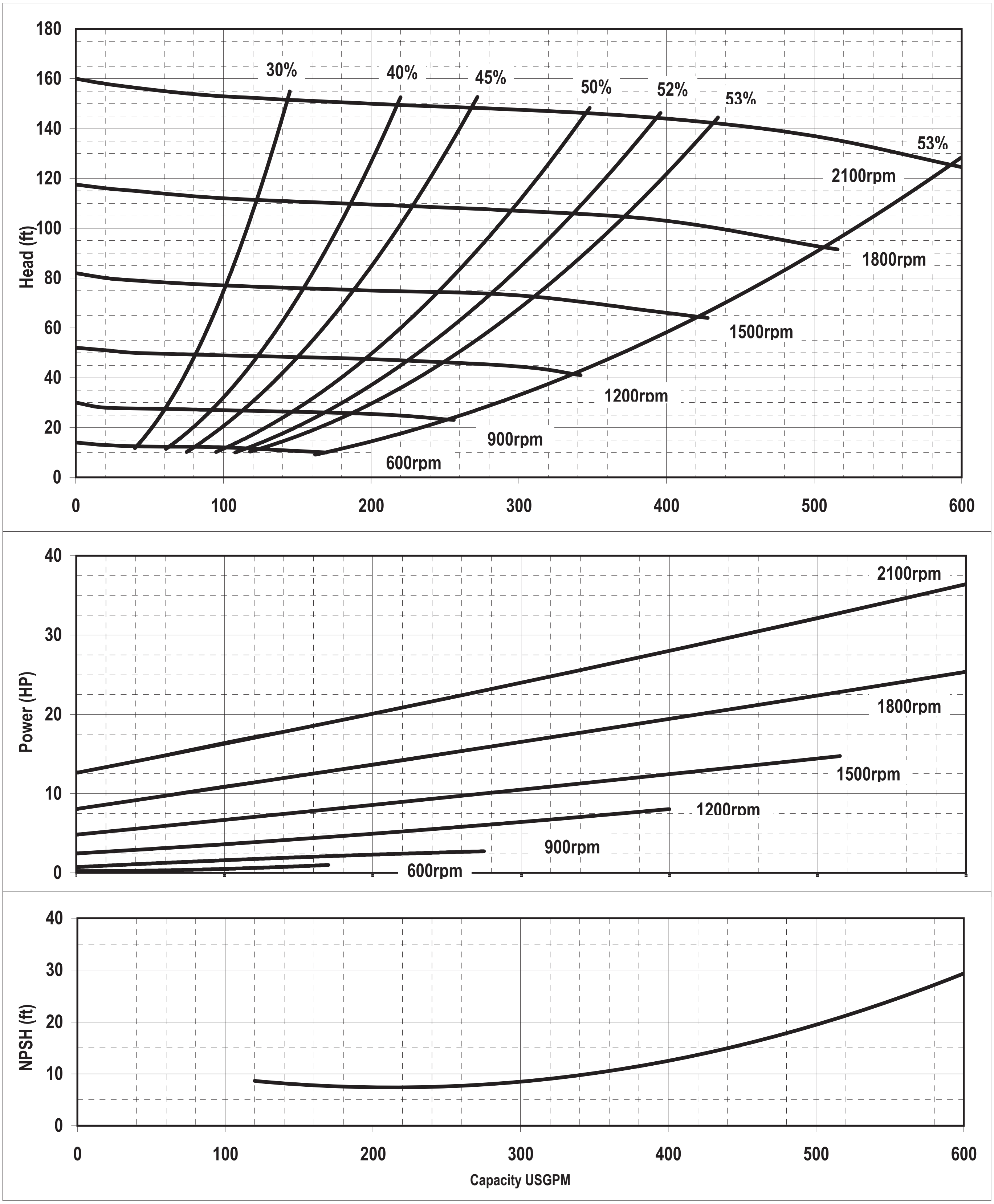
Standard Pump Curve

Linapump model 3/3 LPIIIr

McLanahan

AGGREGATE PROCESSING DIVISION

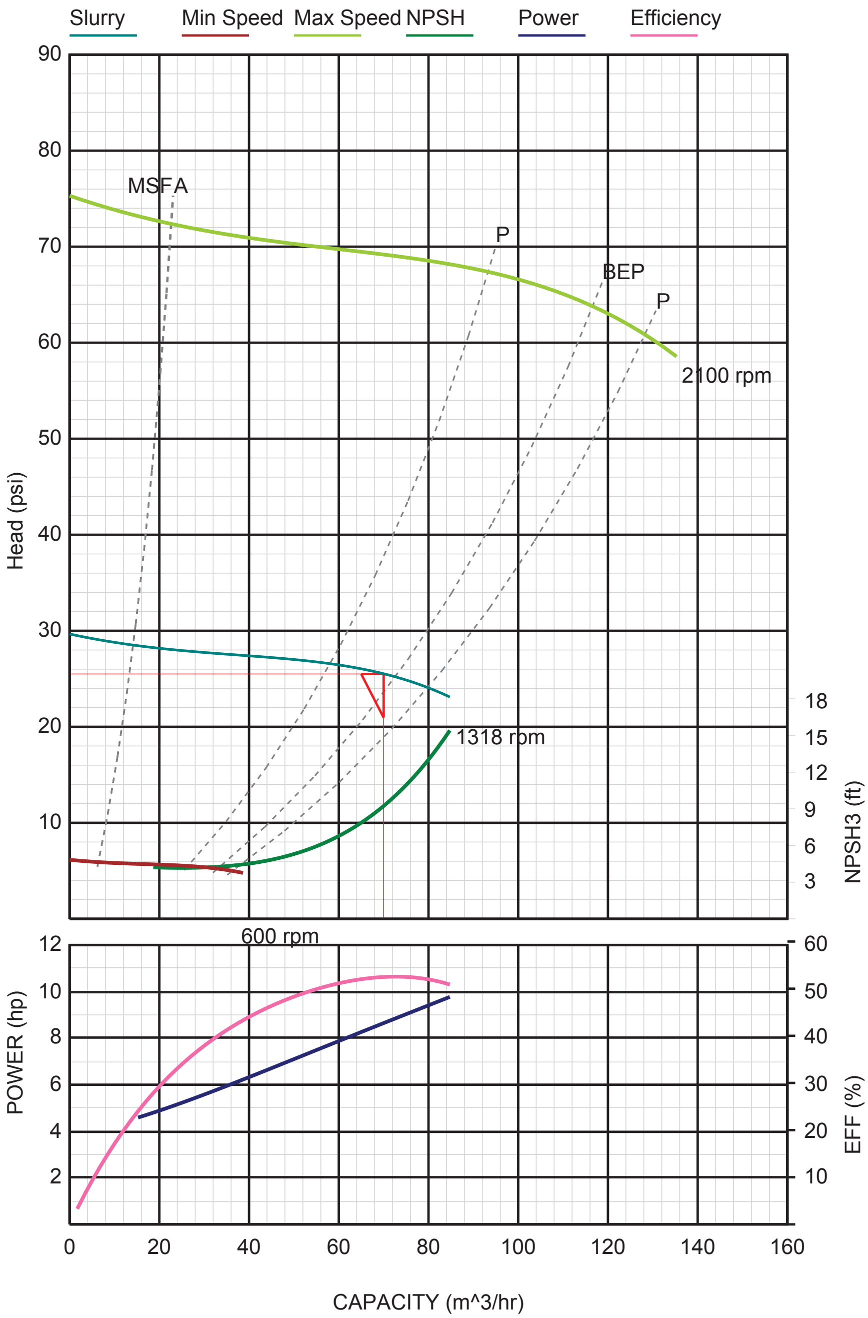
Impellar Diameter	10"	Maximum Speed	2100rpm	Max. Solids size	$^5/_8$"	Curve No	080/01.96
No. of Vanes	4	Maximum Power	60hp	Model	3/3	date	02-Apr-97



JMI - Agnico Eagle-Amaruk /

Q20180320-01, March 20, 2018

M3H-CR 3/3 , 1318 rpm, 15 hp



Pump model: M3H-CR 3/3

Pump	
Pump range	-CR
Speed	1318 rpm
Max Speed	2100 rpm
Efficiency @ BEP	53.13 %

Duty Point	
Flow	70 m^3/hr
Static Head	0 psi
Total Head	25.5 psi
Efficiency	53.15 %
NPSH required	7.664 ft
% of BEP	96.51 %
Power absorbed - @ Duty	8.635 hp
Motor size	15 hp
Tip Speed	57.03 ft/s
Impeller Diameter	10 in
Speed Head	25.97 psi

Slurry Data	
Solid flow rate	12.98 Tons/hr
Solid SG	2.7
Slurry SG	1.104
% Comp. by Weight	15 %
% comp. by Volume	6.135 %
Ave. Particle size (D50)	100 microns
Max Particle Size	300 microns
Head Ratio	0.982

Engineer's Notes

JMI - Agnico Eagle-Amaruk /
Q20180320-01, March 20, 2018
M3H-CR 3/3 , 1318 rpm, 15 hp

Pump Details		
Pump Model	M3H-CR 3/3	
Rated Flow	70	m^3/hr
Rated Head	25.5	psi
Efficiency	53.15	%
QBEP	96.51	%
Impeller Diameter	10	in
Pump Speed	1318	rpm
Minimum Speed	600	rpm
Maximum Speed	2100	rpm
Tip speed	57.03	ft/s
NPSH required	9.421	ft

Selection Details		
Required Flow	70	m^3/hr
Required Head	25.5	psi
Static Head	0	psi
Friction Head	25.5	psi
Suction Height	0	psi
Discharge Height	0	psi
Discharge Pressure	0	kPa
Head Ratio	0.982	
NPSH Available	0	psi

Slurry Details		
Solid flow rate	12.98	Tonnes/hr
Slurry flow rate	70	m^3/hr
SG solid	2.7	
SG liquid	1	
SG slurry	1.104	
% comp. by weight	15	%
% comp by volume	6.135	%
Ave. particle size	100	microns
Max particle size	300	microns
Widely graded particles	False	
Froth factor	0	
Set ER & HR manually	False	
Efficiency ratio	0.982	
Head ratio	0.982	

Electrical Driver Details		
Motor	15	hp
Power absorbed by pump	9	hp
Power required	8.049	hp
Frame size	160M	
Temperature rise	0	
Insulation class		
Bearing size D/E		
Bearing size N/D/E		
Weight	0	
Shaft size	0	

Specific Information About Your Pump

<table>
<tr><td colspan="4">Company Name:</td></tr>
<tr><td colspan="2" rowspan="2">Address:</td><td colspan="2">Tel:</td></tr>
<tr><td colspan="2">Fax:</td></tr>
<tr><td rowspan="3">Supplier:</td><td colspan="3">Type of Industry:</td></tr>
<tr><td colspan="2">Pump Model:</td><td>Size:</td></tr>
<tr><td colspan="2">Serial No:</td><td>Flange Type:</td></tr>
<tr><td>Contact Person:</td><td colspan="2">Gland Size:</td><td>Drive Style:</td></tr>
<tr><td colspan="4">Start-up date/remarks:</td></tr>
</table>

Design Condition (To be filled in by distributor or owner)

The following data should be completed as a record of the duty for which the pump was originally sold. During its lifetime the pumping requirements may change; if so, the new speed and operating conditions must be carefully engineered. McLanahan engineers are able to assist you in doing this. U.S. units are used, unless otherwise noted.

Details of Solids

Description of Solids: ____

Specific Gravity Solids: S=____________ Quantity of Solids M: ______________ dry tons/hr

Particle Size: Topsize= _______mesh (mm). 50% passing size= __________mesh (mm).

Details of Liquor

Description of Liquor: ______________________________

Specific Gravity of Liquor: Sl = ______________________

Details of Slurry

Specific Gravity of Slurry: Sm = _____________________

Percent (%) of solids by volume in slurry: Cv=________________________

Percent (%) of solids by weight in slurry: Cm = _______________________

Flow rate of slurry: Q=________________________________gpm (l/s, m^3/Hr).

Calculated Design Data

Total Head: ________ft (m). Maximum working Head: ___________ft (m).
NPSHa: _________________ft (m). NPSHr: _________________ft (m).
Pump Speed on Slurry: ________________________rpm. Derate factor for Slurry: _______________

Motor Data

Motor Power rating: ___________________________HP (kW).
Motor Frame size: _____________________________
Motor Speed: _________________________________rpm.
Motor Shaft Size: ______________________________in (mm).

Vee-Belt Drive Data

Motor pulley O.D. __________________in (mm). Pump pulley O.D.: __________________in (mm).
Taper lock Bush No: ____________________ Taper lock Bush No: ______________________
Vee-belt: ________________No off____________ No of grooves/pulley: _____________________

Gland Water Requirements (H and P glands only)

Quantity: __________________________gpm (l/s)
Pressure: __________________________psi (m)

Technical Data

Pump Mass: ___________________________________lbs (kg).
Motor Mass: __________________________________lbs (kg).
Pump Shaft Size: _______________________________mm
Noise Level: __________________________________db (A)

Gland Options

Gland Seals

The **gland** is usually the weakest point on any **pump**; therefore, it requires the most attention and maintenance. All glands need cooling and lubrication between the sliding surfaces, so **a leisurely drip from the glands is normal**. **NOTE: DO NOT PREVENT DRIP.** All glands must be finally adjusted while the pump is running.

The McLanahan Glands have been developed to minimize the attention and service needed; Pressure of the fluid being pumped, the size and shape of the solid particles and the concentration of the solid particles in the liquid all affect wear and tear on pumps. Three unique seal arrangements have been developed and McLanahan engineers can give advice regarding the optimum selection for a specific duty.

"H" and "P" Glands

The slurry pressure at the gland is reduced by back pump out vanes on the impeller. The rubber axial expeller, which is a stretch fit on the shaft of the "H" and "P" glands, is used to avert waste.

The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the "H" Gland, the adjusting gland must be eased **outward** to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to provide a flawless seal while limiting the amount of "digging" onto the gland sleeve.

The gland sealing water must be as clean as possible and at a pressure of about 3-5psi (2-4m water gauge) above the discharge pressure. A high-flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

“D” Gland

This is a unique type of mechanical seal. The **face seal** runs against the **hard wearing face**.

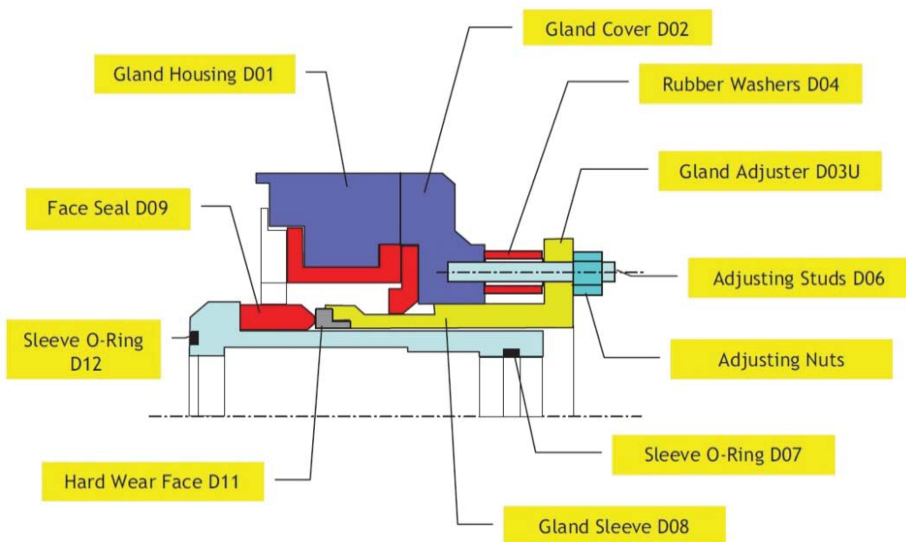
The **face seal** acts as a spring and if any grit particles get between the rotating rubber and stationary **wear face** it is pressed into the rubber. The **face seal** is a stretch fit on the **shaft sleeve**. As the gland pressure increases, the rubber extends axially and increases the pressure at the rubbing interface. Be sure not to over-tighten the adjusting sleeve.

When the pump is first started, ensure that the adjusting nuts are finger tight. While the pump runs, adjust the gland nuts so there are approximately five (5) drops per minute from the gland. This should reduce to one (1) occasional drop and run satisfactorily for up to a year without further attention in a good application.

Dry Gland

Also known as "D" type gland
This gland has a unique proprietary design and is unlike conventional mechanical seals. A rotating rubber **face seal** is adjusted against a static **hard wearing face**; it is **self-lubricating -** pressure from inside the pump head forces small amounts of liquid between the surfaces for lubrication.

Note: The gland needs no external water source to lubricate the gland; both small amounts of water and the fines do exit the pump, accumulating at its base, hence the term **dry gland**.

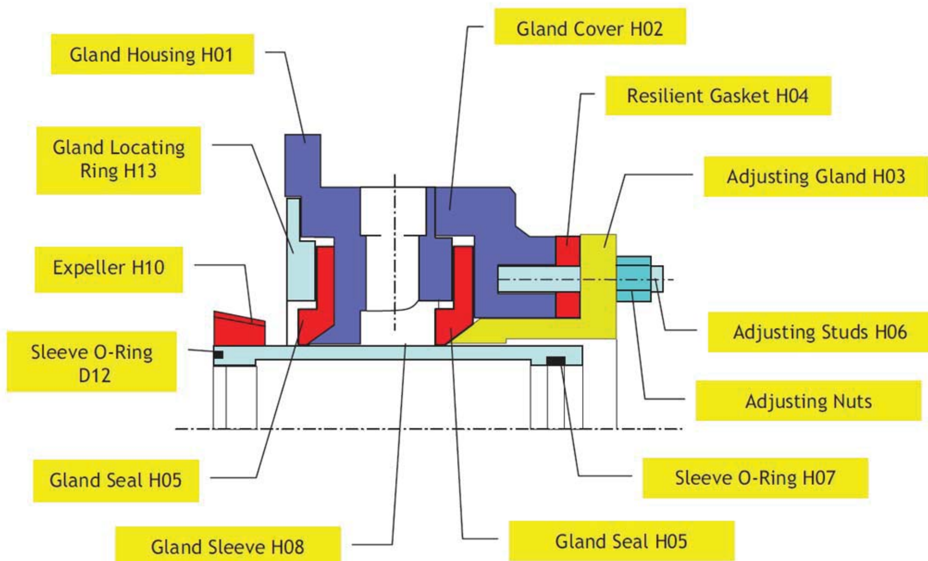


The **face seal** acts as a spring; if any grit particles get between the rotating rubber and **stationary wear face**, it is pressed into the rubber. The **face seal** is a stretch fit on the shaft sleeve. As the gland pressure increases, the rubber extends axially and increases the pressure at the rubbing interface.

While the pump is running, adjust the gland nuts so there are approximately five (5) drops per minute from the gland. This should reduce to one (1) occasional drop and run satisfactorily for up to one year without further attention in a typical application.

Hydrostatic Gland

Also known as "H" type gland
This gland has a unique proprietary design with the lowest maintenance and longest life. The unique rubber gland seal is designed to deflect inwards to provide an effective seal. The **slurry pressure** at the gland is reduced by back pump out vanes on the impeller; when fitted, it is reduced by the **rubber axial expeller**, which is a stretch fit on the shaft of the "H" gland sleeve.



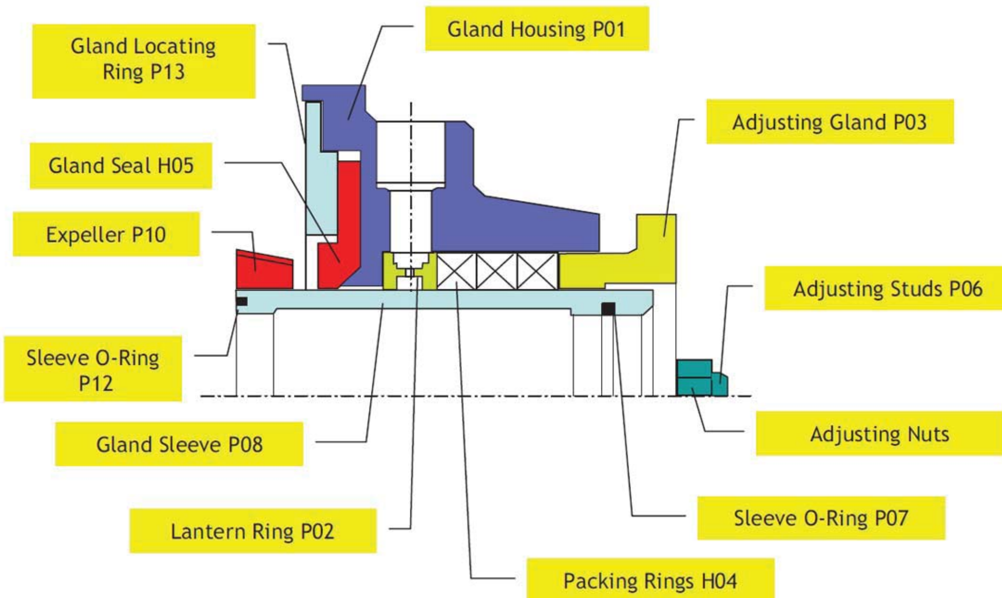
The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the H Gland, the adjusting gland must be eased outwards to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to give a good seal while limiting the amount of "digging" onto the gland sleeve.

The gland sealing water must be as clean as possible at a pressure of about 5psi (4m water gauge) above the discharge pressure and at a volume of between 1 to 5 gpm depending on pump size. A high-flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

Packed Gland

"P" Type Gland
In a classic "stuffing box" design, sealing is obtained by compressing the gland packing rings onto the shaft sleeve. The gland offers the capacity to seal the pump even at high pressures, for instance, in series pumping.



The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the "P" gland, the adjusting gland must face inwards to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to give a good seal while limiting the amount of "digging" onto the gland sleeve.

The gland sealing water must be as clean as possible at a pressure of about 5psi (4m water gauge) above the discharge pressure and at a volume of between 1 to 5 gpm depending on pump size. A high flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

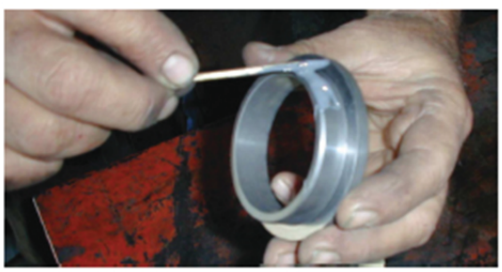
A pressure-fed grease supply can be used with the "P" gland; be sure to use synthetic rubber parts (special order).

McLanahan

Assembly of Dry Gland – Hard Wear Face & Gland Adjuster (2” x 2” shown)

1. Check all components

2. Extrude epoxy from package & mix thoroughly



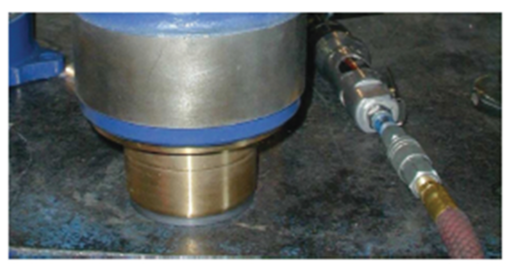
3. Apply epoxy to outer rim of Hard Wear Face (D11)

4. Place ‘O’ Ring (D10) on outer rim of Hard Wear Face (D11). Position ‘O’ Ring at leading edge.

5. Position Hard Wear Face & ‘O’ Ring into Gland Adjuster (D03U)

6. Using a slight twisting motion Carefully push Hard Wear Face into Adjuster

7. Wipe off excess epoxy



8. Place a heavy object on top of the assembly until dry (min 30 minutes)

General Pump Suction Requirements

A pump does not “suck,” as fluid has no tensile strength. The centrifugal expulsion of fluids creates a low pressure area at the eye of the impeller; atmospheric pressure, plus any static head, pushes fluid into the pump. It is essential that suction systems do not restrict flow from the sump into the pump. With slurries, this is even more important as the solids themselves can settle and cause obstructions to flow.

In order to maintain the short pipelines and prevent obstruction**, cleaning is essential**. A trap to remove tramp material is beneficial as well.

Air entrained in the slurry reduces the pump’s capacity and head; an air vent pipe on the suction pipe close to the pump inlet is often essential.

The pump will operate best if the flow velocity approaching the impeller is evenly distributed across the suction eye, and is sensibly axial, without swirl.

Pump performance is potentially impaired by a number of factors. Intake conditions in the sump, such as the formation of vortices, can cause an uneven flow over the eye of the impeller. Intake conditions in the suction pipeline, such as a sharp bend just before the pump, can affect performance as well.

Installation

Important Notes

- The maintenance of rotating machinery should be done by experienced mechanics.
- Protective clothing as well as proper tools and lifting equipment, all in good condition, must be used.
- Do not lift heavy weights without mechanical aids.
- Do not take any risks with your health and safety.
- If a pump has run without discharge, the fluid temperature and pressure may be dangerously high.
- The casing suspension arm is fitted as a maintenance aid only.
- The installer must ensure that guards are fitted in accordance with national & local regulations.

The following notes cover most situations; however, certain installations will require additional assessments.

Noise

Because of its heavy construction, rigid bearing housing and the sound attenuation due to the rubber lining, the noise generated by a bare shaft McLanahan Pump is low: less than 70dB (A).

The noise emission from a complete pump and drive unit will be dependent upon various factors including that from the motor, its fan and the V-belt drive. To obtain an indication of the noise level generated by a specific complete unit, take the highest component noise level, which is generally the motor, and multiply by 1.15.

For example:

dB (A) pump + dB (A) motor + dB (A) drive = 1.15 x dB (A) motor.

Other factors, including the piping system and hydraulically-generated noise as well as any reflected noise, will affect the final installed figure.

Foundations

Location and dimensions must be checked and matched to the pump-certified drawing when holding down bolts, bolt holes in steel work or pockets in concrete. The foundations must be rigid.

The pump base must be level in its final position; it must also be rigidly supported at each bolt, which is designed to hold it down, before the bolts are tightened.

Pipe Work

The suction and delivery pipe work must be independently supported and the pump must not be used as an anchor to pull the pipes into position.

The procedure for discarding solids in an emergency situation should be planned before it is needed. If the removal of suction and delivery pipe work is planned ahead of time, it will facilitate unblocking and servicing of the pump.

Precautionary checks that need to be completed include:

- Areas that could cause restriction on the suction side
- The possibility of thermal expansion in the pipework causing undue loads on the pump
- The pipework should match up to the pump without strain

The lining on the McLanahan model lllr is continued out to form gaskets on the suction and discharge flanges, therefore the use of joint rings or additional gaskets is not necessary. Connections to the pump should be made using flat-faced flanges only.

When fitting McLanahan pumps to rubber-lined equipment such as valves, hose or lined pipe, a steel gasket must be used.

Power

Check that the motor voltage, power and starter rating and supply match.

Gland Services

If gland sealing water is required, the quantity, quality and availability should be checked.

Access

Crane capacity and access routes from the delivery point should be checked. Access for maintenance, protection from flooding, as well as ventilation for motor cooling, must all be checked.

Impeller Adjustment Axially

The position of the rotating element must be set so there is a minimum running clearance, approximately 1/16” – 1/8” between the suction bush and the impeller. The bearing housing must then be locked into position. This clearance should be checked by bolting a dummy flange or stub pipe to the suction flange. This ensures any movement of the rubber lining on connection is allowed. Once connected to suction and delivery lines, the unit should be checked for free rotation.

Coupling Alignment

The pump and motor couplings must be aligned in accordance with good engineering practice. Axial or radial run-out must be less than 0.05 mm total indicated reading on a clock gauge. With V-belt pulleys, the faces of the couplings must be exactly in line and the shafts must be parallel to each other. A check with a straight edge or string line across the pulley faces should have no visible gap.

Motor Rotation

Before the belts are fitted or the couplings are connected, the direction of rotation of the motor must be checked. Incorrect motor rotation can cause the impeller to unscrew and destroy the pump.

Tension V-belts

When the motor’s direction of rotation is correct, fit and tension the V-belts in accordance with the maker’s recommendation. In general, a quarter to a half twist of the belt will be possible at the center of the belt by simply using fingers. Check the tension after a few running hours.

Belt Guard

The belt guard provided with this pump unit is manufactured with the shaft aperture fully closed with mesh. On installation of the V-belt drive and determination of pulley centers, the shaft guard is offered up and the mesh relieved locally to allow the shafts to pass through. Allowance may be required for movement of shafts when belt tensioning.

The mesh should be relieved and a guard should be fitted in a manner which prevents accidental contact with the rotating parts of the drive assembly.

The installer must ensure that the guard is installed in accordance with national and local regulations.

Gland Service

When these are fitted, be sure that gland water supply and protection systems are working.

Greased Bearings

The pump bearings have been greased at the factory. **Over-greasing them can cause them to overheat**; they should be looked over but may not need grease. **Suitable grease types** are: Shell Alvania 3, Mobil EP2, Caltex LS3 or their equivalents.

Final Checks

- All nuts and bolts are tight
- Gland adjusting nuts are finger tight
- No loose material is lying around the pump set
- The guards are securely fitted and the pump is safe to start

The running speed of the pump must not exceed the following:

Pump	1½ x 1½	2x2	3x3n	4x4	6x5	8x6	10x8	12x10
MAX RPM	2750	2400	2100	1600	1400	1200	1200	900

Electrical Installation

This equipment must be installed and controlled in accordance with applicable national and local regulations.

Gland Services

On the hydrostatic gland and also on the packed gland, it is usually necessary to have a clean water flushing supply to the gland.

The pressure should be 3-5 psi (2-4m) water gauge above the pump discharge pressure (remember to include the S.G. of the slurry) and the flow rate should be in accordance with the table below.

Pump	units	1½x1½	2x2	3x3n	4x4	6x5	8x6	10x8	12x10
Water flow.	USgpm	1	1	1	2	2	2	3	4
Water flow.	liter/sec	0.04	0.04	0.05	0.07	0.07	0.09	0.1	0.2

The gland flushing water should be clean. The life of the gland and gland sleeve is significantly affected by the cleanliness of the flushing water. Although a few particles will not do instant damage, the seal life will be reduced. Slurry must not be used.

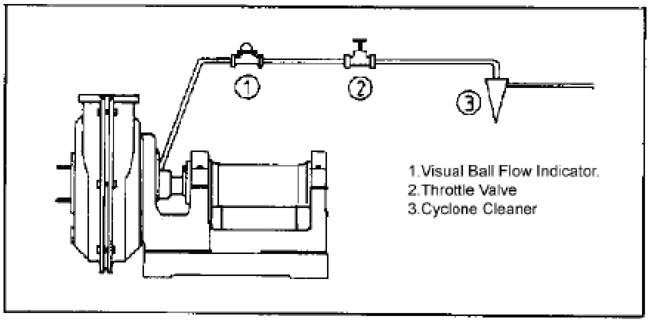
There are many combinations of flow control devices that may be used. A few of these are shown on the diagram below. The objective is to maintain a secure supply of clean flushing water to extend the gland life.

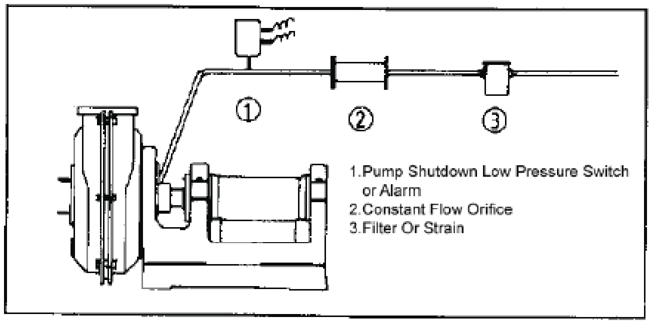
With pumps in series, there are three main ways of supplying gland service water.

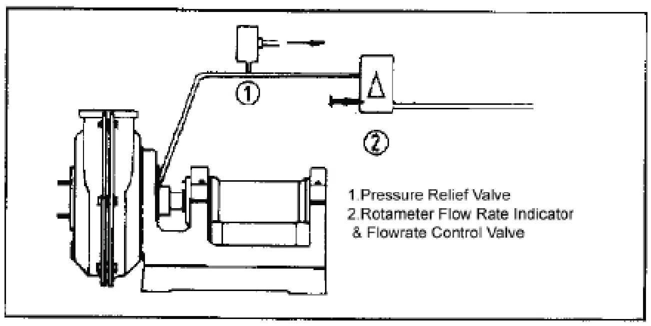
- Individual dedicated pumps at the correct pressure and flow rate.
- One large pump at the highest pressure throttling down the supply to each pump in the series.
- One multi-stage pump tapping off a supply at a different stage to each pump in the series.

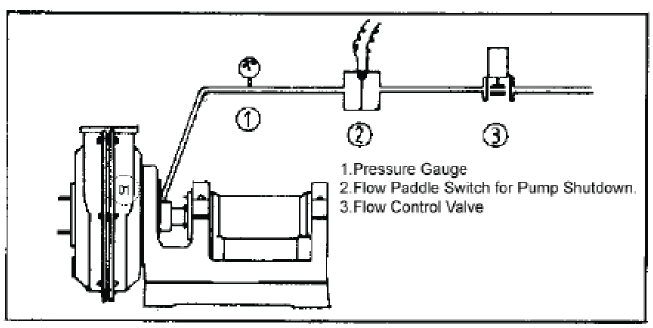
Gland Service Systems

These are a few typical systems. Any selection of items may be combined.









Lubrication and Cooling

Additional grease must only be added about twice per year, as the bearings are already lubricated. **DO NOT over grease the bearings**.

The bearing assemblies are all checked in the factory to prove that they are correctly assembled.

The bearings are designed to run at high temperatures (maximum 120° C) and the grease has to be compatible with this operating condition. Clean grease must be used.

If water gets into the bearings, the assembly must be stripped, thoroughly dried and greased over; then, any seal failure must be corrected.

Recommended greases are Shell Alvania 3, Mobile EP2, Caltex LS3 or their equivalents.

Start-Up Procedure

The recommended procedure to follow is listed below:

- Check the free rotation of the pump
- If required, verify that water for gland services is running
- At first start, or after any work on the electric motor terminal box, check direction of rotation **with drive belts removed**.
- Prime the pump
- Check that all guards are in place and that the pump is safe to run
- Start the pump
- If the pipeline is empty and there is no discharge valve (possibly due to abrasive nature of the product), the pump motor may be bogged down for a period of time and the pump may begin to go through the process of cavitation. This condition should be examined to evaluate the possible long term effect on the equipment.
- Check the pump for noise, vibration or any hot spots.
- **Adjust the gland to maintain a drip**, which is necessary for lubrication and for cooling.

Shutdown Procedure

This depends ultimately on the system and process flow requirements but the following procedure is recommended.

- Stop the flow of solids into the sump.
- Turn the sluicing water or run system on water only to wash out the pump and delivery pipeline.
- Shut down the pump.
- Shut down the gland service water system.

In cold weather, the pump and auxiliary equipment should be drained to prevent freezing damage.

Disassembly Procedure

Check that all power is switched off and isolated and that it is safe, electrically and mechanically, to work the pump. The following sequence is a general guide to stripping the pump for inspection. Refer to Cross Section drawings in Appendix.

On sizes up to the 4x4 (100x100) there is no separate suction bush or liner.

1. Remove the suction pipe and inspect for wear.
2. Check the suction bush liner for wear, noting any uneven wear pattern and position. Check the axial clearance.
3. Between the suction bush liner and the eye of the impeller (or on smaller pumps between the casing liner and eye of the impeller).
4. Remove nuts and suction bush. The suction bush liner is pushed out of the suction bush from the suction side. Some water spread under the lip of the suction bush liner will lubricate its passage out of the suction bush.

5. Remove casing bolts after supporting the suction side casing. Lift off the suction side casing. A crane will be necessary on the larger pumps.
6. The impeller is exposed for inspection. Hold the shaft using a spanner, which is a good fit, on the flats between the gland and the flinger. The impeller is screwed onto the shaft with an Acme right hand thread. The impeller may be very tightly locked onto the shaft and may need an impact force or a long lever to loosen it. If the impeller is to be used again, protect the rubber against damage. Inspect the impeller and note unusual wear patterns in the flow passages and back or front pump out vanes. Check that the "O" ring behind the impeller has sealed against the gland sleeve and slurry has not corroded the impeller or shaft thread. This "O" ring should be replaced at every strip-down.
7. Remove the axial expeller, which is a stretch fit on the gland sleeve. If "D" gland is fitted, the gland sleeve should be removed at this point.
8. Support the gland side casing, undo the casing to pedestal nuts and remove casing half along with the gland assembly. Undo the gland holding screws and remove the gland assembly. Undo liner nuts. The casing liner can now be removed for inspection; be sure to note any unusual wear patterns.
9. Remove bearing pedestal caps and fixings; unfasten the axial positioning jack to enable bearing assembly to be removed.
10. To disassemble the bearing assembly, remove the gland sleeve, flinger and bearing covers. The bearings can be inspected at this stage. If there is no sign of damage, the bearings should not be disturbed and they should merely be washed out with mild solvent oil and re-greased.
11. Press the shaft (with the bearing still fitted) out of the bearing housing. Push the shaft from the impeller side out of the bearing housing. The inner ring of the front bearing will still be attached to the shaft and can be removed later.
12. The remainder of the front bearing can then be withdrawn from housing.
13. Loosen the tab washer, undo the locknut and pull the end bearing off of the shaft.

Notes:

1. The 2x2, 3x3 and 4x4 pumps do not have a loose suction bush liner or suction bush.
2. The 10x8 (250/200) and larger sizes have the inside gland cover, which is held in position by (H14 / P14 / D14). Undo and withdraw the inside gland cover from the impeller side.
3. The Casing Suspension Arm is fitted as a maintenance aid ONLY and as much may be used to support **singularly**, either of the casing halves and its associated liner or the impeller. It must not be used for any other purpose. Suspension arm not fitted to 1.5 x 1.5 and 2x2 (50/50) pump.

Assembly Procedure

Before assembly, ensure all parts are clean and free of old grease and dirt. The new bearings or replacement bearings should be generously filled with grease between the rollers. Check that the Neoprene grease seals are not soft or distorted. Replace if necessary.

1. Clamp the shaft horizontally in a vice. Heat the spherical roller end bearing in an oil bath or induction heater to 240°F (115°C) and fit it to the drive end of the shaft using clean insulated gloves. Ensure the inner ring of the bearing is hard against its seat by tapping it with a brass pin. Fit the tab washer and the lock nut.
2. Fit the inner ring of the front bearing to the impeller end of the shaft. Ensure, by tapping with a brass pin, that it is hard against its seat.
3. Clamp bearing housing securely, grease bearing. Fit shaft and end bearing assembly into housing. Ensure that outer race of bearing is hard against seat.
4. Fit neoprene seal and bearing cover seal to end cover and fix to bearing housing using set screws.

5. Mount bearing housing vertically with front end upwards and wedge shaft so it is central in the housing. Fill front bearing with grease and carefully tap outer ring into bearing housing.
6. Fit neoprene seal and bearing seal cover to front cover and fix to bearing housing using set screws. Fit V-Ring Seal to shaft and place with slight tension against front cover. Fit flinger ring to shaft and locate in position using screw clamp supplied with flinger ring.
7. Set bearing housing assembly into pedestal and loosely assemble bearing pedestal caps with pedestal cap screws; fit axial positioning jack. Rarely, shims are required for shaft alignment; if factory fitted, the thickness of shim required will be stamped on the vertical face of the pedestal adjacent to the pedestal cap stud.
8. If “D” gland is to be fitted – loosely assemble gland components without damaging the wearing face when fitting. Leave the gland sleeve out, as well as “O” rings and face seal. Fit the gland side liner into the gland side casing by securing with liner nuts. Bolt the gland assembly loosely to the casing. Fit the casing and gland assembly to the pedestal using fixings; take care not to damage the wearing face against the shaft on assembly. Fit the “O” rings and face seal to gland sleeve. Slide home onto shaft, through casing and into the gland assembly. Carefully align gland components (specifically check concentricity of gland parts relative to the shaft) and tighten all fixings.
9. If “H” or “P” gland is to be fitted, fit “O” rings to gland sleeve. Slide home onto the shaft. Loosely assemble gland components, slide over shaft and onto the gland sleeve. Fit the gland side liner into the gland side casing securing with liner nuts. Fit the casing to the pedestal using fixings. Carefully align the components of the gland assembly (specifically check concentricity of gland parts relative to the shaft) and fit to the casing. The axial expeller will then have a stretch fit over the gland sleeve.
10. Smear the impeller thread on the shaft with protective long life graphite grease before screwing on the impeller, ensuring that the impeller “O” ring is fitted into the gland sleeve.
11. Fit the suction side liner in the suction side casing using liner nuts.
12. Fit the suction bush liner inside the suction bush before bolting it to the suction side casing using the bolts. NOTE: using soapy water will facilitate the process.
13. Check the concentricity of the fit between suction bush liner and the impeller.
14. Using the axial positioning jack, adjust the impeller toward the suction bush liner, keeping the holding down studs loose. Check the axial clearance between the impeller and the suction bush liner. A steel ring or dummy flange should be bolted to the suction flange to simulate any distortion in the suction bush liner when connected to the suction pipe before the axial clearance is checked. This clearance should be set at approximately 1/8”. Rotate the shaft to ensure effective clearance.
15. Tighten the bearing holding down nuts and the axial positioning jack.

ATTENTION PLANT OPERATORS: HANG THIS NEAR YOUR PUMP

McLanahan Model IIIr Centrifugal Pump
With Type "D" Gland

MOTOR DIRECTION TEST

⚠	*ALWAYS PERFORM THE MOTOR DIRECTION TEST WITH THE V BELTS REMOVED*

Note: The pump ships with the V-belts removed

⚠	*WARNING: RUNNING THE PUMP IN THE WRONG DIRECTION MAY CAUSE THE IMPELLER TO UNSCREW, AND DESTROY THE PUMP.*

A motor direction test should be carried out without the belts installed before running the pump for the first time, or after any work on the motors, switchgear or softstart that may affect the direction of rotation of the motor.

STARTING UP AND RUNNING THE PUMP

⚠	*BEFORE STARTING, ENSURE THAT THIS PUMP IS BEING SUPPLIED WITH GLAND SERVICE WATER. RUNNING THE PUMP WITHOUT GLAND SERVICE WATER WILL DESTROY THE GLAND*

With the pump full of water, and all isolation valves open (if present) start the pump. The pump should immediately start pumping.

BEFORE STARTING THE PUMP FOR THE FIRST TIME

The gland should be pre-set before starting the pump for the first time. To do so:

- Fill the feed sump with water and open the suction isolation valve (if present).
- Evenly adjust the gland Adjusting Nuts (see section 5) so a steady trickle leaks from the gland. Note: On a "P" Gland, tightening the nuts decreases the leak rate.

⚠	*WARNING: THE PUMP MUST NOT BE ALLOWED TO RUN IF IT DOES NOT DISCHARGE*
⚠	*DANGER: RUNNING THE PUMP WITH NO DISCHARGE WILL CAUSE THE LIQUID INSIDE THE PUMP TO HEAT UP. IN EXTREME CASES THIS CAN LEAD TO THE LIQUID BOILING, & THE PUMP CASE MAY EXPLODE*

The outside of the pump may not feel hot, as the rubber lining of the pump acts as thermal insulation. If by accident the pump has run without pumped discharge, it must be stopped immediately and the cause of the problem investigated.

⚠	*DANGER: IF IT IS SUSPECTED THAT THE PUMP HAS OPERATED WITHOUT DISCHARGE, EXTREME CAUTION SHOULD BE USED IN DRAINING THE PUMP – THE LIQUID INSIDE MAY BE DANGEROUSLY HOT AND UNDER PRESSURE*

PRIMING

The McLanahan centrifugal pump is NOT self-priming. For this reason the pump must be installed with a flooded suction, or with the appropriate system for suction lift.

ADJUSTING THE "P" TYPE PACKED GLAND:

Before starting, the gland should have been adjusted so a steady trickle leaks from the gland (see section 2). Check that Gland Service Water is being supplied. See the Manual for details of the flow & pressure requirements.

Final adjustment of the gland should be done with the pump in operation. Tighten the adjusting nuts until the leak reduces to drips. (60 drops /minute maximum, 5 TO 45 drops per minute minimum). Care must be exercised not to tighten too much, which may lead to damage to the seal.

⚠	*WARNING: THE ADJUSTING NUTS SHOULD BE ADJUSTED INCREMENTALY, EVENLY, AND IN TURN, TO ENSURE THAT THE GLAND COMPONENTS STAY PARALLEL. TIGHTENING ONE NUT MORE THAN THE OTHERS MAY CAUSE MISALIGNMENT AND DAMAGE TO THE GLAND*

STOPPING THE PUMP

Before stopping the pump, it is advisable (if possible) to run the pump on clear water before turning it off, to prevent solids from settling out in the pump casing.

LUBRICATION

The Pump comes from the factory fully greased. The Shaft Bearings should be greased with the correct grade of grease every 1000 hours of operation. Inject grease into the grease nipples by six strokes of a regular size (2" diameter body) grease gun.

The recommended grease is "Conoco Tacna HD No. 2" or equivalent grade grease.

MAINTENANCE

Except for attention to the gland while the pump is in operation, there is no daily maintenance required on the pump. It is essential, however, that routine inspections be carried out, with the first such inspection taking place approximately three months from startup. This inspection should provide some idea of the wear rate, which will be a guide for scheduling future inspections and maintenance. For instructions on dismantling and reassembling the pump, see the instruction manual supplied with the pump.

SPARES

Recommended spare parts are listed in the instruction manual. It is recommended that a supply of the wear parts listed be kept in stock so as to minimize down time in the event of failure of the part. (SEE NEXT PAGE)

PUMP BEARING TEMPERATURE

On high speed duties it is to be expected that the bearings will run hotter than on low speed duties. At 150 F (65 C) the assembly will be uncomfortable to the hands for more than a second or two, but this is not unduly hot for the bearing assemblies. The bearings are designed to run at high temperatures, maximum 120° C.

3X3 DRY GLAND, NITRILE PUMP SPARE PARTS LIST

OVERVIEW

McLANAHAN CORPORATION recommends that you keep certain replacement parts at your facility. These parts will be available in the event of a breakdown and will also be available to perform any repairs that must be made as a result of regularly scheduled maintenance checks. **McLANAHAN CORPORATION** stocks a wide variety of commonly used components; however storing these parts at your facility will eliminate the expense of air-freighting critical parts that may be required during a breakdown situation. Refer to the "PARTS LIST AND ASSEMBLY" drawing(s) to assist with parts identification, part numbers and quantities. Contact the Parts Department at **McLANAHAN CORPORATION** for price and availability of all parts for your McLanahan equipment.

Qty	Part Number	Description	Lead Time	
1	09110203321	Dry Gland Repair Kit, Nitrile	Stock	
1	09110003133	Suction Side Liner, Nitrile	Stock	
1	09110003134	Gland Side Liner, Nitrile	Stock	
1	09110003135	Impeller, Nitrile	Stock	
1	09110003116	Bearing Assembly	Stock	
1	09110003225	Bearing Repair Kit	Stock	
1	09110003202	Shaft	Stock	

Appendix - Long Term Storage

General:

The following are recommendations in reference to long term storage of McLanahan Pumps and Drives; McLanahan does not accept liability for components under these conditions. Documentation and photographic evidence is necessary for warranties to apply.

Preventive Maintenance for Stored Rotating Spares

In the absence of data on premature bearing failures and armature/shaft sag and imbalance, we recommend a general procedure as follows:

The motor shaft targets should generally be used on any motor of 50HP or higher. They also should be used on fans and any other large rotating equipment that sits in storage for lengthy periods of time. By rotating these shafts monthly (or more, depending on the floor vibrations), you are preventing armature and shaft sag as well as false brinelling of the bearings into the races.

You may also find some smaller motors that have premature bearing failures after prolonged storage in your facility. If this is the case, the shaft targets should be attached (with double-stick foam tape) and smaller motors must be rotated.

What is False Brinelling?

Whenever a **non-rotating bearing** is subjected to external vibration, **false brinelling** can occur. A protective oil film cannot form between the races and rotating elements when the bearing isn't turning, causing metal-to-metal contact. False brinelling can occur during transportation, typically truck or rail, and during motor storage if the storage area is subject to vibration.

Another type of brinelling, **true brinelling** occurs in **rotating bearings**.

Pump

If stored, the pump should be kept in a clean, dry, vibration-free environment. The shaft should be rotated manually every three (3) months, or at the same interval as recommended by the electric motor manufacturer. In order to care for the natural rubber linings and components, follow the recommendations below.

Electric Motor

The following information is reprinted from the WEG "Installation and Maintenance Manual for NEMA low Voltage Electric Motors"

Storage

Motors should be raised by their eyebolts and never by their shafts. It is important that high rating three phase motors be raised by their eyebolts. Raising and lowering must be steady; otherwise bearings may be harmed. When motors are not immediately installed, they should be stored in their normal upright position in a dry even temperature place, free of dust, gases and corrosive atmosphere. Other objects should not be placed on or against them. Motors stored over long periods are subject to loss of insulation resistance and oxidation of bearings.

Bearings and lubricant deserve special attention during prolonged periods of storage. Depending on the length and conditions of storage it may be necessary to re-grease or change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from between the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact. As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and every 3 month their shafts should be rotated manually.

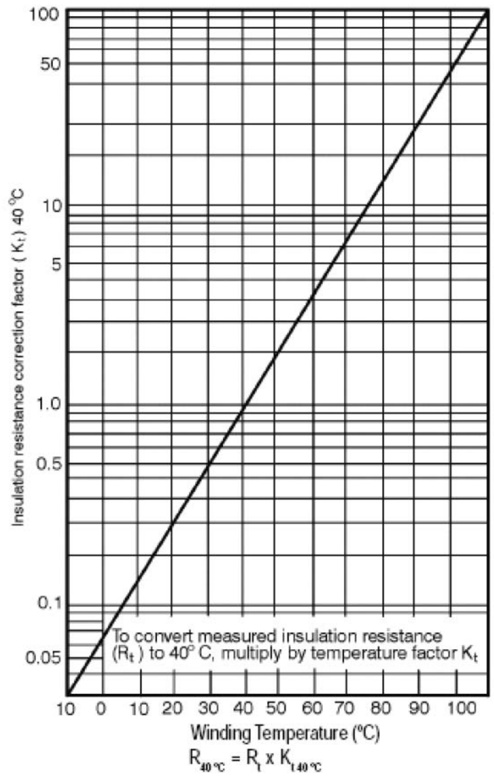
Insulation resistance fluctuates widely with temperature and humidity variations and the cleanliness of components. When a motor is not immediately put into service it should be protected against moist, high temperatures and impurities, thus avoiding damage to insulation resistance. If the motor has been in storage more than six month or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmeter. If the resistance is lower than ten megohms the windings should be dried in one of the two following ways:
1) Bake in oven at temperatures not exceeding 194 degrees F until insulation resistance becomes constant.
2) With rotor locked, apply low voltage and gradually increase current through windings until temperature measured with thermometer reaches 194 degrees F. Do not exceed this temperature. If the motor is stored for an extensive period, the rotor must be periodically rotated. Should the ambient conditions be very humid, a periodical inspection is recommended during storage. It is difficult to prescribe rules for the true insulation resistance value of a machine as resistance varies according to the type, size and rated voltage and the state of the insulation material used, method of construction and the machine's insulation antecedents. A lot of experience is necessary in order to decide when a machine is ready or not to be put into service. Periodical records are useful in making this decision.

The following guidelines show the approximate values that can be expected of a clean and dry motor, at 40°C test voltage in applied during one minute.

Insulation resistance Rm is obtained by the formula: $Rm = Vn + 1$

Where: Rm – minimum recommended insulation resistance in MΩ with winding at 40°C
Vn – rated machine voltage in kV

In case the test is carried out at a temperature other than 40°C, the value must be corrected to 40°C using an approximated curve of insulation resistance vs temperature of the winding (see graph below).



Example:
Ambient temperature = 50°C
Motor winding resistance at 50°C = 1.02 MΩ
Correction to 40°C

R 40°C = R 50°C x K 50°C
R 40º C = 1.02 x 1.3
R 40º C = 1.326 M&
The minimum resistance Rm will be:
Rm = Vn + 1
Rm = 0.440 + 1
Rm = 1.440 MΩ

On new motors, lower values are often attained due to solvents present in the insulating varnishes that later evaporate during normal operation.

This does not necessarily mean that the motor is not operational, since insulating resistance will increase after a period of service. On motors which have been in service for a while, a comparison of the values recorded in previous tests on the same motor under similar load, temperature and humidity conditions, serves as a better indication of insulation condition than that of the value derived from a single test. The cause for any substantial or sudden reduction should be determined, followed by corrective action.

Insulation resistance is usually measured with a **megger**.

In the event that insulation resistance is inferior to the values derived from the above formula, motors should be subjected to a drying process.

Drying the windings

Only qualified personnel should carry out this operation. The temperature should not rise more than 5°C per hour and the overall temperature should not exceed 105°C; if either of these two things occur, vapor which is harmful to the insulation, may be generated.

Temperature should be accurately controlled and insulation resistance should be properly measured at regular intervals during the drying process. During early stages of drying, insulation resistance will decrease as a result of the temperature increasing. However, the resistance will increase again when the insulation dries a little more.

The drying process should be extended until successive measurements of insulation resistance indicate that a constant value above the minimum acceptable value has been attained. It is extremely important that the interior of the motor be well-ventilated during the drying operation to ensure that the dampness is really removed.

Heat for drying can be obtained from outside sources such as an oven or space heater, or by introducing a current through the actual winding of the motor being dried.

Electric machines should be installed in order to allow an easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or contain flammable substances or particles, it is essential to ensure an adequate degree of protection. The installation of motors in environments where there are vapors, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) standards.

Under no circumstances are motors to be enclosed in boxes or covered with materials which may impede or reduce the free circulation of ventilating air. Machines fitted with external ventilation should be at least 50cm from the wall to permit the passage of air. The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes or other objects. The place of installation should allow for renewal at a rate of 700 cubic feet per minute for each 75 HP motor capacity.

Rubber Products

Rubber products in storage can be adversely affected by several factors, including:

- Temperature
- Humidity
- Ozone
- Sunlight
- Oils
- Solvents
- Corrosive liquids and fumes
- Insects and rodents
- Radiation

The warehousing area should be relatively cool, dark and free from dampness and mildew. All rubber products should be used on a first-in, first-out basis since even under these conditions an unusual length of time in storage can result in the deterioration of certain products.

The ideal storage temperature for rubber products is 50 to 70°F (10 to 21°C) with a maximum limit of 100°F (38°C). If stored below 32°F (0°C), some products may become stiff and should be warmed before being placed in service. Rubber products should not be stored near sources of heat, such as radiators and base heaters.

Rubber products **should not** be stored under conditions of high or low humidity.

To protect against the adverse effects of ozone, rubber products should not be stored near electrical equipment that may generate ozone and should not be stored for any lengthy period in geographical areas of known high ozone concentrations. Exposure to direct and reflected sunlight should also be avoided.

Whenever viable, rubber products should be stored in their original shipping containers, especially when such containers are wooden crates or cardboard cartons; this will provide protection against the deteriorating effects of oils, solvents and corrosive liquids, and will also provide some protection against ozone and sunlight.

Certain rodents and insects thrive on rubber products, so the equipment must be protected.

*McLanahan **Pump Applications***

Sand plants
Feeding sand and water to all types of classification and dewatering plants; effluent water transfer duties.

Coal preparation plants
For dense medium circuits, feeding hydrocyclones, filtrate pumping, handling the underflow from thickeners, disposal of effluent, etc.

Chemical manufacturing & Environmental applications
McLanahan pumps, by virtue of their various rubber linings, are suitable for pumping many chemical solutions, acid or alkaline, at moderate temperatures and for the disposal of effluent.

Cement manufacture
Slurry feed to: tube mill circuits, thickener feed and underflow, flotation plant circuits.

Metalliferous mining
Mill circuits, feeding hydrocyclones, cyanide plant filter residues, concentrates, tailings disposal and other pulp and slurry handling duties.

Irrigation systems and dredging
Silt removal in dams and canal sand traps

Paper mills
China clay slurries, paper stock, effluent disposal

Steel works and manufacturing applications
Pickling acid distribution circuits in plate and wire de-scaling plants, abrasive wet scrubber blow-down

Power stations
Boiler house ash disposal, de-scaling plants

China clay production
Feeding slurry to hydrocyclones and for general use in the preparation of china clay

Glass manufacturing
Feeding polishing media, sand plants, handling effluent

Troubleshooting

If a pump fails to pump through a blockage, switch off **immediately**. Take extreme care as the pump may be filled with scorching steam and solids at a high pressure.

Wear and Replacement of Parts

To obtain the best service and performance from the pump, periodic routine inspections should be executed. The rate of wear on pumps is not precisely predictable since it varies from one application to the next, so intervals at which these inspections should be made vary. Initially, the pump should be allowed to run for a period of time (for example, three months); afterward, an examination of the pump will give some idea of the length of life, which may be expected from the rubber-covered parts.

No Discharge When Pump Runs

The pump must not be allowed to run if it does not discharge. If it is noted that the pump has been running without discharge, cease it immediately.

Take extreme care in dismantling after such an occurrence due to high temperature and pressure, which may be present in the pump casing. Do not remove the drain plug until the fluid temperature in the pump has dropped.

Air Lock

Air lock in the casing is the most common cause of failure on a newly installed pump. Even when a pump is well below water level, it may retain a large bubble inside the casing, which prevents the start of pumping. This phenomenon is far more likely with horizontal undershot discharge branch arrangements than any other practical configuration. It is least likely with horizontal overshot arrangements.

If you suspect air lock as the cause of failure to pump, start and stop pump several times to drive the air out, one fraction at a time. When using this procedure, ensure that you do not damage the motor starter or burn out the motor by trying too many starts in a short period of time. The number of permissible attempts will vary with the equipment installed but usually it is safe to try one start every three to four minutes.

Inadequate Prime

Failure to pump may be caused by inadequate priming. This is usually rectified by allowing more time for priming to occur.

It is possible when "jet priming" to have such a small amount of priming water that the pump will never prime; in this case, more water for the priming option will be needed.

Usually, the diameter of the priming branch should be at least one-third of the diameter of the suction pipe. NOTE: 2" (50mm) will prime 6" (150mm), 3" (80mm) will prime 8" (200mm) etc. The minimum water required is about 30% of the pump capacity.

If priming is by vacuum pump, there must be a valve or at least an air-lock on the delivery side. The vacuum pump must be able to "beat" the air leakage throughout the gland. To assist in this, always attempt to prime with the gland water running, no matter what style of priming is being attempted.

Installation Faults

Failure to discharge on start-up can be caused by installation faults. The most common is inadequate sump capacity. The result of installing a sump with inadequate capacity is to risk repeated air-locks of the pump. This can happen when the pump reduces the water level, either allowing a vortex to form, which air-locks the pump, or (when water is introduced to the sump) it entrains so much air that it produces the same effect.

A small sump can easily prevent any discharge reaching the end of the pump discharge line. The only remedy is to extend the sump capacity. We recommend sumps of at least one minute's pumping time as a minimum. NOTE: This recommendation does not apply to feed regulating sumps in sand plants where greater capacity is required.

Other installation faults are more obvious, such as tramp material lodged over a pump suction or a kinked suction hose.

Brief Discharge Only

1. Air Lock

A pump with a suction lift and partial air lock will often start to pump at a greatly reduced rate after each start, and then it will give up completely. At the discharge end of the pipe this may appear as a brief surge followed by failure.

This problem can only be overcome by closer attention to the priming system.

2. Obstructed Suction

If the suction line is obstructed either by tramp material or a delaminated suction hose lining, the pump may start well. However, when the discharge rate rises, the suction obstruction throttles the pump in a way that it quickly fails by gross cavitation.

Detection of this sort of condition is difficult. The only way to guarantee finding out what is actually happening is by using a vacuum gauge immediately before the pump suction. An obstructed suction line will be indicated by a sudden increase in vacuum reading immediately before the failure.

3. Lack of Delivery Resistance

A pump, which is required to pump with a suction or with a fair length of suction pipe, although with practically no resistance on the delivery side, may pump briefly before failing. The reason for this is that centrifugal pumps on open discharge need positive pressure on the suction eye to prevent gross cavitation. If the installation does not provide sufficient positive pressure on the suction side, the pump will fail.

Usually, the easiest way to overcome this difficulty is to artificially create resistance on the delivery side by extending the pipe work or introducing a valve or other resistance, such as an orifice.

Pumps water but not solids

1. Air Leaks on Suction Side

Joints in the suction line or air entrainment with feed into a sump may be insufficient if they are made poorly. Poorly made joints sometimes prevent a pump from pumping water satisfactorily. However, when solids are introduced (particularly coarse solids) the pump has a more arduous duty; it has to entrain the solids into the fast moving stream in the suction pipe. In effect, it has to "dredge" the solids into the stream. Even if the solids were already moving in the right general direction, they must be accelerated up to the water velocity and thus they act as a suction resistance for the pump.

Introducing solids into an aerated system will cause failure. The pump can only handle a small margin of solids when pumping water alone. Air leaks can usually be detected as water leaks when the pump is not running; **where water can get out, air can get in**. Air entrainment with the feed can sometimes be overcome by the use of baffles in the sump. The air bubbles have time to rise to the surface before being drawn down to the suction.

2. Poor Suction Line

Several different factors in the suction line may allow a pump to appear adequate when it is not. A long suction line, a line with a considerably small diameter or a line with a restriction (sudden step-downs in diameter are the worst) will all affect whether or not the pump can handle solids. The reasons for this are explained in the two previous paragraphs.

Reworking the suction line is the only solution to this problem. If the line increased in diameter it should be brought to the pump inlet diameter by a specially rolled flanged taper pipe. It must not be stepped down by a mismatch.

3. Electric Motor Wrongly Wired

Most Squirrel Cage Induction Motors can be wired in two ways: **Star** or **Delta**. In order to reduce the current surge when a motor is brought **on line**, some users start their motors in **Star.** They do this because this mode gives good starting torque and a reduced starting current surge. Then, change to running their motors in **Delta** once smooth starting has been achieved. The **Delta** mode of powering the motor increases the speed close to synchronous speed, which is maximum, and maintains a constant speed under variations in load.

If a motor is left to run continuously in **Star**, it will vary its speed dramatically with load. If a mistake has been made in the wiring of the motor, it may appear that the pump is unable to pick up solids but is still pumping water. The reason would be that on **Star**, the motor speed drops when the solids load comes on.

To detect this fault, the easiest method is to check the speed of the motor shaft and compare it with the Nameplate rating. There should not be more than a few RPM difference between Nameplate RPM rating and actual speed, no matter what load the pump is pulling.

NOTE: Correction of this fault is intended for an electrician.

Overloads for Motor Trip Out

1. Wrong Pump Speed

The power drawn by a centrifugal pump discharging through a given delivery system is approximately proportional to the cube of its speed. As an example, if the speed is changed by 20% to 1.2 times the original speed, you can expect its power demand to rise by the cube of 1.2, i.e. 1.728, or nearly 73% above the original. Even a rise in speed of 10% to 1.1 times the original speed will give a rise of 33% in power demanded by the pump.

The relationship is not exact but it is close enough for field calculation purposes.

If a pump is run at the wrong speed, it can make a considerable difference to the load drawn from the motor.

Calculation of the correct pump speed is based on:

- Flow rate to be pumped
- Difference in height between pump and discharge points
- Length, diameter and inner surface of pipeline through which pump must deliver
- Number of elbows, bends, valves, other fittings in pipeline
- Equipment at end of pipeline such as hydrocyclones, pressurized distributors, jets, etc.
- Grading, tonnage and specific gravity of solids to be pumped
- Pump performance curves

As far as fault finding is concerned, the actual RPM of a pump should be compared with the RPM specified. Corrections to pump speed can be made by pulley changes.

2. Changed Pipeline System

It is not uncommon for a pump speed to be calculated on the basis of a pipeline system intended to be used at the time of the negotiations for the purchase of the pump, but to be commissioned into service with a different pipeline system. A client may say, "but it's not such a high lift so the pump does not have to work quite so hard." **This is not true.** At a given pump speed, a pump will pump a larger amount through a shorter pipeline (or lesser vertical height) and **will take more power**, not less.

When confronted with this situation, the only thing to do is to calculate the correct **head** and RPM before making a pulley change. The affinity rule can be used or the drive can be recalculated.

3. Low Voltage

The power consumed by an electric motor is the product of the voltage, amperage and power factor for the motor. If a pump demands a certain power from the motor, the motor in turn will demand corresponding amperage from the electric supply system. However, if the voltage of the electric supply system happens to be lower than normal, the motor will draw extra amps to meet the pump's power demand. This way the power consumed by the motor, the product of voltage, amperage and power factor remains unchanged.

Circumstances where lower than standard voltages might be encountered include:

- When power supply is from a generator set
- At the end of a long trailing cable
- At the end of an electric supply system remote from the nearest transformer substation
- In an area where very heavy start-up loads can occur, such as near large crusher stations or long conveyor installations

Low voltage can readily cause a motor overload by drawing higher than expected amps; this is, in no way, related to the pump itself.

If low voltage is suspected as the cause of motor overload, a qualified electrician should be called.

4. Wrongly Set Overload Protection

All motor starting equipment has some form of overload protection equipment built into the system so a burnt out motor or locked-rotor motor does not cause more extensive damage. If a motor repeatedly drops out on overload and there is no other readily apparent reason, the electrical overload protection equipment should be checked.

5. Mechanical Fault in Pump

The pump shaft should be free to turn by hand. Remove the V-belts and check the pump shaft for freedom to turn. If there is no resistance, the fault must be in the motor. If a jarring or resistance can be felt when attempting to turn the pump shaft, drop off the suction pipe and check the clearance between the impeller and suction plate. Also check for blockages.

If this proves clear, remove the suction bush and look for marks on the surface of the impeller, which might indicate if the impeller has been rubbing. In this case, rotate the shaft again to determine if the resistance is still present; if it is, remove the impeller and inspect the gland side liner. If there is still no evidence of rubbing, rotate the shaft by hand again to check that the resistance is still present; then, remove the gland sleeve. If the resistance can still be felt by hand it can only be the bearings of the pump.

The remedies for the faults, which may be revealed by this step-by-step approach are:

- Impeller rubs on suction bush: release bearing housing, set impeller to suction bush clearance by adjusting position of bearing housing until impeller runs free. Tighten bearing housing. Replace suction pipe. Re-align belt drive.
- Impeller rubs on gland half lining; reset the suction bush clearance. Check for movement of casing liner.
- Seizure in the gland area. Strip and inspect.
- Shaft tight in bearings; there is no simple field remedy if the pump shaft is found to be tight in the bearings, the rotating assembly must be removed and stripped for inspection of the bearings and grease seals.

6. Air Entrainment

In sump-fed pump systems, air entrainment with the pump feed can produce periodic overloads on the motor by the following sequence of events:

- Air entrainment with feed gives the pump a “spongy” pulp, which reduces the pump throughput and power.
- Flow through the sump is reduced allowing air in the feed now entering the sump to escape to the surface. Solids, of course, reach the pump suction.
- The pump now has a largely de-aired pulp of far greater percentage solids than intended, and the power demand rises. At this stage the pump may choke. This is a dangerous condition.
- Pump entrains the accumulated solids into suction pipeline and begins to pump normally again, increasing throughput through sump.
- Air entrainment begins to reach pump suction again and sequence repeats.
- Air entrainment can permanently reduce slurry throughput and make it appear as if the pump is not working.

In small installations this surge may be repeated at three minute intervals; in large installations, it may take as long as five minutes for the full cycle to complete. If the cycle terminates at stage three, the pump may explode, if it is left to run while blocked.

Pump Handles Only a Limited Percentage Solids

Pump Speed Incorrect

With increasing solids feed into a pumping system three major factors will limit the percentage solids handled:

- Friction resistance increases, leaving less pressure on the delivery side to maintain the velocity in the pipeline
- Critical (settling) velocity for the pulp in the pipeline increases
- Pump performance “drops” so that the total head generated by the pump diminishes

Clearly, if the pump speed has been calculated for water only, increasing tonnages of solids are fed into the system; the combination of factors above may soon produce a situation where the pipeline velocity is too low to maintain movement of the solids.

Air Entrainment

Under 15.3, section 1 above, there is an explanation of how a pump can handle water, but due to the air entrainment, fails when solids are introduced to the system. The same fault can sometimes explain why a pump appears to perform well on pulp up to a certain percentage solids, then “gives up” when this is passed.

Poor Suction Line

A suction line layout as described in 15.3, section 2 is far worse as the percentage solids is increased and can become completely blocked.

Cavitation

If a pump is expected to draw relatively coarse solids from a sump below the pump centerline, depending on the speed of the pump and its capacity in relation to the flow rate being handled, it may suffer from cavitation. When this happens, and the onset is often quite sudden and sharp, the total head generated by the pump diminishes dramatically. As described previously, the conditions for blocking a line are suddenly created; namely reduced delivery pressure for maintaining flow combined with increased requirement for velocity in the pipeline.

Generally, if cavitation is the source of the trouble, there is ample evidence; audible cavitation “rattle” in the pump or from the bearings, sudden reduction in power demand, the gland leaks or draws air and there is a dramatic drop in delivery pressure.

The solution to the problem is to make the suction arrangements as smooth as possible without restrictions as well as to arrange for the feed to come gradually up to load without sudden surges of solids. If these measures do not overcome the problem it may be necessary to change the suction line to a size larger and fit a flat topped taper-piece to the pump suction. If trouble persists, a larger pump will have to be installed. Something effective must be done as the situation is potentially dangerous.

Gland Will Not Seal Adequately

1. Poor Adjustment

The outer seal of a Hydrostatic gland assembly must be allowed to rub lightly on the gland sleeve for an effective seal to be maintained. If the gland adjuster is pushed in too far this will lift the seal off the sleeve and the gland will leak profusely. When seeing a leaking gland, most people immediately think to tighten it. With the Hydrostatic gland, the **gland adjuster must be moved outward to reduce leakage.**

Type D and P glands should be tightened for reduction of leakage in the same way as standard packed glands in water pumps. **Over tightening should be avoided**, especially on "D" glands as a drip is always necessary to lubricate the rubber face seal.

2. Dry Running

The glands will not be damaged by a few seconds of running without lubrication and cooling by water, but if either gland runs for a length of time without water in the pump, there is danger of melting the rubber seals. If a Type D gland has been correctly adjusted, this is a fairly remote danger because without hydraulic pressure to force the rubber seal against the gland seat, the seal should run without touching the seat. However, do not run a pump in dry conditions because of the danger of damaging the gland seals.

Once seals have been damaged in this way, they must be replaced.

3. Too Much Sealing Pressure

Too much water pressure in either type of gland can make the glands almost impossible to seal reliably. With Hydrostatic glands the solution to the problem is to insert a pressure control in the gland water line. With Type D glands the problem usually only arises with pumps being run in a series or as booster pumps. In either case, the only solution is to convert the pump over to H gland or P gland and provide suitably pressured gland water.

4. Inadequate Prime

The "snore" condition for operating a pump is very difficult to seal without unacceptable leakage. Under this condition a pump continuously receives a good proportion of air drawn in with the pulp from the sump, in which the level is too low, or the sump has inadequate capacity, or both. The sump should contain a minimum of one minute's pumping time.

Excessive Heat in Drive

1. Slack V-belts

The most common cause for generation of heat in the drive to a newly installed pump is undoubtedly lack of tension in the V-belts. All V-belts should be tensioned periodically and newly commissioned drives should be re-tensioned an hour or so after start up.

This fault is easily detected (pulleys are the hottest part of the drive) as the belts will have been slipping.

2. Hot pump Bearings

On high speed duties it is to be expected that the bearings will run hotter than on low speed duties. Providing the shaft is free spinning by hand, the heat generated while running under power is probably immaterial. At 150°F (65°C) the assembly will be uncomfortable to the hands for more than a second or two; this is not unduly hot for the bearing assembles. If the bearing is failing, the shaft will not run free.

3. Inadequate Lubrication of Pump Bearings

The bearings will be charged with grease before dispatch from the factory. Details of lubricants are given in this Manual.

Addition of grease should be tried if bearings become very hot or noisy. Excess greasing should be avoided.

4. **Motor Runs Hot**

Motors are intended to run hot. With Continuous Maximum Rated Motors, the temperature rises are surprising and are allowed for in the design of the motor and the selection of the insulation.

Generally, heat from a motor can be safely ignored, provided the amperage drawn is lower or equal to the nameplate rating. Many motors are fitted with Thermistors in the windings, which sense the temperature rise and are wired to operate a cut-out relay if the temperature exceeds a safe limit.

If a pump is choked when the motor starts, the protection must trip out the supply to the motor.

Bearing troubles in motors are generally indicated b noise as well as heat and can sometimes be detected by use of a long-stemmed screwdriver. The blade of the screwdriver is pushed against the bearing cover and the ear of the investigator pushed up to the handle. With a limited amount of experience bearing “rumble” can quite easily be detected.

Sudden Reduction in Discharge

1. **Change in Feed Conditions**

Operators do not always recognize a pump as simply one element in a complete system and any change in that system will bear on all the parts of it. For instance, if a screen rejecting plus ¼” (6 mm) material is worn and passes 1” (25 mm) stones, this affects the pump performance. The suction resistance of the larger stones will cause the suction pressure to reduce and have less head available for pushing the pulp through the delivery side piping.

At the pump, the larger stones will make a significant difference to the pump performance, decreasing flow and potentially causing damage to Impeller and Linings.

In the pipeline, the large stones will probably progress by “saltation,” that is, leaping along the bottom of the pipe. The rest of the pulp is fully in suspension and has to flow past these slow moving obstacles. Overall this means the resistance of the pipeline to flow has increased, thus, again reducing flow.

A simple fault such as a screen cloth with a hole in it can cause a sudden reduction in discharge. If it causes the pipeline to block, the condition is potentially dangerous.

Other changes in feed conditions, which must be investigated are: increased tonnage of solids, change of grading of solids and change in manner of introduction of solids to pump system. On this last count, a plant, which was started in summer, and is bin-fed via a vibrating feeder, will perform differently in winter when the wetter feed “hangs up” in the feed bin and collapses down onto the feeder intermittently in larger dollops.

2. Air leaks on the Suction Pipe

A pipe, which has been steadily wearing away from the inside may break through to the open air near a flange (in a welded area) at the bottom of the pipe, which is where the coarsest solids run. In a suction pipe this will almost certainly allow air into the pipe with all the resultant ills described elsewhere.

Frequently, a pinhole leak will not allow enough air into a pump for any of the five faults listed to become critical. Operators, being human, postpone the repair or replacement of the worn pipe. The last chapter of the saga occurs surprisingly quickly and usually on nightshift – when fault produces a blocked pipeline.

3. Suction Blockage

In dredging applications there is always the danger that the pump suction will be suddenly submerged in collapsed solids from the surrounding pit contours. When pumping from a sump, the same thing can happen when solids, which have been clinging precariously to the steel sides of the sump, subside and momentarily block the pump suction.

If the pump is feeding a fair length of delivery piping, it will not be possible for the long column of pulp in that piping to come instantly to rest when the suction gets blocked. The pulp in an 8" (200mm) pipe, 1000 ft (300 m) long, moving at 10ft/sec (3 m/sec) has considerable momentum. It cannot be stopped dead in the same short length of time it takes to block the suction.

The result is a massive reduction in pressure throughout the system. It can cause a massive "water hammer" and surges that can split the pump casing, valves and piping. This can cause hoses to collapse – delivery as well as suction – and almost invariably leads to a great gulp of air being sucked through the pump gland. Usually this is sufficient to air-lock the pump.

When an operator hears the air hiss into the gland and then has to contend with the resultant air-lock, the assumption is that the gland is at fault for pump failure. However, the trouble generally begins at the end of the suction pipe and the gland collapses afterward.

In dredging applications, better control should be taken over the pit development. In sump-fed systems, the feed pulp can sometimes be directed to flush away any build-up of solids on the sides or valleys of the sump.

If this is not possible, a larger capacity take-off box at the base of the sump must improve the situation. The blocked pipeline situation is potentially dangerous.

4. Tramp Material

The simplest explanations of a fault should never be overlooked. If the complaint is sudden reduction in discharge, drain the sump and before removing any pipe work or dismantling the pump in any way, examine the take-off box at the base of the sump.

Sudden Increases in Power Demand

5. Damage Inside Pump

Pumps wear with each use. Results of abrasion, which will give an increase in power demand, are shown below in order of occurrence frequency.

- Excessive gap between impeller and suction bush
- Cut or ripped rubber in suction bush or casing gland rubbing against impeller
- Worn out cutwater
- Worn out or broken casing liners
- Impeller worn through back shroud
- Impeller passages worn significantly wider than intended

6. Change in Pipeline System
DO NOT alter pipeline system by shortening or changing layout. If altered, it will pump larger amounts and take more power.

7. Low Voltage
A new installation near the pump site can make a significant difference in the amount of voltage available, depending on the electric distribution system in the area. Lower volts means higher current for the same power output of the motor.

8. Changed Pump Speed
When dismounting both pump and motor pulleys, electricians have, in the past, interchanged the pulleys when reassembling the pump set. Ensure this does not happen.

9. Air Entrainment
In sump-fed pump systems, air entrainment can produce cyclic pump overload, caused by a change to the amount or direction in which a sump is fed. It could also be caused by a casual change to the feed type baffle arrangement in the sump.

Rapid Component Wear

1. Air Entrainment
As an experiment, place some sand in an empty bottle, fill the bottle to the very top with water, place the palm of one hand over the top and shake the bottle. You will find it difficult to move the sand vigorously against your hand. Now tip out a third of the water, and repeat the test. You will undoubtedly feel the sand in the air-water froth hitting your palm.

The point of the experiment is to show how much more readily sand can move around in froth than it can in water without air bubbles. Therefore any air leaks in the suction side accelerate abrasion.

If air entrainment is severe enough to produce an air lock in the presence of solids and water, the result is an escalation of the abrasion rate.

Air entrainment can also cause severe abrasion indirectly. With cyclic changes in pulp density due to air, the pump may have to handle far denser pulp than intended. This is also an abrasive accelerator.

2. Properties of the Solids
When confronted with a rapid abrasion problem such as coarse or sharp-edged particles, always reduce pump speed if possible. A larger pump with a larger diameter impeller will be rotating slower at the suction eye of the impeller for a given head than a smaller pump would. So, if wear on the leading edge of the vanes occurs, a larger pump would help.

3. Change in Feed Conditions
A change in feed conditions, such as extra tonnage, coarser grading or higher proportion of crushed material will all affect the rate of wear on a pump. As an example, deposits from a river are notoriously variable; the proportion of crushed sand in relation to natural sand can vary widely. However, to the operator, sand is sand, and the fact that the pump is now handling, say 80% crushed material, while three months ago it was 60% natural sand may not appear significant.

If there is a permanent change in feed conditions, which makes component life unsatisfactory, consider modifying the pump. A two-stage pump set will allow each pump to run at about 70% of the speed that a single unit would run, which would make a significant change to the abrasion rate.

4. Shaft Misalignment

After several years of wear and tear, the saddles on the pedestal occasionally wear out, thus allowing the shaft to point downward. If the eccentricity of the shaft through the gland is severe enough, the gland will not seal properly. There will also be a misalignment between the eye of the impeller and the suction bush, which will detract from pump performance. In this case, the most effective solution, reducing cost and saving time, would be to purchase a new pedestal. Temporarily, the saddles may be packed with shims; however, these inevitably get lost during impeller adjustment.

Mechanical Failure

1. Broken Shaft

Typically, the only broken shafts on McLanahan pumps are those where there has been tramp material in the feed, a bearing has seized, or slurry has worn through the gland sleeve. In this case, wear will of course weaken the shaft.

2. Broken Pedestal or Casing

Although the front bracket of the pump pedestal appears massive, it can be broken down from the box section of the pedestal by simply starting the pump backwards. As a result, the impeller will begin to unscrew from the shaft, and while in motion, strikes the suction bush, which is fixed in place by the flange of the suction pipe work. Because something has to give, occasionally, with older shafts, the thread in the shaft is stripped instead of the pedestal being broken.

Realigning broken pedestals can be quite difficult; therefore, the quickest, most cost-effective way to fix a broken pedestal is merely to replace it.

A pump running backwards is an electrical problem, which is overcome quite easily, and should not happen to begin with. Electricians are required to check the direction of rotation of a motor prior to fitting the V-belts onto the pulleys.

3. Pump Explodes

The centrifugal pump (McLanahan or any other) can potentially explode by running with pulp or water in the casing when there is no discharge. This can happen in a pump that is drawing pulp from a sump and pumping it to a cyclone through a rising pipeline. If the pump receives a sudden surge of solids, which blocks off the suction, flow will cease. In the delivery line, the solids will settle in the rising pipe but will be unable to enter the casing because the impeller will still be spinning.

As the impeller rotates, the pump will continue absorbing power. The power raises the fluid temperature. The water will eventually boil and the pressure may be enough to destroy the rubber or cause the pump head to explode. **If a pump head feels unusually warm and is not discharging**, switch the power off immediately. **Do not approach the pump** until it has been relieved of pressure, preferably through the suction or discharge pipework by flushing away the solids plugs. A sign that a pump may explode will be a considerable amount of steam leaking from the gland.

NOTE: at this point, even if a pump does not feel hot, be extremely cautious when dismantling, as the pump may be full of scalding water. Do not remove the drain plug until certain the fluid temperature in the pump has reduced. If in doubt, carefully clear blockages in the manner described above.

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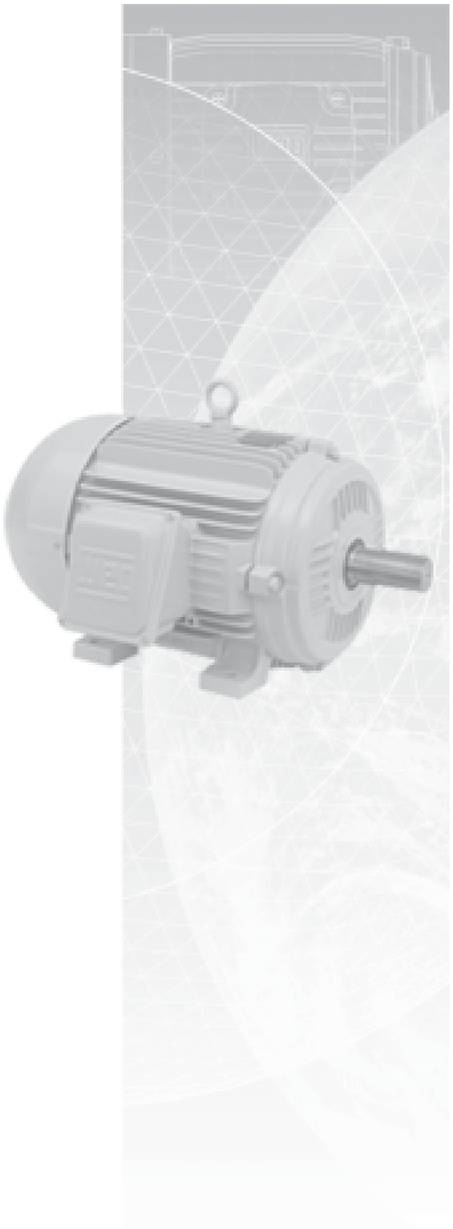
INSTALLATION AND MAINTENANCE MANUAL FOR NEMA LOW VOLTAGE ELECTRIC MOTORS

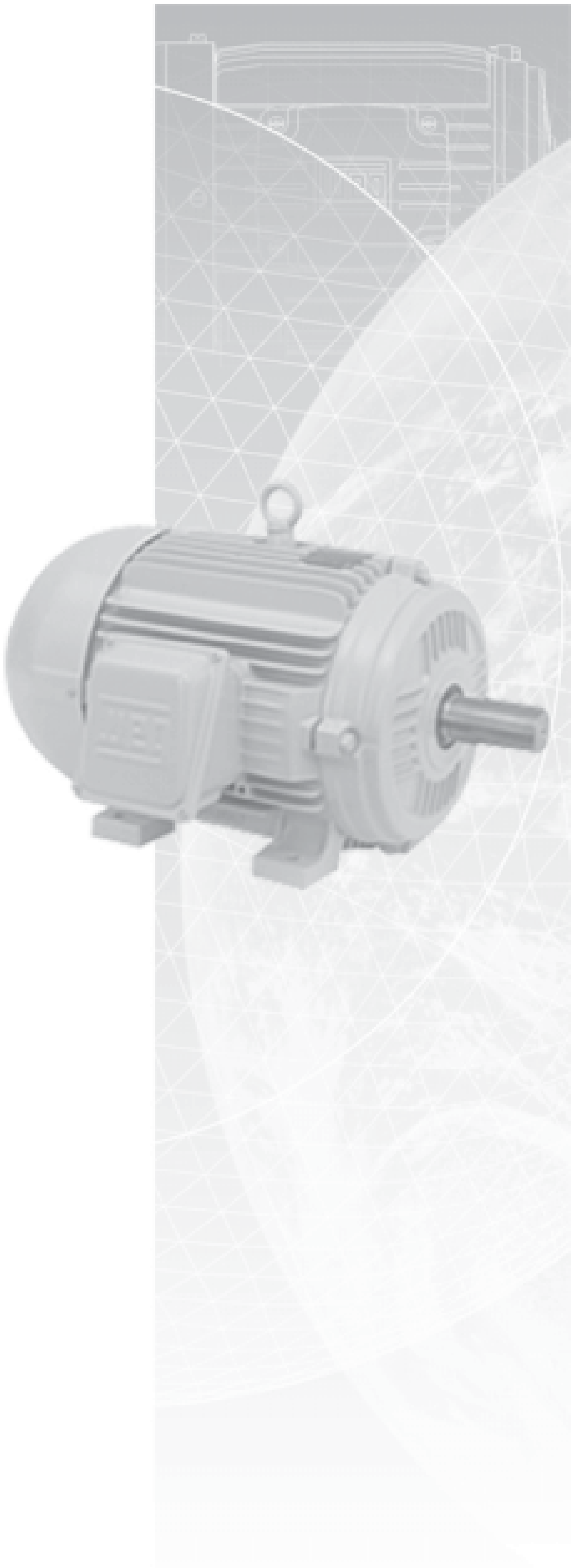


The electric motor is the item of equipment most widely used by man in his pursuit of progress, as virtually all machines and many renowned inventions depend upon it.
By virtue of the prominent role the electric motor plays in the comfort and welfare of mankind, it must be regarded and treated as a prime power unit embodying features that merit special attention, including its installation and maintenance.
This means that the electric motor should receive proper attention.
Its installation and routine maintenance require specific care to ensure perfect operation and longer life of the unit.
THE WEG ELECTRIC MOTOR INSTALLATION AND MAINTENANCE MANUAL provides the necessary information to properly install, maintain and preserve the most important component of all equipment:

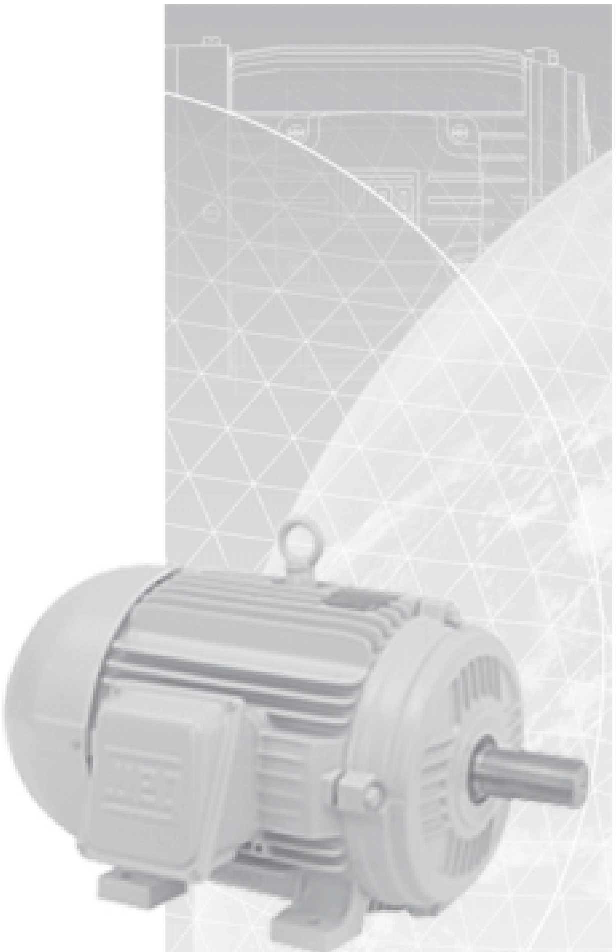
THE ELECTRIC MOTOR!

WEG

Contents



1. Introduction



This manual covers all the three-phase and single-phase asynchronous squirrel-cage induction motors, from 140T to 580T frame sizes.

The motors described in this manual are subject to continuous improvement and all information is subject to change without notice.
For further details, please consult WEG.

2. Basic Instructions

2.1 Safety Instructions

All personnel involved with electrical installations, either handling, lifting, operation and maintenance, should be well-informed and up-to-date concerning the safety standards and principles that govern the work and carefully follow them.
Before work commences, it is the responsibility of the person in charge to ascertain that these have been duly complied with and to alert his personnel of the inherent hazards of the job in hand.
It is recommended that these tasks be undertaken only by qualified personnel and they should be instructed to:

- avoid contact with energized circuits or rotating parts,
- avoid by-passing or rendering inoperative any safeguards or protective devices,
- avoid extended exposure in close proximity to machinery with high noise levels,
- use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment, and
- follow consistently any instructions and product documentation supplied when they do such work.

Before initiating maintenance procedures, be sure that all power sources are disconnected from the motor and accessories to avoid electric shock.
Fire fighting equipment and notices concerning first aid should not be lacking at the job site; these should be visible and accessible at all times.

2.2 Delivery

Prior to shipment, motors are factory-tested and balanced. They are packed in boxes or bolted to a wooden base.
Upon receipt, we recommend careful handling and a physical examination for damage which may have occurred during transportation.
In the event of damage and in order to guaranty insurance coverage, both the nearest WEG sales office and the carrier should be notified without delay.

2.3 Storage

Motors should be raised by their eyebolts and never by their shafts. It is important that high rating three-phase motors be raised by their eyebolts. Raising and lowering must be steady and joltless, otherwise bearings may be harmed.
When motors are not immediately installed, they should be stored in their normal upright position in a dry even temperature place, free of dust, gases and corrosive atmosphere.
Other objects should not be placed on or against them.
Motors stored over long periods are subject to loss of insulation resistance and oxidation of bearings.

Bearings and lubricant deserve special attention during prolonged periods of storage. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from between the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact.
As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and every 3 month their shafts should be rotated manually.

Insulation resistance fluctuates widely with temperature and humidity variations and the cleanliness of components. When a motor is not immediately put into service it should be protected against moist, high temperatures and impurities, thus avoiding damage to insulation resistance.
If the motor has been in storage more than six month or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmeter.
If the resistance is lower than ten megohms the windings should be dried in one of the two following ways:

1) Bake in oven at temperatures not exceeding 194 degrees F until insulation resistance becomes constant.
2) With rotor locked, apply low voltage and gradually increase current through windings until temperature measured with thermometer reaches 194 degrees F. Do not exceed this temperature.

If the motor is stored for an extensive period, the rotor must be periodically rotated.
Should the ambient conditions be very humid, a periodical inspection is recommended during storage. It is difficult to prescribe rules for the true insulation resistance value of a machine as resistance varies according to the type, size and rated voltage and the state of the insulation material used, method of construction and the machine's insulation antecedents. A lot of experience is necessary in order to decide when a machine is ready or not to be put into service. Periodical records are useful in making this decision.

The following guidelines show the approximate values that can be expected of a clean and dry motor, at 40°C test voltage in applied during one minute.

Insulation resistance Rm is obtained by the formula:

$$\boxed{Rm = Vn + 1}$$

Where: Rm - minimum recommended insulation resistance in MΩ with winding at 40°C
Vn - rated machine voltage in kV

In case the test is carried out at a temperature other than 40°C, the value must be corrected to 40°C using an approximated curve of insulation resistance v.s temperature of the winding with the aid of Figure 2.1; it's possible verify that resistance practically doubles every 10°C that insulating temperature is lowered.

Example:

Ambient temperature = 50°C
Motor winding resistence at 50°C = 1.02 MΩ
Correction to 40°C

$R_{40°C} = R_{50°C} \times K_{50°C}$

$R_{40º C} = 1.02 \times 1.3$

$R_{40º C} = 1.326\ M\Omega$

The minimum resistence Rm will be:

Rm = Vn + 1
Rm = 0.440 + 1
Rm = 1.440 MΩ

On new motors, lower values are often attained due to solvents present in the insulating varnishes that later evaporate during normal operation. This does not necessarily mean that the motor is not operational, since insulating resistance will increase after a period of service.
On motors which have been in service for a period of time much larger values are often attained. A comparison of the values recorded in previous tests on the same motor under similar load, temperature and humidity conditions, serves as a better indication of insulation condition than that of the value derived from a single test. Any substantial or sudden reduction is suspect and the cause determined and corrective action taken.
Insulation resistance is usually measured with a MEGGER.
In the event that insulation resistance is inferior to the values derived from the above formula, motors should be subjected to a drying process.

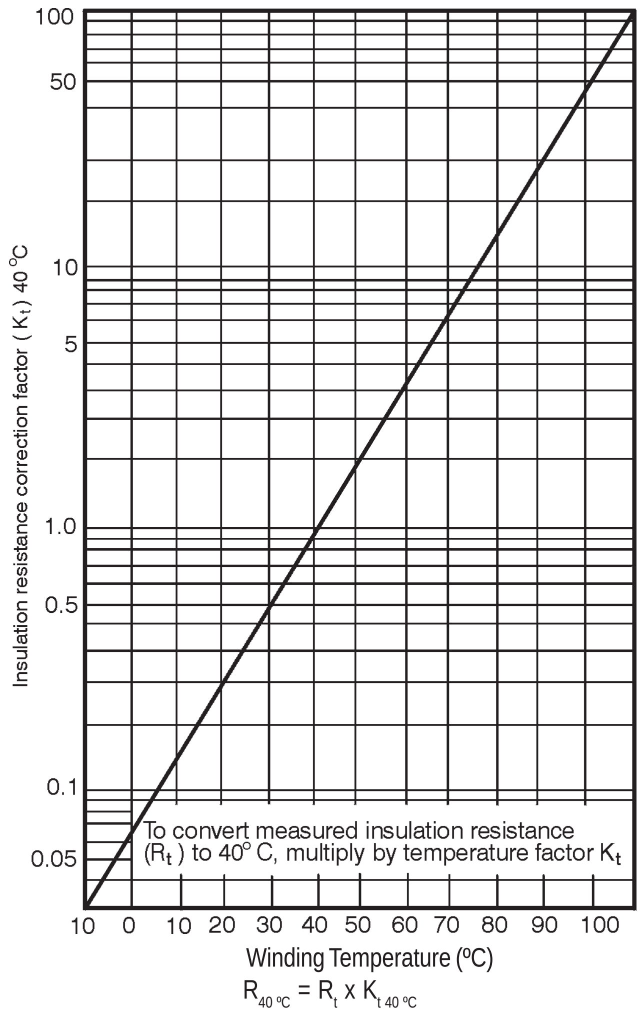


Figure 2.1

2.3.1 Drying the windings

This operation should be carried out with maximum care, and only by qualified personnel. The rate of temperature rise should not exceed 5°C per hour and the temperature of the winding should not exceed 105°C. An overly high final temperature as well as a fast temperature increase rate can each generate vapour harmful to the insulation.
Temperature should be accurately controlled during the drying process and the insulation resistance measured at regular intervals.
During the early stages of the drying process, insulation resistance will decrease as a result of the temperature increase, but the resistance will increase again when the insulation becomes dryer.
The drying process should be extended until sucessive measurements of insulation resistance indicate that a constant value above the minimum acceptable value has been attained. It is extremely important that the interior of the motor be well ventilated during the drying operation to ensure that the dampness is really removed.
Heat for drying can be obtained from outside sources (an oven), energization of the space heater (optional), or introducing a current through the actual winding of the motor being dried.

3. Installation

Electric machines should be installed in order to allow an easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or contain flammable substances or particles, it is essential to ensure an adequate degree of protection.
The installation of motors in environments where there are vapours, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) Standards.
Under no circumstances can motors be enclosed in boxes or covered with materials which may impede or reduce the free circulation of ventilating air. Machines fitted with external ventilation should be at least 50cm from the wall to permit the passage of air.
The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes or other objects.
The place of installation should allow for air renewal at a rate of 700 cubic feet per minute for each 75 HP motor capacity.

3.1 Mechanical Aspects

3.1.1 Foundation

The motor base must be levelled and as far as possible free of vibrations. A concrete foundation is recommended for motors over 100 HP. The choice of base will depend upon the nature of the soil at the place of erection or of the floor capacity in the case of buildings.
When dimensioning the motor base, keep in mind that the motor may occasionally be run at a torque above that of the rated full load torque.
Based upon Figure 3.1, foundation stresses can be calculated by using the following formula:

$$F1 = 0.2247\ (0.009 \times g \times G - 213\ \text{Tmáx}/A)$$

$$F2 = 0.2247\ (0.009 \times g \times G + 213\ \text{Tmax}/A)$$

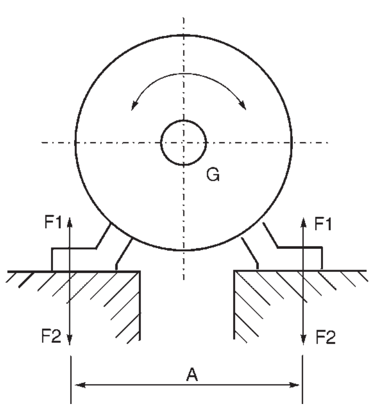


Figure 3.1 - Base stresses

Where:

F1 and F2 - Lateral stress (Lb)
g - Force of gravity (32.18 ft/s^2)
G - Weight of motor (Lb)
Tmax - Maximum torque (Lb . Ft)
A - Obtained from the dimensional drawing of the motor (in)

Sunken bolts or metallic base plates should be used to secure the motor to the base.

3.1.2 Types of Bases

a) Slide Rails

When motor drive is by pulleys the motor should be mounted on slide rails and the lower part of the belt should be pulling.
The rail nearest the drive pulley is positioned in such a manner that the adjusting bolt be between the motor and the driven machine.
The other rail should be positioned with the bolt in the opposite position, as shown in Figure 3.2.
The motor is bolted to the rails and set on the base. The drive pulley is aligned such that its center is on a plane with the center of the driven pulley and the motor shaft and that of the machine be parallel.

The belt should not be overly stretched, see Figure 3.11.
After the alignment, the rails are fixed.

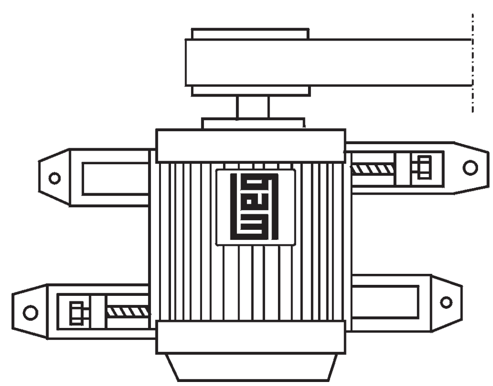


Figure 3.2 - Positioning of slide rails for motor alignment

b) Foundation Studs

Very often, particularly when drive is by flexible coupling the motor is anchored directly to the base with foundation studs.
It is recommended that shim plates of approximately 0.8 inches be used between the foundation studs and the feet of the motor for replacement purposes. These shim plates are useful when exchanging one motor for another of larger shaft height due to variations allowed by standard tolerances.
Foundation studs should neither be painted nor rusted as both interfere with to the adherence of the concrete, and bring about loosening.
After accurate alignment and levelling of the motor, the foundation studs are cemented and their screws tightened to secure the motor.

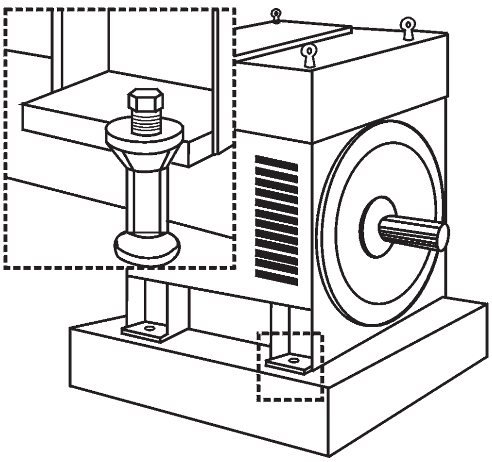


Figure 3.3 - Motor mounted on a concrete base with foundation studs

3.1.3 Alignment

The electric motor should be accurately aligned with the driven machine, particularly in cases of direct coupling. An incorrect alignment can cause bearing failure vibrations and even shaft rupture.
The best way to ensure correct alignment is to use dial gauges placed on each coupling half, one reading radially and the other exially - Figure 3.5.

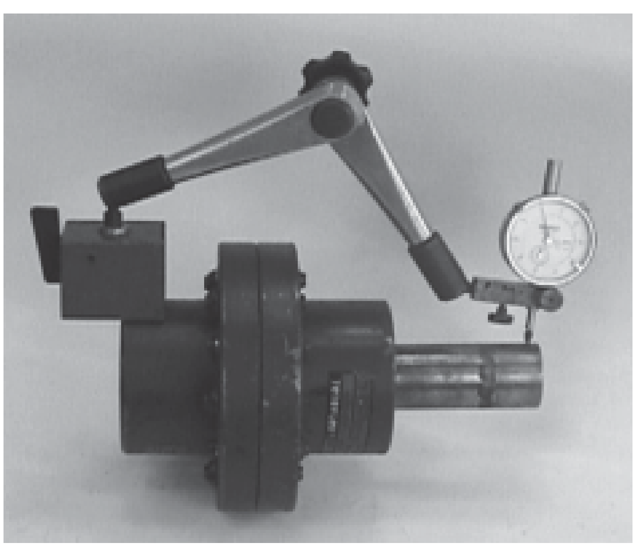


Figure 3.5 - Alignment with dial gauges

Thus, simultaneous readings are possible and allow for checking for any parallel (Figure 3.6a) and concentricity deviations (Figure 3.6b) by rotating the shafts one turn.
Gauge readings should not exceed 0.02 inches. If the installer is sufficiently skilled, he can obtain alignment with feeler gauges and a steel ruler, providing that the couplings are perfect and centered - Figure 3.6c.

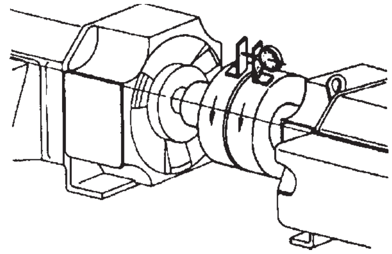


Figure 3.6a - Deviation from parallel

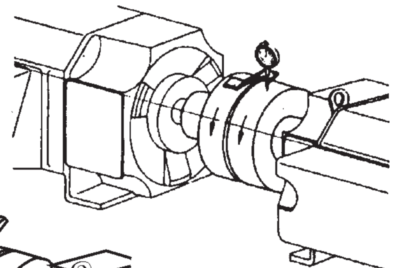


Figure 3.6b - Deviation from concentricity

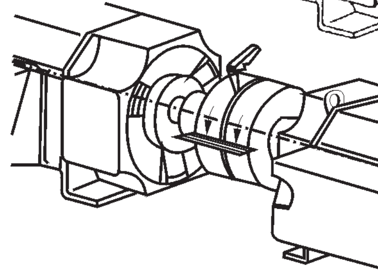


Figure 3.6c - Alignment with a steel ruler

3.1.4 Coupling

a) Direct Coupling

Direct coupling is always preferable due to its lower cost, space economy, no belt slippage and lower accident risk.
In the case of speed ratio drives, it is also common to use a direct coupling with a reducer (gear box).

CAUTION: Carefully align the shaft ends using, whenever feasible, a flexible coupling.

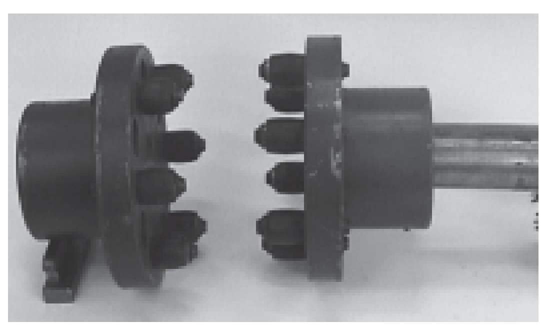


Figure 3.7 - A type of direct coupling

b) Gear Coupling

Poorly aligned gear couplings are the cause of jerking motions which bring about the vibration of the actual drive and vibrations within the motor.

Therefore, due care must be given to perfect shaft alignment: exactly parallel in the case of straight gears, and at the correct angle for bevel or helical gears.
Perfect gear engagement can be checked by the insertion of a strip of paper on which the teeth marks will be traced after a single rotation.

c) Belt and Pulley Coupling

Belt coupling is most commonly used when a speed ratio is required.
Assembly of Pulleys: To assemble pulleys on shaft ends with a keyway and threaded end holes the pulley should be inserted halfway up the keyway merely by manual pressure.
On shafts without threaded end holes the heating of the pulley to about 80°C is recommended, or alternatively, the devices illustrated in Figure 3.8 may be employed.

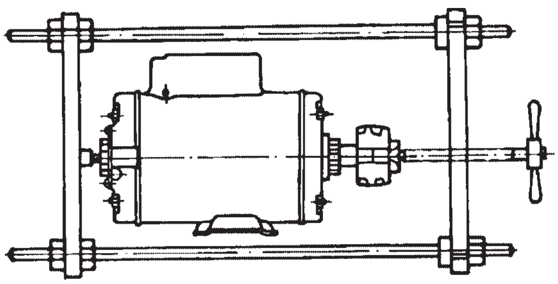


Figure 3.8 - Pulley mounting device

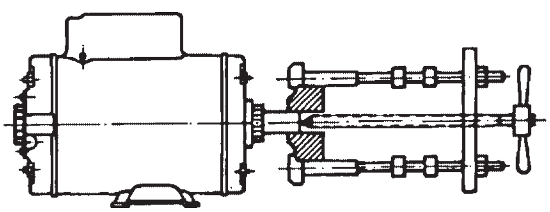


Figure 3.8a - Pulley extractor

Hammers should be avoided during the fitting of pulleys and bearings. The fitting of bearings with the aid of hammers leaves blemishes on the bearing races. These initially small flaws increase with usage and can develop to a stage that completely impairs the bearing.
The correct positioning of a pulley is shown in Figure 3.9.

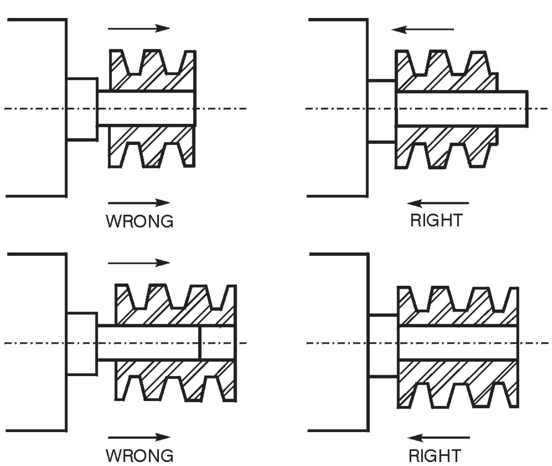


Figure 3.9 - Correct positioning of pulley on the shaft

RUNNING: To avoid needless radial stresses on the bearings it is imperative that shafts are parallel and the pulleys perfectly aligned. (Figure 3.10).

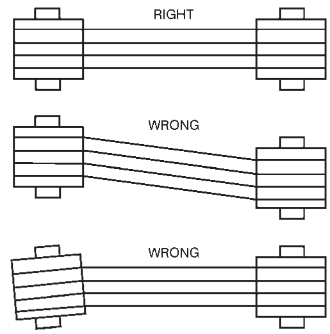


Figure 3.10 - Correct pulley alignment

Laterally misaligned pulleys, when running, transmit alternating knocks to the rotor and can damage the bearing housing. Belt slippage can be avoided by applying a resin (rosin for example).
Belt tension should be sufficient to avoid slippage during operation (Figure 3.11).
Pulleys that are too small should be avoided; these cause shaft flexion because belt traction increases in proportion to a decrease in the pulley size. Table 1 determines minimum pulley diameters, and Tables 2 and 3 refer to the maximum stresses acceptable on motor bearings up to frame 580. Beyond frame size 600, an analysis should be requested from the WEG engineering.

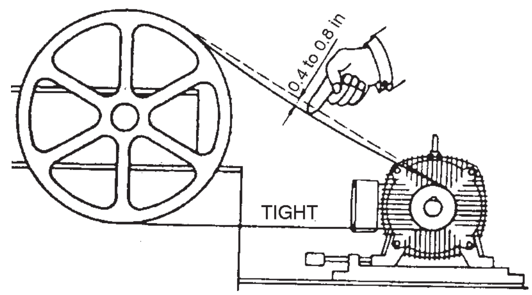
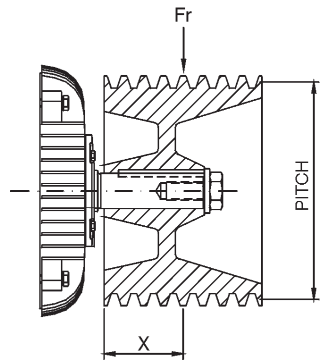


Figure 3.11 - Belt tensions

***Table 1** - Minimum pitch diameter of pulleys*

Frame	Ball bearings						
	Bearing	Size X Inches					
		0.79	1.57	2.36	3.15	3.94	4.72
140	6205-Z	1.7	1.85	2			
W 180	6206-Z	3.03	3.23	3.46			
180	6307-Z	1.69	1.81	1.93			
W 210	6308-Z		2.86	3.00	3.16		
210	6308-Z		2.90	3.06	3.22		
W 250	6309 C3		4.37	4.54	4.72	4.92	
250	6309 C3		4.41	4.59	4.77	4.97	
280	6311 C3			5.08	5.19	5.47	5.65
320	6312 C3			7.44	7.76	7.94	8.18
360	6314 C3			8.73	9.00	9.28	9.57



Frame	Poles	Ball Bearing					Roller Bearing						
		Bearing	Size X Inches				Bearing	Size X Inches					
			1.97	3.15	4.33	5.51		1.97	3.15	4.33	5.51	6.69	8.27
400	II	6314 C3	7.3	7.62	7.94	8.24		-	-	-	-	-	-
	IV-VI-VII	6314 C3					NU 316	4.13	4.31	4.49	4.67	4.85	-
440	II	6314 C3	11.75	12.16	12.61	13.08		-	-	-	-	-	-
	IV-VI-VIII	6319 C3					NU 319	4.02	4.17	4.32	4.47	4.62	4.82
500	II	6314 C3	23.54	24.34	25.12	25.87		-	-	-	-	-	-
	IV-VI-VIII	6319 C3					NU 319	6.52	6.73	6.95	7.17	7.39	7.67
5008	II	6314 C3	44.66	45.79	46.98	48.23		-	-	-	-	-	-
	IV-VI-VIII	6322 C3					NU 322	8.73	8.95	9.96	11.34	12.87	14.82
580	II	6314 C3	57	58	59	60		-	-	-	-	-	-
	IV-VI-VIII	6322 C3					NU 322	10.72	10.91	11.11	11.31	11.50	11.76

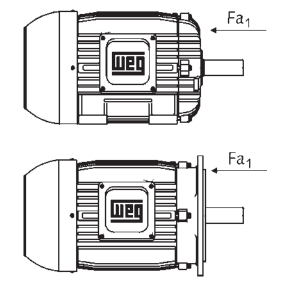
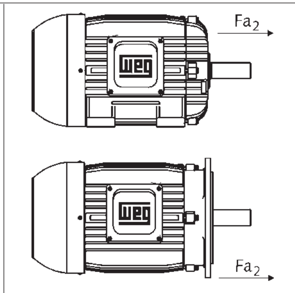
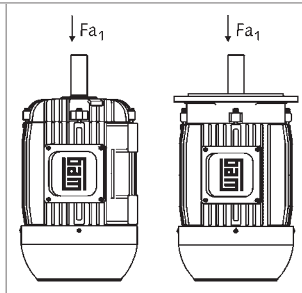
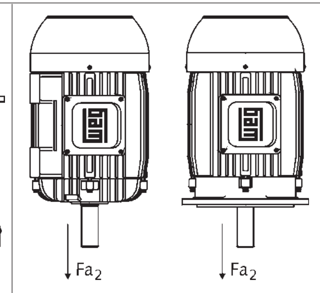
Important: 1) Peripheral speeds for solid grey cast iron pulleys FC 200 is V = 115 ft/s.
2) Use steel pulleys when peripheral speed is higher than 115 ft/s.
3) V-belt speed should not exceed 115 ft/s.

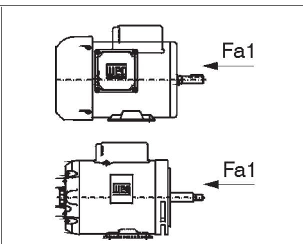
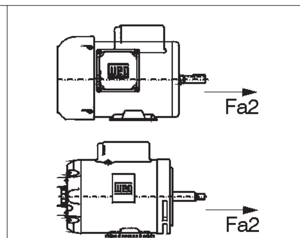
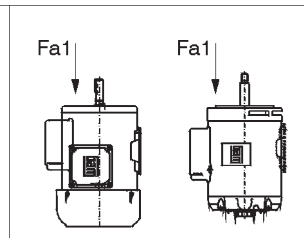
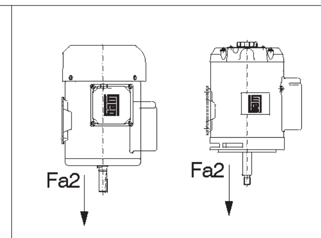
***Table 2** - Maximum acceptable radial load (Lbf)*

Nema 56 Motors				
Frame	Radial Force (Lbf)			
	Poles	Distance X		
		1	1,18	2
56A	II	88	-	59
	IV	88	-	59
56B	II	88	-	59
	IV	86	-	59
56D	II	127	-	70
	IV	141	-	70

Saw Arbor Motors				
80 LMS	II	-	355	-
80 MMS	II	-	359	-
80 SMS	II	-	357	-
90 LMS	II		427	-
	IV	-	555	-

***Table 3** - Maximum acceptable axial load (Lbf)*

IP55 Totally Enclosed Motors - 60Hz Position / Construction Form																
FRAME																
	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII
140	103	141	167	187	112	152	185	207	99	132	158	178	105	143	174	198
W 180	108	145	180	202	154	209	255	286	94	130	165	183	141	194	240	269
180	149	207	249	286	269	370	443	500	136	189	229	266	253	352	421	480
W 210	196	264	326	368	329	447	544	610	176	238	297	339	310	421	518	582
210	189	257	315	357	324	443	533	599	160	220	275	310	295	405	493	553
W 250	282	372	443	485	471	620	734	811	240	317	394	414	430	564	685	743
250	273	368	436	485	463	615	727	813	220	310	379	421	410	557	672	749
280	355	480	551	624	621	826	959	1,082	275	388	427	502	540	736	838	961
320	374	498	588	668	703	930	1,091	1,232	266	366	432	511	597	793	937	1,078
360	890	1,181	1,144	1,323	890	1,181	1,375	1,552	745	985	1,144	1,323	745	985	1,144	1,323
400	877	1,148	1,347	1,521	877	1,148	1,347	1,521	705	890	1,060	1,241	705	890	1,060	1,241
440	842	1,303	1,563	1,821	842	1,303	1,563	1,821	568	884	1,109	1,488	568	884	1,109	1,488
500	769	1,250	1,481	1,728	769	1,250	1,481	1,728	355	721	844	1,190	355	721	844	1,109
5008	791	1624	1909	2137	791	1624	1909	2137	728	1548	1808	2029	728	1548	1808	2029
580	679	1,406	1,649	1,865	679	1,406	1,649	1,865	033	474	549	597	033	474	549	597

Open Motors - NEMA 56 Frames - 60Hz Position / Construction Form								
FRAME								
	II	IV	II	IV	II	IV	II	IV
56 A	68	90	83	112	63	85	79	108
56 B	66	90	81	110	63	83	77	105
56 D	63	88	105	145	59	81	101	138

The maximum radial load for each frame are determined, by graphs.

INSTRUCTIONS ON HOW TO USE THE GRAPHS

1 - Maximum radial load on shaft.
2 - Maximum radial load on bearings.

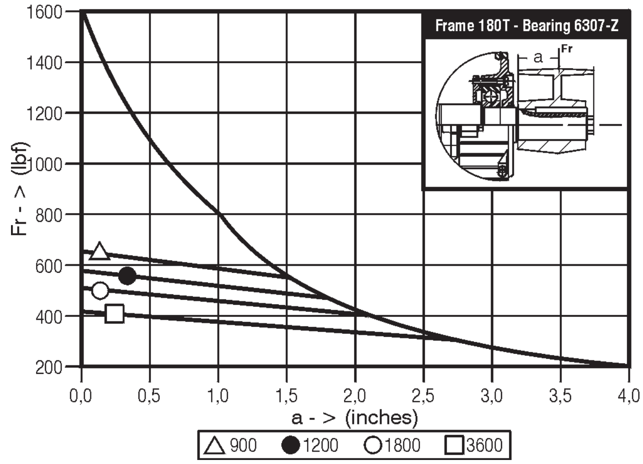
Where: X - Half of pulley width (inches)
Fr- Maximum radial load in relation to the diameter and pulley width.

Example:
Verify whether a 2HP motor, II Pole, 60Hz withstands a radial load of 110Lb, considering a pulley width of 4 inches.

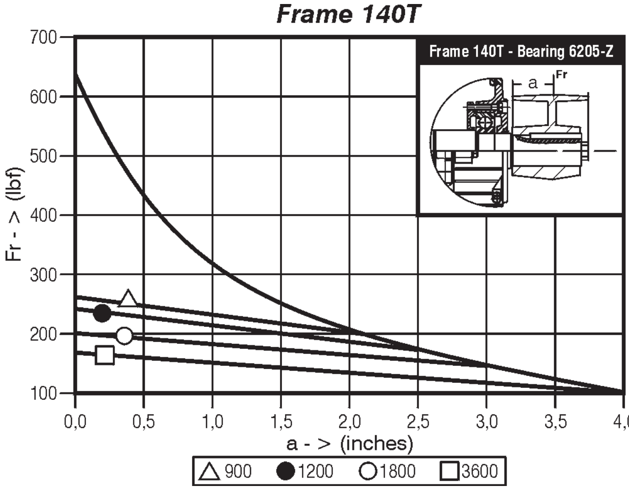
Frame: 145T
Fr: 110Lb
X: 2 inches

1 - Mark the distance X
2 - Find out line N = 3600 for bearing
Based on the above, this bearing withstands a radial load of 130Lb.

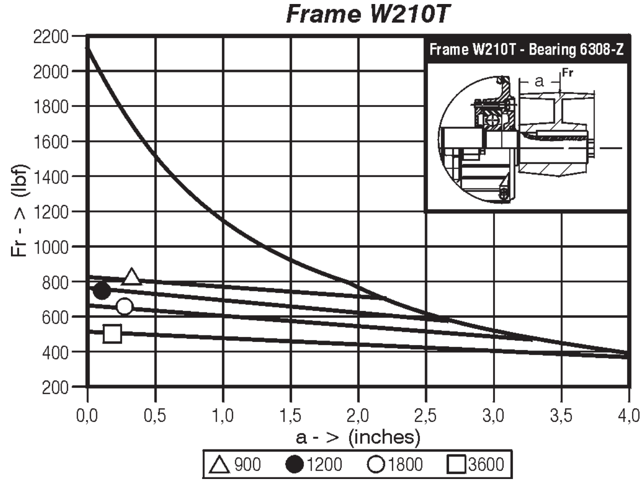
Frame 180T



Frame 140T



Frame W210T



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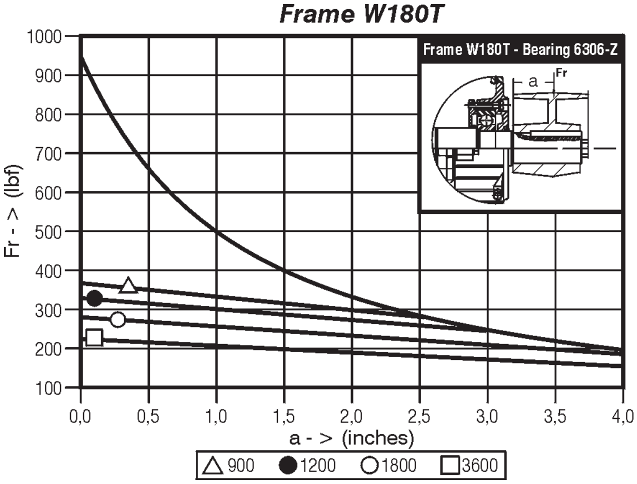
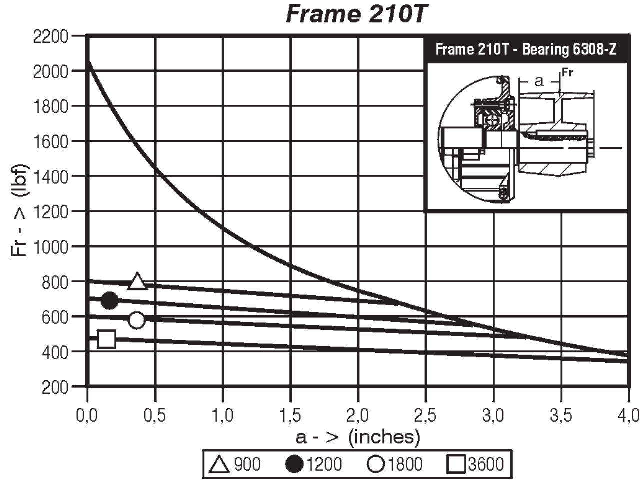
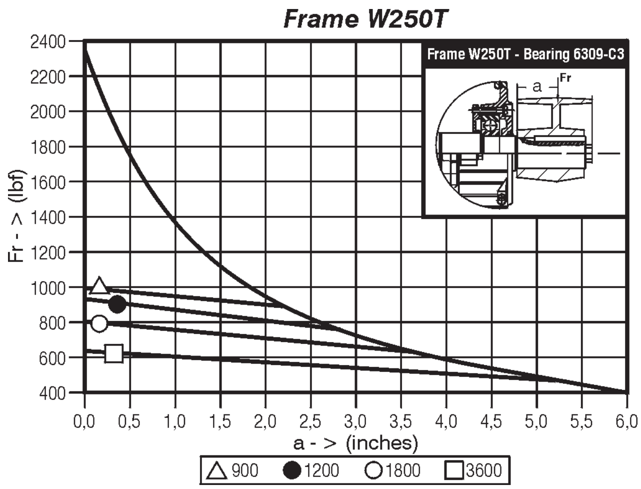
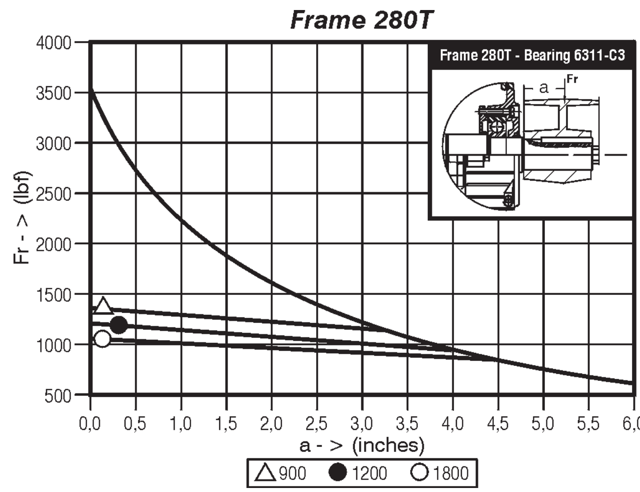
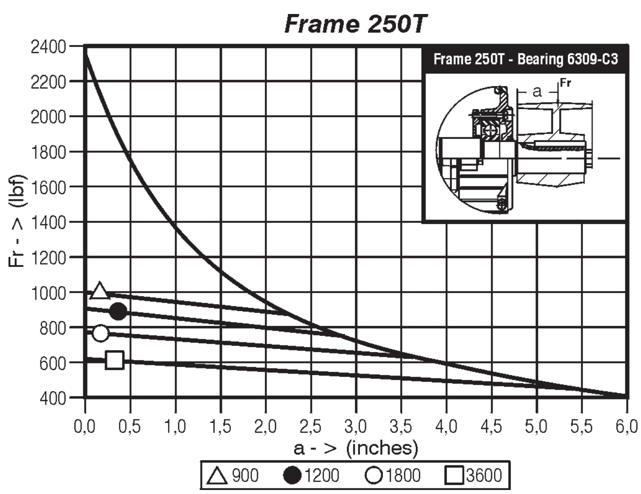


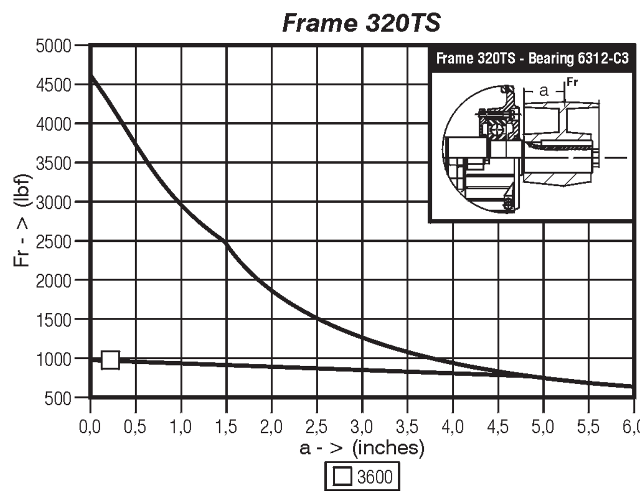
Frame 210T

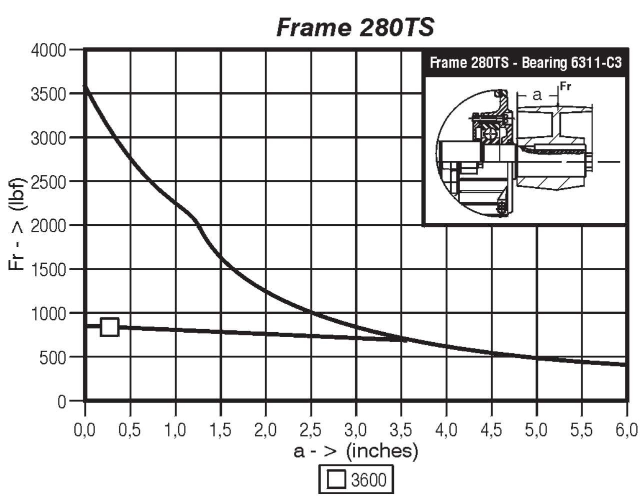


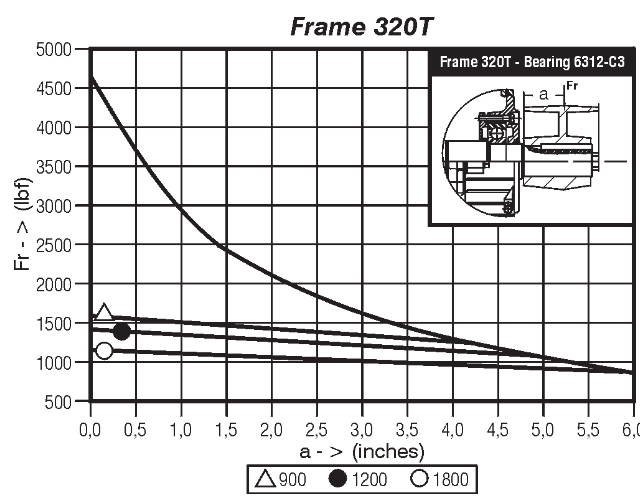

Frame W250T
Frame W250T - Bearing 6309-C3
Fr - > (lbf)
a - > (inches)
900 1200 1800 3600


Frame 280T
Frame 280T - Bearing 6311-C3
Fr - > (lbf)
a - > (inches)
900 1200 1800

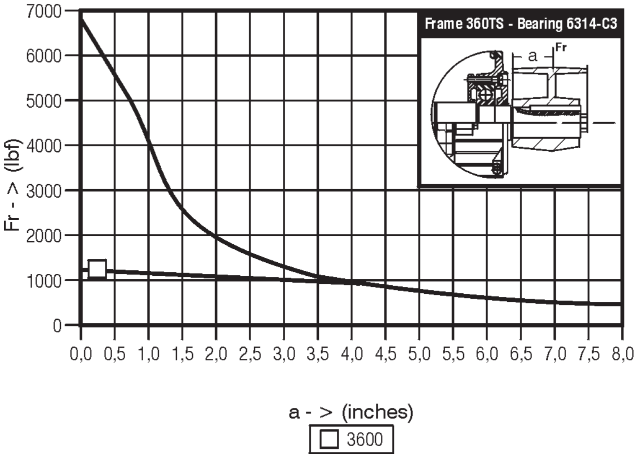

Frame 250T
Frame 250T - Bearing 6309-C3
Fr - > (lbf)
a - > (inches)
900 1200 1800 3600


Frame 320TS
Frame 320TS - Bearing 6312-C3
Fr - > (lbf)
a - > (inches)
3600

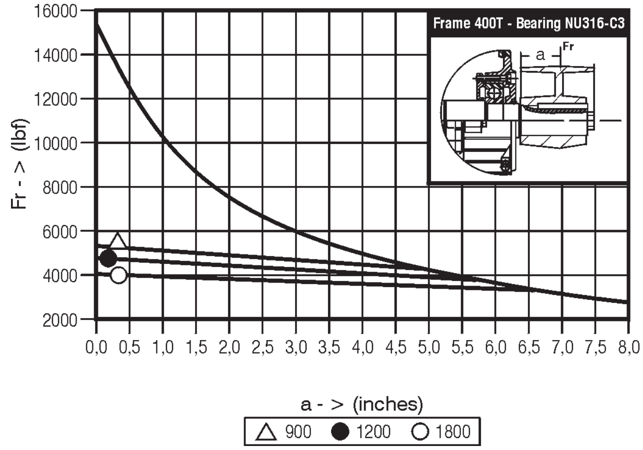

Frame 280TS
Frame 280TS - Bearing 6311-C3
Fr - > (lbf)
a - > (inches)
3600


Frame 320T
Frame 320T - Bearing 6312-C3
Fr - > (lbf)
a - > (inches)
900 1200 1800

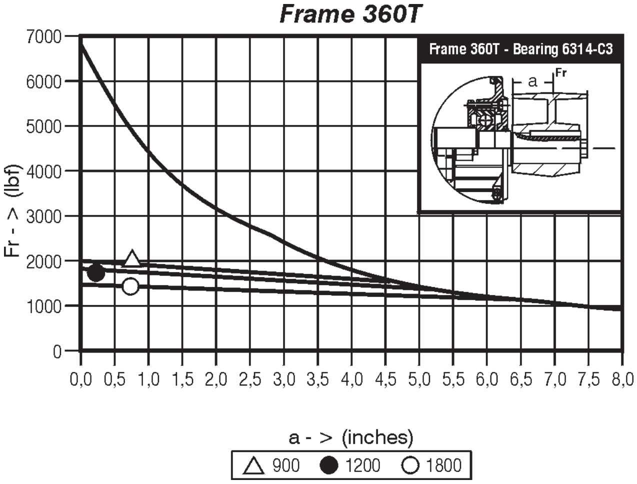
Frame 360TS



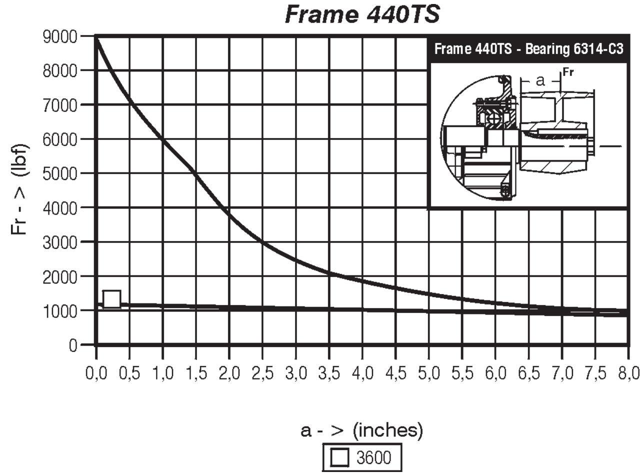
Frame 400T



Frame 360T



Frame 440TS



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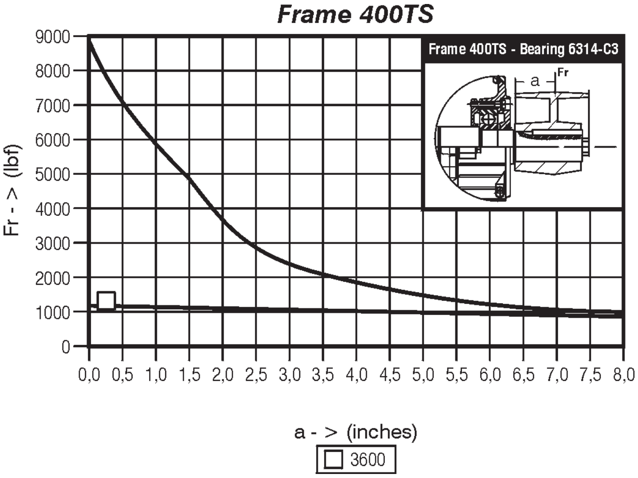

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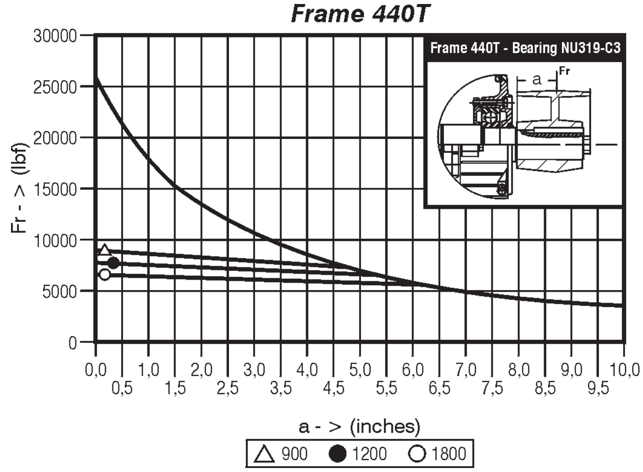
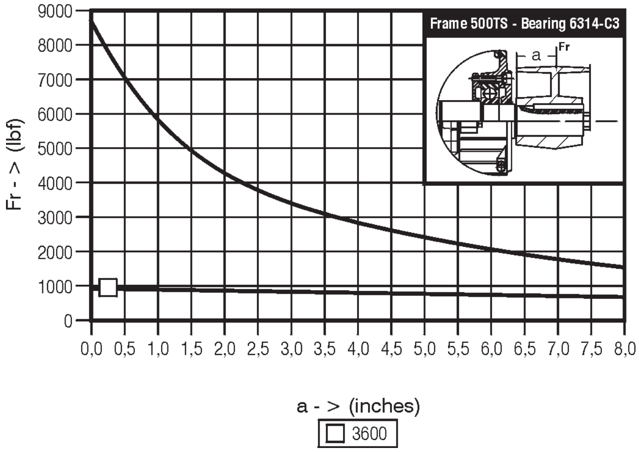
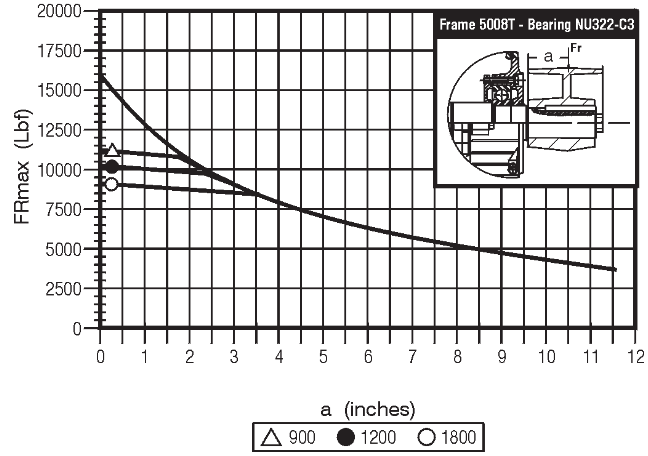


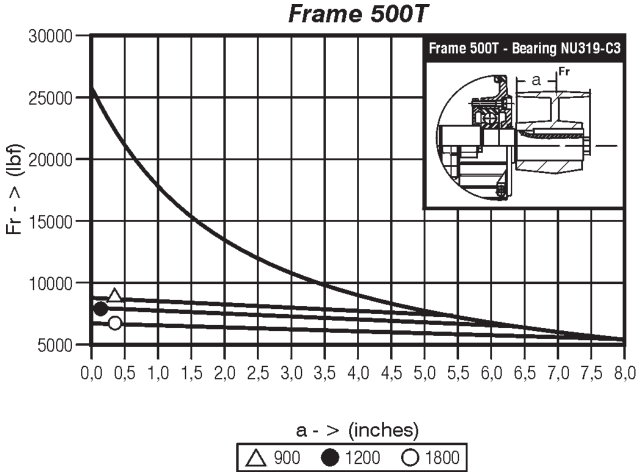
Frame 500TS



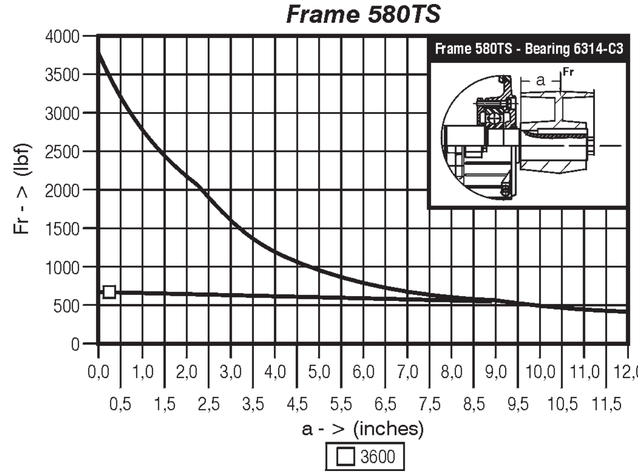
Frame 5008T



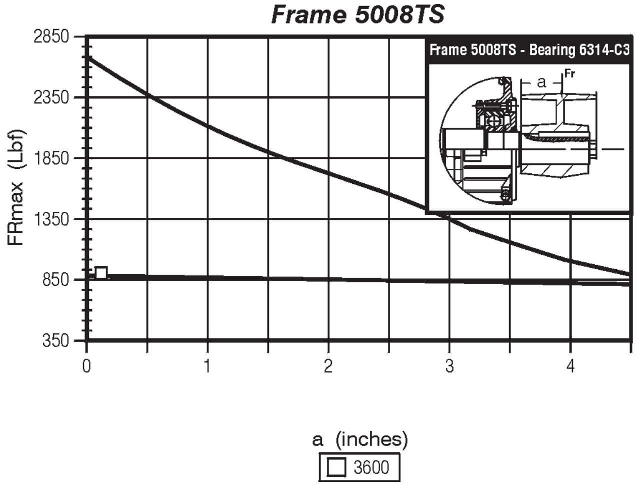
Frame 500T



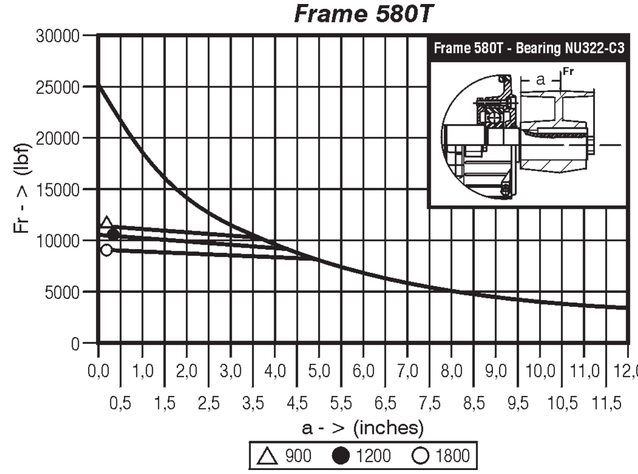
Frame 580TS



Frame 5008TS



Frame 580T



Note: For frames 600 and above, consult your engineering representative.

3.2 Electrical Aspects

3.2.1 Feed System

Proper electric power supply is very important. The choice of motor feed conductors, whether branch or distribution circuits, should be based on the rated current of the motors as per NFPA-70 Standard article 430.
Tables 4, 5 and 6 show minimum conductor gauges sized according to maximum current capacity and maximum voltage drop in relation to the distance from the distribution center to the motor, and to the type of installation (Overhead or in ducts).

To determine the conductor gauge proceed as follows:

a) Determine the current by multiplying the current indicated on the motor nameplate by 1.25 and then locate the resulting value on the corresponding table.
If the conductor feeds more than one motor, the value to be sought on the table should be equal 1.25 times the rated current of the largest motor plus the rated current of the other motors.
In the case of variable speed motors, the highest value among the rated currents should be considered.
When motor operation is intermittent, the conductors should have a current carrying capacity equal or greater, to the product of the motor rated current times the running cycle factor shown on Table 7.

***Table 7** - Running cycle factor*

Motor Short

Duty Classification \ Motor short time rating	5min	15min	30 at 60min	Continuos
Short (operating valves, activating contacts etc)	1.10	1.20	1.50	-
Intermittent (passenger or freight elevators, tools, pumps, rolling bridges etc)	0.85	0.85	0.90	1.40
Cyclic (rolling mills,mining machines etc)	0.85	0.90	0.95	1.40
Variable	1.10	1.20	1.50	2.00

b) Locate the rated voltage of the motor and the feed network distance in the upper part of the corresponding table. The point of intersection of the distance column and the line referring to current will indicate the minimum required gauge of the conductor.

Example:
Size the conductors for a 15 HP, three-phase, 230V, 42A, motor located 200 feet from the main supply with cables laid in conduits.

a) Current to be located: 1.25 x 42A = 52.5A
b) Closest value on table 6:55A
c) Minimum gauge: 6 AWG

3.2.2 Starting of Electric Motor

Induction motors can be started by the following methods:

Direct Starting

Whenever possible a three-phase motor with a squirrel cage rotor should be started directly at full supply voltage by means of a contactor (Connection diagram a). This method is called Direct-on-Line (DOL) starting.
There are DOL starter assemblies available combining a three-pole contactor, a bimetal relay (overload protection device), and a fuse (short circuit protection on branch circuit).
DOL starting is the simplest method, only feasible however, when the locked rotor current (LRC) does not influence the main electric supply lines.
Initial locked rotor current (LRC) in induction motors reach values six to eight times the value of the full load current. During starting by the DOL method, starting current can reach these high levels. The main electrical supply should be rated sufficiently, such that during the starting cycle no supply disturbance to others on the power network is caused by the voltage drop in the main supply.
This can be achieved under one of the following situations:

a) The rated main supply current is high enough for the locked rotor current not to be proportionally high.
b) Motor locked rotor current is low with no effect on the networks.
c) The motor is started under no-load conditions with a short starting cycle and, consequently, a low locked rotor current with a transient voltage drop tolerable to other consumers.

Starting with a compensating switch (auto-transformer starting)

Should direct on line starting not be possible, either due to restrictions imposed by the power supply authority or due to the installation itself, reduced voltage indirect starting methods can be employed to lower the locked rotor current. The single line connection diagram (C) shows the basic components of a compensating switch featuring a transformer (usually an auto-transformer) with a series of taps corresponding to the different values of the reduced voltage. Only three terminals of the motor are connected to the switch, the other being interconnected as per diagram, for the indicated voltage.

Star-Delta starting

It is fundamental to star-delta starting that the three-phase motor has the necessary numbers of leads for both connections:

6 leads for Y/Δ
or 12 leads for YY/$\Delta\Delta$

All the connections for the various voltages are made through terminals in the terminal box in accordance with the wiring diagram that accompanies the motor. This diagram may be shown on the nameplate or in the terminal box.
The star-delta connection is usually used only in low-voltage motors due to normally available control and protection devices. In this method of starting the locked rotor current is approximately 30% of the original LRC. The locked rotor torque is reduced proportionally as well. For this reason, it is very important before deciding to use

***Table 4** - Wire and cable gauges for single-phase motor installation (voltage drop < 5%) (in conduits)*

Supply Voltage	Distance of motor from distribution centre (feet)													
115	34	51	69	85	102	137	171	205	240	273	308	342	428	514
230	69	102	138	170	204	274	342	410	480	546	616	684	856	1028
460	138	204	276	340	408	548	684	820	960	1092	1232	1368	1712	2056
575	170	250	338	420	501	670	840	1010	1181	1342	1515	1680	2105	2530
Current (A)	**Cable gauge (conductor)**													
5	14	14	14	14	14	14	14	12	12	12	12	10	10	8
10	14	14	14	14	12	12	10	10	10	8	8	8	6	6
15	12	12	12	12	12	10	8	8	6	6	6	6	4	2
20	12	12	12	10	10	8	8	6	6	6	4	4	4	2
30	10	10	10	8	8	6	6	6	4	4	2	2	2	1/0
40	8	8	8	8	6	6	4	4	2	2	2	2	1/0	2/0
55	6	6	6	6	6	4	4	2	2	1/0	1/0	1/0	1/0	2/0
70	4	4	4	4	4	2	2	2	1/0	1/0	2/0	2/0	2/0	2/0
95	2	2	2	2	2	2	1/0	1/0	1/0	2/0	3/0	3/0	4/0	250M

***Table 5** - Wire and cable gauges for three-phase motor installation - aerial conductors with 25cm spacing (voltage drop < 5%)*

Supply Voltage	Distance of motor from distribution centre (feet)													
115	51	69	85	102	137	171	205	240	273	308	342	428	514	685
230	102	138	170	204	274	342	410	480	546	616	684	856	1028	1370
460	204	276	340	408	547	684	820	960	1092	1232	1368	1712	2056	2740
575	250	338	420	501	670	840	1010	1181	1342	1515	1680	2105	2530	3350
Current (A)	**Cable gauge (conductor)**													
15	14	14	14	12	12	10	10	10	8	8	8	6	6	4
20	14	14	12	12	10	10	8	8	8	6	6	4	4	2
30	14	12	10	8	8	8	6	6	4	4	4	2	2	1/0
40	12	10	10	8	8	6	4	4	4	2	2	2	1/0	2/0
55	10	10	8	8	6	4	4	2	2	2	1/0	2/0	3/0	--
70	8	8	6	6	4	2	2	2	1/0	1/0	2/0	3/0	--	--
100	6	6	4	4	2	2	1/0	2/0	3/0	4/0	4/0	--	--	--
130	4	4	4	2	1/0	1/0	2/0	4/0	--	--	--	--	--	--
175	2	2	2	1/0	2/0	3/0	--	--	--	--	--	--	--	--
225	1/0	1/0	1/0	2/0	3/0	--	--	--	--	--	--	--	--	--
275	2/0	2/0	2/0	4/0	--	--	--	--	--	--	--	--	--	--
320	3/0	3/0	3/0	4/0	--	--	--	--	--	--	--	--	--	--

***Table 6** - Wire and cable gauges for three-phase motor installation (voltage drop < 5%) (in conduits)*

Supply Voltage	Distance of motor from distribution centre (feet)											
115	85	102	120	137	171	205	240	273	308	342	428	514
230	170	204	240	274	342	410	480	546	616	684	856	1028
460	340	408	480	548	684	820	960	1092	1232	1368	1712	2056
575	420	501	590	670	840	1010	1181	1342	1515	1680	2105	2530
Current (A)	**Cable gauge (conductor)**											
15	12	12	12	10	10	8	8	8	6	6	6	4
20	12	10	10	10	8	8	6	6	6	6	4	4
30	10	8	8	8	6	6	6	4	4	4	2	2
40	8	8	6	6	6	4	4	4	2	2	2	1/0
55	6	6	6	4	4	4	2	2	2	1/0	1/0	1/0
70	4	4	4	4	2	2	2	1/0	1/0	1/0	2/0	2/0
95	2	2	2	2	2	1/0	1/0	1/0	1/0	2/0	3/0	4/0
125	1/0	1/0	1/0	1/0	1/0	1/0	2/0	2/0	3/0	3/0	4/0	250M
145	2/0	2/0	2/0	2/0	2/0	2/0	2/0	3/0	3/0	4/0	250M	300M
165	3/0	3/0	3/0	3/0	3/0	3/0	3/0	3/0	4/0	4/0	250M	350M
195	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	250M	250M	300M	350M
215	250M	250M	250M	250M	250M	250M	250M	250M	250M	300M	350M	400M
240	300M	300M	300M	300M	300M	300M	300M	300M	300M	300M	400M	500M
265	350M	350M	350M	350M	350M	350M	350M	350M	350M	350M	500M	500M
280	400M	400M	400M	400M	400M	400M	400M	400M	400M	400M	400M	--
320	500M	500M	500M	500M	500M	500M	500M	500M	500M	500M	500M	--

Note: The above indicated values are orientative. For guaranteed values, contact the Local Power Company.

star-delta starting to verify if the reduced locked rotor torque in “STAR” connection is enough to accelerate the load.

3.2.3 Motor Protection

Motor circuits have, in principle, two types of protection: motor overload, locked rotor and protection of branch circuit from short circuits. Motors in continuous use should be protected from overloading by means of a device incorporated into the motor, or by an independent device, usually a fixed or adjustable thermal relay equal or less than to the value derived from multiplying the rated feed current at full load by:

- 1.25 for motors with a service factor equal or superior to 1.15 or;
- 1.15 for motors with service factor equal to 1.0.

Some motors are optionally fitted with overheating protective detectors (in the event of overload, locked rotor, low voltage, inadequate motor ventilation) such as a thermostat (thermal probe), thermistor (PTC), RTD type resistance which dispense with independent devices.

THERMOSTAT (THERMAL PROBE)**:** Bimetallic thermal detectors with normally closed silver contacts. These open at pre-determined temperatures. Thermostats are series connected directly to the contactor coil circuit by two conductors.

THERMISTORS: Semi-conductor heat detectors positive temperature coeficient (PTC) that sharply change their resistance upon reaching a set temperature. Thermistors, depending upon the type, are series or parallel-connected to a control unit that cuts out the motor feed, or actuates an alarm system, in response to the thermistors reaction.

RESISTANCE TEMPERATURE DETECTORS (RTD) - PT 100:The resistance type heat detector (RTD) is a resistance element usually manufactured of copper or platinum.
The RTD operates on the principle that the electrical resistance of a metallic conductor varies linearly with the temperature. The detector terminals are connected to a control panel, usually fitted with a temperature gauge, a test resistance and a terminal changeover switch.

Subject to the desired degree of safety and the client’s specification, three (one per phase) or six (two per phase) protective devices can be fitted to a motor for the alarm stems, circuit breaker or combined alarm and circuit breaker, with two leads from the terminal box to the alarm or circuit breaker system and four for the combined system (alarm and circuit breaker).
Table 9 compares the two methods of protection.

3.3 Start-up

3.3.1 Preliminary Inspection

Before starting a motor for the first time, it will be necessary to:

a) Remove all locking devices and blocks used in transit and check that the motor rotates freely;

b) Check that the motor is firmly secured and that coupling elements are correctly mounted and aligned.;

c) Ascertain that voltage and frequency correspond to those indicated on the nameplate. Motor performance will be satisfactory with main supply voltage fluctuation within ten per cent of the value indicated on the nameplate or a frequency fluctuation within five per cent or, yet, with a combined voltage and frequency variance within ten per cent;

d) Check that connections are in accordance with the connection diagram shown on the nameplate and be sure that all terminal screws and nuts are tight;

e) Check the motor for proper grounding. Providing that there are no specifications calling for ground-insulated installation, the motor must be grounded in accordance with prevalent standard for grounding electrical machines. The screw identified by the symbol ⏚ should be used for this purpose.
This screw is generally to be found in the terminal box or on one foot of the frame;

f) Check that motor leads connecting with the mains, as well as the control wires and the overload protection device, are in accordance with Nema Standards;

g) If the motor has been stored in a damp place, or has been stopped for some time, measure the insulating resistance as recommended under the item covering storage instructions;

h) Start the motor uncoupled to ascertain that it is turning in the desired direction. To reverse the rotation of a three-phase motor, invert two terminal leads of the mains supply.
High voltage motors bearing an arrow on the frame indicating rotation direction can only turn in the direction shown.

3.3.2 The First Start-up

Three-Phase Motor with Cage Rotor:
After careful examination of the motor, follow the normal sequence of starting operations listed in the control instructions for the initial start-up.

3.3.3 Operation

Drive the motor coupled to the load for a period of at least one hour while watching for abnormal noises or signs of overheating.
Compare the line current with the value shown on the nameplate.
Under continuous running conditions without load fluctuations this should not exceed the rated current times the service factor, also shown on the nameplate.
All measuring and control instruments and apparatus should be continuously checked for anomalies, and any irregularities corrected.

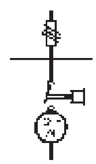
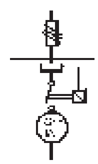
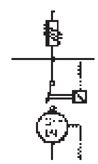
3.3.4 Stopping

Warning:

To touch any moving part of a running motor, even though disconnected, is a danger to life and limb.

Three-phase motor with cage rotor:
Open the stator circuit switch. With the motor at a complete stop, reset the auto-transformer, if any, to the "start" position.

Table 9 *- Comparison between motor protection system*

Causes of overheating	Current-based protection		Protection with probe thermistor in motor
	Fuse only	Fuse and thermal protector	
			
1. Overload with 1.2 times rated current	○	●	●
2. Duty cycles S1 to S8 IEC 34, EB 120	○	◑	●
3. Brakings, reversals and frequent starts	○	◑	●
4. Operating with more than 15 starts p/hour	○	◑	●
5. Locked rotor	◑	◑	●
6. Fault on one phase	○	◑	●
7. Execessive voltage fluctuation	○	●	●
8. Frequency fluctuation on main supply	○	●	●
9. Excessive ambient temperature	○	●	●
10. External heating caused by bearings, belts, pulleys etc.	○	○	●
11. Obstructed ventilation	○	○	●

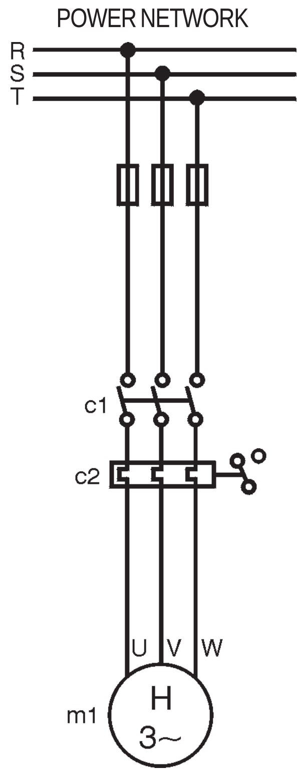
Caption: ○ unprotected

◑ partially protected

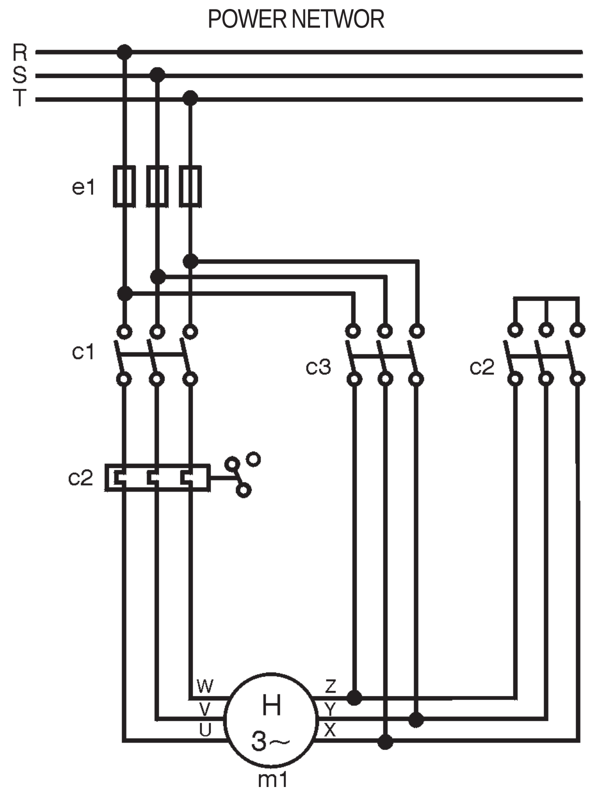
● totally protected

CONNECTION DIAGRAMS

a) Direct starting



b) Star-Delta starting



c) Auto-transformer starting

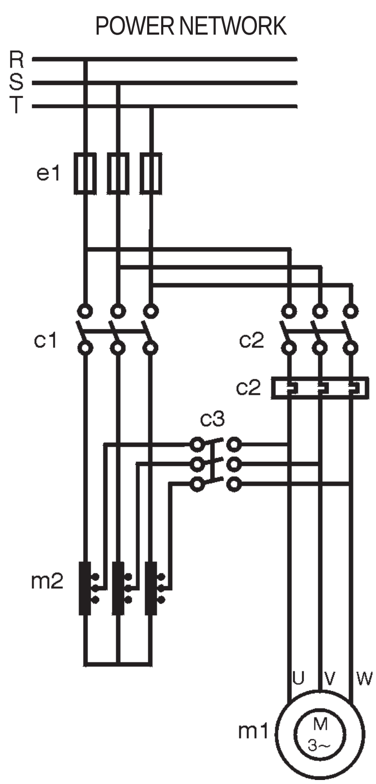


***Table 11** - Bearing specifications by type of motor*

NEMA Frames	Mounting	Bearings	
		Front (D.E.)	Rear (O.D.E.)
Open drip proof motors			
B48 and C48	ALL FORMS	6203 Z	6202 Z
56 and A56		6203 Z	6202 Z
B56 and C56		6203 Z	6202 Z
D56 and F56H/G56H		6204 Z	6202 Z / 6203 Z
Totally enclosed fan cooled motors			
143 T	ALL FORMS	6205 ZZ	6204 ZZ
145 T		6205 ZZ	6204 ZZ
182 T		6307 ZZ	6206 ZZ
184 T		6307 ZZ	6206 ZZ
W 182 T		6206 ZZ	6205 ZZ
W 184 T		6206 ZZ	6205 ZZ
213 T		6308 ZZ	6207 ZZ
215 T		6308 ZZ	6207 ZZ
W 213 T		6308 ZZ	6207 ZZ
W 215 T		6308 ZZ	6207 ZZ
254 T		6309-C3	6209 Z-C3
256 T		6309-C3	6209 Z-C3
W 254 T		6309-C3	6209 Z-C3
W 256 T		6309-C3	6209 Z-C3
284 T and TS		6311-C3	6211 Z-C3
286 T and TS		6311-C3	6211 Z-C3
324 T and TS		6312-C3	6212 Z-C3
326 T and TS		6312-C3	6212 Z-C3
364 T and TS		6314-C3	6314-C3
365 T and TS		6314-C3	6314-C3
404 T		NU 316-C3	6314-C3
404 TS		6314-C3	6314-C3
405 T		NU 316-C3	6314-C3
405 TS		6314-C3	6414-C3
444 T		NU 319-C3	6316-C3
444 TS		6314-C3	6314-C3
445 T		NU 319-C3	6316-C3
445 TS		6314-C3	6314-C3
447 T		NU 319-C3	6316-C3
447 TS		6314-C3	6314-C3
449 T		NU 322-C3	6319-C3
449 TS		6314-C3	6314-C3
504 T		NU 319-C3	6316-C3
504 TS		6314-C3	6314-C3
505 T		NU 319-C3	6316-C3
505 TS		6314-C3	6314-C3
5008 T		NU 322-C3	6319-C3
5008TS		6314-C3	6314-C3
586 T		NU 322-C3	6319-C3
586 TS		6314-C3	6314-C3
587 T		NU 322-C3	6319-C3
587 TS		6314-C3	6314-C3

Saw Arbor motor frame	Mounting	Bearings	
		Front (D.E.)	Rear (O.D.E.)
80 S MS	B3	6307 ZZ	6207 ZZ
80 M MS		6307 ZZ	6207 ZZ
80 L MS		6307 ZZ	6207 ZZ
90 L MS		6308 ZZ	6208 ZZ

ODP Motors Nema-T frames	Mounting	Bearings	
		Front (D.E.)	Rear (O.D.E.)
E143/5T	HORIZONTAL MOUNTING ONLY	6205 ZZ	6204 ZZ
F143/5T		6205 ZZ	6204 ZZ
182 T		6206 ZZ	6205 ZZ
184 T		6202 ZZ	6205 ZZ
213/5T		6208 ZZ	6206 ZZ
254 T		6309 Z-C3	6209 Z-C3
256 T		6309 Z-C3	6209 Z-C3
284 T		6311 Z-C3	6211 Z-C3
284 TS		6311 Z-C3	6211 Z-C3
286 T		6311 Z-C3	6211 Z-C3
286 TS		6311 Z-C3	6211 Z-C3
324 T		6312 Z-C3	6212 Z-C3
324 TS		6312 Z-C3	6212 Z-C3
326 T		6312 Z-C3	6212 Z-C3
326 TS		6312 Z-C3	6212 Z-C3
364 T		6314 C3	6314 C3
364 TS		6314 C3	6314 C3
365 T		6314 C3	6314 C3
365 TS		6314 C3	6314 C3
404 T		NU 316 C3	6314 C3
404 TS		6314 C3	6314 C3
405 T		NU 316 C3	6314 C3
405 TS		6314 C3	6314 C3
444 T		NU 319 C3	6316 C3
444 TS		6314 C3	6314 C3
445 T		NU 319 C3	6316 C3
445 TS		6314 C3	6314 C3

IEC frame	Mounting	Bearings	
		Front (D.E.)	Rear (O.D.E.)
Totally enclosed fan cooled motors			
63	B3	6201 ZZ	6201 ZZ
71		6203 ZZ	6202 ZZ
80		6204 ZZ	6203 ZZ
90 S - L		6205 ZZ	6204 ZZ
100 L		6206 ZZ	6205 ZZ
112 M		6307 ZZ	6206 ZZ
132 S - M		6308 ZZ	6207 ZZ
160 M - L		6309-C3	6209 Z-C3
180 M - L		6311-C3	6211 Z-C3
200 M - L		6312-C3	6212 Z-C3
225 S/M		6314-C3	6314-C3
250 S/M		6314-C3	6314-C3
280 S/M		6314-C3	6314-C3
		6316-C3	6316-C3
315 S/M		6314-C3	6314-C3
		6319-C3	6316-C3
355 M/L		6314-C3	6314-C3
		NU 322-C3	6319-C3

***Table 12** – Bearing lubrication intervals and amount of grease*

BALL BEARINGS - Series 62/63												
Relubrication intervals (running hours – horizontal position)												
	II pole		IV pole		VI pole		VIII pole		X pole		XII pole		Amount of grease
Serie 62													
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
6209	18400	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	9
6211	14200	16500	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	11
6212	12100	14400	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
Serie 63													
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
6309	15700	18100	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
6311	11500	13700	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	18
6312	9800	11900	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	21
6314	3600	4500	9700	11600	14200	16400	17300	19700	19700	20000	20000	20000	27
6316	-	-	8500	10400	12800	14900	15900	18700	18700	20000	20000	20000	34
6319	-	-	7000	9000	11000	13000	14000	17400	17400	18600	18600	20000	45
6322	-	-	5100	7200	9200	10800	11800	15100	15100	15500	15500	19300	60

Table 13 – Bearing lubrication intervals and amount of grease

BALL BEARINGS - Series NU3													
Relubrication intervals (running hours – horizontal position)													
	II pole		IV pole		VI pole		VIII pole		X pole		XII pole		Amount of grease
Bearing	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	(g)
NU 309	9800	13300	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	13
NU 311	6400	9200	19100	20000	20000	20000	20000	20000	20000	20000	20000	20000	18
NU 312	5100	7600	17200	20000	20000	20000	20000	20000	20000	20000	20000	20000	21
NU 314	1600	2500	7100	8900	11000	13100	15100	16900	16900	19300	19300	20000	27
NU 316	-	-	6000	7600	9500	11600	13800	15500	15500	17800	17800	20000	34
NU 319	-	-	4700	6000	7600	9800	12200	13700	13700	15700	15700	20000	45
NU 322	-	-	3300	4400	5900	7800	10700	11500	11500	13400	13400	17300	60
NU 324	-	-	2400	3500	5000	6600	10000	10200	10200	12100	12100	15000	72

Notes:
- The ZZ bearings from 6201 to 6307 do not require relubrication as its life time is about 20,000 hours.
- Tables 1 and 2 are intended for the lubrication period under bearing temperature of 70ºC (for bearings up to 6312 and NU 312) and temperature of 85ºC (for bearings 6314 and NU 314 and larger).
- For each 15ºC of temperature rise, the relubrication period is reduced by half.
- The relubrication periods given above are for those cases applying Polyrex® EM grease.
- When motors are used on the vertical position, their relubrication interval is reduced by half if compared to horizontal position motors.

Compatibility of Polyrex® EM grease with other types of grease:

Containing polyurea thickener and mineral oil, the Polyrex® EM grease is compatible with other types of grease that contain:
- Lithium base or complex of lithium or polyurea and highly refined mineral oil.
- Inhibitor additive against corrosion, rust and anti-oxidant additive.

Notes:
- Although Polyrex® EM is compatible with types of grease given above, we do no recommended to mix it with any other greases.
- If you intend to use a type of grease different than those recommended above , first contact WEG.
- On applications (with high or low temperatures, speed variation, etc), the type of grease and relubrification interval are given on an additional nameplate attached to the motor.

4. Maintenance

A well-designed maintenance program for electric motors can be summed up as: periodical inspection of insulation levels, temperature rise, wear, bearing lubrication and the occasional checking of fan air flow.
Inspection cycles depend upon the type of motor and the conditions under which it operates.

4.1 Cleanliness

Motors should be kept clean, free of dust, debris and oil. Soft brushes or clean cotton rags should be used for cleaning. A jet of compressed air should be used to remove non-abrasive dust from the fan cover and any accumulated grime from the fan and cooling fins.
Oil or damp impregnated impurities can be removed with rags soaked in a suitable solvent.
Terminal boxes fitted to motors with IP55 protection should be cleaned; their terminals should be free of oxidation, in perfect mechanical condition, and all unused space dust-free.
Motors with IPW 55 protection are recommended for use under unfavourable ambient conditions.

4.2 Lubrication

Proper lubrication extends bearing life.

Lubrication Maintenance Includes:

a) Attention to the overall state of the bearings;
b) Cleaning and lubrication;
c) Critical inspection of the bearings.

Motor noise should be measured at regular intervals of one to four months. A well-tuned ear is perfectly capable of distinguishing unusual noises, even with rudimentary tools such as a screw driver, etc., without recourse to sophisticated listening aids or stethescopes that are available on the market.
A uniform hum is a sign that a bearing is running perfectly. Bearing temperature control is also part of routine maintenance.
Constant temperature control is possible with the aid of external thermometers or by embedded thermal elements. WEG motors are normally equipped with grease lubricated ball or roller bearings.
Bearings should be lubricated to avoid metallic contact of the moving parts, and also for protection against corrosion and wear. Lubricant properties deteriorate in the course of time and mechanical operation: furthermore, all lubricants are subject to contamination under working conditions.
For this reason lubricants must be renewed and any lubricant consumed needs replacing from time to time.

4.2.1 Periodical Lubrication

WEG motors are supplied with sufficient grease for a long running period. Lubrication intervals, the amount of grease and the type of bearing used in frames 140T to 580T are to be found in Tables 11, 12 and 13.
Lubrication intervals depend upon the size of the motor, speed, working conditions and the type of grease used.

4.2.2 Quality and Quantity of Grease

Correct lubrication is important!
Grease must be applied correctly and in sufficient quantity as both insufficient or excessive greasing are harmful.
Excessive greasing causes overheating brought about by the greater resistance encountered by the rotating parts and, in particular, by the compacting of the lubricant and its eventual loss of lubricating qualities.
This can cause seepage with the grease penetrating the motor and dripping on the coils.

GREASES FOR MOTOR BEARINGS

For operating temperatures from -30 to 170ºC	
Type	**Supplier**
Polyrex® EM	Esso

4.2.3 Lubricating Instructions

a) Frame 140T to 210T motors
Frame 140T to 210T size motors are not fitted with grease nipples. Lubrication is carried out during periodical overhauls when the motor is taken apart.

Cleaning and Lubrication of Bearings

With the motor dismantled and without extracting the bearings from the shaft, all existing grease should be removed and the bearings cleaned with Diesel oil, kerosene or other solvent, until thoroughly clean.
Refill the spaces between the balls or rollers and the bearing cages with grease immediately after washing. Never rotate bearings in their dry state after washing.
For inspection purposes apply a few drops of machine oil. During these operations maximum care and cleanliness is recommended to avoid the penetration of any impurities or dust that could harm the bearings. Clean all external parts prior to reassembly.

b) Frame 360T to 580T Motors
Motors above 360T frame size are fitted with regreasable bearing system.
The lubrication system from this frame size upwards was designed to allow the removal of all grease from the bearing races through a bleeder outlet which at the same time impedes the entry of dust or other contaminants harmful to the bearing.
This outlet also prevents injury to the bearings from the well-known problem of over-greasing.

It is advisable to lubricate while the motor is running, to allow the renewal of grease in the bearing case.
Should this procedure not be possible because of rotating parts in the proximity of the nipple (pulleys, coupling sleeves, etc.) that are hazardous to the operator the following procedure should be followed:
- Inject about half the estimated amount of grease and run the motor at full speed for approximately a minute; switch off the motor and inject the remaining grease.
The injection of all the grease with the motor at rest could cause penetration of a portion of the lubricant through the internal seal of the bearing case and hence into the motor.

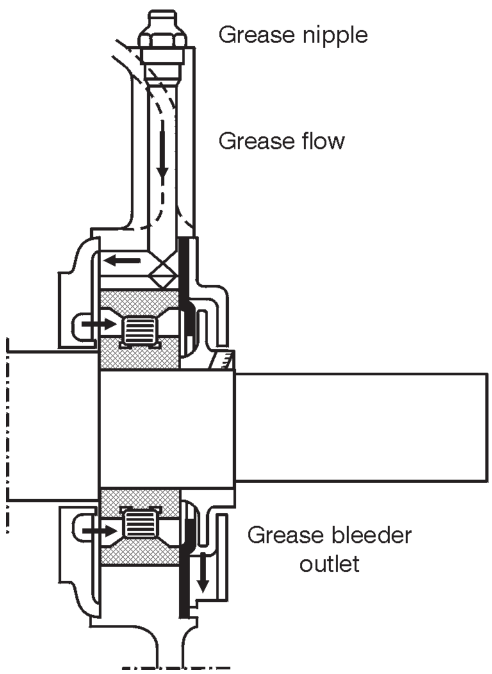


Figure 4.1 - Bearings and lubrication system

Nipples must be clean prior to introduction of grease to avoid entry of any alien bodies into the bearing.
For lubricating use only a manual grease gun.

Bearing Lubrication Steps

1. Cleanse the area around the grease nipples with clean cotton fabric.
2. With the motor running, add grease with a manual grease gun until the lubricant commences to be expelled from the bleeder outlet, or until the quantity of grease recommended in Tables 12 or 13 has been applied.
3. Allow the motor to run long enough to eject all excess grease.

4.2.4 Replacement of Bearings

The opening of a motor to replace a bearing should only be carried out by qualified personnel.
Damage to the core after the removal of the bearing cover can be avoided by filling the gap between the rotor and the stator with stiff paper of a proper thickness.
Providing suitable tooling is employed, disassembly of a bearing is not difficult.
The extractor grips should be applied to the sidewall of the inner ring to be stripped, or to an adjacent part.
To ensure perfect functioning and to prevent injury to the bearing parts, it is essential that the assembly be undertaken under conditions of complete cleanliness and by competent personnel.
New bearings should not be removed from their packages until the moment of assembly.
Prior to fitting a new bearing, ascertain that the shaft has no rough edges or signs of hammering.

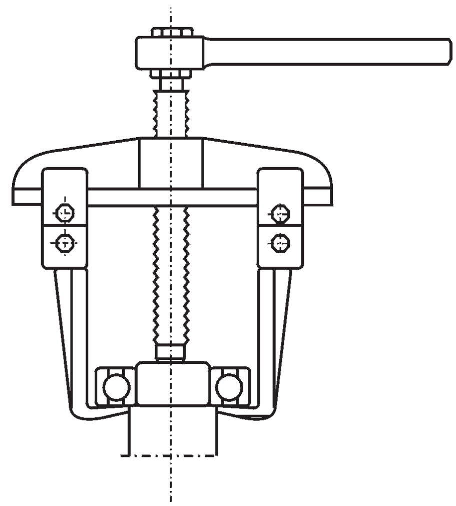


Figure 4.2 - A bearing extractor

During assembly bearings cannot be subjected to direct blows.
The aid used to press or strike the bearing should be applied to the inner ring.

4.3 Air Gap Checking (Large Rating Open Motors)

Upon the completion of any work on the bearings check the gap measurement between the stator and the rotor using the appropriate gazes.
The gap variation at any two vertically opposite points must be less than 10% of the average gap measurement.

4.4 Explosion Proof Motor Repair Steps

4.4.1 Objective

In view of the heavy liability associated with burning of motors of this type, this product has been designed and manufactured to high technical standards, under rigid controls. In addition, in many areas it is required that explosion proof motors ONLY be repaired by licensed personnel or in licensed facilities authorized to do this type of work. The following general procedures, safeguards, and guidelines must be followed in order to ensure repaired explosion proof motors operate as intended.

4.4.2 Repair Procedure and Precautions

Dismantle the damaged motor with appropriate tools without hammering and/or pitting machined surfaces such as enclosure joints, fastening

holes, and all joints in general.
The position of the fan cover should be suitably marked prior to removal so as to facilitate reassembly later on.
Examine the motor's general condition and, if necessary, disassemble all parts and clean them with kerosene. Under no circumstances should scrapers, emery papers or tools be used that could affect the dimensions of any part during cleaning.
Protect all machined parts against oxidation by applying a coating of vaseline or oil immediately after cleaning.

STRIPPING OF WINDINGS

This step requires great care to avoid knocking and/or denting of enclosure joints and, when removing the sealing compound from the terminal box, damage or cracking of the frame.

IMPREGNATION

Protect all frame threads by inserting corresponding bolts, and the joint between terminal box and frame, by coating it with a non-adhesive varnish (ISO 287 - ISOLASIL).
Protective varnish on machined parts should be removed soon after treating with impregnating varnish. This operation should be carried out manually without using tools.

ASSEMBLY

Inspect all parts for defects, such as cracks, joint incrustations, damaged threads and other potential problems.
Assemble using a rubber headed mallet and a bronze bushing after ascertaining that all parts are perfectly fitted.
Bolts should be positioned with corresponding spring washers and evenly tightened.

TESTING

Rotate the shaft by hand while examining for any drag problems on covers or fastening rings.
Carry out running tests as for standard motors.

MOUNTING THE TERMINAL BOX

Prior to fitting the terminal box all cable outlets on the frame should be sealed with a sealing compound (I^{st} layer) and an Epoxy resin (ISO 340) mixed with ground quartz (2^{nd} layer) in the following proportions:

340A resin	50 parts
340B resin	50 parts
Ground quartz	100 parts

Drying time for this mixture is two hours during which the frame should not be handled and cable outlets should be upwards.
When dry, see that the outlets and areas around the cables are perfectly sealed.
Mount the terminal box and paint the motor.

4.4.3 Miscellaneous Recommendations

- Any damaged parts (cracks, pittings in machined surfaces, defective threads) must be replaced and under no circumstances should attempts be made to recover them.
- Upon reassembling explosion proof motors IPW55 the substitution of all seals is mandatory.
- Should any doubts arise, consult WEG.

5. Malfunctioning

Most malfunctions affecting the normal running of electric motors can be prevented by maintenance and the appropriate precautions.
While ventilation, cleanliness and careful maintenance are the main factors ensuring long motor life, a further essential factor is the prompt attention to any malfunctioning as signalled by vibrations, shaft knock, declining insulation resistance, smoke or fire, sparking or unusual slip ring or brush wear, sudden changes of bearing temperatures.
When failures of an electric or mechanical nature arise, the first step to be taken is to stop the motor and subsequent examination of all mechanical and electrical parts of the installation.
In the event of fire, the installation should be isolated from the mains supply, which is normally done by turning off the respective switches.
In the event of fire within the motor itself, steps should be taken to restrain and suffocate it by covering the ventilation vents.
To extinguish a fire, dry chemical or $C0_2$ extinguishers should be used - never water.

5.1 Standard Three-Phase Motor Failures

Owing to the widespread usage of asynchronous three-phase motors in industry which are more often repaired in the plant workshops, there follows a summary of possible failures and their probable causes, detection and repairs.
Motors are generally designed to Class B or F insulation and for ambient temperatures up to 40°C.
Most winding defects arise when temperature limits, due to current overload, are surpassed throughout the winding or even in only portions thereof. These defects are identified by the darkening or carbonizing of wire insulation.

5.1.1 Short Circuits Between Turns

A short circuit between turns can be a consequent of two coinciding insulation defects, or the result of defects arising simultaneously on two adjacent wires. As wires are randomly tested, even the best quality wires can have weak spots. Weak spots can, on occasion, tolerate a voltage surge of 30% at the time of testing for shorting between turns, and later fail due to humidity, dust or vibration.
Depending on the intensity of the short, a magnetic hum becomes audible.
In some cases, the three-phase current imbalance can be so insignificant that the motor protective device fails to react. A short circuit between turns, and phases to ground due to insulation failure is rare, and even so, it nearly always occurs during the early stages of operation.

5.1.2 Winding Failures

a) One burnt winding phase

This failure arises when a motor runs wired in delta and current fails in one main conductor.
Current rises from 2 to 2.5 times in the remaining winding with a simultaneous marked fall in speed. If the motor stops, the current will increase from 3.5 to 4 times its rated value.
In most instances, this defect is due to the absence of a protective switch, or else the switch has been set too high.

b) Two burnt winding phases

This failure arises when current fails in one main conductor and the motor winding is star-connected. 0ne of the winding phases remains currentless while the others absorb the full voltage and carry an excessive current.
The slip almost doubles.

c) Three burnt winding phases

Probable cause 1
Motor only protected by fuses; an overload on the motor will be the cause of the trouble.
Consequently, progressive carbonizing of the wires and insulation culminate in a short circuit between turns, or a short against the frame occurs.
A protective switch placed before the motor would easily solve this problem.

Probable cause 2
Motor incorrectly connected. For example: A motor with windings designed for 230/400V is connected through a star-delta switch to 400V connection.
The absorted current will be so high that the winding will burn out in a few seconds if the fuses or a wrongly set protective switch fail to react promptly.

Probable cause 3
The star-delta switch is not commutated and the motor continues to run for a time connected to the star under overload conditions.
As it only develops 1/3 of its torque, the motor cannot reach rated speed. The increased slip results in higher ohmic losses arising from the Joule effect. As the stator current, consistent with the load, may not exceed the rated value for the delta connection, the protective switch will not react.
Consequent to increased winding and rotor losses the motor will overheat and the winding burn out.

Probable cause 4
Failures from this cause arise from thermal overload, due to too many starts under intermittent operation or to an overly long starting cycle.
The perfect functioning of motor operating under these conditions is only assured when the following values are heeded:
a) number of starts per hour;
b) starting with or without load;
c) mechanical brake or current inversion;
d) acceleration of rotating masses connected to motor shaft;
e) load torque vs. speed during acceleration and braking.

The continuous effort exerted by the rotor during intermittent starting brings about heavier losses which provoke overheating.
Under certain circumstances with the motor idle there is a possibility that the stator winding is subjected to damage as a result of the

heating of the motor. In such a case, a slip ring motor is recommended as a large portion of the heat (due to rotor losses) is dissipated in the rheostat.

5.1.3 Rotor Failures

If a motor running under load conditions produces a noise of varying intensity and decreasing frequency while the load is increased, the reason, in most cases, will be an unsymmetrical rotor winding.
In squirrel-cage motors the cause will nearly always be a break in one or more of the rotor bars; simultaneously, periodical stator current fluctuations may be recorded. As a rule, this defect appears only in molded or die cast aluminum cages.
Failures due to spot heating in one or another of the bars in the rotor stack are identified by the blue coloration at the affected points.
Should there be failures in various contiguous bars, vibrations and shuddering can occur as if due to an unbalance, and are often interpreted as such. When the rotor stack acquires a blue or violet coloration, it is a sign of overloading.
This can be caused by overly high slip, by too many starts or overlong starting cycles. This failure can also arise from insufficient main voltage.

5.1.4 Bearing Failures

Bearing damage is a result of overloading brought about by an overly taut belt or axial impacts and stresses.
Underestimating the distance between the drive pulley and the driven pulley is a common occurrence.
The arc of contact of the belt on the drive pulley thus becomes inadmissibly small and thereby belt tension is insufficient for torque transmission.
In spite of this it is quite usual to increase belt tension in order to attain sufficient drive.
Admittably, this is feasible with the latest belt types reinforced by synthetic materials.
However, this practice fails to consider the load on the bearing and the result is bearing failure within a short time.
Additionally there is the possibility of the shaft being subjected to unacceptably high loads when the motor is fitted with a pulley that is too wide.

5.1.5 Shaft Fractures

Although bearings traditionally constitute the weaker part, and the shafts are designed with wide safety margins, it is not beyond the realm of possibility that a shaft may fracture by fatigue from bending stress brought about by excessive belt tension.
In most cases, fractures occur right behind the drive end bearing.
As a consequence of alternating bending stress induced by a rotating shaft, fractures travel inwards from the outside of the shaft until the point of rupture is reached when resistance of the remaining shaft cross-section no longer suffices.
Avoid additional drilling the shaft (fastening screw holes) as such operations tend to cause stress concentration.

5.1.6 Unbalanced V-Belt Drives

The substitution of only one of a number of other parallel belts on a drive is frequently the cause of shaft fractures, as well as being malpractice.
Any used, and consequently stretched belts retained on the drive, especially those closest to the motor, while new and unstretched belts are placed on the same drive turning farther from the bearing, can augment shaft stress.

5.1.7 Damage Arising from Poorly Fitted Transmission Parts or Improper Motor Alignment

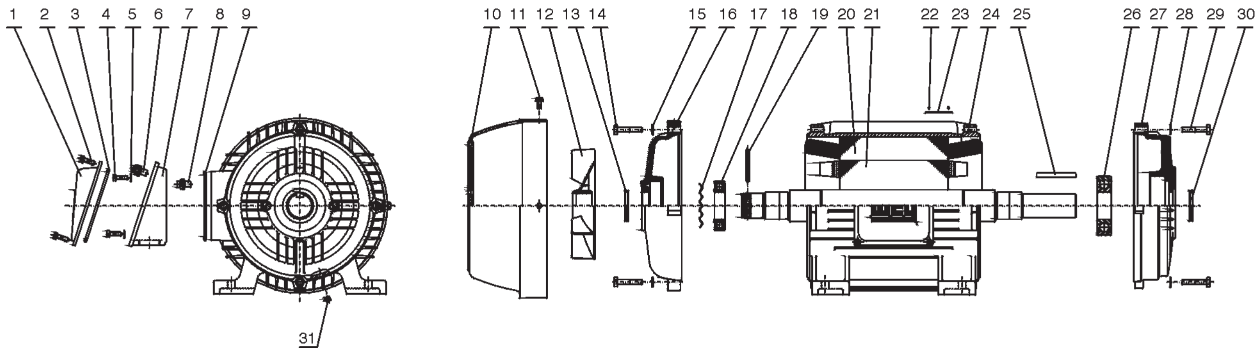
Damage to bearing and fracture in shafts often ensue from inadequate fitting of pulleys, couplings or pinions. There parts “knock” when rotating. The defect is recognized by the scratches that appear on the shaft or the eventual scalelike flaking of the shaft end.
Keyways with edges pitted by loosely fitted keys can also bring about shaft failures.
Poorly aligned couplings cause knocks and radial and axial shaking to shaft and bearings.
Within a short while these malpractices cause the deterioration of the bearings and the enlargement of the bearing cover bracket located on the drive end side.
Shaft fracture can occur in more serious cases.

5.2 Troubleshooting chart

FAILURE	PROBABLE CAUSE	CORRECTIVE MEASURES
Motor fails to start	• No voltage supply • Low voltage supply • Wrong control connections • Loose connection at some terminal lug • Overload	• Check feed connections to control system and from this to motor. • Check voltage supply and ascertain that voltage remains within 10% of the rated voltage shown on the motor nameplate. • Compare connections with the wiring diagram on the motor nameplate. • Tighten all connections. • Try to start motor under no-load conditions. If it starts, there may be an overload condition or a blocking of the starting mechanism. Reduce load to rated load level and increase torque.
High noise level	• Unbalance • Distorted shaft • Incorrect alignment • Uneven air gap • Dirt in the air gap • Extraneous matter stuck between fan and motor casing • Loose motor foundation • Worn bearings	• Vibrations can be eliminated by balancing rotor. If load is coupled directly to motor shaft, the load can be unbalanced. • Shaft key bent; check rotor balance and eccentricity. • Check motor aligment with machine running. • Check shaft for warping or bearing wear. • Dismantle motor and remove dirt or dust with jet of dry air. • Dismantle motor and clean. Remove trash or debris from motor vicinity. • Tighten all foundation studs. If necessary, realign motor. • Check lubrication. Replace bearing if noise is excessive and continuous.
Overheating of bearings	• Excessive grease • Excessive axial or radial strain on belt • Deformed shaft • Rough bearing surface • Loose or poorly fitted motor end shields • Lack of grease • Hardened grease cause locking of balls • Foreign material in grease	• Remove grease bleeder plug and run motor until excess grease is expelled. • Reduce belt tension. • Have shaft straightened and check rotor balance. • Replace bearings before they damage shaft. • Check end shields for close fit and tightness around circumference. • Add grease to bearing. • Replace bearings. • Flush out housings and relubricate.
Intense bearing vibration	• Unbalanced rotor • Dirty or worn bearing • Bearing rings too tight on shaft and/or bearing housing • Extraneous solid particles in bearing	• Balance rotor statically and dynamically. • If bearing rings are in perfect condition, clean and relubricate the bearing, otherwise, replace bearing. • Before altering shaft or housing dimensions, it is advisable to ascertain that bearing dimensions correspond to manufacturer's specifications. • Take bearing apart and clean. Reassemble only if rotating and support surfaces are unharmed.
Overheating of motor	• Obstructed cooling system • Overload • Incorrect voltages and frequecies • Frequent inversions • Rotor dragging on stator • Unbalanced electrical load (burnt fuse, incorrect control)	• Clean and dry motor; inspect air vents and windings periodically. • Check application, measuring voltage and current under normal running conditions. • Compare values on motor nameplate with those of mains supply. Also check voltage at motor terminals under full load. • Exchange motor for another that meets needs. • Check bearing wear and shaft curvature. • Check for unbalanced voltages or operation under single-phase condition.

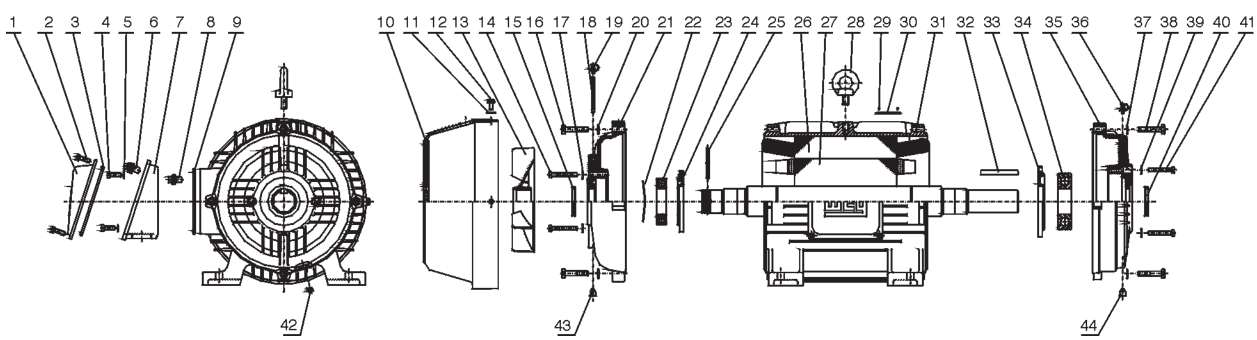
6. Spare Parts and Component Terminology

THREE-PHASE MOTORS IP55 NEMA
Frames 140T - W180T - 180T - 210T and W210T



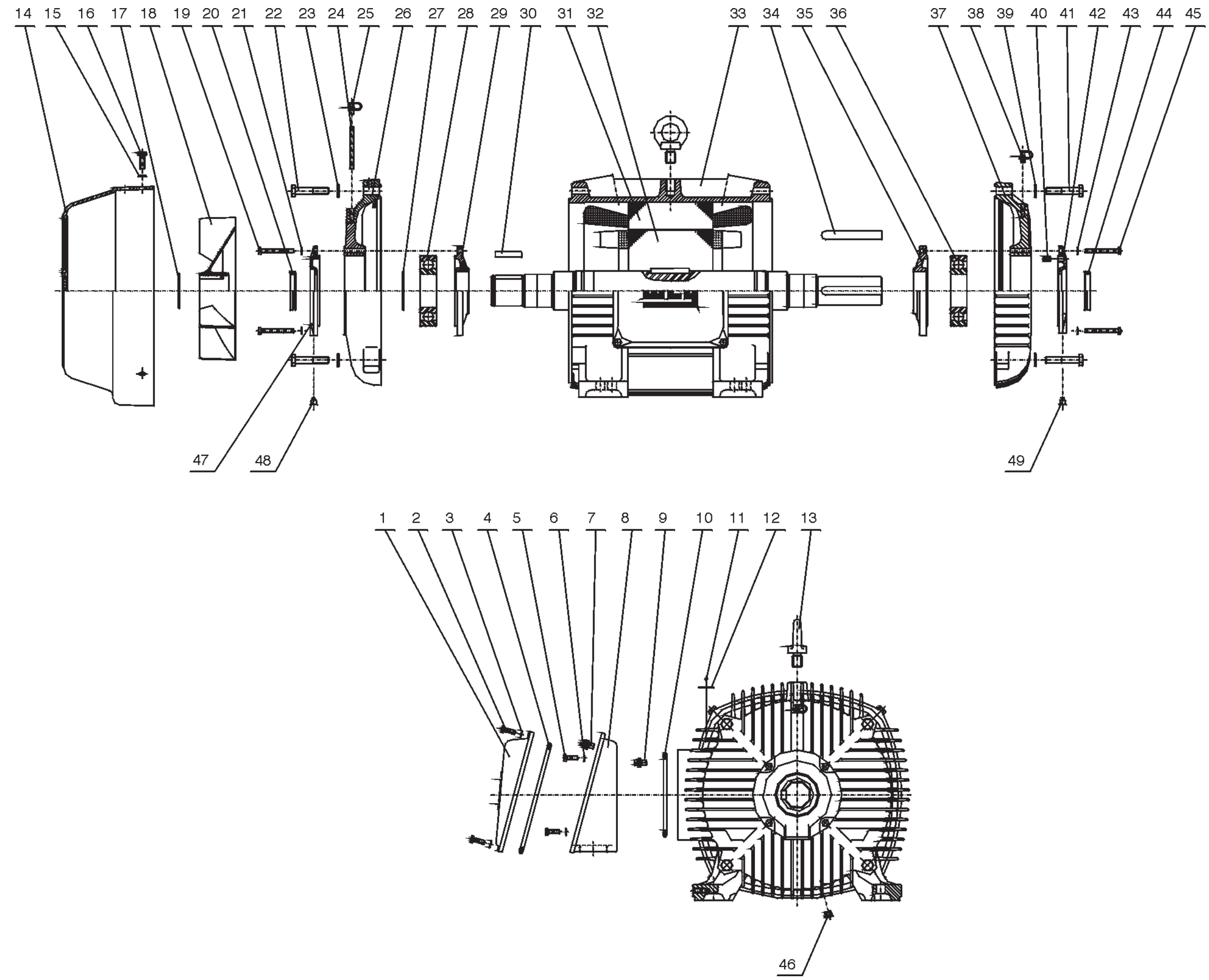
Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover gasket
4	Terminal box fixing bolt
5	Terminal box fixing washer
6	Terminal box grounding lug
7	Terminal box
8	Frame grounding lug
9	Terminal box o'ring gasket
10	Fan cover
11	Fan cover fixing bolt
12	Fan
13	V'Ring
14	Non-drive end endshield fixing bolt
15	Non-drive end endshield washer
16	Non-drive endshield
17	Spring washer
18	Non-drive bearing
19	Fan fixing pin
20	Wound stator
21	Rotor / shaft assembly
22	Nameplate fixing rivet
23	Nameplate
24	Frame
25	Shaft key
26	Drive end bearing
27	Drive endshield
28	Drive endshield washer
29	Drive end endshield fixing bolt
33	V'Ring
31	Drain plug

THREE-PHASE MOTORS IP55 NEMA
Frames 250T - W250T - 280T and 320T



Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover gasket
4	Terminal box fixing bolt
5	Terminal box fixing washer
6	Terminal box grounding lug
7	Terminal box
8	Frame grounding lug
9	Terminal box o'ring gasket
10	Fan cover
11	Fan cover washer
12	Fan cover fixing bolt
13	Fan
14	Non-drive end bearing cap bolt
15	V'Ring
16	Non-drive end endshield fixing bolt
17	Non-drive end bearing cap washer
18	Non-drive end grease nipple
19	Non-drive end grease nipple cover
20	Non-drive end endshield washer
21	Non-drive endshield
22	Spring washer
23	Non-drive end bearing
24	Non-drive end bearing cap
25	Fan fixing pin
26	Wound stator
27	Rotor and shaft
28	Eyebolt
29	Nameplate fixing rivet
30	Nameplate
31	Frame
32	Shaft key
33	Drive end bearing cap
34	Drive end bearing
35	Drive andshield
36	Drive end grease nipple cover
37	Drive endshield washer
38	Drive end endshield fixing bolt
39	Drive end bearing cap washer
40	V'Ring
41	Drive end bearing cap fixing bolt
42	Drain plug
43	Non-drive and grease relief
44	Drive end grease relief

THREE-PHASE MOTORS IP55 NEMA T
Frames 360T - 400T - 440T - 500T and 580T

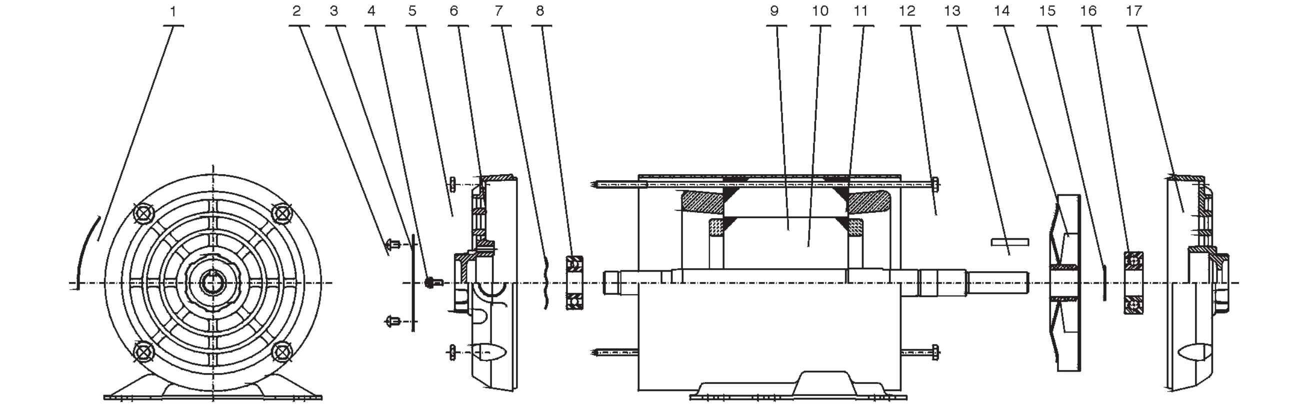


Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover washer
4	Terminal box cover gasket
5	Terminal box fixing bolt
6	Terminal box fixing washer
7	Terminal box grounding lug
8	Terminal box
9	Frame grounding lug
10	Terminal box o'ring gasket
11	Nameplate fixing rivet
12	Nameplate
13	Eyebolt
14	Fan cover
15	Fan cover washer
16	Fan cover fixing bolt
17	Fan fixing ring

Part Nr.	Description
18	Fan
19	Non-drive end bearing cap bolt
20	V'Ring
21	Non-drive end bearing cap washer
22	Non-drive end endshield fixing bolt
23	Non-drive end endshield washer
24	Non-drive end grease nipple
25	Non-drive end grease nipple cover
26	Non-drive enshield
27	Bearing cap
28	Non-drive bearing
29	Internal non-drive end bearing cap
30	Fan fixing key
31	Wound stator
32	Rotor / shaft assembly
33	Frame

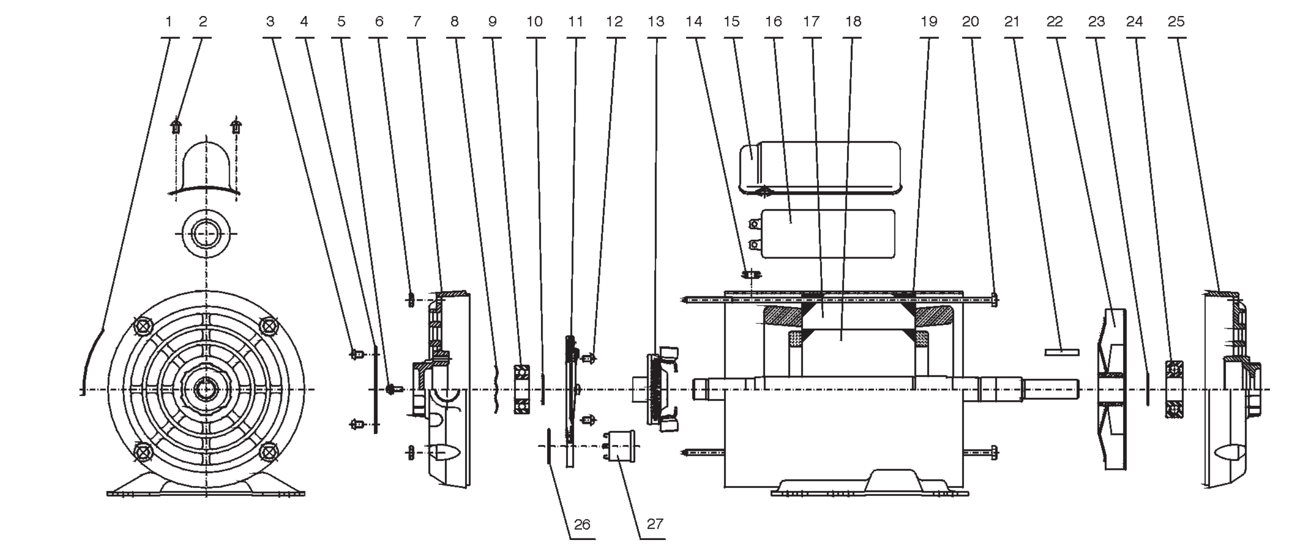
Part Nr.	Description
34	Shaft key
35	Internal drive end bearing cap
36	Drive end bearing
37	Drive endshield
38	Drive end grease nipple cover
39	Drive endshield washer
40	Pre-load spring
41	Drive end endshield fixing bolt
42	External drive end bearing cap
43	Drive end bearing cap washer
44	V'Ring
45	Drive end bearing cap fixing bolt
46	Drain plug
47	External non-drive end bearing cap
48	Non drive end grease relief
49	Non-drive end grease relief

THREE-PHASE MOTORS NEMA 56
Frames A56 - B56 - D56 - F56H and G56H



Part Nr.	Description
1	Sticker
2	Terminal box cover fixing bolt
3	Terminal box cover
4	Grounding lug
5	Through bolt fastening nut
6	Non-drive endshield
7	Spring washer
8	Non-drive end bearing
9	Wound stator
10	Rotor / shaft assembly
11	Frame
12	Through bolt
13	Shaft key
14	Fan
15	Drive end bearing fastening washer
16	Drive end bearing
17	Drive endshield

SINGLE-PHASE MOTORS NEMA 56
Frames B48 - C48 - C56 - A56 - B56 - D56 - F56H - G56H



Part Nr.	Description
1	Sticker
2	Capacitor cover fixing bolt
3	Terminal box cover fixing bolt
4	Terminal box cover
5	Grounding lug
6	Through bolt fastening nut
7	Non-drive endshield
8	Spring washer
9	Non-drive and bearing
10	Non-drive and bearing fastening washer
11	Stationary switch
12	Stationary switch fastening bolt
13	Centrifugal switch
14	Rubber ring for lead passing hole to capacitor
15	Capacitor cover
16	Capacitor
17	Wound stator
18	Rotor / shaft assembly
19	Frame
20	Through bolt
21	Shaft key
22	Fan
23	Drive end bearing fastening washer
24	Drive end bearing
25	Drive endshield
26	Overload thermal protector fixing ring
27	Overload thermal protector

Note: *For F56H and G56H frame motors: 1) Part nr. 2 = 3 pieces; 2) Part nr. 15 and 16 = 2 pieces*

NOTES:

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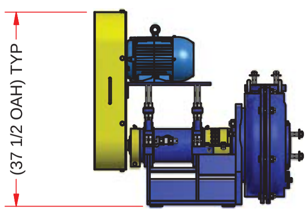
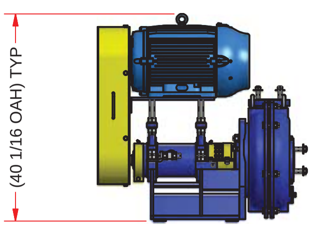
DESCRIPTION: GENERAL ARRANGEMENT 3" X 3" PUMP ASSEMBLY TYPICAL FOR ALL GLANDS & LININGS TABLE MOUNTED MOTORS (5-30 HP) REFERENCE DWG: N/A		DESIGNED BY: BFERRELL	ORIGIN: TN	DWG SIZE: B
		DRAWN BY: BFERRELL	DATE: 12/2/2013	SCALE: AS NOTED
		CHECKED BY: BFERRELL	DATE: 12/2/2013	SHEET#: 1 /1
PART NUMBER: 3X3GA	WEIGHT: AS NOTED	DRAWING NUMBER: 3X3GA		REV: 00

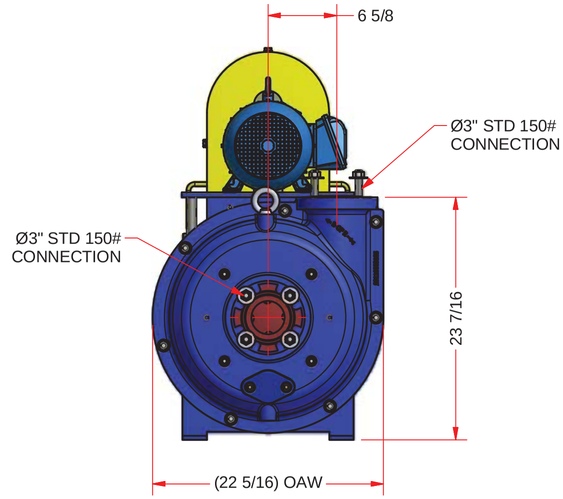
NOTE: CRANE & CRAWL ASSEMBLY NOT SHOWN HEREIN



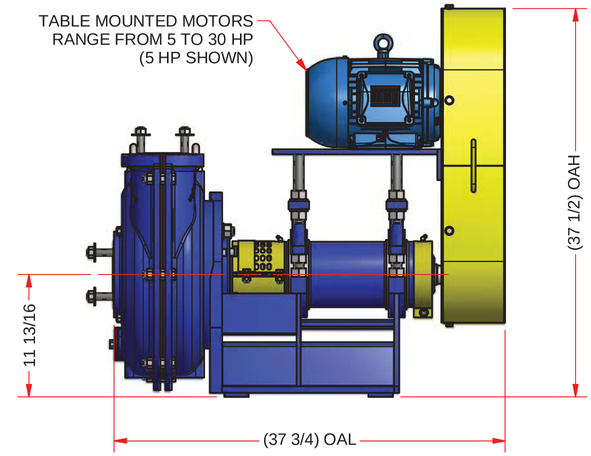
7.5 - 10 HP MOTORS
ESTIMATED WEIGHTS:
7.5 HP MOTOR = 899.0 LBS
10 HP MOTOR = 917.0 LBS
SCALE 1:24



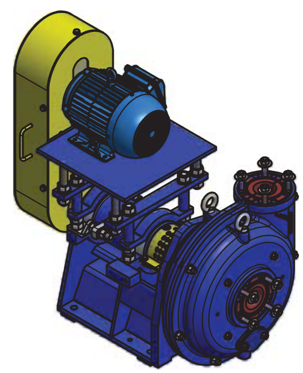
15 - 30 HP MOTORS
ESTIMATED WEIGHTS:
15 HP MOTOR = 996.0 LBS
20 HP MOTOR = 1,036.0 LBS
25 HP MOTOR = 1,133.0 LBS
30 HP MOTOR = 1,182.0 LBS
SCALE 1:24



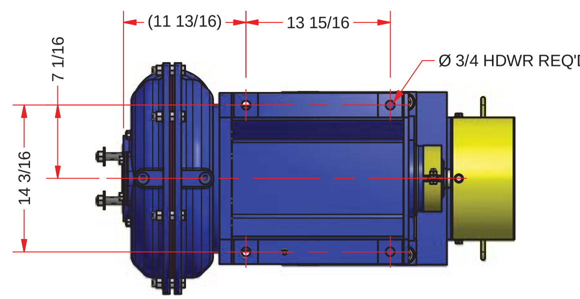
FRONT
ESTIMATED WEIGHT: 840.0 LBS
SCALE 1:12



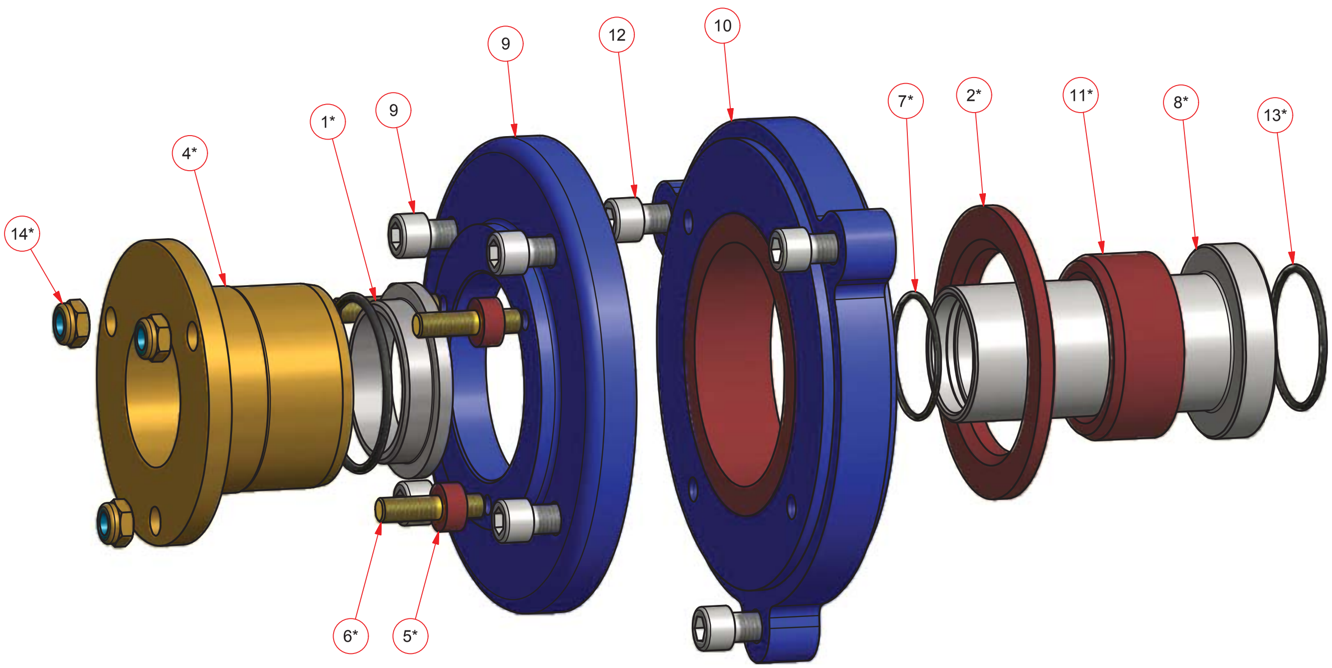
SIDE



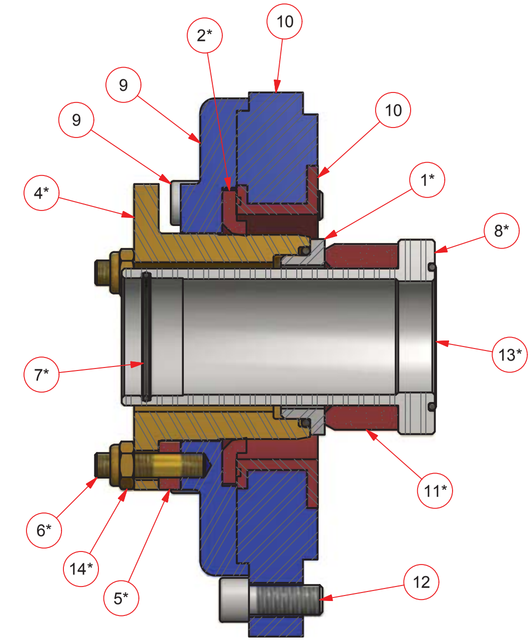
ISOMETRIC
NTS



BOTTOM
FOOT PRINT



EXPLODED ASSEMBLY
SCALE 1:2



SECTION A-A
SCALE 1:2

NOTE: REPAIR KIT 09110203321 ITEMS MARKED WITH AN ASTERISK *.

MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION	LBS	TOTAL LBS
1*	1	09110002311	CERAMIC WEAR FACE KIT	0.2	0.2
			C/W CERAMIC FACE, O-RING & EPOXY		
2*	1	09110002335	SEAL, DRY GLAND, NITRILE	0.1	0.1
9	1	09110003302	GLAND COVER, DRY GLAND	6.0	6
4*	1	09110003303	SLEEVE, AD□USTING, DRY GLAND	4.1	4.1
5*	3	09110003304	WASHER, DRY GLAND	0.0	0
6*	1	09110003306	STUD SET, AD□USTING	0.2	0.2
7*	1	09110003307	O-RING, 48 □□ I.D. X 2.4 □□	0.0	0

MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION	LBS	TOTAL LBS
8*	1	09110003308	SLEEVE, GLAND, DRY GLAND	2.2	2.2
9	1	09110003314	SCREW SET, COVER	0.4	0.4
10	1	09110003331	GLAND HOUSING, NITRILE	11.9	11.9
11*	1	09110003339	SEAL, FACE, DRY GLAND, NITRILE	0.1	0.1
12	1	09110003421	SCREW SET, HOUSING	0.3	0.3
13*	1	09110004307	O- RING, 54 □□ I.D. x 3 □□	0.0	0
14*	3	296220100	NUT, M10, HEX, BRASS, NYLON	0.0	0.1

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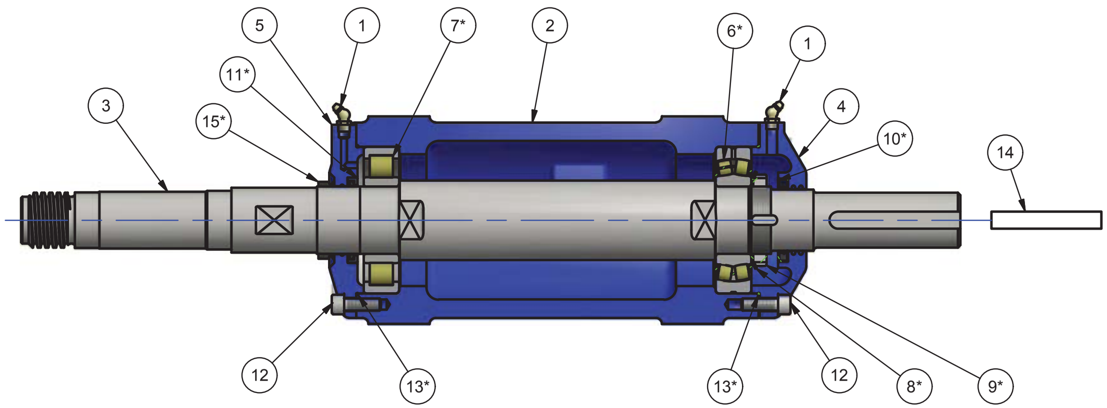
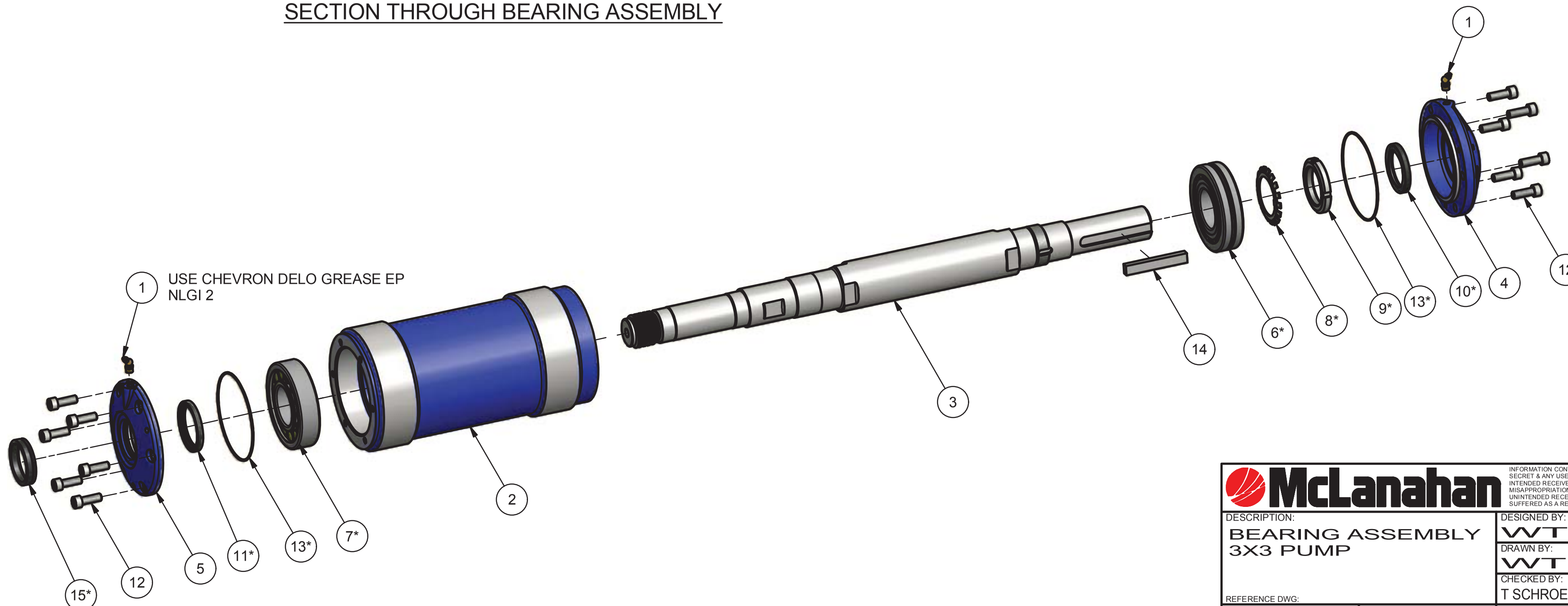
DESCRIPTION: ASSEMBLY DRAWING DRY GLAND NITRILE RUBBER 3X3 PUMP	DESIGNED BY: T SCHROEDER	ORIGIN: TN		DWG SIZE: B
	DRAWN BY: T SCHROEDER	DATE: 9/6/2013		SCALE: AS NOTED
REFERENCE DWG: N/A	CHECKED BY: T SCHROEDER	DATE: 9/6/2013		SHEET#: 1 /1
PART NUMBER: 09110203325	WEIGHT: 25.55 LBS	DRAWING NUMBER: 09110203325		REV: 0



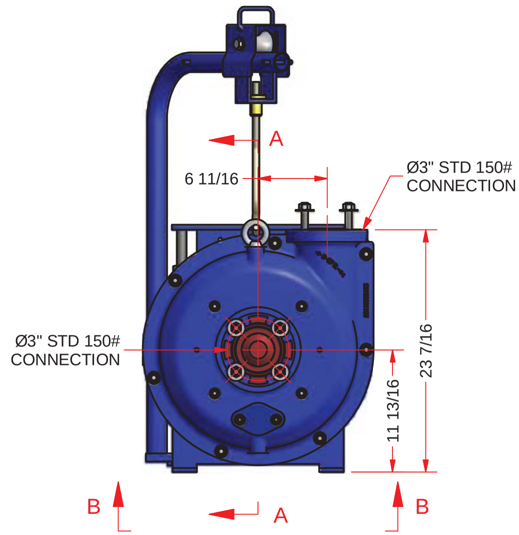
SECTION THROUGH BEARING ASSEMBLY

MATERIAL LIST					
ITE	QTY	PART NUMBER	DESCRIPTION	LBS.	TOTAL LBS.
1	2	09110002212	NIPPLE, GREASE	0.0	0.0
2	1	09110003201	BEARING HOUSING	45.8	45.8
3	1	09110003202	SHAFT	31.0	31.0
4	1	09110003203	COVER, END	5.2	5.2
5	1	09110003204	COVER, FRONT	4.4	4.4
6*	1	09110003205	BEARING, END	0.5	0.5
7*	1	09110003206	BEARING, FRONT	0.4	0.4
8*	1	09110003207	WASHER, TAB	0.1	0.1
9*	1	09110003208	NUT, LOCK	0.4	0.4
10*	1	09110003209	SEAL, END, GREASE	0.0	0.0
11*	1	09110003210	SEAL, FRONT, GREASE	0.0	0.0
12	12	09110003211	SOCKET HEAD CAP SCREW - M10x1.5x30	0.1	0.8
13*	2	09110003213	O-RING, 2MM DIA X 119MM ID, SEAL, BEARING HOUSING	0.0	0.0
14	1	09110003215	KEY, SHAFT, 89.83 MM X 9.10 MMX 13.95 MM	0.2	0.2
15*	1	09110003217	SEAL, VEE	0.0	0.0

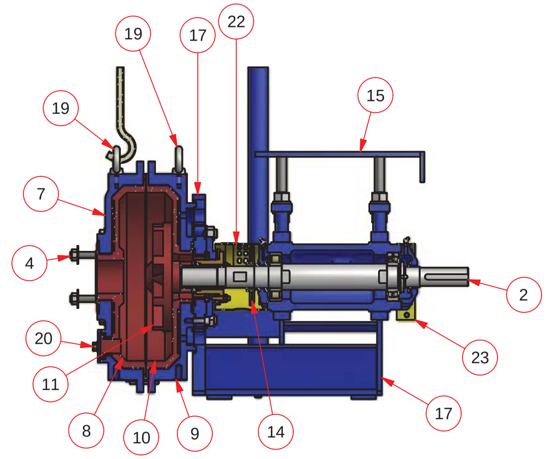
NOTE: REPAIR KIT 09110003225 INCLUDES ITEMS MARKED WITH "*"



DESCRIPTION: BEARING ASSEMBLY 3X3 PUMP		DESIGNED BY: WTD	ORIGIN: TN	DWG SIZE: B
		DRAWN BY: WTD	DATE: 7/23/2010	SCALE: AS NOTED
REFERENCE DWG:		CHECKED BY: T SCHROEDER	DATE: 3/18/2013	SHEET#: 1 /1
PART NUMBER: 09110003116	WEIGHT: 88.86 LBS	DRAWING NUMBER: 09110003116		REV: 00



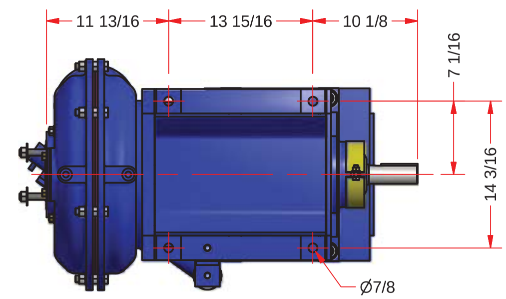
FRONT
SCALE 1:12



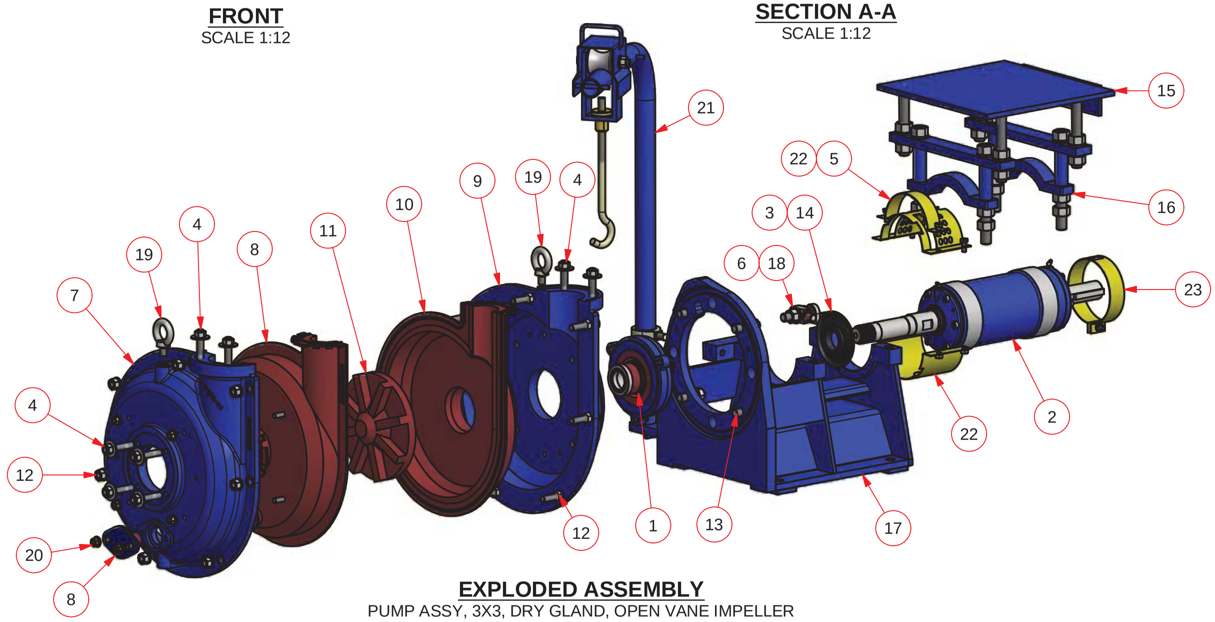
SECTION A-A
SCALE 1:12

MATERIAL LIST					
ITEM	QTY	PART NUMBER	DESCRIPTION	LBS	TOTAL LBS
1	1	09110203325	DRY GLAND ASSEMBLY (NITRILE)	25.6	25.6
2	1	09110003116	BEARING ASSEMBLY	88.9	88.9
3	1	09110002001	CLAMP, SS	0.1	0.1
4	1	09110002125	STUD SET, FLANGE	3.6	3.6
5	1	09110002137	PROTECTIVE STRIP	0.3	0.3
6	1	09110003035	WASHER, AXIAL POSITIONING JACK	0.0	0
7	1	09110003105	CASING, SUCTION SIDE	98.5	98.5
8	1	09110003133	LINER, SUCTION SIDE, C/W DRAIN PLUG & HARDWARE, (NITRILE)	15.4	15.4
9	1	09110003108	CASING, GLAND SIDE	105.0	105
10	1	09110003134	LINER, GLAND SIDE C/W HARDWARE (NITRILE)	14.5	14.5
11	1	09110003135	IMPELLER, OPEN VANE (NITRILE)	17.8	17.8
12	1	09110003111	BOLT SET, CASING	3.6	3.6
13	1	09110003113	STUD SET, CASING TO PEDESTAL	2.5	2.5
14	1	09110003115	FLINGER	0.2	0.2
15	1	09110003117	MOTOR TABLE	74.3	74.3
16	2	09110003118	PEDESTAL CAP	4.4	8.7
17	1	09110003119	PEDESTAL	149.1	149.1
18	1	09110003120	JACK, AXIAL POSITIONING	2.6	2.6
24	3	09110003121	SCREW SET, HOLDING	0.3	0.9
19	2	09110003122	EYEBOLT, CASING	0.8	1.5
20	1	09110003126	STUD SET, DRAIN PLUG	0.2	0.2
21	1	09110003127	CRANE & CRAWL ASSEMBLY, 3X3	28.1	28.1
22	1	09110003130	GUARD, SHAFT	2.1	2.1
23	1	09110003139	GUARD, PULLEY SHAFT	0.7	0.7

NOTE: P/N 09110003129 NOT SHOWN, SHAFT SPANNER USED FOR MAINTENANCE



VIEW B-B
SCALE 1:12



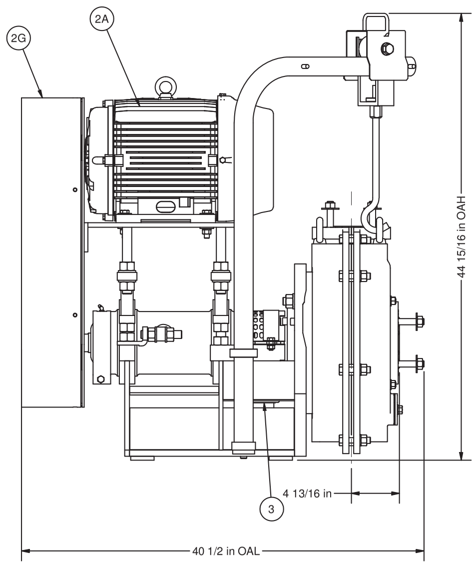
EXPLODED ASSEMBLY
PUMP ASSY, 3X3, DRY GLAND, OPEN VANE IMPELLER
SCALE 1:12

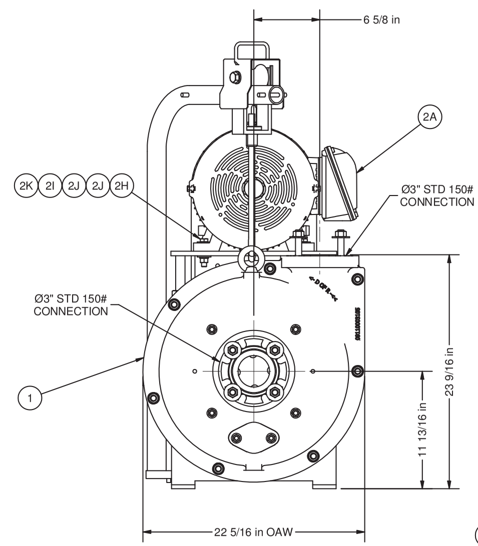
McLanahan

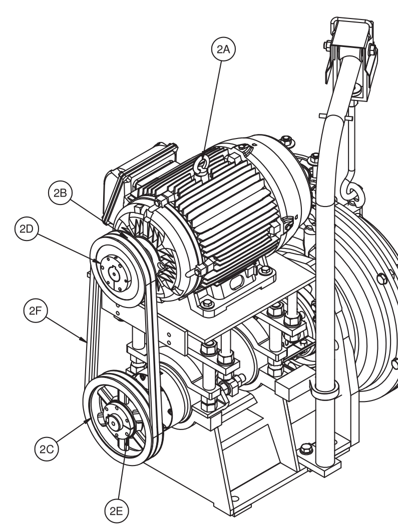
DESCRIPTION:	DESIGNED BY:	ORIGIN:	DWG SIZE:
ASSEMBLY DRAWING PUMP ASSEMBLY, 3X3 DRY GLAND, NITRILE LINERS, & OPEN VANE IMPELLER	T SCHROEDER	TN	B
	DRAWN BY: T SCHROEDER	DATE: 2/21/2014	SCALE: AS NOTED
REFERENCE DWG: N/A	CHECKED BY: T SCHROEDER	DATE: 2/24/2014	SHEET#: 1 /1
PART NUMBER: 09100203000 / WEIGHT: 719 LBS	DRAWING NUMBER: 09100203000		REV: 0

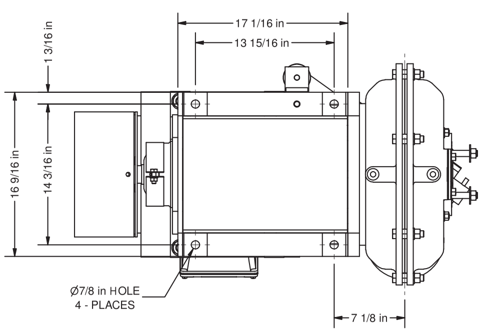
Bill Of Materials

Item	Qty.	Part Number	Description	Fin Wt
1	1	09100203000	PUMP ASSEMBLY, NITRILE, 3 IN X 3 IN DRY GLAND	717 lbmass
2	1	09710015084	DRIVE PACKAGE, 15 HP, 1,327 RPM, 575V, 254T TEFC, 45MM DRIVEN SHAFT	
2A	1	294315083	ELECTRIC MOTOR, 15HP, 1765 RPM, 575V, 3PH, 60HZ, 1.25 SF, 254T, TEFC, FOOT MOUNT, NEMA DES. B, CLASS F INS., 14.4 FLA, NEMA PREMIUM EFFECIENCY	291 lbmass
2B	1	2-937-40708	PULLEY, 7.35" O.D., 2-B GROOVES, "SK"	1 kg
2C	1	293740912	V-BELT PULLEY, 9.75" OD, 2-B GROOVES, MACHINED FOR "SK" BUSHING	13 lbmass
2D	1	2-938-00426	BUSHING, TYPE 'SK', 1-5/8" BORE	1 kg
2E	1	293890026	BUSHING, TYPE 'SK', 45MM BORE	3 lbmass
2F	2	293946058	V-BELT, BX58	1 lbmass
2G	1	09110003128	GUARD, BELT, 3 X 3 PUMP	35 lbmass
2H	4	294740840	CAPSCREW, HEX HEAD, 1/2" X 2-1/2", NC, GRADE 5, ZINC PLATED	1 lbmass
2I	4	296700800	WASHER, LOCK, 1/2", ZINC PLATED	0 lbmass
2J	8	296600800	WASHER, FLAT, 1/2", ZINC PLATED	0 lbmass
2K	4	296507080	NUT, HEX, 1/2", NC, GRADE 5, ZINC PLATED	0 lbmass
3	1	09110000000	DRIP TRAY, 5" X 9" X 1" DEEP, MAGNETIC MOUNTING, 1/2" HOSE CONNECTION	4 lbmass









NOTE: DRIVE GAURD ITEM #2G
REMOVED FOR CLARITY

UNLESS OTHERWISE NOTED, TOLERANCES ON DIMENSIONS ARE: .xx ±0.01 in; .xxx ±0.005 in; PROFILE/SAW ±1/16 in; FABRICATION ±1/8 in; ANGLE ±1°; SURFACE √125	McLanahan	WEIGHT 1,073#	SHEET NUMBER 1 OF 1	SCALE 1:8
		THIS DRAWING IS THE PROPERTY OF MCLANAHAN CORPORATION AND SHALL NOT BE USED OR COPIED EXCEPT AS EXPRESSLY AUTHORIZED. INFORMATION CONTAINED IN THIS DOCUMENT IS A TRADE SECRET AND ANY USE OF THE INFORMATION, EXCEPT BY ITS INTENDED RECEIVER, IS STRICTLY PROHIBITED AND MISAPPROPRIATION OF THE INFORMATION SHALL MAKE THE NONINTENDED RECEIVER LIABLE FOR ANY AND ALL DAMAGES SUFFERED AS A RESULT BY THE McLANAHAN CORPORATION.		DRAWN BY KAZ; CHECKED BY DEM
REFERENCES		THIRD ANGLE PROJECTION	ASSEMBLY DRAWING	APPROVED BY

PART NUMBER: 09106203013

DESCRIPTION: PUMP ASSY, 3 X 3 DRY GLAND, NITRILE LINERS C/W 15HP, 575V, 254T FRAME DRIVE PKG., 1,327 RPM, TOP VERT. DISCHG., & DRIP TRAY

1ST ISSUE DATE	SHEET SIZE	DRAWING NUMBER	REVISION
4/5/2017	C	09106203013	

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Mc LANAHAN

MODEL M3H-CR 1.5/1.5, MULTIFLO EXTRACTION PUMP (P2-014/023)

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McLanahan
585 Airport Road, Gallatin, TN 37066 USA Tel: +1 (615) 451 4440 Fax: +1 (615) 451 4461 mclanahan.com

May 22, 2018
VEOLIA WATER TECH
3901 RUE SARTELON
VILLE ST LAURENT QC H4S 2A6
CANADA

Thank you for your recent purchase of the following McLanahan equipment with your Purchase Order 18000888 HD referencing our Sales Order 114630.

This document contains important information regarding the installation & operations of your new equipment. Having recommended spare parts at your plant will assure minimum down time in order to perform periodic maintenance and will also eliminate the expense of air freight of critical parts. They are available for immediate shipment from our inventory.

When ordering parts, you will be required to provide the equipment's serial number.

- (2) PUMP ASSEMBLIES NITRILE, DRY GLAND 1.5X1.5 W/ DRIVE
  S/N: **20182147 -20182148**

We suggest you become familiar with the enclosed literature to ensure the proper installation of this equipment.

Should you have any questions regarding the installation and/or operation of the equipment you have purchased, please contact our Process Equipment Department at (615) 451-4440.

Sincerely,

McLanahan Corporation

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INSTALLATION, OPERATION & MAINTENANCE MANUAL

(2) PUMP ASSEMBLIES NITRILE, DRY GLAND 1.5X1.5 W/ DRIVE

PROJECT ID #20182147 -20182148

McLanahan®

WORLD HEADQUARTERS	200 Wall Street, Hollidaysburg, PA 16648 USA	Ph: +1 (814) 695 9807	Fax: +1 (814) 695 6684
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FLORIDA	6550 New Tampa Highway, Lakeland, FL 33815 USA	Ph: +1 (863) 667 2090	Fax: +1 (863) 667 0449
IOWA	800 First Avenue N.W., Cedar Rapids, IA 52405 USA	Ph: +1 (319) 365 0441	Fax: +1 (319) 369 5440
AUSTRALIA	16 Callistemon Close, Warabrook, NSW 2304 Australia	Ph: +02 49 248 248	Fax: +02 4926 2514
UNITED KINGDOM	Unit 15, Newman Lane, Alton, Hampshire, GU34 2QR, UK	Ph: +44 (0) 1420 542489	

mclanahan.com

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INSTALLATION, OPERATION & MAINTENANCE MANUAL

1.5 x 1.5 Nitrile Dry Gland Pump Assembly Manual

WORLD HEADQUARTERS 200 Wall Street, Hollidaysburg, PA 16648 USA Tel: +1 814-695-9807 Fax: +1 814-695-6684

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IOWA 800 First Avenue N.W., Cedar Rapids, IA 52405 USA Tel: +1 319-365-0441 Fax: +1 319-369-5440

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UNITED KINGDOM 11 Warren Rise, Frimley, Surrey, GU16 8SH UK Tel: +44 (0)7407 344757

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Table of Contents

Safety Precautions

Overview

READ THIS MANUAL IN ITS ENTIRETY BEFORE BEGINNING OPERATION.

- **DO NOT** install, operate or service this equipment (or any portion thereof) without fully understanding the information contained herein.
- **DO NOT** operate this equipment in any manner other than that for which it has been designed or approved.

NOTE: A copy of this manual **must** be provided to the operator of this equipment and **must** be kept with the equipment at all times.

The safety instructions presented throughout this manual do not supersede any other directives or practices associated with this equipment or its operation. Rather, they are to be used in addition to any other applicable guidelines set forth by governing bodies (ANSI, ISO, OSHA, MSHA, etc.), plant administrators, signs, tags or placards, etc. (Refer to the **TAGS** section of this manual for information regarding safety and instructional tags provided with the equipment.) In the event of conflicting information, **always use the guidelines providing the highest degree of protection/safety.**

The safety instructions used throughout this manual and on the equipment contain a “signal word” (CAUTION, WARNING or DANGER) that indicates the seriousness of the hazard as described below.

DANGER *indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.*

WARNING *indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.*

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

CAUTION *(used without the safety alert symbol) indicates a potentially hazardous situation, which, if not avoided, may result in property damage.*

The safety instructions listed below are general guidelines. Additional safety instructions are listed throughout this manual as required. **<u>All</u>** safety instructions **<u>must</u>** be followed at all times to ensure personal safety and to prevent equipment damage.

DANGER — **Verify that all personnel are clear of any/all moving or rotating parts** (or parts that are subject to movement or rotation) before installing, operating or servicing this equipment or any portion thereof.

WARNING — **Verify that all guards and safety devices are in place, secured and functional** before operating this equipment or any portion of it. **DO NOT** circumvent or disable any safety devices.

WARNING — **Lockout/Tagout all controls and secure all applicable components to prevent unexpected movement** before performing any maintenance, repairs or adjustments on this equipment or any portion thereof.

WARNING — **Lockout/Tagout power at the source** before accessing any electrical panels or devices on this equipment or before performing any maintenance or repairs to the power line(s) feeding this equipment.

CAUTION — Wear appropriate personal protective equipment at all times.

CAUTION — **Obey all safety tags and signs** and replace any that are illegible or missing.

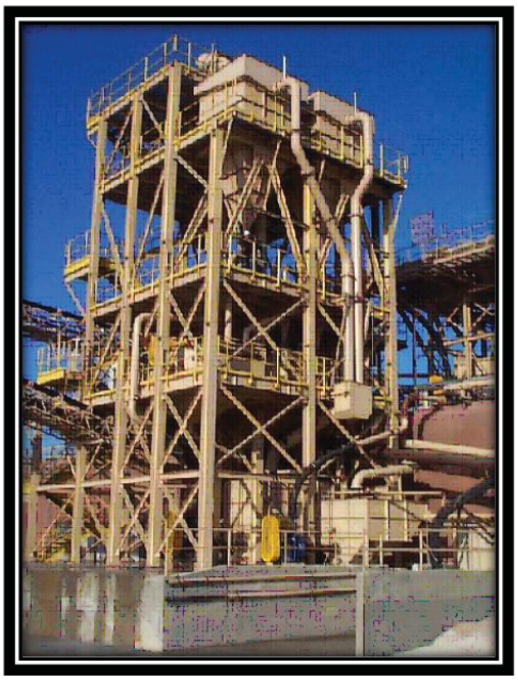
If any questions arise concerning the safe operation of this equipment, or if clarification of any information is required, cease operation and contact **McLanahan Corporation** immediately.

The McLanahan Pump

Introduction

The Aggregate Processing Division of McLanahan is a major manufacturer of process plants for the minerals industry. The McLanahan Model lllr is the latest generation of successful abrasion/corrosion-resistant slurry handling pumps.

This manual should be carefully read before attempting to install or operate this McLanahan Model lllr Pump.



Service, Selection and Support

Total Service

From design to installation and beyond, McLanahan engineers are available to give advice on your slurry pumping needs and solutions for your problems.

The McLanahan Model lllr range has been designed to offer a wide choice of pump sizes to suit most slurry pumping applications. A standard questionnaire is available to ensure that the most complex installation, as well as the more straightforward pumping application, receives individual consideration.

McLanahan can also advise on the ancillary components within the pumping system. The provision of low head loss valves, gland feed pumps, priming devices and flexible bends, all incorporating application specific linings for trouble-free life, are an important aspect of ensuring a totally successful pump installation.

Design Specifications and Options

The McLanahan Model lllr standard casing is designed for a maximum working pressure of 88psi (6 bar). A high pressure casing is available, rated at 272psi (18.5 bar). Please contact McLanahan for pressures higher than this.

The pump units in the McLanahan Model lllr range are designated by the size of suction and discharge ports. Units up to 4” (100mm) have equal size suction and discharge; above this, the Model lllr has a larger suction than discharge. Size is given in inches i.e. 8”/6” (200/150mm) Model lllr has an 8” (200mm) suction port and a 6” (150mm) discharge port.

Suction and discharge flanges are universal and, as a standard, are available in ASA150 drilling patterns. Other drilling patterns (metric & BS4504) are available to special order. Orientation of discharge to 4 positions according to installation requirements.

The McLanahan Model lllr pump components are designed and manufactured in accordance with appropriate International Quality Standards, such as ISO9000.

"Pumptec" Computer Software

Many complex calculations are needed in order to

- Size a pump
- Establish the optimum pipeline carrying velocity
- De-rate the pump for a slurry duty
- Calculate pipeline friction head losses
- Calculate power absorbed
- Analyze the system head

McLanahan Corporation uses unique software, **Pumptec,** to perform these calculations.

The pump is able to adapt to a change of V-belt sheave ratios and different speeds. However, it is **crucial** to recalculate duty parameters and check motor and drives to guarantee that they are not overloaded under any normal operating condition.

Please consult McLanahan Corporation before making any changes to your pump system to ensure the correct combination of speed and power is selected.

Input criteria required:

- Volume to be pumped
- Percent solids
- Gradation of solids (top size & 50% passing size)
- Specific Gravity of Solids
- Specific Gravity of Liquid
- Temperature of Liquid
- Elevation above sea level
- Height of liquid level in tank (**if negative suction**, height from liquid surface to center line of pump inlet)
- Vertical height from pump inlet to discharge point
- Pressure required at delivery point
- Pipe diameter (inside diameter important)
- Pipe material
- Pipe fittings – type and quantity

Pumptec: Computer Aided Support

To complement and facilitate optimum selection of your slurry system, McLanahan uses **Pumptec.**

This unique computer program:

- Analyzes the effects of changing slurry density
- Calculates the P_{50} particle size from a sieve analysis
- Calculates settling velocities and select pump sizes
- Calculates pipeline frictional losses in various pipe materials and pipe fittings
- Calculates the pump duty and selects a pump and drive based on input parameters
- Prints full application and selection data including NPSH, BEP, RPM, HP, etc.

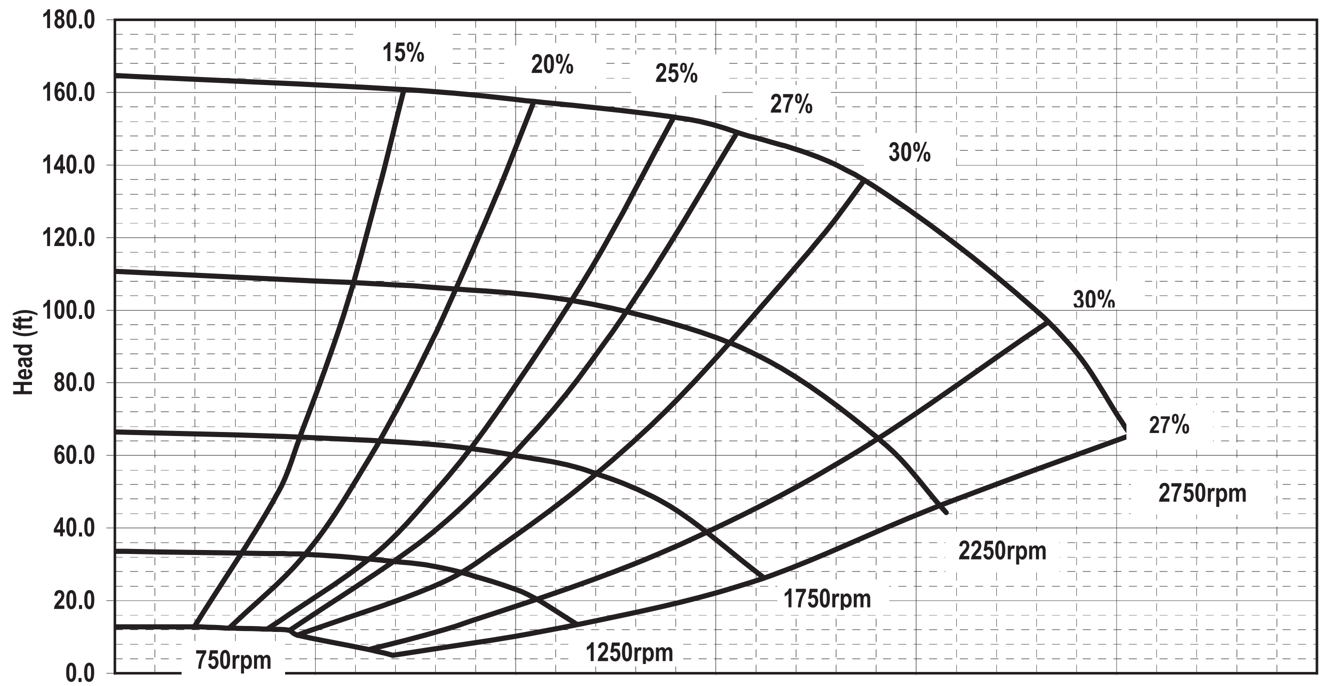
Troubleshooting is made easier using **Pumptec** Software to evaluate different scenarios.

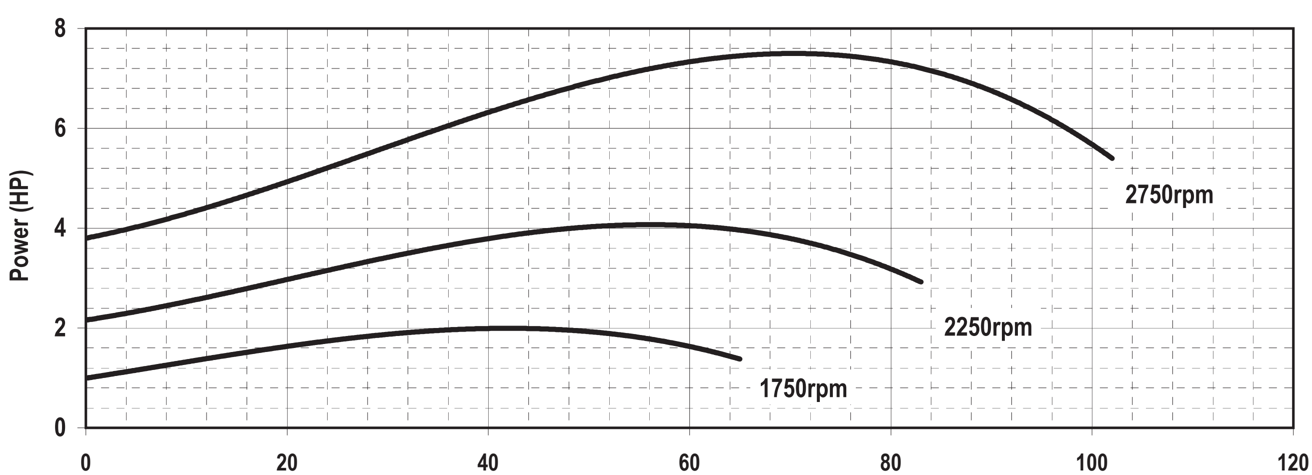
McLanahan
AGGREGATE PROCESSING DIVISION

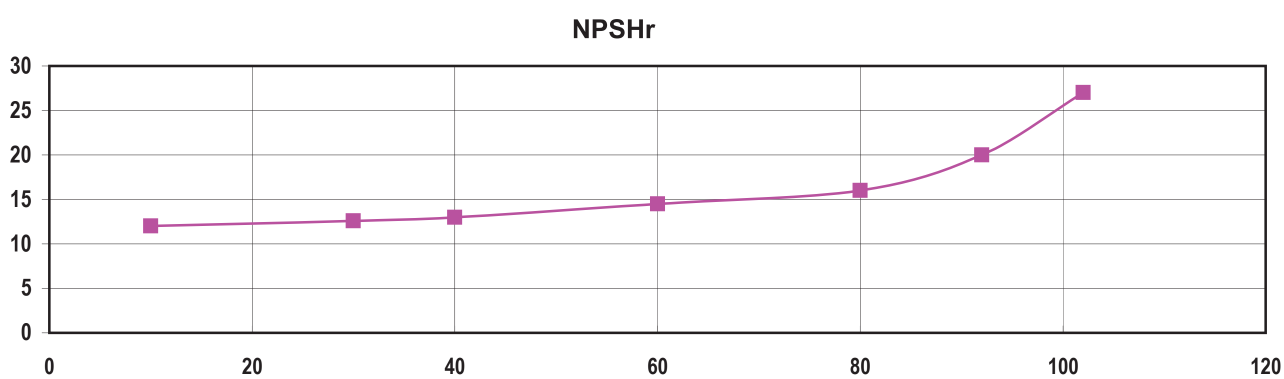
Standard Pump Curve

Linapump model 1.5/1.5 LPIIIr

Impellar Diameter	8"	Maximum Speed	2750rpm	Max. Solids size	$^{3}/_{8}$"	Curve No	B35.80
No. of Vanes	4	Maximum Power	30hp	Model	LP 1½" x 1½"	date	09-Oct-03



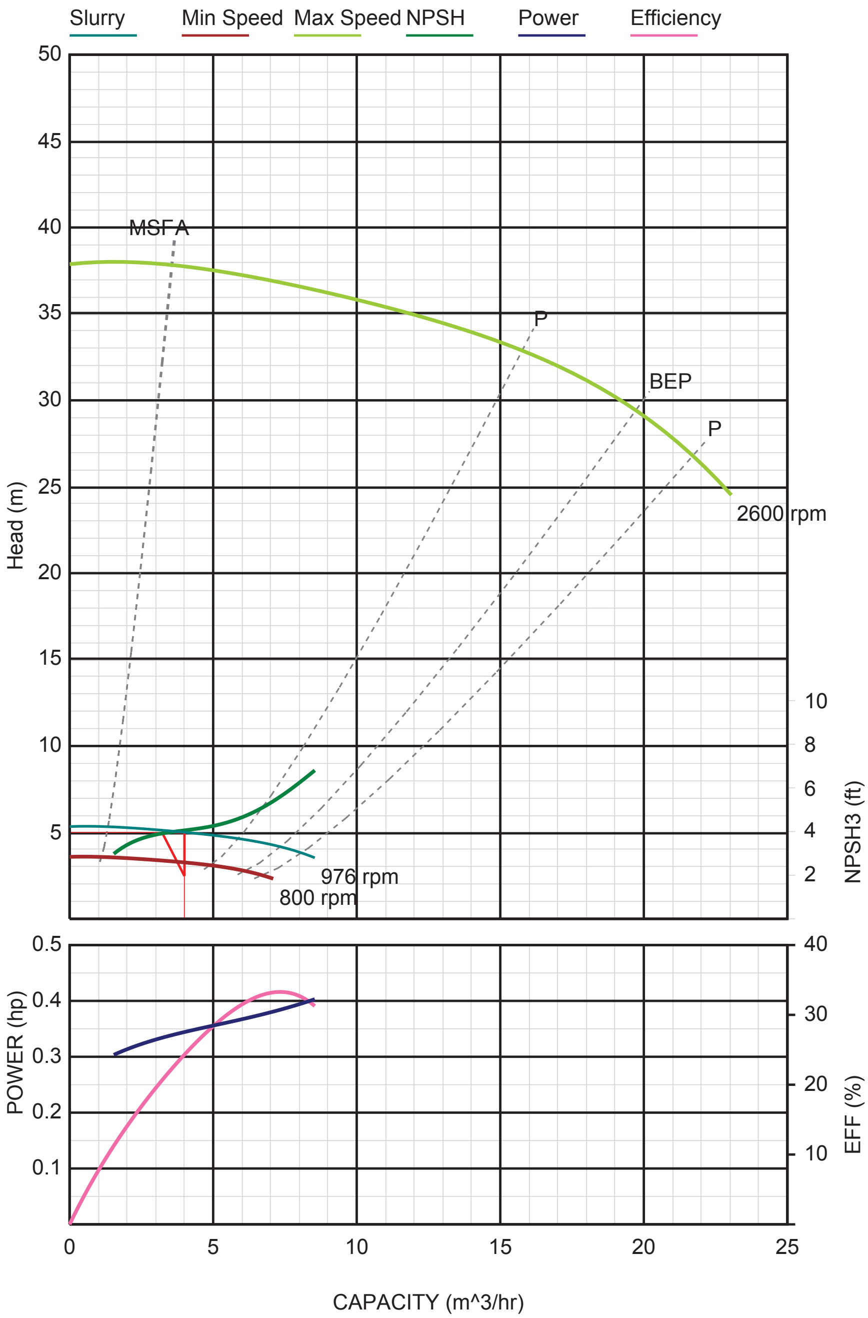




JMI - 5000218009 /

20180423-01, April 23, 2018

M3H-CR 1.5/1.5 , 976 rpm, 0.37 hp



Pump model: M3H-CR 1.5/1.5

Pump	
Pump range	-CR
Speed	976 rpm
Max Speed	2600 rpm
Efficiency @ BEP	33.24 %

Duty Point	
Flow	4 m^3/hr
Static Head	0 m
Total Head	5 m
Efficiency	24.3 %
NPSH required	2.23 ft
% of BEP	54.53 %
Power absorbed - @ Duty	0.344 hp
Motor size	0.37 hp
Tip Speed	33.1 ft/s
Impeller Diameter	7.874 in
Speed Head	5.128 m

Slurry Data	
Solid flow rate	1.025 Tons/hr
Solid SG	2.7
Slurry SG	1.144
% Comp. by Weight	20 %
% comp. by Volume	8.475 %
Ave. Particle size (D50)	100 microns
Max Particle Size	200 microns
Head Ratio	0.975

Engineer's Notes

JMQ- t 888n/ 688D F
n8/ 68hn3-8/ , Ap5il n3, n8/ 6
M3H-CR / at F/ at , D9S 5pm, 8a39 2p

Pump Details	
Pump Model	M3H-CR / at F/ at
Rw7ed 0lo^	h mr 3F25
Rw7ed Hewd	t m
. ssiEief Ec	nha3 y
1 % P	t hat 3 y
Qmpelle5 Biwme7e5	9a69h if
Pump I peed	D9S 5pm
Mif imum I peed	688 5pm
Mwximum I peed	nS88 5pm
Tip Npeed	33a/ s7FN
q PI H 5e4ui5ed	ha866 s7

Slurry Details	
I olid slo^ 5w7e	/ a8nt Tof NF25
I lu55c slo^ 5w7e	h mr 3F25
I G Nolid	na9
I G li4uid	/
I G Nlu55c	/ a/ hh
y Eompa bc ^eig27	n8 y
y Eomp bc volume	6ah9t y
Avea pw57iEle Nize	/ 88 miE5of N
Mwx pw57iEle Nize	n88 miE5of N
Widelc g5wded pw57iEleN	0wlNe
05o72 swE7o5	8
I e7 . R & HR mwf uwllc	0wlNe
. ssiEief Ec 5w7io	8aD9t
Hewd 5w7io	8aD9t

Electrical Driver Details	
Mo7o5	8a39 2p
Po^e5 wbNo5bed bc pump	8 2p
Po^e5 5e4ui5ed	8a3n 2p
05wme Nize	9/
Tempe5w7u5e 5iNe	8
Qf Nulw7iof ElwNN	
%ew5if g Nize BF.	
%ew5if g Nize qFBF.	
Weig27	8
I 2ws7 Nize	8

Selection Details	
Re4ui5ed 0lo^	h mr 3F25
Re4ui5ed Hewd	t m
I 7w7iE Hewd	8 m
05iE7iof Hewd	t m
I uE7iof Heig27	8 m
BiNE2w5ge Heig27	8 m
BiNE2w5ge P5eNNu5e	8 kPw
Hewd Rw7io	8aD9t
q PI H Avwilwble	8 m

Maska Fuod ys nc4.
6l 2PB9uo l aGc9cPg $ -e aiC
P 4Pe acaCa l 2d 1R2
Tt o(06l)l l 3-3311 Vax:(06l)l l 3-5265
www.maskapuod ys.49m

Selection Parameters

Family: Classic & Narrow belts drives

Shaft diameter Driver: 6-6/l nc4h
Shaft diameter Driven: 02MM
Service Factor: 1.2
Driver power: 5 hp
Rpm Driver: 6705
Rpm Driven: 878 **Tolerance:** -3% +3%
Center distance : Micimum: 61.5 nc4h
Maximum: 63.5 nc4h
Belts: BX

Max. Hub Load: 8888
Rim Speed min.: 822 VFM
Rim Speed max.: . 522 VFM
Nbr of Grooves min.: 6
Nbr of Grooves max.: 65

Pitch Diameter (Inch)

	Min.	Max.
Driver	2.52	76.22
Driven	2.52	76.22

Actual Drive Values

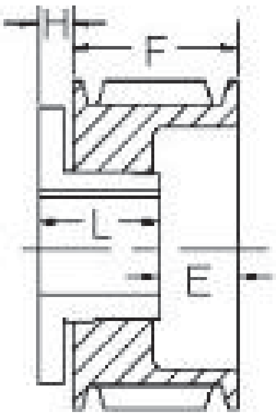
Maximum number of results: 12

Rpm: 878
Service Factor: 1.36
BeltSpeed (fpm): 68l ,
List Price: 135.52

Center distance (Inch): 61.l
Power/Belt (hp): 5.l

Deflection (inch): 2.1
Deflection Force (lbs): 3.6
Hub Loads (lbs): 650

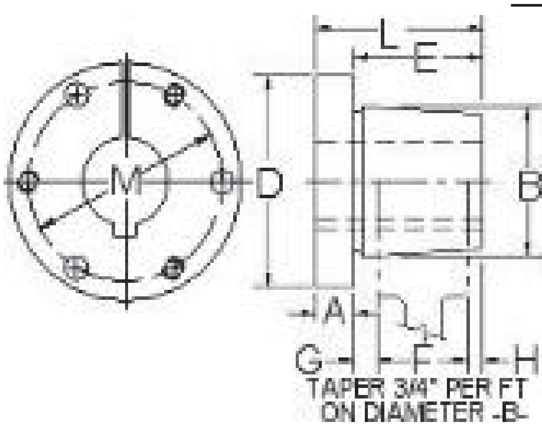
Driver Sheave: 2B40



f isSFC4t : 00.22
D t iGhS 3.02 dLs

v .v . q 9C0f Bt oS 3., 2A
v .v . B 9C5f Bt oS 0.22A
W 36/31A
V: 6 3/0A
b : 65/31A
f : 6 6/0A
" .v .: 0.35A

Driver Bushing: SHX1-1/8

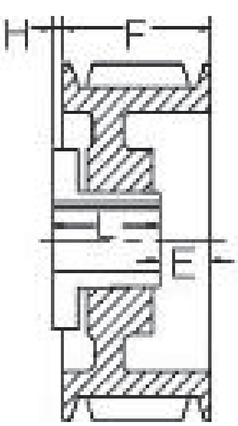


f isSFC4t : 60.82
D t iGhS 2.82 dLs

q: 3/l A
B: 6 7/l A
v : 1 66/6, A
W 7/l A
V: 3/0A
l : 6/0A
b : -6/l A
Et yst aS 6/0 x 6/l A
f : 6 6/0A
M: 1 6/0A

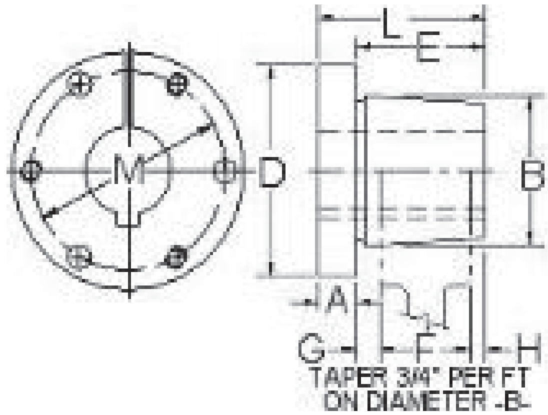
FC9Qu4Sspt 4iHl4aS9cs: g SacQaCQwiSh st Ss4C w 9Ct Ckt yway.
b t x L9oS 3K6/0-12 UNe x 6-3/l
g t Ss4C w - v imt csi9cs: 6/0-12 UNe x 6/0

Driven Sheave: 2B74



f isSFC4t : 73.22
D t iGhS 62.05 dLs

v .v . q 9C0f Bt oS 7.22A
v .v . B 9C5f Bt oS 7.02A
W 6/0A
V: 6 3/0A
b : 3/l A
f : 6 7/l A
" .v .: 7.75A

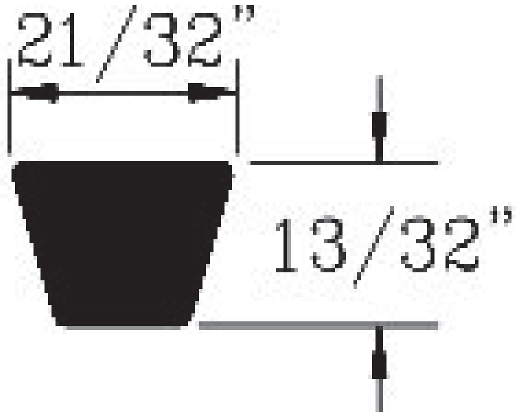


Driven Bushing: SKX40MM

f isSFG4t : 1, .I 2
D t iGhS 1.I 2 dLs

q: 6/1A
B: 1 63/6, A
v : 3 7/I A
W 6 3/I A
V: 6 6/0A
I : 5/6, A
b : 3/6, A
Et y: 61 x I A
f : 6 7/I A
M: 3 5/6, A

b t x L9dS 3K5/6, -6I UNe X 1
FG9Qu4Sspt 4iHi4aS9cs: g SacQaCQwiSh st Ss4Ct w 9Ct Ckt yway.
gt Ss4Ct w - v imt csi9cs: 6/0-12 UNe x 6/0



Belts: VBBX42 (Qty:2)

f isSFG4t : 3I .02
D t iGhS 2.0I dLs

Specific Information About Your Pump

Company Name:		
Address:	Tel:	
	Fax:	
Supplier:	Type of Industry:	
	Pump Model:	Size:
	Serial No:	Flange Type:
Contact Person:	Gland Size:	Drive Style:
Start-up date/remarks:		

Design Condition (To be filled in by distributor or owner)

The following data should be completed as a record of the duty for which the pump was originally sold. During its lifetime the pumping requirements may change; if so, the new speed and operating conditions must be carefully engineered. McLanahan engineers are able to assist you in doing this. U.S. units are used, unless otherwise noted.

Details of Solids

Description of Solids: ____

Specific Gravity Solids: S=____________ Quantity of Solids M: ______________ dry tons/hr

Particle Size: Topsize= _______mesh (mm). 50% passing size= __________mesh (mm).

Details of Liquor

Description of Liquor: ______________________________

Specific Gravity of Liquor: Sl = _______________________

Details of Slurry

Specific Gravity of Slurry: Sm = ______________________

Percent (%) of solids by volume in slurry: Cv=_________________________

Percent (%) of solids by weight in slurry: Cm = ________________________

Flow rate of slurry: Q=________________________________gpm (l/s, m^3/Hr).

Calculated Design Data

Total Head: ________ft (m). Maximum working Head: ___________ft (m).

NPSHa: _________________ft (m). NPSHr: _________________ft (m).

Pump Speed on Slurry: ________________________rpm. Derate factor for Slurry: _______________

Motor Data

Motor Power rating: ___________________________HP (kW).

Motor Frame size: _____________________________

Motor Speed: _________________________________rpm.

Motor Shaft Size: ______________________________in (mm).

Vee-Belt Drive Data

Motor pulley O.D. __________________in (mm). Pump pulley O.D.: __________________in (mm).

Taper lock Bush No: ____________________ Taper lock Bush No: ______________________

Vee-belt: ________________No off____________ No of grooves/pulley: _____________________

Gland Water Requirements (H and P glands only)

Quantity: __________________________gpm (l/s)

Pressure: __________________________psi (m)

Technical Data

Pump Mass: __________________________________lbs (kg).

Motor Mass: __________________________________lbs (kg).

Pump Shaft Size: _______________________________mm

Noise Level: __________________________________db (A)

Gland Options

Gland Seals

The **gland** is usually the weakest point on any **pump**; therefore, it requires the most attention and maintenance. All glands need cooling and lubrication between the sliding surfaces, so **a leisurely drip from the glands is normal**. **NOTE: DO NOT PREVENT DRIP.** All glands must be finally adjusted while the pump is running.

The McLanahan Glands have been developed to minimize the attention and service needed; Pressure of the fluid being pumped, the size and shape of the solid particles and the concentration of the solid particles in the liquid all affect wear and tear on pumps. Three unique seal arrangements have been developed and McLanahan engineers can give advice regarding the optimum selection for a specific duty.

"H" and "P" Glands

The slurry pressure at the gland is reduced by back pump out vanes on the impeller. The rubber axial expeller, which is a stretch fit on the shaft of the "H" and "P" glands, is used to avert waste.

The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the "H" Gland, the adjusting gland must be eased **outward** to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to provide a flawless seal while limiting the amount of "digging" onto the gland sleeve.

The gland sealing water must be as clean as possible and at a pressure of about 3-5psi (2-4m water gauge) above the discharge pressure. A high-flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

“D” Gland

This is a unique type of mechanical seal. The **face seal** runs against the **hard wearing face**.

The **face seal** acts as a spring and if any grit particles get between the rotating rubber and stationary **wear face** it is pressed into the rubber. The **face seal** is a stretch fit on the **shaft sleeve**. As the gland pressure increases, the rubber extends axially and increases the pressure at the rubbing interface. Be sure not to over-tighten the adjusting sleeve.

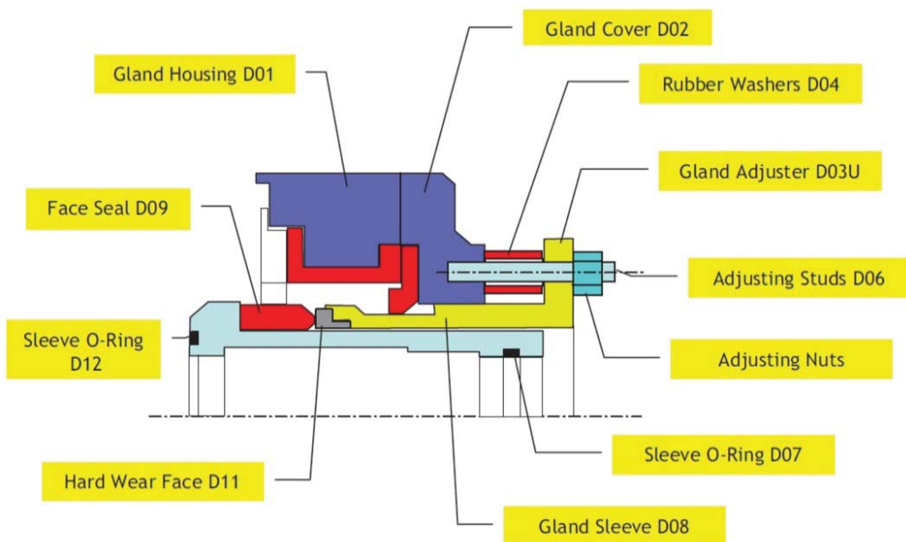
When the pump is first started, ensure that the adjusting nuts are finger tight. While the pump runs, adjust the gland nuts so there are approximately five (5) drops per minute from the gland. This should reduce to one (1) occasional drop and run satisfactorily for up to a year without further attention in a good application.

McLanahan

Dry Gland

Also known as "D" type gland
This gland has a unique proprietary design and is unlike conventional mechanical seals. A rotating rubber **face seal** is adjusted against a static **hard wearing face**; it is **self-lubricating -** pressure from inside the pump head forces small amounts of liquid between the surfaces for lubrication.

Note: The gland needs no external water source to lubricate the gland; both small amounts of water and the fines do exit the pump, accumulating at its base, hence the term **dry gland**.

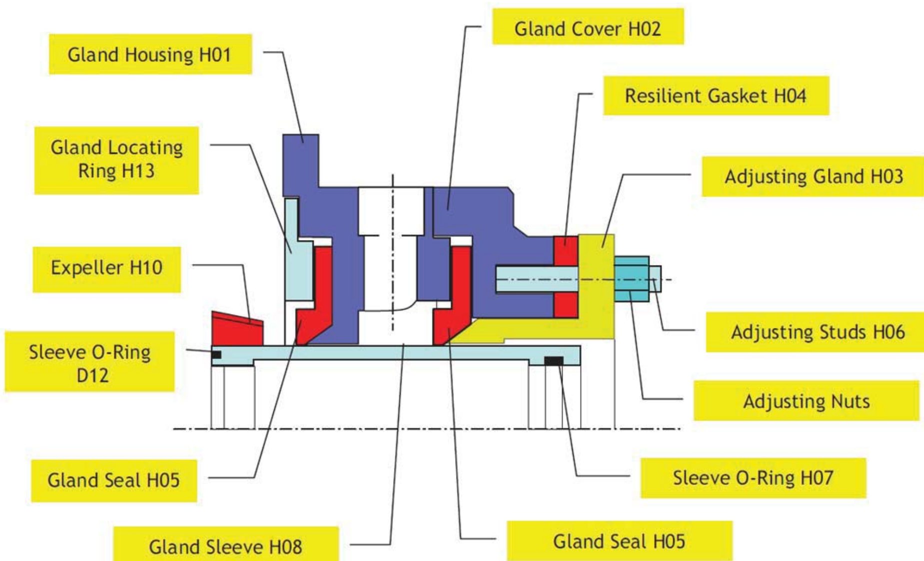


The **face seal** acts as a spring; if any grit particles get between the rotating rubber and **stationary wear face**, it is pressed into the rubber. The **face seal** is a stretch fit on the shaft sleeve. As the gland pressure increases, the rubber extends axially and increases the pressure at the rubbing interface.

While the pump is running, adjust the gland nuts so there are approximately five (5) drops per minute from the gland. This should reduce to one (1) occasional drop and run satisfactorily for up to one year without further attention in a typical application.

Hydrostatic Gland

Also known as “H” type gland
This gland has a unique proprietary design with the lowest maintenance and longest life. The unique rubber gland seal is designed to deflect inwards to provide an effective seal. The **slurry pressure** at the gland is reduced by back pump out vanes on the impeller; when fitted, it is reduced by the **rubber axial expeller**, which is a stretch fit on the shaft of the “H” gland sleeve.



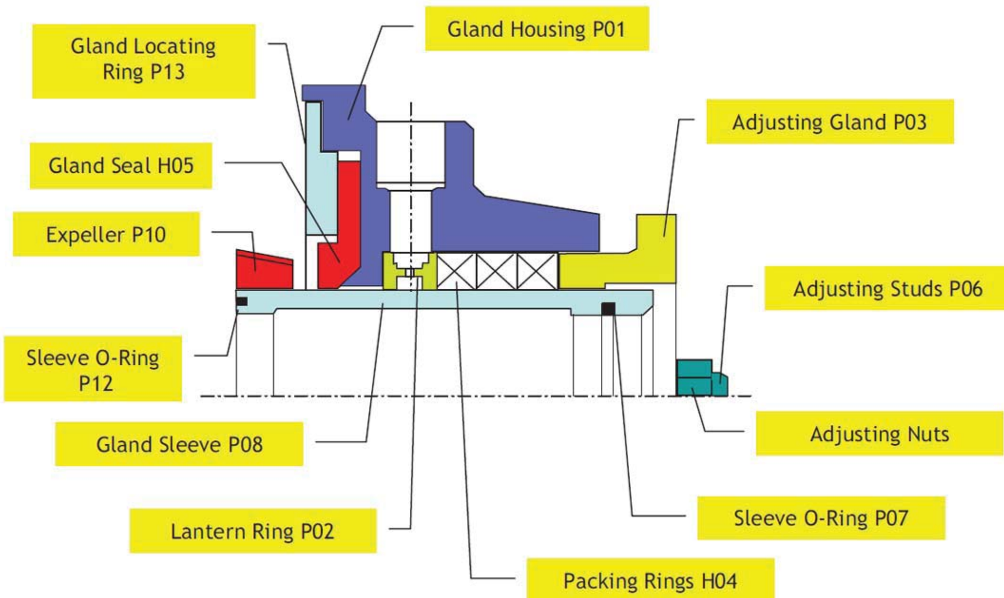
The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the H Gland, the adjusting gland must be eased outwards to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to give a good seal while limiting the amount of “digging” onto the gland sleeve.

The gland sealing water must be as clean as possible at a pressure of about 5psi (4m water gauge) above the discharge pressure and at a volume of between 1 to 5 gpm depending on pump size. A high-flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

Packed Gland

“P” Type Gland
In a classic “stuffing box” design, sealing is obtained by compressing the gland packing rings onto the shaft sleeve. The gland offers the capacity to seal the pump even at high pressures, for instance, in series pumping.



The solids are restrained by the outward centrifugal swirl behind the impeller, the axial expeller and the restricted path to the seal interface.

With the “P” gland, the adjusting gland must face inwards to increase the sealing pressure. The geometric shape of the **gland seal** is carefully designed to give a good seal while limiting the amount of “digging” onto the gland sleeve.

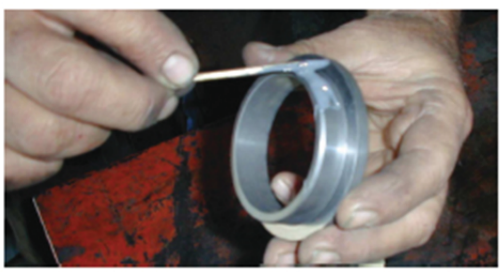
The gland sealing water must be as clean as possible at a pressure of about 5psi (4m water gauge) above the discharge pressure and at a volume of between 1 to 5 gpm depending on pump size. A high flushing water pressure results in greater water use and greater dilution of the pumped slurry without any benefit to the seal.

A pressure-fed grease supply can be used with the “P” gland; be sure to use synthetic rubber parts (special order).

Assembly of Dry Gland – Hard Wear Face & Gland Adjuster (2” x 2” shown)

1. Check all components

2. Extrude epoxy from package & mix thoroughly



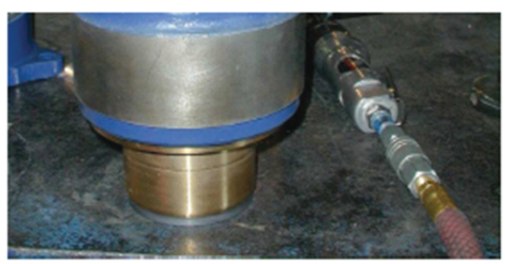
3. Apply epoxy to outer rim of Hard Wear Face (D11)

4. Place ’O’ Ring (D10) on outer rim of Hard Wear Face (D11). Position ’O’ Ring at leading edge.

5. Position Hard Wear Face & ’O’ Ring into Gland Adjuster (D03U)

6. Using a slight twisting motion Carefully push Hard Wear Face into Adjuster

7. Wipe off excess epoxy



8. Place a heavy object on top of the assembly until dry (min 30 minutes)

General Pump Suction Requirements

A pump does not "suck," as fluid has no tensile strength. The centrifugal expulsion of fluids creates a low pressure area at the eye of the impeller; atmospheric pressure, plus any static head, pushes fluid into the pump. It is essential that suction systems do not restrict flow from the sump into the pump. With slurries, this is even more important as the solids themselves can settle and cause obstructions to flow.

In order to maintain the short pipelines and prevent obstruction**, cleaning is essential**. A trap to remove tramp material is beneficial as well.

Air entrained in the slurry reduces the pump's capacity and head; an air vent pipe on the suction pipe close to the pump inlet is often essential.

The pump will operate best if the flow velocity approaching the impeller is evenly distributed across the suction eye, and is sensibly axial, without swirl.

Pump performance is potentially impaired by a number of factors. Intake conditions in the sump, such as the formation of vortices, can cause an uneven flow over the eye of the impeller. Intake conditions in the suction pipeline, such as a sharp bend just before the pump, can affect performance as well.

Installation

Important Notes

- The maintenance of rotating machinery should be done by experienced mechanics.
- Protective clothing as well as proper tools and lifting equipment, all in good condition, must be used.
- Do not lift heavy weights without mechanical aids.
- Do not take any risks with your health and safety.
- If a pump has run without discharge, the fluid temperature and pressure may be dangerously high.
- The casing suspension arm is fitted as a maintenance aid only.
- The installer must ensure that guards are fitted in accordance with national & local regulations.

The following notes cover most situations; however, certain installations will require additional assessments.

Noise

Because of its heavy construction, rigid bearing housing and the sound attenuation due to the rubber lining, the noise generated by a bare shaft McLanahan Pump is low: less than 70dB (A).

The noise emission from a complete pump and drive unit will be dependent upon various factors including that from the motor, its fan and the V-belt drive. To obtain an indication of the noise level generated by a specific complete unit, take the highest component noise level, which is generally the motor, and multiply by 1.15.

For example:

dB (A) pump + dB (A) motor + dB (A) drive = 1.15 x dB (A) motor.

Other factors, including the piping system and hydraulically-generated noise as well as any reflected noise, will affect the final installed figure.

Foundations

Location and dimensions must be checked and matched to the pump-certified drawing when holding down bolts, bolt holes in steel work or pockets in concrete. The foundations must be rigid.

The pump base must be level in its final position; it must also be rigidly supported at each bolt, which is designed to hold it down, before the bolts are tightened.

Pipe Work

The suction and delivery pipe work must be independently supported and the pump must not be used as an anchor to pull the pipes into position.

The procedure for discarding solids in an emergency situation should be planned before it is needed. If the removal of suction and delivery pipe work is planned ahead of time, it will facilitate unblocking and servicing of the pump.

Precautionary checks that need to be completed include:

- Areas that could cause restriction on the suction side
- The possibility of thermal expansion in the pipework causing undue loads on the pump
- The pipework should match up to the pump without strain

The lining on the McLanahan model lllr is continued out to form gaskets on the suction and discharge flanges, therefore the use of joint rings or additional gaskets is not necessary. Connections to the pump should be made using flat-faced flanges only.

When fitting McLanahan pumps to rubber-lined equipment such as valves, hose or lined pipe, a steel gasket must be used.

Power

Check that the motor voltage, power and starter rating and supply match.

Gland Services

If gland sealing water is required, the quantity, quality and availability should be checked.

Access

Crane capacity and access routes from the delivery point should be checked. Access for maintenance, protection from flooding, as well as ventilation for motor cooling, must all be checked.

Impeller Adjustment Axially

The position of the rotating element must be set so there is a minimum running clearance, approximately 1/16” – 1/8” between the suction bush and the impeller. The bearing housing must then be locked into position. This clearance should be checked by bolting a dummy flange or stub pipe to the suction flange. This ensures any movement of the rubber lining on connection is allowed. Once connected to suction and delivery lines, the unit should be checked for free rotation.

Coupling Alignment

The pump and motor couplings must be aligned in accordance with good engineering practice. Axial or radial run-out must be less than 0.05 mm total indicated reading on a clock gauge. With V-belt pulleys, the faces of the couplings must be exactly in line and the shafts must be parallel to each other. A check with a straight edge or string line across the pulley faces should have no visible gap.

Motor Rotation

Before the belts are fitted or the couplings are connected, the direction of rotation of the motor must be checked. Incorrect motor rotation can cause the impeller to unscrew and destroy the pump.

Tension V-belts

When the motor's direction of rotation is correct, fit and tension the V-belts in accordance with the maker's recommendation. In general, a quarter to a half twist of the belt will be possible at the center of the belt by simply using fingers. Check the tension after a few running hours.

Belt Guard

The belt guard provided with this pump unit is manufactured with the shaft aperture fully closed with mesh. On installation of the V-belt drive and determination of pulley centers, the shaft guard is offered up and the mesh relieved locally to allow the shafts to pass through. Allowance may be required for movement of shafts when belt tensioning.

The mesh should be relieved and a guard should be fitted in a manner which prevents accidental contact with the rotating parts of the drive assembly.

The installer must ensure that the guard is installed in accordance with national and local regulations.

Gland Service

When these are fitted, be sure that gland water supply and protection systems are working.

Greased Bearings

The pump bearings have been greased at the factory. **Over-greasing them can cause them to overheat**; they should be looked over but may not need grease. **Suitable grease types** are: Shell Alvania 3, Mobil EP2, Caltex LS3 or their equivalents.

Final Checks

- All nuts and bolts are tight
- Gland adjusting nuts are finger tight
- No loose material is lying around the pump set
- The guards are securely fitted and the pump is safe to start

The running speed of the pump must not exceed the following:

Pump	1½ x 1½	2x2	3x3n	4x4	6x5	8x6	10x8	12x10
MAX RPM	2750	2400	2100	1600	1400	1200	1200	900

Electrical Installation

This equipment must be installed and controlled in accordance with applicable national and local regulations.

Gland Services

On the hydrostatic gland and also on the packed gland, it is usually necessary to have a clean water flushing supply to the gland.

The pressure should be 3-5 psi (2-4m) water gauge above the pump discharge pressure (remember to include the S.G. of the slurry) and the flow rate should be in accordance with the table below.

Pump	units	1½x1½	2x2	3x3n	4x4	6x5	8x6	10x8	12x10
Water flow.	USgpm	1	1	1	2	2	2	3	4
Water flow.	liter/sec	0.04	0.04	0.05	0.07	0.07	0.09	0.1	0.2

The gland flushing water should be clean. The life of the gland and gland sleeve is significantly affected by the cleanliness of the flushing water. Although a few particles will not do instant damage, the seal life will be reduced. Slurry must not be used.

There are many combinations of flow control devices that may be used. A few of these are shown on the diagram below. The objective is to maintain a secure supply of clean flushing water to extend the gland life.

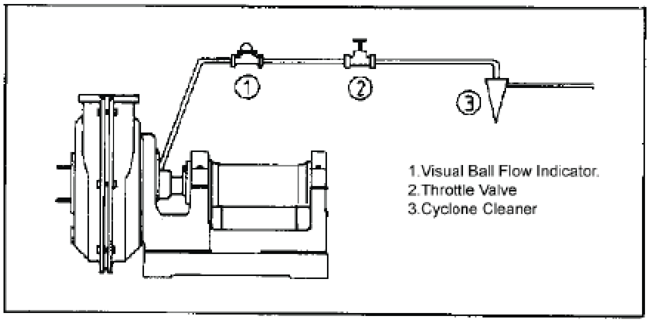
With pumps in series, there are three main ways of supplying gland service water.

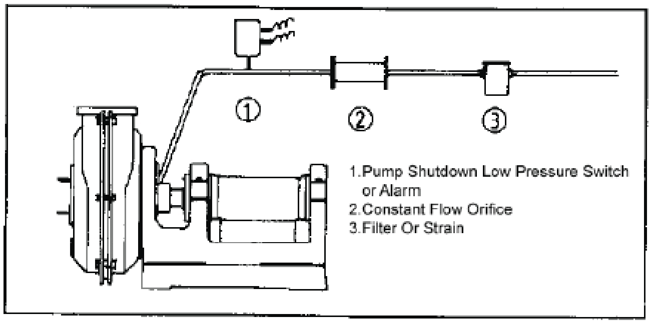
- Individual dedicated pumps at the correct pressure and flow rate.
- One large pump at the highest pressure throttling down the supply to each pump in the series.
- One multi-stage pump tapping off a supply at a different stage to each pump in the series.

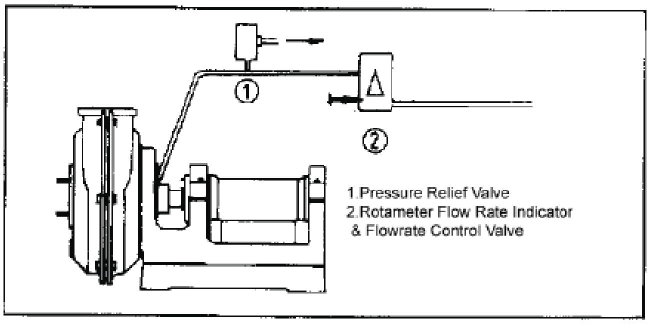
![McLanahan logo]

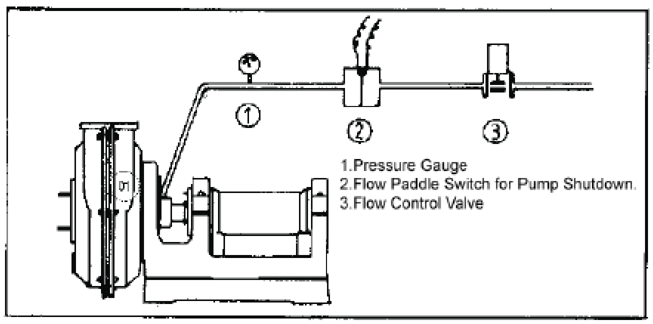
Gland Service Systems

These are a few typical systems. Any selection of items may be combined.









Lubrication and Cooling

Additional grease must only be added about twice per year, as the bearings are already lubricated. **DO NOT over grease the bearings**.

The bearing assemblies are all checked in the factory to prove that they are correctly assembled.

The bearings are designed to run at high temperatures (maximum 120° C) and the grease has to be compatible with this operating condition. Clean grease must be used.

If water gets into the bearings, the assembly must be stripped, thoroughly dried and greased over; then, any seal failure must be corrected.

Recommended greases are Shell Alvania 3, Mobile EP2, Caltex LS3 or their equivalents.

Start-Up Procedure

The recommended procedure to follow is listed below:

- Check the free rotation of the pump
- If required, verify that water for gland services is running
- At first start, or after any work on the electric motor terminal box, check direction of rotation **with drive belts removed**.
- Prime the pump
- Check that all guards are in place and that the pump is safe to run
- Start the pump
- If the pipeline is empty and there is no discharge valve (possibly due to abrasive nature of the product), the pump motor may be bogged down for a period of time and the pump may begin to go through the process of cavitation. This condition should be examined to evaluate the possible long term effect on the equipment.
- Check the pump for noise, vibration or any hot spots.
- **Adjust the gland to maintain a drip**, which is necessary for lubrication and for cooling.

Shutdown Procedure

This depends ultimately on the system and process flow requirements but the following procedure is recommended.

- Stop the flow of solids into the sump.
- Turn the sluicing water or run system on water only to wash out the pump and delivery pipeline.
- Shut down the pump.
- Shut down the gland service water system.

In cold weather, the pump and auxiliary equipment should be drained to prevent freezing damage.

Disassembly Procedure

Check that all power is switched off and isolated and that it is safe, electrically and mechanically, to work the pump. The following sequence is a general guide to stripping the pump for inspection. Refer to Cross Section drawings in Appendix.

On sizes up to the 4x4 (100x100) there is no separate suction bush or liner.

1. Remove the suction pipe and inspect for wear.
2. Check the suction bush liner for wear, noting any uneven wear pattern and position. Check the axial clearance.
3. Between the suction bush liner and the eye of the impeller (or on smaller pumps between the casing liner and eye of the impeller).
4. Remove nuts and suction bush. The suction bush liner is pushed out of the suction bush from the suction side. Some water spread under the lip of the suction bush liner will lubricate its passage out of the suction bush.

5. Remove casing bolts after supporting the suction side casing. Lift off the suction side casing. A crane will be necessary on the larger pumps.
6. The impeller is exposed for inspection. Hold the shaft using a spanner, which is a good fit, on the flats between the gland and the flinger. The impeller is screwed onto the shaft with an Acme right hand thread. The impeller may be very tightly locked onto the shaft and may need an impact force or a long lever to loosen it. If the impeller is to be used again, protect the rubber against damage. Inspect the impeller and note unusual wear patterns in the flow passages and back or front pump out vanes. Check that the “O” ring behind the impeller has sealed against the gland sleeve and slurry has not corroded the impeller or shaft thread. This “O” ring should be replaced at every strip-down.
7. Remove the axial expeller, which is a stretch fit on the gland sleeve. If “D” gland is fitted, the gland sleeve should be removed at this point.
8. Support the gland side casing, undo the casing to pedestal nuts and remove casing half along with the gland assembly. Undo the gland holding screws and remove the gland assembly. Undo liner nuts. The casing liner can now be removed for inspection; be sure to note any unusual wear patterns.
9. Remove bearing pedestal caps and fixings; unfasten the axial positioning jack to enable bearing assembly to be removed.
10. To disassemble the bearing assembly, remove the gland sleeve, flinger and bearing covers. The bearings can be inspected at this stage. If there is no sign of damage, the bearings should not be disturbed and they should merely be washed out with mild solvent oil and re-greased.
11. Press the shaft (with the bearing still fitted) out of the bearing housing. Push the shaft from the impeller side out of the bearing housing. The inner ring of the front bearing will still be attached to the shaft and can be removed later.
12. The remainder of the front bearing can then be withdrawn from housing.
13. Loosen the tab washer, undo the locknut and pull the end bearing off of the shaft.

Notes:

1. The 2x2, 3x3 and 4x4 pumps do not have a loose suction bush liner or suction bush.
2. The 10x8 (250/200) and larger sizes have the inside gland cover, which is held in position by (H14 / P14 / D14). Undo and withdraw the inside gland cover from the impeller side.
3. The Casing Suspension Arm is fitted as a maintenance aid ONLY and as much may be used to support **singularly**, either of the casing halves and its associated liner or the impeller. It must not be used for any other purpose. Suspension arm not fitted to 1.5 x 1.5 and 2x2 (50/50) pump.

Assembly Procedure

Before assembly, ensure all parts are clean and free of old grease and dirt. The new bearings or replacement bearings should be generously filled with grease between the rollers. Check that the Neoprene grease seals are not soft or distorted. Replace if necessary.

1. Clamp the shaft horizontally in a vice. Heat the spherical roller end bearing in an oil bath or induction heater to 240°F (115°C) and fit it to the drive end of the shaft using clean insulated gloves. Ensure the inner ring of the bearing is hard against its seat by tapping it with a brass pin. Fit the tab washer and the lock nut.
2. Fit the inner ring of the front bearing to the impeller end of the shaft. Ensure, by tapping with a brass pin, that it is hard against its seat.
3. Clamp bearing housing securely, grease bearing. Fit shaft and end bearing assembly into housing. Ensure that outer race of bearing is hard against seat.
4. Fit neoprene seal and bearing cover seal to end cover and fix to bearing housing using set screws.

5. Mount bearing housing vertically with front end upwards and wedge shaft so it is central in the housing. Fill front bearing with grease and carefully tap outer ring into bearing housing.
6. Fit neoprene seal and bearing seal cover to front cover and fix to bearing housing using set screws. Fit V-Ring Seal to shaft and place with slight tension against front cover. Fit flinger ring to shaft and locate in position using screw clamp supplied with flinger ring.
7. Set bearing housing assembly into pedestal and loosely assemble bearing pedestal caps with pedestal cap screws; fit axial positioning jack. Rarely, shims are required for shaft alignment; if factory fitted, the thickness of shim required will be stamped on the vertical face of the pedestal adjacent to the pedestal cap stud.
8. If “D” gland is to be fitted – loosely assemble gland components without damaging the wearing face when fitting. Leave the gland sleeve out, as well as “O” rings and face seal. Fit the gland side liner into the gland side casing by securing with liner nuts. Bolt the gland assembly loosely to the casing. Fit the casing and gland assembly to the pedestal using fixings; take care not to damage the wearing face against the shaft on assembly. Fit the “O” rings and face seal to gland sleeve. Slide home onto shaft, through casing and into the gland assembly. Carefully align gland components (specifically check concentricity of gland parts relative to the shaft) and tighten all fixings.
9. If “H” or “P” gland is to be fitted, fit “O” rings to gland sleeve. Slide home onto the shaft. Loosely assemble gland components, slide over shaft and onto the gland sleeve. Fit the gland side liner into the gland side casing securing with liner nuts. Fit the casing to the pedestal using fixings. Carefully align the components of the gland assembly (specifically check concentricity of gland parts relative to the shaft) and fit to the casing. The axial expeller will then have a stretch fit over the gland sleeve.
10. Smear the impeller thread on the shaft with protective long life graphite grease before screwing on the impeller, ensuring that the impeller “O” ring is fitted into the gland sleeve.
11. Fit the suction side liner in the suction side casing using liner nuts.
12. Fit the suction bush liner inside the suction bush before bolting it to the suction side casing using the bolts. NOTE: using soapy water will facilitate the process.
13. Check the concentricity of the fit between suction bush liner and the impeller.
14. Using the axial positioning jack, adjust the impeller toward the suction bush liner, keeping the holding down studs loose. Check the axial clearance between the impeller and the suction bush liner. A steel ring or dummy flange should be bolted to the suction flange to simulate any distortion in the suction bush liner when connected to the suction pipe before the axial clearance is checked. This clearance should be set at approximately 1/8”. Rotate the shaft to ensure effective clearance.
15. Tighten the bearing holding down nuts and the axial positioning jack.

ATTENTION PLANT OPERATORS:
HANG THIS NEAR YOUR PUMP

McLanahan Model IIIr Centrifugal Pump
With Type "D" Gland

MOTOR DIRECTION TEST

ALWAYS PERFORM THE MOTOR DIRECTION TEST WITH THE V BELTS REMOVED

Note: The pump ships with the V-belts removed

WARNING: RUNNING THE PUMP IN THE WRONG DIRECTION MAY CAUSE THE IMPELLER TO UNSCREW, AND DESTROY THE PUMP.

A motor direction test should be carried out without the belts installed before running the pump for the first time, or after any work on the motors, switchgear or softstart that may affect the direction of rotation of the motor.

STARTING UP AND RUNNING THE PUMP

BEFORE STARTING, ENSURE THAT THIS PUMP IS BEING SUPPLIED WITH GLAND SERVICE WATER. RUNNING THE PUMP WITHOUT GLAND SERVICE WATER WILL DESTROY THE GLAND

With the pump full of water, and all isolation valves open (if present) start the pump. The pump should immediately start pumping.

BEFORE STARTING THE PUMP FOR THE FIRST TIME

The gland should be pre-set before starting the pump for the first time. To do so:

- Fill the feed sump with water and open the suction isolation valve (if present).
- Evenly adjust the gland Adjusting Nuts (see section 5) so a steady trickle leaks from the gland. Note: On a "P" Gland, tightening the nuts decreases the leak rate.

WARNING: THE PUMP MUST NOT BE ALLOWED TO RUN IF IT DOES NOT DISCHARGE

DANGER: RUNNING THE PUMP WITH NO DISCHARGE WILL CAUSE THE LIQUID INSIDE THE PUMP TO HEAT UP. IN EXTREME CASES THIS CAN LEAD TO THE LIQUID BOILING, & THE PUMP CASE MAY EXPLODE

The outside of the pump may not feel hot, as the rubber lining of the pump acts as thermal insulation. If by accident the pump has run without pumped discharge, it must be stopped immediately and the cause of the problem investigated.

DANGER: IF IT IS SUSPECTED THAT THE PUMP HAS OPERATED WITHOUT DISCHARGE, EXTREME CAUTION SHOULD BE USED IN DRAINING THE PUMP – THE LIQUID INSIDE MAY BE DANGEROUSLY HOT AND UNDER PRESSURE

PRIMING

The McLanahan centrifugal pump is NOT self-priming. For this reason the pump must be installed with a flooded suction, or with the appropriate system for suction lift.

ADJUSTING THE "P" TYPE PACKED GLAND:

Before starting, the gland should have been adjusted so a steady trickle leaks from the gland (see section 2). Check that Gland Service Water is being supplied. See the Manual for details of the flow & pressure requirements.

Final adjustment of the gland should be done with the pump in operation. Tighten the adjusting nuts until the leak reduces to drips. (60 drops /minute maximum, 5 TO 45 drops per minute minimum). Care must be exercised not to tighten too much, which may lead to damage to the seal.

⚠	*WARNING: THE ADJUSTING NUTS SHOULD BE ADJUSTED INCREMENTALY, EVENLY, AND IN TURN, TO ENSURE THAT THE GLAND COMPONENTS STAY PARALLEL. TIGHTENING ONE NUT MORE THAN THE OTHERS MAY CAUSE MISALIGNMENT AND DAMAGE TO THE GLAND*

STOPPING THE PUMP

Before stopping the pump, it is advisable (if possible) to run the pump on clear water before turning it off, to prevent solids from settling out in the pump casing.

LUBRICATION

The Pump comes from the factory fully greased. The Shaft Bearings should be greased with the correct grade of grease every 1000 hours of operation. Inject grease into the grease nipples by six strokes of a regular size (2" diameter body) grease gun.

The recommended grease is "Conoco Tacna HD No. 2" or equivalent grade grease.

MAINTENANCE

Except for attention to the gland while the pump is in operation, there is no daily maintenance required on the pump. It is essential, however, that routine inspections be carried out, with the first such inspection taking place approximately three months from startup. This inspection should provide some idea of the wear rate, which will be a guide for scheduling future inspections and maintenance. For instructions on dismantling and reassembling the pump, see the instruction manual supplied with the pump.

SPARES

Recommended spare parts are listed in the instruction manual. It is recommended that a supply of the wear parts listed be kept in stock so as to minimize down time in the event of failure of the part. (SEE NEXT PAGE)

PUMP BEARING TEMPERATURE

On high speed duties it is to be expected that the bearings will run hotter than on low speed duties. At 150 F (65 C) the assembly will be uncomfortable to the hands for more than a second or two, but this is not unduly hot for the bearing assemblies. The bearings are designed to run at high temperatures, maximum 120° C.

1.5 X 1.5 DRY GLAND NITRILE PUMP SPARE PARTS LIST

OVERVIEW

McLANAHAN CORPORATION recommends that you keep certain replacement parts at your facility. These parts will be available in the event of a breakdown and will also be available to perform any repairs that must be made as a result of regularly scheduled maintenance checks. **McLANAHAN CORPORATION** stocks a wide variety of commonly used components; however storing these parts at your facility will eliminate the expense of air-freighting critical parts that may be required during a breakdown situation. Refer to the "PARTS LIST AND ASSEMBLY" drawing(s) to assist with parts identification, part numbers and quantities. Contact the Parts Department at **McLANAHAN CORPORATION** for price and availability of all parts for your McLanahan equipment.

Qty	Part Number	Description	Lead Time	
1	09111002000	Gland Repair Kit, Nitrile	Stock	
1	09110001134	Gland Side Liner	Stock	
1	09110001133	Suction Liner	Stock	
1	09110001135	Impeller	Stock	
1	09110002225	Bearing Repair Kit	Stock	
2	293946042	V-BELTS BX42	2 weeks	

Appendix - Long Term Storage

General:

The following are recommendations in reference to long term storage of McLanahan Pumps and Drives; McLanahan does not accept liability for components under these conditions. Documentation and photographic evidence is necessary for warranties to apply.

Preventive Maintenance for Stored Rotating Spares

In the absence of data on premature bearing failures and armature/shaft sag and imbalance, we recommend a general procedure as follows:

The motor shaft targets should generally be used on any motor of 50HP or higher. They also should be used on fans and any other large rotating equipment that sits in storage for lengthy periods of time. By rotating these shafts monthly (or more, depending on the floor vibrations), you are preventing armature and shaft sag as well as false brinelling of the bearings into the races.

You may also find some smaller motors that have premature bearing failures after prolonged storage in your facility. If this is the case, the shaft targets should be attached (with double-stick foam tape) and smaller motors must be rotated.

What is False Brinelling?

Whenever a **non-rotating bearing** is subjected to external vibration, **false brinelling** can occur. A protective oil film cannot form between the races and rotating elements when the bearing isn't turning, causing metal-to-metal contact. False brinelling can occur during transportation, typically truck or rail, and during motor storage if the storage area is subject to vibration.

Another type of brinelling, **true brinelling** occurs in **rotating bearings**.

Pump

If stored, the pump should be kept in a clean, dry, vibration-free environment. The shaft should be rotated manually every three (3) months, or at the same interval as recommended by the electric motor manufacturer. In order to care for the natural rubber linings and components, follow the recommendations below.

Electric Motor

The following information is reprinted from the WEG "Installation and Maintenance Manual for NEMA low Voltage Electric Motors"

Storage

Motors should be raised by their eyebolts and never by their shafts. It is important that high rating three phase motors be raised by their eyebolts. Raising and lowering must be steady; otherwise bearings may be harmed. When motors are not immediately installed, they should be stored in their normal upright position in a dry even temperature place, free of dust, gases and corrosive atmosphere. Other objects should not be placed on or against them. Motors stored over long periods are subject to loss of insulation resistance and oxidation of bearings.

Bearings and lubricant deserve special attention during prolonged periods of storage. Depending on the length and conditions of storage it may be necessary to re-grease or change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from between the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact. As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and every 3 month their shafts should be rotated manually.

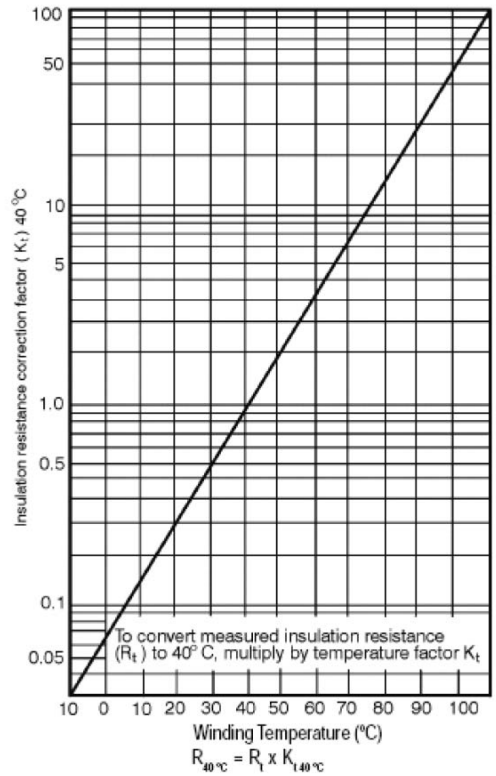
Insulation resistance fluctuates widely with temperature and humidity variations and the cleanliness of components. When a motor is not immediately put into service it should be protected against moist, high temperatures and impurities, thus avoiding damage to insulation resistance. If the motor has been in storage more than six month or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmeter. If the resistance is lower than ten megohms the windings should be dried in one of the two following ways:
1) Bake in oven at temperatures not exceeding 194 degrees F until insulation resistance becomes constant.
2) With rotor locked, apply low voltage and gradually increase current through windings until temperature measured with thermometer reaches 194 degrees F. Do not exceed this temperature. If the motor is stored for an extensive period, the rotor must be periodically rotated. Should the ambient conditions be very humid, a periodical inspection is recommended during storage. It is difficult to prescribe rules for the true insulation resistance value of a machine as resistance varies according to the type, size and rated voltage and the state of the insulation material used, method of construction and the machine's insulation antecedents. A lot of experience is necessary in order to decide when a machine is ready or not to be put into service. Periodical records are useful in making this decision.

The following guidelines show the approximate values that can be expected of a clean and dry motor, at 40°C test voltage in applied during one minute.

Insulation resistance Rm is obtained by the formula: $Rm = Vn + 1$

Where: Rm – minimum recommended insulation resistance in MΩ with winding at 40°C
Vn – rated machine voltage in kV

In case the test is carried out at a temperature other than 40°C, the value must be corrected to 40°C using an approximated curve of insulation resistance vs temperature of the winding (see graph below).



Example:
Ambient temperature = 50°C
Motor winding resistance at 50°C = 1.02 MΩ
Correction to 40°C

R 40°C = R 50°C x K 50°C
R 40º C = 1.02 x 1.3
R 40º C = 1.326 M&
The minimum resistance Rm will be:
Rm = Vn + 1
Rm = 0.440 + 1
Rm = 1.440 MΩ

On new motors, lower values are often attained due to solvents present in the insulating varnishes that later evaporate during normal operation.

This does not necessarily mean that the motor is not operational, since insulating resistance will increase after a period of service. On motors which have been in service for a while, a comparison of the values recorded in previous tests on the same motor under similar load, temperature and humidity conditions, serves as a better indication of insulation condition than that of the value derived from a single test. The cause for any substantial or sudden reduction should be determined, followed by corrective action.

Insulation resistance is usually measured with a **megger**.

In the event that insulation resistance is inferior to the values derived from the above formula, motors should be subjected to a drying process.

Drying the windings

Only qualified personnel should carry out this operation. The temperature should not rise more than 5°C per hour and the overall temperature should not exceed 105°C; if either of these two things occur, vapor which is harmful to the insulation, may be generated.

Temperature should be accurately controlled and insulation resistance should be properly measured at regular intervals during the drying process. During early stages of drying, insulation resistance will decrease as a result of the temperature increasing. However, the resistance will increase again when the insulation dries a little more.

The drying process should be extended until successive measurements of insulation resistance indicate that a constant value above the minimum acceptable value has been attained. It is extremely important that the interior of the motor be well-ventilated during the drying operation to ensure that the dampness is really removed.

Heat for drying can be obtained from outside sources such as an oven or space heater, or by introducing a current through the actual winding of the motor being dried.

Electric machines should be installed in order to allow an easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or contain flammable substances or particles, it is essential to ensure an adequate degree of protection. The installation of motors in environments where there are vapors, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) standards.

Under no circumstances are motors to be enclosed in boxes or covered with materials which may impede or reduce the free circulation of ventilating air. Machines fitted with external ventilation should be at least 50cm from the wall to permit the passage of air. The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes or other objects. The place of installation should allow for renewal at a rate of 700 cubic feet per minute for each 75 HP motor capacity.

Rubber Products

Rubber products in storage can be adversely affected by several factors, including:

- Temperature
- Humidity
- Ozone
- Sunlight
- Oils
- Solvents
- Corrosive liquids and fumes
- Insects and rodents
- Radiation

The warehousing area should be relatively cool, dark and free from dampness and mildew. All rubber products should be used on a first-in, first-out basis since even under these conditions an unusual length of time in storage can result in the deterioration of certain products.

The ideal storage temperature for rubber products is 50 to 70°F (10 to 21°C) with a maximum limit of 100°F (38°C). If stored below 32°F (0°C), some products may become stiff and should be warmed before being placed in service. Rubber products should not be stored near sources of heat, such as radiators and base heaters.

Rubber products **should not** be stored under conditions of high or low humidity.

To protect against the adverse effects of ozone, rubber products should not be stored near electrical equipment that may generate ozone and should not be stored for any lengthy period in geographical areas of known high ozone concentrations. Exposure to direct and reflected sunlight should also be avoided.

Whenever viable, rubber products should be stored in their original shipping containers, especially when such containers are wooden crates or cardboard cartons; this will provide protection against the deteriorating effects of oils, solvents and corrosive liquids, and will also provide some protection against ozone and sunlight.

Certain rodents and insects thrive on rubber products, so the equipment must be protected.

McLanahan ***Pump Applications***

Sand plants
Feeding sand and water to all types of classification and dewatering plants; effluent water transfer duties.

Coal preparation plants
For dense medium circuits, feeding hydrocyclones, filtrate pumping, handling the underflow from thickeners, disposal of effluent, etc.

Chemical manufacturing & Environmental applications
McLanahan pumps, by virtue of their various rubber linings, are suitable for pumping many chemical solutions, acid or alkaline, at moderate temperatures and for the disposal of effluent.

Cement manufacture
Slurry feed to: tube mill circuits, thickener feed and underflow, flotation plant circuits.

Metalliferous mining
Mill circuits, feeding hydrocyclones, cyanide plant filter residues, concentrates, tailings disposal and other pulp and slurry handling duties.

Irrigation systems and dredging
Silt removal in dams and canal sand traps

Paper mills
China clay slurries, paper stock, effluent disposal

Steel works and manufacturing applications
Pickling acid distribution circuits in plate and wire de-scaling plants, abrasive wet scrubber blow-down

Power stations
Boiler house ash disposal, de-scaling plants

China clay production
Feeding slurry to hydrocyclones and for general use in the preparation of china clay

Glass manufacturing
Feeding polishing media, sand plants, handling effluent

Troubleshooting

If a pump fails to pump through a blockage, switch off **immediately**. Take extreme care as the pump may be filled with scorching steam and solids at a high pressure.

Wear and Replacement of Parts

To obtain the best service and performance from the pump, periodic routine inspections should be executed. The rate of wear on pumps is not precisely predictable since it varies from one application to the next, so intervals at which these inspections should be made vary. Initially, the pump should be allowed to run for a period of time (for example, three months); afterward, an examination of the pump will give some idea of the length of life, which may be expected from the rubber-covered parts.

No Discharge When Pump Runs

The pump must not be allowed to run if it does not discharge. If it is noted that the pump has been running without discharge, cease it immediately.

Take extreme care in dismantling after such an occurrence due to high temperature and pressure, which may be present in the pump casing. Do not remove the drain plug until the fluid temperature in the pump has dropped.

Air Lock

Air lock in the casing is the most common cause of failure on a newly installed pump. Even when a pump is well below water level, it may retain a large bubble inside the casing, which prevents the start of pumping. This phenomenon is far more likely with horizontal undershot discharge branch arrangements than any other practical configuration. It is least likely with horizontal overshot arrangements.

If you suspect air lock as the cause of failure to pump, start and stop pump several times to drive the air out, one fraction at a time. When using this procedure, ensure that you do not damage the motor starter or burn out the motor by trying too many starts in a short period of time. The number of permissible attempts will vary with the equipment installed but usually it is safe to try one start every three to four minutes.

Inadequate Prime

Failure to pump may be caused by inadequate priming. This is usually rectified by allowing more time for priming to occur.

It is possible when “jet priming” to have such a small amount of priming water that the pump will never prime; in this case, more water for the priming option will be needed.

Usually, the diameter of the priming branch should be at least one-third of the diameter of the suction pipe. NOTE: 2” (50mm) will prime 6” (150mm), 3” (80mm) will prime 8” (200mm) etc. The minimum water required is about 30% of the pump capacity.

If priming is by vacuum pump, there must be a valve or at least an air-lock on the delivery side. The vacuum pump must be able to “beat” the air leakage throughout the gland. To assist in this, always attempt to prime with the gland water running, no matter what style of priming is being attempted.

Installation Faults

Failure to discharge on start-up can be caused by installation faults. The most common is inadequate sump capacity. The result of installing a sump with inadequate capacity is to risk repeated air-locks of the pump. This can happen when the pump reduces the water level, either allowing a vortex to form, which air-locks the pump, or (when water is introduced to the sump) it entrains so much air that it produces the same effect.

A small sump can easily prevent any discharge reaching the end of the pump discharge line. The only remedy is to extend the sump capacity. We recommend sumps of at least one minute's pumping time as a minimum. NOTE: This recommendation does not apply to feed regulating sumps in sand plants where greater capacity is required.

Other installation faults are more obvious, such as tramp material lodged over a pump suction or a kinked suction hose.

Brief Discharge Only

1. Air Lock

A pump with a suction lift and partial air lock will often start to pump at a greatly reduced rate after each start, and then it will give up completely. At the discharge end of the pipe this may appear as a brief surge followed by failure.

This problem can only be overcome by closer attention to the priming system.

2. Obstructed Suction

If the suction line is obstructed either by tramp material or a delaminated suction hose lining, the pump may start well. However, when the discharge rate rises, the suction obstruction throttles the pump in a way that it quickly fails by gross cavitation.

Detection of this sort of condition is difficult. The only way to guarantee finding out what is actually happening is by using a vacuum gauge immediately before the pump suction. An obstructed suction line will be indicated by a sudden increase in vacuum reading immediately before the failure.

3. Lack of Delivery Resistance

A pump, which is required to pump with a suction or with a fair length of suction pipe, although with practically no resistance on the delivery side, may pump briefly before failing. The reason for this is that centrifugal pumps on open discharge need positive pressure on the suction eye to prevent gross cavitation. If the installation does not provide sufficient positive pressure on the suction side, the pump will fail.

Usually, the easiest way to overcome this difficulty is to artificially create resistance on the delivery side by extending the pipe work or introducing a valve or other resistance, such as an orifice.

Pumps water but not solids

1. Air Leaks on Suction Side

Joints in the suction line or air entrainment with feed into a sump may be insufficient if they are made poorly. Poorly made joints sometimes prevent a pump from pumping water satisfactorily. However, when solids are introduced (particularly coarse solids) the pump has a more arduous duty; it has to entrain the solids into the fast moving stream in the suction pipe. In effect, it has to "dredge" the solids into the stream. Even if the solids were already moving in the right general direction, they must be accelerated up to the water velocity and thus they act as a suction resistance for the pump.

Introducing solids into an aerated system will cause failure. The pump can only handle a small margin of solids when pumping water alone. Air leaks can usually be detected as water leaks when the pump is not running; **where water can get out, air can get in**. Air entrainment with the feed can sometimes be overcome by the use of baffles in the sump. The air bubbles have time to rise to the surface before being drawn down to the suction.

2. Poor Suction Line

Several different factors in the suction line may allow a pump to appear adequate when it is not. A long suction line, a line with a considerably small diameter or a line with a restriction (sudden step-downs in diameter are the worst) will all affect whether or not the pump can handle solids. The reasons for this are explained in the two previous paragraphs.

Reworking the suction line is the only solution to this problem. If the line increased in diameter it should be brought to the pump inlet diameter by a specially rolled flanged taper pipe. It must not be stepped down by a mismatch.

3. Electric Motor Wrongly Wired

Most Squirrel Cage Induction Motors can be wired in two ways: **Star** or **Delta**. In order to reduce the current surge when a motor is brought **on line**, some users start their motors in **Star.** They do this because this mode gives good starting torque and a reduced starting current surge. Then, change to running their motors in **Delta** once smooth starting has been achieved. The **Delta** mode of powering the motor increases the speed close to synchronous speed, which is maximum, and maintains a constant speed under variations in load.

If a motor is left to run continuously in **Star**, it will vary its speed dramatically with load. If a mistake has been made in the wiring of the motor, it may appear that the pump is unable to pick up solids but is still pumping water. The reason would be that on **Star**, the motor speed drops when the solids load comes on.

To detect this fault, the easiest method is to check the speed of the motor shaft and compare it with the Nameplate rating. There should not be more than a few RPM difference between Nameplate RPM rating and actual speed, no matter what load the pump is pulling.

NOTE: Correction of this fault is intended for an electrician.

Overloads for Motor Trip Out

1. Wrong Pump Speed

The power drawn by a centrifugal pump discharging through a given delivery system is approximately proportional to the cube of its speed. As an example, if the speed is changed by 20% to 1.2 times the original speed, you can expect its power demand to rise by the cube of 1.2, i.e. 1.728, or nearly 73% above the original. Even a rise in speed of 10% to 1.1 times the original speed will give a rise of 33% in power demanded by the pump.

The relationship is not exact but it is close enough for field calculation purposes.

If a pump is run at the wrong speed, it can make a considerable difference to the load drawn from the motor.

Calculation of the correct pump speed is based on:

- Flow rate to be pumped
- Difference in height between pump and discharge points
- Length, diameter and inner surface of pipeline through which pump must deliver
- Number of elbows, bends, valves, other fittings in pipeline
- Equipment at end of pipeline such as hydrocyclones, pressurized distributors, jets, etc.
- Grading, tonnage and specific gravity of solids to be pumped
- Pump performance curves

As far as fault finding is concerned, the actual RPM of a pump should be compared with the RPM specified. Corrections to pump speed can be made by pulley changes.

2. Changed Pipeline System

It is not uncommon for a pump speed to be calculated on the basis of a pipeline system intended to be used at the time of the negotiations for the purchase of the pump, but to be commissioned into service with a different pipeline system. A client may say, "but it's not such a high lift so the pump does not have to work quite so hard." **This is not true.** At a given pump speed, a pump will pump a larger amount through a shorter pipeline (or lesser vertical height) and **will take more power**, not less.

When confronted with this situation, the only thing to do is to calculate the correct **head** and RPM before making a pulley change. The affinity rule can be used or the drive can be recalculated.

3. Low Voltage

The power consumed by an electric motor is the product of the voltage, amperage and power factor for the motor. If a pump demands a certain power from the motor, the motor in turn will demand corresponding amperage from the electric supply system. However, if the voltage of the electric supply system happens to be lower than normal, the motor will draw extra amps to meet the pump's power demand. This way the power consumed by the motor, the product of voltage, amperage and power factor remains unchanged.

Circumstances where lower than standard voltages might be encountered include:

- When power supply is from a generator set
- At the end of a long trailing cable
- At the end of an electric supply system remote from the nearest transformer substation
- In an area where very heavy start-up loads can occur, such as near large crusher stations or long conveyor installations

Low voltage can readily cause a motor overload by drawing higher than expected amps; this is, in no way, related to the pump itself.

If low voltage is suspected as the cause of motor overload, a qualified electrician should be called.

4. Wrongly Set Overload Protection

All motor starting equipment has some form of overload protection equipment built into the system so a burnt out motor or locked-rotor motor does not cause more extensive damage. If a motor repeatedly drops out on overload and there is no other readily apparent reason, the electrical overload protection equipment should be checked.

5. Mechanical Fault in Pump

The pump shaft should be free to turn by hand. Remove the V-belts and check the pump shaft for freedom to turn. If there is no resistance, the fault must be in the motor. If a jarring or resistance can be felt when attempting to turn the pump shaft, drop off the suction pipe and check the clearance between the impeller and suction plate. Also check for blockages.

If this proves clear, remove the suction bush and look for marks on the surface of the impeller, which might indicate if the impeller has been rubbing. In this case, rotate the shaft again to determine if the resistance is still present; if it is, remove the impeller and inspect the gland side liner. If there is still no evidence of rubbing, rotate the shaft by hand again to check that the resistance is still present; then, remove the gland sleeve. If the resistance can still be felt by hand it can only be the bearings of the pump.

The remedies for the faults, which may be revealed by this step-by-step approach are:

- Impeller rubs on suction bush: release bearing housing, set impeller to suction bush clearance by adjusting position of bearing housing until impeller runs free. Tighten bearing housing. Replace suction pipe. Re-align belt drive.
- Impeller rubs on gland half lining; reset the suction bush clearance. Check for movement of casing liner.
- Seizure in the gland area. Strip and inspect.
- Shaft tight in bearings; there is no simple field remedy if the pump shaft is found to be tight in the bearings, the rotating assembly must be removed and stripped for inspection of the bearings and grease seals.

6. Air Entrainment

In sump-fed pump systems, air entrainment with the pump feed can produce periodic overloads on the motor by the following sequence of events:

- Air entrainment with feed gives the pump a “spongy” pulp, which reduces the pump throughput and power.
- Flow through the sump is reduced allowing air in the feed now entering the sump to escape to the surface. Solids, of course, reach the pump suction.
- The pump now has a largely de-aired pulp of far greater percentage solids than intended, and the power demand rises. At this stage the pump may choke. This is a dangerous condition.
- Pump entrains the accumulated solids into suction pipeline and begins to pump normally again, increasing throughput through sump.
- Air entrainment begins to reach pump suction again and sequence repeats.
- Air entrainment can permanently reduce slurry throughput and make it appear as if the pump is not working.

In small installations this surge may be repeated at three minute intervals; in large installations, it may take as long as five minutes for the full cycle to complete. If the cycle terminates at stage three, the pump may explode, if it is left to run while blocked.

Pump Handles Only a Limited Percentage Solids

Pump Speed Incorrect

With increasing solids feed into a pumping system three major factors will limit the percentage solids handled:

- Friction resistance increases, leaving less pressure on the delivery side to maintain the velocity in the pipeline
- Critical (settling) velocity for the pulp in the pipeline increases
- Pump performance “drops” so that the total head generated by the pump diminishes

Clearly, if the pump speed has been calculated for water only, increasing tonnages of solids are fed into the system; the combination of factors above may soon produce a situation where the pipeline velocity is too low to maintain movement of the solids.

Air Entrainment

Under 15.3, section 1 above, there is an explanation of how a pump can handle water, but due to the air entrainment, fails when solids are introduced to the system. The same fault can sometimes explain why a pump appears to perform well on pulp up to a certain percentage solids, then “gives up” when this is passed.

Poor Suction Line

A suction line layout as described in 15.3, section 2 is far worse as the percentage solids is increased and can become completely blocked.

Cavitation

If a pump is expected to draw relatively coarse solids from a sump below the pump centerline, depending on the speed of the pump and its capacity in relation to the flow rate being handled, it may suffer from cavitation. When this happens, and the onset is often quite sudden and sharp, the total head generated by the pump diminishes dramatically. As described previously, the conditions for blocking a line are suddenly created; namely reduced delivery pressure for maintaining flow combined with increased requirement for velocity in the pipeline.

Generally, if cavitation is the source of the trouble, there is ample evidence; audible cavitation “rattle” in the pump or from the bearings, sudden reduction in power demand, the gland leaks or draws air and there is a dramatic drop in delivery pressure.

The solution to the problem is to make the suction arrangements as smooth as possible without restrictions as well as to arrange for the feed to come gradually up to load without sudden surges of solids. If these measures do not overcome the problem it may be necessary to change the suction line to a size larger and fit a flat topped taper-piece to the pump suction. If trouble persists, a larger pump will have to be installed. Something effective must be done as the situation is potentially dangerous.

Gland Will Not Seal Adequately

1. Poor Adjustment

The outer seal of a Hydrostatic gland assembly must be allowed to rub lightly on the gland sleeve for an effective seal to be maintained. If the gland adjuster is pushed in too far this will lift the seal off the sleeve and the gland will leak profusely. When seeing a leaking gland, most people immediately think to tighten it. With the Hydrostatic gland, the **gland adjuster must be moved outward to reduce leakage.**

Type D and P glands should be tightened for reduction of leakage in the same way as standard packed glands in water pumps. **Over tightening should be avoided**, especially on "D" glands as a drip is always necessary to lubricate the rubber face seal.

2. Dry Running
The glands will not be damaged by a few seconds of running without lubrication and cooling by water, but if either gland runs for a length of time without water in the pump, there is danger of melting the rubber seals. If a Type D gland has been correctly adjusted, this is a fairly remote danger because without hydraulic pressure to force the rubber seal against the gland seat, the seal should run without touching the seat. However, do not run a pump in dry conditions because of the danger of damaging the gland seals.

Once seals have been damaged in this way, they must be replaced.

3. Too Much Sealing Pressure
Too much water pressure in either type of gland can make the glands almost impossible to seal reliably. With Hydrostatic glands the solution to the problem is to insert a pressure control in the gland water line. With Type D glands the problem usually only arises with pumps being run in a series or as booster pumps. In either case, the only solution is to convert the pump over to H gland or P gland and provide suitably pressured gland water.

4. Inadequate Prime
The "snore" condition for operating a pump is very difficult to seal without unacceptable leakage. Under this condition a pump continuously receives a good proportion of air drawn in with the pulp from the sump, in which the level is too low, or the sump has inadequate capacity, or both. The sump should contain a minimum of one minute's pumping time.

Excessive Heat in Drive

1. Slack V-belts
The most common cause for generation of heat in the drive to a newly installed pump is undoubtedly lack of tension in the V-belts. All V-belts should be tensioned periodically and newly commissioned drives should be re-tensioned an hour or so after start up.

This fault is easily detected (pulleys are the hottest part of the drive) as the belts will have been slipping.

2. Hot pump Bearings
On high speed duties it is to be expected that the bearings will run hotter than on low speed duties. Providing the shaft is free spinning by hand, the heat generated while running under power is probably immaterial. At 150°F (65°C) the assembly will be uncomfortable to the hands for more than a second or two; this is not unduly hot for the bearing assembles. If the bearing is failing, the shaft will not run free.

3. Inadequate Lubrication of Pump Bearings
The bearings will be charged with grease before dispatch from the factory. Details of lubricants are given in this Manual.

Addition of grease should be tried if bearings become very hot or noisy. Excess greasing should be avoided.

4. Motor Runs Hot

Motors are intended to run hot. With Continuous Maximum Rated Motors, the temperature rises are surprising and are allowed for in the design of the motor and the selection of the insulation.

Generally, heat from a motor can be safely ignored, provided the amperage drawn is lower or equal to the nameplate rating. Many motors are fitted with Thermistors in the windings, which sense the temperature rise and are wired to operate a cut-out relay if the temperature exceeds a safe limit.

If a pump is choked when the motor starts, the protection must trip out the supply to the motor.

Bearing troubles in motors are generally indicated b noise as well as heat and can sometimes be detected by use of a long-stemmed screwdriver. The blade of the screwdriver is pushed against the bearing cover and the ear of the investigator pushed up to the handle. With a limited amount of experience bearing "rumble" can quite easily be detected.

Sudden Reduction in Discharge

1. Change in Feed Conditions

Operators do not always recognize a pump as simply one element in a complete system and any change in that system will bear on all the parts of it. For instance, if a screen rejecting plus ¼" (6 mm) material is worn and passes 1" (25 mm) stones, this affects the pump performance. The suction resistance of the larger stones will cause the suction pressure to reduce and have less head available for pushing the pulp through the delivery side piping.

At the pump, the larger stones will make a significant difference to the pump performance, decreasing flow and potentially causing damage to Impeller and Linings.

In the pipeline, the large stones will probably progress by "saltation," that is, leaping along the bottom of the pipe. The rest of the pulp is fully in suspension and has to flow past these slow moving obstacles. Overall this means the resistance of the pipeline to flow has increased, thus, again reducing flow.

A simple fault such as a screen cloth with a hole in it can cause a sudden reduction in discharge. If it causes the pipeline to block, the condition is potentially dangerous.

Other changes in feed conditions, which must be investigated are: increased tonnage of solids, change of grading of solids and change in manner of introduction of solids to pump system. On this last count, a plant, which was started in summer, and is bin-fed via a vibrating feeder, will perform differently in winter when the wetter feed "hangs up" in the feed bin and collapses down onto the feeder intermittently in larger dollops.

2. Air leaks on the Suction Pipe

A pipe, which has been steadily wearing away from the inside may break through to the open air near a flange (in a welded area) at the bottom of the pipe, which is where the coarsest solids run. In a suction pipe this will almost certainly allow air into the pipe with all the resultant ills described elsewhere.

Frequently, a pinhole leak will not allow enough air into a pump for any of the five faults listed to become critical. Operators, being human, postpone the repair or replacement of the worn pipe. The last chapter of the saga occurs surprisingly quickly and usually on nightshift – when fault produces a blocked pipeline.

3. Suction Blockage

In dredging applications there is always the danger that the pump suction will be suddenly submerged in collapsed solids from the surrounding pit contours. When pumping from a sump, the same thing can happen when solids, which have been clinging precariously to the steel sides of the sump, subside and momentarily block the pump suction.

If the pump is feeding a fair length of delivery piping, it will not be possible for the long column of pulp in that piping to come instantly to rest when the suction gets blocked. The pulp in an 8” (200mm) pipe, 1000 ft (300 m) long, moving at 10ft/sec (3 m/sec) has considerable momentum. It cannot be stopped dead in the same short length of time it takes to block the suction.

The result is a massive reduction in pressure throughout the system. It can cause a massive “water hammer” and surges that can split the pump casing, valves and piping. This can cause hoses to collapse – delivery as well as suction – and almost invariably leads to a great gulp of air being sucked through the pump gland. Usually this is sufficient to air-lock the pump.

When an operator hears the air hiss into the gland and then has to contend with the resultant air-lock, the assumption is that the gland is at fault for pump failure. However, the trouble generally begins at the end of the suction pipe and the gland collapses afterward.

In dredging applications, better control should be taken over the pit development. In sump-fed systems, the feed pulp can sometimes be directed to flush away any build-up of solids on the sides or valleys of the sump.

If this is not possible, a larger capacity take-off box at the base of the sump must improve the situation. The blocked pipeline situation is potentially dangerous.

4. Tramp Material

The simplest explanations of a fault should never be overlooked. If the complaint is sudden reduction in discharge, drain the sump and before removing any pipe work or dismantling the pump in any way, examine the take-off box at the base of the sump.

Sudden Increases in Power Demand

5. Damage Inside Pump

Pumps wear with each use. Results of abrasion, which will give an increase in power demand, are shown below in order of occurrence frequency.

- Excessive gap between impeller and suction bush
- Cut or ripped rubber in suction bush or casing gland rubbing against impeller
- Worn out cutwater
- Worn out or broken casing liners
- Impeller worn through back shroud
- Impeller passages worn significantly wider than intended

6. Change in Pipeline System
DO NOT alter pipeline system by shortening or changing layout. If altered, it will pump larger amounts and take more power.

7. Low Voltage
A new installation near the pump site can make a significant difference in the amount of voltage available, depending on the electric distribution system in the area. Lower volts means higher current for the same power output of the motor.

8. Changed Pump Speed
When dismounting both pump and motor pulleys, electricians have, in the past, interchanged the pulleys when reassembling the pump set. Ensure this does not happen.

9. Air Entrainment
In sump-fed pump systems, air entrainment can produce cyclic pump overload, caused by a change to the amount or direction in which a sump is fed. It could also be caused by a casual change to the feed type baffle arrangement in the sump.

Rapid Component Wear

1. Air Entrainment
As an experiment, place some sand in an empty bottle, fill the bottle to the very top with water, place the palm of one hand over the top and shake the bottle. You will find it difficult to move the sand vigorously against your hand. Now tip out a third of the water, and repeat the test. You will undoubtedly feel the sand in the air-water froth hitting your palm.

The point of the experiment is to show how much more readily sand can move around in froth than it can in water without air bubbles. Therefore any air leaks in the suction side accelerate abrasion.

If air entrainment is severe enough to produce an air lock in the presence of solids and water, the result is an escalation of the abrasion rate.

Air entrainment can also cause severe abrasion indirectly. With cyclic changes in pulp density due to air, the pump may have to handle far denser pulp than intended. This is also an abrasive accelerator.

2. Properties of the Solids
When confronted with a rapid abrasion problem such as coarse or sharp-edged particles, always reduce pump speed if possible. A larger pump with a larger diameter impeller will be rotating slower at the suction eye of the impeller for a given head than a smaller pump would. So, if wear on the leading edge of the vanes occurs, a larger pump would help.

3. Change in Feed Conditions
A change in feed conditions, such as extra tonnage, coarser grading or higher proportion of crushed material will all affect the rate of wear on a pump. As an example, deposits from a river are notoriously variable; the proportion of crushed sand in relation to natural sand can vary widely. However, to the operator, sand is sand, and the fact that the pump is now handling, say 80% crushed material, while three months ago it was 60% natural sand may not appear significant.

If there is a permanent change in feed conditions, which makes component life unsatisfactory, consider modifying the pump. A two-stage pump set will allow each pump to run at about 70% of the speed that a single unit would run, which would make a significant change to the abrasion rate.

4. Shaft Misalignment

After several years of wear and tear, the saddles on the pedestal occasionally wear out, thus allowing the shaft to point downward. If the eccentricity of the shaft through the gland is severe enough, the gland will not seal properly. There will also be a misalignment between the eye of the impeller and the suction bush, which will detract from pump performance. In this case, the most effective solution, reducing cost and saving time, would be to purchase a new pedestal. Temporarily, the saddles may be packed with shims; however, these inevitably get lost during impeller adjustment.

Mechanical Failure

1. Broken Shaft

Typically, the only broken shafts on McLanahan pumps are those where there has been tramp material in the feed, a bearing has seized, or slurry has worn through the gland sleeve. In this case, wear will of course weaken the shaft.

2. Broken Pedestal or Casing

Although the front bracket of the pump pedestal appears massive, it can be broken down from the box section of the pedestal by simply starting the pump backwards. As a result, the impeller will begin to unscrew from the shaft, and while in motion, strikes the suction bush, which is fixed in place by the flange of the suction pipe work. Because something has to give, occasionally, with older shafts, the thread in the shaft is stripped instead of the pedestal being broken.

Realigning broken pedestals can be quite difficult; therefore, the quickest, most cost-effective way to fix a broken pedestal is merely to replace it.

A pump running backwards is an electrical problem, which is overcome quite easily, and should not happen to begin with. Electricians are required to check the direction of rotation of a motor prior to fitting the V-belts onto the pulleys.

3. Pump Explodes

The centrifugal pump (McLanahan or any other) can potentially explode by running with pulp or water in the casing when there is no discharge. This can happen in a pump that is drawing pulp from a sump and pumping it to a cyclone through a rising pipeline. If the pump receives a sudden surge of solids, which blocks off the suction, flow will cease. In the delivery line, the solids will settle in the rising pipe but will be unable to enter the casing because the impeller will still be spinning.

As the impeller rotates, the pump will continue absorbing power. The power raises the fluid temperature. The water will eventually boil and the pressure may be enough to destroy the rubber or cause the pump head to explode. **If a pump head feels unusually warm and is not discharging**, switch the power off immediately. **Do not approach the pump** until it has been relieved of pressure, preferably through the suction or discharge pipework by flushing away the solids plugs. A sign that a pump may explode will be a considerable amount of steam leaking from the gland.

NOTE: at this point, even if a pump does not feel hot, be extremely cautious when dismantling, as the pump may be full of scalding water. Do not remove the drain plug until certain the fluid temperature in the pump has reduced. If in doubt, carefully clear blockages in the manner described above.

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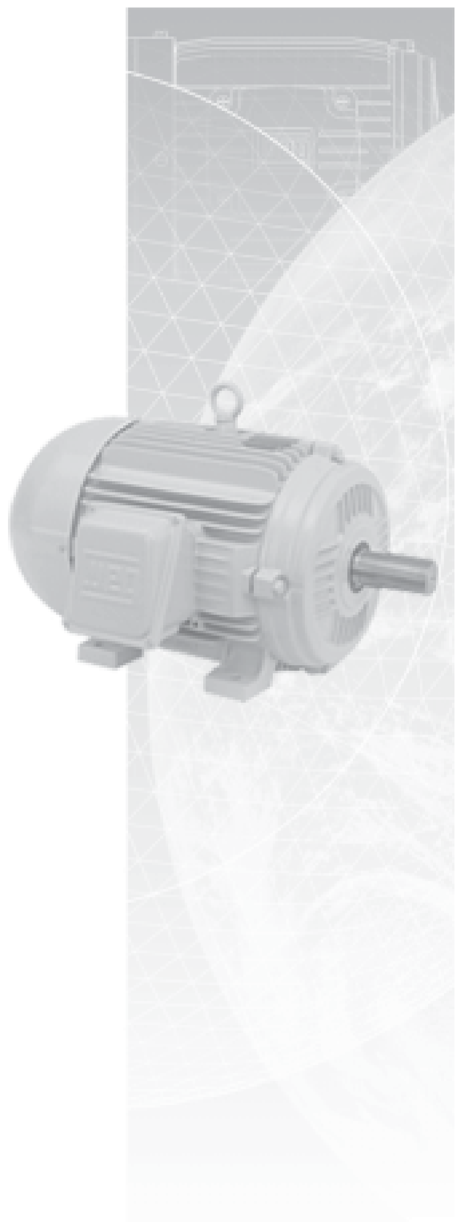
INSTALLATION AND MAINTENANCE MANUAL FOR NEMA LOW VOLTAGE ELECTRIC MOTORS



The electric motor is the item of equipment most widely used by man in his pursuit of progress, as virtually all machines and many renowned inventions depend upon it.
By virtue of the prominent role the electric motor plays in the comfort and welfare of mankind, it must be regarded and treated as a prime power unit embodying features that merit special attention, including its installation and maintenance.
This means that the electric motor should receive proper attention.
Its installation and routine maintenance require specific care to ensure perfect operation and longer life of the unit.
THE WEG ELECTRIC MOTOR INSTALLATION AND MAINTENANCE MANUAL provides the necessary information to properly install, maintain and preserve the most important component of all equipment:

THE ELECTRIC MOTOR!

WEG

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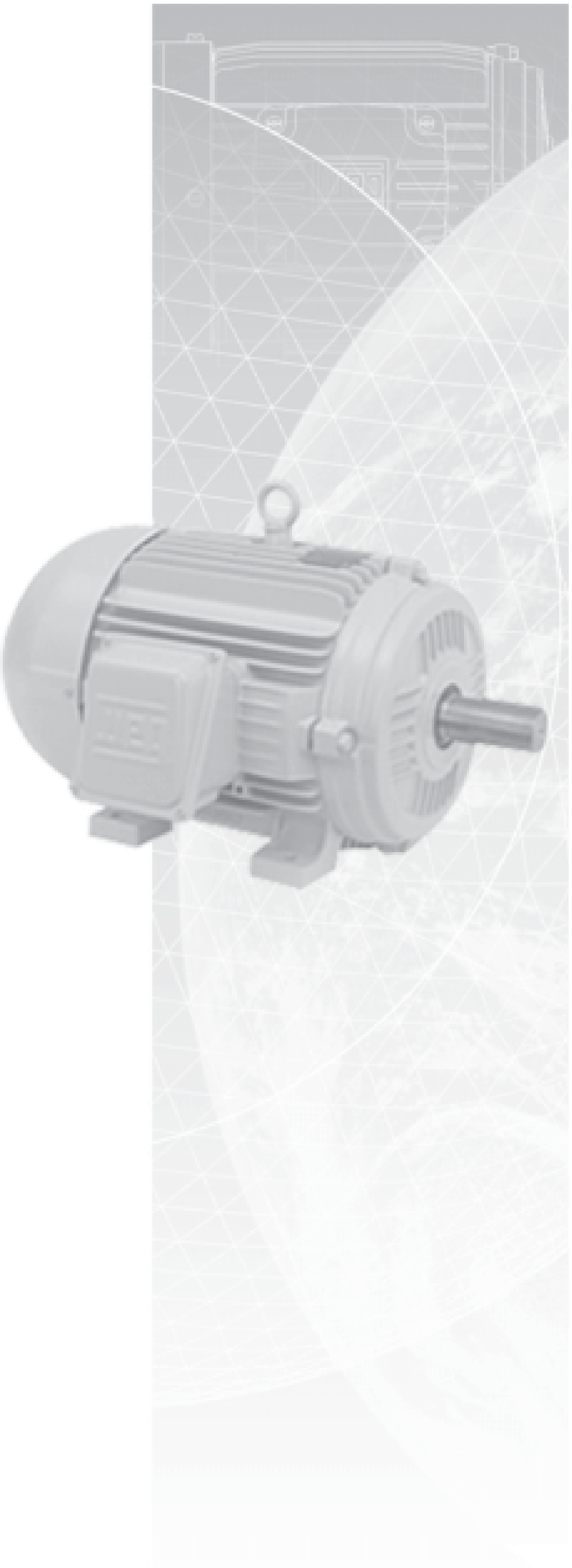
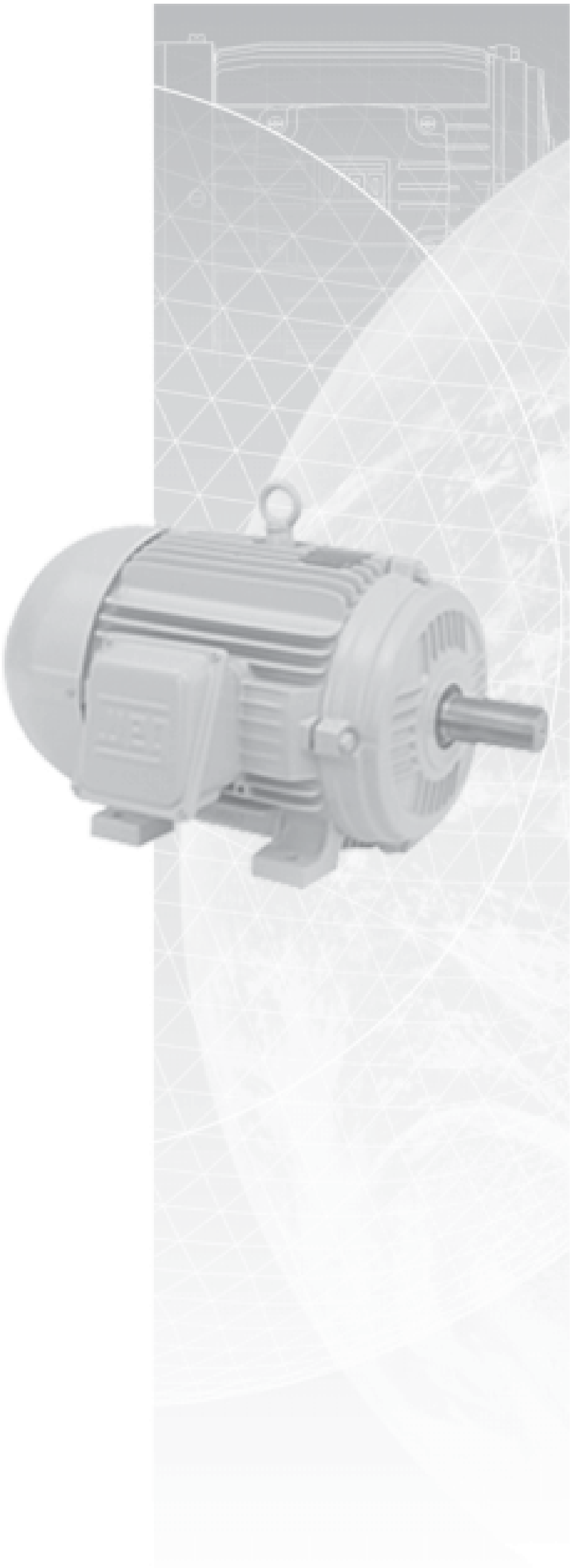


1. Introduction



This manual covers all the three-phase and single-phase asynchronous squirrel-cage induction motors, from 140T to 580T frame sizes.

The motors described in this manual are subject to continuous improvement and all information is subject to change without notice.
For further details, please consult WEG.

2. Basic Instructions

2.1 Safety Instructions

All personnel involved with electrical installations, either handling, lifting, operation and maintenance, should be well-informed and up-to-date concerning the safety standards and principles that govern the work and carefully follow them.
Before work commences, it is the responsibility of the person in charge to ascertain that these have been duly complied with and to alert his personnel of the inherent hazards of the job in hand.
It is recommended that these tasks be undertaken only by qualified personnel and they should be instructed to:

- avoid contact with energized circuits or rotating parts,
- avoid by-passing or rendering inoperative any safeguards or protective devices,
- avoid extended exposure in close proximity to machinery with high noise levels,
- use proper care and procedures in handling, lifting, installing, operating and maintaining the equipment, and
- follow consistently any instructions and product documentation supplied when they do such work.

Before initiating maintenance procedures, be sure that all power sources are disconnected from the motor and accessories to avoid electric shock.
Fire fighting equipment and notices concerning first aid should not be lacking at the job site; these should be visible and accessible at all times.

2.2 Delivery

Prior to shipment, motors are factory-tested and balanced. They are packed in boxes or bolted to a wooden base.
Upon receipt, we recommend careful handling and a physical examination for damage which may have occurred during transportation.
In the event of damage and in order to guaranty insurance coverage, both the nearest WEG sales office and the carrier should be notified without delay.

2.3 Storage

Motors should be raised by their eyebolts and never by their shafts. It is important that high rating three-phase motors be raised by their eyebolts. Raising and lowering must be steady and joltless, otherwise bearings may be harmed.
When motors are not immediately installed, they should be stored in their normal upright position in a dry even temperature place, free of dust, gases and corrosive atmosphere.
Other objects should not be placed on or against them.
Motors stored over long periods are subject to loss of insulation resistance and oxidation of bearings.

Bearings and lubricant deserve special attention during prolonged periods of storage. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from between the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact.
As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and every 3 month their shafts should be rotated manually.

Insulation resistance fluctuates widely with temperature and humidity variations and the cleanliness of components. When a motor is not immediately put into service it should be protected against moist, high temperatures and impurities, thus avoiding damage to insulation resistance.
If the motor has been in storage more than six month or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmeter.
If the resistance is lower than ten megohms the windings should be dried in one of the two following ways:

1) Bake in oven at temperatures not exceeding **1**94 degrees F until insulation resistance becomes constant.
2) With rotor locked, apply low voltage and gradually increase current through windings until temperature measured with thermometer reaches **1**94 degrees F. Do not exceed this temperature.

If the motor is stored for an extensive period, the rotor must be periodically rotated.
Should the ambient conditions be very humid, a periodical inspection is recommended during storage. It is difficult to prescribe rules for the true insulation resistance value of a machine as resistance varies according to the type, size and rated voltage and the state of the insulation material used, method of construction and the machine's insulation antecedents. A lot of experience is necessary in order to decide when a machine is ready or not to be put into service. Periodical records are useful in making this decision.

The following guidelines show the approximate values that can be expected of a clean and dry motor, at 40°C test voltage in applied during one minute.

Insulation resistance Rm is obtained by the formula:

$$\boxed{Rm = Vn + 1}$$

Where: Rm - minimum recommended insulation resistance in MΩ with winding at 40°C
Vn - rated machine voltage in kV

In case the test is carried out at a temperature other than 40°C, the value must be corrected to 40°C using an approximated curve of insulation resistance v.s temperature of the winding with the aid of Figure **2.1**; it's possible verify that resistance practically doubles every **1**0°C that insulating temperature is lowered.

Example:

Ambient temperature = 50°C
Motor winding resistence at 50°C = 1.02 MΩ
Correction to 40°C

$$R_{40°C} = R_{50°C} \times K_{50°C}$$

$$R_{40°C} = 1.02 \times 1.3$$

$$R_{40°C} = 1.326\ M\Omega$$

The minimum resistence Rm will be:

Rm = Vn + 1
Rm = 0.440 + 1
Rm = 1.440 MΩ

On new motors, lower values are often attained due to solvents present in the insulating varnishes that later evaporate during normal operation. This does not necessarily mean that the motor is not operational, since insulating resistance will increase after a period of service.
On motors which have been in service for a period of time much larger values are often attained. A comparison of the values recorded in previous tests on the same motor under similar load, temperature and humidity conditions, serves as a better indication of insulation condition than that of the value derived from a single test. Any substantial or sudden reduction is suspect and the cause determined and corrective action taken.
Insulation resistance is usually measured with a MEGGER.
In the event that insulation resistance is inferior to the values derived from the above formula, motors should be subjected to a drying process.

2.3.1 Drying the windings

This operation should be carried out with maximum care, and only by qualified personnel. The rate of temperature rise should not exceed 5°C per hour and the temperature of the winding should not exceed 105°C. An overly high final temperature as well as a fast temperature increase rate can each generate vapour harmful to the insulation.
Temperature should be accurately controlled during the drying process and the insulation resistance measured at regular intervals.
During the early stages of the drying process, insulation resistance will decrease as a result of the temperature increase, but the resistance will increase again when the insulation becomes dryer.
The drying process should be extended until sucessive measurements of insulation resistance indicate that a constant value above the minimum acceptable value has been attained. It is extremely important that the interior of the motor be well ventilated during the drying operation to ensure that the dampness is really removed.
Heat for drying can be obtained from outside sources (an oven), energization of the space heater (optional), or introducing a current through the actual winding of the motor being dried.

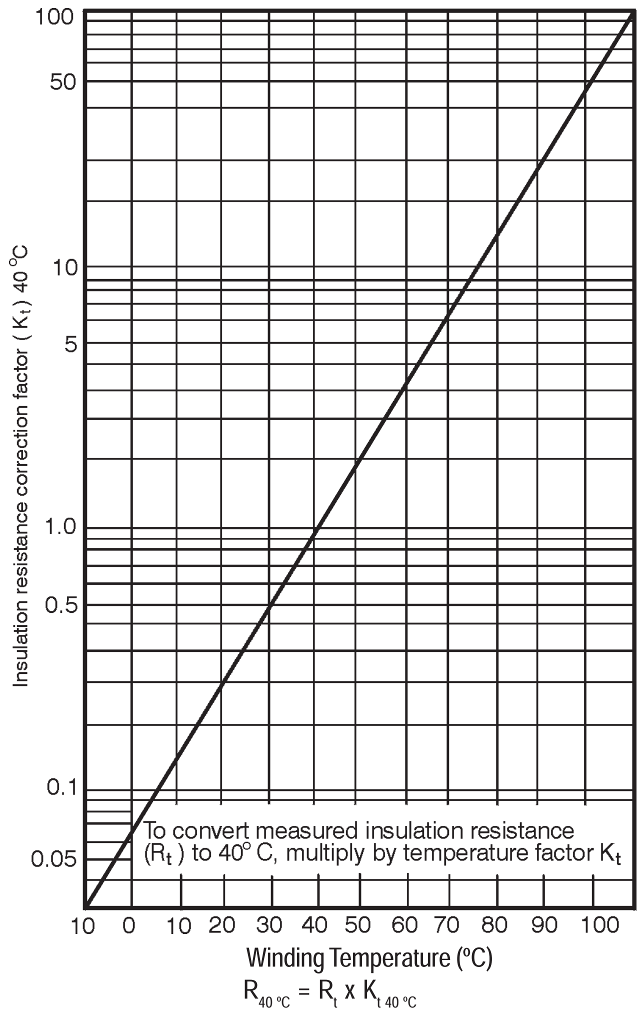


*Figure **2.1***

3. Installation

Electric machines should be installed in order to allow an easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or contain flammable substances or particles, it is essential to ensure an adequate degree of protection.
The installation of motors in environments where there are vapours, gases or dusts, flammable or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) Standards.
Under no circumstances can motors be enclosed in boxes or covered with materials which may impede or reduce the free circulation of ventilating air. Machines fitted with external ventilation should be at least 50cm from the wall to permit the passage of air.
The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes or other objects.
The place of installation should allow for air renewal at a rate of 700 cubic feet per minute for each 75 HP motor capacity.

3.1 Mechanical Aspects

3.1.1 Foundation

The motor base must be levelled and as far as possible free of vibrations. A concrete foundation is recommended for motors over 100 HP. The choice of base will depend upon the nature of the soil at the place of erection or of the floor capacity in the case of buildings.
When dimensioning the motor base, keep in mind that the motor may occasionally be run at a torque above that of the rated full load torque.
Based upon Figure 3.1, foundation stresses can be calculated by using the following formula:

$$F1 = 0.2247\ (0.009 \times g \times G - 213\ \text{Tmáx}/A)$$

$$F2 = 0.2247\ (0.009 \times g \times G + 213\ \text{Tmax}/A)$$

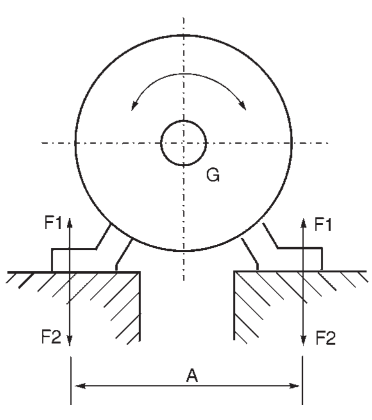


Figure 3.1 - Base stresses

Where:

F1 and F2 - Lateral stress (Lb)
g - Force of gravity (32.18 ft/s²)
G - Weight of motor (Lb)
Tmax - Maximum torque (Lb . Ft)
A - Obtained from the dimensional drawing of the motor (in)

Sunken bolts or metallic base plates should be used to secure the motor to the base.

3.1.2 Types of Bases

a) Slide Rails

When motor drive is by pulleys the motor should be mounted on slide rails and the lower part of the belt should be pulling.
The rail nearest the drive pulley is positioned in such a manner that the adjusting bolt be between the motor and the driven machine.
The other rail should be positioned with the bolt in the opposite position, as shown in Figure 3.2.
The motor is bolted to the rails and set on the base. The drive pulley is aligned such that its center is on a plane with the center of the driven pulley and the motor shaft and that of the machine be parallel.

The belt should not be overly stretched, see Figure 3.11.
After the alignment, the rails are fixed.

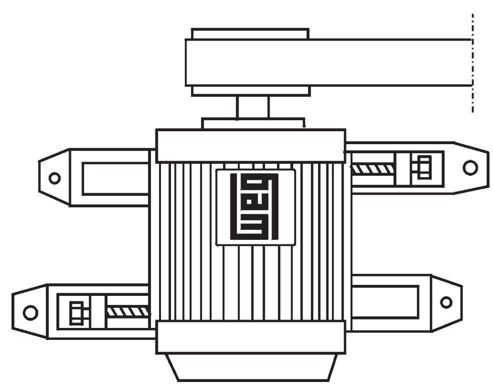


Figure 3.2 - Positioning of slide rails for motor alignment

b) Foundation Studs

Very often, particularly when drive is by flexible coupling the motor is anchored directly to the base with foundation studs.
It is recommended that shim plates of approximately 0.8 inches be used between the foundation studs and the feet of the motor for replacement purposes. These shim plates are useful when exchanging one motor for another of larger shaft height due to variations allowed by standard tolerances.
Foundation studs should neither be painted nor rusted as both interfere with to the adherence of the concrete, and bring about loosening.
After accurate alignment and levelling of the motor, the foundation studs are cemented and their screws tightened to secure the motor.

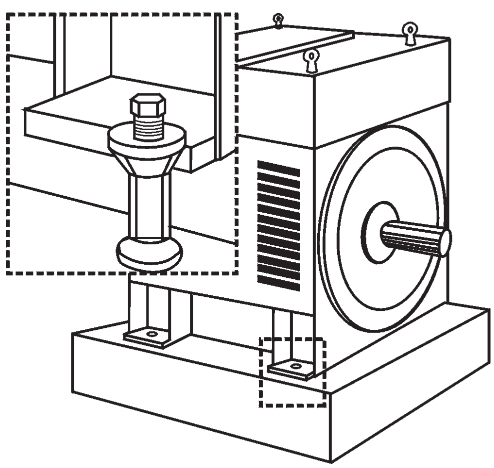


Figure 3.3 - Motor mounted on a concrete base with foundation studs

3.1.3 Alignment

The electric motor should be accurately aligned with the driven machine, particularly in cases of direct coupling. An incorrect alignment can cause bearing failure vibrations and even shaft rupture.
The best way to ensure correct alignment is to use dial gauges placed on each coupling half, one reading radially and the other exially - Figure 3.5.

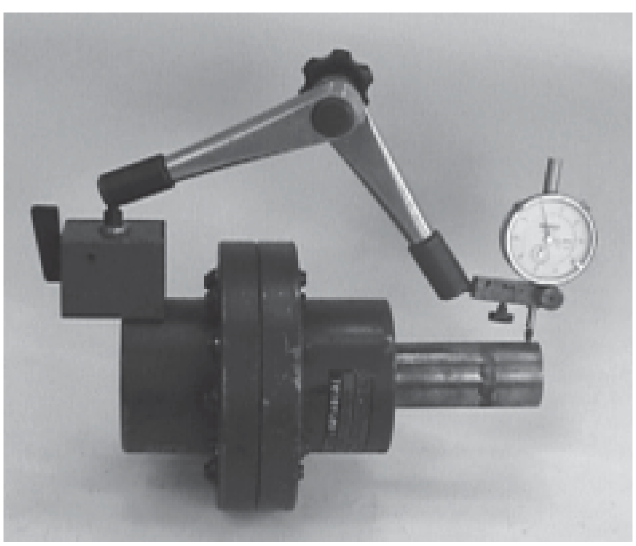


Figure 3.5 - Alignment with dial gauges

Thus, simultaneous readings are possible and allow for checking for any parallel (Figure 3.6a) and concentricity deviations (Figure 3.6b) by rotating the shafts one turn.
Gauge readings should not exceed 0.0**2** inches. If the installer is sufficiently skilled, he can obtain alignment with feeler gauges and a steel ruler, providing that the couplings are perfect and centered **-** Figure 3.6c.

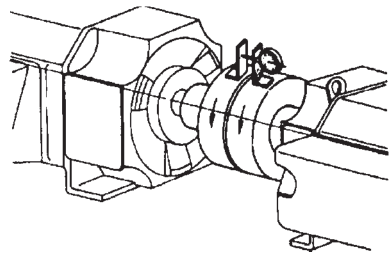


Figure 3.6a - Deviation from parallel

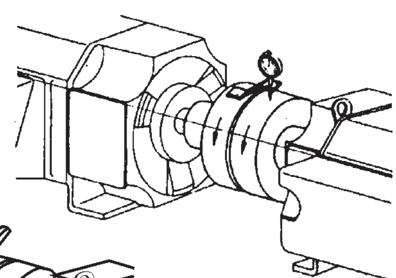


Figure 3.6b - Deviation from concentricity

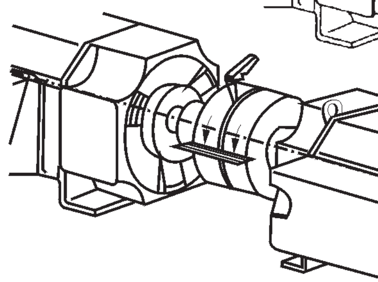


Figure 3.6c - Alignment with a steel ruler

3.1.4 Coupling

a) Direct Coupling

Direct coupling is always preferable due to its lower cost, space economy, no belt slippage and lower accident risk.
In the case of speed ratio drives, it is also common to use a direct coupling with a reducer (gear box).

CAUTION: Carefully align the shaft ends using, whenever feasible, a flexible coupling.

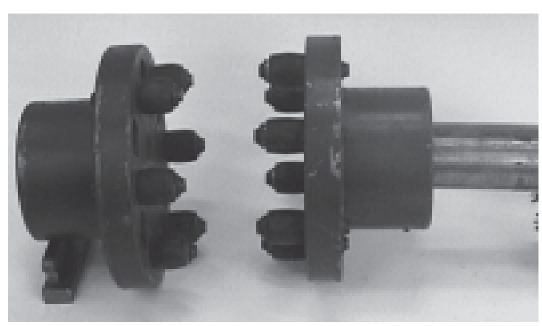


Figure 3.7 - A type of direct coupling

b) Gear Coupling

Poorly aligned gear couplings are the cause of jerking motions which bring about the vibration of the actual drive and vibrations within the motor.

Therefore, due care must be given to perfect shaft alignment: exactly parallel in the case of straight gears, and at the correct angle for bevel or helical gears.
Perfect gear engagement can be checked by the insertion of a strip of paper on which the teeth marks will be traced after a single rotation.

c) Belt and Pulley Coupling

Belt coupling is most commonly used when a speed ratio is required.
Assembly of Pulleys: To assemble pulleys on shaft ends with a keyway and threaded end holes the pulley should be inserted halfway up the keyway merely by manual pressure.
On shafts without threaded end holes the heating of the pulley to about 80°C is recommended, or alternatively, the devices illustrated in Figure 3.8 may be employed.

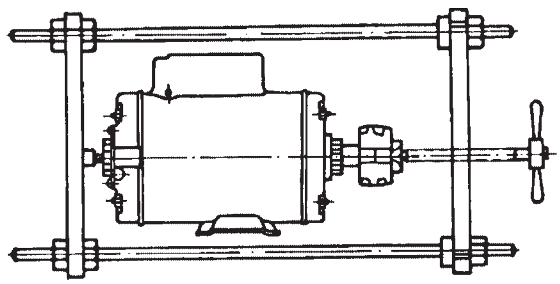


Figure 3.8 - Pulley mounting device

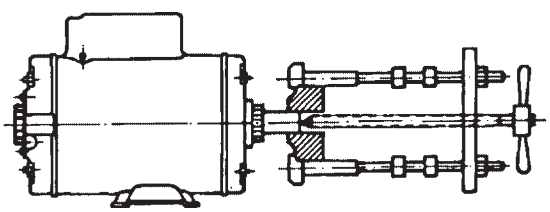


Figure 3.8a - Pulley extractor

Hammers should be avoided during the fitting of pulleys and bearings. The fitting of bearings with the aid of hammers leaves blemishes on the bearing races. These initially small flaws increase with usage and can develop to a stage that completely impairs the bearing.
The correct positioning of a pulley is shown in Figure 3.9.

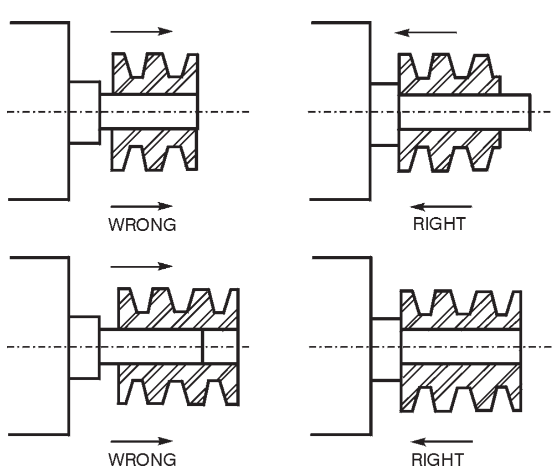


Figure 3.9 - Correct positioning of pulley on the shaft

RUNNING: To avoid needless radial stresses on the bearings it is imperative that shafts are parallel and the pulleys perfectly aligned. (Figure 3.**10**).

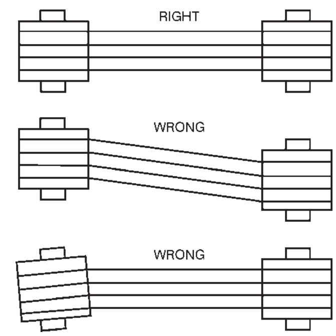


*Figure 3.**10** - Correct pulley alignment*

Laterally misaligned pulleys, when running, transmit alternating knocks to the rotor and can damage the bearing housing. Belt slippage can be avoided by applying a resin (rosin for example).
Belt tension should be sufficient to avoid slippage during operation (Figure 3.**11**).
Pulleys that are too small should be avoided; these cause shaft flexion because belt traction increases in proportion to a decrease in the pulley size. Table **1** determines minimum pulley diameters, and Tables **2** and 3 refer to the maximum stresses acceptable on motor bearings up to frame 580. Beyond frame size 600, an analysis should be requested from the WEG engineering.

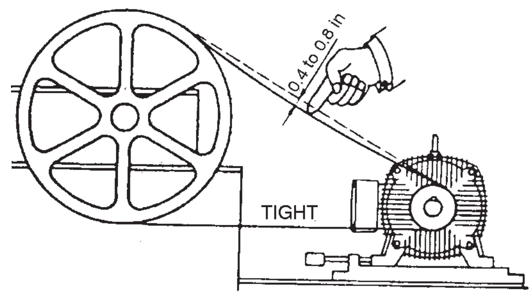
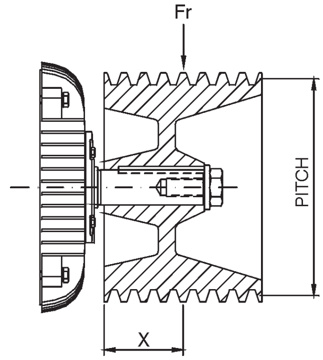


*Figure 3.**11** - Belt tensions*

***Table 1** - Minimum pitch diameter of pulleys*

Frame	Ball bearings						
	Bearing	Size X Inches					
		0.79	1.57	2.36	3.15	3.94	4.72
140	6205-Z	1.7	1.85	2			
W 180	6206-Z	3.03	3.23	3.46			
180	6307-Z	1.69	1.81	1.93			
W 210	6308-Z		2.86	3.00	3.16		
210	6308-Z		2.90	3.06	3.22		
W 250	6309 C3		4.37	4.54	4.72	4.92	
250	6309 C3		4.41	4.59	4.77	4.97	
280	6311 C3			5.08	5.19	5.47	5.65
320	6312 C3			7.44	7.76	7.94	8.18
360	6314 C3			8.73	9.00	9.28	9.57



Frame	Poles	Ball Bearing					Roller Bearing						
		Bearing	Size X Inches				Bearing	Size X Inches					
			1.97	3.15	4.33	5.51		1.97	3.15	4.33	5.51	6.69	8.27
400	II	6314 C3	7.3	7.62	7.94	8.24		-	-	-	-	-	-
	IV-VI-VII	6314 C3					NU 316	4.13	4.31	4.49	4.67	4.85	-
440	II	6314 C3	11.75	12.16	12.61	13.08		-	-	-	-	-	-
	IV-VI-VIII	6319 C3					NU 319	4.02	4.17	4.32	4.47	4.62	4.82
500	II	6314 C3	23.54	24.34	25.12	25.87		-	-	-	-	-	-
	IV-VI-VIII	6319 C3					NU 319	6.52	6.73	6.95	7.17	7.39	7.67
5008	II	6314 C3	44.66	45.79	46.98	48.23		-	-	-	-	-	-
	IV-VI-VIII	6322 C3					NU 322	8.73	8.95	9.96	11.34	12.87	14.82
580	II	6314 C3	57	58	59	60		-	-	-	-	-	-
	IV-VI-VIII	6322 C3					NU 322	10.72	10.91	11.11	11.31	11.50	11.76

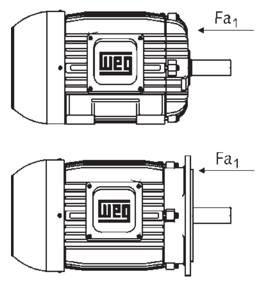
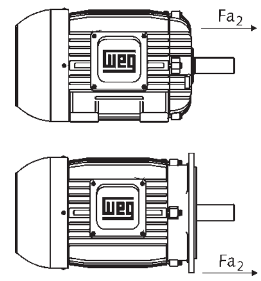
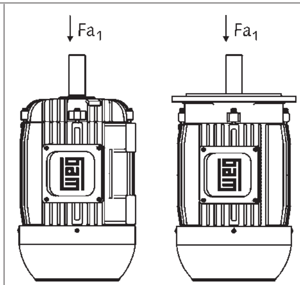
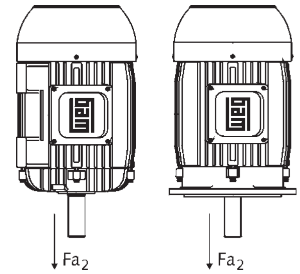
Important: 1) Peripheral speeds for solid grey cast iron pulleys FC 200 is V = 115 ft/s.
2) Use steel pulleys when peripheral speed is higher than 115 ft/s.
3) V-belt speed should not exceed 115 ft/s.

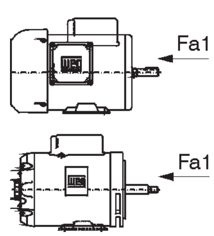
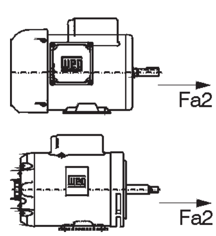
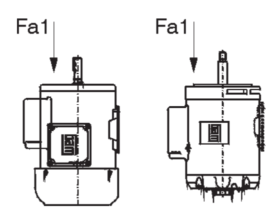
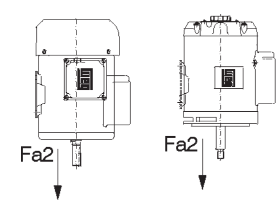
***Table 2** - Maximum acceptable radial load (Lbf)*

Nema 56 Motors				
Frame	Radial Force (Lbf)			
	Poles	Distance X		
		1	1,18	2
56A	II	88	-	59
	IV	88	-	59
56B	II	88	-	59
	IV	86	-	59
56D	II	127	-	70
	IV	141	-	70

Saw Arbor Motors				
80 LMS	II	-	355	-
80 MMS	II	-	359	-
80 SMS	II	-	357	-
90 LMS	II		427	-
	IV	-	555	-

Table 3 *- Maximum acceptable axial load (Lbf)*

IP55 Totally Enclosed Motors - 60Hz Position / Construction Form																
FRAME																
	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII
140	103	141	167	187	112	152	185	207	99	132	158	178	105	143	174	198
W 180	108	145	180	202	154	209	255	286	94	130	165	183	141	194	240	269
180	149	207	249	286	269	370	443	500	136	189	229	266	253	352	421	480
W 210	196	264	326	368	329	447	544	610	176	238	297	339	310	421	518	582
210	189	257	315	357	324	443	533	599	160	220	275	310	295	405	493	553
W 250	282	372	443	485	471	620	734	811	240	317	394	414	430	564	685	743
250	273	368	436	485	463	615	727	813	220	310	379	421	410	557	672	749
280	355	480	551	624	621	826	959	1,082	275	388	427	502	540	736	838	961
320	374	498	588	668	703	930	1,091	1,232	266	366	432	511	597	793	937	1,078
360	890	1,181	1,144	1,323	890	1,181	1,375	1,552	745	985	1,144	1,323	745	985	1,144	1,323
400	877	1,148	1,347	1,521	877	1,148	1,347	1,521	705	890	1,060	1,241	705	890	1,060	1,241
440	842	1,303	1,563	1,821	842	1,303	1,563	1,821	568	884	1,109	1,488	568	884	1,109	1,488
500	769	1,250	1,481	1,728	769	1,250	1,481	1,728	355	721	844	1,190	355	721	844	1,109
5008	791	1624	1909	2137	791	1624	1909	2137	728	1548	1808	2029	728	1548	1808	2029
580	679	1,406	1,649	1,865	679	1,406	1,649	1,865	033	474	549	597	033	474	549	597

Open Motors - NEMA 56 Frames - 60Hz Position / Construction Form								
FRAME								
	II	IV	II	IV	II	IV	II	IV
56 A	68	90	83	112	63	85	79	108
56 B	66	90	81	110	63	83	77	105
56 D	63	88	105	145	59	81	101	138

The maximum radial load for each frame are determined, by graphs.

INSTRUCTIONS ON HOW TO USE THE GRAPHS

1 - Maximum radial load on shaft.
2 - Maximum radial load on bearings.

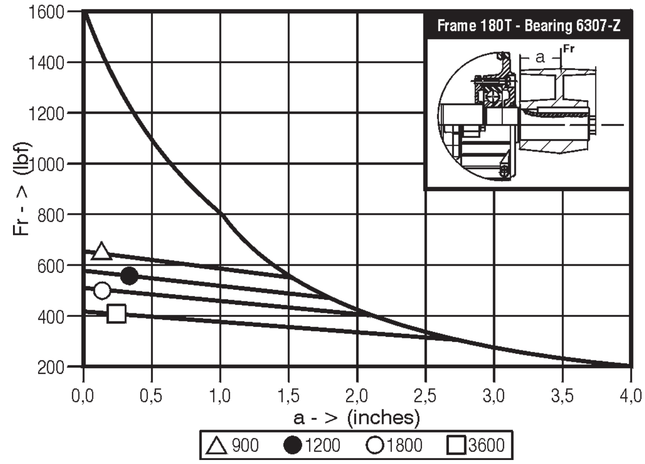
Where: X - Half of pulley width (inches)
Fr- Maximum radial load in relation to the diameter and pulley width.

Example:
Verify whether a **2**HP motor, II Pole, 60Hz withstands a radial load of **11**0Lb, considering a pulley width of 4 inches.

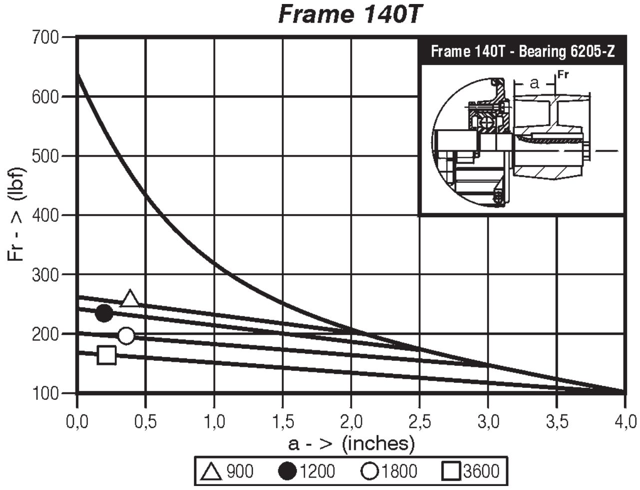
Frame: **1**45T
Fr: **11**0Lb
X: **2** inches

1 - Mark the distance X
2 - Find out line N = 3600 for bearing
Based on the above, this bearing withstands a radial load of **1**30Lb.

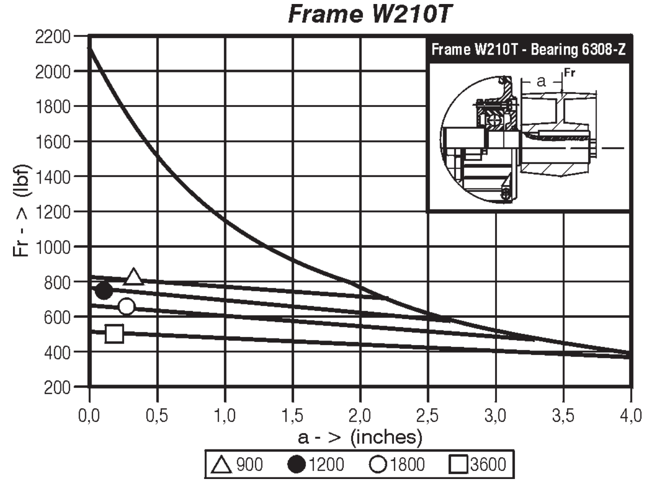
Frame 180T



Frame 140T



Frame W210T



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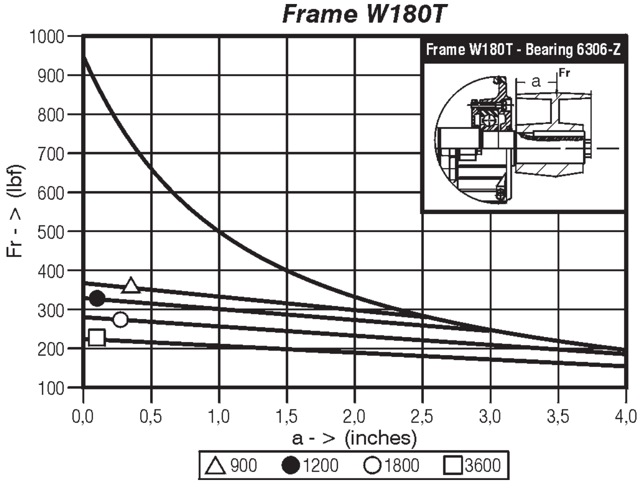

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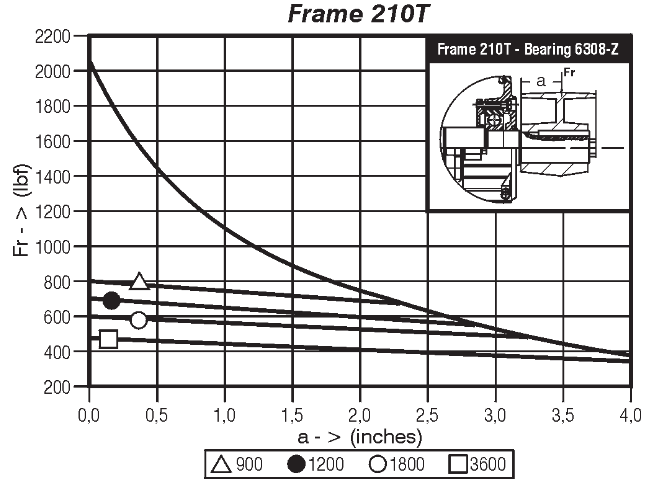

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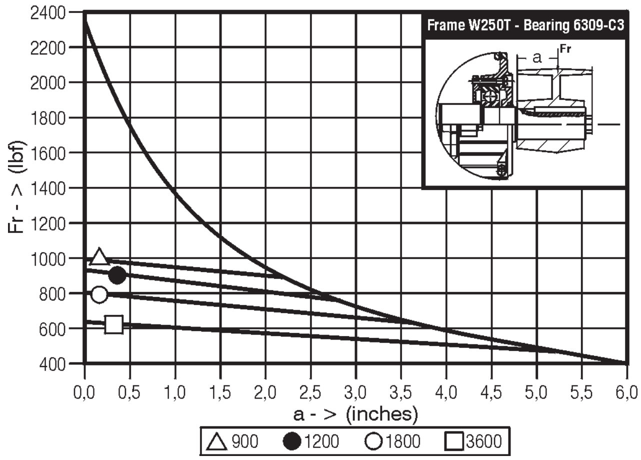
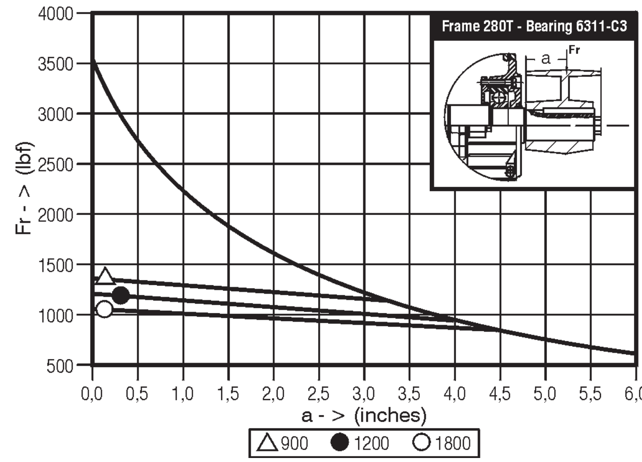


Frame 280T



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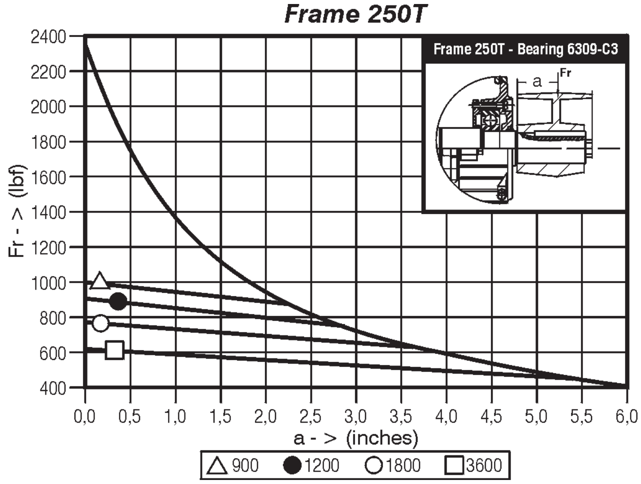
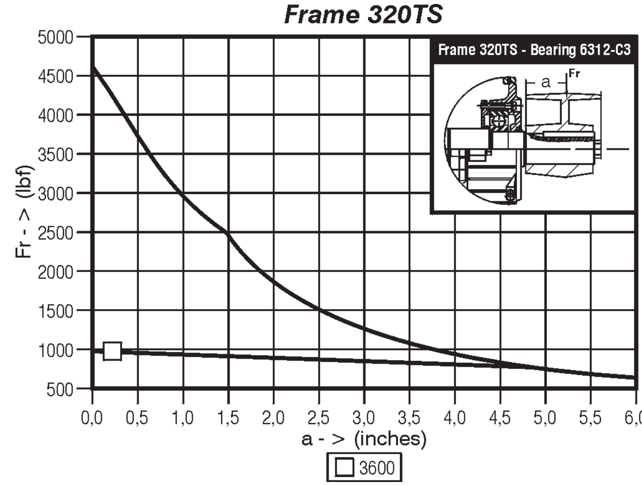


Frame 320TS



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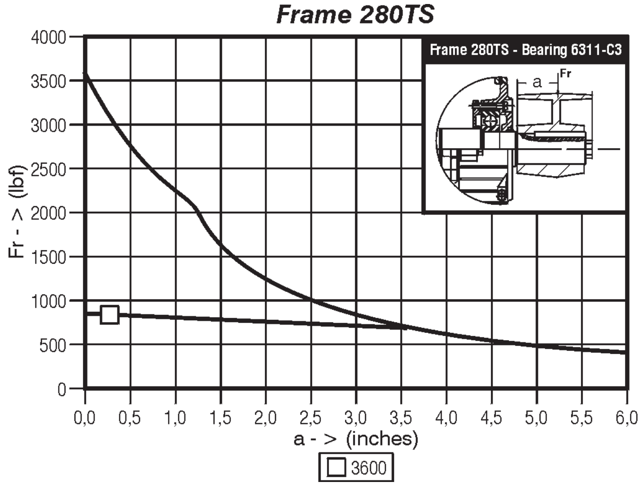

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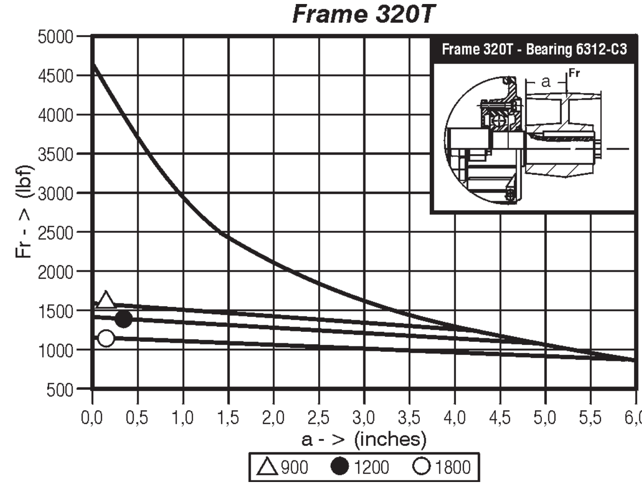
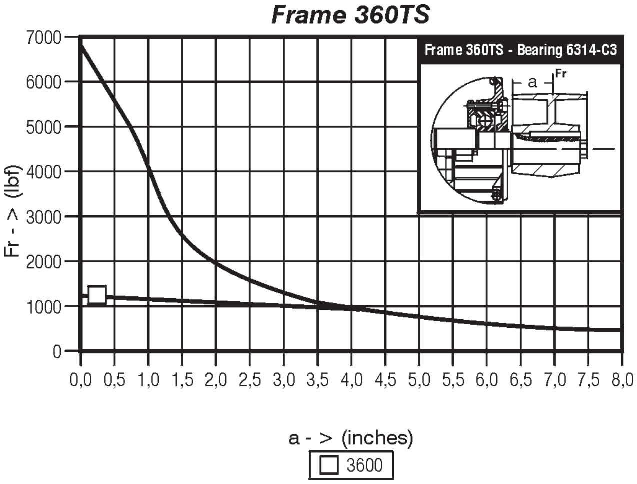
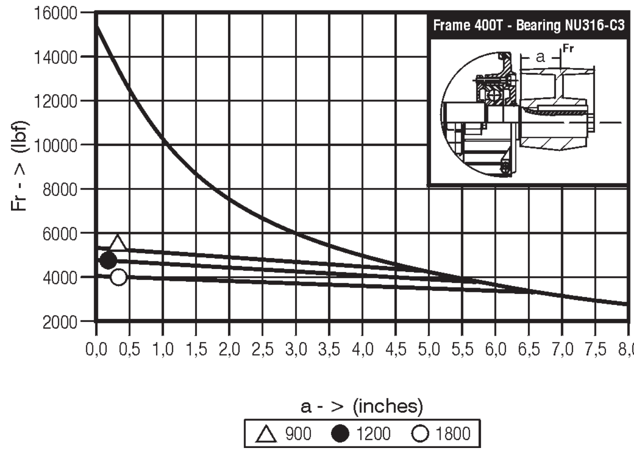


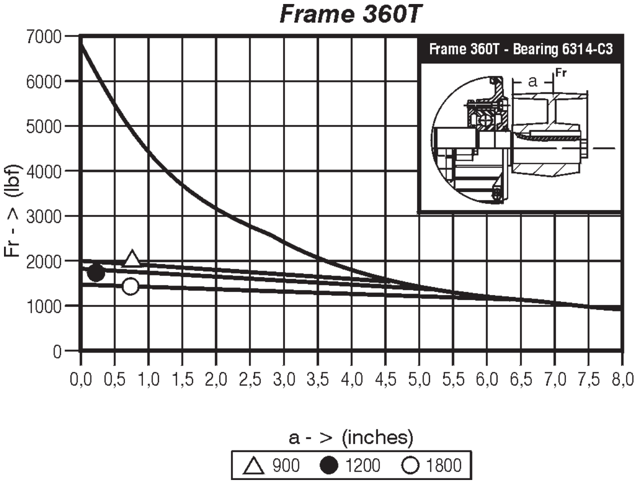
Frame 360TS



Frame 400T



Frame 360T



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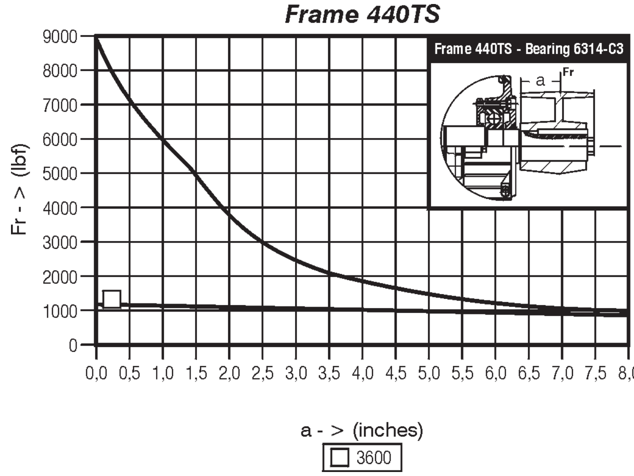

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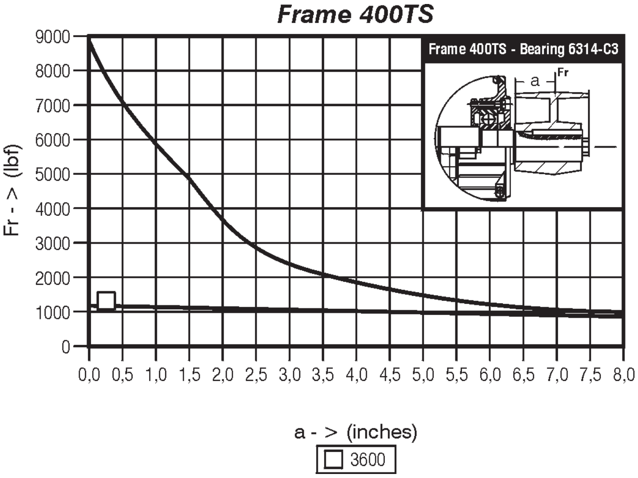

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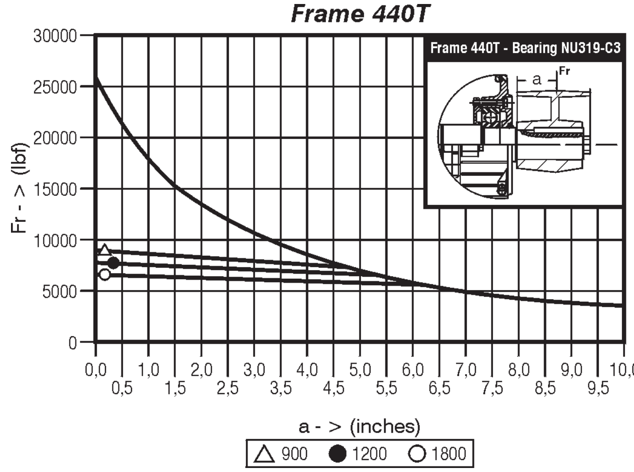

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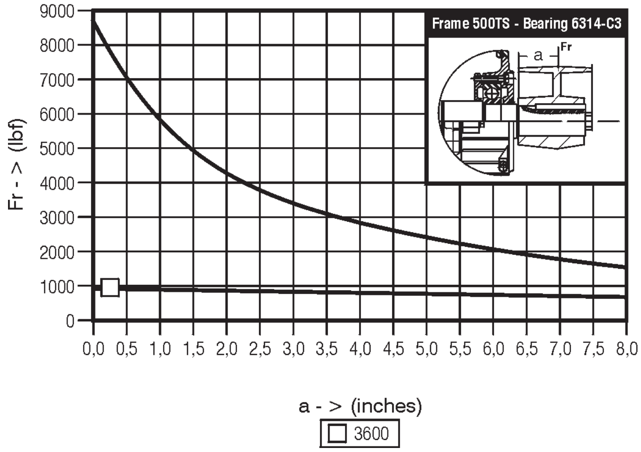
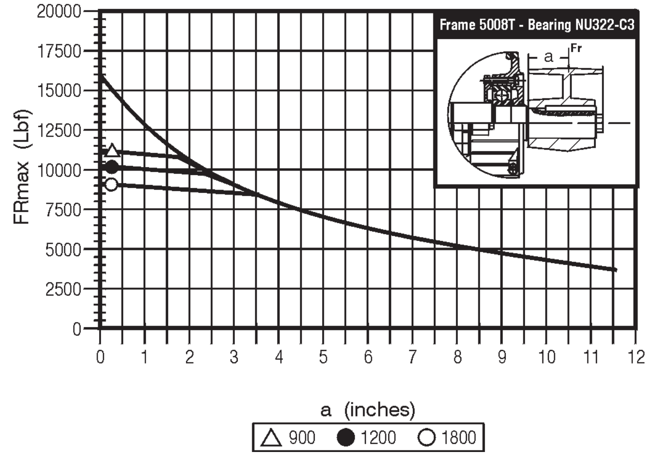
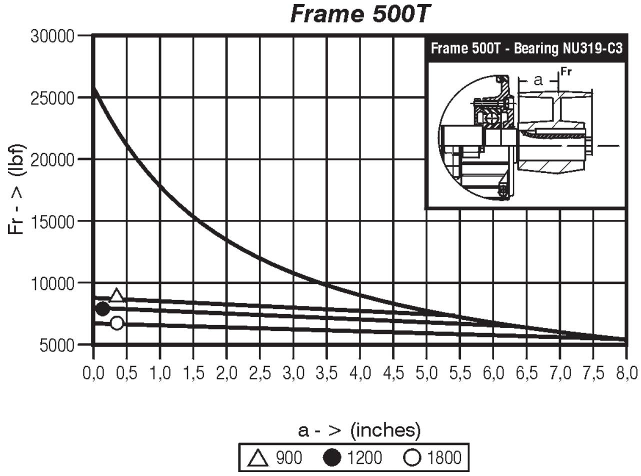


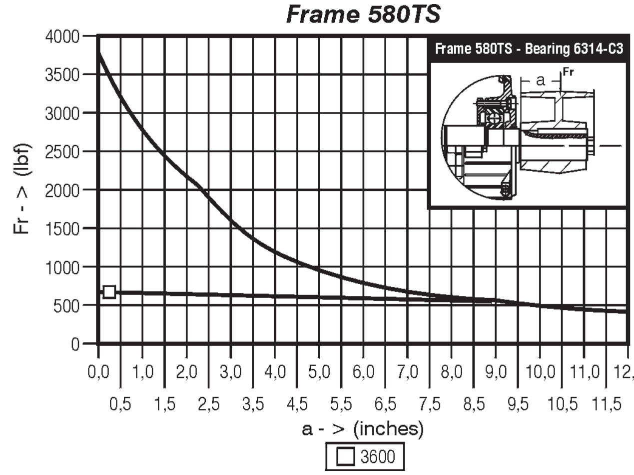
Frame 5008T



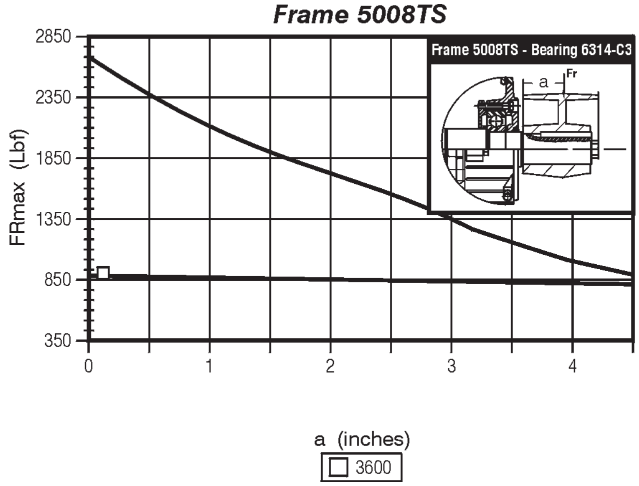
Frame 500T



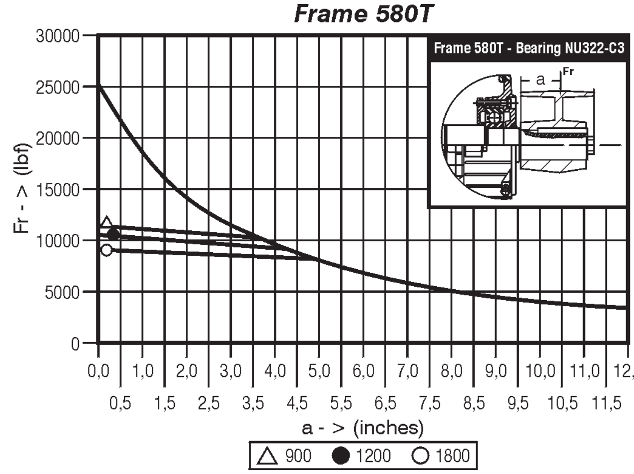
Frame 580TS



Frame 5008TS



Frame 580T



Note: For frames 600 and above, consult your engineering representative.

3.2 Electrical Aspects

3.2.1 Feed System

Proper electric power supply is very important. The choice of motor feed conductors, whether branch or distribution circuits, should be based on the rated current of the motors as per NFPA-70 Standard article 430.
Tables 4, 5 and 6 show minimum conductor gauges sized according to maximum current capacity and maximum voltage drop in relation to the distance from the distribution center to the motor, and to the type of installation (Overhead or in ducts).

To determine the conductor gauge proceed as follows:

a) Determine the current by multiplying the current indicated on the motor nameplate by **1.2**5 and then locate the resulting value on the corresponding table.
If the conductor feeds more than one motor, the value to be sought on the table should be equal **1.2**5 times the rated current of the largest motor plus the rated current of the other motors.
In the case of variable speed motors, the highest value among the rated currents should be considered.
When motor operation is intermittent, the conductors should have a current carrying capacity equal or greater, to the product of the motor rated current times the running cycle factor shown on Table 7.

Table 7 *- Running cycle factor*

Motor Short

Duty Classification \ Motor short time rating	5min	**1**5min	30 at 60min	Continuos
Short (operating valves, activating contacts etc)	**1.1**0	**1.2**0	**1**.50	-
Intermittent (passenger or freight elevators, tools, pumps, rolling bridges etc)	0.85	0.85	0.90	**1**.40
Cyclic (rolling mills,mining machines etc)	0.85	0.90	0.95	**1**.40
Variable	**1.1**0	**1.2**0	**1**.50	**2**.00

b) Locate the rated voltage of the motor and the feed network distance in the upper part of the corresponding table. The point of intersection of the distance column and the line referring to current will indicate the minimum required gauge of the conductor.

Example:
Size the conductors for a **1**5 HP, three-phase, **2**30V, 4**2**A, motor located **2**00 feet from the main supply with cables laid in conduits.

a) Current to be located: **1.2**5 x 4**2**A = 5**2**.5A
b) Closest value on table 6:55A
c) Minimum gauge: 6 AWG

3.2.2 Starting of Electric Motor

Induction motors can be started by the following methods:

Direct Starting

Whenever possible a three-phase motor with a squirrel cage rotor should be started directly at full supply voltage by means of a contactor (Connection diagram a). This method is called Direct-on-Line (DOL) starting.
There are DOL starter assemblies available combining a three-pole contactor, a bimetal relay (overload protection device), and a fuse (short circuit protection on branch circuit).
DOL starting is the simplest method, only feasible however, when the locked rotor current (LRC) does not influence the main electric supply lines.
Initial locked rotor current (LRC) in induction motors reach values six to eight times the value of the full load current. During starting by the DOL method, starting current can reach these high levels. The main electrical supply should be rated sufficiently, such that during the starting cycle no supply disturbance to others on the power network is caused by the voltage drop in the main supply.
This can be achieved under one of the following situations:

a) The rated main supply current is high enough for the locked rotor current not to be proportionally high.
b) Motor locked rotor current is low with no effect on the networks.
c) The motor is started under no-load conditions with a short starting cycle and, consequently, a low locked rotor current with a transient voltage drop tolerable to other consumers.

Starting with a compensating switch (auto-transformer starting)

Should direct on line starting not be possible, either due to restrictions imposed by the power supply authority or due to the installation itself, reduced voltage indirect starting methods can be employed to lower the locked rotor current. The single line connection diagram (C) shows the basic components of a compensating switch featuring a transformer (usually an auto-transformer) with a series of taps corresponding to the different values of the reduced voltage. Only three terminals of the motor are connected to the switch, the other being interconnected as per diagram, for the indicated voltage.

Star-Delta starting

It is fundamental to star-delta starting that the three-phase motor has the necessary numbers of leads for both connections:

6 leads for Y/Δ
or **12** leads for YY/ΔΔ

All the connections for the various voltages are made through terminals in the terminal box in accordance with the wiring diagram that accompanies the motor. This diagram may be shown on the nameplate or in the terminal box.
The star-delta connection is usually used only in low-voltage motors due to normally available control and protection devices. In this method of starting the locked rotor current is approximately 30% of the original LRC. The locked rotor torque is reduced proportionally as well. For this reason, it is very important before deciding to use

Table 4 *- Wire and cable gauges for single-phase motor installation (voltage drop < 5%) (in conduits)*

Supply Voltage	Distance of motor from distribution centre (feet)													
115	34	51	69	85	102	137	171	205	240	273	308	342	428	514
230	69	102	138	170	204	274	342	410	480	546	616	684	856	1028
460	138	204	276	340	408	548	684	820	960	1092	1232	1368	1712	2056
575	170	250	338	420	501	670	840	1010	1181	1342	1515	1680	2105	2530
Current (A)	Cable gauge (conductor)													
5	14	14	14	14	14	14	14	12	12	12	12	10	10	8
10	14	14	14	14	12	12	10	10	10	8	8	8	6	6
15	12	12	12	12	12	10	8	8	6	6	6	6	4	2
20	12	12	12	10	10	8	8	6	6	6	4	4	4	2
30	10	10	10	8	8	6	6	6	4	4	2	2	2	1/0
40	8	8	8	8	6	6	4	4	2	2	2	2	1/0	2/0
55	6	6	6	6	6	4	4	2	2	1/0	1/0	1/0	1/0	2/0
70	4	4	4	4	4	2	2	2	1/0	1/0	2/0	2/0	2/0	2/0
95	2	2	2	2	2	2	1/0	1/0	1/0	2/0	3/0	3/0	4/0	250M

Table *5 - Wire and cable gauges for three-phase motor installation - aerial conductors with **2**5cm spacing (voltage drop < 5%)*

Supply Voltage	Distance of motor from distribution centre (feet)													
115	51	69	85	102	137	171	205	240	273	308	342	428	514	685
230	102	138	170	204	274	342	410	480	546	616	684	856	1028	1370
460	204	276	340	408	547	684	820	960	1092	1232	1368	1712	2056	2740
575	250	338	420	501	670	840	1010	1181	1342	1515	1680	2105	2530	3350
Current (A)	Cable gauge (conductor)													
15	14	14	14	12	12	10	10	10	8	8	8	6	6	4
20	14	14	12	12	10	10	8	8	8	6	6	4	4	2
30	14	12	10	8	8	8	6	6	4	4	4	2	2	1/0
40	12	10	10	8	8	6	4	4	4	2	2	2	1/0	2/0
55	10	10	8	8	6	4	4	2	2	2	1/0	2/0	3/0	--
70	8	8	6	6	4	2	2	2	1/0	1/0	2/0	3/0	--	--
100	6	6	4	4	2	2	1/0	2/0	3/0	4/0	4/0	--	--	--
130	4	4	4	2	1/0	1/0	2/0	4/0	--	--	--	--	--	--
175	2	2	2	1/0	2/0	3/0	--	--	--	--	--	--	--	--
225	1/0	1/0	1/0	2/0	3/0	--	--	--	--	--	--	--	--	--
275	2/0	2/0	2/0	4/0	--	--	--	--	--	--	--	--	--	--
320	3/0	3/0	3/0	4/0	--	--	--	--	--	--	--	--	--	--

Table 6 *- Wire and cable gauges for three-phase motor installation (voltage drop < 5%) (in conduits)*

Supply Voltage	Distance of motor from distribution centre (feet)											
115	85	102	120	137	171	205	240	273	308	342	428	514
230	170	204	240	274	342	410	480	546	616	684	856	1028
460	340	408	480	548	684	820	960	1092	1232	1368	1712	2056
575	420	501	590	670	840	1010	1181	1342	1515	1680	2105	2530
Current (A)	Cable gauge (conductor)											
15	12	12	12	10	10	8	8	8	6	6	6	4
20	12	10	10	10	8	8	6	6	6	6	4	4
30	10	8	8	8	6	6	6	4	4	4	2	2
40	8	8	6	6	6	4	4	4	2	2	2	1/0
55	6	6	6	4	4	4	2	2	2	1/0	1/0	1/0
70	4	4	4	4	2	2	2	1/0	1/0	1/0	2/0	2/0
95	2	2	2	2	2	1/0	1/0	1/0	1/0	2/0	3/0	4/0
125	1/0	1/0	1/0	1/0	1/0	1/0	2/0	2/0	3/0	3/0	4/0	250M
145	2/0	2/0	2/0	2/0	2/0	2/0	2/0	3/0	3/0	4/0	250M	300M
165	3/0	3/0	3/0	3/0	3/0	3/0	3/0	3/0	4/0	4/0	250M	350M
195	4/0	4/0	4/0	4/0	4/0	4/0	4/0	4/0	250M	250M	300M	350M
215	250M	250M	250M	250M	250M	250M	250M	250M	250M	300M	350M	400M
240	300M	300M	300M	300M	300M	300M	300M	300M	300M	300M	400M	500M
265	350M	350M	350M	350M	350M	350M	350M	350M	350M	350M	500M	500M
280	400M	400M	400M	400M	400M	400M	400M	400M	400M	400M	400M	--
320	500M	500M	500M	500M	500M	500M	500M	500M	500M	500M	500M	--

Note: The above indicated values are orientative. For guaranteed values, contact the Local Power Company.

star-delta starting to verify if the reduced locked rotor torque in "STAR" connection is enough to accelerate the load.

3.2.3 Motor Protection

Motor circuits have, in principle, two types of protection: motor overload, locked rotor and protection of branch circuit from short circuits. Motors in continuous use should be protected from overloading by means of a device incorporated into the motor, or by an independent device, usually a fixed or adjustable thermal relay equal or less than to the value derived from multiplying the rated feed current at full load by:

- 1.25 for motors with a service factor equal or superior to 1.15 or;
- 1.15 for motors with service factor equal to 1.0.

Some motors are optionally fitted with overheating protective detectors (in the event of overload, locked rotor, low voltage, inadequate motor ventilation) such as a thermostat (thermal probe), thermistor (PTC), RTD type resistance which dispense with independent devices.

THERMOSTAT (THERMAL PROBE): Bimetallic thermal detectors with normally closed silver contacts. These open at pre-determined temperatures. Thermostats are series connected directly to the contactor coil circuit by two conductors.

THERMISTORS: Semi-conductor heat detectors positive temperature coeficient (PTC) that sharply change their resistance upon reaching a set temperature. Thermistors, depending upon the type, are series or parallel-connected to a control unit that cuts out the motor feed, or actuates an alarm system, in response to the thermistors reaction.

RESISTANCE TEMPERATURE DETECTORS (RTD) - PT 100:The resistance type heat detector (RTD) is a resistance element usually manufactured of copper or platinum.
The RTD operates on the principle that the electrical resistance of a metallic conductor varies linearly with the temperature. The detector terminals are connected to a control panel, usually fitted with a temperature gauge, a test resistance and a terminal changeover switch.

Subject to the desired degree of safety and the client's specification, three (one per phase) or six (two per phase) protective devices can be fitted to a motor for the alarm stems, circuit breaker or combined alarm and circuit breaker, with two leads from the terminal box to the alarm or circuit breaker system and four for the combined system (alarm and circuit breaker).
Table 9 compares the two methods of protection.

3.3 Start-up

3.3.1 Preliminary Inspection

Before starting a motor for the first time, it will be necessary to:

a) Remove all locking devices and blocks used in transit and check that the motor rotates freely;

b) Check that the motor is firmly secured and that coupling elements are correctly mounted and aligned.;

c) Ascertain that voltage and frequency correspond to those indicated on the nameplate. Motor performance will be satisfactory with main supply voltage fluctuation within ten per cent of the value indicated on the nameplate or a frequency fluctuation within five per cent or, yet, with a combined voltage and frequency variance within ten per cent;

d) Check that connections are in accordance with the connection diagram shown on the nameplate and be sure that all terminal screws and nuts are tight;

e) Check the motor for proper grounding. Providing that there are no specifications calling for ground-insulated installation, the motor must be grounded in accordance with prevalent standard for grounding electrical machines. The screw identified by the symbol ⏚ should be used for this purpose.
This screw is generally to be found in the terminal box or on one foot of the frame;

f) Check that motor leads connecting with the mains, as well as the control wires and the overload protection device, are in accordance with Nema Standards;

g) If the motor has been stored in a damp place, or has been stopped for some time, measure the insulating resistance as recommended under the item covering storage instructions;

h) Start the motor uncoupled to ascertain that it is turning in the desired direction. To reverse the rotation of a three-phase motor, invert two terminal leads of the mains supply.
High voltage motors bearing an arrow on the frame indicating rotation direction can only turn in the direction shown.

3.3.2 The First Start-up

Three-Phase Motor with Cage Rotor:
After careful examination of the motor, follow the normal sequence of starting operations listed in the control instructions for the initial start-up.

3.3.3 Operation

Drive the motor coupled to the load for a period of at least one hour while watching for abnormal noises or signs of overheating.
Compare the line current with the value shown on the nameplate.
Under continuous running conditions without load fluctuations this should not exceed the rated current times the service factor, also shown on the nameplate.
All measuring and control instruments and apparatus should be continuously checked for anomalies, and any irregularities corrected.

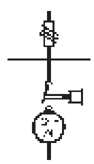
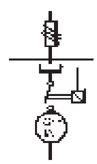
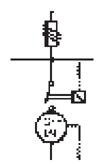
3.3.4 Stopping

Warning:

To touch any moving part of a running motor, even though disconnected, is a danger to life and limb.

Three-phase motor with cage rotor:
Open the stator circuit switch. With the motor at a complete stop, reset the auto-transformer, if any, to the “start” position.

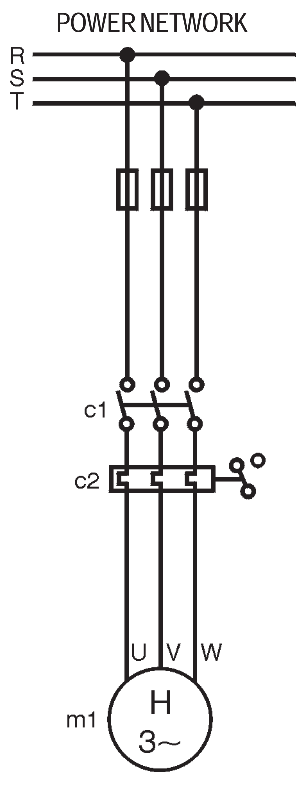
***Table 9** - Comparison between motor protection system*

Causes of overheating	Current-based protection		Protection with probe thermistor in motor
	Fuse only	Fuse and thermal protector	
			
1. Overload with 1.2 times rated current	○	●	●
2. Duty cycles S1 to S8 IEC 34, EB 120	○	◐	●
3. Brakings, reversals and frequent starts	○	◐	●
4. Operating with more than 15 starts p/hour	○	◐	●
5. Locked rotor	◐	◐	●
6. Fault on one phase	○	◐	●
7. Execessive voltage fluctuation	○	●	●
8. Frequency fluctuation on main supply	○	●	●
9. Excessive ambient temperature	○	●	●
10. External heating caused by bearings, belts, pulleys etc.	○	○	●
11. Obstructed ventilation	○	○	●

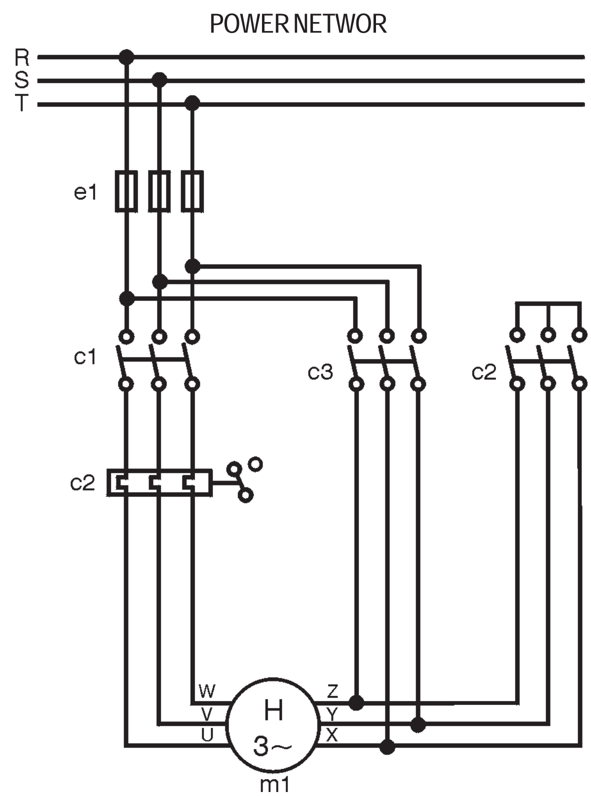
Caption:
○ unprotected
◐ partially protected
● totally protected

CONNECTION DIAGRAMS

a) Direct starting



b) Star-Delta starting



c) Auto-transformer starting