FINAL

OPERATION AND MAINTENANCE DATA

WYCKOFF GROUNDWATER TREATMENT PLANT
(Volume II)

Wyckoff/Eagle Harbor Superfund Site
Kitsap County, Washington

Prepared for

U.S. Army Corps of Engineers
Seattle District
4735 East Marginal Way South
Seattle, Washington 98134

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WYCKOFF GROUNDWATER TREATMENT PLANT

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PROCESS PUMPS

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Volume II

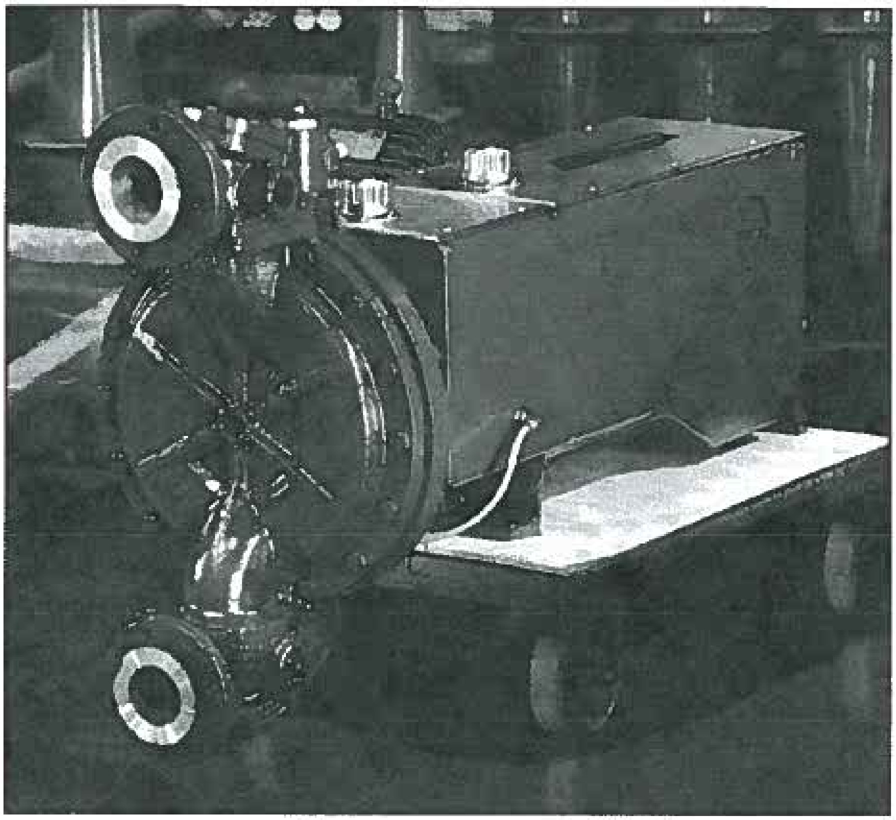
11240 - Froth Pumps 50P1251/50P1252

Attachment 2.1

Section 11240 - Metering Pumps 1.03.A.1.a,b
Section 11240 - Metering Pumps 2.03.A.1 and 3

MILROYAL C PUMPS

MILROYAL C WITH HPD LIQUID END



GENERAL SPECIFICATIONS

Section 2.03.A.1 and
Section 2.03.A.3

Drive
Polar crank design—all moving parts submerged in oil

Capacity Control
Manual Micrometer standard; Electronic, pneumatic, or variable speed optional

Accuracy
±1.0% over 10:1 turndown ratio

Weight for pump is
1225 lbs.
Section 1.03.A.1.a

Approximate Shipping Weight
850–1400 lbs. (simplex), depending upon liquid end selected

Liquid Ends Available
High Performance Diaphragm (HPD); Packed Plunger; Disc Diaphragm

Multiplexing
Up to 6 pumps driven by one motor. Limited to a maximum of 25 HP. Consult Applications Engineering concerning capabilities for a specific application.

Maximum Performance Ratings (per head)
2080 GPH (7873 l/h) @ 50 psig (3 bar) to
28.7 GPH (109 l/h) @ 10,000 psig (1450 bar)

Section 11240 - Metering Pumps 1.03.A.1.a and 1.03.A.1.d

MILROYAL C

HIGH PERFORMANCE DIAPHRAGM (HPD) LIQUID END PERFORMANCE

Typical performance based on 1725 RPM, 3 Phase, 60 Hz motor. Derate flow rates for all other RPM speeds.

Plunger Dia.	Gear Ratio Code	SPM @ 1725 RPM	Maximum Capacity*		1 HP (0.75 kW)		1 1/4 HP (1.1kW)		2 HP (1.5 kW)		3 HP (2.2 kW)		5 HP (4 kW)	
					Maximum Discharge Pressure*									
			GPH	L/H	PSIG	BAR	PSIG	BAR	PSIG	BAR	PSIG	BAR	PSIG	BAR
	8K	43	23	87	745	51	1545	107	2235	154	3025	209	—	—
	8J	71	38	143	465	32	1000	69	1550	107	2635	182	3025	209
1"	8H	85	46	174	315	22	770	53	1240	85	2150	148	3025	209
(25 mm)	8G	113	61	230	240	17	580	40	935	64	1620	112	[illegible]	[illegible]
	8F	140	76	287	165	11	510	35	855	59	[illegible]	[illegible]	[illegible]	[illegible]
	8K	43	37	140	480	33	950	66	1420	98	[illegible]	[illegible]	[illegible]	[illegible]
	8J	71	60	227	295	20	640	44	1000	69	1680	116	1930	133
1¼"	8H	85	72	272	200	14	490	34	790	54	1370	94	1930	133
(32 mm)	8G	113	97	367	150	10	370	26	590	41	1030	71	1900	131
	8F	140	120	454	110	8	325	22	545	38	970	67	1840	127
	8K	43	53	200	335	23	660	46	990	68	1350	93	—	—
	8J	71	88	333	205	14	445	31	695	48	1170	81	1350	93
1½"	8H	85	105	397	140	10	345	24	550	38	950	66	1350	93
(38 mm)	8G	113	140	529	105	7	260	18	415	29	720	50	1300	90
	8F	140	173	654	75	5	230	16	380	26	675	47	1280	88
	8K	43	97	367	190	13	370	26	560	39	745	51	—	—
	8J	71	151	571	115	8	250	17	390	27	660	46	745	51
2"	8H	85	181	685	80	6	190	13	310	21	540	37	745	51
(51 mm)	8G	113	240	908	60	4	145	10	235	16	400	28	745	51
	8F	140	299	1131	40	3	130	9	215	15	380	26	740	51
	8K	43	145	548	120	8	240	17	350	24	500	34	—	—
	8J	71	240	908	70	5	160	11	250	17	420	29	470	32
2½"	8H	85	288	1090	50	3	120	8	200	14	340	23	470	32
(64 mm)	8G	113	383	1449	40	3	90	6	150	10	260	18	380	26
	8F	140	475	1797	—	—	75	5	122	8	211	15	350	24
	8K	43	297	1124	60	4	120	8	185	13	235	16	—	—
	8J	71	490	1854	—	—	80	6	125	9	220	15	235	16
3½"	8H	85	587	2221	—	—	60	4	100	7	175	12	220	15
(89 mm)	8G	113	780	2952	—	—	—	—	75	5	130	9	175	12
	8F	140	968	3663	—	—	—	—	60	4	100	7	170	12
	8K	43	573	2168	—	—	55	4	90	6	105	7	—	—
	8J	71	947	3584	—	—	35	[illegible]	[illegible]	[illegible]	95	7	105	7
[illegible]	8H	85	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	85	6	105	7
	8G	113	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]	[illegible]	65	4	80	6
	8F‡	116	1545	5847	—	—	—	—	—	—	60	4	70	5
	8K	43	770	2914	—	—	50	3	65	4	—	—	—	—
	8J	71	1270	4807	—	—	35	2	55	4	65	4	—	—
5¾"	8H	85	1520	5753	—	—	—	—	40	3	55	4	65	4
(146 mm)	8G	113	2025	7664	—	—	—	—	—	—	40	3	50	3
	8F‡	116	2080	7872	—	—	—	—	—	—	40	3	50	3

Capacities listed are for discharge pressures up to 200 PSIG (14 Bar).
Capacity will decrease 0.8% for each 100 PSIG (7 Bar) over 200 PSIG (14 Bar).

Section 1.03.A.1.a
Power Requirement for pump

Section 1.03.A.1.d
Stroke Rate

Section 1.03.A.1.d
Gallons Per Hour

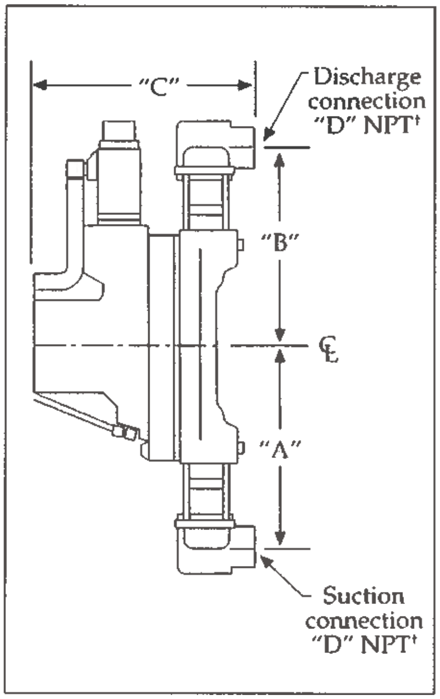
Section 1.03.A.1.d
Discharge PSI

NOTES:

* Plastic Liquid Ends are limited to 150 PSIG (10 Bar) @ 68°F (20°C) and are linearly derated to 65 PSI (4 Bar) @ 140°F (60°C).
† Derate capacities 5% when applying a diaphragm rupture detection system.
‡ These gear ratios are limited to 1450 RPM maximum. SPM and pump capacity noted is based on 1450 RPM motor.

Section 11240 - Metering Pumps 1.03.A.1.d
Pipe Connection Sizes

HPD LIQUID END DIMENSIONS



Material	Plunger Diameter		A‡		B‡		C		D
	in.	mm	in.	mm	in.	mm	in.	mm	in.
Metal	1"	25	5 7/32"	133	5 7/32"	133	7 3/4"	197	1/2"
	1 1/4"	32	7 1/16"	179	7 1/16"	179	9 13/16"	249	1"
	1 1/2"	38	7 17/32"	191	7 17/32"	191	9 13/16"	249	1"
	2"	51	7 17/32"	191	7 17/32"	191	9 13/16"	249	1"
	2 1/2"	64	10 1/8"	257	10 1/8"	257	12 5/16"	313	1 1/2"
	3 1/2"	89	10 1/8"	257	10 1/8"	257	12 5/16"	313	1 1/2"
	5"	127	12 3/8"	314	12 3/8"	314	16 7/8"	429	*
	5 3/4"	146	12 3/8"	314	12 3/8"	314	16 7/8"	429	*
Plastic	2 1/2"	64	13"	330	13"	330	12"	305	1 1/2"
	3 1/2"	89	13"	330	13"	330	12"	305	1 1/2"
	5"	127	18 1/2"	470	14"	356	13 7/8"	352	2 1/2"†
	5 3/4"	146	18 1/2"	470	14"	356	13 7/8"	352	2 1/2"†

NOTES:

* 3"–150 lb. ANSI raised face flange.

† Suction and discharge connections are horizontal on metal and vertical on plastic, except on plastic 5" (127 mm) and 5 3/4" (146 mm) plungers, where suction is horizontal and discharge is vertical.

‡ A & B dimensions are based on standard ball check configuration: metallic-single ball checks (single poppet on 5" (127 mm) and 5 3/4" (146 mm)); plastic-double ball checks (single on 5" (127 mm) and 5 3/4" (146 mm)).

MILROYAL C

MAXIMUM ALLOWABLE SUCTION PRESSURE RANGE — HPD

Plunger Diameter		Standard		Mid Range		High Range		Maximum Range	
in.	mm	PSIG	Bar	PSIG	Bar	PSIG	Bar	PSIG	Bar
1"	25	100	7	—	—	—	—	—	—
1 1/4"	32	100	7	—	—	—	—	—	—
1 1/2"	38	85	6	100	7	—	—	—	—
2"	51	70	5	100	7	—	—	—	—
2 1/2"	64	50	3	70	5	100	7	—	—
3 1/2"	89	30	2	40	3	70	5	100	7
5"	127	12	1	17	1	28	2	65	4
5 3/4"	146	9	1	13	1	21	1	50	3

MILTON ROY

Section 11240 - Metering Pumps 1.03.A.1.a
Make and Model
Section 11240 - Metering Pumps 2.03.A and C

Section 1.03.A.1.a

HIGH PERFORMANCE DIAPHRAGM (HPD) LIQUID END MODEL CODE

End Item Model Code: M C H 5 6 1 — Option Select Number: 8 G P B C B M 1 S E S T 1 1 N N 1 1

Plunger Dia.
16 = 1"*
BG= 1" (1600 psi+)
20 = 1¼"*
CA= 1¼"* (1000 psi+)
24 = 1½"*
CE= 1½" (1000 psi+)
32 = 2"*
40 = 2½"†
56 = 3½"*†
80 = 5"‡
92 = 5¾"‡

Liquid End Material
1 = 316 SS
2 = Plastic
5 = Alloy 20
6 = Alloy C22

Section 2.03.C.1

Gear/Shaft
Single Shaft
8F = 12.5:1
8G = 15.5:1
8H = 20.5:1
8J = 24.5:1
8K = 40:1
Double Shaft
8A = 12.5:1
8B = 15.5:1
8C = 20.5:1
8D = 24.5:1
8E = 40:1

Operating Pressure§

1", 1¼" Plunger Dia.
PB = 0-400 psi (460 max. RV)
PC = 401-750 psi (860 max. RV)
PD = 751-1550 psi (1780 max. RV)
PE = 1551-3025 psi (3500 max. RV)

1½", 2" Plunger Dia.
PB = 0-220 psi (250 max. RV)
PC = 221-450 psi (515 max. RV)
PD = 451-750 psi (860 max. RV)
PE = 751-1000 psi (1150 max. RV)
PF = 1001-2060 psi (2370 max. RV)

2½", 3½", 5", 5¾" Plunger Dia.
PB = 0-220 psi (250 max. RV)
PC = 221-340 psi (390 max. RV)
PD = 341-500 psi (575 max. RV)

Motor Mount
AA = None

Flange Mount
CB = Nema 56C
CC = Nema 143TC, 145TC
CD = Nema 182TC, 184TC
CE = Nema 213TC, 215TC
CF = Nema 254TC, 256TC

Metric Mount, B5 Flange
ME = 1EC 90
MF = 1EC 100
MG = 1EC 132
MH = 1EC 160

Foot Mount
FK = Nema 143T, 145T
FN = Nema 182T, 184T
FP = Nema 213T, 215T
FR = Nema 254T, 256T

Suction Pressure Range**
ST = Standard
H2 = Medium
H3 = High
H7 = Maximum

Base
11 = Simplex
22 = Duplex
33 = Simplex
NN = None

Ball Quantity***
11 = Single
22 = Double

Rupture Detection/Double Dia.
NN = None
C5 = Rupt. Det. w/gauge††
SN = Rupt. Det. w/gauge & Nema 4 switch††
SE = Rupt. Det. w/gauge & exp. pr. switch††
DD = Double Diaphragm
DP = Double Diaphragm w/Probe

Connections‡‡
SE = NPT
T1 = ANSI 150 lb. threaded
T3 = ANSI 300 lb. threaded
T6 = ANSI 600 lb. threaded
S1 = ANSI 150 lb. socket weld
S3 = ANSI 300 lb. socket weld
S6 = ANSI 600 lb

Section 2.03.A.4

Capacity Adjustment

Manual
M1 = Micrometer (316 SS)

Electronic, 4-20 mA Input
E1 = Nema 4, 115 V
E2 = Nema 4, 230 V, 60 Hz
E3 = Nema 4, 230 V, 50 Hz
EA = Explosion Proof, 115 V
EB = Explosion Proof, 230 V, 60 Hz§§
EC = Explosion Proof, 230 V, 50 Hz§§

Pneumatic
PN = 3-15 PSI

NOTES:

* Plunger codes 16, BG, 20, CA, 24, CE, & 32 are not available with plastic liquid ends (liquid end material code 2) since this capacity range is covered by the Milroyal B Series.

† Plunger codes 40 & 56 are only available with double ball checks (ball quantity code 22) when ordered in plastic.

‡ Plunger codes 80 & 92 are only available with poppet valves on metallic pumps or single ball checks on plastic pumps (ball quantity code 11), and ANSI 150 lb. socket weld connections (connection code S1). Plunger codes 80 & 92 are not available in Alloy C22 (liquid end material code 6).

§ Operating pressure is the application system pressure. The internal relief valve is normally set 15% above the operating pressure. If an internal relief valve setting greater than 15% above the operating pressure range is required, select the operating pressure range that will accommodate the relief valve setting.

** Refer to suction pressure table for maximum suction pressure vs. range.

†† Options C5, SN, and SE are only available on metallic liquid ends.

‡‡ Flange sizes equal the NPT connection size as noted on the liquid end drawing.

§§ Explosion proof electronic actuators are certified by Factory Mutual for Class I, Division I, Groups B, C, & D; Class II, Division I, Groups E, F, & G.

***Special ball check and seat materials are available for severe slurry service. Contact factory.

Section 11240 - Metering Pumps 1.03.A.1.b
Materials of Construction
Section 11240 - Metering Pumps 2.03.C.2

HPD LIQUID END MATERIALS OF CONSTRUCTION—WETTED PARTS

Materials of Construction	Diaphragm	Diaphragm Head	Port Connection	Ball Seat	Ball Check	Ball Guide
316 SS‡	PTFE/Elastomer	316 SS CF-8M	316 SS CF-8M	316 SS	316 SS	316 SS CF-8M§
Alloy 20‡	PTFE/Elastomer	20Cb-3 CN-D7M**	20Cb-3 CN-7M**	20Cb-3	20Cb-3	20Cb-D3 CN-7M*
Plastic†	PTFE/Elastomer	PVC*	PVC	PVC	Ceramic†	PVC
Alloy C22	PTFE/Elastomer	Alloy C22 CX2MW††	Alloy C22 CX2MW††	Alloy C22	Alloy C22	Alloy C22 CX2MW††

Section 2.03.A.C.2

NOTES:
* Polyethylene diaphragm heads on 5" (127 mm) and 5¾" (146 mm) plunger size.
† PTFE single ball checks used on 5" (127 mm) and 5¾" (146 mm) plunger size.
‡ Temperature range for metallic versions is 10°F (-12°C) to 225°F (107°C). PTFE/FKM diaphragm option is required above 190°F (88°C). Temperature range for plastic versions is 10°F (-12°C) to 140°F (60°C).
§ CF–8M is the cast equivalent to wrought 316 SS.
** CN–7M is the cast equivalent to wrought 20Cb-3 SS.
†† CX2MW is the cast equivalent to wrought Alloy 20.

MILROYAL C

DISC DIAPHRAGM MATERIALS OF CONSTRUCTION—WETTED PARTS

Materials of Construction	Diaphragm Head	Cartridge Body	Seats	Balls	Limit Pins	Diaphragm	Contour Plate
316 SS*	316 SS CF-8M†	316 SS CF-8M†	316 SS	316 SS	316 SS	PTFE	316 SS CF-8M†
Alloy 20*	20Cb-3 CN-7M‡	20Cb-3 CN-7M‡	Alloy 20	Alloy 20	Alloy 20	PTFE	20Cb-3 CN-7M‡

NOTE:
* Temperature range is 20°F (-7°C) to 250°F (121°C).
† CF–8M is the cast equivalent to wrought 316 SS.
‡ CN–7M is the cast equivalent to wrought 20Cb-3 SS.

PACKED PLUNGER LIQUID END MATERIALS OF CONSTRUCTION—WETTED PARTS

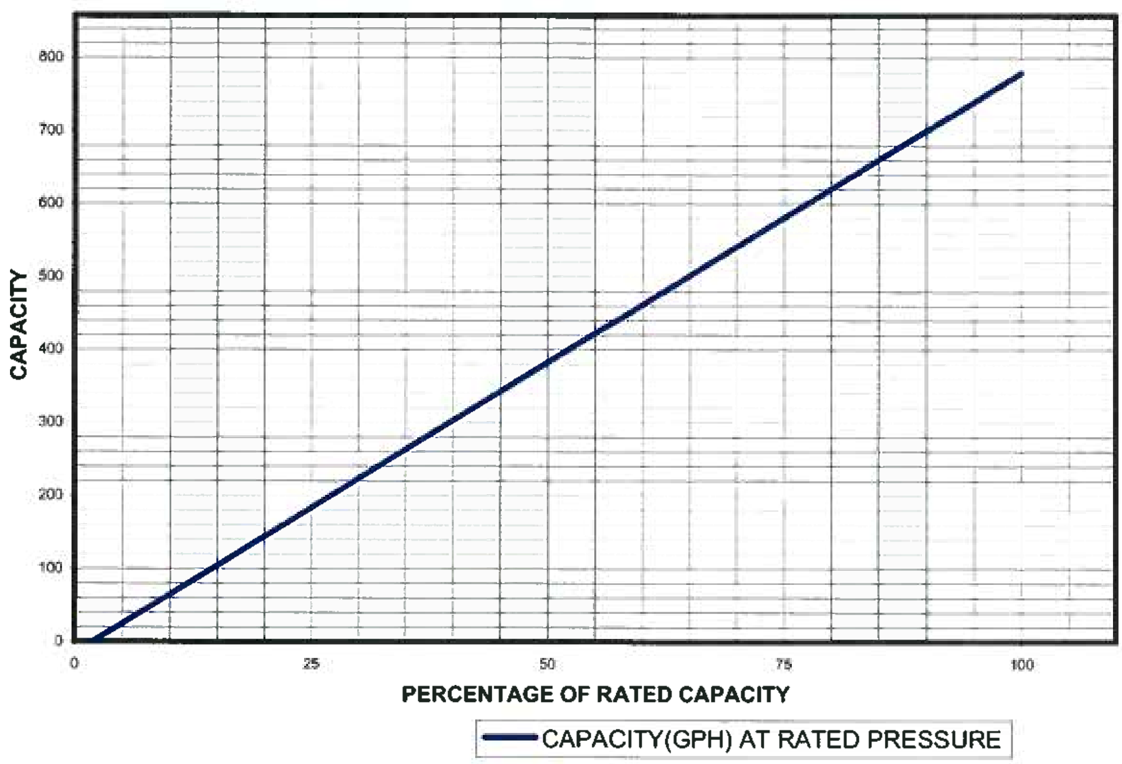
Liquid End Material	Plunger	Check Valve	Seat	Seat Seal	Ball	Lantern Ring/ Spacers	Packing Spring	Gland Cap
316 SS	316 SS (to 1500 psi)	316 SS CF-8M*	316 SS	PTFE	316 SS	316 SS CF-8M*	N/A	316 SS CF-8M*
	Colmonoy (to 5000 psi)	316 SS CF-8M*	316 SS	PTFE	316 SS	316 SS CF-8M*	316 SS	316 SS CF-8M*
	Carbide (to 10,000 psi)	316 SS CF-8M*	Hardened 13-8 Mo	PTFE	Carbide	316 SS CF-8M*	316 SS	316 SS CF-8M*
Alloy 20	20Cb-3 CN-7M†	20Cb-3 CN-7M†	20Cb-3	PTFE	N/A	20Cb-3 CN-7M†	N/A	20Cb-3 CN-7M†

NOTES:
* CF–8M is the cast equivalent to wrought 316 SS.
† CN–7M is the cast equivalent to wrought 20Cb-3 SS.

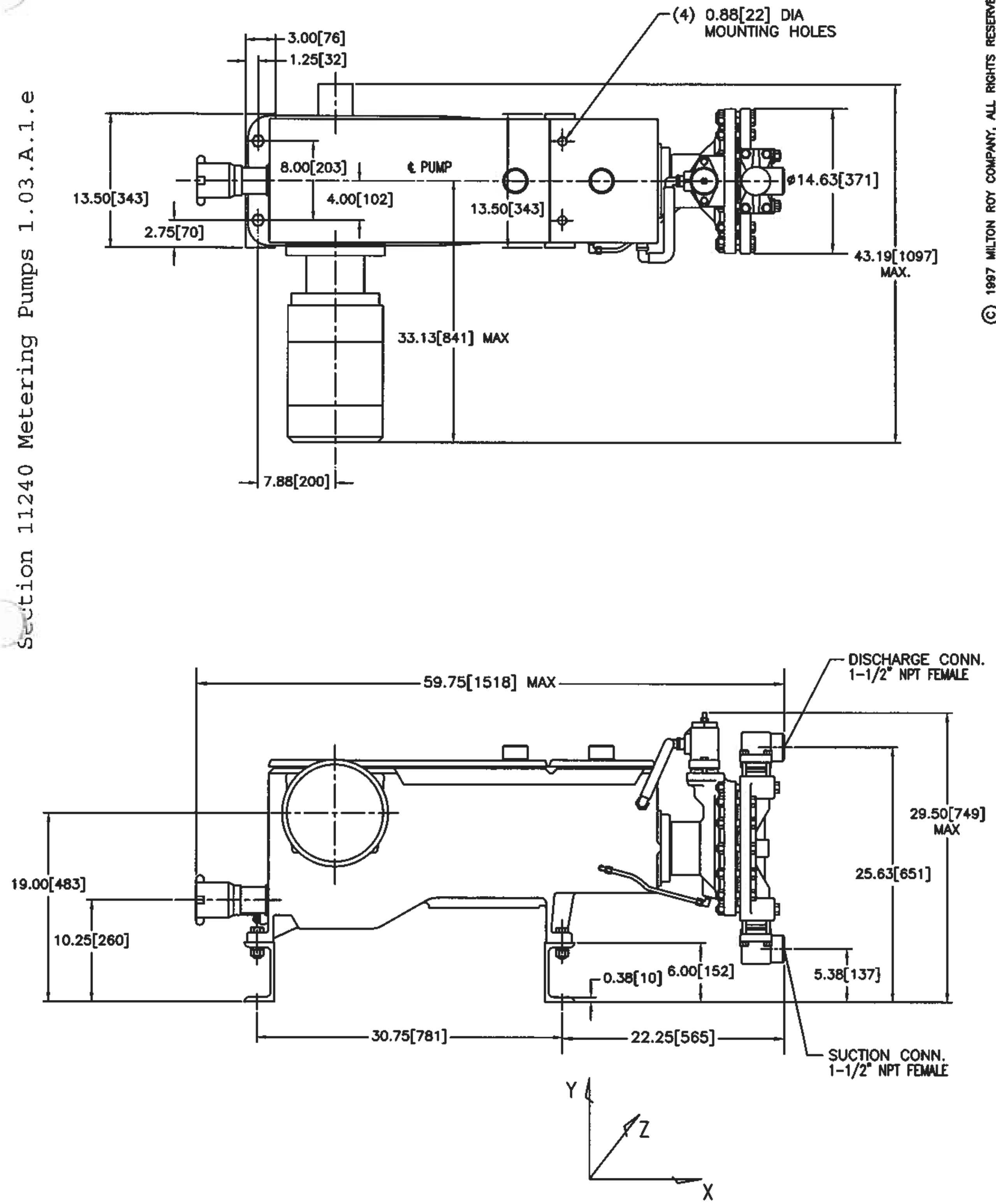
THEORETICAL PUMP PERFORMANCE

PUMP SERIAL NO.:	TBD	
PUMP MODEL NO.:	MCH5618GPBCBM1SEST11NN11	
RATED CAPACITY:	780	GPH
RATED PRESSURE:	175	PSIG
CUSTOMER:	FINE LINE INSTRUMENT	
PURCHASE ORDER NO.:		
CUSTOMER REFERENCE:	SUBMITTAL	

THEORETICAL PERFORMANCE VS. PERCENTAGE OF CAPACITY



Prepared By: Patrick Flaherty, Application Engineer
Submittal Date: 7/19/2007



Fx-150# Mx-255 Ft#
Fr-204# Fy-98# My-130 Ft# Mr-314 Ft#
Fz-98# Mz-130 Ft#
MAXIUM CONDITIONS

SIMPLEX MILROYAL "C"
HPD LIQUID END: DOUBLE SHAFT
PLUNGER DIA: 2-1/2, 3-1/2"
STROKE ADJ: MICROMETER
SINGLE BALL CHECK VALVES

MILTON ROY
FLOW CONTROL DIVISION
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CUSTOMER DIMENSIONAL OUTLINE
C | 105-0230-111 | A
SCALE: NONE | SHEET 1 OF 1

TOLERANCE UNLESS OTHERWISE SPECIFIED
INCHES[MILLIMETERS]
± .12" [3 MM]
THIRD ANGLE PROJECTION
DRAWN DATE: B.EMS 8/27/97
CHECKED DATE

CERTIFIED DIMENSIONS: ____
SERIAL NO.: ____
DATE: ____

High Performance Diaphragm...

The High Performance Diaphragm liquid end, HPD, combines all of the best characteristics of traditional liquid ends into one technologically advance design. It's operating characteristics and simplicity of operation make the best pump to consider first for most metering pump applications.

HPD operations is similar to the disc diaphragm in that it is hydraulically actuated and utilizes the same shape and diaphragm. It is similar to a tubular diaphragm in the respect that the process fluid has a "straight through" path through the liquid end. It is low NPSH requirements requirements are similar to that of a packed plunger liquid end. But the primary advantages of the HPD are the unique design features that separate it from traditional designs.

The MARS Advantage

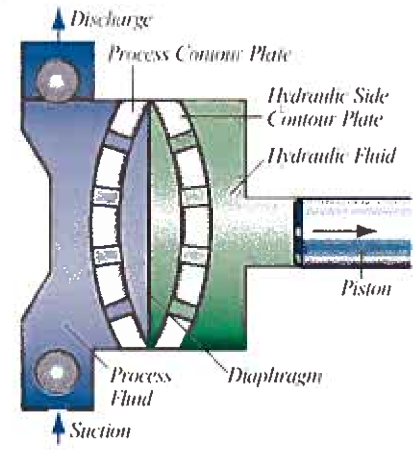
A hydraulically actuated diaphragm liquid end design requires a refill system to compensate for hydraulic fluid that bleeds past the piston or through an air bleed valve during normal operation. Hydraulic fluid is also expelled from the chamber through the internal relief valve when the system experiences excess pressure, and therefore must also be replenished.

The HPD features a Mechanically Actuated Refill System (MARS) that offers a number of advantages over traditional refill systems. To understand the advantages of MARS, traditional refill systems must first be explored.

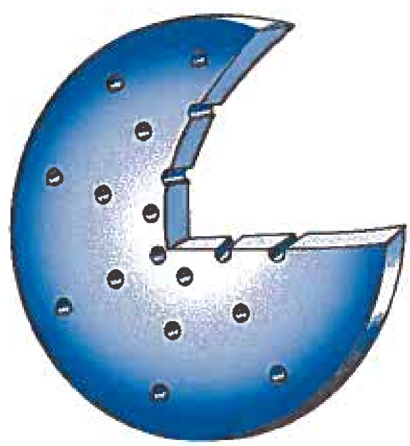
Traditional Designs

Traditional designs use a system that refills the chamber when a vacuum is created by the inability of the diaphragm to move beyond the hydraulic contour plate. It also refills when the suction is momentarily or permanently starved by accidental valve closure, insufficient NPSH, or other similar occurrences. When this happens, the hydraulic fluid chamber is overfilled because a vacuum has been created even though the diaphragm has not been able to travel rearward. To avoid diaphragm rupture due to overfilled hydraulic oil, a process side contour plate stops the diaphragm's forward travel, and forces the hydraulic relief valve to open, thus expelling the excess fluid.

The contour plate is a concave (actually, concave-convex) disc that supports the diaphragm and limits its travel. The plate has a series of holes bored through it to permit the fluid



Traditional Liquid End with Process and Hydraulic contour Plates (refill system not shown)



Typical Contour Plate (Section cutaway)

to come into contact with the diaphragm. The pattern and size of these holes requires careful engineering to maintain the contour plate strength required to withstand the force of the diaphragm experience at the operating pressure.

The hydraulic contour plate does not cause any problems in pump operation since the hydraulic fluid passes easily through the contour plate holes. However, a process contour plate, required by traditional disc diaphragm liquid ends, places limitations on the types of process fluids the pump can handle (such as slurries) since the process fluid must also pass through contour plate holes. The process contour plate also creates a pressure loss which raises the NPSH requirement of the liquid end.

The MARS System

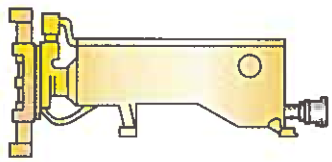
The MARS System eliminates the need for a process contour plate by assuring that the hydraulic fluid can only be refilled when the diaphragm has traveled all the way back to the contour plate. The diaphragm presses against the MARS valve, which only then permits a poppet valve to open from the vacuum created by insufficient hydraulic fluid. (See the illustration lower right)

Hydraulic overfill is therefore impossible. With the process contour plate gone, the straight through path of the process liquid makes the HPD a perfect choice for slurries and viscous materials. It also lowers the NPSH requirements of the pump, since pressure loss through a process contour plate is eliminated.

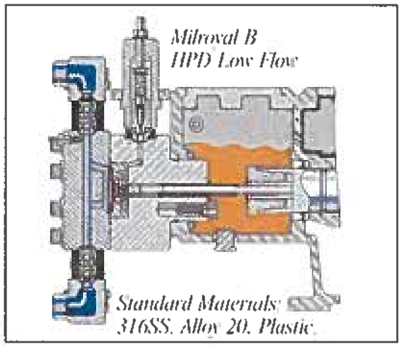
The MARS system also simplifies HPD start-up. Unlike other hydraulic liquid ends, the refill valve does not need adjustment. Additionally, since the HPD hydraulic fluid cannot be overfilled, there is no need to perform delicate procedures to synchronize hydraulic fluid balances (a difficult task required for tubular and other double diaphragm liquid ends). With HPD, you just fill the reservoirs, and turn it on.

...Advanced Liquid End Technology

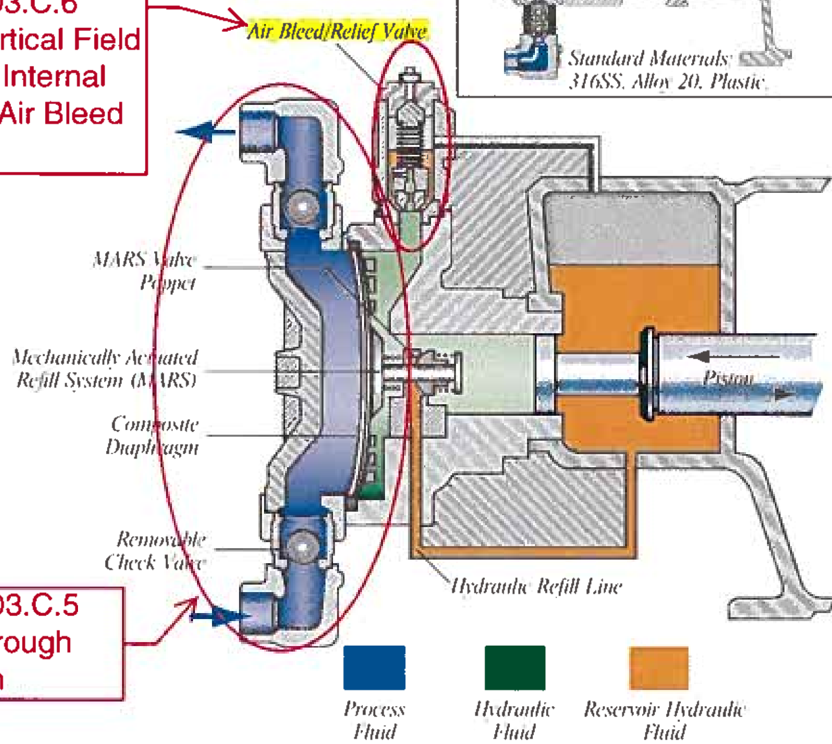
HPD Pre-shaped Composite Diaphragm



Full side view of HPD Liquid End on MilRoyal Drive



Section 2.03.C.6
Integral Vertical Field Adjustable Internal Relief and Air Bleed Valves



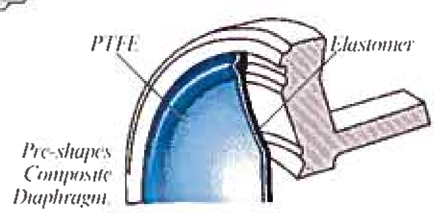
Section 2.03.C.5
Straight-through flow design

Available on: Milroyal C., Milroyal D, Centrac and Maxroyal.
Standard Materials of Construction: 316SS, Alloy 20, Plastic.

The HPD features a pre-shaped PTFE/elastomer composite disc diaphragm. On the process side, the chemical resistance of PTFE is utilized. On the hydraulic side, the elastomer imparts favorable elastic and mechanical factors.

The composite diaphragm eliminates the inherent problems of pure PTFE diaphragms. PTFE tends to cold flow when compressed between two metal parts (such as those required to seal the hydraulic side from the process side). The HPD composite diaphragm features an integral "O" ring seal around the perimeter of the diaphragm, which provides a better seal between hydraulic and process fluids than conventional diaphragm materials.

The HPD is capable of handling pressures up to 3025 psi and temperatures up to 300°F (with special modifications).



MARS System Operation

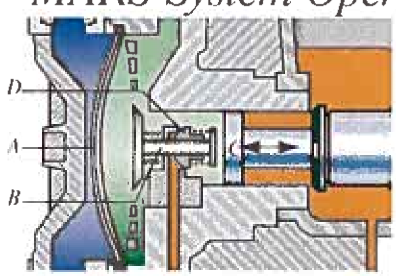


Figure 1
Diaphragm (A) and piston (C) are full forward. Mars valve (B) in forward position holds poppet valve (D) closed, preventing refill line hydraulic oil from entering the chamber.

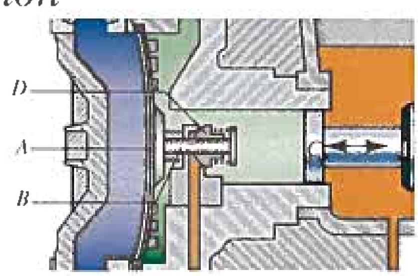


Figure 2
Diaphragm (A) and piston (C) are full rearward. Mars valve (B) is also rearward due to diaphragm position, thus freeing poppet (D) to open if required. Poppet (D) is shown closed, indication hydraulic oil refill is not required.

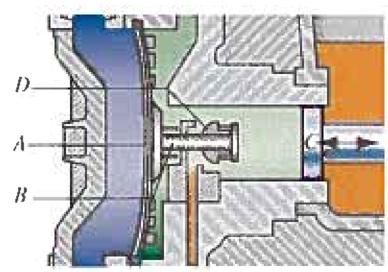


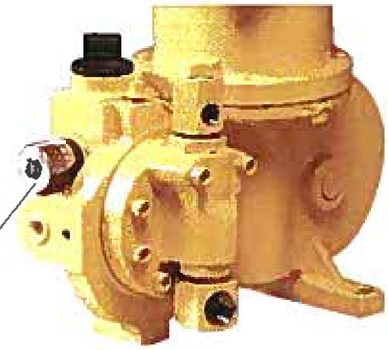
Figure 3
Diaphragm (A) and piston (C) are full rearward, once again forcing Mars valve (B) to its rearward position, which allows poppet (D) to open if required. Low oil volume creates a vacuum and opens poppet, permitting hydraulic fluid to enter the chamber from the refill line.

Capacity Adjustment

Metering pumps allow the user to vary capacity as the process requires. All Milton Roy metering pumps permit adjustment whether the pump is running or not. With the exception of the Centrac (see Centrac drive), Milton Roy pumps are supplied with a manual micrometer for performing manual capacity adjustments. Depending on the type of drive mechanism and the application requirements, one of several capacity adjustment options can be supplied.

Manual Micrometer

The manual micrometer can be used to adjust the metering pump's capacity anywhere between 0 and 100%. While not directly proportional to flow, this calibrated adjustment can be used to accurately set pump capacity based on the pump performance curve within + 1.0% over the turndown ratio.



Manual Micrometer

Electronic Actuator

Option Available for: mRoy A & B, MaxRoy, Milroyal B & C

The Milton Roy Electronic Actuator responds to electronic process signals or remote manual adjustments. In addition, a local handwheel is provided to permit manual adjustments when unpowered.

Milton Roy's electronic actuator is different from electric actuators in that it utilizes electronic limits. It is built around stepper motor technology, which allows it to travel precisely to position without overshoot or hunting.

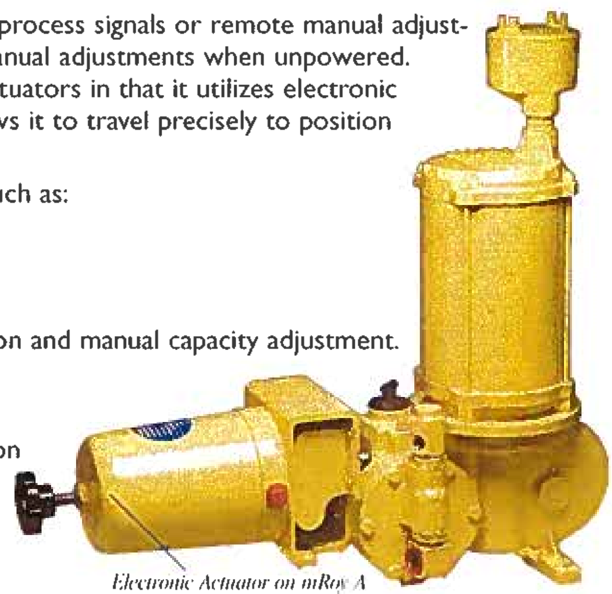
This design also provides superior operating characteristics such as:

- 100% duty cycle
- + 0.5% position accuracy or better
- low maintenance

Remote control stations are available for local/remote selection and manual capacity adjustment.

Specifications:

- NEMA 4 (Explosion proof available)
- 4-20 mA input signal standard
- Direct or reverse acting
- 1-5 VDC stroke position output signal
- Single phase 50/60 cycle 115 VAC



Electronic Actuator on mRoy A

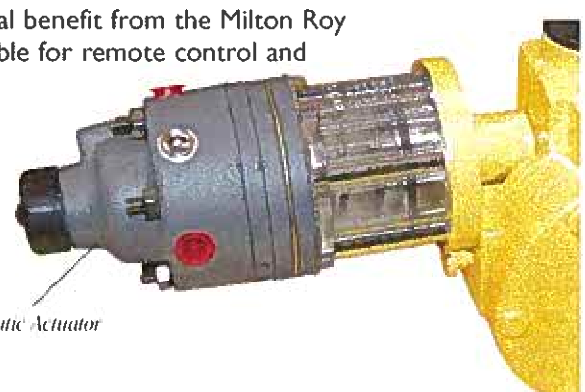
Pneumatic Actuators

Option Available for: mRoy A & B, Milroyal B & C

Automatic systems that supply a pneumatic process signal benefit from the Milton Roy pneumatic actuator. A separate air control panel is available for remote control and auto/manual switching.

Specifications:

- 3-15 or 3-27 psi pneumatic signal
- Direct or reverse acting
- Requires 60 psi supply air pressure



Pneumatic Actuator

SUCTION OPERATING REQUIREMENTS

Milroyal C HPD Liquid Ends

Minimum Internal Pressure: 3 psia (0.2 bar absolute)

Suction Lift: Capabilities vary with plunger diameter, suction piping design, and stroking speed. Calculate NPSH to determine exact lift capabilities of each application.

Recommended Pipe Diameter: Minimum diameter recommended is same as connection size. Calculate NPSH to determine exact diameter required for each application.

Recommended Pipe Length: 6 feet (2 meters) recommended maximum, but can vary greatly depending on liquid viscosity, tank pressure sources, etc. Calculate NPSH to determine actual maximum for each application.

Maximum Suction Pressure: The HPD diaphragm can sustain pressures up to 100 psig (7 bar) at 80°F (26°C) and below. Above 80°F (26° C) derate suction pressure limitations linearly to 10 psig (0.7 bar) at 200°F (93° C) (7 ½ psi per 10°F increase.)

Maximum suction pressures are limited by the gear oil pressure relief valve according to the table below. 275 psig oil relief valve setting requires a price adder.

Plunger Diameter	Maximum Suction Pressures @: Gear Oil Relief Valve Setting			
	100 psi (7 bar) (std)	200 psi (14 bar)	375 psi (26 bar)	750 psi (51 bar)
1"	100 psi (7 bar)	—	—	—
1¼"	100 psi (7 bar)	—	—	—
1½"	85 psi (5.8 bar)	100 psi (7 bar)	—	—
2"	70 psi (4.7 bar)	100 psi (7 bar)	—	—
2½"	50 psi (3.5 bar)	70 psi (4.7 bar)	100 psi (7 bar)	—
3½"	30 psi (2 bar)	40 psi (2.7 bar)	70 psi (4.7 bar)	100 psi (7 bar)
5"	—	—	—	65 psi (4.5 bar)
5¾"	—	—	—	50 psi (3.5 bar)

Manufacturers specified compatibility information on wetted parts does not cover unknown mixes of liquids.

Wetted End Liquid end will be 316 SST per engineered specifications.

Liquid being pumped is a mix of sludge and seawater.

Factory Finish

MISC PL 4
1/1/2007

Painting and Preparation

Section 11240 - Metering Pumps 1.03.A.1.h

PAINT PRICING

Standard Paint	Milton Roy Yellow Two-Part Epoxy
Customer Specified Color	$ 150.00 Per Pump (All models)

Section 11240 – Metering Pumps 2.01.A and 2.01.B

Paragraph is not applicable since pumps are manually controlled and do not have drives or other motor speed controllers.

MILTON ROY
a Hamilton Sundstrand Company
ISO 9001 Certified Quality Sytem

201 Ivyland Rd.
Ivyland, PA 18974-0577
(215)441-0800

Pump Test Report

Customer	FINE LINE INDUSTRIAL PRODU(	Model	MCH561-8GPBCBM1SEST11NN11
P.O. Number	16449	Serial Number	2405977-1
Order Number	1445445	Date	8/31/2007 6:07:04 AM
Reference	SS TAG #50P1251	Operator	TLP

File Name: 2405977-1_MCH561-

Rated Flow

780.00 G.P.H. @ 75.00 PSI
2952.61 L.P.H @ 5.27 kg/sq. cm.
2952.61 L.P.H @ 5.17 Bar

Test Results
(*Tested with water, adequate flooded suction)

Average Flow (GPH)	859.3900
Average Flow (LPH)	3253.1349
Repetative Accuracy (%)	99.0536

Drive Data

Horsepower	2 HP / 1.5 KW
Motor Voltage	460 V
Supply Type	Three Phase
Frequency	60 Hz

MILTON ROY
a Hamilton Sundstrand Company
ISO 9001 Certified Quality Sytem

201 Ivyland Rd.
Ivyland, PA 18974-0577
(215)441-0800

Pump Test Report

Customer	FINE LINE INDUSTRIAL PRODU(	Model	MCH561-8GPBCBM1SEST11NN11
P.O. Number	16449	Serial Number	2405977-2
Order Number	1445445	Date	8/31/2007 6:23:05 AM
Reference	SS TAG #50P1252	Operator	TLP

File Name: 2405977-2_MCH561-

Rated Flow

780.00 G.P.H. @ 75.00 PSI
2952.61 L.P.H @ 5.27 kg/sq. cm.
2952.61 L.P.H @ 5.17 Bar

Test Results
(*Tested with water, adequate flooded suction)

Average Flow (GPH)	852.2375
Average Flow (LPH)	3226.0598
Repetative Accuracy (%)	99.8781

Drive Data

Horsepower	2 HP / 1.5 KW
Motor Voltage	460 V
Supply Type	Three Phase
Frequency	60 Hz

MILTON ROY
Metering Pumps

Instruction Manual

Milroyal C Drive only

339-0009-000

Issued 8/01

See other manuals for appropriate Liquid End

CONTENTS

LIST OF ILLUSTRATIONS

METERING PUMP PRODUCTS
THIRTY-SIX MONTH

LIMITED WARRANTY

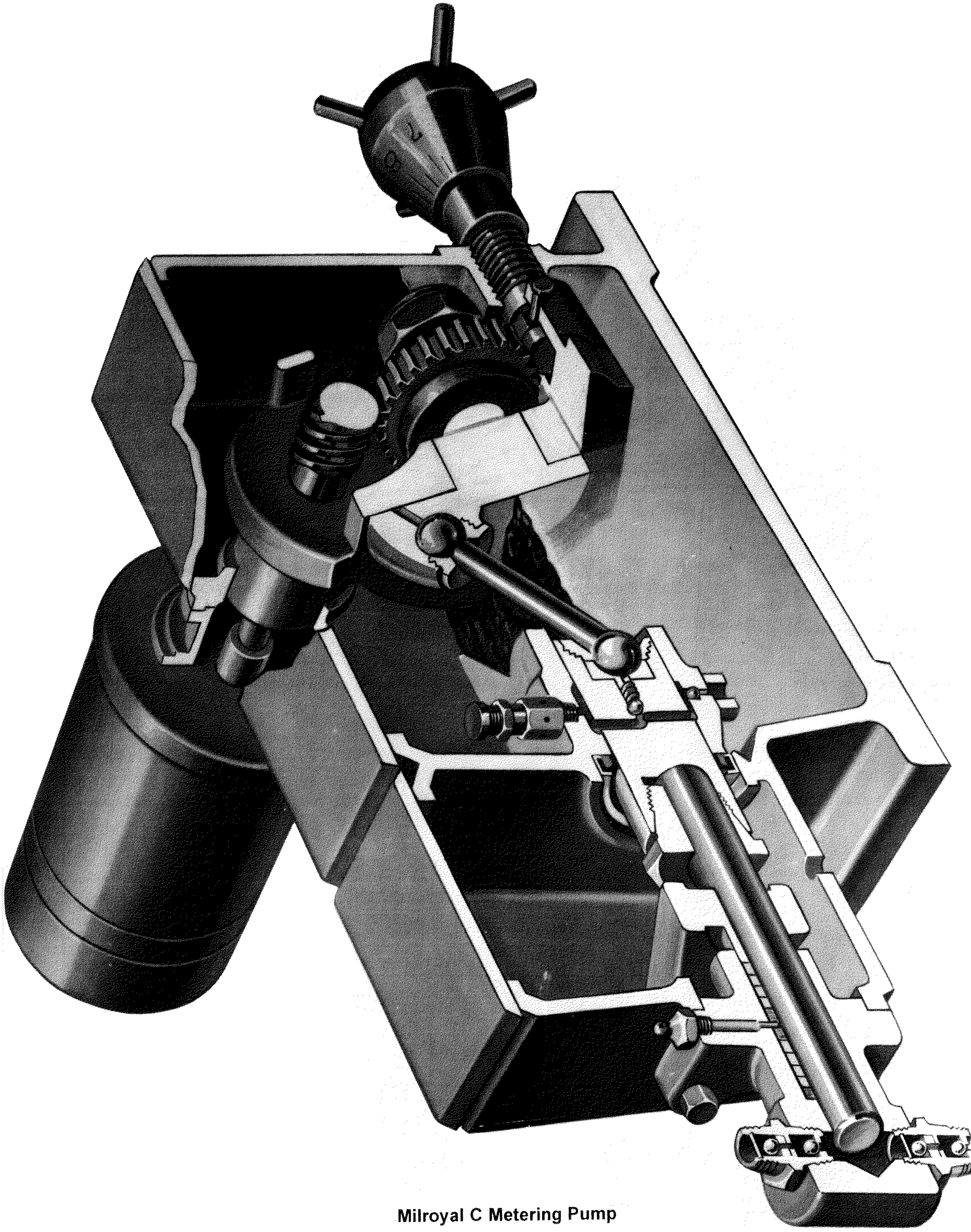
The Flow Control Division of the Milton Roy Company warrants its metering pump products against defects in workmanship or materials for three years under normal use form the date of shipment from our warehouse or the warehouse of our agent. All metering pump components are warranted for three years, except that warranties on equipment and accessories furnished with the pump but manufactured by others are limited to the warranties offered by the manufacturers of their respective products. This warranty is not extended to electronic or Pneumatic control devices supplied with a Milton Roy metering pump. These items are covered by the warranties offered by the manufacturer or the Milton Roy Warranty for Electronic Controls and Actuators.

All obligations and liabilities under this warranty are limited to refunding, repairing or replacing (at our option), f.o.b. our plant, such allegedly defective units as are returned to our plant, carrier charges prepaid. Repairs or replacements are made subject to factory inspection of returned items.

This warranty does not extend to damage by corrosion or erosion. The materials of construction offered are recommendations subject in all cases to verification and acceptance by the customer. These recommendations, based on previous Company experience and best available information, do not constitute guarantees against wear or chemical action.

Expressly excluded from this warranty are defects caused by misuse, abuse, or improper application, employment, or operation of the unit. Expendable items and damage resulting from unauthorized repair are not covered by this warranty. No liability for consequential damages or reinstallation labor is accepted. Milton Roy Company will not assume responsibility for contingent liability for alleged failure of its products.

This warranty is in lieu of all other warranties expressed or implied.



Milroyal C Metering Pump

SECTION 1
DESCRIPTION

GENERAL

The Milroyal C is a reciprocating positive-displacement controlled-volume or metering pump designed to move specific volumes of liquid against a positive pressure differential between the pump suction and the pump discharge. The delivered volume is controllable within one percent of setting.

The pump consists of three major components: (1) a drive unit, (2) a reciprocating plunger, and (3) a liquid end. Pump delivery is a function of drive speed, plunger stroke length, and plunger diameter. In addition, delivered volume for a given pump can be varied by mechanical (micrometer handknob) or (optional) electrical or pneumatic adjustment of plunger stroke length. Pump drives may be fitted with HPD (High Performance Diaphragm) or several styles of packed plunger liquid ends. This manual covers the mechanically adjusted drive only.

MODEL CODE/PUMP IDENTIFICATION

Milroyal C pumps manufactured during and after 1995 were given a new model code which completely defines the material and options selected. The first digits indicate the frame size, followed by the "options" code.

MCP 321 8B CB M1 NM GF

frame/material......gear ratio.....motor mt......capacity adjust.....packing/plunger....packing lube...

SE ST 11

connection type....Oil R.V. setting....Base

PRINCIPLE OF OPERATION

The drive unit moves the pump plunger to draw liquid into the liquid end on the suction stroke and to expel the liquid on the subsequent discharge stroke. Accurate flow control is achievable only if the discharge line pressure (discharge head) is greater than the suction line pressure (suction head). For aid in determining acceptable piping performance, please refer to Milton Roy's NPSH calculator, available on line at www.miltonroy.com.

The unique Milroyal C pump drive mechanism operates on a patented polar crank principle. Essentially, a crank driven by a worm gear rotates on a variable plane. As the crank plane is changed from vertical, a reciprocating motion results from the crank connection to the plunger. Pump stroke length is increased from zero to maximum by adjusting the slope of the crank plane from vertical. (See Figure 1.)

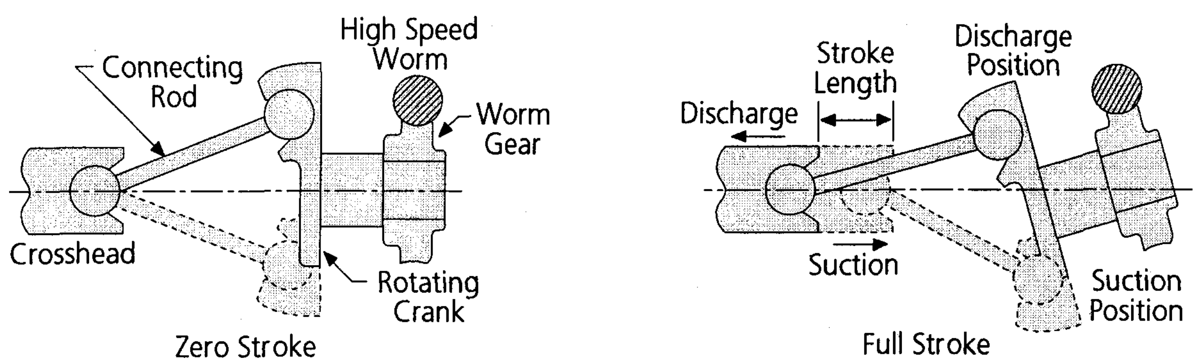


Figure 1. Capacity Adjustment.

As the plunger reciprocates in the liquid end, the pumped liquid is alternately drawn into and discharged from the liquid end. Each suction (rearward) stroke of the pump plunger creates a negative pressure in the displacement chamber. The pressure of the liquid in the suction line unseats the suction ball-checks and liquid flows into the displacement chamber. On the discharge stroke, the plunger moves forward and pressurizes the liquid which unseats the discharge ball-checks to flow out the discharge port. On each suction stroke, the discharge ball-checks are seated, and on each discharge stroke, the suction ball-checks are seated (pressure in pump head is greater than suction line pressure). This mode of operation prevents back flow and ensures liquid movement from the suction port, through the displacement chamber, and out the discharge port.

In packed plunger liquid ends, the plunger contacts the process liquid, while diaphragm liquid ends isolate the process fluid from the pump plunger. In the latter designs, the plunger displaces hydraulic fluid which moves a diaphragm in contact with the process liquid, forcing the process liquid through the liquid end. Diaphragm liquid ends are covered in a separate instruction manual.

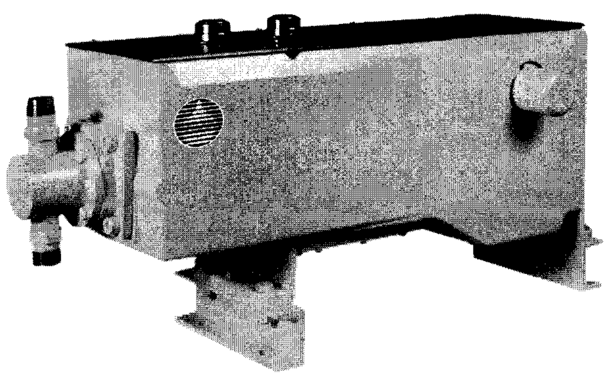


Figure 2. Packed Plunger Liquid End

See manual 339-0074-000

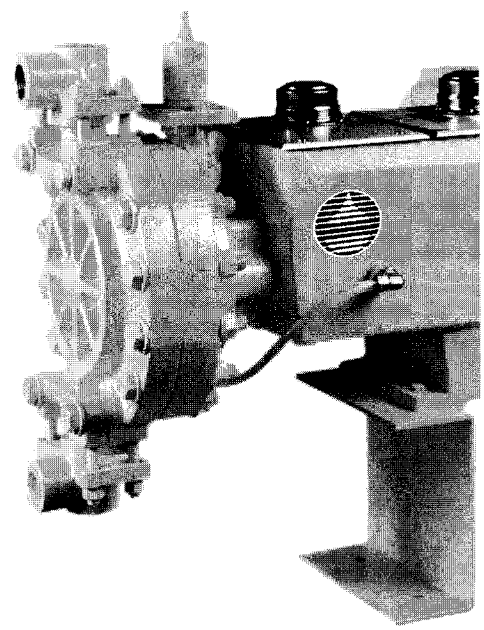


Figure 3. HPD Liquid End

See manual 339-0014-000

SAFETY PRECAUTIONS

When installing, operating, and maintaining the Milroyal C keep safety considerations foremost. Use proper tools, protective clothing and eye protection when working on the equipment and install the equipment with a view toward ensuring safe operation. Follow the instructions in this manual and take additional safety measures appropriate to the liquid being pumped. *Be extremely careful in the presence of hazardous substances (e.g., corrosives, toxins, solvents, acids, caustics, flammables, etc.).*

SPECIFICATIONS

Detailed specifications for this pump are listed on the pump Data Face Sheet included with this manual.

SECTION 2
INSTALLATION

UNPACKING

Pumps are shipped f.o.b. factory and title passes to customer when carrier signs for receipt of pump. The customer, therefore, must file any damage claims with the carrier.

Carefully examine the shipping crate upon receipt form carrier to be sure there is no obvious damage to contents. Open the crate carefully, as accessory items fastened to the inside of the crate may be lost or damaged. Examine all material inside crate and check against packing list to be sure that all items are accounted for and undamaged.

MOUNTING

Support the pump firmly in a level position on a solid, vibration-free foundation, preferable with the base above floor level to protect it from washdowns and to provide easier access for service. The pump features mounting holes to accommodate anchor bolts.

Some Milroyal pumps are shipped with motors dismounted. After anchoring pump drive in position, install motor.

PIPING

General Rules

Never connect rigid pipe to plastic liquid ends; rather, use flexible connections to both suction and discharge.

Use piping materials that will resist corrosion by the liquid being pumped. Use care in selecting materials to avoid galvanic corrosion at pump liquid end connections.

Use piping heavy enough to withstand maximum pressures.

Size piping to accommodate peak instantaneous flow. Because of the reciprocating motion of the pump plunger, pump delivery follows an approximate sine curve with a peak instantaneous flow pi (3.14) times the average flow. Therefore, piping must be designed for a flow 3.14 times the pump capacity; this means that a pump rated for 88 gallons per hour requires piping sufficient for 88 gph (333.1 L/hr) 3.14 (or 276) gph (1044.7 L/hr). Please refer to Milton Roy's NPSH calculator, on line at www.miltonroy.com

To minimize viscous flow losses, pipe viscous liquids with line up to four sizes larger than the pump port.

Remove burrs, sharp edges and debris from inside piping. Flush and blow out all pipe lines before making final connections to pump.

Provide for pipe expansion when hot liquids are to be pumped. Support piping so that pipe weight is not placed on the pump. Never spring piping to make connections.

Piping should be sloped to prevent vapor pockets, because vapor in the liquid end will cause inaccurate pump delivery.

When pumping suspended solids (such as slurries), install plugged crosses at all 90 degree line turns to permit line cleaning without dismantling piping.

Suction Piping

It is preferable to have the suction of the pump flooded by locating the liquid end below the lowest level of the liquid in the supply tank. Installing a hold-up tower or supply vessel on the suction line close to the pump can help ensure a flooded suction line. (Consult the Milton Roy Company, Flow Control Division for assistance in such applications.)

Avoid negative suction pressure conditions (suction lift), as such conditions adversely affect metering accuracy. If such conditions are unavoidable, contact Milton Roy Flow Control Division for recommendations.

When pumping a liquid near its boiling point, provide enough suction head to prevent the liquid from "flashing" into vapor when it enters the pump liquid end on the suction stroke.

If possible, use metal or plastic tubing for the suction line because tubing has a smooth inner surface and can be formed into long, sweeping bends to minimize frictional flow losses.

A strainer should be used in the suction line to prevent foreign particles from entering the liquid end. This and any other measures which prevent debris from entering and fouling the ball-checks will give increased maintenance-free service.

Keep suction piping as short and straight as possible.

When suction piping is long, and particularly at stroke speeds above 70 strokes per minute (spm), piping size should be larger than the liquid end suction fitting to prevent pump starvation.

If long suction lines are unavoidable, install a float box (see figure 4) or auxiliary feed tank (stand pipe) near the suction side of the pump. The float box may be calibrated and used to check pump capacity by measuring the time required for pumping a specific quantity of liquid from the box. In many cases, installing an accumulator or pulsation dampener at the pump suction connection will promote flooded suction even when the suction line is long. Consult Milton Roy Flow Control Division for details.

Suction piping must be absolutely airtight to ensure accurate pumping. After installation, test suction piping for leaks with air and soap solution.

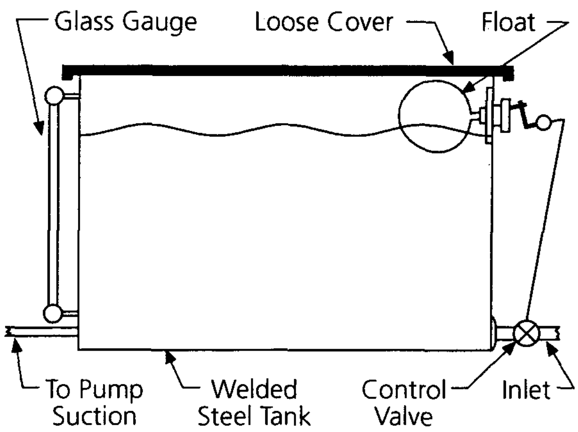


Figure 4. Float Box.

Discharge Piping

Install pipe large enough to prevent excessive pressure losses on the discharge stroke of the pump. Maximum pressure at the discharge fitting on the liquid end must be kept at or below the maximum pressure rating shown on the pump data plate.

The pump will not deliver a controlled flow unless the discharge line pressure is greater than the suction line pressure. Piping should be arranged to provide at least 5 psi (35 kPa) positive pressure differential between the discharge side and the suction side. There are a number of ways to create an artificial discharge pressure, such as by installing a vented riser or a back pressure valve. (Please consult Milton Roy Flow Control Division for recommendations to increase back pressure in slurry applications.)

When pumping water-treating chemicals directly into boiler drums, use one liquid end assembly for each boiler drum. Discharging into a manifold having the slightest pressure difference between its several discharge connections can diminish metering accuracy as the outlet with the lowest pressure will receive more liquid than the other outlets.

Vented Risers

A vented riser (figure 5) is simply a vertical extension of the discharge pipe into an open tee. The other side of the tee goes to the process. Practically maintenance-free, this device prevents siphoning and provides an artificial discharge head; however, a clogged or closed line may cause the riser to overflow. Therefore, substitute a pulsation dampener and back pressure valve for a vented riser when pumping hazardous liquids.

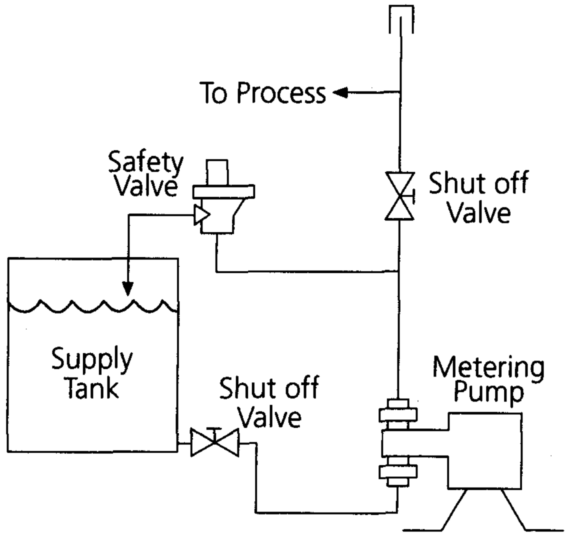


Figure 5. Vented Riser.

Back Pressure Valves

A Milton Roy back pressure valve should be installed in the discharge line near the pump to ensure sufficient discharge head pressure for proper pump metering action. Normally, the valve should be located near the pump; however, back pressure valves for large pumps with long and extremely small discharge lines may have to be installed near the point of discharge into the process (to minimize siphoning tendencies). Contact Milton Roy Company for sizing recommendations.

Accumulators (Surge Chambers)

An accumulator, surge chamber, surge suppressor, or pulsation dampener should be used with the back pressure valve in the discharge line to absorb the flow peaks between the pump and the back pressure valve. Without the pulsation dampener the valve mechanism will snap open and closed with the surge from each pump stroke. The pulsation dampener will allow the back pressure valve to oscillate about a partly-closed position, thus minimizing wear on the valve. Discharge line pulsation dampeners offer the further advantage of limiting the flow and pressure variations characteristic of this kind of pump. Installing a properly sized pulsation dampener will improve pump performance and may reduce system costs dramatically by permitting the substitution of smaller piping. Please contact Milton Roy Company for further information on pulsation dampeners.

Safety Valves

Motor-driven positive displacement pumps can develop tremendous discharge pressures long before thermal overload devices interrupt the motor electrical circuit. To prevent a blocked discharge line from causing damage to the pump, piping, or process equipment, install a Milton Roy Safety Valve in the pump discharge line. This valve is designed and sized to handle system flow rates and pressures safely while resisting corrosion by the process liquid.

Install the safety valve in the discharge line between the pump and the nearest shut-off valve. (This will prevent pump damage from accidental valve closure.) Pipe the safety valve outlet back to the suction tank or to drain, but in either case ensure that the pipe end is continuously visible so safety valve leakage may be detected.

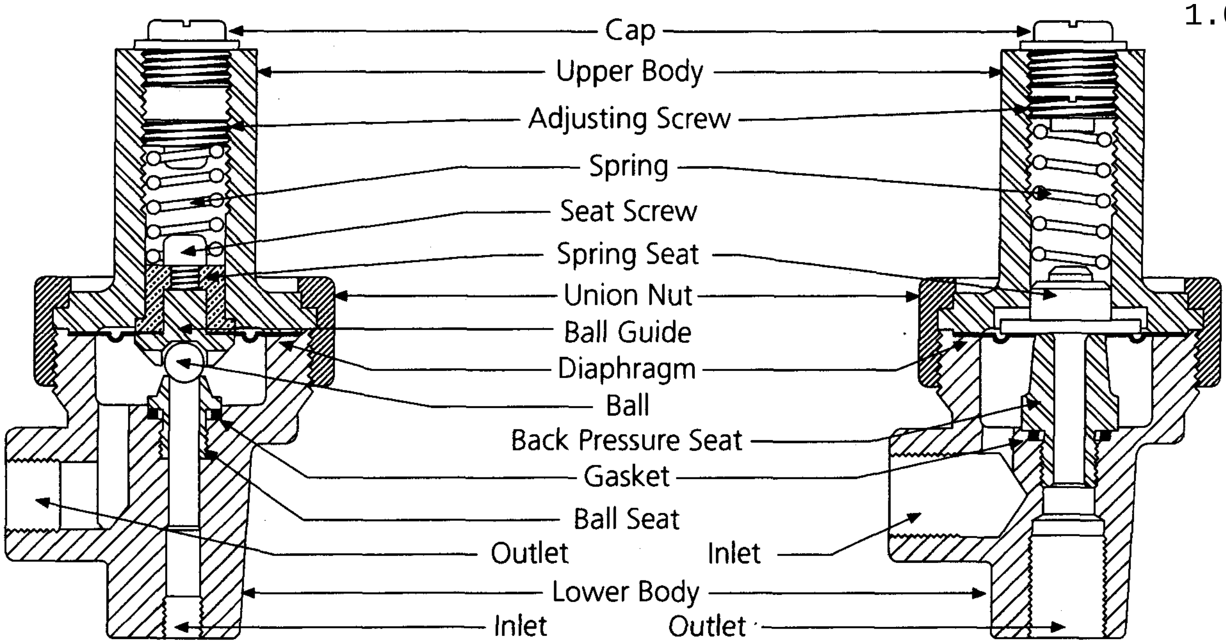


Figure 6. Safety and Back Pressure Valves

Check Valves

A check valve should be installed at the point where the discharge line enters a boiler or other high-pressure vessel. This will prevent back flow through the discharge piping and will isolate the pump discharge from system pressures (a safety consideration).

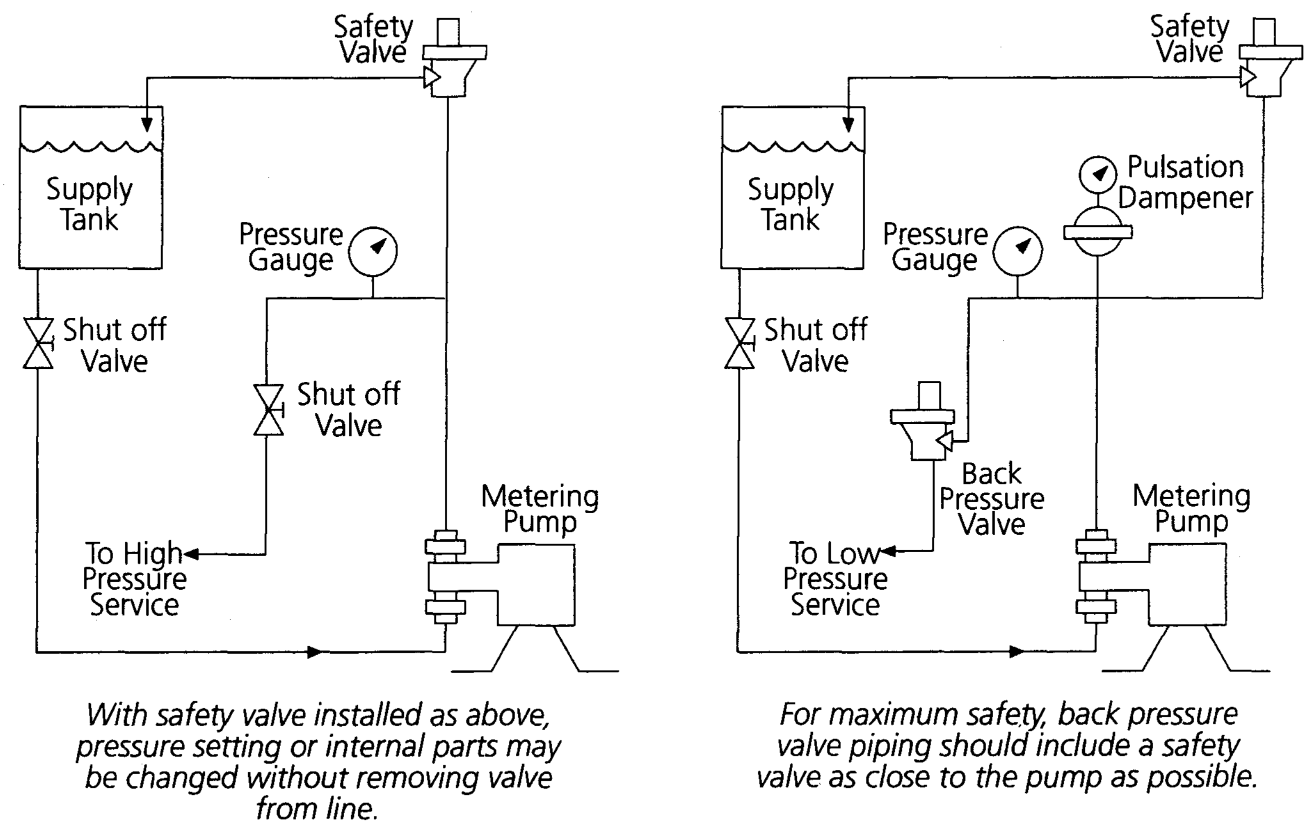


Figure 7. Recommended Valve Locations

Shut-Off Valves

Provide shut-off valves in both suction and discharge lines nest to the pump. Locate discharge line shut-off valve downstream from the inlet connection of the safety valve. Figure 7 shows recommended valve locations.

SERVICE CONNECTIONS

Pump Drive

Check the nameplate data on the pump drive motor and insure proper power supply is available before making any connections.

1. The preferred motor shaft rotation is shown by an arrow on the drive side flange of the pump (see Figure 14). If necessary, motor can be run in the opposite direction, but connecting rod (375) set screws should first be checked for tightness. This added precaution will ensure that reversed directional stresses do not loosen the tension bearings. To reverse motor rotation, reverse motor lead connections.

2. For drives other than constant speed electric motors, refer to manufacturer's instructions and service information included with the pump.

Drains

Provide drains convenient to the pump so that any leakage may be easily removed. The pump catchall area is provided with a hole drilled and tapped to receive piping for drainage. A plastic funnel is also supplied with each Milroyal packed plunger pump to help direct corrosive liquid away from catchall metallic surfaces.

Auxiliary (Accessory) Equipment

Service connections for auxiliary or accessory electrical equipment should be determined by referring to wiring diagrams, instruction manuals, and the data plate furnished with the equipment.

Air-operated equipment should normally be supplied with two sources of air. The power elements require a standard 60 psig (414 kPa) (80-100 psig (552-690 kPa) at compressor) plant air supply (however, an 80 psig (552 kPa) supply (90-100 psig (621-690 kPa) at compressor) is recommended to ensure maximum performance under all conditions). Instrument air should be supplied from a control instrument or from a manual air pressure regulator furnished with 30 psig (207 kPa) service.

SECTION 3
OPERATION

INITIAL START-UP (SEE FIGURE 14)

Remove covers (*6083 and 6085*) from top of pump casing and check that interior is free of debris. Reinstall catchall cover (6085). Install oil cleaning magnet (*12*) over the oil pump intake hole on the underside of the crosshead guide section of the pump casing (see Assembly Drawing, Figure 13 for magnet location). The magnet is bagged with other loose parts shipped in the catchall of the pump.

Check that all mounting bolts are tight, piping is installed properly, and the discharge line is open.

Fill the pump casing with the lubricant supplied with the pump; fill to the bottom of the oil level plug which is located at the level of the crosshead (12-1/2" above the housing feet). Pour lubricant into the casing over the bearings and gear set. (refill amount shown below). Replace cover (*6083)* over the oil sump.

Note

Because gear oil viscosity increases as the ambient temperature decreases, you must choose a gear oil appropriate for both the ambient and operating temperatures. Operating temperatures are typically 75°F higher than ambient temperatures. See below for oil recommendations.

Connect pump motor for clockwise rotation as indicated by arrow (412) on pump casing.

OIL SPECIFICATIONS

Operating Oil Temperature*	Type Oil Recommended
-30°F to 250°F	Mobil SHC 634 Synthetic
-10°F to 40°F	Mobil Gear 629
15°F to 125°F	AGMA #7 Comp.

*Maximum Oil Temperature 250°F. The nominal capacity of the Milroyal C housing is 80 pints (44 liters).

INITIAL ADJUSTMENTS

Micrometer Capacity Control

To adjust pump capacity, loosen the stroke locking screw (110, Figure 13) in the casing above the micrometer-adjust handknob (490), and turn the handknob until the desired capacity percentage is just visible on the stroke indicator plate (95). Then tighten the locking screw to maintain capacity setting.

Electric Capacity Control

An Electric Capacity Control may be mounted on the pump housing in place of the micrometer-adjust handknob. This accessory adjusts stroke length in response to manual or automatic electric signals from process control instruments. Electric Capacity Control is described in a separate Instruction Manual.

Pneumatic Capacity Control

Pneumatic Capacity Control may be mounted on the pump housing in place of the micrometer-adjust handknob. This accessory adjusts stroke length in response to pneumatic signals from a remotely located control unit. Pneumatic Capacity Control is described in a separate Instruction Manual.

Speed Capacity Control

Milroyals may be fitted with variable-speed motors to provide capacity control through adjustments in drive speed. Such motors and control accessories are available as options from Milton Roy Company.

Capacity Calibration

After the first 12 hours of operation, the pump may be tested and calibrated to find the exact pump capacity under specific operating conditions.

Usually, calibrating the pump at only 100, 50, and 10 percent capacity settings is enough to indicate pump performance throughout the adjustment range.

The pump can be calibrated by one of two methods carried out in a given time:

1. Measure the decrease in liquid level pumped from a calibrated vessel.

2. Collect and measure pumped liquid at the pump discharge port. (It may be necessary to create a discharge head at the liquid take-off point; otherwise pump will not operate properly. See Section 2 for ways to do this.)

The first method is recommended for hazardous liquids because it eliminates operator contact with the liquid.

Filling Pumping System

It is especially important that pump suction and discharge lines be free of entrained air. To ensure this condition, operate the pump under no discharge pressure and fill the entire pumping system with liquid before starting pressure tests.

If the pump is idle for long periods, temperature changes in the process liquid may produce air in the system. To discharge the air, install a valve in the discharge line which will allow the process liquid to be pumped to exhaust when starting the pump.

PREVENTIVE MAINTENANCE

Milroyal C pumps are carefully designed, manufactured, assembled and quality tested to give reliable service with minimal maintenance. However, a daily maintenance check is recommended to visually confirm proper operation of the pump.

Drive

Check gear drive oil level monthly and add oil as required.

Change gear drive lubricant and clean magnetic filter below crosshead chamber every six months or after every 2500 hours of operation, whichever occurs first. (This may be scheduled with seasonal oil changes.)

Motor

Lubricate drive motor annually or according to motor manufacturer's instructions.

Check Valves

Check valve assemblies are designed to be self-cleaning by pumping a hot detergent solution for 15 minutes, followed by water flushing.

SECTION 4
TROUBLESHOOTING GUIDE

SYMPTOM	CAUSES	REMEDIES
Pump will not operate.	Low liquid level.	Add liquid.
	Blocked discharge line.	Clear line.
	Frozen liquid.	Thaw liquid throughout pumping system.
	Blown fuse.	Replace fuse.
	Open thermal overload device in starter.	Reset device.
	Broken wire.	Locate and repair.
	Low Voltage.	Investigate and correct (wiring may be too light).
	Pump not primed.	Allow suction line and pump head to fill with liquid before pumping against pressure.
Insufficient delivery.	Incorrect capacity adjustment.	Readjust capacity setting.
	Incorrect pump speed.	Match line voltage and frequency to pump motor data plate.
	Starved suction.	Increase piping size or suction head.
	Leaky suction piping.	Repair piping.
	High suction lift.	Rearrange equipment to decrease lift.
	Liquid near boiling.	Cool liquid or increase suction head.
	Leaky packing.	Adjust or replace packing.
	Leaky safety valve in discharge line.	Repair or replace safety valve.
	High liquid viscosity.	Reduce viscosity (e.g., heat or dilute liquid).
	Worn or dirty check valve seats.	Clean or replace.

SYMPTOM	CAUSES	REMEDIES
Erratic delivery.	Leaky suction piping.	Repair piping.
	Leaky packing.	Adust or replace packing.
	Leaky safety valve.	Replair or replace packing.
	Insufficient suction head.	Raise suction tank level or pres-surize tank.
	Liquid near boiling.	Cool liquid or increase suction head.
	Worn or dirty valve seats.	Clean or replace.
	Clogged or dirty line strainer.	Clean strainer.
Motor overheating. (Note: Totally enclosed and explosion proof motors run hotter than open motors.)	Wrong or insufficient gear case lubricant.	Check oil level and type. Replace questionable lubricant.
	Tight or dry packing.	Adjust and lubricate packing.
	Operation beyond rated capac-ity.	Constrain operation to specifications.
	Incorrect power supply.	Match line voltage and frequency to pump motor data plate.
	Misalignment.	Check alignment of moving parts.
	Over-tightened bearing adjuster.	Remove and properly reinstall bearing adjuster.
Oil leakage around worm shaft.	Damaged or worn oil seal.	Replace seal.
Oil leakage around trunnion.	Insufficient Loctite® applied at assembly.	Disassemble/clean replace Loctite®.
Oil leakage around crosshead.	Damaged or worn seal.	Replace seal.
Incorrect zero stroke indication.	Maladjusted stroke adjusting micrometer handknob.	Set pump to zero stroke. (At zero stroke, minimum plunger travel occurs when motor is running.) Loosen stroke adjusting handknob setscrew, set handknob to zero, and retighten setscrew.
Minimum stroke limitation.	Misaligned gear housing.	Disassemble pump and reas-semble properly aligned.

SYMPTOM	CAUSES	REMEDIES
Gear noise.	Excessive backlash.	Adjust backlash or replace gears.
	Incorrect worm shaft lateral running clearance.	Adjust shaft lateral running clearance.
	Worn bearings.	Replace bearings.
	Wrong or insufficient lubricant.	Replace or replenish lubricant.
Loud knock with each stroke.	Insufficient torque on trunnions.	Re-torque trunnions.
	Loose crank nut.	Tighten nut.
	Loose or worn connecting rod tension bearings.	Tighten or replace bearings.
	Worn conical sleeve bearings.	Replace bearings.
	Excessive gear set wear.	Replace gear set.
	Loose clevis.	Tighten clevis.
Rocking gear housing.	Worn stroke adjusting screw or keys.	Replace worn parts.
Crosshead hesitation.	Loose tension bearing.	Remove and inspect connecting; reinstall or replace and secure tension bearing.
Crosshead rotation.	Dog point set screw not seated in crosshead sliding shoe.	Remove crosshead, examine for scoring; polish smooth and reinstall.
Worn connecting rod bearings.	Contaminated oil.	Replace worn parts and oil and change oil on schedule.
	Plugged connecting rod.	Clear connecting rod.
	Faulty relief valve.	Replace relief valve.
	Fouled or missing ball checks in forced feed lubrication system.	Clean or install ball checks.

SECTION 5
CORRECTIVE MAINTENANCE

SPARE PARTS

The following spare parts should be stocked for each pump to prevent serious delays in repair.

Part No.	Qty.	Description
NOT SHOWN	1	Plunger
375	1	Connecting rod assembly
310	2	Conical sleeve bearings
104	2	Lead screw lock inserts
250	1	Gear set
480	1	Crosshead seal
355	2	Worm shaft bearings
PARTSKIT302	1	Tool kit

Parts orders must include the following information:

1. Part number.*
2. Quantity.*
3. Part description and drawing reference number.*
4. Pump serial number (include in all correspondence regarding the pump).**
5. Full model number.**

*Found on drawings in this manual.
**Found on pump nameplate.

Example:
One No.375 connecting rod assembly 2140019000, for Serial No. 123459 model MCH161
(1) (2) (3) (4) (5)

NOTE: Pumps will not be accepted for repair without a Return Material Authorization (RMA), available from the Factory Aftermarket Service Department. Pumps returned to the Factory for repairs should be clearly labeled to indicate the liquid being pumped. Process liquid should be flushed from liquid end before pump is shipped.

IMPORTANT: United States of America Federal Law prohibits handling of equipment that is not accompanied by an OSHA Material Safety Data Sheet (MSDS). A completed MSDS must be packed in the shipping crate of any pump shipped for repair. These safety precautions will aid the trouble-shooting and repair procedure and preclude injury to repair personnel from corrosive residue in pump liquid end. Material Safety Data Sheet must accompany all returns.

All inquiries or parts orders should be addressed to your local Milton Roy representative or sent to:

Parts Department
Milton Roy CO.
201 Ivyland Road
Ivyland, PA 18974

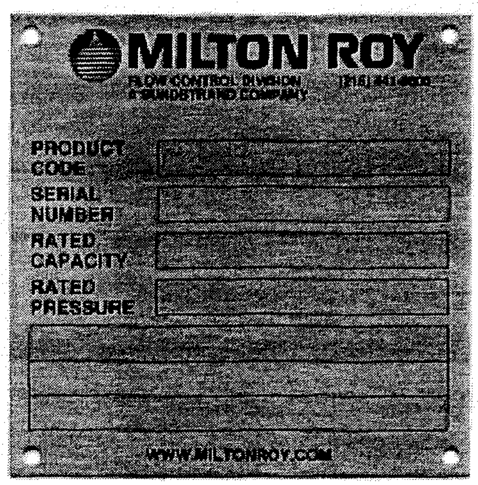


Figure 8. Pump Nameplate.

DISASSEMBLY

The pump may be dismantled for parts replacement through the following procedures. (Numbers in parentheses are drawing location numbers found on the parts list and drive drawings, Figures 11, 12, &13.)

Pump Drive

The following special tools (PARTSKIT302) will be required for disassembling the pump drive (crosshead and gear housing):

#211-0029-006	Wrench for tension bearing
#211-0032-002	Wrench for bearing adjuster
#211-0031-002	Wrench for trunnion
#211-0028-006	Centering tool
#5411-001-002	Torque wrench adapter

Remove the crosshead from the pump as follows (refer to figures 11, 12, and 13):

1. Disconnect motor power supply.
2. Remove covers (6083 and 6085). Drain oil from pump casing.
3. Loosen plunger adapter, shown in the liquid end manual.
4. Remove liquid end from pump drive.
5. Set stroke at 20% and rotate worm until crank is horizontal. Loosen connecting rod (375) set screws. (Use wrench #211-0029-006).
6. Loosen sliding shoe nut (391) and remove sliding shoe set screw (405) from sliding shoe (385).
7. Slowly remove crosshead assembly from liquid end side of pump. Be careful not to lose sliding shoe (in crosshead slot). Take care as well not to damage crosshead oil seal (480).

Remove gear housing from pump drive as follows:

1. Disconnect motor power supply.
2. Drain oil from pump casing.
3. Loosen connecting rod (375) set screws and unscrew tension bearing on end of connecting rod from the crank (220). (Use wrench #211-0029-006).
4. Unbolt and remove motor and motor adapter (455) from pump casing (55).
5. Set capacity adjustment to 0% stroke.
6. Using wrench #211-0032-002 remove bearing adjuster (431).
7. Loosen the trunnion thread lock set screws.
8. Support gear housing assembly in position. Remove motor side trunnion (330) with wrench #211-0031-002. Press tapered roller bearing cup from trunnion and remove worm shaft oil seal (421).
9. Withdraw worm shaft from casing. (Bearing cones will come away with shaft; remaining bearing cup may stay in trunnion still in casing).
10. Remove second trunnion in same manner as motor side trunnion. Pull bearing cup from trunnion.
11. Remove nylon thread lock inserts by tightening the trunnion thread lock set screws until the inserts drop through the trunnion bores; then remove the set screws.
12. Lift gear housing (200) from pump casing. To disassemble gear housing assembly, remove crank nut (280) from crank shaft (220) and pull components from crank shaft.
13. Back off stroke locking screw (110). Turn stroke adjustment screw (102) counterclockwise to remove it from pump casing. If the stroke adjustment screw is removed, its O-ring seal (103) should be replaced.

REASSEMBLY

Pump Drive

Review drawings and then install gear housing in pump casing as follows. Thoroughly clean all parts for reassembly.

1. Reassemble gear housing components as follows:

   a. The distance between the worm shaft lateral center line through the gear housing conical bores and the flat circular bearing face against which the crank bears during rotation is machined to hold 4.744: (120.5 mm) mean tolerance (Dimension A) on gear housing (200).

   b. Find machined hub length (Dimension A) stamped on rough cast side of the crank (220).

   c. The distance between the worm gear radial center line and the inboard end of the worm gear hub (dimension C) is 1.562" (39.67 mm). This dimension is held on the side of the gear on which the part code number is stamped.

   d. Subtract Dimensions B and C from Dimension A. The difference is the thickness of shims

(240) required to space the worm gear center line under the center of the worm.

e. Assemble the crank hub into the gear housing bore. Using the thickness of shims calculated in step d, insert the crankshaft through the front of the crank while placing the shims between the closely held side of the worm gear and the crank. Insert the crankshaft entirely through the assembly.

f. Place housing on a work surface so that the weight of the assembly forces the crank against the bearing surface of the housing. Assemble an excessive number of shims (240) over the crankshaft and against the hub of the worm gear, then assemble the crankshaft rear bearing (270) and clamp in place with crank nut (280). Measure the resulting distance between the rear face of the gear housing and the inside surface of the bearing with a feeler gage.

g. Subtract .002-.003" (.051-.076 mm) from the measurement obtained in step f. The resulting figure is the thickness of shims to be removed to provide the end play required for rotational clearance. Replace the rear bearing (270) and nut (280) and tighten nut securely against bearing face.

2. Heavily coat both sides of the trunnion conical sleeve bearings (310) with grease. Push the bearings into the gear housing bores so that the grease coating retains each in place.

3. Slowly lower gear assembly into pump casing (with a hoist) while carefully aligning lead screw keys (290) on either side of stroke adjustment screw (102).

4. Align holes in gear housing with trunnion bores in pump casing. Thoroughly clean trunnion outside threads and mating threads in housing with solvent. Apply Loctite® to trunnion outside threads and install trunnions (330) in casing. Turn trunnions in evenly to engage sleeve bearings in gear housing. Take care to seat sleeve bearings in their bores.

5. Remove crosshead from pump casing (see "Disassembly"). Set capacity adjustment to 0% stroke. Insert centering tool #211-0028-006 in the crosshead bore with its point close to crankshaft (220). Adjust the two trunnions and the stroke adjustment screw until the center hole in the crankshaft aligns with the point of the tool.

6. Using wrench #211-0031-002 and adapter #5411-001-002, alternately tighten trunnions until each is torqued to 170 ft.-lb. (231 N-m) and gear housing is still centered as in step 5. (On Automatic Capacity Control equipped pumps, torque to 150 ft.-lb (203 N-m).

7. Install new nylon thread lock inserts in holes above trunnions. Install thread lock set screws above lock inserts and tighten set screws to force inserts into trunnion threads to lock trunnions in place. Remove centering tool from crosshead bore.

8. Apply Loctite® sparingly to bearing cup outside diameters. Install bearing cup in closed trunnion and install the worm shaft with bearing cone seated in bearing cup in trunnion. Install motor side bearing cup in open trunnion.

9. Press oil seal (421) into bearing adjuster (431).

10. Ensure bearing adjuster threads and inside threads of open trunnion are completely cleaned of grease. Apply Loctite® sparingly to bearing adjuster outside thread and install bearing adjuster with wrench #211-0032-002. Be careful not to cut oil seal on shaft keyway edges.

Ensure proper gear set tooth engagement and bearing seating by rotating worm while tightening bearing adjuster till snug. After bearing cups are seated, back out bearing adjuster 1/2 turn, then tighten to allow only .002-.003" (.051-.076 mm) lateral running clearance for worm shaft (check with dial indicator from side of pump casing to end of worm shaft).

11. Now let pump sit undisturbed for at least eight hours at 70°F to allow Loctite® to set up.

12. After Loctite® has hardened, coat motor adapter flange bolt threads with liquid sealing compound (e.g., Permatex #2, non-hardening type) and install motor and motor adapter (455) to pump casing.

Reassemble crosshead in casing as follows:

1. Make certain crosshead ball-check is in place in bottom of crosshead bore. Then, with sliding shoe (385) in crosshead keyway, install crosshead into crosshead bore, aligning sliding shoe with the hole for its set screw.

2. Install sliding shoe set screw (405) in place in casing. Tighten set screw till its dog point seats in the sliding shoe against the crosshead, then back out the set screw 1/4 turn to allow free lateral movement of the crosshead. Lock set screw in place with locknut (391).

3. Set stroke adjustment at 20%. Position crank (220) horizontal and move the crosshead toward the crank so that connecting rod ball can seat in the crank bearing.

4. Thread connecting rod tension bearing into crank arm. Tighten the tension bearing to seat the connecting rod ball in the crank arm. (Use wrench #211-0029-006).

5. Loosen the tension bearing and re-tighten till connecting rod is just free enough to rotate with fingers.

6. Tighten both connecting rod set screws.

7. Install liquid end to pump drive.

Figure 9 Pump Drive Parts

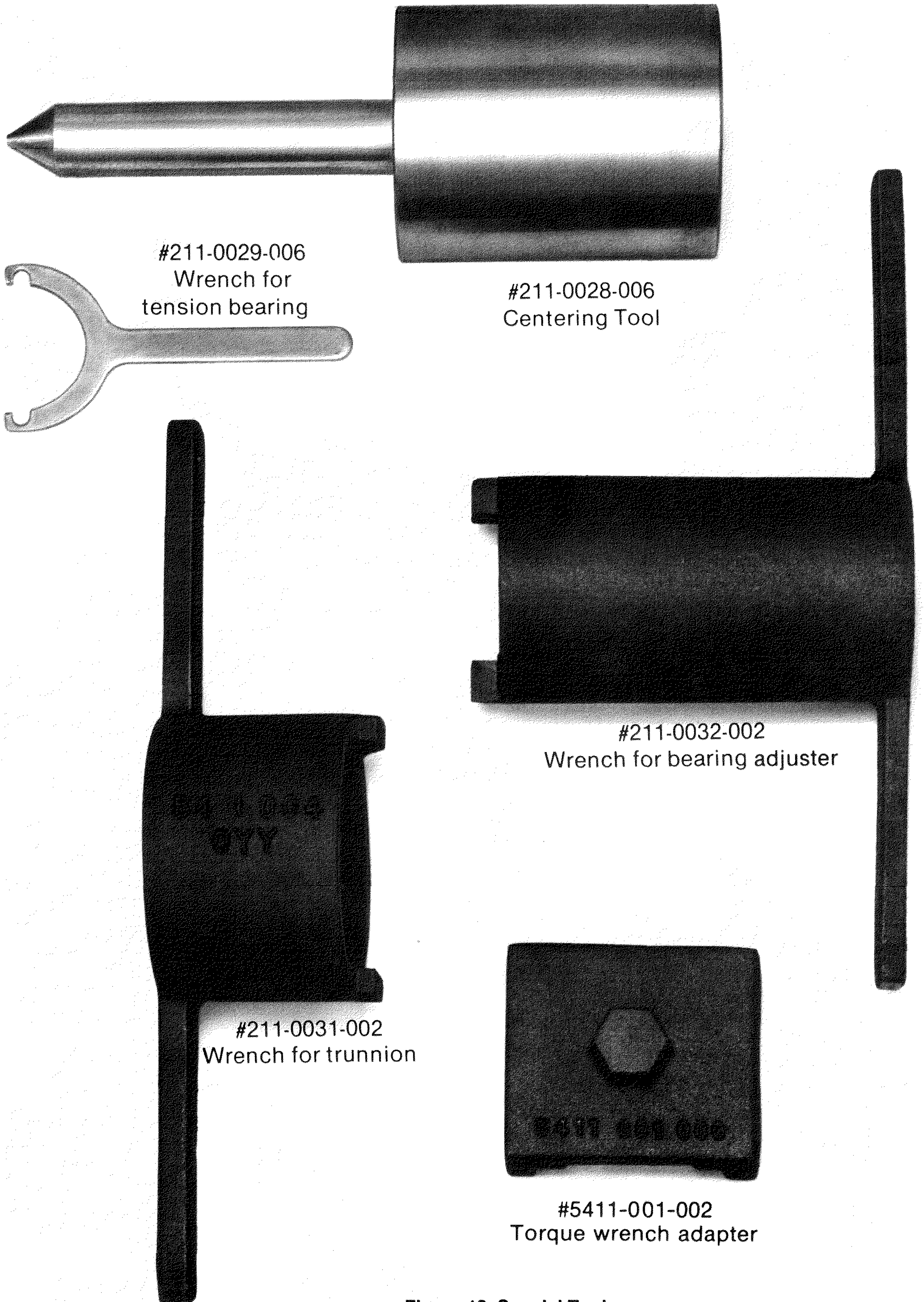
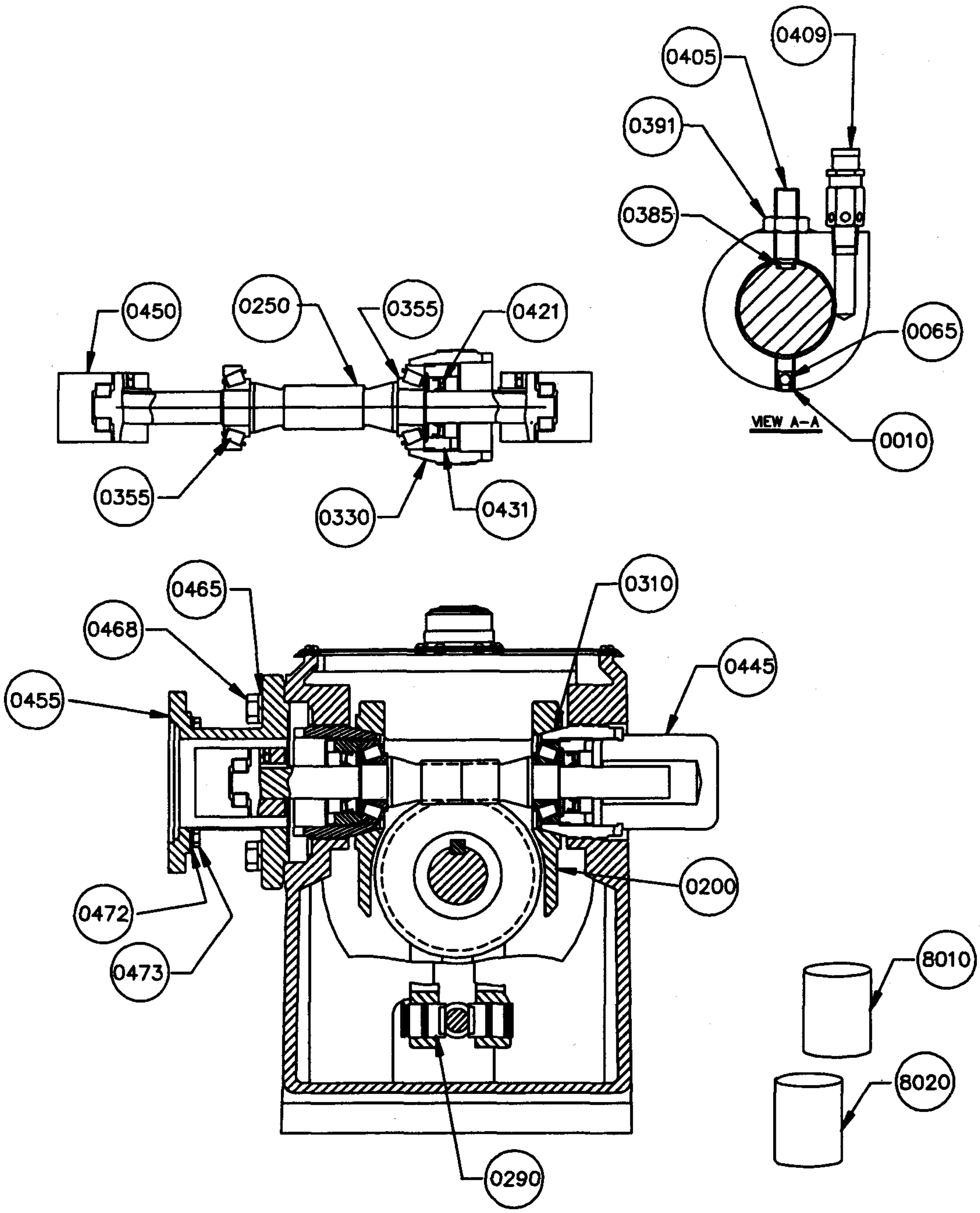


Figure 10. Special Tools.

Drawing Location Reference	Description	Picture cross reference see Figure 11	Part Number	Qty per	Options
10	Soc Set screw Cpt 3/8-16x3/8 steel	405-C	4050045034	3	
12	Magnet	406-A	4060227000	1	
20	Gasket		2250076000	1	
31	Bottom Cover		2810180006	1	
41	Lock Washer 5/16"		4040040028	12	
50	Hex Head Screw 5/16X3/4"		4050017091	12	
55	Drive Housing, All HPD		2810179301	1	Std operating Pressure
65	Ball 1/2 440ss		4070014150	1	
80	Plug 1/2 Npt Socket Hex Head		4020095041	2	
90	1/2" Steel Elbow 150# Threaded		4020031041	1	Std operating Pressure
95	Stroke Plate		2530009062	1	
102	Lead Screw, Steel	256-A	2560040006	1	
103	O-Ring for lead screw	408-A	4080095111	1	
104	Lock Insert- touches lead screw	243-A	2430028274	1	
106	Locking Insert- touches locking screw 110	243-B	2430031039	1	
108	O-Ring 2-012 Buna N 70 Duro		4080109091	1	
110	Locking Screw, Steel	256-B	2560012006	1	
200	Gear Housing Mod C		2810167001	1	
210	Crank Shaft		2680012006	1	
220	Crank		2160003062	1	
230	Crank Key		2110025006	1	
240	Arbor Spacers		4040115011	1	
240	Arbor Spacers		4040115031	1	
240	Shim Wash Keyed 2.25x3.25x.01		4040115101	1	
250	Worm & Gear Set 15.5:1 Dbl Ext	252-J	2520024400	1	Std operating Pressure
260	Shim		2190026106	1	
270	Crank Shaft Bearing		2370019062	1	
280	Hex Jam Nut 1-1/2-12-Unf		4050237021	1	
290	Lead Screw Key		2110052006	2	
300	Socket Set screw 5/16-18x1 Nylk		4050239114	2	
310	Sleeve Bearing Bronze	237-H	2370020052	2	
330	Open Trunnion	237-C	20242	2	
340	Plug 1"NPT Sq. head		4020009021	1	
355	Tapered Roller Bearing	409	4090081000	2	
365	Crosshead Steel, Complete,	210	2100003006	1	Std operating Pressure
365	Crosshead Bearing		2370017062	1	Std operating Pressure
365	Spring, Ball Check		2800029041	1	Std operating Pressure
365	Ball 3/8 440ss		4070014110	1	Std operating Pressure
375	Connecting Rod Assy	214	2140019000	1	Std operating Pressure
385	Sliding Shoe Steel	261	2610002006	1	
391	Hex Nut 1/2-13nc 18.8ss	405-D	4050068012	1	
405	Set screw 1/2-13x1-1/4 steel	405-H	4050226054	1	
409	Relief Valve, Watts	407-B	4070125000	1	Std operating Pressure
411	Nipple, 1/4" X 2"		4020050031	1	
412	Hex pipe bushing 3/8 X 1/4 steel		4020001023	1	
413	Pipe plug 3/8"		4020011031	1	
414	Oil Relief Valve 375 PSI and 750 PSI		4070157040	1	
414	Oil Relief Valve 200 PSI		4070125000	1	
421	Shaft Seal	408-B	4080075010	1	2 required for duplex pumps
431	Bearing Adjuster	237-D	2370014006	1	
431	Bearing Adjuster		2370014006	1	Std operating Pressure
445	Shaft Cover		20244	1	For duplex pumps
450	Coupling L-100 1-3/16 X 1-3/16		4100068070	1	For duplex pumps
450	Coupling L-100 1-3/16 X 5/8		4100068230	1	Frame 56C mount
450	Coupling L-100 7/8 X 1-3/16		4100068200	1	Frame 143/145tc 182/184c
453	Crank Key		2110018406	1	
455	Flange Adapter		2720035001	1	Frame 56C mount
455	Flange Adapter		2720035001	1	Frame 143/145tc 182/184c
465	Spring Lock Washer 5/8 18.8ss		4040044022	4	Frame 56C mount
465	Spring Lock Washer 5/8 18.8ss		4040044022	4	Frame 143/145tc 182/184c
468	Hex head screw 5/8-11x1 steel		4050021111	4	Duplex coupling guard
468	Hex head screw 5/8-11x2 steel		4050021161	4	Frame 56C mount
468	Hex head screw 5/8-11x2 steel		4050021161	4	Frame 143/145tc 182/184c
472	Spring Lock Washer 3/8 18.8ss		4040041022	4	Frame 56C mount
472	Spring Lock Washer 3/8 18.8ss		4040041022	4	Frame 143/145tc 182/184c
473	Hex head screw 3/8-16x1-1/4 Z Plt		4050018136	4	Frame 56C mount
473	Hex head screw 3/8-16x1-1/4 Z Plt		4050018136	4	Frame 143/145tc 182/184c
480	Oil Seal- Crosshead	408-C	4080035010	1	
490	Stroke Adjust Knob	255-A	2550038015	1	
495	Socket Set screw 3/8-16x1/2 steel	405-J	4050045054	2	
496	Socket Set screw 3/8-16x1-1/2		4050045114	1	
6072	Coupling Guard		2490065006	1	Std operating Pressure
6075	Nameplate Milroyal-B and C		20662	1	
6080	Stick Screw 5/32 steel		4050280000	4	
6083	Cover (Main)		2810279040	1	
6085	Cover Assembly Catchall		2810279030	1	
6090	Pan head screw 1/4-20x3/4 18-8ss		4050213072	10	
8002	Arrow, Motor Rotation		4120007010	2	
8004	Capacity Adjustment Lock Decal		2530022000	1	
8005	HPD Caution Sticker		2530007099	1	
8010	Gear Oil Agma 7, 12.5 Gallons		30620	1	
	Allen Wrenches		4130004050	1	

Figure 11 Drive Components



THIS DRAWING (ALL SHEETS) SHOWS REFERENCE NUMBERS FOR PUMPS MANURACTURED AFTER 1996

Figure 12 Drive End View

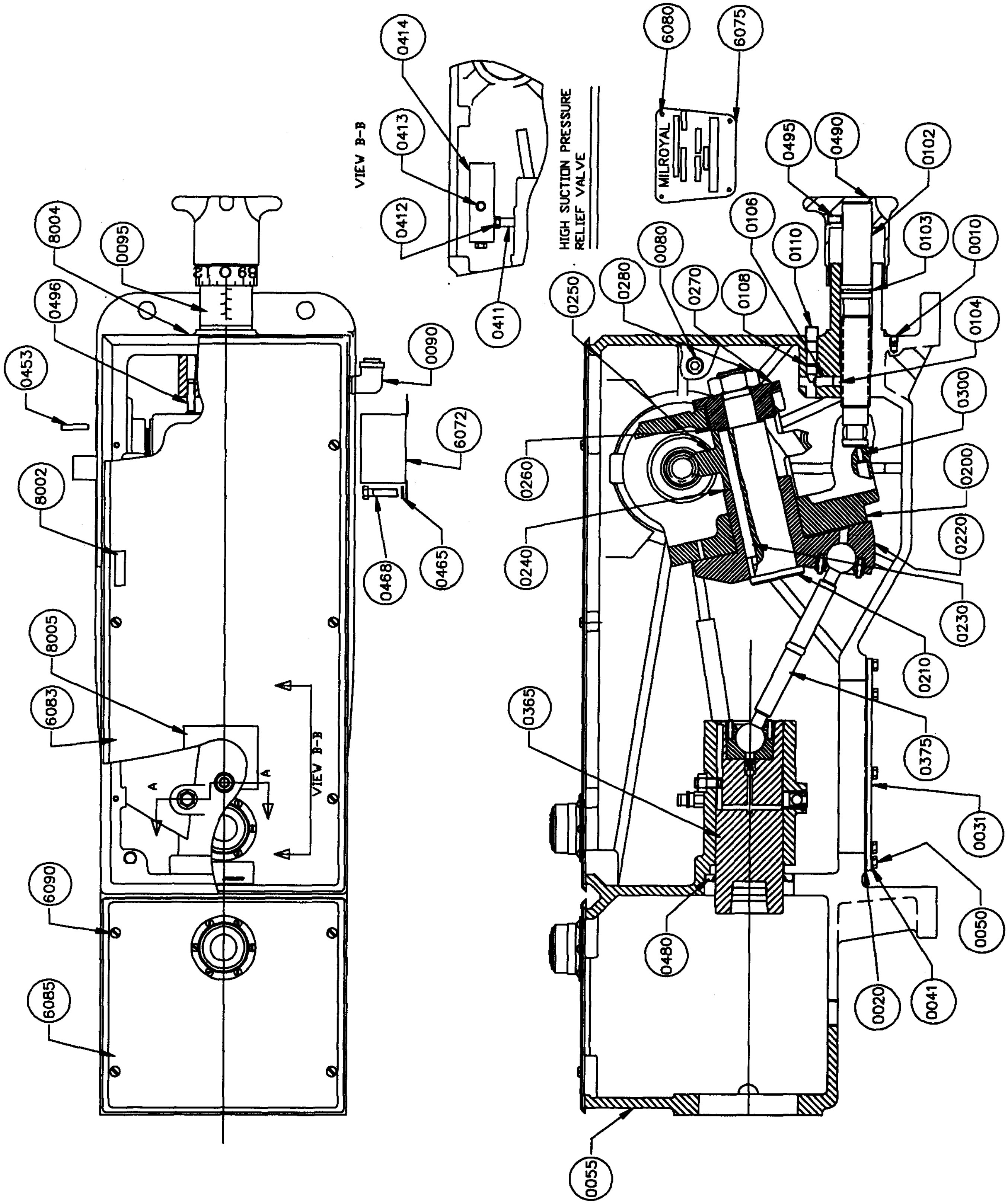


Figure 13 Drive Side and Top Views

SERVICE RECORD

Pump Model No. ______________________________

Pump Serial No. ______________________________ Liquid Pumped

This page is designed as an aid in maintaining the Milroyal pump. Common service operations are listed here with general recommendations based on Service Department field experience.

Gear Drive Lubricant. Monthly inspection of level and condition is recommended. Also recommended is replacement of the lubricant 90 days after the pump is first placed in service. Thereafter, change the lubricant at 6 month or 2500 hour intervals (whichever occurs first).

Supply Tank and Piping. Clean and flush annually.

Suction Line Strainer. Clean as required.

Ball-Check Valves. Flush with clean liquid as often as necessary to maintain full metering accuracy.

SERVICE RECORD (CONTINUED)

Service Operation	Date	Hours	Remarks

TABLE OF EQUIVALENTS

1 atmosphere	equals	1.0333 kilograms/square centimeter 101.33 kilopascals 1.0135 bars
1 Btu/hour	equals	.2928 Watts
Degrees Fahrenheit	equals	1.8° Celsius + 32
1 Engler degree	equals	7.45 square millimeters/second
1 foot	equals	30.48 centimeters 12 inches
1 Ford cup #4	equals	3.76 square millimeters/second
1 gallon (U.S.)	equals	.1337 cubic feet .8333 Imperial gallons 3.785 liters 4 quarts
1 gallon/hour (U.S.)	equals	.003785 cubic meters/hour .002228 cubic feet/minute
1 horsepower	equals	745.7 Watts
1 inch	equals	2.540 centimeters
1 inch of mercury	equals	.03442 kilograms/square centimeter 3376.5 Pascals .4897 pounds/square inch
1 pint (liquid)	equals	.4732 liters 16 ounces
1 pound/square inch	equals	.06804 atmospheres .06897 bars .07029 kilograms/square centimeter 6894.8 Pascals
1 Redwood Admiralty	equals	2.340 square millimeters/second
1 Redwood Standard	equals	.237 square millimeters/second
1 Saybolt Furol	equals	2.16 square millimeters/second
1 Saybolt Second Universal	equals	.216 square millimeters/second

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1M801

MILTON ROY
Metering Pumps

Instruction Manual

High Performance Diaphragm Liquid End (HPD) — Milroyal B, C, and D

339-0014-000

Issued 6/94

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIMITED WARRANTY

The Milton Roy Company ("Company") warrants that its pumping products will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of thirty six months from shipment by the Company. The Company additionally warrants that all of its other products, including actuators, will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of twelve months from shipment by the Company. The Company will, at its option, repair or replace its products provided the Company's inspection reveals the products to have been defective or nonconforming within the terms of this warranty. This warranty is expressly conditioned upon the following: (a)proper installation, maintenance, and use under the Company specified service conditions, (b)prompt notice of nonconformance or defect, (c)the Company's prior written authorization for return, (d)the products being returned to the Company, or at the Company's discretion, to a Factory Authorized Service Center, all at no cost to the Company. The Company will deliver repaired or replacement products Ex Works its factory or Factory Authorized Service Center. Products not of the Company's manufacture are warranted only to the extent provided by the original manufacturer. The Company shall not be liable for damage of any kind resulting from erosive, corrosive or other harmful action of any liquids, gases, or any other substance handled by the Company's products.

THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS, OR LIABILITIES, WHETHER EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM THIS CONTRACT, ITS PERFORMANCE, OR IN CONNECTION WITH THE USE OF, OR INABILITY TO USE THE COMPANY'S PRODUCTS.

The liability of the Company in respect of all damages, losses, costs or expenses, whether suffered or incurred by the Purchaser or any third party arising in any manner or incident related to this contract or the performance hereunder, shall be limited in the aggregate to the actual price paid by the Purchaser to the Company.

SECTION 1
DESCRIPTION

This instruction manual is designed to serve as a supplement to instruction manuals 339-0007-000, 339-0009-000 and 339-0010-000, which provide both general information and specific instructions for installing, operating, and maintaining Milton Roy pumps. This manual covers only the optional High Performance Diaphragm Liquid End (HPD). This manual covers single diaphragm HPD's only. For double disaphragm liquid ends, refer to instruction manual 339-0025-000. This liquid end cannot be retrofitted to a drive housing in place of other packed plunger, tubular diaphragm or disc diaphragm liquid ends. Do not rely on this manual alone when installing, maintaining and operating Milton Roy pumps.

DESCRIPTION

The High Performance Diaphragm (HPD) liquid end combines all of the best characteristics of traditional liquid ends into one technologically advanced design. Its operating characteristics and simplicity of operation make it the best liquid end to consider first for most metering pump applications.

Milton Roy's HPD liquid end overcomes the net positive suction head (NPSH) restrictions associated with conventional disc diaphragm metering pumps. This is accomplished by a patented mechanically actuated refill system (MARS) that eliminates the process side support plate and lowers NPSH requirements.

The MARS also does away with the need for field adjustment of the refill mechanism by automatically compensating for process liquid modifications. This, combined with removable check valves, makes the HPD an ideal choice for any process in which downtime is critical.

The HPD features a preformed, PTFE faced elastomer diaphragm that is compatible with a wide range of process liquids and chemicals. The composite diaphragm also offers extended life over conventional designs.

The HPD liquid End is particularly suitable for pumping costly, aggressive or hazardous liquids without leakage.

PRINCIPLE OF OPERATION

The mechanical drive system of the pump drives the piston back and forth in the High Performance Diaphragm (HPD) liquid end supplied with the pump. At the start of a suction stroke, the plunger moves away from the liquid end, drawing hydraulic fluid with it. As the hy-

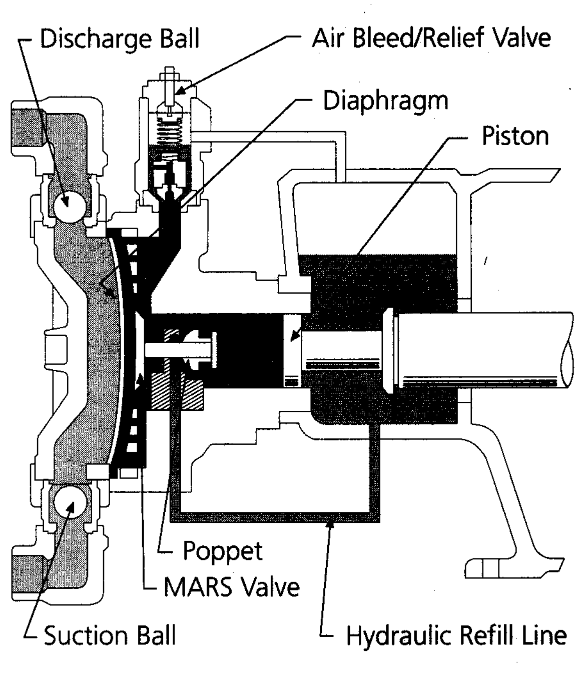


Figure 1. Principle of Operation—Suction.

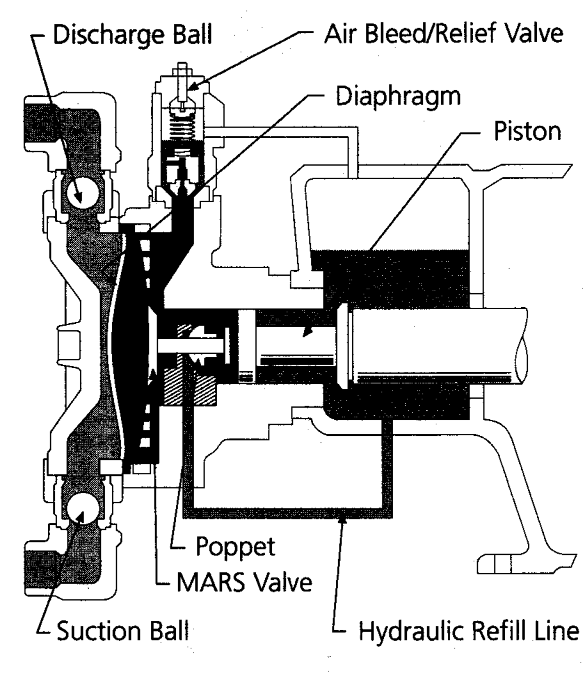


Figure 2. Principle of Operation—Discharge.

draulic fluid is drawn back, the flexible diaphragm follows, lowering the pressure on the process fluid in the liquid end. This pressure causes the fluid to flow inward, lifting the suction ball check, and allowing process fluid to pass through the suction line into the diaphragm head. At the same time, the discharge ball check is pulled closed, blocking flow back through the discharge line.

At the end of the suction stroke, the process reverses, beginning the discharge stroke. Now the plunger moves forward, pushing hydraulic fluid before it. The hydraulic oil must therefore press against the diaphragm, flexing it forward and raising the pressure on the process fluid in the liquid end. This pressure causes the process fluid to flow outward, forcing the discharge ball check open and the suction ball check to seat, blocking back flow through the suction line. The process fluid flows out of the diaphragm head and into the discharge line. This suction/discharge action is repeated with every stroke of the pump plunger, and is the direct cause of the pumping action.

As the pump operates, a small quantity of hydraulic oil is continuously bled through the air bleed/relief valve. After a while, this results in a shortage of hydraulic oil in the displacement chamber. When this happens, the diaphragm will be pulled tight against the contour plate, and part of the diaphragm will press against the patented Mechanically Actuated Refill System (MARS) valve. Now, when the plunger draws back, a vacuum is created in the displacement chamber. These two factors (diaphragm pressing against MARS valve & a vacuum in the displacement chamber) must occur together to trigger the MARS valve.

When both of these conditions are met, the MARS valve is forced to its rearward position, and the poppet opens, allowing hydraulic oil from the reservoir to enterand replentish the lost oil. In this manner, proper hydraulic ballance is constantly maintained in the displacement chamber.

MODEL CODING

The presence of an HPD liquid end on a Milroyal pump is indicated by an "H" in the third position of the pump model code (xxH-xxx-xxxx-x). This model code can be found on the data plate attached to the pump. For more information on pump model coding and data plates, see the appropriate pump instruction manual.

SPECIFICATIONS

Plunger Diameters

Milroyal D—1", 1¼", 1½"
Milroyal B—1", 1¼", 1½", 2", 2½", 3½"
Milroyal C—1", 1¼", 1½", 2", 2½", 3½", 5", 5¾"

Materials of Construction

316 SS, Alloy 20, Plastic

Temperature Range

Metallic—10°F–190°F (standard)
Metallic—10°F–225°F (optional)
Plastic—10°F–140°F

SECTION 2
INSTALLATION

UNPACKING

Pumps are shipped f.o.b. from the factory and the title passes to the customer when the carrier signs for receipt of it. The customer, therefore, must file damage claims with the carrier.

The shipping crate should be carefully examined upon receipt from the carrier to be sure there is no obvious damage to the contents. Open the crate carefully, as there are sometimes accessory items fastened to the inside of the crate which may be lost or damaged. Examine all material inside crate and check against the packing list to be sure that all items are accounted for and undamaged.

SAFETY PRECAUTIONS

When installing, operating, and maintaining an HPD pump, keep safety considerations foremost. Use proper tools, protective clothing, and eye protection when working on the equipment and install the equipment with a view toward ensuring safe operation. Follow the instructions in this manual and take additional safety measures appropriate to the liquid being pumped. *Be extremely careful in the presence of hazardous substances (e.g., corrosives, toxics, solvents, acids, caustics, flammables, etc.).*

MOUNTING

The HPD liquid end is shipped already mounted to the appropriate pump. Mounting, therefore, is simply a matter of securing the pump to a safe, level surface. For further information on proper pump mounting, see the appropriate pump instruction manual:

Milroyal B 339-0007-000
Milroyal C 339-0009-000
Milroyal D 339-0010-000

CONVERSION PROCEDURES

A pump fitted for operation with any liquid end other than HPD cannot be converted for operation with an HPD liquid end. Drive housings for other liquid ends contain some machined features which make them incompatible with HPD liquid ends.

A pump can, however, be converted from one HPD liquid end plunger size or material of construction to other select HPD designs. For more information on converting between different HPD liquid end models, please contact the Milton Roy factory or your local authorized representative.

PIPING CONNECTIONS

General

General piping instructions are given in the pump drive instruction manual. No reciprocating plunger pump can be expected to perform satisfactorily unless those recommendations are followed. Pay particular attention to plastic liquid ends, as these units are relatively fragile and can be damaged by the installation. For best results, avoid straining the liquid end by installing a very short section of flexible tubing between rigid, fixed piping and suction and discharge cartridges on plastic liquid ends.

> *NOTE*
> *Maximum safety and reliability may be ensured by protecting liquid ends and piping with an external relief valve installed in the system discharge line.*

NPSH Considerations

The HPD liquid end is far superior to conventional diaphragm liquid ends for suction lift and many other NPSH critical applications. Its patented diaphragm and advanced design refill mechanism give this liquid end truly high performance in these applications.

For more NPSH information, refer to the Practical Handbook for NPSH, bulletin 220, but apply a 3 psia limitation and contour plate loss (instead of 9 psia) in evaluating applications for this liquid end.

Typical Piping

In order to adjust the HPD relief valve, it is necessary to have a pressure gauge and a shut off valve installed in the discharge line. The pressure gauge must have a higher range than the desired pump relief pressure, and should be installed as close to the pump discharge conndction as possible. The shut off valve should be installed downstream of the pressure gauge. These items are not required for normal operation, but for ease of pump maintenance and adjustment, it is suggested that they be permanently piped into the line.

Be sure to see the instructions in the appropriate pump instuction manual for additional typical piping instructions.

SECTION 3
OPERATION

INITIAL START-UP

After installing the pump and the HPD liquid end, perform the following operations before placing the pump into service. Numbers refer to part numbers shown in assembly drawings included with this manual.

If your pump has been supplied with a double diaphragm HPD liquid end, be sure to reference the double diaphragm supplemental instruction manual (339-0025-000).

1. Disconnect outlet tube from relief valve (335-B) and remove relief valve from liquid end. Make sure that the O-ring between displacement chamber and relief valve does not get lost or damaged, and that the opening in the displacement chamber is clean.
2. Make sure that the capacity adjustment (hand knob or automatic control) is set at 100%.
3. Rotate motor coupling until the piston and crosshead are in the full forward position (closest to pump liquid end).
4. Fill the opening in the displacement chamber (221-A) through the port uncovered by removal of the relief valve in step 1 with the hydraulic oil furnished with the pump, or with the oil listed in the chart below. Fill the chamber slowly, allowing air bubbles to escape, until the oil level reaches the very top.

Pump	Hydraulic Oil
Milroyal D	Mobil SHC 629
Milroyal B	Zurnpreen 15A
Milroyal C	Zurnpreen 15A

5. Replace the relief valve, making sure that the O-ring is properly seated. Install the (2) relief valve mounting bolts into the relief valve mounting collar and tighten the bolts evenly and securely.
6. Remove the small square cover over the front chamber of the pump and fill the chamber with hydraulic oil (same oil as used in step 4) to a level equal to the top of the oil seal which surrounds the crosshead.
7. Replace the relief valve outlet tube and the front chamber cover.
8. The pump liquid end hydraulic oil servicing is now complete.
9. Before placing pump into operation, please refer to the instruction manual furnished along with this manual, which covers the lubrication instructions for the pump gear box, the instructions for bleeding all air from the suction piping and pump head, and for proper direction of motor rotation.
10. Do not start up pump drive motor before filling gear box with oil or serious damage will occur.

RELIEF VALVE ADJUSTMENT

All HPD liquid ends have a built in relief valve which allows hydraulic fluid to return to the hydraulic fluid reservoir if excessive pressure builds up in the discharge line. This effectively stops the pump from pumping, since the forward stroke of the piston will not displace the hydraulic fluid and force the diaphragm to flex. Please read the "Principle of Operation" and see Figures 1 and 2 for more information.

The HPD liquid end relief valve may be adjusted to operating conditions by the following procedure. Adjust the relief valve after first installing the pump and after any maintenance procedures.

> *WARNING*
> *The pressure relief valve (335-B) is factory set to open at a pressure slightly above the pump maximum operating discharge pressure; never set the valve at any greater pressure.*

1. A pressure gauge and shut off valve must be installed in the discharge line to complete this procedure. If the necessary equipment is not installed, refer to the "Typical Piping" instructions in Section 2.
2. Make sure shut off valve is open. Start pump and pump process liquid to drain or other safe point to establish proper pumping action.
3. Set capacity control at 30%.
4. Close shut off valve ("dead head" the pump) and closely watch the pressure increase on the pressure gauge. If pressure exceeds desired value, quickly open shut off valve to relieve pressure in line.

WARNING
Keep hands away from reciprocating plunger and crosshead.

WARNING
Do not leave pump operating unattended with shut off valve closed! Excessive pressure can build quickly, possibly causing severe damage to pump and/or piping. Since the relief valve is not yet properly adjusted, it can not be relied on to limit excessive pressure build-up. Be sure to watch pressure gauge very carefully and open shut off valve immediately if excessive pressure develops.

5. With shut off valve still closed, loosen relief valve adjusting screw located on top of valve until the maximum pressure gauge reading reaches and maintains the relief valve pressure setting desired.
6. After setting relief valve, make sure shut off valve is fully open. Remove pressure gauge from line or leave in place, as desired, and place pump in routine service.

SECTION 4
MAINTENANCE

RECOMMENDED SPARE PARTS

To avoid delays in repairs, the following spare parts should be ordered for each pump:

1 Routine Preventive Maintenance Kit

Part orders must include the following information:

1. Quantity reqiured
2. Part number
3. Part description
4. Serial number (found on nameplate)
5. Model number (found on nameplate)

Always include the serial and model numbers in all correspondence regarding the unit.

RETURNING UNITS TO THE FACTORY

Pumps will not be accepted for repair without a Return Material Authorization, available from the factory or other authorized Customer Service Department. Pumps returned to the factory for repairs should be clearly labeled to indicate the liquid being pumped. Process liquid should be flushed from the pump liquid end before the pump is shipped.

NOTE
Federal law prohibits handling of equipment that is not accompanied by an OSHA Material Safety Data Sheet (MSDS). A completed MSDS must be packed in the shipping crate with any pump returned to the factory. These safety precautions will aid the troubleshooting and repair procedure and preclude serious injury to repair personnel from hazardous residue in pump liquid end. A Material Safety Data Sheet must accompany all returns.

All inquiries on part orders should be addressed to your local Milton Roy sales representative or sent to:

Parts Department
Milton Roy Company
Flow Control Division
201 Ivyland Road
Ivyland, PA 18974-0577
Phone: (215) 441-0800
FAX (215) 441-8620

ROUTINE PREVENTIVE MAINTENANCE

WARNING
Before any maintenance, relieve all pressure from system, isolate liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.

Hydraulic Oil Replacement

Inspect and replace hydraulic oil on the same schedule as the pump's gear drive lubricant (see the appropriate pump drive instruction manual for this information). Semiannual replacement is recommended, and can be scheduled to coincide with seasonal oil changes.

To replace the hydraulic oil:

1. Remove the catchall cover by unscrewing the four screws which hold it on.
2. Place a container under the pump catchall to catch the oil and unscrew the catchall drain plug (402-J).
3. When oil has finished draining, make sure that the area around the drain hole is clean. Screw drain plug back in securely.
4. Fill the catchall to the top of the oil seal which surrounds the crosshead with new, clean oil. Use hydraulic oil or any good quality type A automobile automatic transmission fluid.
5. Replace the catchall cover and screw firmly in place.

NOTE
It is not necessary to purge the liquid end displacement chamber of oil during annual oil replacement.

6. Dispose of oil according to any federal, state or local codes which may apply.

Check Valve Maintenance

HPD check valves are modular in design and can be serviced without disconnecting them from the piping system. At the user's option, they can be supplied as either single or double ball configuration.

Milton Roy recommends an annual tune up using a Routine Preventive Maintenance (RPM) Kit. RPM kits contain replacements for those parts which are subject to wear; specifically the ball checks, check valve seats, gaskets, and the strainer. Replacing these parts annually with an RPM kit can reduce the possibility of unexpected downtime and will help to extend pump life.

Disassembly

> *WARNING*
> *Before performing any maintenance on the check valves, relieve all pressure from system, isolate liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.*

After insuring that all system pressure has been relieved and that all hazardous process liquids have been flushed from the liquid end, disconnect both the suction inlet and discharge outlet from the system piping. Loosen the four retaining nuts (405-F) evenly, then remove. A slight force applied to the port connector (271-A) will provide sufficient clearance to lift and slide out the ball guide (292-A), seat, ball, and gaskets (see the exploded drawing in the RPM Kit brochure RPM 11.1 or RPM 11.2). Once disassembled, the gaskets (225-A) are not suitable for reuse and should be discarded.

Inspect the balls carefully. If they are smooth, round and free of deposits or pits, then they are suitable for continued use. Examine the check valve seats. The area of the seat where it meets the ball (the un-chamfered side) must be in near perfect condition for continued use. Any imperfection visible on the seating surface (pits, erosion, cracks, or a ball shaped contour greater than 0.030 deep) makes the seat unusable. If both the balls and the seats are in good condition, then the length of time between parts replacement may be lenghtened. If the balls and seats are severely damaged, then the length of time between parts replacement should be shortened.

Thin PTFE gaskets fit between all mating components of the check valve stack, and are held in place with sealing grooves in the metallic or plastic parts. Inspect these grooves with a magnifying glass. If the grooves are deformed, dented, or damaged in any manner, the damaged part should be replaced to prevent leakage. Clean these grooves with a small, stiff brush prior to reassembly. Note that the port connections and ball cages are not included with the RPM kit. If these parts are damaged, they must be ordered seperately.

Reassembly

Replace the components in the orientation shown in the RPM Kit exploded drawing, using the new parts included in the kit. Install an unused gasket between each set of thoroughly cleaned components. Tighten the stud nuts evenly by hand only, then rotate the components to insure that they are properly guided and mated. Snug up on the nuts evenly to prevent cocking of the assembly and subsequent leakage of process liquid to surroundings.

Hydraulic Oil (MARS Inlet) Strainer Replacement

The strainer which screws into the pump body can become fouled or clogged over time. It should therefore be replaced yearly, and is included with the check valve parts in the RPM Kit. If the strainer becomes clogged more frequently than once a year (which is extremely unlikely), it can be ordered seperately.

Since the hydraulic oil must first be drained from the hydraulic oil reservoir, it is a good idea to schedule strainer replacement with hydraulic oil replacement.

1. Drain hydraulic oil according to steps 1 through 3 of the hydraulic oil replacement instructions.
2. Unscrew the hydraulic refill line from the strainer.
3. Unscrew the strainer from the pump body. Clean any debris from the mouth of the hole.
4. Screw a new strainer into the pump body and reattach the hydraulic refill line.
5. Refill catchall with fresh hydraulic oil according to steps 4 through 6 of the hydraulic oil replacement instructions.

CORRECTIVE MAINTENANCE

Relief Valve Assembly

The relief valve assembly (335-B) operates in filtered hydraulic oil and should require maintenance only if unusual circumstances occur, such as if corrosive media contaminates the fluid.

Assembly and disassembly is straightforward. Field servicing should be limited to inspection and cleaning only. Repairs of this critical component should only be carried out by an authorized Milton Roy repair facility.

"MARS" Refill Valve Assembly

The refill valve assembly (see figure 17) requires no periodic maintenance. Clean hydraulic oil is critical for proper operation. Field servicing should be limited to inspection and cleaning only. Repairs of this critical component should only be carried out by an authorized Milton Roy repair facility.

If this valve is to be removed from the displacement chamber (221-A), follow steps 1 through 7 under "Removing the Liquid End" and steps 8 through 13 under "Removing the Diaphragms." Once these steps have been accomplished, the MARS valve can be carefully pushed out. Push the valve only on its body (221). It is recommended that a length of pipe be inserted through the plunger bore and used to push the MARS valve out. Be careful to center the head of the MARS valve poppet stem (268) inside the pipe. No pressure should be put on the MARS valve poppet stem whatsoever, or it may become damaged! Do not attempt removal by prying the MARS valve poppet stem on the front side of the valve.

To reinstall the valve, replace the two o-rings (408-A) and back-up rings (408-B) with new ones. Back-up rings should be installed on the inside side of the o-rings (refer to figure 17 for proper positions). Lubricate the rings and displacement chamber liberally with oil, and press the valve straight into the chamber. Follow steps 14 through 19 under "Replacing the Diaphragms." New O-rings should always be used, but, if the diaphragm(s) appear in good condition after close inspection, the diaphragm(s) can be reused. Follow steps 20 through 21 under "Reinstalling the Liquid End."

Diaphragm Replacement

HPD liquid ends are designed to provide reliable service and the diaphragm should not need replacement. However, in the unlikely event of a failure, the diaphragm can be replaced by following the procedure below:

Removing the Liquid End

> *WARNING*
> *Before beginning disassembly procedures, relieve all pressure from system, isolate the liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.*

1. Disconnect both the suction inlet and discharge outlet from the piping system. If desired, the suction and discharge assemblies can be removed.
2. Remove the catchall cover and drain catchall of hydraulic oil by unscrewing the catchall drain plug.
3. Completely loosen the piston rod retention nut (272-B) located inside the catchall.
4. Disconnect all tubing which connects the liquid end to the pump body.
5. On larger pumps, the liquid end can be very heavy (150 lbs. or more), and a hoist may be required to move it.
6. Unscrew the bolts (405-H) located inside the catchall which hold the displacement chamber to the pump body. Pull liquid end and plunger off, being careful to protect the plunger from damage.
7. Remove plunger from liquid end by pulling firmly but carefully, being careful not to bend or otherwise damage the plunger. Place the liquid end, diaphragm head up, on a bench or other clean, flat, convenient working area.

Removing the Diaphgrams

8. During these procedures, a pint to a quart of hydraulic oil will be released. Prepare your work area accordingly.
9. Loosen the diaphragm head bolts which hold the head to the displacement chamber. Oil will begin to leak out. Depending on the

liquid end size, the diaphragm head can weigh between 10 lbs. and 150 lbs. If necessary, be sure to have a hoist or other means of lifting the diaphragm head available.

10. Once the diaphragm head is adequately supported, the diaphragm head bolts can be removed entirely. Carefully pull the diaphragm head away from the displacement chamber. In most cases, the white teflon diaphragm and contour plate will remain with the displacement chamber.
11. Remove the diaphragm and contour plate carefully, being careful not to drop the contour plate. The contour plate can be heavy, and if it is dropped, it could be damaged or cause personal injury.
12. The contour plate o-ring will come off with the contour plate. Clean the diaphragm groove and o-ring groove of the contour plate well. Be very careful not to scratch the grooves, or leakage will occur.
13. Clean the diaphragm groove in the displacement chamber and the flat surface in the displacement chamber where the o-ring rests.

Replacing the Diaphragm

14. Apply a light coating of grease to the o-ring, contour plate o-ring groove, and diaphragm groove. Place o-ring into contour plate o-ring groove.
15. Place the contour plate into the displacement chamber. If your HPD liquid end has an orientation pin near the outer edge on the back side of the contour plate, make sure it is in the twelve o'clock position and that it slides into the orientation pin hole in the displacement chamber. The contour plate should rest flat against the displacement chamber and does not rock.
16. Place the black rubber side of the diaphragm against the contour plate, making sure the diaphragm sealing bead fits securely in the diaphragm groove of the contour plate. The white teflon side of the diaphragm should be facing outward and visible.
17. Lift the diaphragm head into place (use a hoist if necessary), making sure that any words cast into the head are in an upright position and that the diaphragm bead fits securely into both the head and contour plate grooves.
18. For plastic liquid ends, install and tighten bolts firmly. Do not overtighten, or the plastic diaphragm head could crack!
19. For metallic liquid ends, lubricate the diaphragm head bolts with pump gear oil or equivalent prior to reassembly. Install the diaphragm head bolts in accordance with the following torque specifications. Bolts should first be torqued, in the sequence shown in the appropriate figure (figure 3 or 4) to one half of the value shown below. Following the same sequence, each bolt should then be torqued to the above final value. The pressure is the maximum discharge pressure listed on the pump nameplate.

Pump Model	Plunger Diameter	Pressure	Torque (ft-lbs)
Milroyal D	All	All	75
Milroyal B	1", 1¼"	All	75
	1½", 2", 2½"	All	110
	3½"	All	150
Milroyal C	1"	≤ 1600 PSI	75
		> 1600 PSI	94
	1¼", 1½", 2"	≤ 1000 PSI	110
		> 1000 PSI	190
	2½", 3½"	All	150
	5", 5¾"	All	97

Reinstalling the Liquid End

20. Reconnect the liquid end to the pump by reversing instructional steps 1 through 7 under "Removing the Liquid End."
21. Fill the liquid end with hydraulic oil (refer to page 9, single & double diaphragm start-up instructions). If working on a double diaphragm pump, be sure to also fill the intermediate chamber as well.

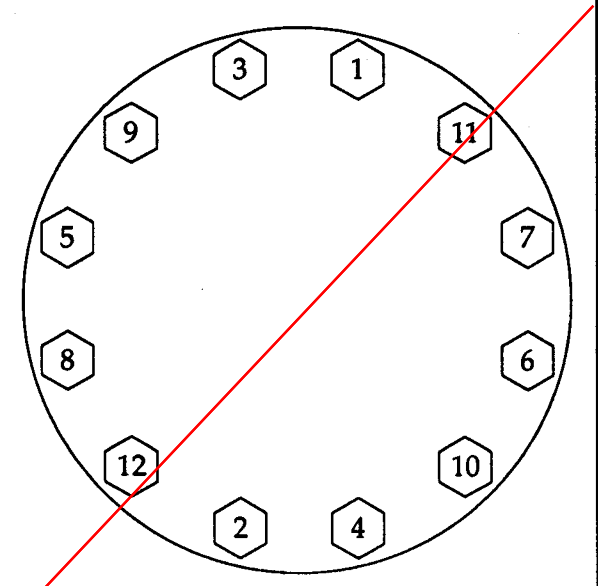


Figure 3. Twelve Bolt Tightening Sequence.

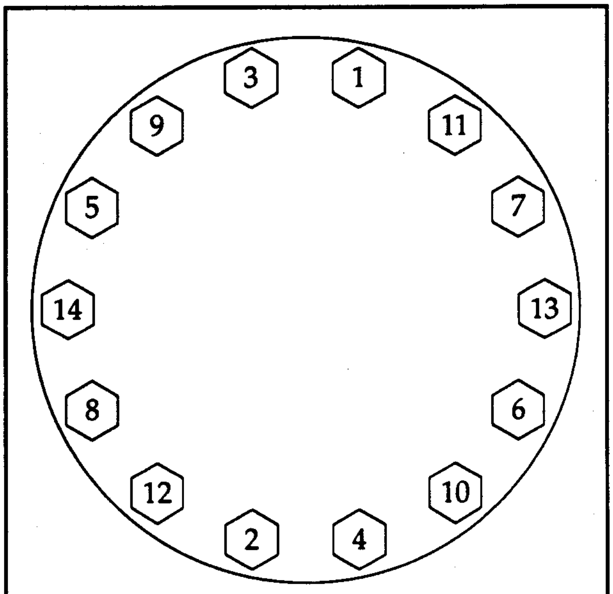


Figure 4. Fourteen Bolt Tightening Sequence.

SECTION 5
TROUBLESHOOTING

Pump drive instruction manuals list most possible malfunctions, their causes and cures. The following problems peculiar to HPD liquid ends may be remedied as indicated below.

Excessive delivery.	• Low discharge line pressure. Increase line pressure (e.g., install a back pressure valve).
Insufficient delivery.	• Relief valve relieving. – Blocked discharge line. Clear line. – Relief valve set too low. Adjust valve to operating conditions. • Air in hydraulic system. Fill displacement chamber with hydraulic oil to proper level. • Clogged refill line. Remove strainer assembly and clean or replace.
Erratic delivery	• Leaky relief valve. Repair or replace valve. • Blocked suction line. Clean line, particularly the line strainer. • Insufficient NPSH. Most common with long suction lines, small diameter suction lines, acid pumping, polymer (viscous) liquids, or drawing from a source lower than the pump. Consult your local representative or the Milton Roy factory.

SECTION 6
PARTS

The following pages contain the parts drawings for the various HPD liquid ends. Refer to the chart below to determine which figure applies to your particular liquid end.

When ordering parts, please refer to the parts ordering instructions listed under "Recommended Spare Parts" in the Maintenance Section (Section 4). Be sure to include all required information with your parts order, or Milton Roy Company may be unable to process your order.

Pump	Plunger Diameter	Diaphragm Diameter	Metallic	Plastic
Milroyal D	All	4.2″	Figure 5	Figure 6
Milroyal B	1″, 1¼″	4.2″	Figure 7	Figure 8
Milroyal C	1″	4.2″		
Milroyal B	1½″, 2″, 2½″	6.5″	Figure 9	Figure 10
Milroyal C	1¼″, 1½″, 2″	6.5″		
Milroyal B	3½″	10.5″	Figure 11	Figure 12
Milroyal C	2½″, 3½″	10.5″		
Milroyal C	5″, 5¾″	14.4″	Figures 13 & 14	Figures 15 & 16
Mechanically Actuated Refill System (MARS) Valve			Figure 17	

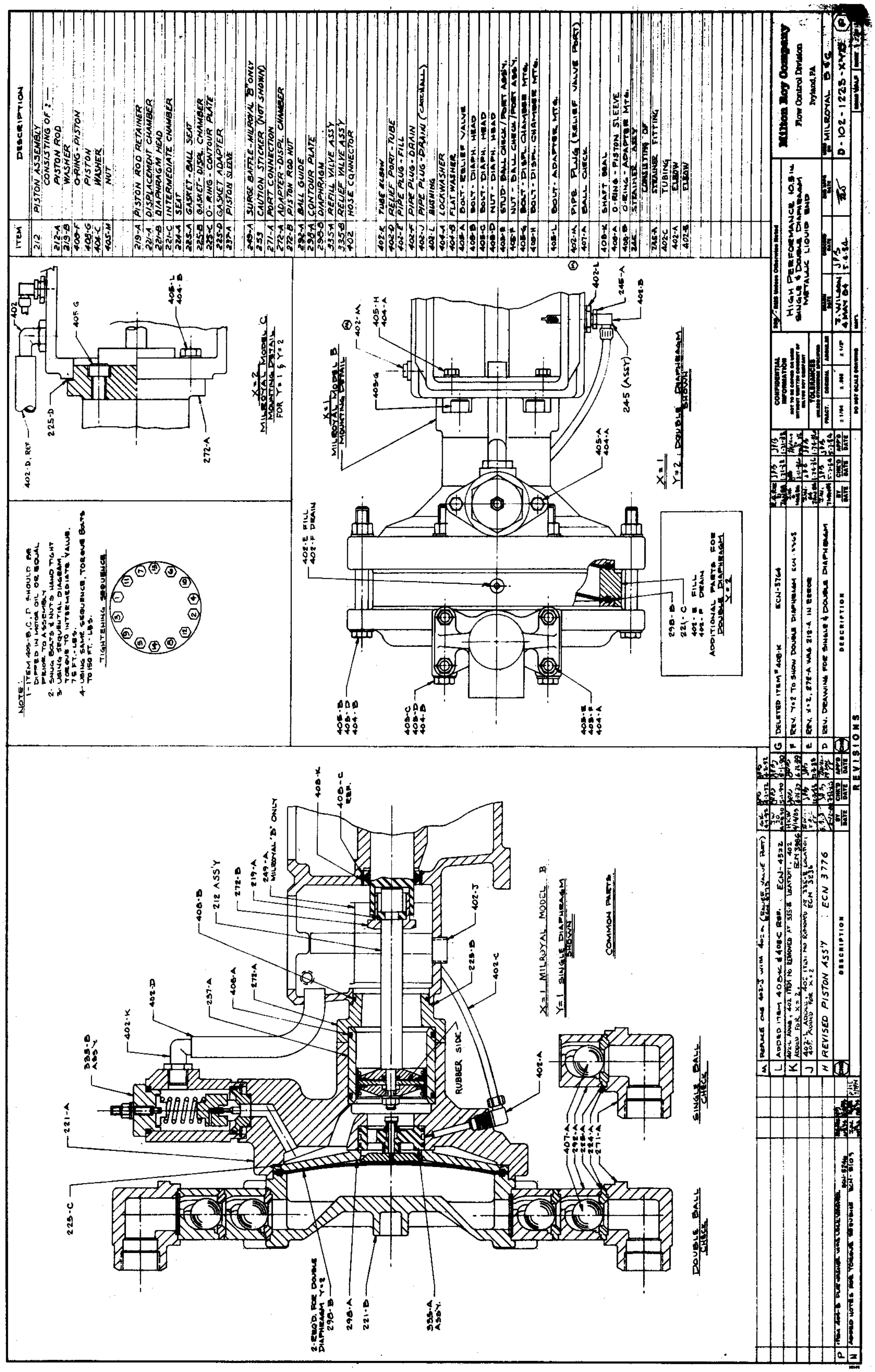


Figure 11. HPD Liquid End Customer Parts Drawing (102-1223-000).

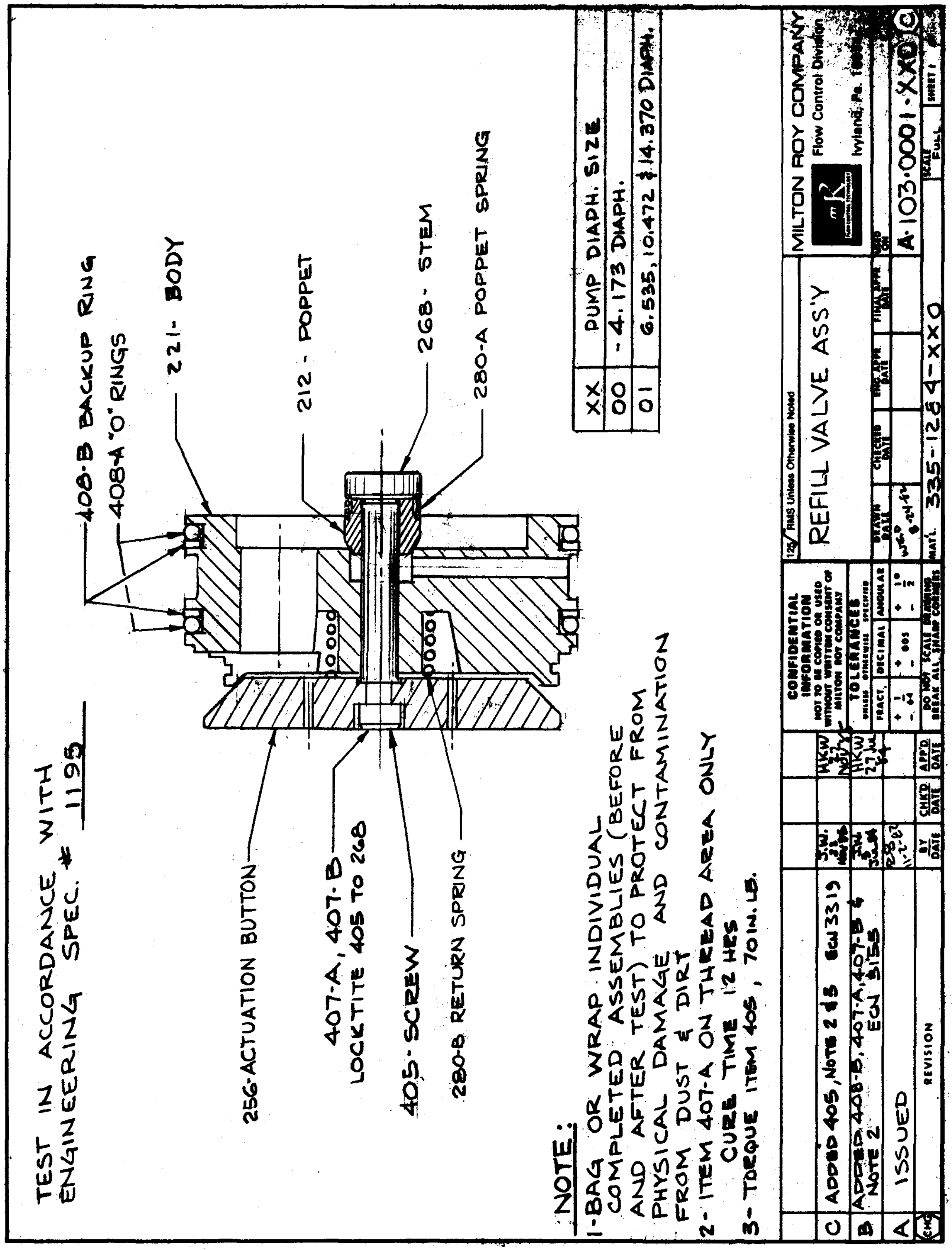
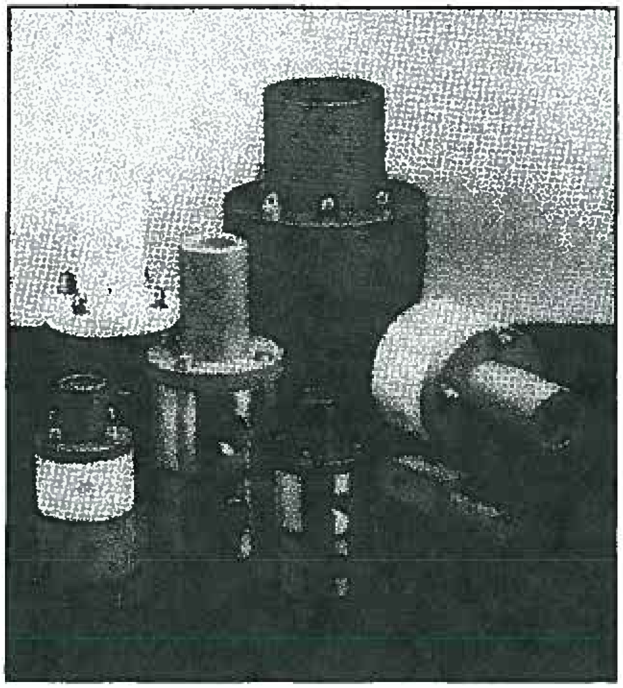


Figure 17. Mechanically Actuated Refill System (MARS) Valve (103-0001-000).

Milton Roy Company
Flow Control Division
www.miltonroy.com

201 Ivyland Road
Ivyland, PA 18974-0577
(215) 441-0800 • FAX: (215) 441-8620

"L" SERIES FAMILY

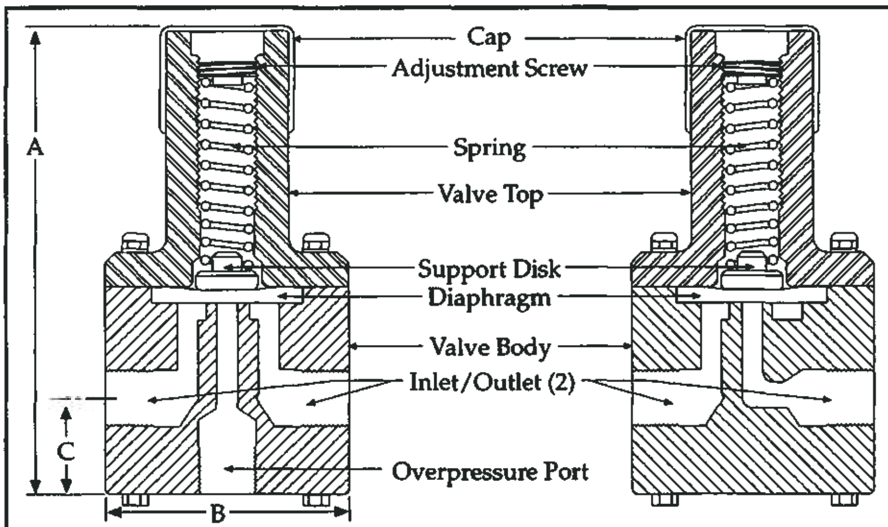


"L" SERIES FEATURES

Milton Roy "L" Series valves are available in ¼" through 2". Materials of construction include PVC, CPVC, PP, PVDF, PTFE, 316 SS, Alloy 20, and hastelloy C276. Valves are field adjustable, and are factory preset at 50 psi.

- High reliability/low cost
- Robust machined construction
- Vulcanized PFA/EPDM diaphragm
- Externally adjustable from 0 to 150 psi standard
- Ventable to suction line
- Wide range of materials
- Tamper resistant adjustment screw

"L" SERIES PARTS & DIMENSIONS



Safety Valve

Back Pressure Valve

NOTES:

1. Max tempetature is 110°F for PVC valves and 250°F for 316, Alloy 20, and Hastelloy C276 valves with steel top.
2. Inlet and outlet port are interchangeable on safety valves. Inlet and outlet ports are marked with arrows on the valve body of back pressure valves, and are not interchangeable.

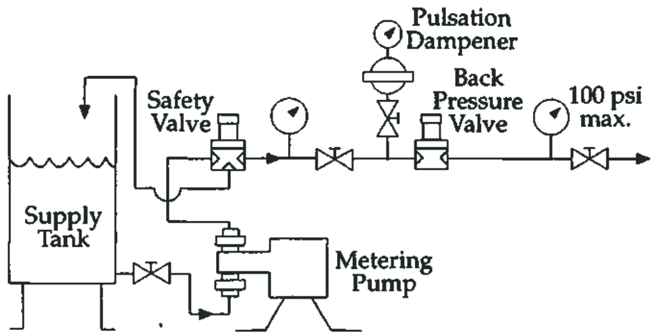
Valve Size	Inlet/Outlet	A (4)		B (4)		C (4)		Avg. Ship. Weight	
		in	cm	in	cm	in	cm	Plastic	Metallic
¼"	¼" NPT	3.500	8.890	2.375	6.033	0.750	1.905	1 lb.	2 lbs.
½"	½" NPT	5.500	13.970	3.500	8.890	1.125	2.858	2 lbs.	7 lbs.
¾"	¾" NPT	5.500	13.970	3.500	8.890	1.125	2.858	2 lbs.	7 lbs.
1"	1" NPT	6.250	15.875	3.500	8.890	1.375	3.493	2 lbs.	7 lbs.
1½"	1½" NPT	9.000	22.860	5.500	13.970	2.250	5.715	8 lbs.	28 lbs.
2"	2" NPT	9.000	22.860	5.500	13.970	2.250	5.175	8 lbs.	28 lbs.

Valves

AD 4301
Effective 2/15/96

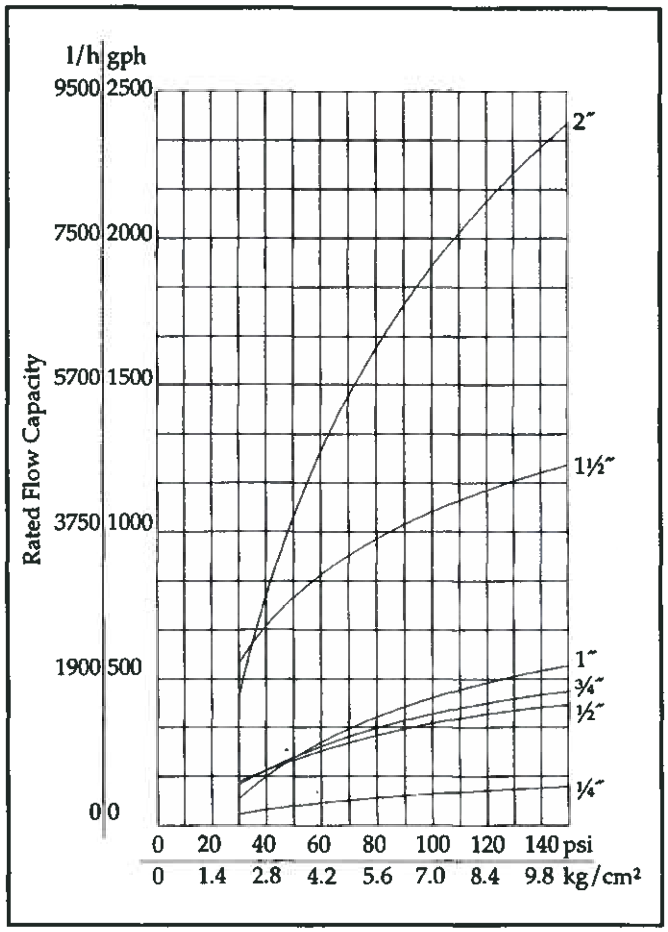
MILTON ROY

"L" SERIES TYPICAL INSTALLATION



NOTE:
It is rcommended that "L" Series safety valves discharge to atmospheric pressure. Also, use of a pulsation dampener in conjunction with a back pressure valve will result in extended valve life (cycling with each pump stroke is eliminated). Maximum allowable pressure downstream of back pressure valve should not exceed valve rated pressure.

"L" SERIES PERFORMANCE CURVES



"L" SERIES MATERIALS

Other materials are available for special applications.

Part	Material of Construction
Daiphragm	PTFE faced EPDM or Viton
Valve Top	Standard: PVC Optional: Steel, 316 SS
Valve Bottom	Choice of PVC, CPVC, PP, PTFE, PVDF, 216 SS, Alloy 20, or Hastalloy C276

"L" SERIES PRODUCT CODE

G V B 2 4 1

Type
S = Safety Valve
B = Back Press. Valve

Size
04 = ¼"
08 = ½"
12 = ¾"
16 = 1"
24 = 1½"
32 = 2"

Material of Construction
1 = 316 SS*
2 = PVC
5 = Alloy 20*
6 = Hastelloy C
C = CPVC
P = Polypropylene
V = PVDF
T = PTFE

NOTE:
* 316 SS and Alloy 20 are not available in ½" and 1" sizes. Order from the "H" Series valve line.

AVAILABLE ACCESSORIES

In addition to metering pumps & chemical feed systems, Milton Roy offers the following accessories:

- Calibration Columns
- Pulsation Dampeners
- Gauge Glasses
- Dissolving Baskets
- Valve Actuators
- Pressure Gauges
- Floats
- Tanks
- Traps
- Mixers

All information contained herein subject to change without notice.

Milton Roy Company
Flow Control Division
www.miltonroy.com

201 Ivyland Road
Ivyland, PA 18974-0577
(215) 441-0800 • FAX: (215) 441-8620

General Information

- Overview
- Specifications
- Performance Data
- Parts List
- Drawings
- Product Literature

More Information

- Where To Buy
- Baldor Sales Offices

Return to List

AC Motors | General Purpose |

Specifications: VEM3558

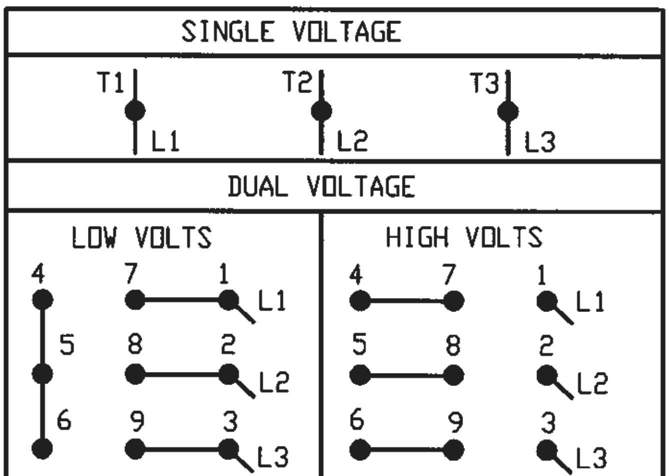
Reliance Equivalent
P56X-1536

Catalog Number:	VEM3558
Specification Number:	35J302T866
Horsepower:	2
Voltage:	208-230/460
Hertz:	60
Phase:	3
Full Load Amps:	5.7-5.4/2.7
Usable at 208 Volts:	5.7
RPM:	1725
Frame Size:	56C
Service Factor:	1.15
Rating:	40C AMB-CONT
Locked Rotor Code:	J
NEMA Design Code:	B
Insulation Class:	F
Full Load Efficiency:	86.5
Power Factor:	82
Enclosure:	TEFC
Baldor Type:	3532M
DE Bearing:	6205
ODE Bearing:	6203
Electrical Specification Number:	35WGT866
Mechanical Specification Number:	35J302
Base:	N
Mounting:	F1

* For certified information, contact your local Baldor office.

A-C MOTOR
CONNECTION DIAGRAM

THREE PHASE SINGLE AND DUAL VOLTAGE



OPTIONAL T10, T11, T12 PRECONNECTED

TO REVERSE ROTATION INTERCHANGE ANY TWO LINE LEADS.

(P. N. 23P5)
(23P63)

C/R 225, 367821

CUSTOMER ______ CUSTOMER ORDER NO. ______ RELIANCE S. O. NO. ______

RELIANCE ELECTRIC CLEVELAND, OHIO 44117	DR. BY E.JAMBOR CK. BY D.FENNER APP. BY H.SAINI DATE 3-18-91	CONNECTION DIAGRAM	416820-133 ISSUE DATE MARCH 18, 1991

BALDOR • RELIANCE

Integral Horsepower
AC Induction Motors
ODP, WPI, WPII Enclosure
TEFC Enclosure
Explosion Proof

Installation & Operating Manual

2/07 MN400

Table of Contents

Section 1
General Information

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

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

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

1. Most Baldor products are warranted for 18 months from the date of shipment to Baldor's customer from Baldor's district warehouse or, if applicable, from Baldor's factory. Baldor Standard-E® standard efficient motors are warranted for 24 months. Standard-E is limited to three phase, general purpose, 1-200 HP ratings that fall under the Energy Policy Act (EPAct). Baldor Super-E® premium efficient motors are warranted for 36 months. Baldor IEEE841 motors are warranted for 60 months. All warranty claims must be submitted to a Baldor Service Center prior to the expiration of the warranty period.
2. Baldor will, at its option repair or replace a motor which fails due to defects in material or workmanship during the warranty period if:
   a. the purchaser presents the defective motor at or ships it prepaid to, the Baldor plant in Fort Smith, Arkansas or one of the Baldor Authorized Service Centers and
   b. the purchaser gives written notification concerning the motor and the claimed defect including the date purchased, the task performed by the Baldor motor and the problem encountered.
3. Baldor will not pay the cost of removal of any electric motor from any equipment, the cost of delivery to Fort Smith, Arkansas or a Baldor Authorized Service Center, or the cost of any incidental or consequential damages resulting from the claimed defects. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply to you.) Any implied warranty given by laws shall be limited to the duration of the warranty period hereunder. (Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.)
4. Baldor Authorized Service Centers, when convinced to their satisfaction that a Baldor motor developed defects in material or workmanship within the warranty period, are authorized to proceed with the required repairs to fulfill Baldor's warranty when the cost of such repairs to be paid by Baldor does not exceed Baldor's warranty repair allowance. Baldor will not pay overtime premium repair charges without prior written authorization.
5. The cost of warranty repairs made by centers other than Baldor Authorized Service Centers **WILL NOT** be paid unless first authorized in writing by Baldor.
6. Claims by a purchaser that a motor is defective even when a failure results within one hour after being placed into service are not always justified. Therefore, Baldor Authorized Service Centers must determine from the condition of the motor as delivered to the center whether or not the motor is defective. If in the opinion of a Baldor Authorized Service Center, a motor did not fail as a result of defects in material or workmanship, the center is to proceed with repairs only if the purchaser agrees to pay for such repairs. If the decision is in dispute, the purchaser should still pay for the repairs and submit the paid invoice and the Authorized Service Center's signed service report to Baldor for further consideration.
7. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Safety Notice:

This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

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

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

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

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

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

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

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

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

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Do not use non UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust. These motors are not designed for atmospheric conditions that require explosion proof operation.**

Safety Notice Continued

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo.**

Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

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

Caution: **Do not over-lubricate motor as this may cause premature bearing failure.**

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

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

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

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

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

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Storage

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

1. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
2. Do not lubricate bearings during storage. Motor bearings are packed with grease at the factory. Excessive grease can damage insulation quality.
3. Rotate motor shaft at least 10 turns every two months during storage (more frequently if possible). This will prevent bearing damage due to storage.
4. If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motors’ space heater (if available) while the motor is in storage.

Unpacking

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

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

Handling

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

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only. A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.
3. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation. Do not lift using the motor lugs or eye bolts provided.

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

Section 2
Installation & Operation

Overview

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

Location

It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip-Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Mounting

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

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

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

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment

Accurate alignment of the motor with the driven equipment is extremely important.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.
4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

Caution: **Do not over tension belts.**

5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting

After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

Power Connection

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

Conduit Box

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

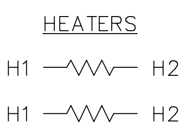
AC Power

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

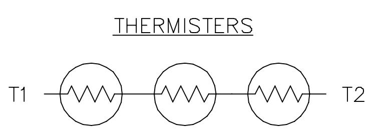
1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

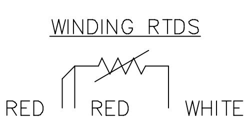
Figure 2-1 Accessory Connections



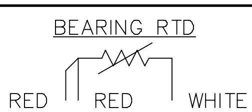
One heater is installed in each end of motor.
Leads for each heater are labeled H1 & H2.
(Like numbers should be tied together).



Three thermisters are installed in windings and tied in series.
Leads are labeled T1 & T2.



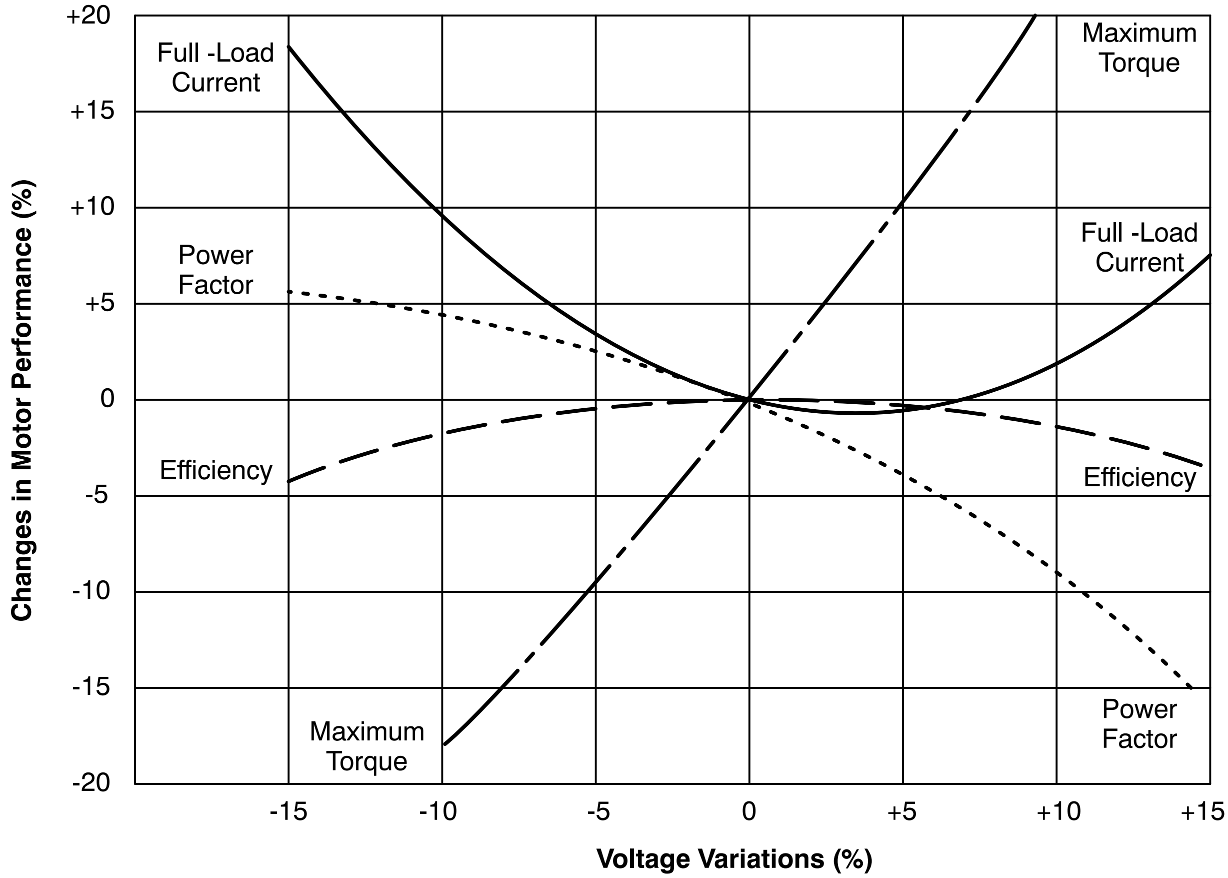
Winding RTDs are installed in windings (2) per phase.
Each set of leads is labeled W1, W2, W3, W4, W5, & W6.



* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE.
* One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE.

* Note RTD may have 2-Red/1-White leads; or 2-White/1-Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



First Time Start Up

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

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity with a Megger.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up

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

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

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

Jogging and Repeated Starts

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

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor distributor or Baldor Service Center.

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection

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

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

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings

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

Type of Grease

A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is Polyrex EM (Exxon Mobil).

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals

Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<-29 ° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the “Large” bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100-112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315-450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315-450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225-280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

Relubrication Procedure Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: Do not over-lubricate motor as this may cause premature bearing failure.

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: Over-lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed.
   This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten “Thru Bolts”.
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs - Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod-Express.
• When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs - Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti-Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:

- Texaco Polystar
- Mobilith SHC-100
- Darmex 707
- Rykon Premium #2
- Pennzoil Pennzlube EM-2
- Darmex 711
- Chevron SRI #2
- Chevron Black Pearl
- Petro-Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

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FAX: 303-339-9633

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5490 MCGINNIS FERRY PLACE
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400-0207

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www.baldor.com

MN400
Printed in USA
2/07

MAINTENANCE SUMMARY FORM 11240

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: Froth Feed Pump 1 and 2

2. MANUFACTURER: Milton Roy, Mil Royal CMCH 561

3. EQUIPMENT/TAG NUMBER(S): 50P1251, 50P1252

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 1225 LBS.

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 2HP, 460V, 3 PH, 1725 RPM, 1.15 Service Factor

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Fine Line Instrument

a. Name: _____ Telephone: 425-861-1110

b. Address: 17371 NE 67th Court, Suite B3, Redmond, WA 98052

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
Check Drive Gear Oil Level	Monthly, add as needed	• AGMA #7 Comp.
Change gear drive lubricant and clean magnetic filter below crosshead chamber	Every 6 months or 2500 service hours whichever occurs first. Recommended after initial 90 days in service.	• AGMA #7 Comp
Lubricate drive motor	Annually	• AGMA #7 Comp.
Check valves self cleaning pump hot detergent solution for 15 minutes, follow with water flushing.	As needed	
Supply tank & piping clean & flush	Annually	
Suction line strainer cleaning	As required or needed	
Ball check valves, flush with clean liquid	As often as necessary for accurate metering.	
HPD Liquid End Displacement Chamber	Every 6 months, 2500 service hours	* Zurnpreen 15 A

8. LUBRICANT LIST

Reference Symbol	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**Or Equal**
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.			
•	AGMA#7 Comp Drive gear Lube			
*	Zurnpreen 15A Hydraulic Oil			

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
RPM Kit	Routine Maintenance Kit	Each	1	$1785.00
302 Parts Kit	Disassembly Tool	Each	1	$1000.00
2980068099	Diaphragm	Each	1	$305.00

Note: Identify parts provided by this Contract with two asterisks.

Volume II

11305 - Submersible Sump Pumps 40P1501/40P1502

Attachment 2.2

MAINTENANCE SUMMARY FORM - 11305

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: FLYGT SUBMERSIBLE PUMP: Model NP3102X-643

2. MANUFACTURER: ITT FLYGT

3. EQUIPMENT/TAG NUMBER(S): 40P1501 AND 40P1502

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 230

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 5HP, 460V, 3PH

6. MANUFACTURER'S LOCAL REPRESENTATIVE: WHITNEY EQUIPMENT CO.

a. Name: BILL CARLSON Telephone: 425-486-9499

b. Address: 21222 - 30TH DR. SE, SUITE 110 BOTHELL, WA 98021

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. If training is required, it can be provided by the manufacturer/representative. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
Inspect visible parts on pump, pump casing & impeller for wear	Annually	n/a
Check lubricant/coolant level & condition, change as necessary	Annually	◘
Check cables & cable entry for wear and tightness	Annually	n/a
Inspect pump voltage draw and meggar readings	Annually	n/a
Check function of level sensors, starter and monitoring equipment	Annually	n/a
Check rotation direction of pump	When reconnecting	n/a
Check pipes, valves peripheral equipment	Annually	n/a
Check cooling system	Annually	n/a

8. LUBRICANT LIST

Reference Symbol	MFR (Name)	MFR (Name)	MFR (Name)	MFR (Name)	Or Equal
◘	Mobil whiterex 309				ISOVG32

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
592 01 03	Inner Mechanical Seal			245.00
592 01 04	Outer Mechanical Seal			320.00
80 32 32	O-Ring Kit			65.00
83 15 73	Upper Bearing			21.00
83 36 90	Lower Bearing			48.00

PHONE (360) 698-1977
FAX (360) 698-1843

11305 1.03 B7

~~Please disregard the previously submitted maintenance summary.~~

Pump model NP3102MT has no adjustment in the impeller, so there is no impeller adjustment procedure. The manufacturer does recommend making sure the impeller is tight for standard maintenance. Please see attached information.

WHITNEY EQUIPMENT COMPANY, INC.

21222 30th Drive SE, Suite 110
Bothell, WA 98021

Tel. (425) 486-9499
Fax. (425) 485-7409

February 29, 2008

Holmes Mechanical, Inc.
10890 Old Frontier Road NW
Siverdale, Wash. 98383

Subject: Wyckoff Groundwater

Subject: Care and Maintenance of Flygt Pumps

Larry,

I have confirmed that the "N" impeller on a Flygt Model NP3102 is not field adjustable.

Beginning with the Model NP 3127 and larger, Flygt uses a shim system which makes adjustment of the impeller clearance fairly simple in the field.

The two smaller models, NP3085 and NP3102 however, do not use this system. The impeller clearance is set at the factory for these models and is not field adjustable. A Flygt service shop can deal with this issue on the smaller pumps if a new impeller is installed.

If you have nay questions, let me know.

Sincerely,

Bill Carson

Bill Carson
Vice President
Whitney Equipment Company, Inc.

WHITNEY EQUIPMENT COMPANY, INC.

21222 30th Drive SE, Suite 110
Bothell, WA 98021

Tel. (425) 486-9499
Fax. (425) 485-7409

February 29, 2008

Holmes Mechanical, Inc.
10890 Old Frontier Road NW
Siverdale, Wash. 98383

Subject: Wyckoff Groundwater

Subject: Care and Maintenance of Flygt Pumps

Larry,

Whitney Equipment furnished two Flygt Model NP3102 submersible pumps on the Wyckoff Groundwater Project. A question has been asked about furnishing grease and a grease gun with the special tools and spare parts.

Beginning four or five years ago, Flygt began furnishing all of their 3000 Series submersible pumps with sealed bearings. You will see in the pump specification included with our original pump submittal, a paragraph titled "Bearings". That paragraph specifies that the bearings are to be "permanently grease lubricated".

Grease is no longer furnished, because these bearings are permanently sealed.

If you have nay questions, let me know.

Sincerely,

Bill Carson

Bill Carson
Vice President
Whitney Equipment Company, Inc.

OPERATION & MAINTENANCE MANUAL

Replacement Groundwater Treatment Plant
Wyckoff/Eagle Harbor Superfund Site
Bainbridge Island, WA

Spec Section 11305
Duplex Pump Control Panel

Triangle Pump & Equipment, Inc.
14940 SE 82nd Dr/PO Box 950
Clackamas, OR 97015

Phone: 503-656-1473
Fax: 503-656-2037

CONTENTS

TABLE OF CONTENTS

SECTION 1

TRIANGLE PUMP
AND EQUIPMENT INC.

CITY OF WYCOFF
DUPLEX PUMP STATION
CONTROL PANEL
OPERATIONAL NARRATIVE

P1 - P2
HAND-OFF-AUTO:

When the HAND-OFF-AUTO selector switch is placed in the OFF position, the pumps will not start.

When the HAND-OFF-AUTO selector switch is placed in the HAND position, the pumps will start and continue to run until either the HAND switch is placed in the OFF position, or one of the following condition happens; High Motor Temperature, Motor Overload, these will cause the pumps to stop in either condition of Auto or Hand.

When the HAND-OFF-AUTO selector switch is placed in the AUTO position, the pump will be enabled and disabled by the low level water float. The lead pump starts when the lead float is made and the lag pump starts when the lag float is made. The pump will run until the water level drops to disable the pump with the low level float, or the switch is placed in the OFF position or one of the following condition happens; High Motor Temperature, Motor Overload will cause the pumps to stop in either condition of Auto or Hand.

When both Pumps are in the Auto Position, and when the liquid tilts the LEAD float switch up, this causes the LEAD pump to start. If the water still rises and the LAG float is tilted up this causes the LAG pump to start and run concurrent to the LEAD pump. These will continue to run until the LOW level Float disengages the pumps stopping them. There is automatic alternation between the Lead/Lag pumps

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P1-ALT-P2:

When the P1-ALT-P2 selector switch is placed in the P1 position, this will make P1 the Lead pump, and P2 the Lag pump when the Level activates operation in the auto cycle.

When the P1-ALT-P2 selector switch is placed in the P2 position, this will make P2 the Lead pump, and P1 the Lag pump when the Level activates operation in the auto cycle.

When the P1-ALT-P2 selector switch is placed in the ALT position, this will make the pumps alternate back and forth as to which is lead and lag when in the auto cycle.

INDICATING LIGHT (FAULT P1-P2):

When the Overload relay is tripped due to a current passing higher than the set point in amps, indicated by the Dial on the relay, or the Motor Temperature Protector within the motor senses a over temperature. This will stop the pump and will illuminate the Light. The cause for the Over temp or Overload should be determined and corrected before placing the motor back in service. Push to test the Amber Indicator lamp light.

INDICATING LIGHT (ON P1-P2):

When the Pump Starter closes initiating run, this indicator will illuminate. Push to test the Red Indicator lamp light.
Note Pumps can start automatically when the switch is placed in the auto cycle or after a power fault.

INDICATING LIGHT (OVERTEMP P1-P2):

When the Pump Motor Thermal Protector opens this will shut down the motor running in the hand position, or the Auto position. This indicator will illuminate. Push to test the Red Indicator lamp light.

INDICATING LIGHT (SEAL LEAK P1-P2):

When the Seal Leak detector detects the presence of water within the oil chamber this will cause the SEAL LEAK Indicator to illuminate this causes the motor to stop. Push to test the Amber Indicator lamp light.

INDICATING LIGHT (HIGH LEVEL):

When the liquid tilts the LSH float switch up, the HIGH LEVEL panel mounted indicating light will be lit. The light will continue to be lit until the liquid drops below the LSH float. Push to test the Amber Indicator lamp light.

PUSH BUTTON SILENCE:

This will Silence the Horn during the alarm.

CONTACT OUTPUTS:

The Following conditions will cause a remote alarm by closing a set of contacts which can be monitored.
High Level, Pump Fail, Motor Run

DISCONNECT SWITCH:

When this is the On position this allows power to the system. In off position no pumps or controls power is energized. When working on the system remember to disconnect power and lock out.
Pumps can start automatically after a power fault or motor temperature shutdown.

ELAPSE TIMER:

This will display the total run hours for each pump.

SECTION 2

Parts List for Assembly P/N: WYCOFF

WYCOFF

WYCOFF- DUPLEX PUMP SYSTEM
Customer: HOLMES MECHANICAL

5 HP, 480 VAC, 3 PH, 7.6 FLA

Type	PL	REV	A
Revision	0	-	
Status	U	sub date:	
Date	4/11/2007	Equip. Ref:	
By		U.L.	

Item	Qty	UseAs	P/N	Type	Stat	Rev	Title	Detail	Reference(m)
6	2	each	CB-3015-481	PS	U		WESTINGHOUSE / CIRCUIT BREAKER	GD3015	
5	1	each	CB-3030-480 -01	PS	U	0	CUTLER HAMMER / CIRCUIT BREAKER	EHD3030	
7	1	each	CB-HM-12-01	PS	U		CUTLER HAMMER / HANDLE MECHANISM	HM1R12	
21	1	each	DB-200-AE	PS	U	0	FERRAZ SHAWMUT / END COVER	U09311	
20	3	each	DB-200-AS	PS	U	0	FERRAZ SHAWMUT / DISTRIBUTION BLOCK	63130	
29	2	each	EN-4030-BP-01	PS	U		HOFFMAN / BACKPANEL	A-40P30	
28	1	each	EN-403212-N 4XF	PS	U		HOFFMAN / ENCLOSURE	U-U1008030	
42	4	each	ENGINEERIN G	PS	U		ENGINEERING		
30	1	each	EN-HEAT-10 0	PS	U		HOFFMAN / HEATER	D-AH1001A	
45	1	each	EN-SWING	PS	U		HOFFMAN / SWING OUT KIT	A-NADFK	
3	4	each	FLOAT-NO-3 0-01-01	PS	U		ANCHOR SCIENTIFIC / FLOAT	SM30NO	
26	2	each	FU-01.0-600	PS	U		LITTLEFUSE / FUSE	KLDR-1A	
25	1	each	FU-02.0-250	PS	U		LITTLEFUSE / FUSE	FLM-2A	
46	1	each	FU-05.0-250	PS	U	0	LITTLEFUSE / FUSE	FLM-5A	
47	2	each	FU-06.0-250	PS	U	0	LITTLEFUSE / FUSE	FLM-6A	
49	1	each	FU-20-250	PS	U	0	LITTLEFUSE / FUSE	FLM-20A	
48	3	each	FU-30.0-600	PS	U	0	LITTLEFUSE / FUSE	KLDR-30A	
23	2	each	FU-HLD-03-I-22	PS	U	0	L-FSE / FUSE HOLDER	LPSC003-ID	
24	3	each	FU-HLD-03-I-23	PS	U	0	L-FSE / FUSE HOLDER	LPSM001-ID	
18	1	each	GFCI-D	PS	U	0	LEVITON	6898-W	
50	1	each	GFCI-WP	PS	U	0	CARLON	E98GFCN-CAR	
10	2	each	HS-01-6.75-1 1.0	PS	U		CUTLER HAMMER / HEATER PACK	H2010B-3	
33	1	each	ISR-06-01	PS	U	0	WARRICK / INTRISICALLY SAFE CONTROL	67E1C0A	

Item	Qty	UseAs	P/N	Type	Stat	Rev	Title	Detail	Reference(m)
4	20	each	LABOR	PS	U		ASSEMBLY TIME (HOURS)		
11	9	each	LT-22-120-RES	PS	U		CUTLER HAMMER / LIGHT UNIT	E22R2	
44	2	each	LT-22-G	PS	U		CUTLER HAMMER / GREEN LENS	E22H3	
12	7	each	LT-22-R	PS	U		CUTLER HAMMER / RED LENS	E22H2	
41	1	each	MISC.	PS	U		MISC. WIRE/DUCT/ETC.		
16	9	each	PB-1NO-01	PS	U		CUTLER HAMMER / CONTACT BLOCK	E22B2	
13	2	each	PB-22-R-01	PS	U		CUTLER HAMMER / RED PUSHBUTTON	E22PB2	
14	2	each	PB-MECH-01	PS	U		CUTLER HAMMER / RESET MECHANISM	E22MRL	
32	1	each	PHM-01B-480	PS	U	0	TIME MARK / PHASE MONITOR	A257B	
1	10	each	RLY-3-120-02	PS	U	0	AB / CONTROL RELAY	700-HB33A1	
27	2	each	RLY-PR-90	PS	U	0	ITT FLYGT/ MINICAS	83 58 48	
9	2	each	ST-AUX-1NO 1NC	PS	U		CUTLER HAMMER / AUX CONTACT	C320KGS3	
39	3	each	STK-B-0803	PS	U		FACTORY CHOICE / OCTAL BASE	STANDARD OCTAL BASE	
2	10	each	STK-B-1101	PS	U	0	AB RELAY BASE	700-HN154	
8	2	each	ST-N01-01	PS	U		CUTLER HAMMER / STARTER	AN16DN0AB	
15	3	each	SW-22-3-01	PS	U		CUTLER HAMMER / SELECTOR SWITCH	E22VBG1	
36	4	each	TB-END-01	PS	U		SIEMENS / TERMINAL BLOCK END	8WA1808	
35	30	each	TB-STD-01	PS	U		SIEMENS / TERMINAL BLOCK	8WA1011-1DG11	
37	10	each	TB-STD-02BL	PS	U	0	ENTRELEC / TERMINAL BLOCK	0125116.01	
34	4	each	TB-STD-99	PS	U		SIEMENS / TERMINAL BLOCK (GND)	8WA1011-1PG00	
38	1	each	TB-STD-END-02BL	PS	U	0	ENTRELEC / END SECTION	0128368.10	
19	2	each	TIM-E-4X-01	PS	U		DANAHER / ELASPED TIME METER	A103-006	
40	1	each	TR-2000-03	PS	U	0	MICRON / TRANSFORMER	EF2K0BTZ13	
31	1	each	TVSS-3-480-01-10	PS	U		UNITED POWER / TVSS	TSS2-B0-040-34-L	

SECTION 3

Gems Sensors

Warrick® Series 67
Intrinsically Safe Multi-Function Control
Installation and Operation Bulletin

Table of Contents

Notes:

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Installation: Intrinsically Safe Sensing Circuits

This bulletin should be used by experienced personnel as a guide to the installation of the series 67. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Gems Sensors or its local representative if further information is required.

IMPORTANT: BEFORE PROCEEDING TO INSTALL AND WIRE THE SERIES 67 CONTROL, READ AND THROUGHLY UNDERSTAND THESE INSTRUCTIONS.

When installing according to these instructions, this device provides intrinsically safe sensing circuits for interface into Class I; Groups C & D, Class II; Groups E, F, & G and Class III; Hazardous Areas. Electrical equipment connected to associated apparatus should not exceed maximum ratings marked on product.

*** **WARNING:** To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

MOUNTING LOCATION

The control must be situated in a non-hazardous area where an explosive atmosphere will not exist at any time; otherwise, it must be mounted in a suitable U.L. approved explosion-proof enclosure with suitable U.L. approved explosion-proof seals.

WIRING: GENERAL INFORMATION

1. Intrinsically safe wiring must be kept separate from non-intrinsically safe wiring.
2. Intrinsically safe and non-intrinsically safe wiring may occupy the same enclosure or raceway if they are at least 2 inches (50mm) apart and separately tied down. Inside panels, field wiring terminals for intrinsically safe circuits must be separated by at least 2 inches (50 mm) from non-intrinsically safe wiring.
3. Wire the control device(s) to the Series 67 relay as shown in figure 1. A separate rigid metallic conduit should be used to enclose the conductors of the intrinsically safe control circuit.
4. An approved seal should be used at the point where the intrinsically safe control circuit wiring enters the hazardous area.
5. Capacitance and inductance of the field wiring from the intrinsically safe equipment to the associated apparatus shall be calculated and must be included in the system calculations as shown in Table 1. Cable capacitance, Ccable, plus intrinsically safe equipment capacitance, Ci must be less than the marked capacitance, Ca (or Co), shown on any associated apparatus used. The same applies for inductance (Lcable, Li and La or Lo, respectively).Where the cable capacitance and inductance per foot are not known, the folllowing values shall be used: Ccable = 60 pF/ft., Lcable = 0.2 µH/ft.

For intrinsically safe output wiring use #14 or #16 AWG type MTW or THHN wire. By using these wire types in conjunction with the following distance recommendations, you will not exceed the maximum capacitance for field wiring. Use Table 2 as a guide for maximum wire runs.

Table 1

I.S. Equipment		Associated Apparatus
V max (or Ui)	≥	Voc or Vt (or Uo)
I max (or Li)	≥	Isc or It (or Io)
P max, Pi	≥	Po
Ci + Ccable	≤	Ca (or Co)
Li + Lcable	≤	La (or Lo)

Entity Parameters

Terminals	Voc	Isc	Po	Ca	La
SIL,G,1-2,2-1	12.82 Vdc	7.2 mA	24.5 mw	6.5 µF	100mH
LSI,G,HSI,LS2	12.82 Vdc	7.62 mA	24.5 mw	6.5 µF	100mH
S3,G,S4	12.82 Vdc	2.54 mA	8.2 mw	6.5 µF	100mH
HS2,G	12.82 Vdc	5.08 mA	16.3 mw	6.5 µF	100mH

Table 2

Model Number	Sensitivity	Distance
[redacted]		
[redacted]		
[redacted]		
[redacted]		
67EXXXA	100K Ohms	300 Feet

Installation: Intrinsically Safe Sensing Circuits

GROUNDING:

The four mounting holes on the Series 67 provide an electrical connection for earth grounding between the control's internal solid state circuitry and the enclosure chassis. To insure proper grounding, use only metal screws and lock washers when mounting this control. Terminal G on the supply line/load side terminal strip is a redundant system ground terminal and must be connected to earth ground buss of the control's AC supply line feeder.

Note:

1. Intrinsically safe terminals can be connected to any non-energy generating or storing switch device such as a pushbutton, limit or float type switch or any Warrick electrode and fitting assembly.
2. To prevent electrical shock from supply line/load side powered connections, the Series 67 should be mounted in a tool accessible enclosure of proper NEMA rated integrity.
3. For U.L. 913 Listed panels, a metallic partition may be necessary to provide adequate spacing between non-intrinsically safe and intrinsically safe wiring and /or terminals.
4. For additional guidance on "Hazardous Location Installation" and "Intrinsically Safe Devices", consult ANSI/ISA standard RP 12-6 or NEC articles 500-516 and local codes.

SENSOR WIRING

The Series 67 control has four independent intrinsically safe channels, which can be connected to different types of sensors including floats, conductance probes, pressure switches and other non-powered contacts or sensors. The connections of the sensors to the terminals will not vary with normally open or closed sensors. However, the Inverse/Direct DIP switches must be set to the proper mode for each channel to achieve the correct operation. Consult tables 2 and 3 for the proper DIP switch setting for various sensors and functions.

The following sections cover the intrinsically safe sensor connections for single and differential level service.

SINGLE LEVEL SERVICE:

All four channels can be used for single level service. Each channel is independent and can be used for its own single point function. However, only channels 3 and 4 have the alarm bell and silence capabilities. Consult the alarm sections for more information regarding the installation and operation of the alarm circuitry. Table 2 covers the sensor style to terminal connections for all four channels.

Table 2

Sensor Style	Terminal Connections	DIP Switch Settings
Normally Open: Closes on Alarm Condition	Channel 1 - HS1 & G* Channel 2 - HS2 & G* Channel 3 - S3 & G Channel 4 - S4 & G	Inverse Mode - Up Position
Normally Open: Opens on Alarm Condition	Channel 1 - HS1 & G* Channel 2 - HS2 & G* Channel 3 - S3 & G Channel 4 - S4 & G	Direct Mode - Down Position
Normally Closed: Closes on Alarm Condition	Channel 1 - HS1 & G* Channel 2 - HS2 & G* Channel 3 - S3 & G Channel 4 - S4 & G	Inverse Mode - Up Position
Normally Closed: Opens on Alarm Condition	Channel 1 - HS1 & G* Channel 2 - HS2 & G* Channel 3 - S3 & G Channel 4 - S4 & G	Direct Mode - Down Position

* **Note**: Channels 1 & 2 cannot activate the alarm bell contacts and do not have the silence/acknowledge capabilities

Installation: Intrinsically Safe Sensing Circuits

DIFFERENTIAL LEVEL SERVICE:
Channels 1 and 2 are designed to provide differential on/off points to control pumps, solenoid valves or other equipment. These channels can also be used in single level service for alarms and cutoffs, however the control's built-in silence circuitry and bell contacts cannot be used. Consult the Alarm section for more information.

When channels 1 and 2 are used for differential level service, the associated sensors must be normally open. The Inverse/Direct DIP switches must also be set to the proper mode for each channel to achieve the correct operation. Table 3 gives the correct sensor to terminal connections an DIP switch settings for various applications.

FOR APPLICATIONS THAT DO NOT REQUIRE DUPLEX ALTERNATION, A JUMPER WIRE MUST BE PLACED FROM THE "G" TO "1-2" TERMINAL.

Table 3

Application	Sensor Contact Style	Sensor Terminal Connections	DIP Switch Setting
Simplex Pump-Down or Solenoid Valve Drain**	Normally Open - Closes on Rising Level	Start Pump / Open Valve - HS1 & G* Stop Pump / Close Valve - LS1 & G*	Direct - Down Channels 1 or 2
Simplex Pump-Up or Solenoid Valve Filll	Normally Open - Closes on Rising Level	Start Pump / Open Valve - LS1 & G* Stop Pump / Close Valve - HS1 & G*	Inverse - Up Channels 1 or 2
Duplex Pump-Down - Common Pump Stop	Normally Open - Closes on Rising Level	Duty Pump Start - HS1 & G* Standby Pump Start - HS2 & G* Duty and Standby Pump Stop - LS1 & G* Jumper - LS1 and LS2	Direct - Down Channels 1 or 2
Duplex Pump-Up - Common Pump Stop	Normally Open - Closes on Rising Level	Duty Pump Start - LS1 & G* Standby Pump Start - LS2 & G* Duty and Standby Pump Stop - HS1 & G* Jumper - HS1 and HS2	Inverse - Up Channels 1 or 2
Duplex Pump-Down - Separate Pump Stops	Normally Open - Closes on Rising Level	Duty Pump Start - HS1 & G* Standby Pump Start - HS2 & G* Duty and Standby Pump Stop - LS1 & G* Jumper - LS2 and G*	Direct - Down Channels 1 or 2
Duplex Pump-Up - Separate Pump Stops	Normally Open - Closes on Rising Level	Duty Pump Start - LS1 & G* Standby Pump Start - LS2 & G* Duty and Standby Pump Stop - HS1 & G* Jumper - HS2 & G*	Inverse - Up Channels 1 or 2

* <u>Note 1</u>: If conductance probes are being used, only one "G" connection is required. Terminal "G" must be grounded to the vessel if metallic. If the electrode fitting being used has a metallic body and is supported directly upon a metallic vessel, the ground connection is facilitated by securing that end of the ground connector beneath the head of one of the screws which fasten the terminal housing to the body of the fitting. When the vessel is non-metallic, terminal "G" must be connected to an additional electrode of length equal to or longer than, the longest electrode. If wire suspension electrodes are being used, more than one Ground/Reference probe may be required.

** <u>Note 2:</u> This setup is based on the use of a Normally Closed (N.C.) solenoid valve that energizes to open when power is applied to the coil circuit.

Installation: Intrinsically Safe Sensing Circuits

ALARM CHANNEL WIRING:

SILENCE CIRCUITRY:
A normally open pushbutton is required for the Series 67's alarm silence circuitry. The N.O. pushbutton must be connected to the "SIL" and "G" terminals. For more information about the operation of the silence circuitry consult the Alarm Operation section on page 11. **NOTE: THE SILENCE PUSHBUTTON IS CONNECTED TO THE INTRINSICALLY SAFE CIRCUITRY. THEREFORE THE PUSHBUTTON AND ITS ASSOCIATED WIRING SHOULD BE SEPARATED FROM THE NON-INTRINSICALLY SAFE WIRING AND DEVICES. CONSULT GENERAL WIRING INFORMATION FOR MORE INFORMATION.**

ALARM DIP SWITCHES:
The alarm DIP switches for channels 3 and 4 can be set to enable the bell contacts for one or both alarm channels. However, this does not disable the alarm contact for that channel. Table 4 covers the DIP switch settings for various alarm conditions.

Table 4

DIP Switch Settings	Bell Contact Status
~~3 Off - Down~~	~~Channel 3 - Off - Disabled~~
~~4 Off - Down~~	~~Channel 4 - Off - Disabled~~
~~3 On - Up~~	~~Channel 3 - On - Enabled~~
~~4 Off - Down~~	~~Channel 4 - Off - Disabled~~
~~3 On - Up~~	~~Channel 3 - On - Enabled~~
~~4 On - Up~~	~~Channel 4 - On - Enabled~~
3 Off - Down	Channel 3 - Off - Disabled
4 On - Up	Channel 4 - On - Enabled

ALTERNATION CIRCUITRY

AUTO OR MANUAL:
Series 67's built-in alternator can be used to automatically alternate between two loads controlled by channels 1 and 2. However, the automatic alternation may be by-passed to become a manual operation. This can be accomplished with the use of jumper wires or a three position switch connected to the 2-1, 1-2 and "G" terminals. Table 5 covers the jumper connections for manual alternation. Refer to figure 1 for more wiring information on the wiring of the three position selector switch. **NOTE: THE MANUAL ALTERNATION CIRCUITRY IS CONSIDERED INTRINSICALLY SAFE. THEREFORE THE SELECTOR SWTICH, JUMPER WIRES AND THEIR ASSOCIATED WIRING SHOULD BE SEPARATED FROM NON-INTRINSICALLY SAFE WIRING DEVICES. CONSULT GENERAL WIRING INFORMATION FOR MORE INFORMATION ON INTRINSIC SAFETY.**

Table 5

Alternation Status	Jumper Required	LED Status Pump-Down*	LED Status Pump-Up*
Automatic*	None	Either	Either
Manual 1-2	Terminals 1-2 to "G"	No. 1**	No. 1**
Manual 2-1*	Terminals 2-1 to "G"	No. 2**	No. 2**

<u>Notes</u>

* For non-alternation applications jumper 1-2 to "G"

** The position of the 1-2 and 2-1 indicating LED's is dependent on the application. The position changes for pump-up or pump-down. Consult control diagram figure 6-1 for more information.

Installation: High Voltage Circuits

A.C. SUPPLY:

Connect the incoming supply HOT lead to the L1 terminal, NEUTRAL lead to the L2 terminal and EARTH GROUND lead to the "G" Terminal. Note: the incoming power supply should have the same electrical characteristics as indicated on the control's label.

GROUNDING

Terminal "G" on the supply line/load side terminal strip is a redundant system ground terminal and must be connected to the earth ground buss of the panel's AC supply line feeder.

OUTPUT CONTACTS

Channels 1-4: Each channel has a dedicated non-powered contacts. These can be either Form C or Form A & B depending on the model. These contacts will change state when their respective channel activates. In DIRECT mode the relay will energize and the contacts will change state when the probe circuit sensor closes. In INVERSE mode the relay will energize and contacts will change state upon power up. The channel will then de-energize and return the contacts to their shelf state when the probe circuit sensor closes.

Form C- This contact configuration consists of one (1) Normally Open contact and one (1) Normally Closed contact. There are three terminals for electrical connections, N.O., N.C. and Common. Each terminal will accept up to two (2) #14 AWG wires

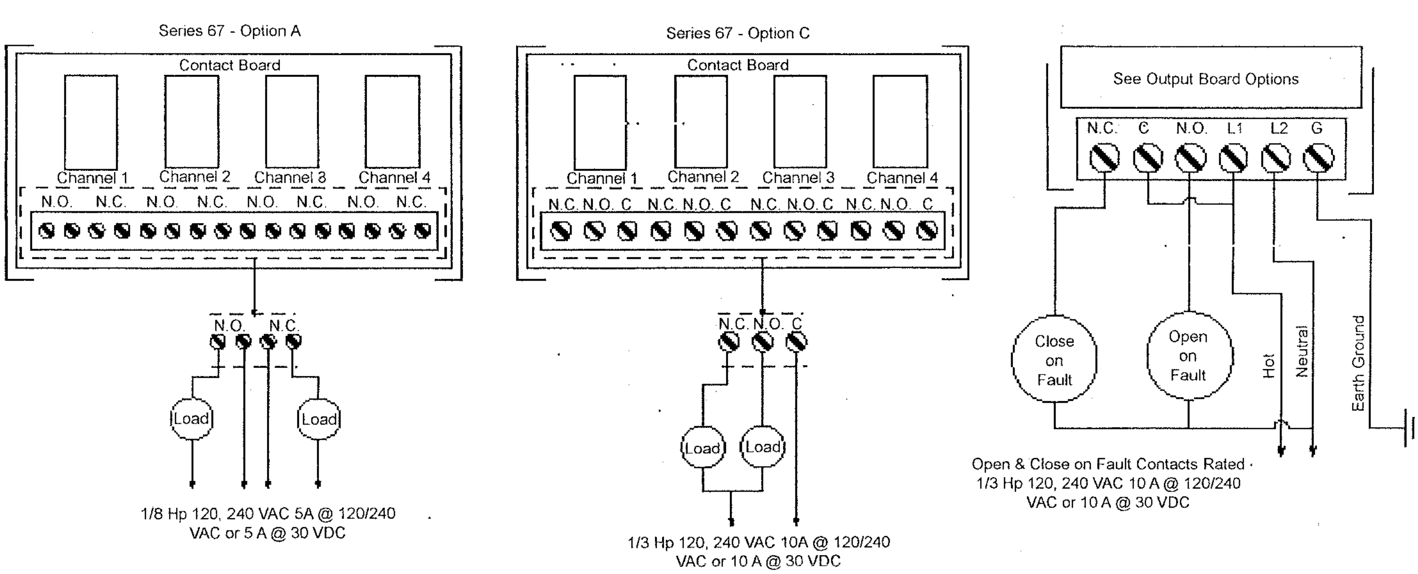
Form A & B: This contact configuration consists of one (1) Normally Open contact and one (1) Normally Closed contact which are electrically isolated from each other. There are two terminals for each contact. Each will accept one (1) # 14 AWG wire.

Alarm Bell: The alarm bell contacts are non-powered Form C construction. This contact configuration consist of consists of one (1) Normally Open contact and one (1) Normally Closed contact. There are three terminals for electrical connections, N.O., N.C. and Common. Each terminal will accept up to two (2) #14 AWG wires

When the output contacts are used to drive loads they should be wired in series with the load. This series branch circuit should then be connected across a power source compatible with the load. See figure 1.

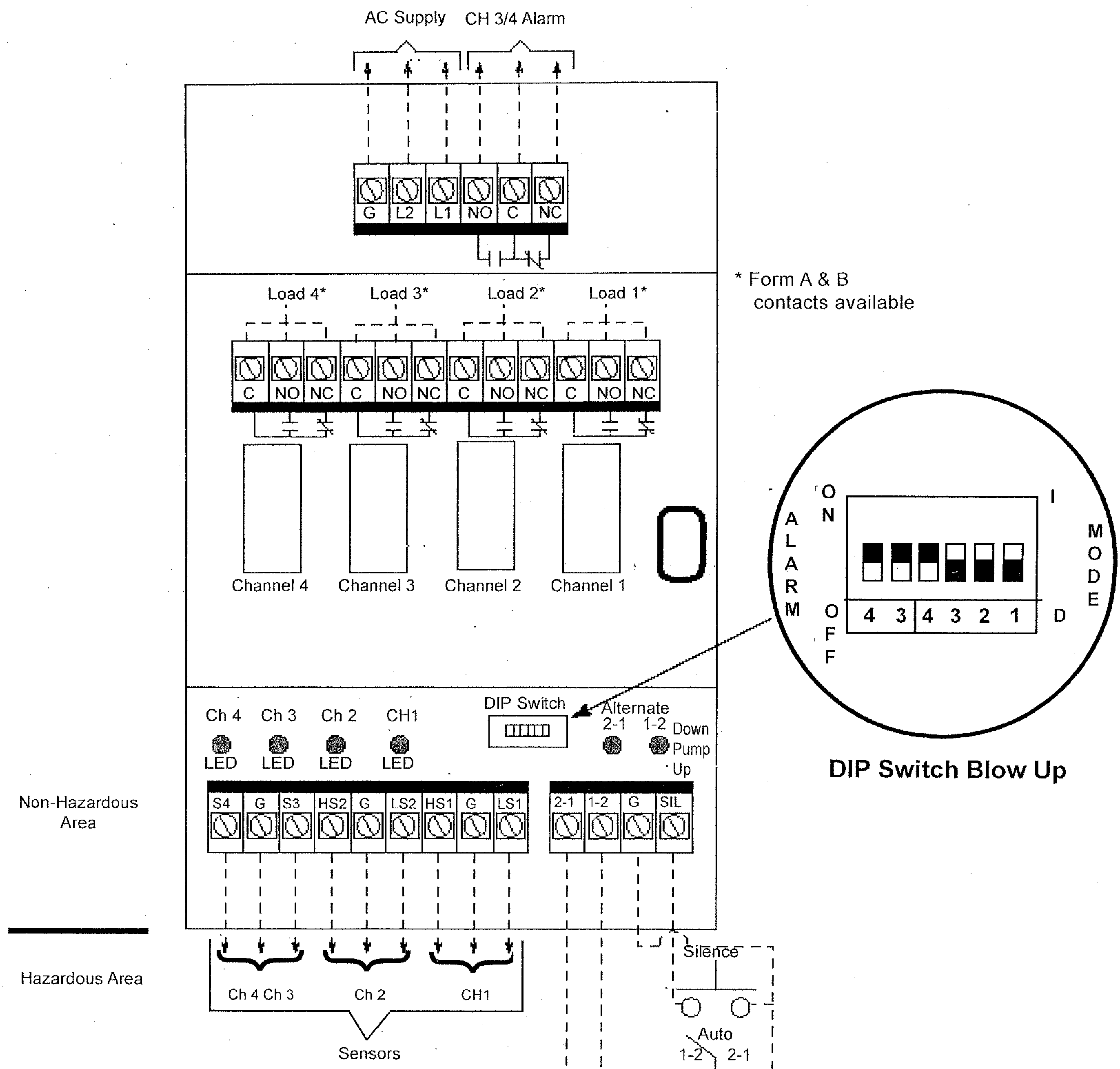
Figure 1

Load Contacts **Alarm Bell Contacts**



Control Diagram

Figure 2



Note: For applications that do not require duplex alternation, a jumper wire must be placed from the "G" to "1-2" terminal.

Technical Information

SPECIFICATIONS

Contact Design: Standard SPDT (1 form C): one normally open (N.O.) and one normally closed (N.C.), non powered contacts Contact Ratings for each channel. Optional 1 Form A (N.O.) and 1 Form B (N.C.) isolated
Load Contact Ratings: Standard Form C- 10A @ 120/240 VAC resistive and 30 VDC resistive, 1/3 Hp @ 120/240 VAC. Optional Form A & B - 5A @120/240 VAC and 30 VDC resistive, 1/8 Hp @ 120/240 VAC.
Bell Contacts: 1 Form C (N.O.), N.C., C)
Bell Contact Ratings: 10A @ 120/240 VAC and 30 VDC resistive, 1/3 Hp @ 120/240 VAC
Contact Life: Mechanical - 10 million operations. Electrical - 1,000,000 operations minimum at rated load.
Primary Voltage: 120 or 240 VAC models + 10% - 15%, 50/60 Hz.
Supply Current: Relays energized - 60ma @ 120 VAC, 30ma @ 240 VAC
Secondary Circuit: 12 VAC RMS voltage on probes, 6ma current RMS.
Sensitivity: Models operate from 4700-100,000 ohms maximum specific resistance
Temperature: -40° to 150° F Ambient
Electronics Module: Solid state components enclosed in a black nylon housing
Terminals: Standard Form C removable terminal strip containing a size 4 pan head screw with a clamping plate. Will accept up to two (2) #14 AWG wires per terminal. Optional Form A & B relay board will accept up to one (1) #14 AWG wire per terminal. Use copper (60-75° C) wire only. Torque to 20 inch pounds.
Listings: U.L. Intrinsically Safe (UL 913) File Number: E87112

ORDERING INFORMATION

67 X X X X X

~~A~~	~~4.7K~~
~~B~~	~~10K~~
~~C~~	~~26K~~
~~D~~	~~50K~~
E	100K

1	120 VAC
~~2~~	~~240 VAC~~

A	1 Form A & B (N.O.) & N.C. Isolated) for each channel
~~C~~	~~1 Form C (N.O., N.C.) for each channel~~

0	None
~~1~~	~~NEMA 1~~
~~4~~	~~NEMA 4~~

A	AC on Probe Circuit
~~B~~	~~DC on Probe Circuit~~

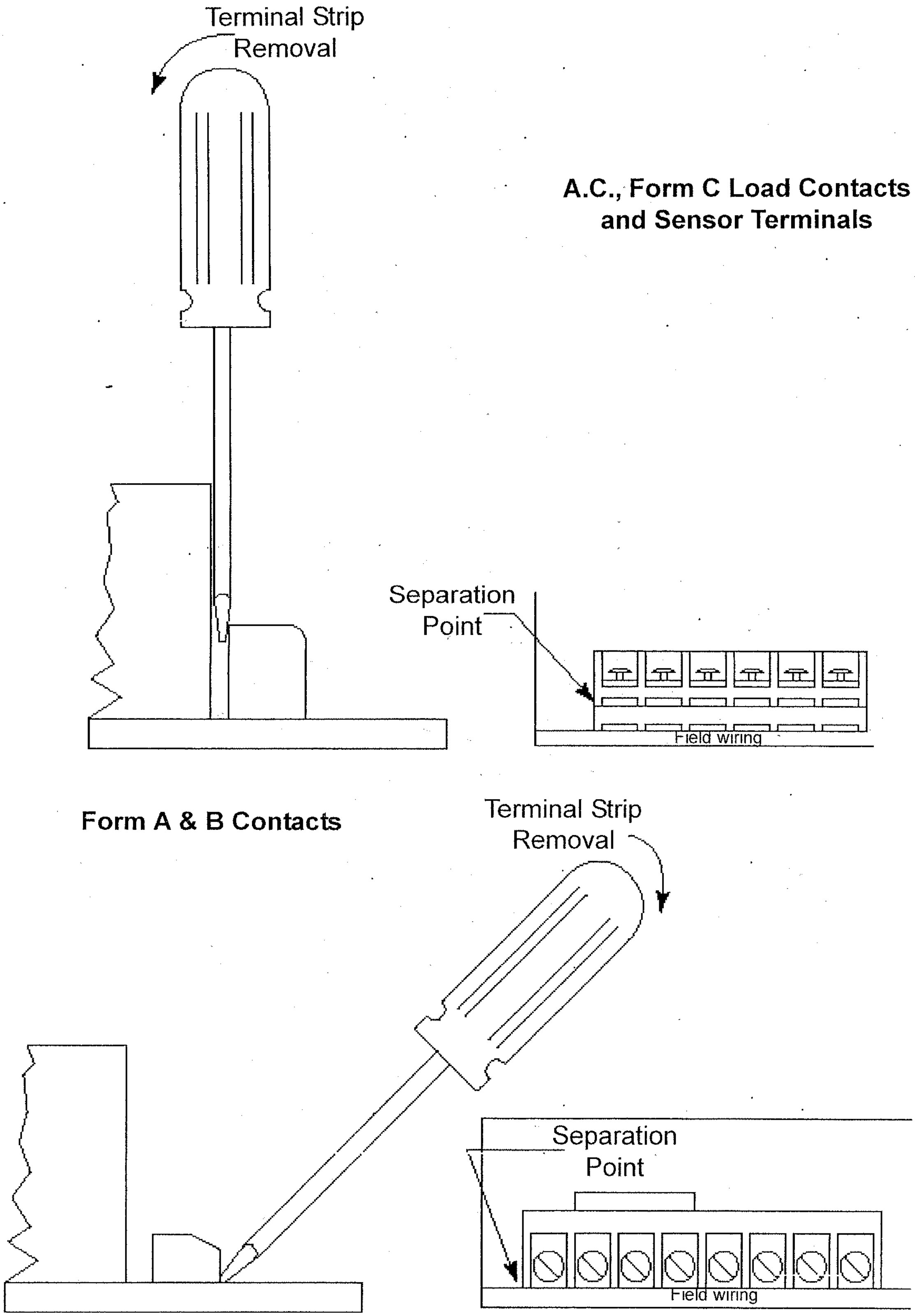
MODULE REPLACEMENT

If the electronic module needs to be replaced:

1. Turn off power to the control and load devices
2. Remove the metal partition located across the center of the module (when required).
3. Remove all field wiring terminal blocks from the electronic module. **The field wires do not need to be removed from the terminal blocks**. The terminal blocks separate from the board as show in figure 8-1.
4. Remove the four (4) retaining screws from the base of the electronic module. The module can now be removed from the control panel.
5. Install a new module and reinstall all of the terminal blocks.
6. Reinstall the metal partition (when required).
7. Set all DIP switches according to previous instructions.

Technical Information: Module Replacement

Diagram 3



Operation Instructions

The Series 67 multi-function control can be used for many different applications including: pump control, solenoid valve control and alarm activation. The following instructions cover the most common applications. If your application is not included, contact Gems Sensors or our authorized representative in your area for assistance.

The operating instructions are broken up into two general categories: SINGLE and DIFFERENTIAL LEVEL SERVICE. The alarm functions are covered under the SINGLE LEVEL SERVICE heading while the pumping and solenoid valve functions are covered under the DIFFERENTIAL LEVEL SERVICE heading.

SINGLE LEVEL SERVICE: CONTACT OPERATION

LOAD CONTACTS: CHANNELS 1-4

The activation of these contacts is dependent upon the type of sensor (normally open or closed) and the mode of operation (direct or inverse). The table 6 gives the sensor activation condition, DIP switch settings, contact status and LED status for various applications and sensors.

Table 6

Application	Warrick Sensor	Sensor" Alarm Activation Condition	DIP Switch Setting	Relay Status Upon Alarm	LED Status Upon Alarm
High Level Alarm Normally Open Float	FE - Reed Switch Float for M Tilt Float	Closes on Rising Level	Inverse UP "I"	De-Energized	ON
High Level Alarm Normally Closed Float	FE - Reed Switch Float for M Tilt Float	Opens on Rising Level	Direct DOWN "D"	De-Energized	OFF
Low Level Alarm Normally Open Float	FE - Reed Switch Float for M Tilt Float	Opens on Falling Level	Direct DOWN "D"	De-Energized	OFF
Low Level Alarm Normally Closed Float	FE - Reed Switch Float for M Tilt Float	Closes on Falling Level	Inverse UP "I"	De-Energized	ON
High Level Alarm Conductance Probes	3R, 3T, 3W, 3Y, 3H or 3S	Probes in Contact with Conductive Liquid	Invers UP "I"	De-Energized	ON
Low Level Alarm Conductance Probes	3R, 3T, 3W, 3Y, 3H or 3S	Probes not in Contact with Conductive Liquid	Direct DOWN "D"	De-Energized	OFF
UNKNOWN SENSOR Normally Open		Closes on Fault	Inverse UP "I"	De-Energized	ON
UNKNOWN SENSOR Normally Closed		Opens on Fault	Direct DOWN "D"	De-Energized	OFF

SINGLE LEVEL SERVICE: ALARM FUNCTIONS

BELL CONTACTS:

Under NORMAL operating conditions the alarm bell relay is held energized. The relay will de-energize to activate an alarm device when an abnormal condition exists on either channels 3 and/or 4. Either one or both alarm bell circuits can be disabled by adjusting the alarm DIP switches. Consult table 4 for more information on the bell DIP switch settings.

SILENCE CIRCUITRY:

Should an abnormal condition exist on either channels 3 and/or 4 the normally closed (N.C.) alarm bell relay contacts will close, activating an alarm device. The N.C. alarm bell contacts can be returned to their normal state (open) silencing the alarm, by depressing a normally open pushbutton connected to the "SIL" and "G" terminals. This will NOT affect the load contacts for channels 3 or 4 as they act independent from the alarm bell contacts.

DIFFERENTIAL LEVEL SERVICE:

The following operating instructions are based on correct DIP switch settings and sensor types. Any deviation from these requirements may result in incorrect system operations. Consult table 7 for further instructions.

Table 7

Application	Warrick Sensor	DIP Switch Setting	Activation Condition	Contact Status	LED Status Sensor Closed
Simplex Pump-Down or Solenoid Valve Drain	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Direct "Down"	Sensor Closes on Rising Level	N.O. - Closes N.C. - Opens	~~ON~~
Simplex Pump-Up or Solenoid Valve Fill	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Inverse "Up"	Sensor Closes on Rising Level	N.O. - Opens N.C. - Closes	~~OFF~~
Duplex Pump-Down - Common Pump Stop	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Direct "Down"	Sensor Closes on Rising Level	N.O. - Closes N.C. - Opens	ON
Duplex Pump-Up - Common Pump Stop	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Inverse "Up"	Sensor Closes on Rising Level	N.O. - Opens N.C. - Closes	~~OFF~~
Duplex Pump-Down - Separate Pump Stop	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Direct "Down"	Sensor Closes on Rising Level	N.O. - Closes N.C. - Opens	~~ON~~
Duplex Pump-Up - Separate Pump Stop	Normally Open: F, M, FE, FOE 3R, 3T, 3W, 3Y, 3H or 3S	Inverse "Up"	Sensor Closes on Rising Level	N.O. - Opens N.C. - Closes	~~OFF~~

DIFFERENTIAL LEVEL SERVICE: SIMPLEX

Simplex Pump Down- Should the level rise to the PUMP START sensor the N.O. load contacts will close starting the pump. The pump will remain running until the level recedes below the PUMP STOP sensor and the load contacts open.

Simples Pump UP- Should the level recede below the PUMP START sensor the N.O. load contacts will close starting the pump. The pump will remain running until the level rises to the PUMP STOP sensor and the load contacts open.

Solenoid Valve Drain- Should the level rise to the VALVE OPEN sensor the N.O. load contacts will close energizing the normally closed valve to open. The valve will remain open until the level recedes below the VALVE CLOSE sensor and the load contacts open

Solenoid Valve Fill- Should the level recede below the VALVE OPEN sensor, the N.O. load contacts will close energizing the normally closed valve to open. The valve will remain open until the level rises to the VALVE CLOSE sensor and load contacts open.

Operation Instructions

DIFFERENTIAL LEVEL SERVICE: DUPLEX PUMP DOWN WITH ALTERNATION

Common Pump Stop- The pumps will alternate each cycle with the duty pump starting when the level rises to the DUTY PUMP START sensor and stops when the level recedes below the PUMP(S) STOP sensor.

If the duty pump fails or cannot meet the demand of the system and the level rises to the STANDBY PUMP START sensor, the standby pump will be started and will continue in operation until the level recedes below the PUMP(S) STOP sensor.

Separate Pump Stops- The pumps will alternate each cycle with the duty pump starting when the level rises to the DUTY PUMP START sensor and stops when the level recedes below the DUTY PUMP STOP sensor.

If the duty pump fails or cannot meet the demand on the system and the level rises to the STANDBY PUMP START sensor, the standby pump will be started and will continue in operation until the level recedes below the STANDBY PUMP STOP sensor.

DIFFERENTIAL LEVEL SERVICE: DUPLEX PUMP UP WITH ALTERNATION

Common Pump Stop- The pumps will alternate each cycle with the duty pump starting when the level recedes below the DUTY PUMP START sensor and stops when the level rises to the PUMP(S) STOP sensor.

If the duty pump fails or cannot meet the demand of the system and the level recedes to the STANDBY PUMP START sensor, the standby pump will be started and will continue in operation until the level rises to the PUMP(S) STOP sensor.

Separate Pump Stops- The pumps will alternate each cycle with the duty pump starting when the level recedes to the DUTY PUMP START sensor and stops when the level rises to the DUTY PUMP STOP sensor.

If the duty pump fails or cannot meet the demand on the system and the level recedes to the STANDBY PUMP START sensor, the standby pump will be started and will continue in operation until the level rises to the STANDBY PUMP STOP sensor.

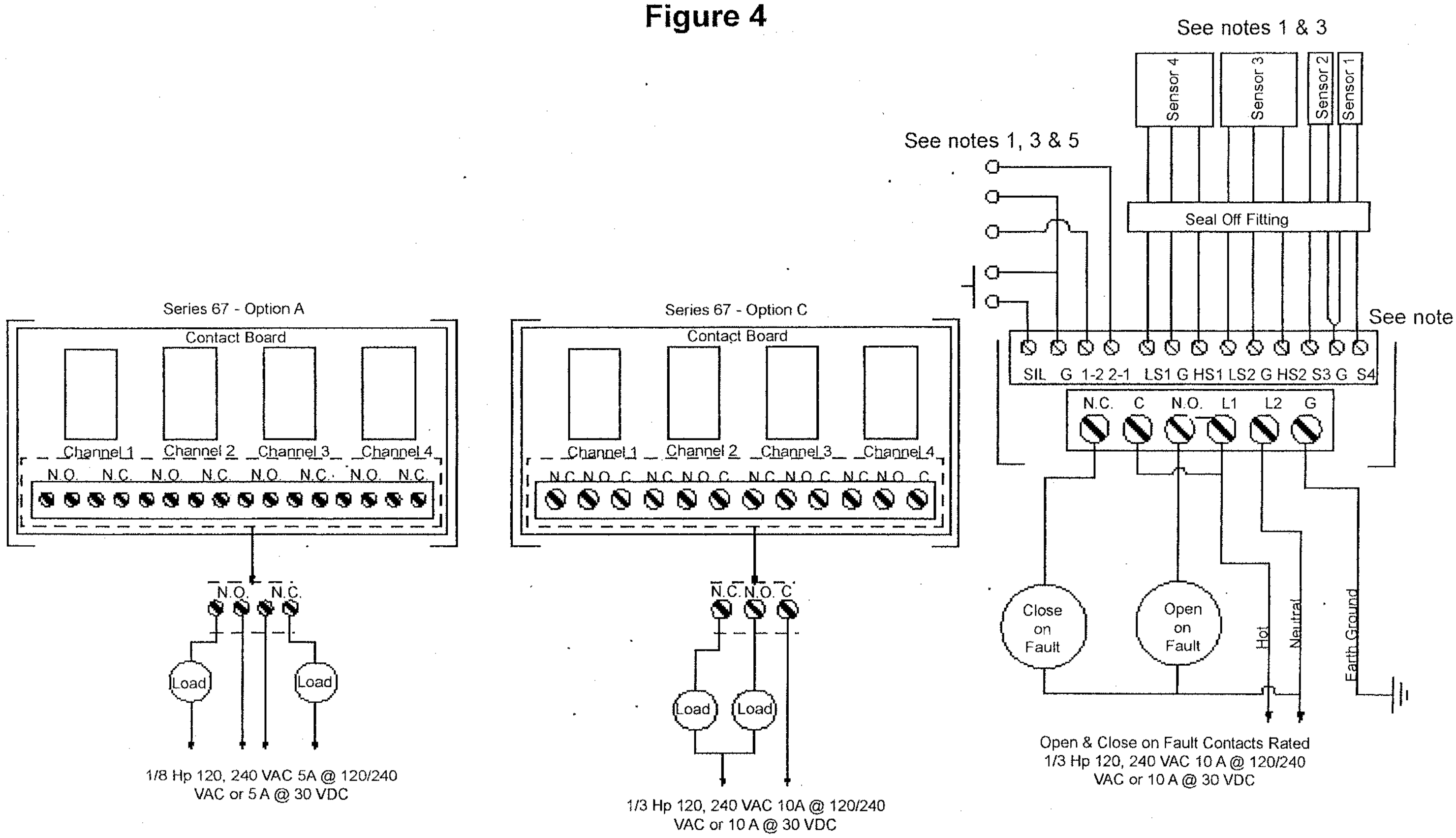
DIFFERENTIAL LEVEL SERVICE: DUPLEX PUMP DOWN WITHOUT ALTERNATION

Same operation as above disregarding the alternation sequence. Use appropriate jumper to determine manual pump start sequence. Refer to table 5 for the manual alternation jumper information.

DIFFERENTIAL LEVEL SERVICE: DUPLEX PUMP UP WITHOUT ALTERNATION

Same operation as above disregarding the alternation sequence. Use appropriate jumper to determine manual pump start sequence. Refer to table 5 for the manual alternation jumper information.

Figure 4



Notes:

1. All intrinsically safe wiring must be installed in accordance with article 504 of the National Electric Code, publication ANSI/NFPA 70 or CEC, Part 1 as applicable.

2. Grounding- The four mounting holes on the Series 67 provide an electrical connection for earth grounding between the controls internal solid state circuitry and the enclosure chassis. To insure proper grounding, use only metal screws and lock washers when mounting the control.

   Terminal "G" on the supply line/load side terminal strip is a redundant system ground terminal and must be connected to the earth ground buss of the controls A.C. supply line feeder. The resistance between the system ground terminals and the earth ground buss must be less than 1 ohm.

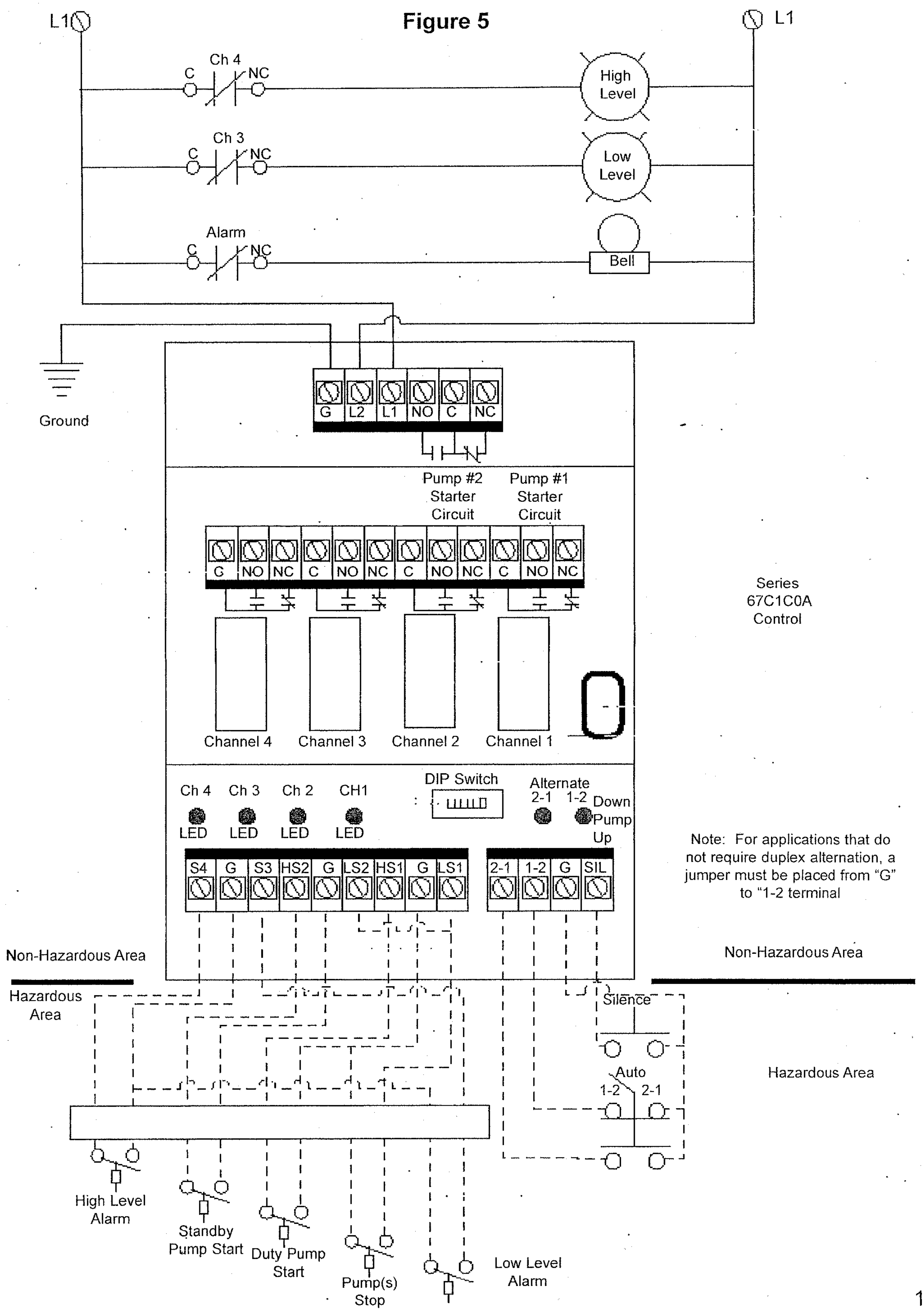
   To prevent electrical shock from supply line/load side powered connections, the Series 67 should be mounted in a metal enclosure of proper NEMA integrity.

3. The maximum total length of all of the intrinsically safe wiring (of each conductor) shall not exceed an accumulative value of 16,000 feet, excluding any ground wiring.

4. The intrinsically safe terminals of the Series 67 can be connected to any non-energy generating or storing switch device such as a push button, a limit or float type switch or any of Warrick's electrode fitting assemblies.

5. When wiring alternation and bell silence switches, the switches and wiring must be separated from non-intrinsically safe circuits and wired in accordance with article 504 of the National Electric Code, publication ANSI/NFPA 70 or CEC, Part 1 as applicable.

Sample Wiring Diagram

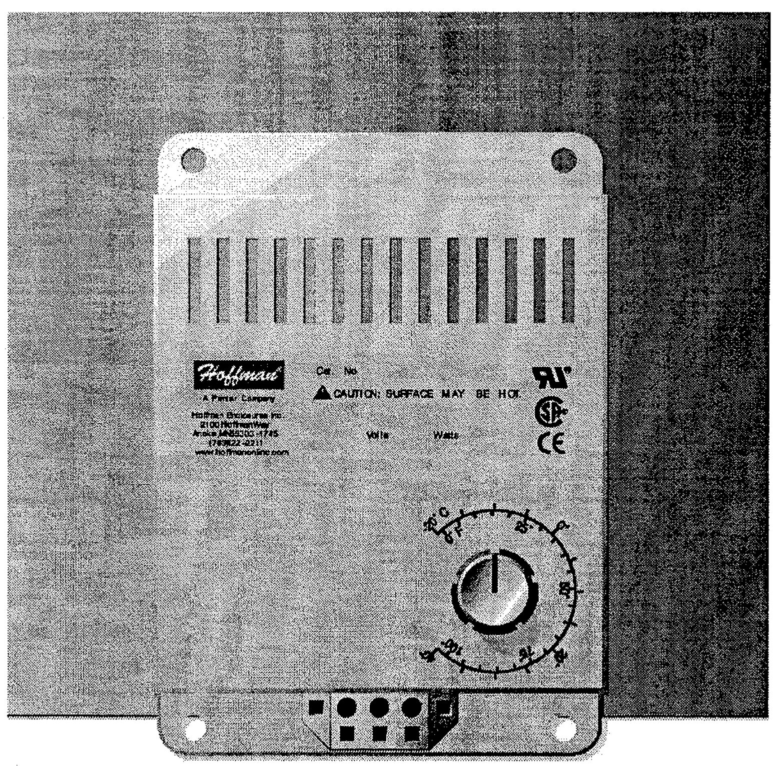


Notes:

Gems Sensors Inc.
One Cowles Road
Plainville, CT 06062-1198
Tel: 860-793-4579
Fax: 860-793-4580

A Pentair Company

Electric Heaters
Elektrisches Heizgerät
Réchauffeur Élétrique
Eléctrico Calentador



Rev. C 113357

P/N 28359001

87565511

English

INTRODUCTION

1. Before installing the electric heater, read these instructions carefully. Failure to follow these instructions could damage the product or cause a hazardous condition.

2. Check the ratings on the heater label to assure the product is suitable for your application.

⚠ WARNING

To avoid electric shock and equipment damage, disconnect any power supplies to the enclosure before installing the electric heater.

GENERAL SAFETY INFORMATION

1. Protect the lead wires from coming in contact with sharp objects, hot surfaces, and/or chemicals.

2. If continuous operation of the heater is essential to the safe functioning of any other equipment, adequate warning devices must be installed to assure safe operation at all times.

⚠ CAUTION

These electric heaters are not designed for use in dusty, dirty, corrosive, or hazardous locations.

Portions of the heater can get hot. Adequate protection must be taken to protect people from potential burns, and to protect other components from this heat.

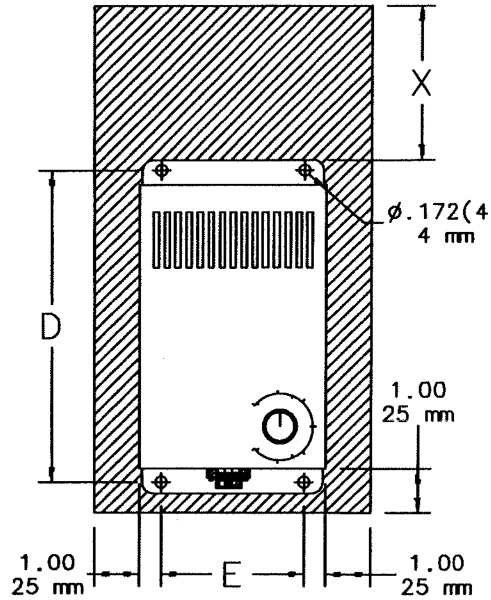
This heater can only be installed in a totally enclosed metal enclosure.

English

LOCATION AND MOUNTING

1. Hoffman electric heaters should be centered as low as possible in the enclosure for optimum heat distribution.
2. It is recommended that the heater be installed on a panel for optimum performance. It may, however, be mounted on any metal surface.
3. The heater should be mounted in a vertical position with the terminal block at the bottom and the air outlet openings at the top as shown.
4. Heaters should not be installed on wood or other combustible surfaces.
5. Heat sensitive components should not be placed above the heater discharge area.
6. The recommended clearances shown by the shadowed area indicate the space that should be kept free of components for safe operation of the heater.
7. Four 10–32 UNF, self–tapping screws are included for installation.

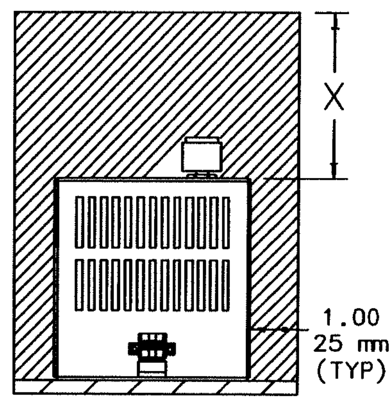
Vertical Surface Mounting



⚠ CAUTION

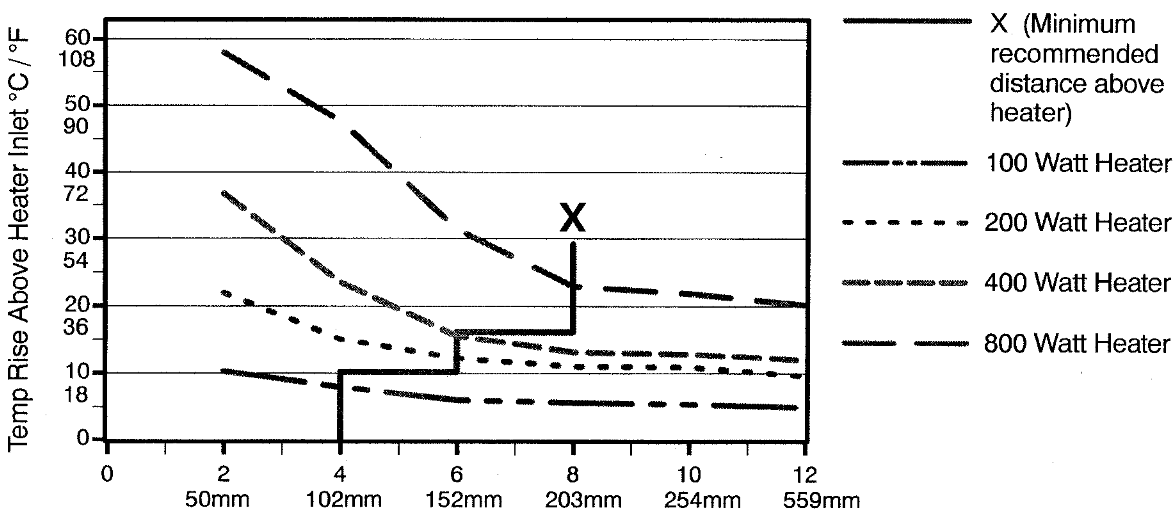
Thermal sensitive devices or materials may need to be located further from the heater than the minimum recommended distance.

Optional Horizontal Surface Mounting



	Watts	X	D	E
DAH1001A DAH1002A	100	4	5.00 127 mm	3.25 83 mm
~~DAH2001A DAH2002A~~	~~200~~	~~6~~		
~~DAH4001B DAH4002B~~	~~400~~	~~6~~	~~7.00 178 mm~~	~~3.50 89 mm~~
~~DAH8001B DAH80002B~~	~~800~~	~~8~~		

Temperature Rise Vs Distance Above Heater



Vertical Distance Above Heater, inches/mm
Temperature measurements reflect unrestricted air flow.

English

WIRING (Reference Page 14)

1. All wiring must comply with applicable local codes and ordinances.
2. Connect the heater leadwires to the proper A.C. power source. Power source for 800 watt heaters should be continuous.
3. The heater must be properly grounded.

NOTE: Exposed wires should not come in contact with the heater housing.

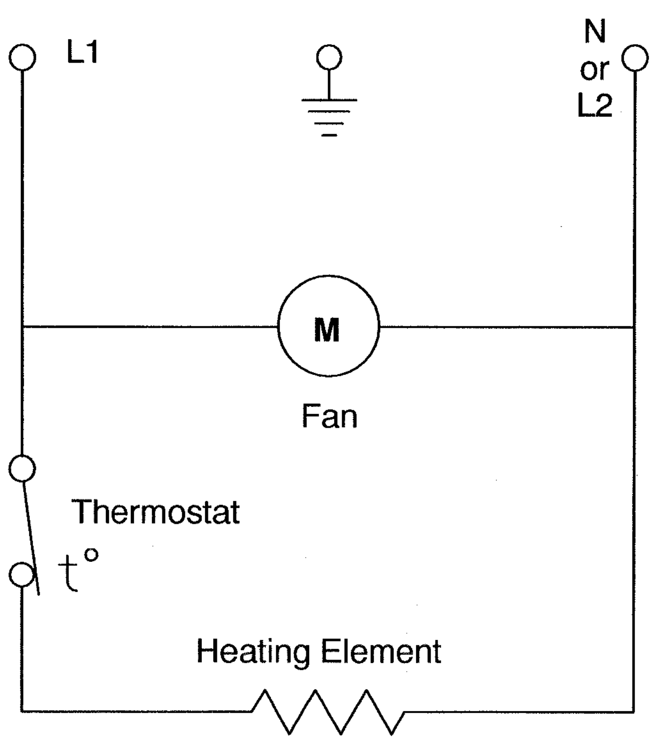
MAINTENANCE

1. Always disconnect power supply before inspecting or working on the heater.

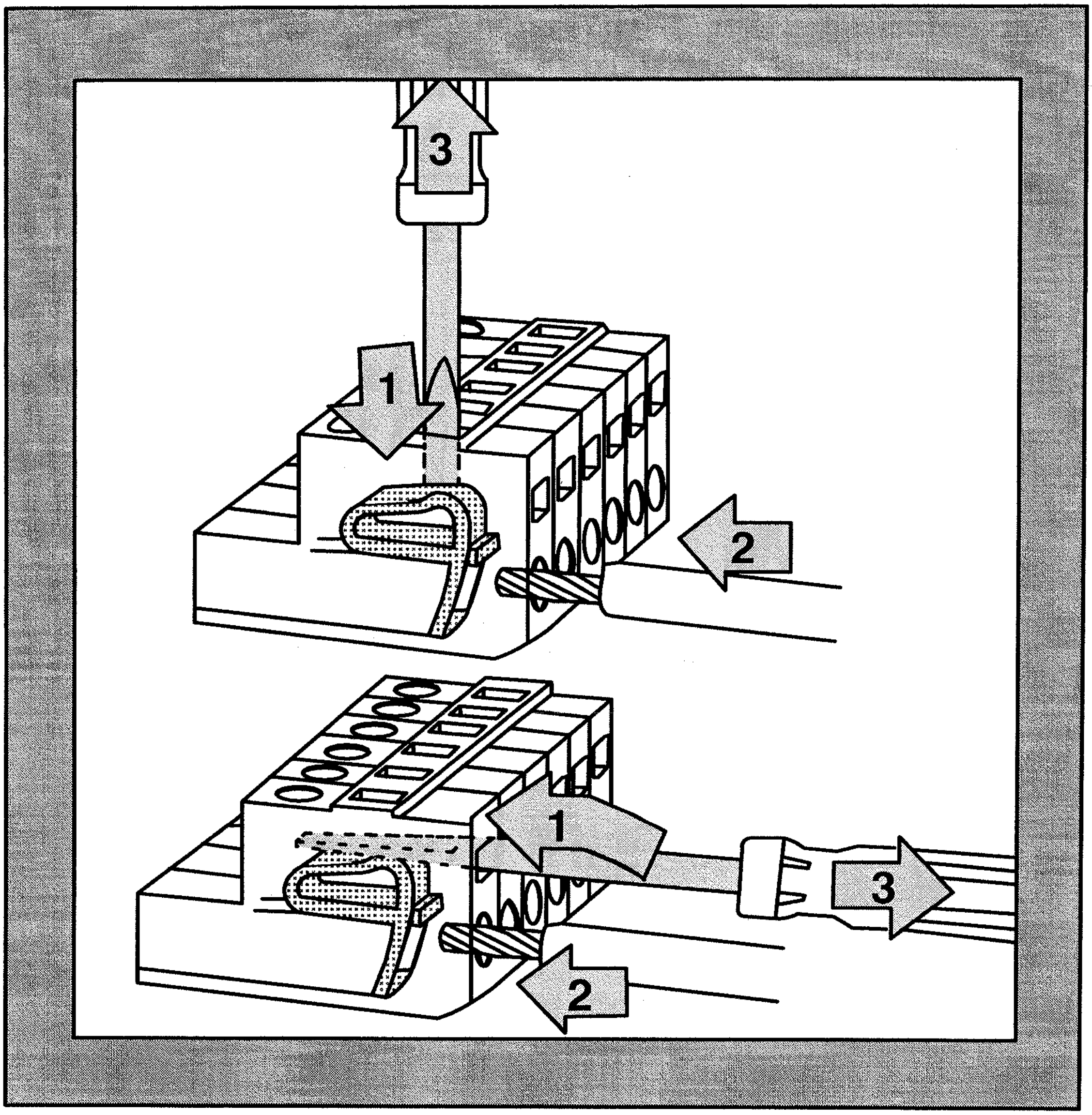
2. Generally the unit requires no maintenance since the fan bearings are permanently lubricated and sealed.

⚠ WARNING

To avoid electric shock, do not energize any circuits before all internal and external electrical and mechanical clearances are checked to assure that all assembled equipment functions safely and properly.



Wiring Schematic



Wiring Illustration

~~Verdrahtung Abbildung~~

~~Illustration d'enfilement~~

~~Ilustración Del Cableado~~

Technical Manual
701954-0007

Eagle Signal brand

A103-006 Elapsed Time Indicator

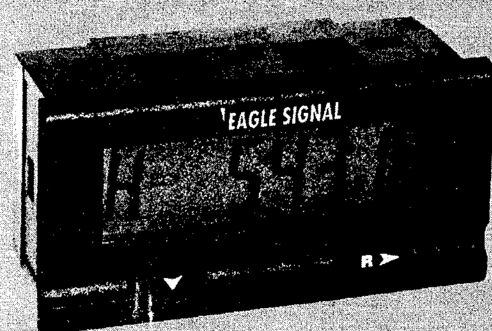
Introduction

Within the Danaher Controls A103 family you'll find a product to meet nearly every requirement for panel mounted control and indication. Housed in a DIN standard 36mm x 72mm case, the A103-006 is designed to accumualate elapsed time for applications such as machine maintenance. The unit is field programmable to display the elapsed time in a variety of units.

The supertwist LCD display with 6 digit display, plus time unit legend, provides easy viewing at a glance. For conditions where ambient light is poor, the display can be backlit by connecting an external DC (10-28 Volt) power supply. The time value can either be reset through the front panel or via a remote signal.

Powered by either one or two replaceable 3V Lithium batteries, this unique design allows for a new battery to be installed before removing the old one, thereby retaining count total and program data. A low battery indicator appears on the screen to provide a warning several weeks before the end of battery life. If two batteries are used simultaneously, the individual expected life doubles to 10 years.

Setup is quick and simple as the two front panel keys are used to scroll through 2 menu choices. A NEMA 4X front panel and noise immunity tested to IEC 801 level 3 makes this unit suitable for harsh environments. Several option modules are also available that provide added functionality and convenience.

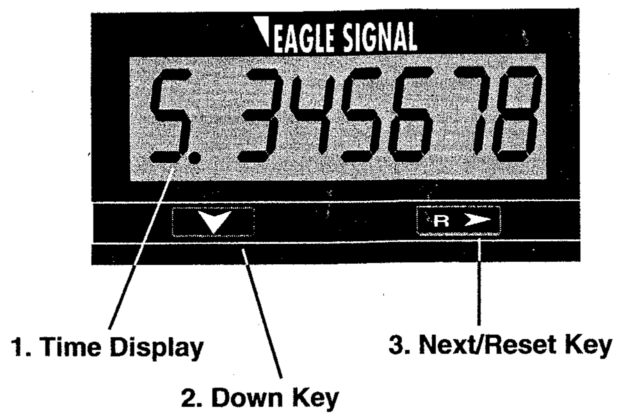


Features

- Large, easy to read 6-digit supertwist LCD display with backlighting capability
- 3 Volt lithium battery provides long life and eliminates the need for external power
- Elapsed time resettable remotely or from the front panel (if enanbled)
- Field programmable time units: Seconds, Minutes, Hours, Hours:Minutes:Seconds
- Option Modules provide added functionality and convenience
- Simple menu-driven setup
- NEMA 4X rated front panel for use in washdown environments

Index

PERATION

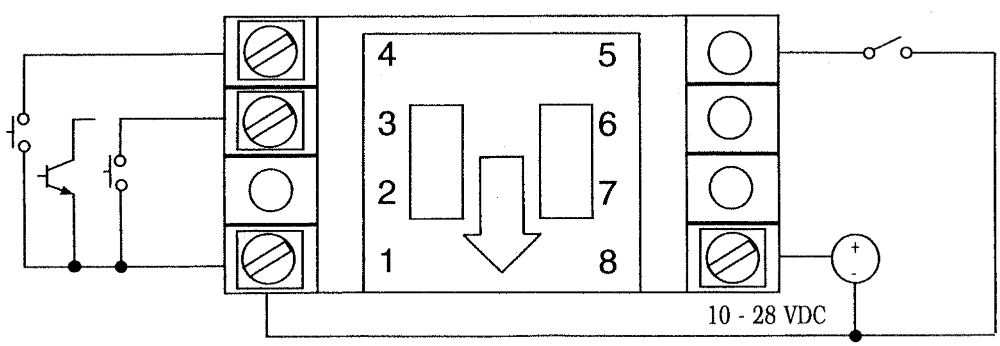


1. Time Display: Accumulates time when the timing start input is active. Timing will not take place when the external or front panel reset is active. The leftmost digit is the time value legend.

2. Down Key: When the program input is active this key is used to scroll through the menu items. After a menu item has been chosen for editing, the down key is used to set the value for the currently selected shing) digit.

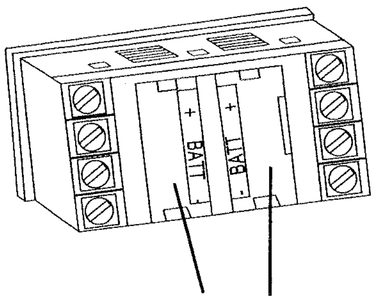
3. Next/Reset Key: Resets the accumulated time if Front Panel Reset is enabled in Programming Mode. When the program input is active this key is used to select a menu item for editing (left most digit will begin to flash) and then move to the desired digit to be changed.

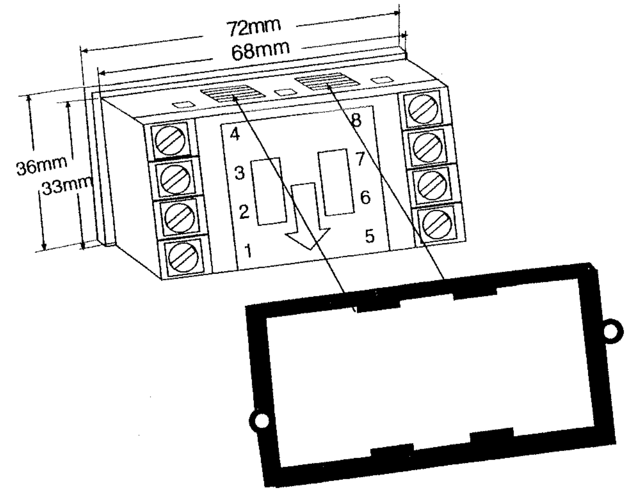
REAR TERMINAL CONNECTIONS



1. **Common**
2. **Not Used**
3. **Timing Enable - NPN or dry contact inputs**
4. **Remote Reset - Resets time value when tied to common**
5. **Front Panel Program Enable - Allows access to program mode when tied to common**
6. **Not Used**
7. **Not Used**
8. **DC Supply Input - For backlighting**

INSTALLATION





Battery Installation - The unit is shipped with one battery, which is not installed. Remove the battery cover by pushing inward and down. Install the battery in either of the two slots. The unit runs on a single battery, and the second slot is provided to allow for installing a new battery before removing the old one, retaining count total and program data. The unit can also be run on two batteries to extend the battery life to 10 years. Once the battery is in place the unit will go into a self test mode, and all the segments on the LCD display will be illuminated. The self test mode is exited by depressing the Next key, which will then display the model number (6). Depress the Next key again to ready the unit for operation.

Front Panel Installation - Place the unit in the panel through the 33mm x 68mm cutout. Slide the included gasket over the rear of the unit, then slide the panel mount bracket into place so that the 4 tabs catch in the groves on the top and the bottom of the unit (the bracket should be oriented so that the tabs are on the side nearest the panel). Use the provided panel mount screws to tighten the bracket until there is a secure seal against the gasket.

PROGRAMMING

Programming parameters can be accessed, when the Program Enable input is active, by pressing the Down key. To edit a parameter use the Down key to scroll until the desired parameter appears on the screen. Pressing the Next key will cause the leftmost digit of that value to begin to flash. Use the Next and Down keys in combination to choose individual digits and change their value.

1. on

Front Panel Reset Enable: When active (ON) the time value, when being displayed, can be reset by pressing the Next/Reset key. If set to OFF, the time value can only be reset through the remote input.

5. ------

Time Format: Sets the units in which the elapsed time will be accumulated. Use the next key to scroll through the available choices: Seconds, Minutes (_ _ _ _ . _), Hours (_ _ _ _ . _) , Hours: Minutes: Seconds.

> **Note: On initial start-up, as well as after any programming changes, it is necessary to reset the unit before begining operation**

SPECIFICATIONS

Timing Start Input (Terminal 3):
Type: NPN Signal or contact-closure
Count Speed: 30 Hz max (50% duty cycle)
Logic: Low < 1.0 VDC, High > 2.0 VDC
Minimum Pulse Width: 12 ms
Maximum Input 28VDC

Front Panel Enable Input (Terminal 5)
Type: NPN Signal, Contact Closure; level sensitive
Maximum Input: 28 VDC

Remote Reset Input (Terminal 4)
Type: NPN Signal, Contact Closure; level sensitive
Frequency Response: 30 Hz (50% duty cycle)
Maximum input: 28 VDC

Power Source:
Type: Single or dual 3V Lithium battery
Expected Life: 5 years typical-single battery, 10 years typical-dual batteries
Low Power Indicator: "Low Bat" flashes on display approx. 2 weeks prior to end of battery life

Display:
Type: Supertwist LCD for use with or without backlighting
Number: 6 digits plus time unit legend
Height: 12mm
Backlighting: Green Illumination over whole viewable area with a 10 to 28 VDC supply (Terminal 8)

Physical:
Dimensions: 36mm x 72mm, 38mm deep
Mounting: Panel Mount (mounting bracket supplied) 33mm x 68mm (+ 0.3mm) panel cutout
Connections: Up to 8 screw terminals
Weight: Approximately 2.25 ounces

WARRANTY

Standard products manufactured by the Company are warranted to be free from defects in workmanship and material for a period of one year from the date of shipment, and products which are defective in workmanship or material will be repaired or replaced, at the option of the Company, at no charge to the Buyer. Final determination as to whether a product is actually defective rests with the Company. The obligation of the Company hereunder shall be limited solely to repair and replacement of products that fall within the foregoing limitations, and shall be conditioned upon receipt by the Company of written notice of any alleged defects or deficiency promptly after discovery within the warranty period, and in the case of components or units purchased by the Company, the obligation of the Company shall not exceed the settlement that the Company is able to obtain from the supplier thereof. No products shall be returned to the Company without its prior consent. Products which the Company consents to have returned shall be shipped F.O.B. the Company's factory. The Company cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective. The life of the products of the Company depends, to a large extent, upon the type of usage thereof, and THE COMPANY MAKES NO WARRANTY AS TO FITNESS OF ITS PRODUCTS FOR SPECIFIC APPLICATIONS BY THE BUYER NOR AS TO PERIOD OF SERVICE UNLESS THE COMPANY SPECIFICALLY AGREES OTHERWISE IN WRITING AFTER THE PROPOSED USAGE HAS BEEN MADE KNOWN TO IT.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

Printed in U.S.A.
#701954-0007
Revision A
7/1/96

Danaher Controls
2100 W. Broad St., P.O. Box 368
Elizabethtown, NC 28337
Phone: 847.662.2666
Fax: 847.662.6633

TECHNICAL ASSISTANCE

Our staff is ready to support you and answer any questions.
Monday through Friday, 8:00 a.m. to 5:00 p.m. (EST) at 800-647-1911.

WARRANTY STATEMENT

During the applicable warranty period, any Joslyn™ surge protector device which fails due to defect in materials, workmanship, or any electrical anomaly, including lightning, shall be repaired or replaced at Joslyn's discretion.

Prior to shipment of any suspect or known defective product to Joslyn a Return Material Authorization (RMA) number must be obtained. An official Joslyn RMA number and shipping instructions can be obtained from the distributor where the product was originally purchased. Distributors can obtain the official Joslyn RMA number by contacting the Joslyn Customer Service Department at 800-647-1911. Products arriving at Joslyn without an official RMA number will not be accepted and will be returned freight collect to the original point of shipment.

Products being returned with an official Joslyn RMA number should be shipped by prepaid freight to the nominated point of return as shown on the RMA documentation.

The Company shall have no liability under this warranty for problems or defects directly or indirectly caused by misuse of the Product, alteration of the Product (including removal of any warning labels), accidents, improper installation, application, operation or improper repair of the Product.

THIS WARRANTY REPRESENTS THE ENTIRE WARRANTY OF THE COMPANY. ALL OTHER WARRANTIES EXPRESS OR IMPLIED, ORAL OR WRITTEN, INCLUDING, BUT NOT LIMITED TO, THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

THE LIABILITY OF THE COMPANY, AT ITS SOLE OPTION, UNDER THIS WARRANTY IS EXPRESSLY LIMITED TO THE REPLACEMENT OR REPAIR OF THE DEFECTIVE PART THEREOF. IN NO EVENT SHALL THE COMPANY BE LIABLE OR RESPONSIBLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY KIND OR CHARACTER, NOR SHALL ITS LIABILITY EVER EXCEED THE PURCHASE PRICE PAID TO JOSLYN FOR SUCH DEFECTIVE PRODUCT.

This warranty is not transferable and may only be enforced by the original purchaser. Claims under this warranty must be submitted to Joslyn within thirty (30) days of discovery of any suspected product defect.

Warranty Period	
SURGITRON® III	3 Years from original date of purchase

5900 Eastport Boulevard Richmond, VA 23231-4453 USA
TEL: 800.647.1911 FAX: 804.236.4047 www.joslynsurge.com

SURGITRON III

AC Surge Protective Device

SURGITRON III Series:

~~1259-21~~
~~120/240V, Single-Phase, 3 Wire + Ground~~
~~1259-21-A~~
~~120/240V, Single-Phase, 3 Wire + Ground~~
~~1260-21~~
~~120V, Single-Phase, 2 Wire + Ground~~
~~1261-21~~
~~208-277V, Single-Phase, 2 Wire + Ground~~
~~1263-21~~
~~480V, Single-Phase, 2 Wire~~
~~1265-21~~
~~120/240V, Single-Phase, 3 Wire + Ground~~
~~1452-21~~
~~240/120V, 3-Phase, CT Delta, 4 Wire + Ground~~
~~1455-21~~
~~208Y/120V, 3-Phase, WYE, 4 Wire + Ground~~
1456-21
480Y/277V, 3-Phase, WYE, 4 Wire + Ground
~~1457-21~~
~~400Y/230V, 3-Phase, WYE, 4 Wire + Ground~~

Installation Operation and Maintenance Manual

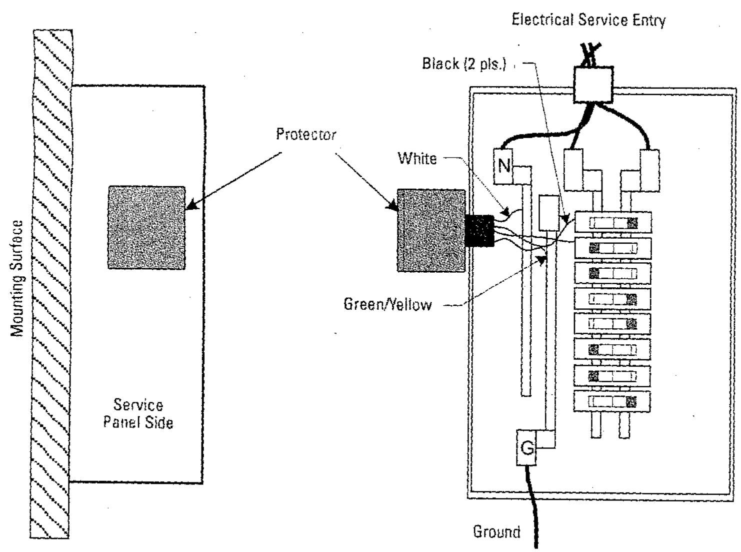
JOSLYN®

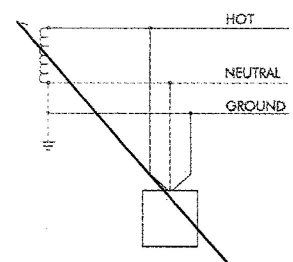
INTRODUCTION

Mount Surge Protector through a knockout on the service cabinet or sub-panel. Locate the Surge Protector so that minimum lead length is used to reach the required 30-ampere circuit breaker or 30-amp fuseless disconnect. Connect the black or brown wires of the surge protector to the 30-amp circuit breaker. Connect the white (or blue) wire to the neutral bar and the green (or green/yellow) wires to the ground bar. **On Model 1452-21, the Orange wire must be connected to Phase B" the "Wild Leg" (208 V_{rms} to neutral) of the power system.** The Surge Protector is protecting when the LEDs are illuminated.

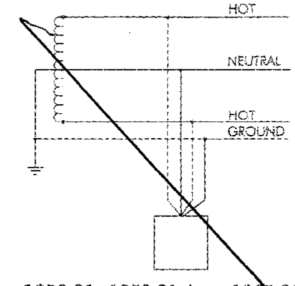
WARNINGS:

1. **A qualified electrican should install the Surge Protector. All applicable codes, listings and ratings must be observed.**
2. **Failure to wire per Installation Instructionsmay cause personal injury or equipment/device damage equipment/device.**
3. **Check all installations for proper and secure grounding. The electrical system must be grounded in accordance with Article 250 of the National Electrical Code. Proper grounding is essential for lightning protection to be effective.**

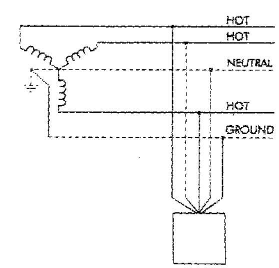




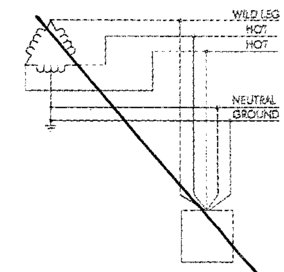
1260-21 or 1261-21



1259-21, 1259-21-A or 1263-21

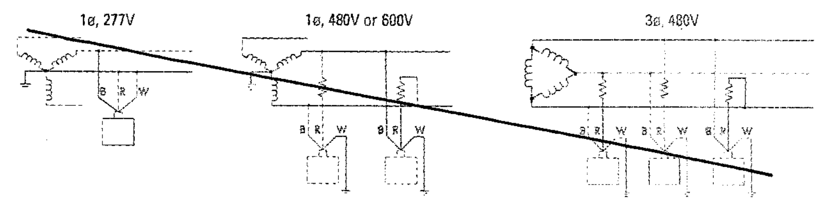


1455-21, 1456-21 or 1457-21



1452-21

Model 1263-21 Connections



This unit contains no serviceable parts.

Monitoring (1263-21 only)

When the arrester is functional, the output of the red Monitor Wire is line voltage (of the black wire), positive half-wave rectified with 60k ohms internal resistance. It must be terminated as shown above, with additional resistance added, in order for the status light to be operational. If the monitoring feature will nt be used, cut the red wire and cap it. – *The arrester is functional and protecting as long as the status light remains lit.–*

Type of Service	Connect RED wire to:	Add Series Resistance
480Y/277V	Neutral	None
480Y/277V	Another Phase	20-40k ohm, 1W
480V Delta	Another Phase	20-40k ohm, 1W
600Y/347V	Neutral	5-10k ohm, 1W
690Y/400V	Neutral	10-20k ohm, 1W

FLYGT

FLYGT CORPORATION
A SUBSIDIARY OF ITT
Trumbull, Connecticut 06611
Phone: (203) 360-4700
Fax: (203) 360-4705

MiniCAS 120 – CONTROL AND STATUS UNIT
14 - 407129

The MiniCAS 120 is a direct replacement for Part No. 14-407113 or 835848. It may also be used to replace Part No. 835857. However, an external reset connected to pin 6 will not function. The MiniCAS 120 may be powered by either 24VAC on pin 2, or by 120VAC on pin 6, but not both.

OPERATION

Manual Reset: If an over temperature alarm condition occurs, the MiniCAS unit will turn the pump off and lock it out of service. After the pump motor has cooled to a point of safe operation, the alarm may be reset by pressing the Overtemp Reset on the front of the unit. The unit may also be reset by pressing a push-button that momentarily interrupts control power to the MiniCas unit.

Auto Reset: If an over temperature alarm condition occurs, the MiniCAS unit will turn the pump off. When the pump motor has cooled to a point of safe operation, the alarm will automatically reset and pump operation will be re-enabled.

When a leakage condition is detected, there is a 5 second delay before the alarm contacts change state. Once the leakage condition clears, the alarm will automatically reset and the alarm contacts will return to their normal state. The leakage alarm resets automatically and is not affected by the position of the reset mode select switch.

LEVITON®
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K-93370-10-00-2A

Installing and Testing a GFCI Receptacle

Please read this leaflet completely before getting started.

UL®

⚠ CAUTION

- To prevent severe shock or electrocution always turn the power OFF at the service panel before working with wiring.
- Use this GFCI with copper or copper-clad wire. Do not use it with aluminum wire.
- Do not install this GFCI receptacle on a circuit that powers life support equipment because if the GFCI trips it will shut down the equipment.
- For installation in wet locations, protect the GFCI receptacle with a weatherproof cover that will keep both the receptacle and any plugs dry.
- Must be installed in accordance with national and local electrical codes.

1. What is a GFCI?

A GFCI receptacle is different from conventional receptacles. In the event of a ground fault, a GFCI will trip and quickly stop the flow of electricity to prevent serious injury

Definition of a ground fault:
Instead of following its normal safe path, electricity passes through a person's body to reach the ground. For example, a defective appliance can cause a ground fault.

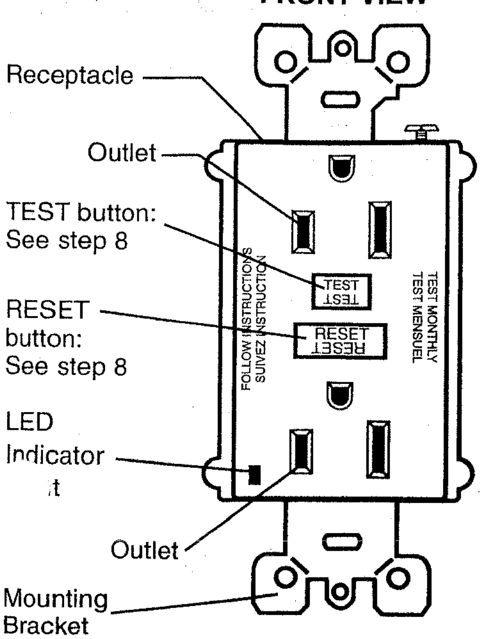
A GFCI receptacle does **NOT** protect against circuit overloads, short circuits, or shocks. Fc example, you can still be shocked if you touc bare wires while standing on a non-conductir surface, such as a wood floor.

GFCI's contain a lockout feature that will prevent RESET if:

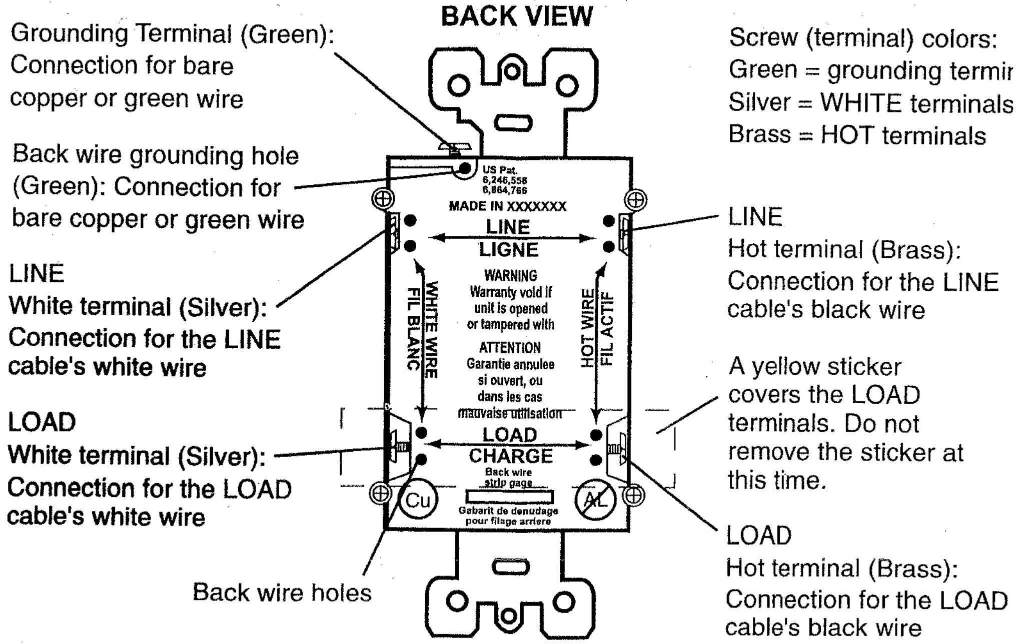
- There is no power being supplied to the GFCI.
- The GFCI is miswired due to reversal of tl LINE and LOAD leads.
- The GFCI cannot pass its internal test, indicating that it may not be able to provic protection in the event of a ground fault.

2. The GFCI's features

FRONT VIEW



BACK VIEW



Screw (terminal) colors:
Green = grounding termir
Silver = WHITE terminals
Brass = HOT terminals

Should you install it?

ɜtalling a GFCI receptacle can be more mplicated than installing a conventional ceptacle.

ake sure that you:

Understand basic wiring principles and techniques

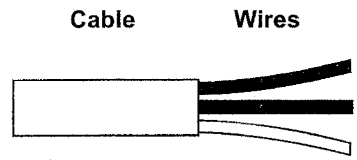
Can interpret wiring diagrams

Have circuit wiring experience

Are prepared to take a few minutes to test your work, making sure that you have wired the GFCI receptacle correctly

4. LINE vs. LOAD

A cable consists of 2 or 3 wires.

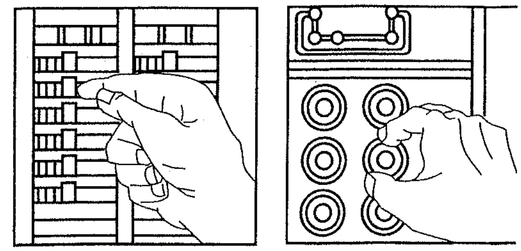


LINE cable:
Delivers power from the service panel (breaker panel or fuse box) to the GFCI. If there is only one cable entering the electrical box, it is the LINE cable. This cable should be connected to the GFCI's LINE terminals only.

LOAD cable:
Delivers power from the GFCI to another receptacle in the circuit. This cable should be connected to the GFCI's LOAD terminals only. The LOAD terminals are under the yellow sticker. Do **NOT** remove the sticker at this time.

5. Turn the power OFF

Plug an electrical device, such as a lamp or radio, into the receptacle on which you are working. Turn the lamp or radio ON. Then, go to the service panel. Find the breaker or fuse that protects that receptacle. Place the breake in the OFF position or completely remove the fuse. The lamp or radio must turn OFF.



Next, plug in and turn ON the lamp or radio at the receptacle's other outlet to make sure the power is OFF at both outlets. If the power is nc OFF, stop work and call an electrician to complete the installation.

ɩ. Identify cables/wires

T ʿant:
)C ..ɔT install the GFCI receptacle in an lectrical box containing (a) more than four (4) ires (not including the grounding wires) or ɔ) cables with more than two (2) wires (not ıcluding the grounding wire). Contact a ualified electrician if either (a) or (b) are true.

you are replacing an old receptacle, pull it out f the electrical box without disconnecting the ires.

If you see one cable (2-3 wires), it is the LINE cable. The receptacle is probably in position C (see diagram to the right). Remove the receptacle and go to step 7A.

If you see two cables (4-6 wires), the receptacle is probably in position A or B (see diagram to the right). Follow steps a-e of the procedure to the right.

Procedure: box with two (2) cables (4-6 wires):

(a) Detach one cable's white wire and hot wires from the receptacle and cap each one separately with a wire connector. Make sure that they are from the same cable.

(b) Re-install the receptacle in the electrical box, attach faceplate, then turn the power ON at the service panel.

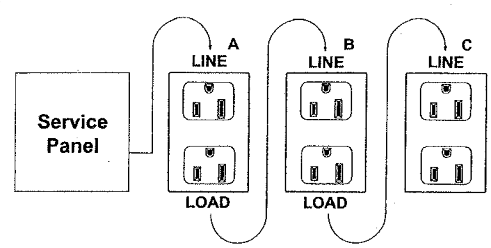
(c) Determine if power is flowing to the receptacle. If so, the capped wires are the LOAD wires. If not, the capped wires are the LINE wires.

(d) Turn the power OFF at the service panel, label the LINE and LOAD wires, then remove the receptacle.

(e) Go to step 7B.

Placement in circuit:
The GFCI's place in the circuit determines if it protects other receptacles in the circuit.

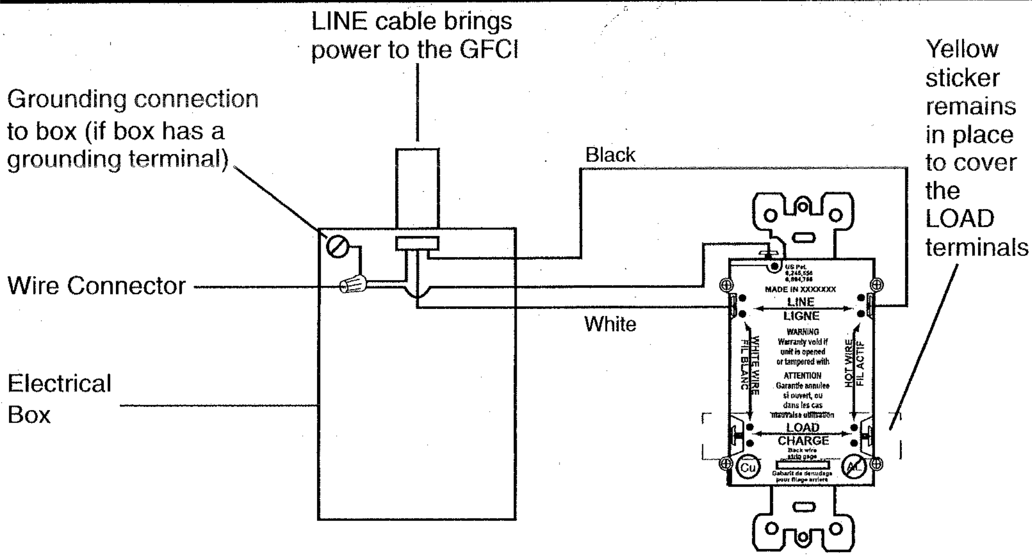
Sample circuit:



Placing the GFCI in position A will also provide protection to "load side" receptacles B and C. On the other hand, placing the GFCI in position C will not provide protection to receptacles A or B. Remember that receptacles A, B, and C can be in different rooms.

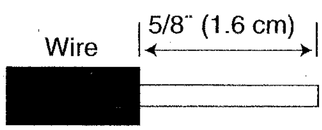
7. Connect the wires (choose A or B)... only after reading other side c

A: One Cable (2 or 3 wires) entering the box

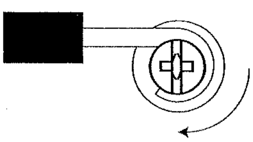


About Wire Connections:

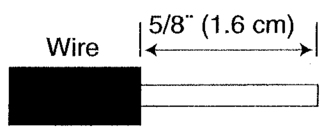
Side Wire:



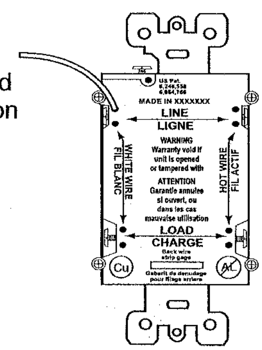
For Side wire -
Loop clockwise 2/3 of the way around screw



Back Wire:



For Back wire -
Insert bare wire fully and tighten terminal clamp on conductor ONLY



Connect the LINE cable wires to the LINE terminals:

- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

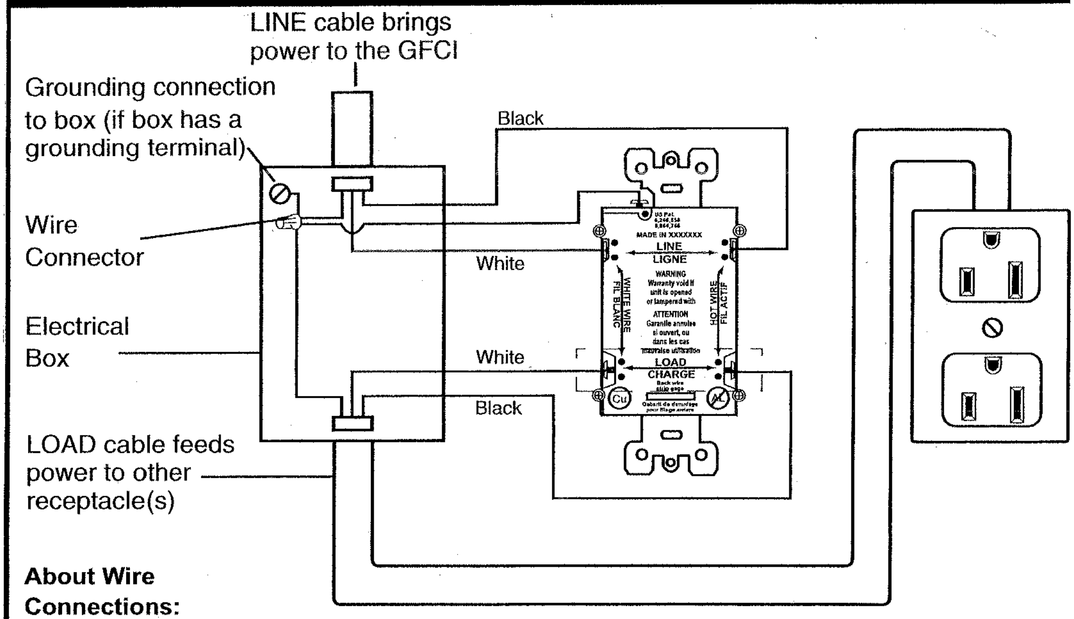
Connect the grounding wire (only if there is a grounding wire):

- For a box with no grounding terminal (diagram not shown): Connect the LINE cable's bare copper (or GREEN) wire directly to the grounding terminal on the GFCI receptacle.
- For a box with a grounding terminal (diagram shown above): Connect a 6-inch bare copper (or GREEN) 12 or 14 AWG wire to the grounding terminal on the GFCI. Also connect a similar wire to the grounding terminal on the box. Connect the ends of these wires to the LINE cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

Complete the installation:

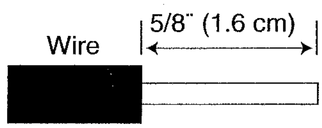
- Fold the wires into the box, keeping the grounding wire away from the WHITE and HOT terminals. Screw the receptacle to the box and attach the faceplate.
- Go to step 8.

B: Two cables (4 or 6 wires) entering the box

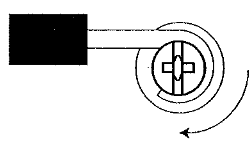


About Wire Connections:

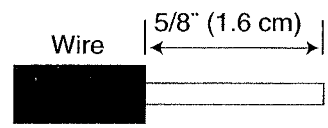
Side Wire:



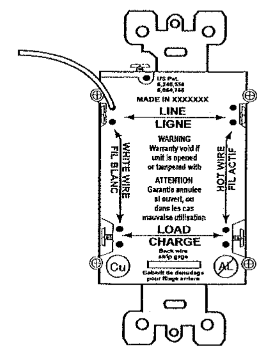
For Side wire -
Loop clockwise 2/3 of the way around screw



Back Wire:



For Back wire -
Insert bare wire fully and tighten terminal clamp on conductor ONLY



Connect the LINE cable wires to the LINE terminals:

- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

Connect the LOAD cable wires to the LOAD terminals:

- Remove the YELLOW sticker to reveal the LOAD terminals
- The white wire connects to the WHITE terminal (Silver)
- The black wire connects to the HOT terminal (Brass)

Connect the grounding wires (only if there is a grounding wire):

- Connect a 6-inch bare copper (or GREEN) 12 or 14 AWG wire to the grounding terminal on the GFCI. If the box has a grounding terminal, also connect a similar wire to the grounding terminal on the box. Connect the ends of these wires to the LINE or LOAD cable's bare copper (or GREEN) wire using a wire connector. If these wires are already in place, check the connections.

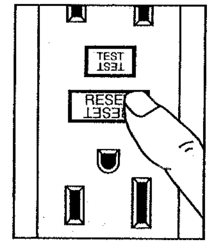
Complete the installation:

- Fold the wires into the box, keeping the grounding wire away from the WHITE and HOT terminals. Screw the receptacle to the box and attach the faceplate.
- Go to step 8.

8. Test your work

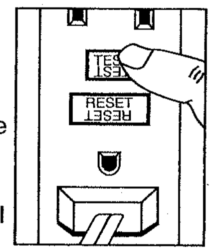
Why perform this test?

- If you miswired the GFCI it may not prevent personal injury or death due to a ground fault (electrical shock).
- If you mistakenly connect the LINE wires to the LOAD terminals, the GFCI will not reset and will not provide power to either the GFCI receptacle face or any receptacles fed from the GFCI.



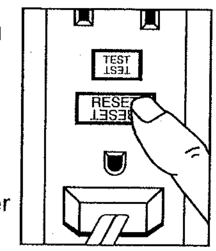
Procedure:

(a) This GFCI is shipped from the factory in the tripped condition and cannot be reset until it is wired correctly and power is supplied to the device. Plug a lamp or radio into the GFCI (and leave it plugged in). Turn the power ON at the service panel. Ensure that the GFCI is still in the tripped condition by pressing the TEST button. If the indicator light on the GFCI receptacle face is ON and the lamp or radio is OFF go to the Troubleshooting section because LINE and LOAD wiring connections have been reversed. You will not be able to RESET the GFCI in this condition.



(b) Press the RESET button ***fully***. If the lamp or radio turns ON and the Indicator Light turns ON, the GFCI has been installed correctly. If the GFCI cannot be reset, go to the Troubleshooting section.

(c) If you installed your GFCI using step 7B press the TEST button, then plug a lamp or radio into surrounding receptacles to see which one(s), in addition to the GFCI, lost power when you pressed the TEST button. DO NOT plug life saving devices into any of the receptacles that lost power. Place a "GFCI PROTECTED OUTLET" sticker on every receptacle that lost power, then press the RESET button to reset the GFCI.



(d) Press the TEST button (then RESET button) every month to assure proper operation. If the Indicator light does not go out and come back on or if the GFCI cannot be reset, then it must be replaced.

TROUBLESHOOTING

Turn the power OFF and check the wire connections against the appropriate wiring diagram in step 7A or 7B. Make sure that there are no loose wires or loose connections. Start the test from the beginning of step 8 if you rewired any connections to the GFCI.

General Information

GFCI ratings:
15A-125V AC - Cat No. 7599 Duplex Receptacle
20A-125V AC - Cat. No. 7590 Faceless
20A-125V AC - Cat. No. 7899 Duplex Receptacle

All devices rated 20A feed-through

This product is covered by U.S. Patents Nos. 6,040,967; 6,246,558; 6,282,070; 6,381,112; 6,437,953; 6,864,766, as well as other U.S. and foreign patents pending.

LIMITED 2 YEAR WARRANTY AND EXCLUSIONS

Leviton warrants to the original consumer purchaser and not for the benefit of anyone else that this product at the time of its sale by Leviton is free of defects in materials and workmanship under normal and proper use for two years from the purchase date. Leviton's only obligation is to correct such defects by repair or replacement, at its option, if within such two year period the product is returned prepaid, with proof of purchase date, and a description of the problem to **Leviton Manufacturing Co., Inc., Att: Quality Assurance Department, 59-25 Little Neck Parkway, Little Neck, New York 11362-2591.** This warranty excludes and there is disclaimed liability for labor for removal of this product or reinstallation. This warranty is void if this product is installed improperly or in an improper environment, overloaded, misused, opened, abused, or altered in any manner, or is not used under normal operating conditions or not in accordance with any labels or instructions. **There are no other or implied warranties of any kind, including merchantability and fitness for a particular purpose,** but if any implied warranty is required by the applicable jurisdiction, the duration of any such implied warranty, including merchantability and fitness for a particular purpose, is limited to two years. **Leviton is not liable for incidental, indirect, special, or consequential damages, including without limitation, damage to, or loss of use of, any equipment, lost sales or profits or delay or failure to perform this warranty obligation.** The remedies provided herein are the exclusive remedies under this warranty, whether based on contract, tort or otherwise.

For Technical Assistance Call:
1-800-824-3005 (U.S.A. Only)
1 800 405-5320 (Canada Only)
www.leviton.com

PK-93370-10-00-2A

Installation Instructions for ~~EHD, EDB, EDS, ED~~, EDH, ~~EDC, FDB, FD, HFD, FDC~~ Circuit Breakers and Molded Case Switches

⚠ WARNING

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. DEATH, SEVERE PERSONAL INJURY OR SUBSTANTIAL PROPERTY DAMAGE CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES.

CUTLER-HAMMER IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

The user is cautioned to observe all recommendations, warnings and cautions relating to the safety of personnel and equipment, as well as all general and local health and safety laws, codes, and procedures.

The recommendations and information contained herein are based on Cutler-Hammer experience and judgment, but should not be considered to be all-inclusive or covering every application or circumstance which may arise. If any questions arise, contact Cutler-Hammer for further information or instructions.

1. INTRODUCTION

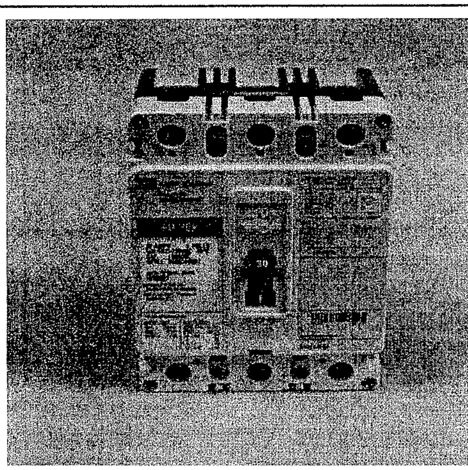


Fig. 1-1. Model D Series C Circuit Breaker and Molded Case Switches

The F-Frame Series C circuit breakers (Fig. 10-1) Types FDB, FD, HFD, and FDC are rated from 15A to 225A (150A for 1 pole versions) continuous current and are available as thermal-magnetic circuit breakers and molded case switches. Type EHD circuit breakers and molded case switches are rated 100A maximum. Types EDB, EDS, ED, EDH, and EDC are rated from 1 00A to 225A continuous current and are available as thermal-magnetic circuit breakers. (Molded case switches are available rated at 100A, 150A, and 225A.) Circuit breakers are listed in accordance with Underwriters Laboratories, Inc. Standard UL489, and Types EHD, EDB, EDS, ED, FDB, EDH, EDC, FD, HFD, and FDC satisfy the (P1) requirements of the International Electrotechnical Commission Recommendation No. IEC 157-1. Molded case switches are listed in accordance with UL1087. For this publication, the term circuit breaker also includes molded case switches. For more information, see Frame Book 29-101.

2. INSTALLATION

The installation procedure consists of inspecting and mounting the circuit breaker, connecting and torquing the line and load terminations, and attaching terminal shields or barriers, when supplied. To install the circuit breaker, perform the following steps:

Note: The EHD, EDB, EDS, ED, EDH, EDC, FDB, FD, HFD, and FDC circuit breakers are factory sealed. UL489 requires that internal accessories be installed at the factory. Where local codes and standards permit and UL listing is not required, internal accessories can be field installed. Accessory installation should be done before the circuit breaker is mounted and connected.

Mounting hardware and unmounted terminations (where required) are supplied in separate packages.

2-1. Make sure that the circuit breaker is suitable for the installation by comparing nameplate data with system requirements. Inspect the circuit breaker for completeness and check for damage before mounting.

⚠ WARNING

BEFORE MOUNTING THE CIRCUIT BREAKER IN AN ELECTRICAL SYSTEM, MAKE SURE THERE IS NO VOLTAGE PRESENT WHERE WORK IS TO BE PERFORMED. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

2-2. Depending on the equipment configuration, the circuit breaker can be mounted using different styles of hardware. The following steps describe how to mount the circuit breaker using standard hardware. When special hardware is needed (for example, with the electrical operator), the instruction leaflet describing the accessory also describes the special mounting arrangements.

Note: Before mounting the circuit breaker, check if the termination devices should be installed first. See terminations instructions.

2-3. To mount the circuit breaker, perform the following steps:

a. For individual mounting panels, make sure that mounting panel is predrilled using bolt drilling plan (Fig. 2-1). For panelboard mounting, only load end support mounting holes are required. For deadfront cover applications make sure panel cover is cut out to correct escutcheon dimensions (Fig. 2-2).

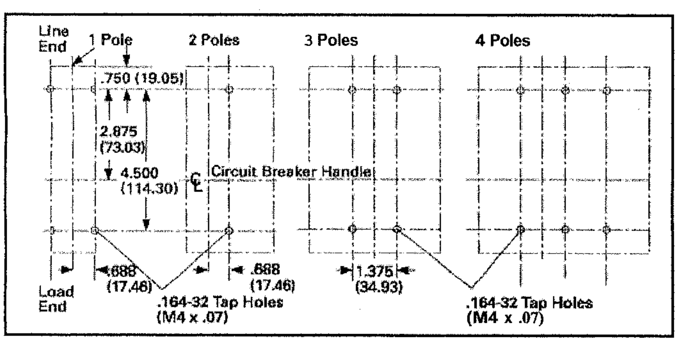
CAUTION

DO NOT EXCEED CONNECTOR/BUS CAPACITY IN CUTLER-HAMMER POWER LINE 3A AND 4 PANELS. USE CONNECTOR KIT KPRL3AFD3 (3 POLE) AND KPRL3AFD2 (2 POLE) IN PANEL TYPE PRL3A AND KPRL4FD (3 POLE) AND KPRL4FD2 (2 POLE) IN PANEL TYPE PRL4.

b. If circuit breaker includes factory installed internal accessories, make sure accessory wiring can be reached when the circuit breaker is mounted.

c. Position circuit breaker on mounting surface.

d. Install mounting screws, washers, and nuts. Tighten screws firmly, but do not exceed 28 pound-inches (3.16 N.m.).



Fig, 2-1. Circuit Breaker Mounting Bolt Drilling Plans

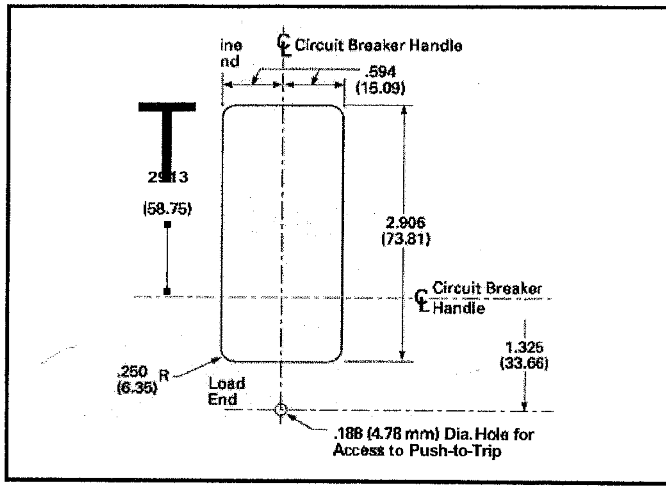


Fig. 2-2. Circuit Breaker Escutcheon Dimensions

2-4. If an optional terminal end cover is to be installed with the circuit breaker (usually line end only), it must be positioned before cable is connected to terminals.

CAUTION

WHEN ALUMINUM CONDUCTORS ARE USED, THE APPLICATION OF A SUITABLE JOINT COMPOUND IS RECOMMENDED TO REDUCE THE POSSIBILITY OF TERMINAL OVERHEATING. TERMINAL OVERHEATING CAN CAUSE NUISANCE TRIPPING AND DAMAGE TO THE CIRCUIT BREAKER.

2-5. After mounting the circuit breaker, line and load terminals and accessory leads should be connected. (See accessory schematic diagram on side of circuit breaker.)

Note: If terminal shield or interphase barriers are to be installed on the circuit breaker, install them after the terminals are connected.

2-6. If required, install terminal shield on circuit breaker cover with mounting screws provided.

2-7. If required, install an interphase barrier by sliding barrier into dovetail grooves between terminals.

2-8. After the circuit breaker is installed, check all mounting hardware and terminal connecting hardware for correct torque loading. Torque values for line/load terminals are given in Tables 2-1 and 2-2 and on the circuit breaker nameplate.

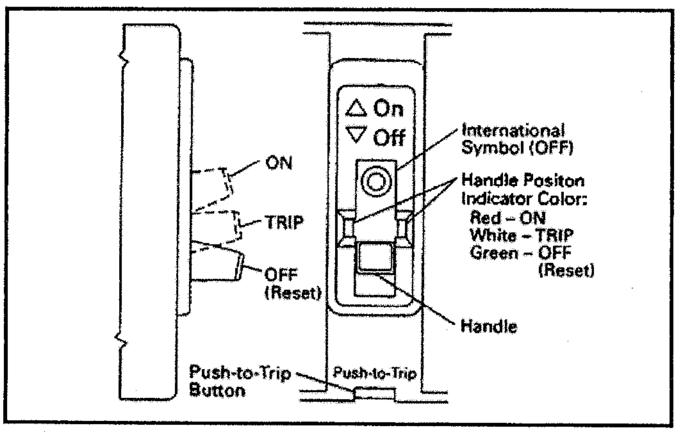


Fig. 3-1. Circuit Breaker Manual Controls

3. MANUAL OPERATION

Manual operation of the circuit breaker is controlled by the circuit breaker handle and the PUSH-TO-TRIP button. The circuit breaker handle has three indicated positions, two of which are shown on the cover with raised lettering to indicate ON and OFF. On the sliding handle barrier, ON, OFF, and trip are also shown by a color-coded strip for each circuit breaker handle position: red for ON, white for tripped, and green for OFF. On the sliding handle barrier, ON/OFF is also shown with the international symbols 1/0 (See Fig. 3-1.)

CIRCUIT BREAKER RESET

After tripping, the circuit breaker is reset by moving the circuit breaker handle to the extreme OFF position.

Note: In the event of a thermal trip, the circuit breaker cannot be reset until the thermal element cools.

PUSH-TO-TRIP BUTTON

The **PUSH-TO-TRIP** button checks the tripping function and is used to periodically exercise the operating mechanism.

4. INSPECTION AND FIELD TESTING

Series C molded case circuit breakers are designed to provide years of almost maintenance-free operation. The following procedure describes how to inspect and test a circuit breaker in service.

INSPECTION

Circuit breakers in service should be Inspected periodically. The inspection should include the following checks 4-1 thru4-7.

⚠ WARNING

BEFORE INSPECTING THE CIRCUIT BREAKER IN AN ELECTRICAL SYSTEM, MAKE SURE THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS TO BE PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO REVERSE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

⚠ CAUTION

MAKE SURE THAT CLEANING AGENTS OR SOLVENTS USED TO CLEAN THE CIRCUIT BREAKER ARE SUITABLE FOR THE JOB. SOME COMMERCIAL CLEANING AGENTS WILL DAMAGE THE NAMEPLATES OR MOLDED PARTS.

4-1. Remove dust, dirt, soot, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. Do not blow debris into circuit breaker. If contamination is found, look for the source and eliminate the problem.

4-2. Switch circuit breaker to ON and OFF several times to be sure that the mechanical linkages are free and do not bind. If mechanical linkages are not free, replace circuit breaker.

4-3. Press the PUSH-TO-TRIP button to mechanically trip the circuit breaker. Trip, reset, and switch circuit breaker ON several times. If mechanism does not reset each time the circuit breaker is tripped, replace the circuit breaker.

4-4. Check base, cover, and operating handle for cracks, chipping, and discoloration. Circuit breakers should be replaced if cracks or severe discoloration is found.

4-5. Check terminals and connectors for looseness or signs of overheating. Overheating will show as discoloration, melting, or blistering of conductor insulation, or as pitting or melting of conductor surfaces due to arcing. If there is no evidence of overheating or looseness, do not disturb or tighten the connections. If there is evidence of overheating, terminations should be cleaned or replaced. Before re-energizing the circuit breaker, all terminations and cable should be refurbished to the condition when originally installed.

4-6. Check circuit breaker mounting hardware. Tighten if necessary.

4-7. Check area where circuit breaker is installed for any safety hazards, including personal safety and fire hazards. Exposure to certain types of chemicals can cause deterioration of electrical connections.

FIELD TESTING

Any field testing should be done in accordance with NEMA Standards Publication AB2 — 1984.

E:T•N | Cutler-Hammer
170 Industry Drive
Pittsburgh, PA 15275

Style No. 6620C41H08
Effective 11/03
Printed in U.S.A./TQC

Installation Instructions for GD/~~GWF~~ Molded Case Circuit Breakers and Switches.

WARNING

DO NOT ATTEMPT TO INSTALL OR PERFORM MAINTENANCE ON EQUIPMENT WHILE IT IS ENERGIZED. SEVERE PERSONAL INJURY, DEATH, OR SUBSTANTIAL PROPERTY DAMAGE CAN RESULT FROM CONTACT WITH ENERGIZED EQUIPMENT. ALWAYS VERIFY THAT NO VOLTAGE IS PRESENT BEFORE PROCEEDING WITH THE TASK, AND ALWAYS FOLLOW GENERALLY ACCEPTED SAFETY PROCEDURES.

CUTLER-HAMMER IS NOT LIABLE FOR THE MISAPPLICATION OR MISINSTALLATION OF ITS PRODUCTS.

The user is cautioned to observe all recommendations, warnings, and cautions relating to the safety of personnel and equipment as well as all general and local health and safety laws, codes, and procedures.

The recommendations and information contained herein are based on Cutler-Hammer experience and judgement, but should not be considered to be all-inclusive or covering every application or circumstance which may arise. If any questions arise, contact Cutler-Hammer for further information or instructions.

1. INTRODUCTION

GD circuit breakers (Figure **1-1**) (hereafter referred to as circuit breaker) are thermal-magnetic 2 and 3 pole devices. The two pole circuit breakers are continuous current rated 15-50A and the three pole circuit breakers are 15-100A. Some styles of circuit breakers have steel terminals as opposed to aluminum terminals. The GD Molded Case Switches are available as 3 pole only and rated at 60A and 100A only with some styles having steel terminals as opposed to aluminum terminals. GWF circuit breakers (Figure **1-1**) (hereafter referred to as circuit breaker) are thermal-magnetic 1, 2, and 3 pole devices with steel terminals and are continuous current rated at 15A-100A. (GWF molded case switches are available as 2 and 3 pole devices only, rated at 63A and 100A only.) Three methods of mounting these circuit breakers are available: hardware, DIN rail, or base mounting plate. These circuit breakers, except for type GWF, are listed in accordance with Underwriters Laboratories, Inc. Standard UL489, and satisfy the (P1)

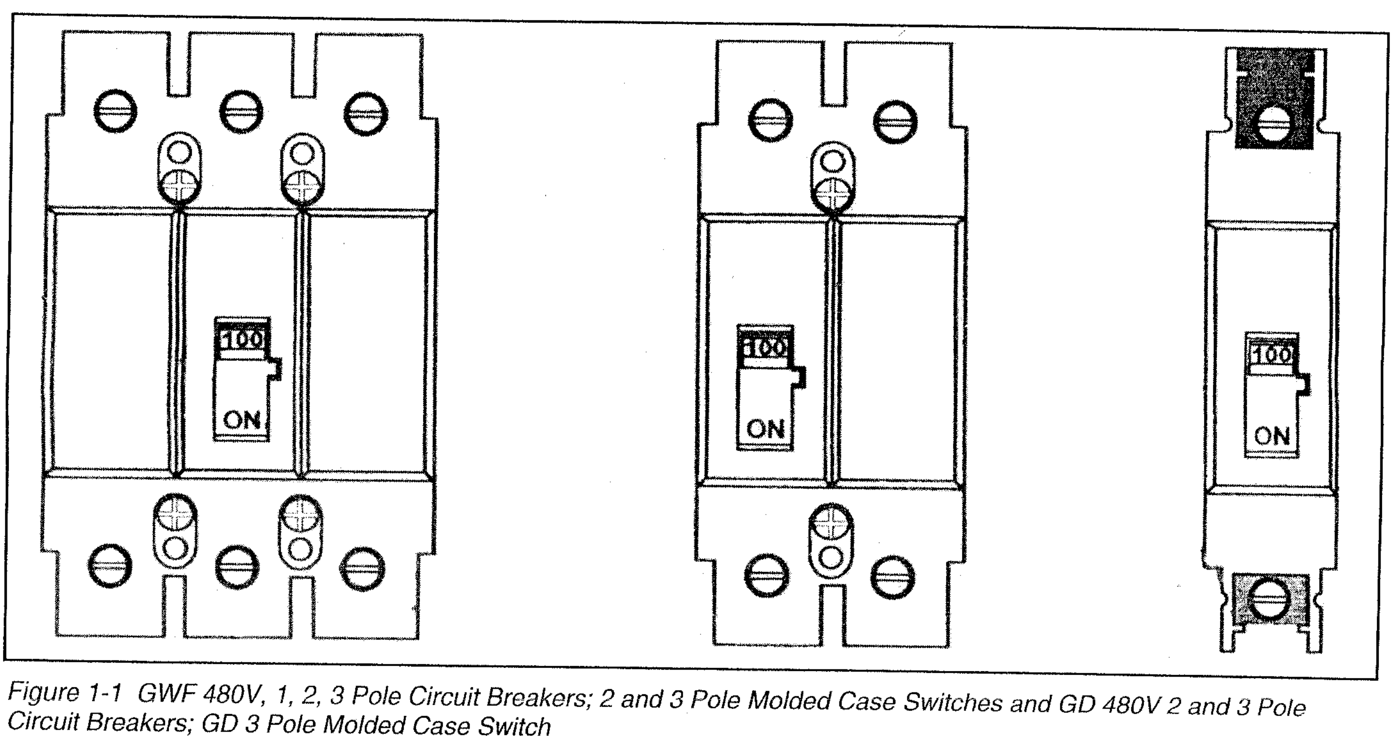
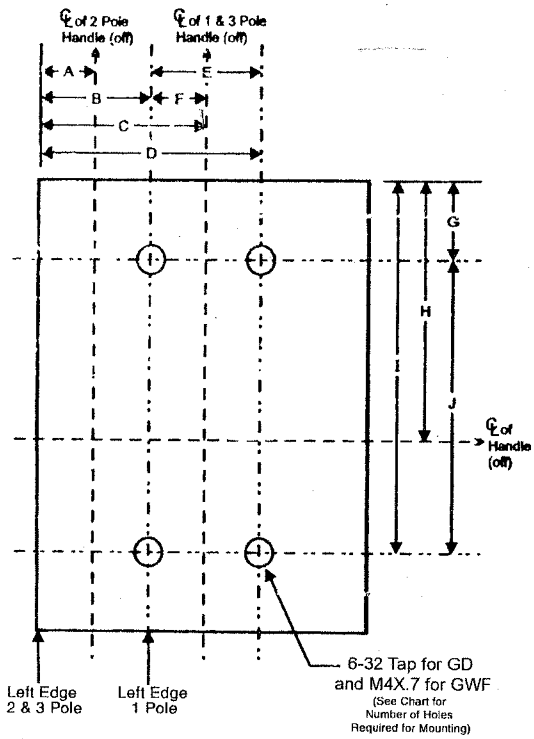


Figure 1-1 GWF 480V, 1, 2, 3 Pole Circuit Breakers; 2 and 3 Pole Molded Case Switches and GD 480V 2 and 3 Pole Circuit Breakers; GD 3 Pole Molded Case Switch



	1 Pole Inches (mm)	2 Pole Inches (mm)	3 Pole Inches (mm)
A	N/A	0.500 (12.70)	N/A
B	N/A	1.000 (25.40)	1.000 (25.40)
C	N/A	N/A	1.500 (38.10)
D	N/A	N/A	2.000 (50.80)
E	0.875 (22.23)	N/A	1.000 (25.40)
F	0.500 (12.70)	N/A	0.500 (12.70)
G	0.547 (13.90)	0.969 (24.61)	0.969 (24.61)
H	2.906 (73.81)	2.906 (73.81)	2.906 (73.81)
I	4.323 (109.80)	4.187 (106.35)	4.187 (106.35)
J	3.776 (95.91)	3.218 (81.74)	3.218 (81.74)
# of Holes	4	2	4

Figure 2-1 Circuit Breaker Mounting Bolt Drilling Plan

requirements of the International Electrotechnical Commission Standard No. IEC 157-1. The GWF version satisfies only the IEC 947-2 requirement. Molded case switches are listed in accordance with UL1087. For this publication, the term circuit breaker also includes molded case switches. The following accessories are available for use with GD/GWF circuit breakers:

- Auxiliary Switch
- Alarm (Signal)/Lockout switch
- Shunt Trip
- Undervoltage Release Mechanism
- Lock Dog (S# 1294C01H01)
- Padlockable Handle (S# 1223C77G03, for 1 pole only)

2. INSTALLATION

The installation procedure consists of inspecting and mounting the circuit breaker, connecting and torquing the terminations. To install the circuit breaker, perform thefollowing steps.

Note: GD/GWF circuit breakers are factory sealed. Underwriters Laboratories, Inc. Standard requires that internal accessories be installed at the factory.

Where local codes and standards permit and UL listing is not required, internal accessories can be field installed. Accessory installation should be done before the circuit breaker is mounted and connected.

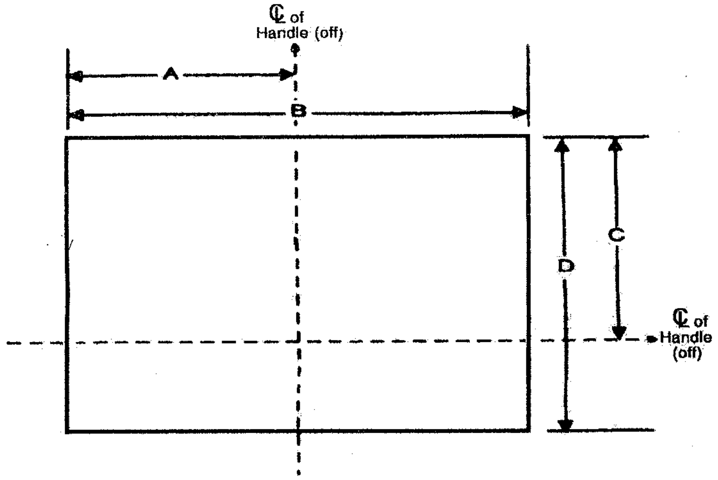
Mounting hardware is supplied with breaker.

2-1. Make sure that the circuit breaker is suitable for the intended installation by comparing nameplate data with system requirements. Inspect the circuit breaker for completeness, and check for damage before mounting.

WARNING

BEFORE MOUNTING THE CIRCUIT BREAKER IN AN ELECTRICAL SYSTEM, MAKE SURE THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THAT THERE IS NO VOLTAGE PRESENT WHERE WORK IS TO BE PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO REVERSE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGE IN ENERGIZED EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

2-2. To mount the circuit breaker, perform the following steps:



	1 Pole Inches (mm)	2 Pole Inches (mm)	3 Pole Inches (mm)
A	0.500 (12.70)	1.500 (38.10)	1.500 (38.10)
B	1.000 (25.40)	2.000 (50.80)	3.000 (76.20)
C	1.500 (38.10)	1.500 (38.10)	1.500 (38.10)
D	2.218 (56.34)	2.218 (56.34)	2.218 (56.34)

Figure 2-2 Circuit Breaker Escutcheon Dimension

Note: If circuit breaker includes factory installed internal accessories, make sure accessory wiring can be reached when the circuit breaker is mounted.

a. Individual Mounting Panels

Predrill panel and tap holes using bolt drilling plan (Figure **2-1**). Install circuit breaker using mounting screws and washers. Tighten screws firmly, but do not exceed 15 inch pounds (1.69 N.m.).

b. DIN Rail Mounting

Adapter kit (S# 1225C79G01 for 1 and 2 pole breakers and S# 1225C79G02 for 3 pole breakers) suitable for use with standard 35 millimeter DIN rail (such as 35mm x 7.5 or 35mm x 15 per DIN EN50022), should be pre-assembled to the rear of the circuit breaker as required by snapping adapter onto DIN rail.

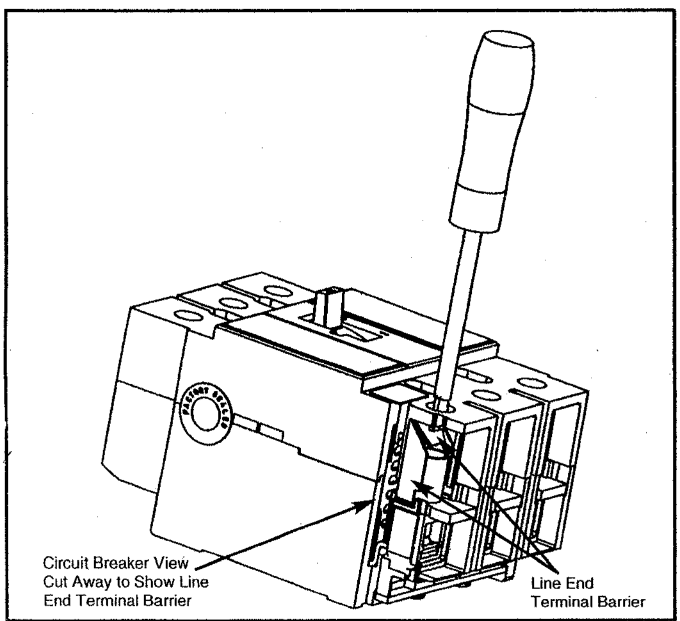


Figure 2-3 Line End Terminal Barrier

c. Base Mounting Plate

Install base mounting plate (S# 207B513G01 - suitable for mounting six 1-pole, three 2-pole, and two 3-pole breakers) with hardware provided. A recess is provided in the line and load-end of the circuit breaker for mounting to base mounting plate. Clip circuit breaker into retaining clips load-end first.

d. Deadfront Cover

Cut out mounting panel cover to correct escutcheon dimensions (Figure **2-2**).

CAUTION

WHEN ALUMINUM CONDUCTORS ARE USED, THE APPLICATION OF A SUITABLE JOINT COMPOUND IS RECOMMENDED TO REDUCE THE POSSIBILITY OF TERMINAL OVERHEATING. TERMINAL OVERHEATING CAN CAUSE NUISANCE TRIPPING AND DAMAGE TO THE CIRCUIT BREAKER.

2-3 After mounting the circuit breaker, line and load terminals and accessory leads should be connected. (See accessory lead identification on side of circuit breaker).

2-4 The line end terminal barriers of **GD circuit breakers and molded case** switches bend when a screwdriver is inserted to tighten line end terminals. (See Figure **2-3**).

Table 2-1 Terminal Types ②

Circuit Breaker Amps	Terminal Type Material	Screw Head Type	Wire Type	AWG Wire Range	Metric Wire ① Range (mm²)	Torque Value Lb-in (N.m.)
Use on GD						
15-20	Clamp (Plated Steel)	Slotted	Cu/Al	#14-10	2.5-4.0	See Table 2-2
25-100	Pressure (Aluminum Body)	Slotted	Cu/Al	#10-1/0	4.0-50	See Table 2-2
Use on GD - Steel Terminals						
15-100	Pressure (Steel Body)	Slotted	75°C Cu Only	#14-3	2.5-26.7	See Table 2-3
Use on GWF ①						
~~15-100~~	~~Pressure~~ (Steel Body)	~~Slotted~~	~~Cu Only~~	~~#14-1~~	~~2.5-50~~	~~See Table 2-4~~

① Not UL Listed Sizes

② For line and load-side. Terminals are suitable for the wire type and size given

Table 2-2 GD Terminal Torque Values

AWG Wire Range	Torque Value Lb-in	Torque Value N.m.
#14-10	20	2.26
#8	40	4.52
#6-4	45	5.08
#3-1/0	45	5.08

Table 2-3 GD With Steel Terminals Torque Values (75°C CU Only)

AWG Wire Range	Torque Value Lb-in	Torque Value N.m.
#14-10	35	3.95
#8	40	4.52
#6-3	45	5.08

Table 2-4 GWF Terminal Torque Values

AWG Wire Range	Torque Value Lb-in	Torque Value N.m.
~~#14-1~~	~~45~~	~~5.08~~

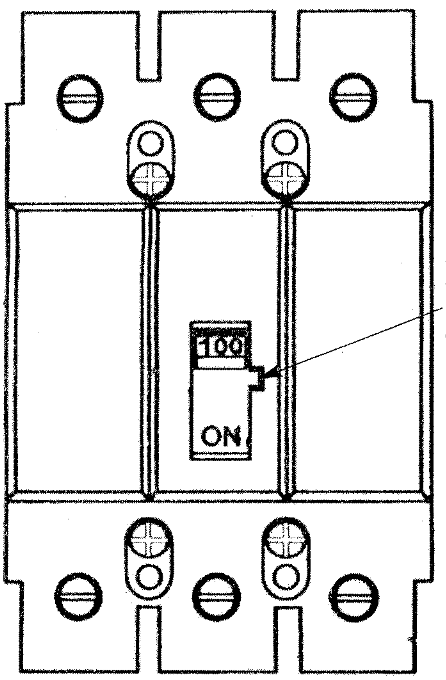


Figure 3-1 Circuit Breaker Manual Controls

2-5 After the circuit breaker is installed, check all mounting hardware and terminal connecting hardware for correct torque loading. Torque values for line/load terminals are given in Tables **2-1**, **2-2** and **2-3** and on the circuit breaker nameplate.

3. Manual Operation

Manual operation of the circuit breaker is controlled by the circuit breaker handle. There are two positions shown on the handle to indicate when the circuit breaker is ON or OFF, also the tripped position is shown by a white strip. (See Figure **3-1**).

Circuit Breaker Reset

After an automatic trip operation, the circuit breaker is reset by moving the circuit breaker handle to the OFF position.

> **Note:** In the event of a thermal trip, the circuit breaker cannot be reset until the thermal element cools.

4. Inspection and Field Testing

Molded case circuit breakers are designed to provide years of almost maintenance-free operation. The following procedure describes how to inspect and test a circuit breaker in service.

Inspection

Circuit breakers in service should be inspected periodically. The inspection should include the following checks.

WARNING

BEFORE INSPECTING THE CIRCUIT BREAKER IN AN ELECTRICAL SYSTEM, MAKE SURE THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THAT THERE IS NO VOLTAGE PRESENT WHERE WORK IS TO BE PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO REVERSE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

CAUTION

MAKE SURE THAT CLEANING AGENTS OR SOLVENTS USED TO CLEAN THE CIRCUIT BREAKER ARE SUITABLE FOR THE JOB. SOME COMMERCIAL CLEANING AGENTS WILL DAMAGE THE NAMEPLATES OR MOLDED PARTS.

4-1 Remove dust, dirt, soot, grease, or moisture from the surface of the circuit breaker using a lint-free dry cloth, brush, or vacuum cleaner. Do not blow debris into circuit breaker. If contamination is found, look for the source and eliminate the problem.
4-2 Switch circuit to ON and OFF several times to be sure that the mechanical linkages are free and do not bind. If mechanical linkages are not free and are binding, replace circuit breaker.

4-3 Check base, cover, and operating handle for cracks, chipping, and discoloration. Circuit breakers should be replaced if cracks or severe discoloration is found.

4-4 Check terminals and connectors for looseness or signs of overheating. Overheating will show as discoloration, melting, or blistering of conductor insulation, or as pitting or melting of conductor surfaces due to arcing. If there is no evidence of overheating or looseness, do not disturb or tighten the connections. If there is evidence of overheating, terminations should be cleaned or replaced. Before reenergizing the circuit breaker, all terminations and cable should be refurbished to the condition when originally installed.

4-5 Check circuit breaker mounting hardware, tighten if necessary.

4-6 Check area where circuit breaker is installed for any safety hazards, including personal safety and fire hazards. Exposure to certain types of chemicals can cause deterioration of electrical connections.

Field Testing

Any field testing should be done in accordance with NEMA Standards Publication AB4-Latest Version.

Eaton Corporation
Eaton Electrical business unit
170 Industry Dirve, RIDC Park West
Pittsurgh, PA 15275, USA
Tel: 1-800-525-2000
www.EatonElectrical.com

Publication 8790C98H04
Effective 11/05

Cutler-Hammer

OVERLOAD RELAY SETTING

This bimetallic ambient compensated overload relay has an adjustable FLA range between 0.254 and 74.9 amperes, depending upon which heater packs are installed.With proper heater selection, the overload relay will ultimately trip at 125% FLA for a 1.15 service factor motor and at 115% FLA for a 1.0 service factor motor.

HEATER SELECTION / INSTALLATION - Select the appropriate heater pack number which corresponds to the motor FLA rating for your application. Insert each heater into the overload relay and tighten heater mounting screws to 9 pound-inches of torque.

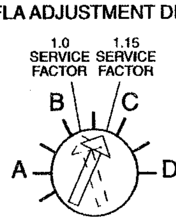
NOTE - Three heater packs with the same number must be installed in the overload relay for the overload relay to work properly.

FLA DIAL ADJUSTMENT - For motors having a 1.15 service factor, rotate the FLA adjustment dial to correspond to the motor's FLA rating. Estimate the dial position when the motor FLA falls between two letter values as shown in the example.

For motors having a 1.0 service factor, rotate the FLA dial one-half position counterclockwise (CCW).

● NOTE: After the above-referenced settings have been made, rotate the FLA dial one position clockwise for these heaters (see table). If less than one position is available, rotate dial to maximum. This note does not apply when these heaters are used with Catalog No. C306TB2 adaptor base.

FLA ADJUSTMENT DIAL



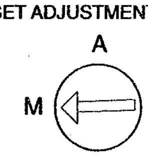
Example of a 12.0 FLA setting for heater pack number H2011B showing position for 1.0 or 1.15 service factor motors.

MANUAL / AUTOMATIC RESET - The overload relay is factory set at "M" for manual reset operation as shown in the illustration. For automatic reset operation, turn the reset adjustment dial to the "A" position.

Automatic reset is not intended for two-wire control devices.

Ce dispositif de reenclenchement automatique ne convient pas aux commandes a deux conducteurs.

RESET ADJUSTMENT DIAL



Example of setting for manual reset

TEST FOR TRIP INDICATION - To test overload relay for trip indication when in manual reset, pull out the blue reset button. An orange flag will appear indicating that the device has tripped. Push reset button in to reset.

LOAD TERMINATION TIGHTENING TORQUE

Use 75°C Copper Conductors Only

For -T16 Catalog Numbers, Torque to 17 lb-in

WIRE SIZE (AWG)	TORQUE (lb-in)	
14 - 10	35	-T16 is for ring lug connection only
8	40	
6 - 4	45	
3 - 2	50	

MAXIMUM RATINGS

NEMA SIZE	AMPS	SIZE *	AMPS
		~~G~~	~~37.0~~
1	27.0	~~H~~	~~44.0~~
~~1-3/4~~	~~36.0~~	~~J~~	~~60.0~~
~~2~~	~~45.0~~	~~K~~	~~73.0~~

* Size is the fifth digit in the catalog number. Example: AE16GN0

HEATER PACK SELECTION

MOTOR FLA RATING ◆ FLA DIAL POSITIONS A	B	C	D	STD TRIP CLASS 20
~~.254~~	~~.306~~	~~.359~~	~~.411~~	~~H2001B~~
~~.375~~	~~.452~~	~~.530~~	~~.607~~	~~H2002B~~
~~.560~~	~~.676~~	~~.791~~	~~.907~~	~~H2003B~~
~~.814~~	~~.983~~	~~1.15~~	~~1.32~~	~~H2004B~~
~~1.20~~	~~1.45~~	~~1.71~~	~~1.96~~	~~H2005B~~
~~1.79~~	~~2.16~~	~~2.53~~	~~2.90~~	~~H2006B~~
~~2.15~~	~~2.60~~	~~3.04~~	~~3.49~~	~~H2007B~~
~~3.23~~	~~3.90~~	~~4.56~~	~~5.23~~	~~H2008B~~
~~4.55~~	~~5.50~~	~~6.45~~	~~7.40~~	~~H2009B~~
6.75	8.17	9.58	11.0	H2010B
~~9.14~~	~~10.8~~	~~12.4~~	~~14.0~~	~~H2011B~~
~~14.0~~	~~16.9~~	~~19.9~~	~~22.8~~	~~H2012B~~
~~18.7~~	~~22.7~~	~~26.7~~	~~30.7~~	~~H2013B~~
~~23.5~~	~~28.5~~	~~33.5~~	~~38.5~~	~~H2014B~~
~~29.0~~	~~34.0~~	~~39.1~~	~~44.1~~	H2015B
~~39.6~~	~~45.5~~	~~51.5~~	~~57.4~~	~~H2016B~~●
~~53.9~~	~~60.9~~	~~67.9~~	~~74.9~~	~~H2017B~~●

HEATER PACK SELECTION

MOTOR FLA RATING ◆ FLA DIAL POSITIONS A	B	C	D	FAST TRIP CLASS 10
.260	.313	.367	.420	H2101B
.384	.464	.543	.623	H2102B
.570	.688	.806	.924	H2103B
.846	1.02	1.20	1.37	H2104B
1.28	1.55	1.83	2.10	H2105B
1.92	2.33	2.74	3.15	H2106B
2.30	2.79	3.28	3.77	H2107B
3.38	4.10	4.82	5.54	H2108B
4.96	6.03	7.09	8.16	H2109B
7.07	8.58	10.1	11.6	H2110B
9.60	11.2	12.8	14.4	H2111B
14.4	17.5	20.7	23.8	H2112B
18.7	21.8	25.0	28.1	H2113B
23.5	27.3	31.0	34.8	H2114B
28.3	32.6	37.0	41.3	H2115B
36.6	42.3	48.1	53.8	H2116B●
53.8	60.8	67.9	74.9	H2117B●

◆ For Motor FLA values not listed, turn the dial clockwise for higher or counterclockwise for lower ratings.

WARNING - To provide continued protection against fire or shock hazard, the complete overload relay must be replaced if burnout of the heater element occurs.

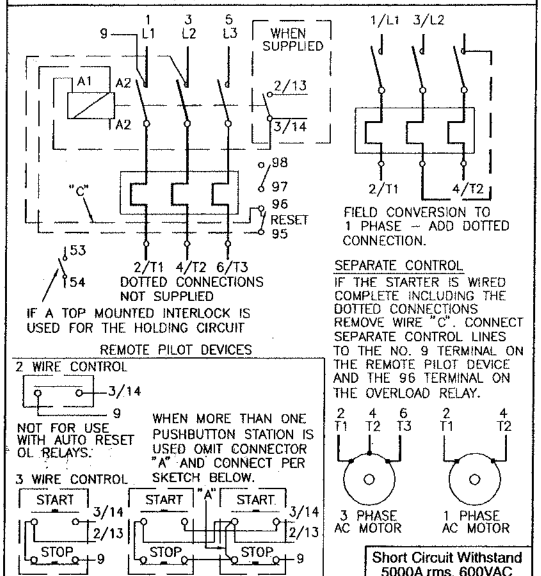
AVERTISSEMENT: Le relais de surcharge doit etre remplace si l'element porteur de courant grille.

FIELD WIRING KIT for -T16

Catalog No. C325KAL40

Pub. 22180 Printed in U.S.A. Rev. A (FH7)

AC FULL VOLTAGE MAGNETIC STARTER



Short Circuit Withstand 5000A rms, 600VAC

POWER TERMINATIONS

Use 75°C Copper Wire Only

LINE TERMINALS

Torque to 15 lb-in.
For catalog numbers with -T16, Torque to 17 lb-in.
-T16 is for ring lug connection only

LOAD TERMINALS

Refer to Overload Relay Setting Publication for Torque Ratings

AUXILIARY CONTACTS

SIDE MOUNTED

Catalog No.	Contacts
C320KGS1	N.O.
C320KGS2	N.C.
C320KGS3	N.O. - N.C.
C320KGS4	2 N.O.
C320KGS5	2 N.C.
C320KGS6	N.O. - N.C.(I.)
C320KGS7	N.O. (E.C.) - N.C.(L.O.)
C320KGS8	N.C.(I.)

CONTROL CIRCUIT FUSEHOLDER KIT

Catalog No.	Fuse Type
C320FBR	Class CC

RENEWAL PARTS

Magnet Coil - Specify the number stamped on coil.

PNEUMATIC TIMERS

Catalog No.	Timing Range
C320TP1	0.3 to 10 Sec.
C320TP2	10 to 180 Sec.

AUXILIARY CONTACTS

TOP MOUNTED

Catalog No.	Contacts
C320KGT1	N.O.
C320KGT2	N.C.
C320KGT3	N.O. - N.C.
C320KGT4	2 N.O.
C320KGT5	2 N.C.
C320KGT6	N.O. - N.C.(I.)
C320KGT7	N.O. (E.C.) - N.C.(L.O.)
C320KGT8	N.C.(I.)
C320KGT9	3 N.O.
C320KGT10	2 N.O. - 1 N.C.
C320KGT11	1 N.O. - 2 N.C.
C320KGT12	3 N.C.
C320KGT13	4 N.O.
C320KGT14	3 N.O. - 1 N.C.
C320KGT15	2 N.O. - 2 N.C.
C320KGT16	1 N.O. - 3 N.C.
C320KGT17	4 N.C.
C320KGT18	3 N.O. - 1 N.C.(I.)
C320KGT19	2 N.O. - 1 N.C.(I.) - 1 N.C.
C320KGT20	2 N.O. - 1 N.O.(E.C.) - 1 N.C.(L.O.)

MOUNTING PLATE

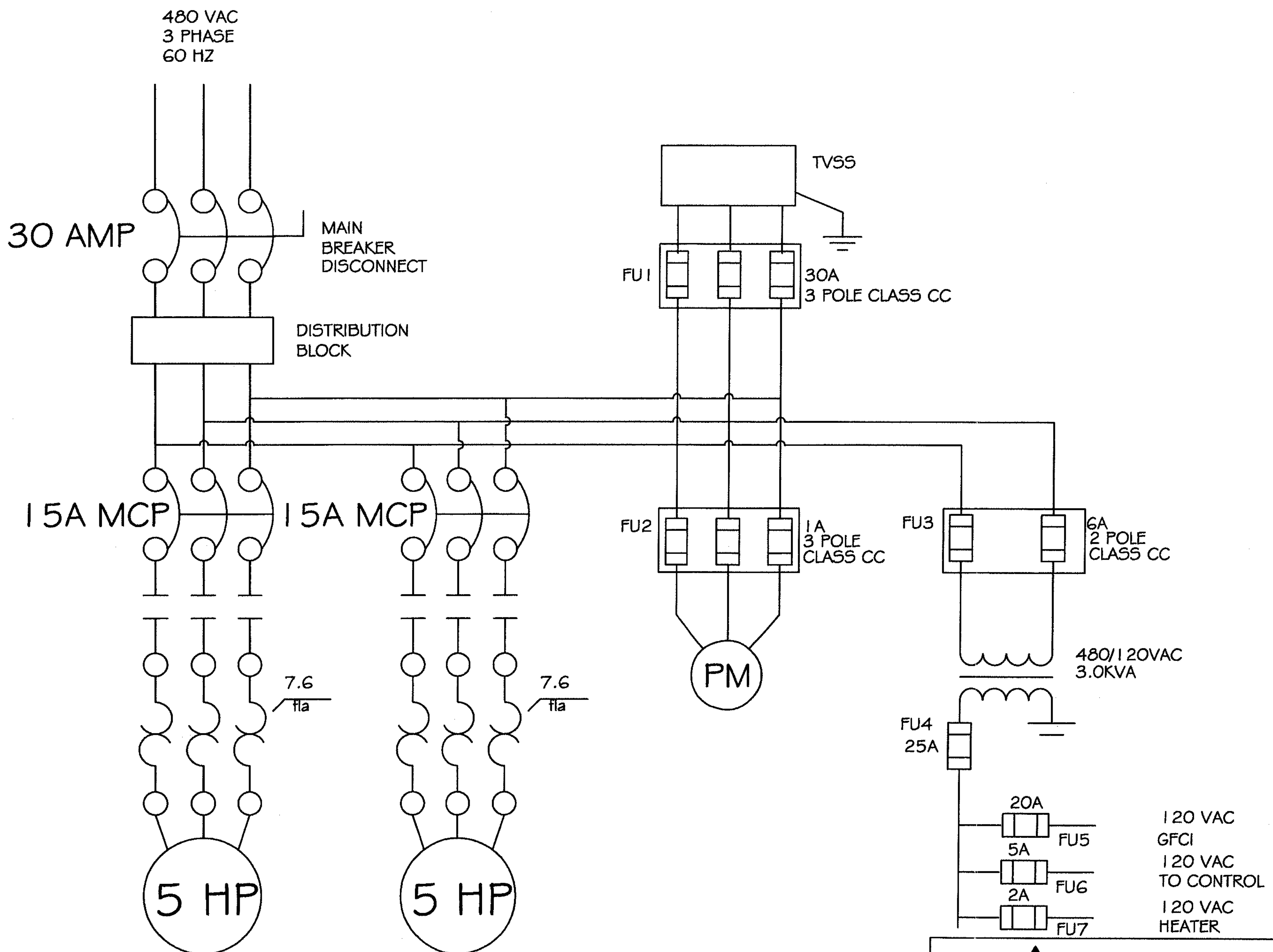
Catalog No.	C321MP3

FIELD WIRING KITS for -T16

Starter	Kit No.
AE16D	C325KAL32 & C325KAL35
AE16E	C325KAL33 & C325KAL35
AE16F	C325KAL34 & C325KAL35

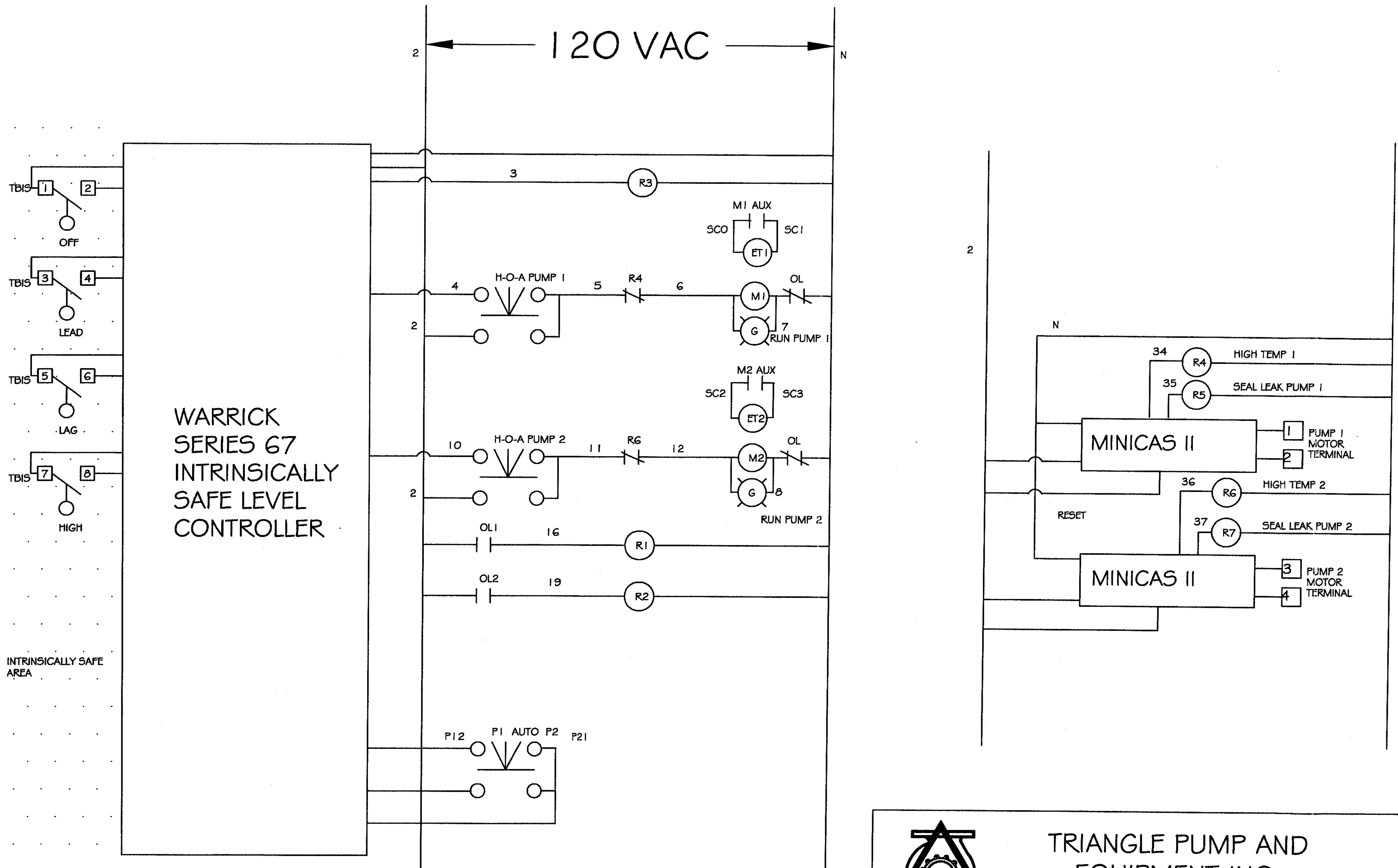
Cutler-Hammer EATON
Pub. 19216 (255772) Printed in U.S.A. Rev. B (FH7)

SECTION 4



TRIANGLE PUMP AND
EQUIPMENT INC.
Clackamas, Oregon - www.trianglepump.com

SCALE: NONE	APPROVED BY	REVISION: A
DATE: 5/07/07		DRAWN BY: ELI
PROJECT: WYCOFF DUPLEX PUMP SYSTEM		
CUSTOMER: HOMES MECHANICAL		DRAWING # WY001



1. CABINET TO BE CONNECTED TO A GOOD GROUND.
2. CAUTION - MAINTAIN SEPARATION BETWEEN INTRINSICALLY SAFE WIRING AND OTHER WIRING.
3. WHEN MULTIPLE BARRIER MODULES ARE USED, THE INTRINSICALLY SAFE CIRCUITS MUST EXIT THROUGH SEPARATE CONDUITS ABLE TO BE SEPARATED FORM EACH OTHER.

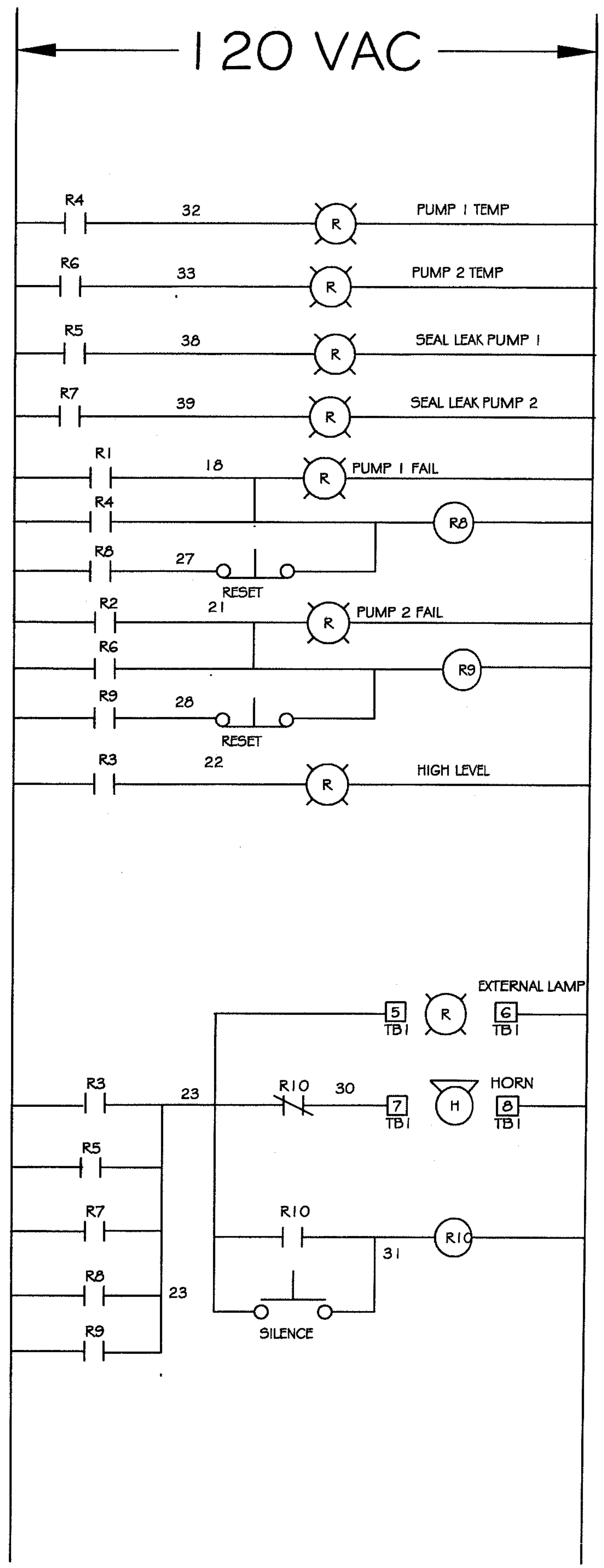
TRIANGLE PUMP AND
EQUIPMENT INC.

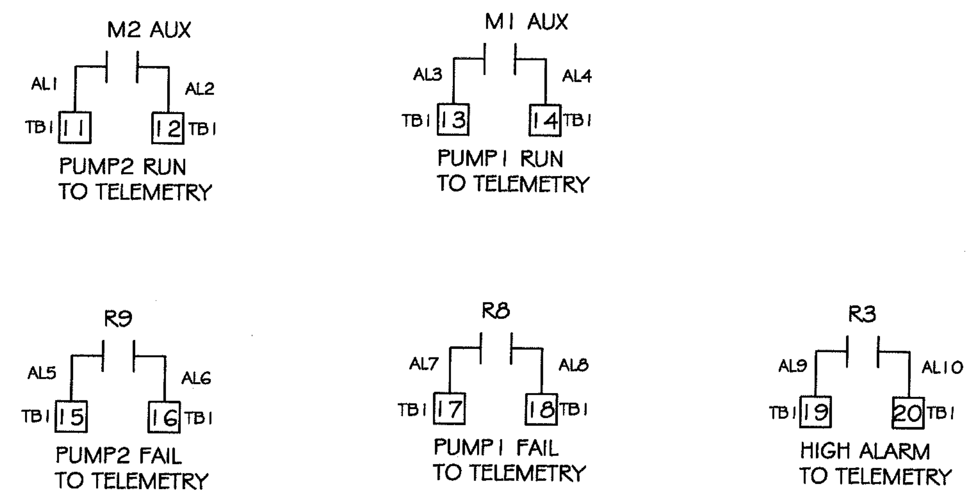
Clackamas, Oregon

SCALE: NONE	APPROVED BY	REVISION: A
DATE: 5/9/07		DRAWN BY: ELI

PROJECT: WYCOFF DUPLEX SYSTEM CONTROL SCHEMETIC

CUSTOMER: HOLMES MECHANICAL	DRAWING # WYC002





TRIANGLE PUMP AND EQUIPMENT INC.

Clackamas, Oregon

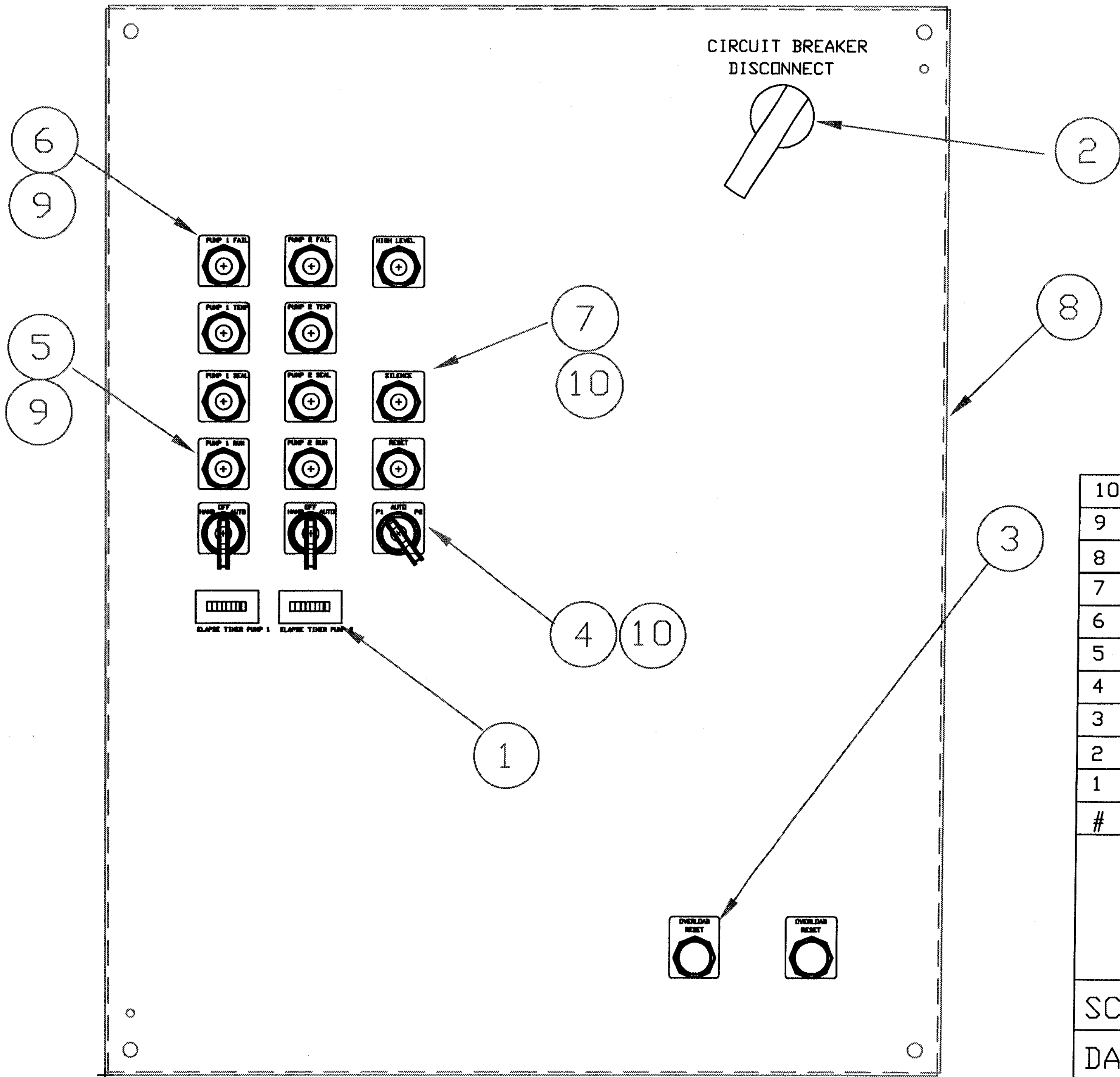
SCALE: NONE	APPROVED BY	REVISION: A
DATE: 5/9/07		DRAWN BY: ELI

PROJECT: WYCOFF DUPLEX SYSTEM CONTROL SCHEMETIC

CUSTOMER: HOLMES MECHANICAL

DRAWING # WYC003

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



INNER DOOR LAYOUT

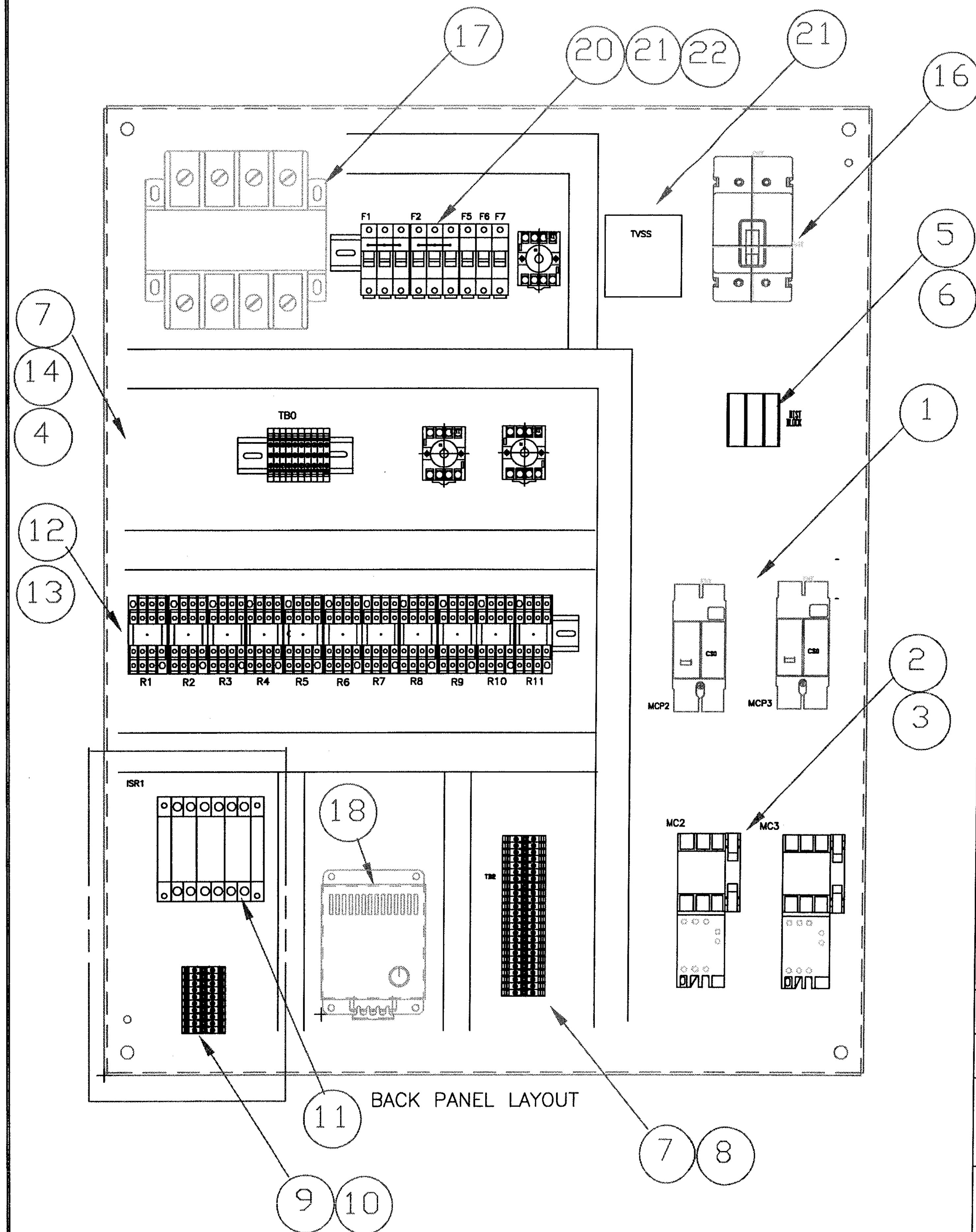
#	QTY	PART NUMBER	DESCRIPTION	MANUFACTURE
10	9	E22B1	CONTACT BLOCK	CUTLER
9	9	E22R2	LIGHT UNIT 120	CUTLER
8	1	A-40P30	BACK PANEL	HOFFMAN
7	2	E22PB1	PUSH BUTTON	CUTLER
6	7	E22H2	LAMP RED	CUTLER
5	2	E22H3	LAMP GREEN	CUTLER
4	3	E22VBG1A	SWITCH 3 POS	CUTLER
3	2	E22MRL	MECHANICAL RESET	CUTLER
2	1	HM1R12	HANDLE	CUTLER
1	2	A103	ELAPSE TIMER	DANAHER

TRIANGLE PUMP AND
EQUIPMENT INC.
Clackamas, Oregon

SCALE: NONE	APPROVED BY	REVISION: A
DATE: 5/9/07		DRAWN BY: ELI

PROJECT: WYCOFF DUPLEX SYSTEM
INNER DOOR LAYOUT

CUSTOMER:	DRAWING #
HOLMES MECHANICAL	WYC004



BACK PANEL LAYOUT

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED

#	QTY	PART NUMBER	DESCRIPTION	MANUFACTURE
22	1	A257B	PHASE MONITOR	TIME
21	3	LSPM001	FUSE HOLDER	LITTLE
20	2	LSPC003	FUSE HOLDER	LITTLE
19	1	1456	TVSS	JOSYLN
18	1	DAH1001	HEATER	HOFFMAN
17	1	EF2KOBTZ	TRANSFORMER	MICRON
16	1	EHD3030	BREAKER	CUTLER
15	1	A-40P30	PANEL	HOFFMAN
14	3	PYF3A-E	BASE RELAY	OMRON
13	10	700HN	BASE RELAY	ALLEN
12	10	700HB	RELAY	ALLEN
11	1	67C1C0A	INTRINSIC RELAY	WARRICK
10	1	0118368.16	TERMINAL END BLUE	ENTRELEC
9	10	0115116.07	TERMINAL BLUE	ENTRELEC
8	4	8WA1808	END TERMINAL	SIEMENS
7	12	8WA1011	TERMINAL	SIEMENS
6	1	U-09311	END COVER	FERRAZ
5	3	63130	DISTRIBUTION BLOCK	FERRAZ
4	2	MINICAS II	MOTOR PROTECTOR	FLYGT
3	3	H2010B-3	HEATER	CUTLER
2	2	AN16DN0AB	STARTER	CUTLER
1	2	GD3015	CIRCUIT BREAKER	CUTLER

TRIANGLE PUMP AND EQUIPMENT INC.
Clackamas, Oregon

SCALE: NONE	APPROVED BY	REVISION: A
DATE: 5/9/07		DRAWN BY: ELI

PROJECT: WYCOFF DUPLEX SYSTEM
BACK PANEL LAYOUT

CUSTOMER: HOLMES MECHANICAL

DRAWING # WYC005

WYKOFF GROUND WATER

Submersible Pumps

Operation & Maintenance Manual
Volume 1 of 1

Manufacturer:
ITT Flygt Corp
790A Chadbourn
Fairfield, CA
(707) 422-9894
(707) 422-9808 Fax

Local Supplier
Whitney Equipment Company
21222 30th Dr SE #110
Bothell, WA 98021
(425) 486-9499
(425) 485-7409 Fax

WYKOFF GROUNDWATER

OPERATION AND MAINTENANCE MANUAL

TABLE OF CONTENTS

SECTION ONE:

- MAINTENANCE AND SERVICE SUMMARY
- MAINTERNANCE SUMMARY FORM
- 21 POINT CHECKLIST
- PUMP CURVES
- RECOMMENDED SPARE PARTS

Maintenance & Service Summary

<u>All</u> centrifugal pumps in sewage applications, including ITT Flygt, will perform better and for a longer period of time if they receive regular service and maintenance. The minimum <u>maintenance</u> required to insure each ITT Flygt pump is eligible for warranty claims is described in Section 3 "Pump Care & Maintenance Manual." However, based on Whitney's more than thirty-years of experience with sewage we recommend the pumps receive service at regular intervals. Listed below are Whitney Equipment Company's <u>service</u> recommendations.

Why service the pump when the maintenance schedule calls for longer intervals? Let us start by describing how we view the difference between maintenance and service. By service we are talking about regular inspection of the station and the pumps. We define maintenance as referring to the replacement of fluids or parts. Service is usually done more frequently with maintenance being a more extensive procedure at longer intervals.

Remember the warranty is about the manufacturing integrity of the pump. The warranty assures the end user of the ITT Flygt quality. In this respect we are glad to honor the warranty in those few instances where a manufacturing defect may have occurred or the pump does not live up to anticipated manufacturing expectations. The warranty does not cover normal or extraordinary wear, damage to the pump from improper handling (such as dropping while lifting out of the wet well) or damage as a result of improper electrical supply issues (1. see details below). But all of these issues can be eliminated or reduced by regular service inspections.

Here are our recommendations for service intervals and what type of inspections should be conducted during these intervals.

Pumps should be serviced as follows:

- An initial service inspection should be conducted of the pump sometime within the first three months of operation.
- Routine service inspection based on the following schedule of run time hours (per pump) or time.
    - One service every 2,000 hours or one year, which ever occurs first.
    - For pumps running between 2,000 to 4,000-hours per year we recommend a service interval of every six months unless the run time occurs mostly during one period during the year (such as a peak flow during the summer or winter months due to a local attraction like a lake or ski resort), service at the beginning or end of the intensive use period.
    - For pump running more than 4,000-hours per year, we recommend a monthly service interval.
    - For any instance where the utility encounters repeated problems or unusual wear at a pump station we recommend more frequent service interval appropriate for a specific condition.

Service and inspection recommendations for operators of lift station:

<u>Minimum service</u> procedure includes the following five steps:

1. Before beginning review all safety procedures.
2. Check amp draw either via amp meters in the control panel or by using a hand held current clamp device. Cross check against amp draw during start-up.
3. Check mini-CAS relay to insure green light is on and there is no leak or thermal indication.
4. Perform a draw down of the wet well to see if pumps are operating and there is no "blow-by" on the discharge elbows.
5. Make a visual inspection of pump cables and lifting device.

<u>Recommended service checks</u> based on the use (run time in hours) and the judgment of the utility operations and maintenance people.

1. After following safety procedures, remove pumps, one at a time from the wet well. We recommend all pumps be shut off while each pump is being removed for service and inspection. A lifting device (crane or hoist) must be available of the appropriate size for service and maintenance.
2. Make a physical inspection of the pump exterior, impeller, power cable and lifting chain and or guide cable.
3. Check for oil or water in the leak chamber (see Care and Maintenance manual for procedure).
4. Examine gap between impeller and volute. If the gap is more than ¼-inch, adjust impeller, or schedule impeller to be adjusted (see Care and Maintenance manual).
5. Insure impeller is not loose (make sure power to pump is shut off before checking impeller - this is where shutting all pumps off is a good idea).
6. Run pump briefly to check for bearing noise.
7. Check rotation of each pump (see Care and Maintenance manual for procedure).
8. Check electrical condition of insulation on power cable and on all phases of the motor using an Ohms meter. Measure resistance between stator windings in Ohms.
9. Check for any loose or faulty electrical connections within the pump control panel.
10. Check voltage supply between all phases of the electrical control panel in volts A/C.
11. Check voltage balance between all phases on the load side of the pump control with each pump on (volts A/C).
12. Reinstall Flygt pumps on their elbows and run to insure pumps are properly seated on their respective discharge connection.
13. Check operation of valves in the station.

Special note on warranty issues.
If you review the ITT Flygt warranty you will see that the coverage is prorated. Four the first 18-months the warranty coverage is 100%. We recommend the first rigorous service inspection during this initial period where the maximum coverage is available.

ITT Flygt warranty: See attached document.

Note on start-up. A formal start-up was done for this lift station and the start-up report is on file at Whitney Equipment Company.

Items not covered by the ITT Flygt warranty:

L1. Mechanical
Damage caused by pumping/mixing liquids in excess of 115° degrees F (46° degrees C) when not authorized by Flygt Corporation in writing.
Repairs not made by a Flygt Authorized Service Facility.
Damage caused by dropping the pump/mixer.
Damage to pump with leakage sensor resulting from pump more than 10° off vertical.
Damage to pumps, parts, or other accessories caused by freight carriers (See "Receiving Damaged Goods").

Electrical
Damage to pumps and electrical motors when inappropriate or inadequate panels are used and have not prevented failure.
Damage to pumps when the failure is electrically related, and proof of motor protection cannot be supplied.
Motor burnout's that are caused by excessive high or low voltage, or unbalanced voltage conditions.
Damage caused by excessive starting frequency (more than 15 evenly spaced starts per hour) unless authorized by Flygt Corporation.
Damage caused by repeated attempted starts, after overload protection has tripped (without investigating cause).
Damage caused by user not utilizing protective leakage & overheating devices.
Motor rewinding by an unauthorized rewind facility.

L2. Hydraulic
Damage caused by running a pump in reverse.
Damage caused by pumping in dotted portion of published curves, unless authorized by Flygt Corporation in writing.
Damage caused by pumping volatile liquids, or liquids which are corrosive or hazardous, except where approved by Flygt Corporation.

Damage caused by pumping liquids with a higher viscosity or higher specific gravity than Flygt Corporation's printed recommendations, unless authorized and approved by Flygt Corporation in writing.

Damage due to normal wear and tear in normal operation of the pump.
Damage to products derived from the use in applications not recommended in Flygt Corporation's printed instructions or sales literature (misapplications).

L3. Miscellaneous
Note: Costs for the following are not covered:
Travel expenses, mileage, or lodging fees to, from or at a repair site, unless requested and/or authorized by Flygt Corporation.
Damage resulting from the use of non-Flygt manufactured or supplied parts.
Damaged caused by using impellers not recommended in our published curves, sales literature, or technical manuals.

Consequential damages caused by a replaced part's secondary or repeated failures.
Product failures that are not reported within the required thirty (30) days from the failure.
Pumps & parts damaged by freezing.
Pumps & parts damaged by lightning.

MAINTENANCE SUMMARY FORM

PROJECT: **WYCKOFF GROUNDWATER**

1. EQUIPMENT ITEM **FLYGT**
2. MANUFACTURE ITT FLYGT
3. SERIAL NUMBER(S) **NP3102.090-0760068, 0760069**
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) N/A
5. NAMEPLATE DATA (HP, VOLTAGE, SPEED, ETC.) **5HP, 460V, 3PH,**
6. MANUFACTURE'S LOCAL REPRESENTATIVE
   a. Name: **Whitney Equipment Co., Inc.** Telephone No.: **(425) 486-9499**
   b. Address: **21222 30th Dr SE Suite 110 Bothell, WA 98021**
7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments (Maintenance Summary)	Frequency	(If Applicable) Lubricant Symbol
Inspect visible parts on pump, pump casing & impeller for wear	annually	n/a
Check lubricant/coolant level & condition, change as necessary	annually	**Monopropylene glycol**
Check cables & cable entry for wear and tightness	annually	n/a
Inspect pump voltage draw and meggar readings	monthly	n/a
Check function of level sensors, starter and monitoring equip.	annually	n/a
Check rotation direction of pump	when reconnecting	n/a
Check pipes, valves, peripheral equipment	annually	n/a
Check cooling system	annually	n/a

8. LUBRICANT LIST

Reference Symbol	Shell	Standard Oil	Gulf	Arco	Or Equal
		Monopro pylene glycol			Marine grade Antifreeze

ITT Industries

ITT Flygt Corporation
790-A Chadbourne Road
Fairfield, CA 94534
Tel: (707) 422-9894
Fax: (707) 422-9808

SCHEDULED PUMP PREVENTATIVE MAINTENANCE INSPECTION AGREEMENT FLYGT CORPORATION

SERVICE - 21 POINT CHECK LIST

- ☐ Check electrical condition of insulation on power cable and on all phases of motor. (In Meg Ohms)
- ☐ Check for any loose or faulty electrical connections within the pump control panel.
- ☐ Measure resistance between stator windings. (In Ohms)
- ☐ Check voltage supply between all phases of the electrical control panel. (VAC)
- ☐ Check voltage balance between all phases on the load side* of the pump control with pump on. (VAC)
- ☐ Check amperage draws on all phases of the pump motor. (In Amps)
- ☐ Check condition and operation of motor thermal protectors control system (if so equipped).
- ☐ Removal of Flygt pump from lift station for physical inspection.
- ☐ Check condition of upper shaft seals (inspect condition of motor housing).
- ☐ Check condition and operation of leakage detector (if so equipped).
- ☐ Check lower shaft seals (inspect condition of oil).
- ☐ Change oil if needed (cost of oil included).
- ☐ Check for worn or loose impeller.
- ☐ Check all impeller wear rings. (Note: Wear rings are not covered by warranty and must be purchased by customer if in need of replacement)
- ☐ Check for noise upper and lower bearings.
- ☐ Check physically for damage of pump and power cable.
- ☐ Clean, reset, and check operation of level sensors.
- ☐ Check for correct shaft rotation.
- ☐ Reinstall Flygt pump and check for leakage at the discharge connection.
- ☐ Test of pump operation cycle (if level of liquid in station permits).
- ☐ Check operating of valves and pipes in station.

FLYGT®

FLYGT	PERFORMANCE CURVE	PRODUCT CP3102.980	TYPE MT
DATE 2007-05-09	PROJECT	CURVE NO 63-432-00-3703	ISSUE 2

	1/1-LOAD	3/4-LOAD	1/2-LOAD
POWER FACTOR	0.81	0.75	0.63
EFFICIENCY	85.0 %	85.0 %	83.5 %
MOTOR DATA	---	---	---

RATED POWER	5	hp
STARTING CURRENT ...	42	A
RATED CURRENT ...	6.8	A
RATED SPEED	1745	rpm
TOT.MOM.OF INERTIA ...	0.044	kgm2
NO. OF BLADES	1	

IMPELLER DIAMETER 183 mm

MOTOR #	STATOR	REV
18-11-4AL	01YSER	11

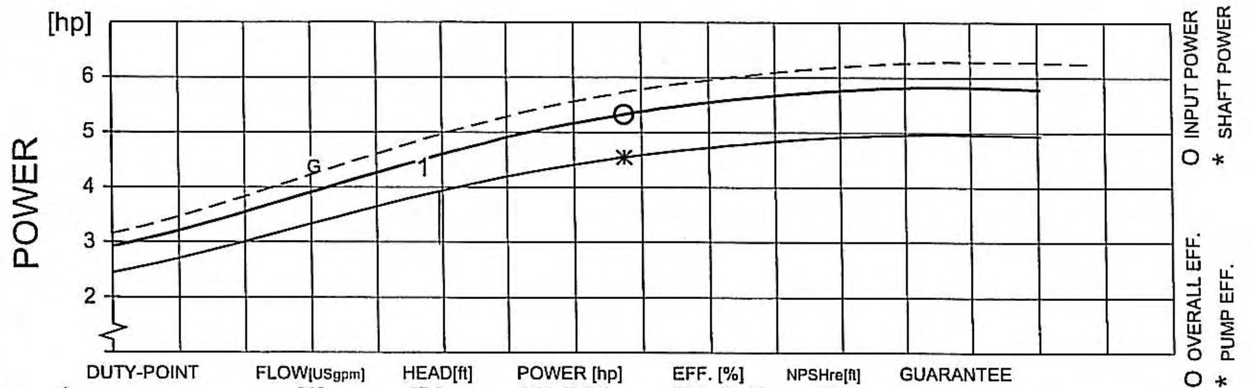
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	460 V	4

GEARTYPE	RATIO
---	---

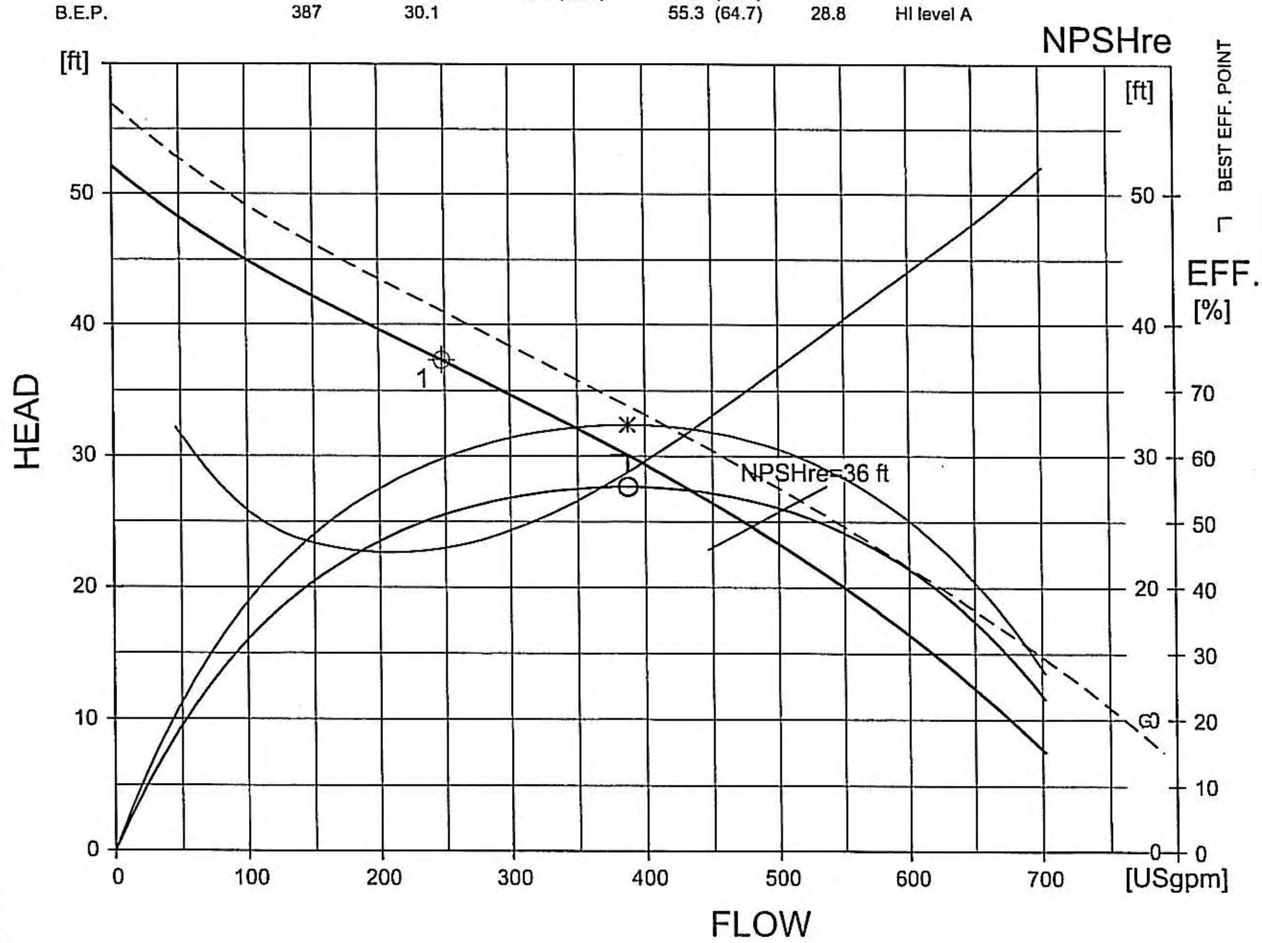
COMMENTS
NEVACLOG

INLET/OUTLET -/ 4 inch

IMP. THROUGHLET 3.0 inch



DUTY-POINT	FLOW[USgpm]	HEAD[ft]	POWER [hp]	EFF. [%]	NPSHre[ft]	GUARANTEE
1	248	37.3	4.61 (3.91)	53.0 (61.9)	23.0	
B.E.P.	387	30.1		55.3 (64.7)	28.8	HI level A



FLYPS3.1.5.8 (20060531)

NPSHre = NPSH3% + min. operational margin

Performance with clear water and ambient temp 40 °C

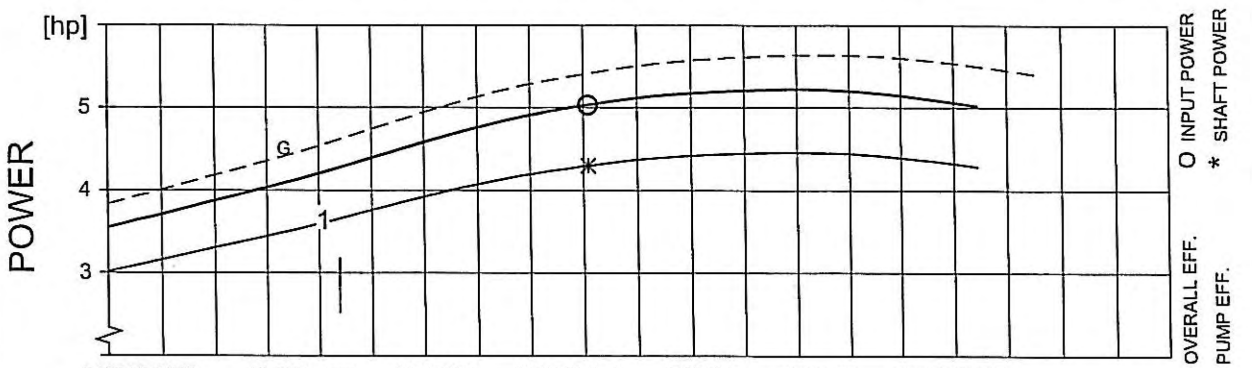
GUARANTEE BETWEEN LIMITS (G) ACC. TO

HI level A

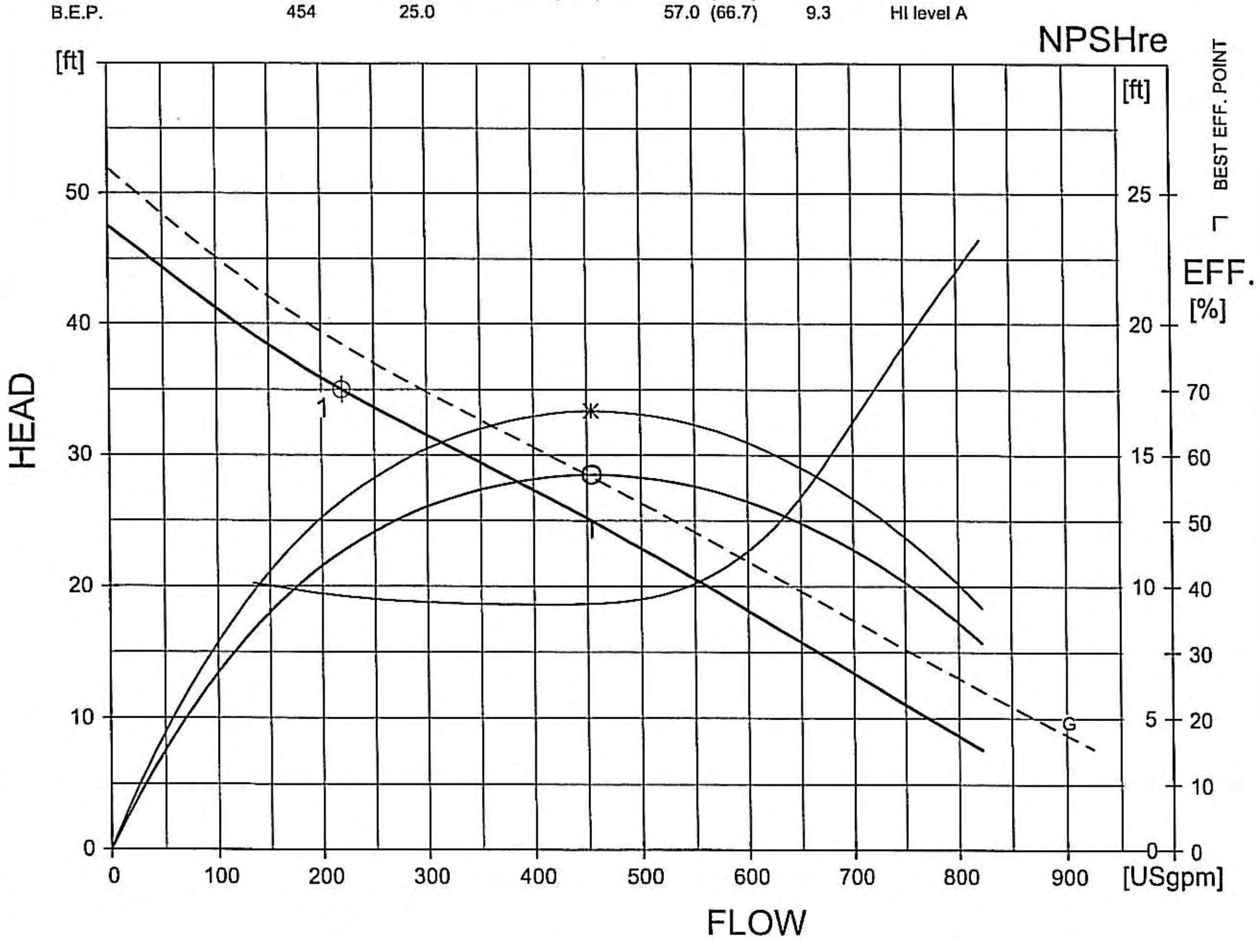
FLYGT	PERFORMANCE CURVE	PRODUCT NP3102.980	TYPE MT
DATE 2007-05-09	PROJECT	CURVE NO 63-463-00-3703	ISSUE 5

	1/1-LOAD	3/4-LOAD	1/2-LOAD			
POWER FACTOR	0.81	0.75	0.64	RATED POWER	5	hp
EFFICIENCY	85.0 %	85.5 %	83.5 %	STARTING CURRENT ...	41	A
MOTOR DATA	---	---	---	RATED CURRENT ...	6.8	A
COMMENTS		INLET/OUTLET -/ 4 inch		RATED SPEED	1745	rpm
		IMP. THROUGHLET ---		TOT.MOM.OF INERTIA ...	0.027	kgm2
				NO. OF BLADES	2	

IMPELLER DIAMETER			
172 mm			
MOTOR #	STATOR	REV	
18-11-4AL	04D	11	
FREQ.	PHASES	VOLTAGE	POLES
60 Hz	3	460 V	4
GEARTYPE	RATIO		
---	---		



DUTY-POINT	FLOW[USgpm]	HEAD[ft]	POWER [hp]	EFF. [%]	NPSHre[ft]	GUARANTEE
1	219	35.0	4.31 (3.61)	47.0 (55.0)	9.6	
B.E.P.	454	25.0		57.0 (66.7)	9.3	HI level A



FLYPS3.1.5.8 (20060531)

NPSHre = NPSH3% + min. operational margin

Performance with clear water and ambient temp 40 °C

GUARANTEE BETWEEN LIMITS (G) ACC. TO

HI level A

ITT FLYGT

RECOMMENDED SPARE PARTS

Submersible Pump Model NP 3102X-643

592 01 03	Inner Mechanical Seal	$ 245.00
592 01 04	Outer Mechanical Seal	$ 320.00
80 32 32	O-Ring Kit	$ 65.00
83 15 73	Upper Bearing	$ 21.00
83 36 90	Lower Bearing	$ 48.00

SPECIAL TOOLS FURNISHED FOR THIS PROJECT

84 08 02	1 each	Snap Ring Pliers Outside
84 08 09	1 each	Snap Ring Pliers Inside
84 13 04	1 each	Hexagon Socket 6 mm
84 13 05	1 each	Hexagon Socket 8 mm
84 13 06	1 each	Hexagon Socket 10 mm
84 13 01	1 each	Hexagon Socket 14 mm
84 14 77	1 each	Hexagon Long Socket 6 mm
84 14 78	1 each	Hexagon Long Socket 8 mm
84 14 79	1 each	Hexagon Long Socket 10 mm
84 14 80	1 each	Hexagon Long Socket 12 mm
84 10 16	1 each	Ratchet Handle ½"
385 66 01	1 each	FM Inspection Tool
	1 each	Metal Tool Box

SECTION TWO:

- FLYGT PUMP SERIALIZED PARTS LIST
- SPECIFICATION DATA SHEET
- PERFORMANCE SPECIFICATION DOCUMENT FOR NP3102
- DIMENSIONAL DRAWING OF NP3102
- LIFT STATION DIMENSIONS
- DUPLEX LIFT STATION LAYOUT
- MOTOR DATA FORM
- CABLE CHART
- EPOXY COATING

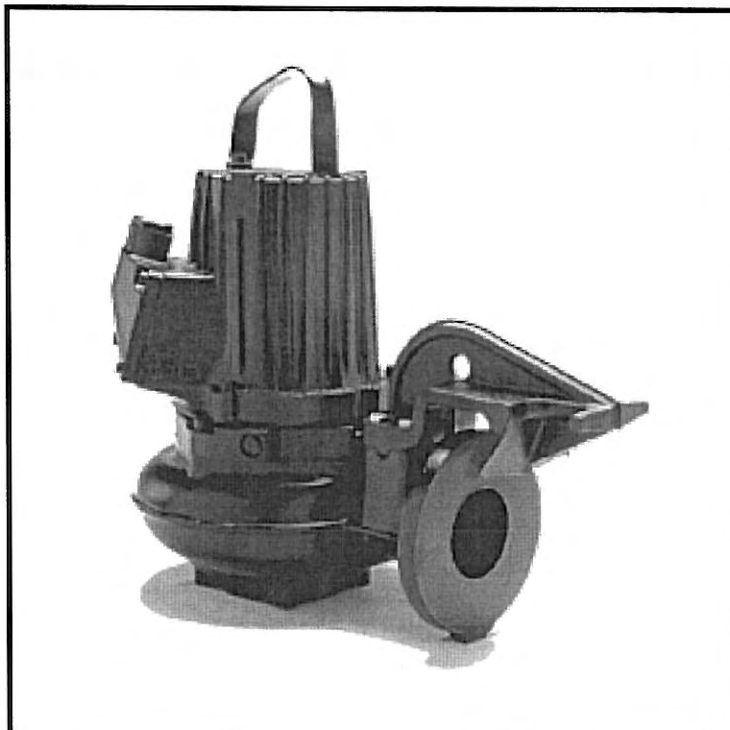
ITT

FM
APPROVED

FLYGT SUBMERSIBLE PUMP

PARTS LIST NP 3102 MT

SERIAL NO 3102.090 0760068



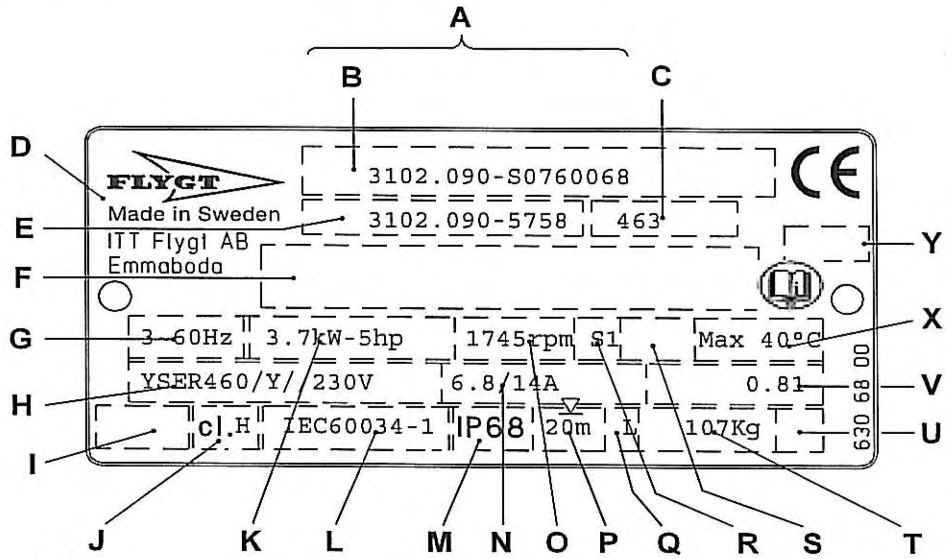
ITT FLYGT CORPORATION
35 NUTMEG DRIVE

TRUMBULL, CT 06611
USA
TELEPHONE NO: 203-3804700

FLYGT NP 3102 MT

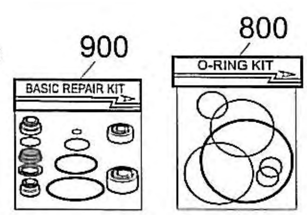
DATE: 2007-11-19

SERIAL NO: 3102.090 0760068



Dataplate interpretation:

A Serial number
B Product code + Number
C Curv code / Propeller code
D Country of origin
E Product number
F Additional information
G Phase; Type of current; Frequency
H Rated voltage
I Thermal protection
J Thermal class
K Rated shaft power
L International standard
M Degree of protection
N Rated current
O Rated speed
P Max. submergence
Q Direction of rotation R=right, L=left
R Duty class
S Duty factor
T Product weight
U Locked rotor code letter
V Power factor
X Max. ambient temperature
Y Notified body
Only for EN-approved Ex-products
Z Read Installation Manual



(1 kg = 2.2 pound, 1 Lit=0.26 US gallon, 1 l = 0,22 UK gallon)

Recommended spare parts:
See REC. column: **A** = Parts for inspection and maintenance
B = Parts for major overhaul

For service;
To ensure long operating life use Flygt Bearing Grease 90 20 61 (Cartridge).
Lubrication kit 84 15 40 contains two 90 20 61 and one 84 15 30 (Grease gun).

The O-ring kit contains a full set of O-rings. Position no 800.

The Basic Repair kits contain both inner and outer Mechanical seals, bearings and a O-ring kit. Position no 900.

A complete set of tools can be ordered for repair and maintenance work, i.e. standard hand tools and special tools for seal change and hydraulic-end use.
Order:
This partlist can be used as an order form by marking out the number of parts in the Qty/Order column.
Please send or fax the form to your Flygt representative.

PARTS LIST

FLYGT NP 3102 MT

SERIAL NO 3102.090 0760068

Item no	Partno	Rec	Denomination	Qty/ord.
1	477 11 00		Lifting handle	1
2	82 00 49	B	Hex.socket hd screw M10X20-A2-70	2
3	630 68 00		Data plate USE 6306801 AS SPARE PART	2
6	83 02 58	B	Hex.socket hd screw M5X12-A4-70	2
8	279 29 00	B	Earthing plate	1
9	82 20 88		Drive screw 4X5	6
10	439 31 03		Stator housing	1
11	82 00 74		Hex.socket hd screw M12X55-A2-70	3
14	630 70 00		Certificate plate FM APPROVED	2
15	550 22 00		Connection plate (FLS)	1
15	698 84 00		Connection plate	1
16	82 74 93	B	O-ring 199.3X5.7-NBR	1
17	83 15 73	B	Ball bearing 6305 Z/C3 25X62X17	1
18	444 75 02		Shaft unit	1
19	310 11 01		Stator 18-11-4a	1
22	83 45 59		Cable tie 200X2,4 PA 6/6 -55+105	1
23	94 21 04	B	Motor cable SUBCAB 12 AWG/7 20-22	16.5 m
24.1	642 17 01		Entrance flange	1
24.3	82 00 71		Hex.socket hd screw M12X40-A2-70	2
24.6	82 17 61		Cutting screw TAPTITE-M6X12	4
24.7	83 42 96		Cable lug 2,5 -6 MM2;M6	2
24.8	83 44 23		Closed end splice 5.1-10,6;(AWG 18-8)L=3	3
24.8	83 44 24		Closed end splice 2.5-6(AWG 12-10)L=17.5	1
24.9	82 74 63		O-ring 49,5X3,0 NBR	1
25	443 50 03		Entrance cover	1
26	82 00 36		Hex.socket hd screw M8X35-A2-70	4
27	82 74 79	AB	O-ring 129,5X3,0-NBR	1
28.1	83 53 21		Terminal clamp	6
28.3	83 53 22		End plate APPA - 1179,6	1
28.6	83 53 31		End support 35X15	2
28.7	443 68 00		Rail	1
28.9	427 13 00		Marking tape	1
28.9	471 77 01		Marking strip	2
30	443 69 00	B	El-lead through	1
30.1	81 98 44		Hex.socket hd screw	1

Ordered by:

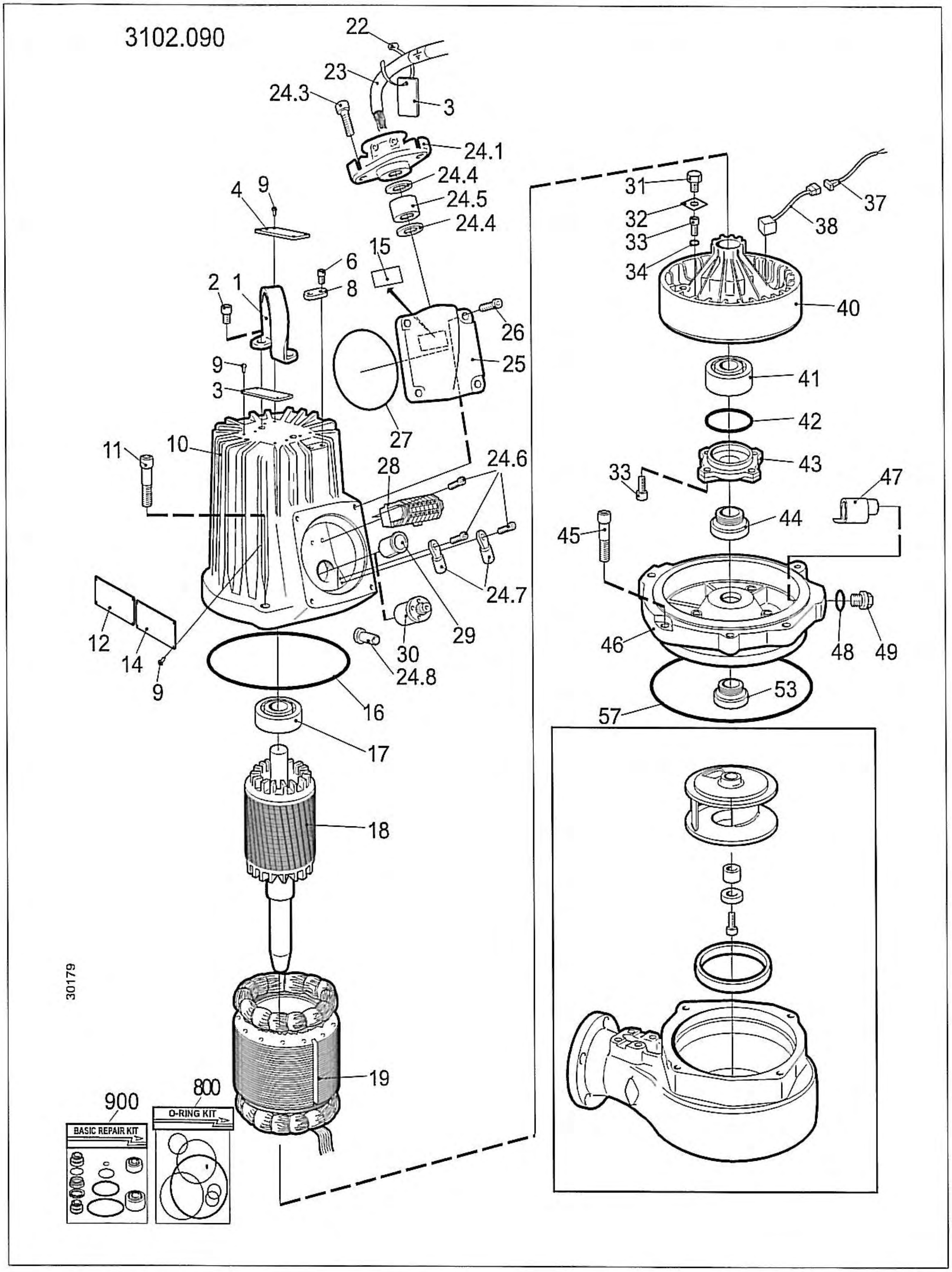
Company:...Ref:.............................Tel:............................Date:......................

PARTS LIST

Item no	Partno	Rec	Denomination	Qty/ord.
30.2	82 35 13		Plain washer	3
31	439 44 01		Screw	3
32	596 07 00		Square washer	3
33	82 17 64		Cutting screw TAPTITE-M6X20	7
34	82 50 60		Lock washer DUBO NR 301	3
37	504 78 07		Cable unit	1
38	518 89 02		Leakage detect.unit (FLS)	1
40	439 33 11		Bearing holder EX.VERSION	1
41	83 36 90	B	Ball bearing 3305A C3 25X62X25,4	1
42	82 74 65	B	O-ring 59,5X3,0-NBR	1
43	605 20 00		Bearing cover	1
44	592 01 03	B	Mechanical seal WCCR/WCCR	1
45	82 00 72		Hex.socket hd screw M12X45-A2-70	4
46	439 32 02		Oil housing bottom	1
47	443 49 00		Sleeve	1
48	82 73 90	AB	O-ring 19.2X3.0 NBR	2
49	428 22 17	B	Inspection screw	2
53	592 01 04	B	Mechanical seal WCCR/WCCR	1
61	380 91 00		Guiding claw	1
62	83 04 53		Hex.socket hd screw M12X45-A4-80	4
63	439 41 00		Sleeve	1
64	678 47 32		Impeller	1
67	303 24 20		Pump housing	1
70	338 13 08		Plain washer	1
72	83 04 56		Hex.socket hd screw M10X35-A4-80	1
79	691 65 00	B	Insert ring	1
121	82 00 51		Hex.socket hd screw M10X25-A2-70	2
122	433 56 00		Cover	1
123	647 99 00		Gasket	1
169	667 40 00		Sticker	2
215	82 40 82		Plain washer (20)-32 MM	4
216	84 18 02		Seal sleeve (20)-23 MM	2
218	597 98 02		Ring	1
800	80 32 32		O-ring kits 3102.090,180<40DGG	1
900	601 89 06		Basic repair kit	1
	90 17 52		Oil	1 l
	90 20 54		Bearing grease	0.037 kg
	82 73 90		O-ring 19.2X3.0 NBR	4
	82 74 79		O-ring 129,5X3,0-NBR	1
	665 90 07	(s)	Zinc anode set	1
...	....		....	....

Ordered by:

Company:..Ref:.............................Tel:............................Date:......................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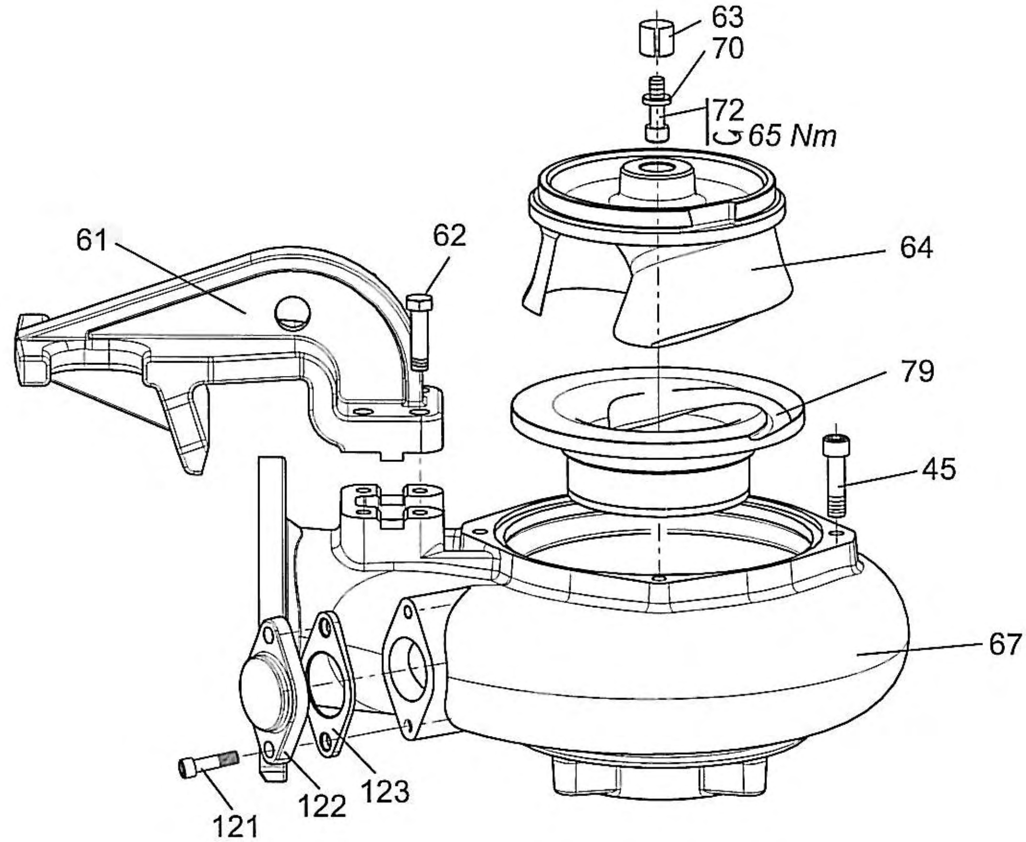
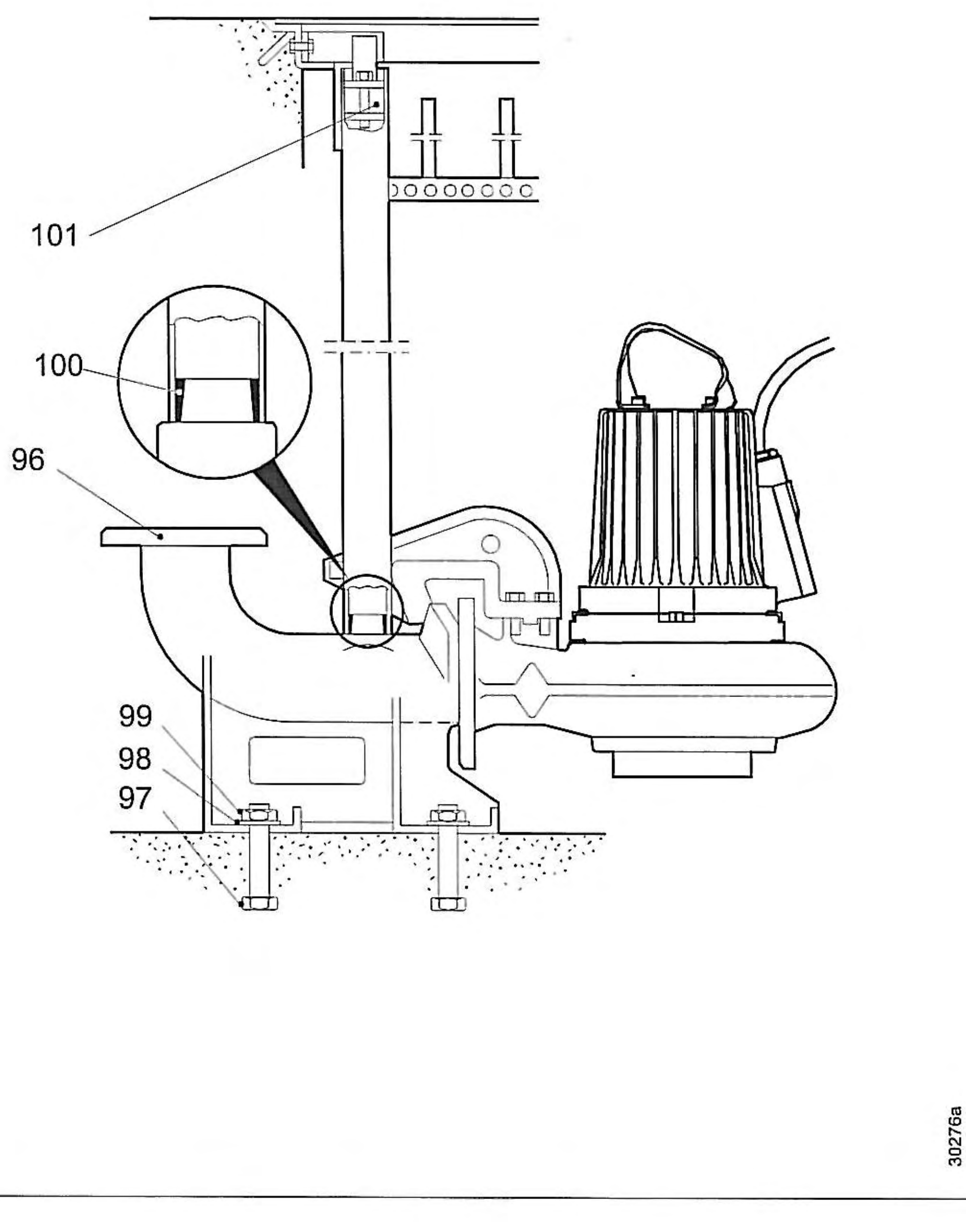
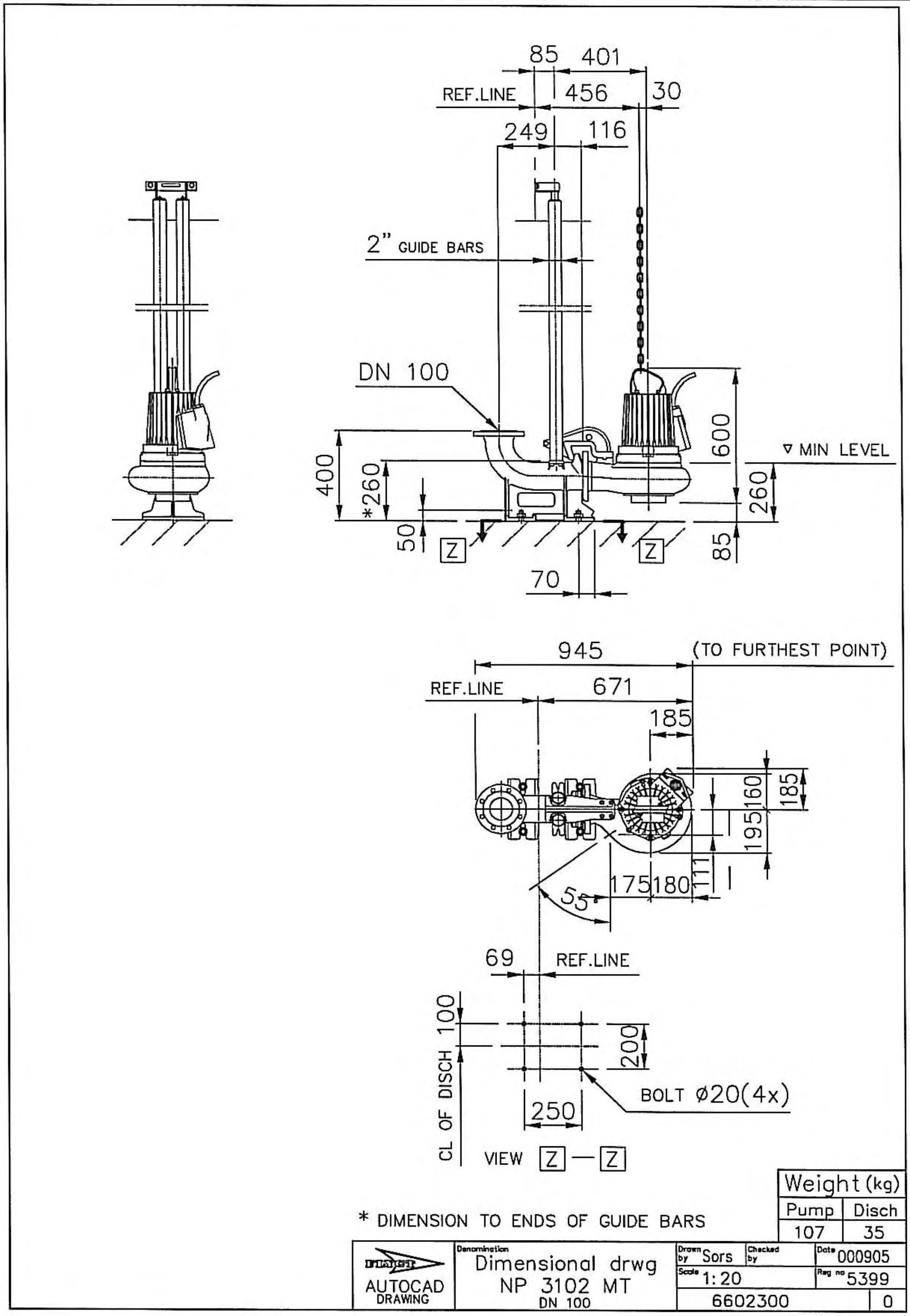
NP 3102 MT



CP, NP 3102



DIMENSIONAL DRAWING



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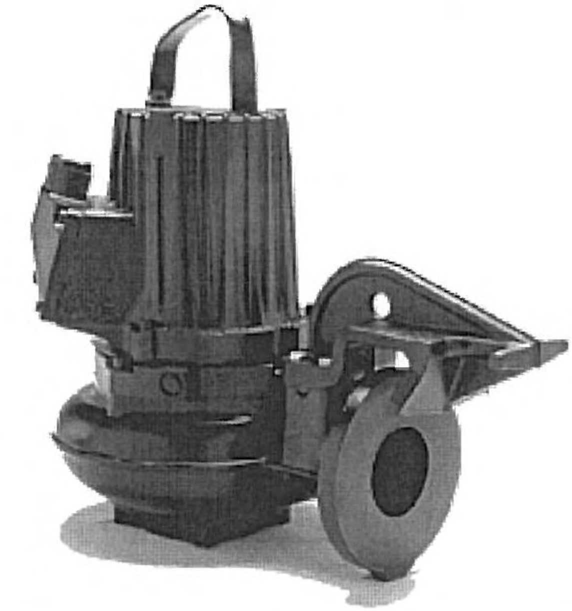
FM APPROVED

FLYGT SUBMERSIBLE PUMP

PARTS LIST NP 3102 MT

SERIAL NO 3102.090 0760069



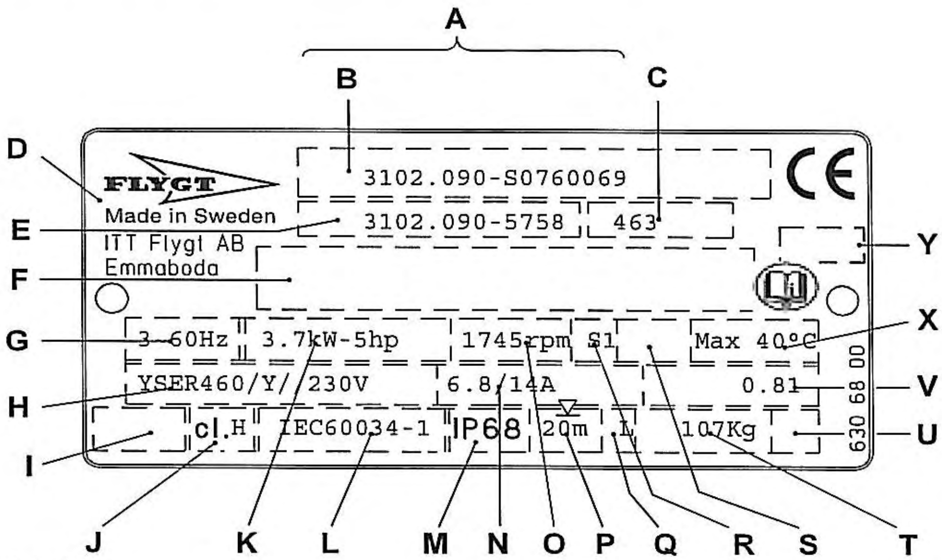
ITT FLYGT CORPORATION
35 NUTMEG DRIVE

TRUMBULL, CT 06611
USA
TELEPHONE NO: 203-3804700

FLYGT NP 3102 MT

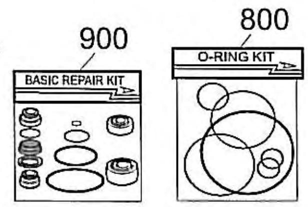
DATE: 2007-11-19

SERIAL NO: 3102.090 0760069



Dataplate interpretation:

A Serial number
B Product code + Number
C Curv code / Propeller code
D Country of origin
E Product number
F Additional information
G Phase; Type of current; Frequency
H Rated voltage
I Thermal protection
J Thermal class
K Rated shaft power
L International standard
M Degree of protection
N Rated current
O Rated speed
P Max. submergence
Q Direction of rotation R=right, L=left
R Duty class
S Duty factor
T Product weight
U Locked rotor code letter
V Power factor
X Max. ambient temperature
Y Notified body
Only for EN-approved Ex-products
Z Read Installation Manual



(1 kg = 2.2 pound, 1 Lit=0.26 US gallon, 1 l = 0,22 UK gallon)

Recommended spare parts:
See REC. column: **A** = Parts for inspection and maintenance
B = Parts for major overhaul

For service;
To ensure long operating life use Flygt Bearing Grease 90 20 61 (Cartridge).
Lubrication kit 84 15 40 contains two 90 20 61 and one 84 15 30 (Grease gun).

The O-ring kit contains a full set of O-rings. Position no 800.

The Basic Repair kits contain both inner and outer Mechanical seals, bearings and a O-ring kit. Position no 900.

A complete set of tools can be ordered for repair and maintenance work, i.e. standard hand tools and special tools for seal change and hydraulic-end use.
Order:
This partlist can be used as an order form by marking out the number of parts in the Qty/Order column.
Please send or fax the form to your Flygt representative.

FLYGT NP 3102 MT

SERIAL NO 3102.090 0760069

Item no	Partno	Rec	Denomination	Qty/ord.
1	477 11 00		Lifting handle	1
2	82 00 49	B	Hex.socket hd screw M10X20-A2-70	2
3	630 68 00		Data plate USE 6306801 AS SPARE PART	2
6	83 02 58	B	Hex.socket hd screw M5X12-A4-70	2
8	279 29 00	B	Earthing plate	1
9	82 20 88		Drive screw 4X5	6
10	439 31 03		Stator housing	1
11	82 00 74		Hex.socket hd screw M12X55-A2-70	3
14	630 70 00		Certificate plate FM APPROVED	2
15	550 22 00		Connection plate (FLS)	1
15	698 84 00		Connection plate	1
16	82 74 93	B	O-ring 199.3X5.7-NBR	1
17	83 15 73	B	Ball bearing 6305 Z/C3 25X62X17	1
18	444 75 02		Shaft unit	1
19	310 11 01		Stator 18-11-4a	1
22	83 45 59		Cable tie 200X2,4 PA 6/6 -55+105	1
23	94 21 04	B	Motor cable SUBCAB 12 AWG/7 20-22	16.5 m
24.1	642 17 01		Entrance flange	1
24.3	82 00 71		Hex.socket hd screw M12X40-A2-70	2
24.6	82 17 61		Cutting screw TAPTITE-M6X12	4
24.7	83 42 96		Cable lug 2,5 -6 MM2;M6	2
24.8	83 44 23		Closed end splice 5.1-10,6;(AWG 18-8)L=3	3
24.8	83 44 24		Closed end splice 2.5-6(AWG 12-10)L=17.5	1
24.9	82 74 63		O-ring 49,5X3,0 NBR	1
25	443 50 03		Entrance cover	1
26	82 00 36		Hex.socket hd screw M8X35-A2-70	4
27	82 74 79	AB	O-ring 129,5X3,0-NBR	1
28.1	83 53 21		Terminal clamp	6
28.3	83 53 22		End plate APPA - 1179,6	1
28.6	83 53 31		End support 35X15	2
28.7	443 68 00		Rail	1
28.9	427 13 00		Marking tape	1
28.9	471 77 01		Marking strip	2
30	443 69 00	B	El-lead through	1
30.1	81 98 44		Hex.socket hd screw	1

Ordered by:

Company:..Ref:...............................Tel:............................Date:......................

PARTS LIST

Item no	Partno	Rec	Denomination	Qty/ord.
30.2	82 35 13		Plain washer	3
31	439 44 01		Screw	3
32	596 07 00		Square washer	3
33	82 17 64		Cutting screw TAPTITE-M6X20	7
34	82 50 60		Lock washer DUBO NR 301	3
37	504 78 07		Cable unit	1
38	518 89 02		Leakage detect.unit (FLS)	1
40	439 33 11		Bearing holder EX.VERSION	1
41	83 36 90	B	Ball bearing 3305A C3 25X62X25,4	1
42	82 74 65	B	O-ring 59,5X3,0-NBR	1
43	605 20 00		Bearing cover	1
44	592 01 03	B	Mechanical seal WCCR/WCCR	1
45	82 00 72		Hex.socket hd screw M12X45-A2-70	4
46	439 32 02		Oil housing bottom	1
47	443 49 00		Sleeve	1
48	82 73 90	AB	O-ring 19.2X3.0 NBR	2
49	428 22 17	B	Inspection screw	2
53	592 01 04	B	Mechanical seal WCCR/WCCR	1
61	380 91 00		Guiding claw	1
62	83 04 53		Hex.socket hd screw M12X45-A4-80	4
63	439 41 00		Sleeve	1
64	678 47 32		Impeller	1
67	303 24 20		Pump housing	1
70	338 13 08		Plain washer	1
72	83 04 56		Hex.socket hd screw M10X35-A4-80	1
79	691 65 00	B	Insert ring	1
121	82 00 51		Hex.socket hd screw M10X25-A2-70	2
122	433 56 00		Cover	1
123	647 99 00		Gasket	1
169	667 40 00		Sticker	2
215	82 40 82		Plain washer (20)-32 MM	4
216	84 18 02		Seal sleeve (20)-23 MM	2
218	597 98 02		Ring	1
800	80 32 32		O-ring kits 3102.090,180<40DGG	1
900	601 89 06		Basic repair kit	1
	90 17 52		Oil	1 l
	90 20 54		Bearing grease	0.037 kg
	82 73 90		O-ring 19.2X3.0 NBR	4
	82 74 79		O-ring 129,5X3,0-NBR	1
	665 90 07	(s)	Zinc anode set	1
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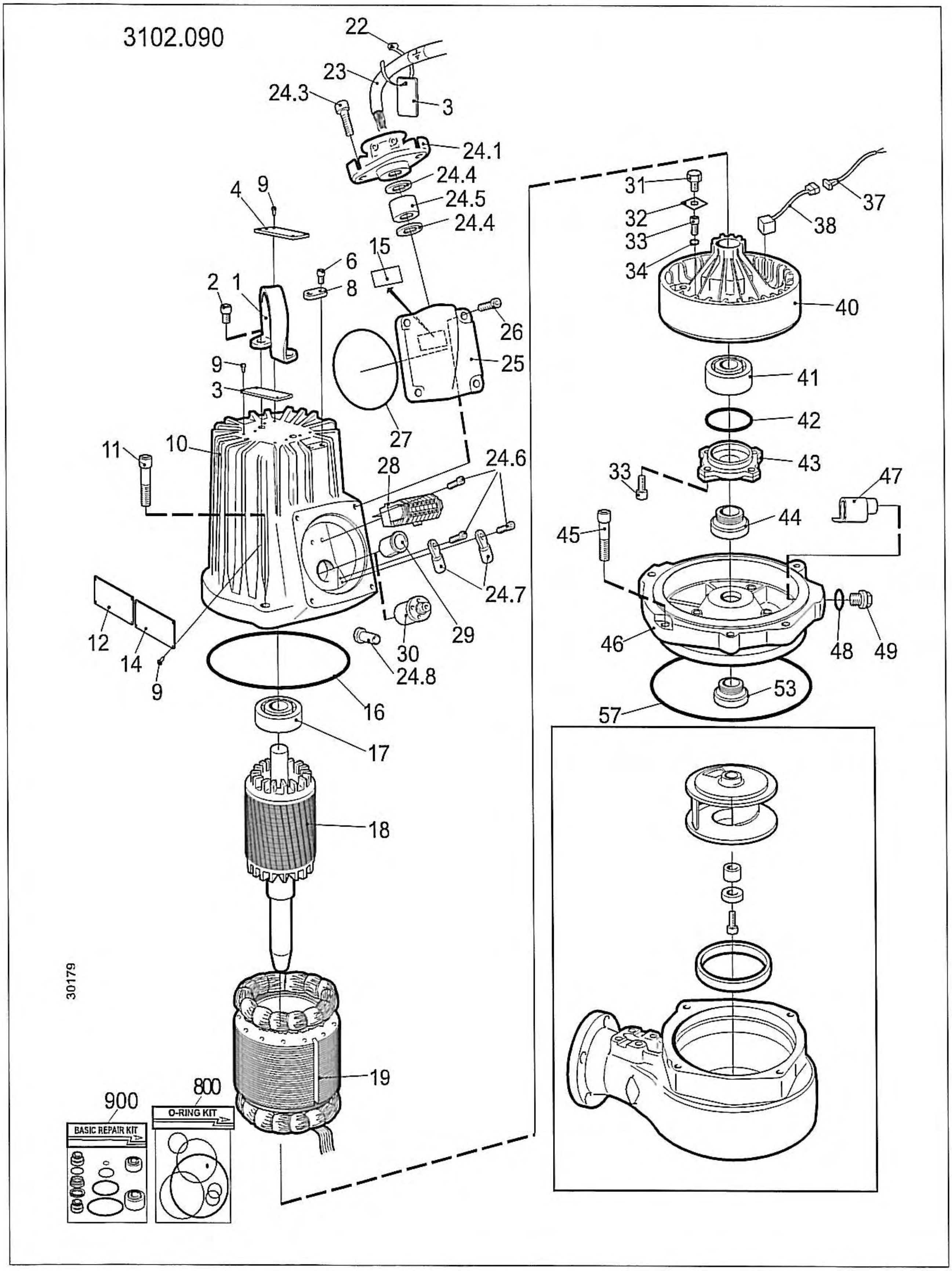
Ordered by:

Company:...Ref:..............................Tel:............................Date:......................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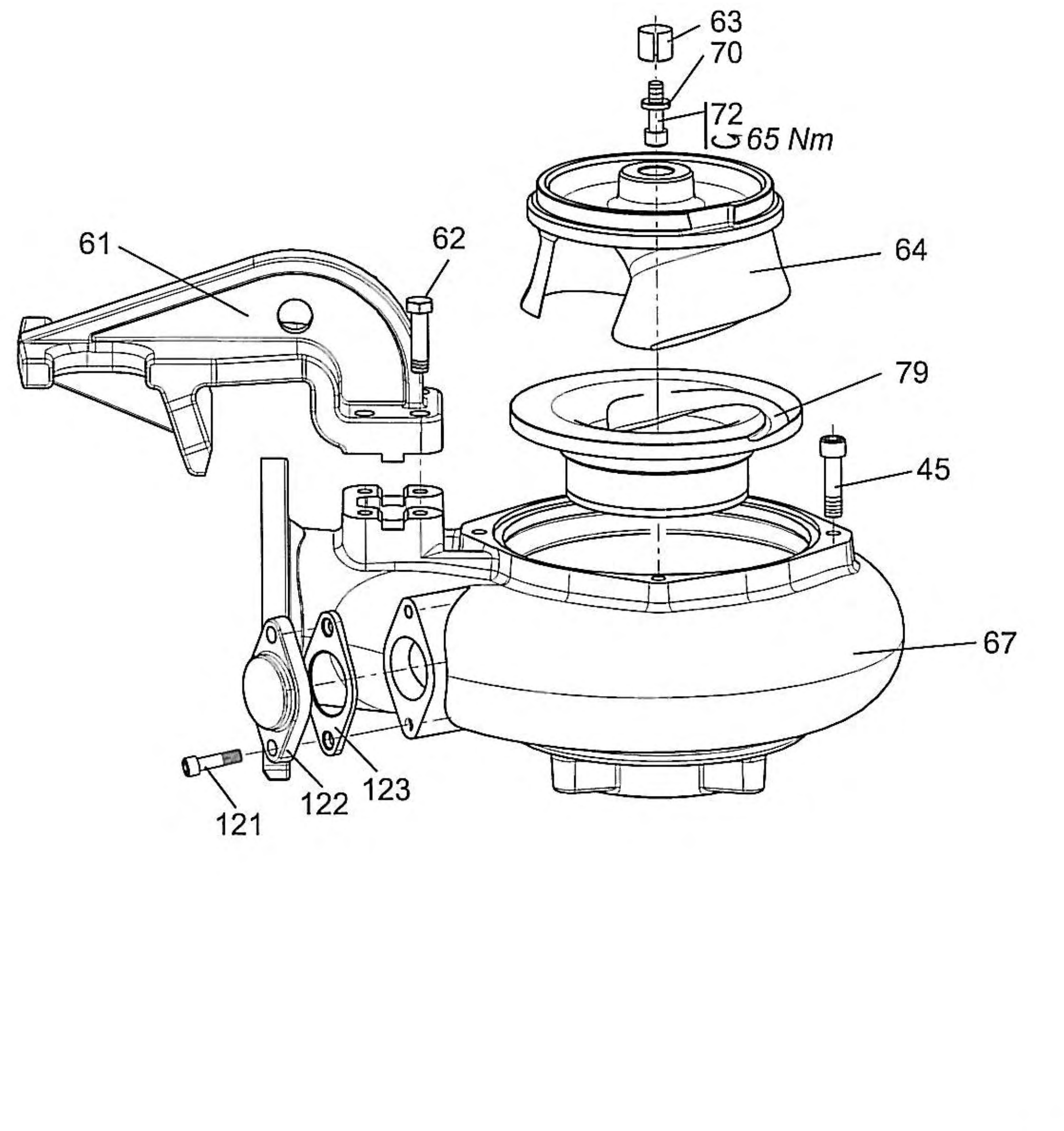
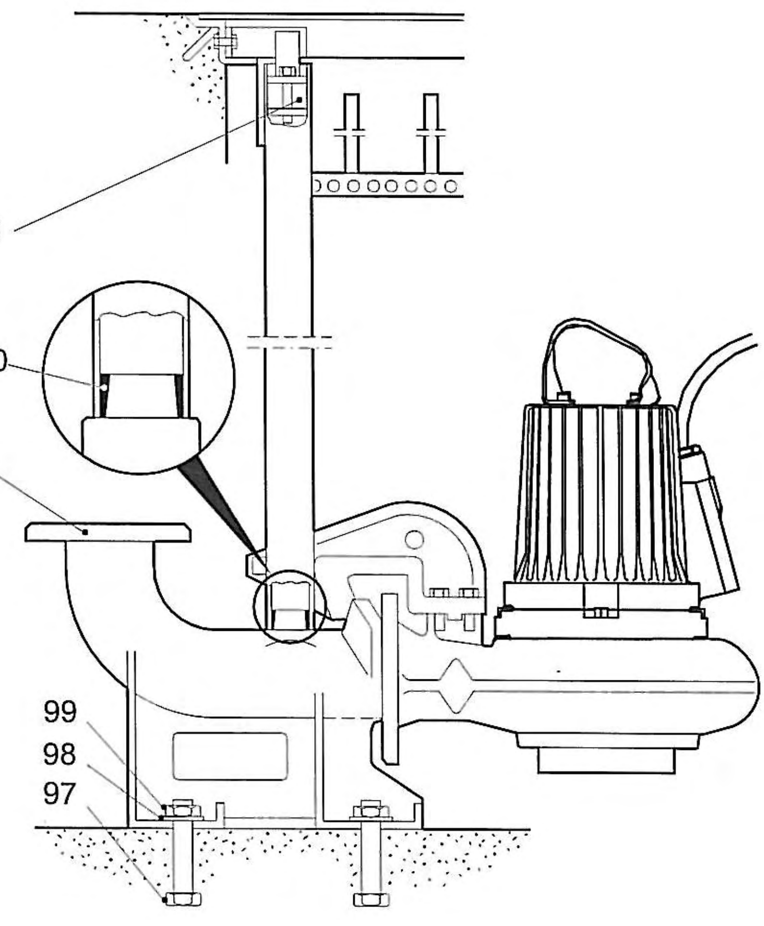
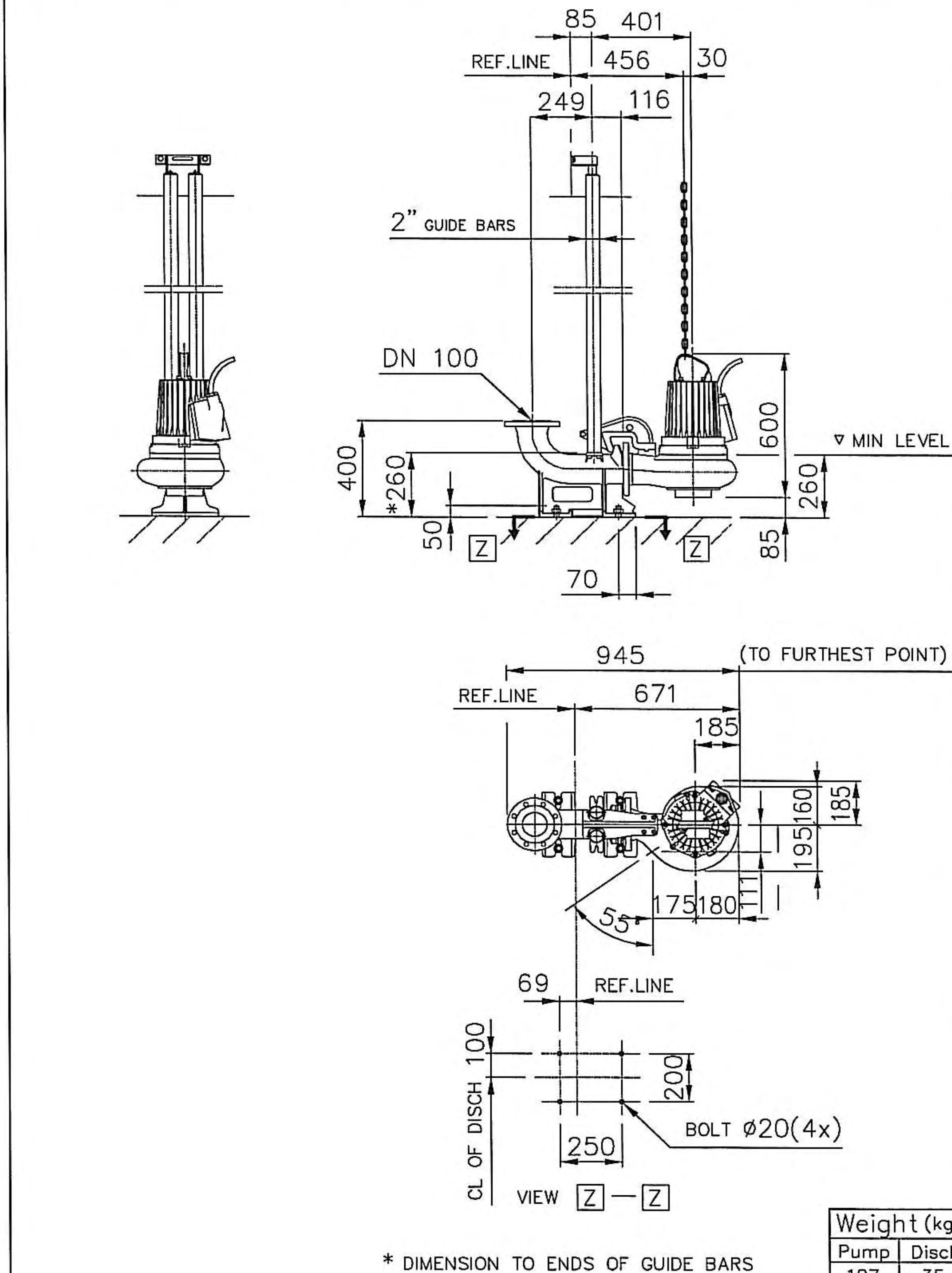
NP 3102 MT



CP, NP 3102





Weight (kg)	
Pump	Disch
107	35

AUTOCAD DRAWING	Denomination: Dimensional drwg NP 3102 MT DN 100	Drawn by Sors	Checked by
		Scale 1: 20	Date 000905 / Reg no 5399
		6602300	0

Flygt

ITT Industries

www.flygt.com

WHITNEY EQUIPMENT COMPANY, INC.
21222 30th Drive SE, Suite 110 Bothell, Wash. 98021
Phone: (425) 486-9499 Fax: (425) 485-7409

Specification Data Sheet For: *FLYGT SUBMERSIBLE PUMP NP-3102X*

DATE:	5/9/07	CONTRACTOR:	Holmes Mechanical, Inc.
SECTION NUMBERS:	11305	OWNER:	Army Corps of Engineers
		PROJECT:	Wyckoff Groundwater
WECO SALES ORDER		LOCATION:	Sump Pumps 1 & 2

REVISION	BY	DATE	DESCRIPTION	NOTES
0	BC	5/9/07	Original Submittal	Submersible Pumps

A	GENERAL SPECIFICATIONS		C	BASIC EQUIPMENT FEATURES	
1	QUANTITY	2	20	CABLE SEAL	GROMMET TYPE
2	MODEL NUMBER	NP-3102X-463	21	CABLE SIZE	12 AWG /7 GC
3	RATED CAPACITY	215 GPM @ 35' TDH	22	SEAL- INNER	TUNGSTEN-CARBIDE
4	TAG NUMBERS	40P1501, 40P1502	23	SEAL- OUTER	TUNGSTEN-CARBIDE
5	SHUTOFF	47' TDH	24	WEIGHT	230 LBS
6	DISCHARGE SIZE	4"	25	LIFTING SYSTEM	STAINLESS STEEL CABLE/CHAIN
7	IMPELLER TYPE	NON-CLOG BACKSWEPT	26	GUIDE BAR BRACKET	STAINLESS STEEL
8	HORSEPOWER	5 HP	27	GUIDE RAILS	2" STAINLESS STEEL
9	MOTOR SPEED	1745 RPM	28	LIFTING DEVICE	FLYGT GRIP EYE
10	MOTOR ELECTRICALS	460V, 3 PH, 60 HZ	29	COATING SYSTEM	INDUSTRIAL EPOXY
11	INSULATION	CLASS H TRICKLE IMPR	30		
12	MOTOR RATING	NEMA MG1, INVERTER	31		
13	PUMP BODY	CAST IRON 35B	32		
14	IMPELLER	463 CAST IRON	33		
15	PUMP SHAFT	420 STAINLESS STEEL	34		
16	MOTOR RATING	EXPLOSION PROOF	35		

B	Spare Parts Included	D	Options Included
17	SET OF SPECIAL TOOLS	36	FLS MOISTURE SENSORS
18		37	MINI-CAS 120 RELAY UNITS
19		38	MANUFACTURERS STARTUP SERVICES

Drawing Number	Showing	Notes
4-3102	PUMP DIMENSIONS	
6-3102	PUMP ELECTRICAL SPECS	
3/2 463	PUMP CURVE	

NP-3102
Performance Specification

REQUIREMENTS

Furnish and install 2 submersible non-clog wastewater pump(s). Each pump shall be equipped with 5 HP, submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, 7 wire service, with 50 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and have P-MSHA Approval. The pump shall be supplied with a mating cast iron 4 inch discharge connection and be capable of delivering 215 GPM at 35' TDH. Shut off head shall be 47 feet (minimum). Each pump shall be fitted with a grip eye lifting system using stainless steel cable and chain. The working load of the lifting system shall be 50% greater than the pump unit weight.

PUMP DESIGN

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

PUMP CONSTRUCTION

Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel or brass construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of alkyd primer with anacrylic dispersion zinc phosphate primer with apolyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

COOLING SYSTEM

Motors are sufficiently cooled by the surrounding environment or pumped media. A water jacket is not required.

CABLE ENTRY SEAL

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

MOTOR

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180-degrees C (356 F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of 40-degrees C (104 F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125-degrees C (260 F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40-degrees C (104 F) ambient and with a temperature rise not to exceed 80-degrees C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

BEARINGS
The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.

MECHANICAL SEAL
Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating **tungsten-carbide** ring. The upper, secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary **tungsten-carbide** seal ring and one positively driven rotating **carbon** seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor **depend on direction of rotation for sealing**. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. For special applications, other seal face materials shall be available.
The following seal types shall not be considered acceptable nor equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. **The motor shall be able to operate dry without damage while pumping under load.**

PUMP SHAFT
Pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be AISI type 431 stainless steel. Shaft sleeves will not be acceptable

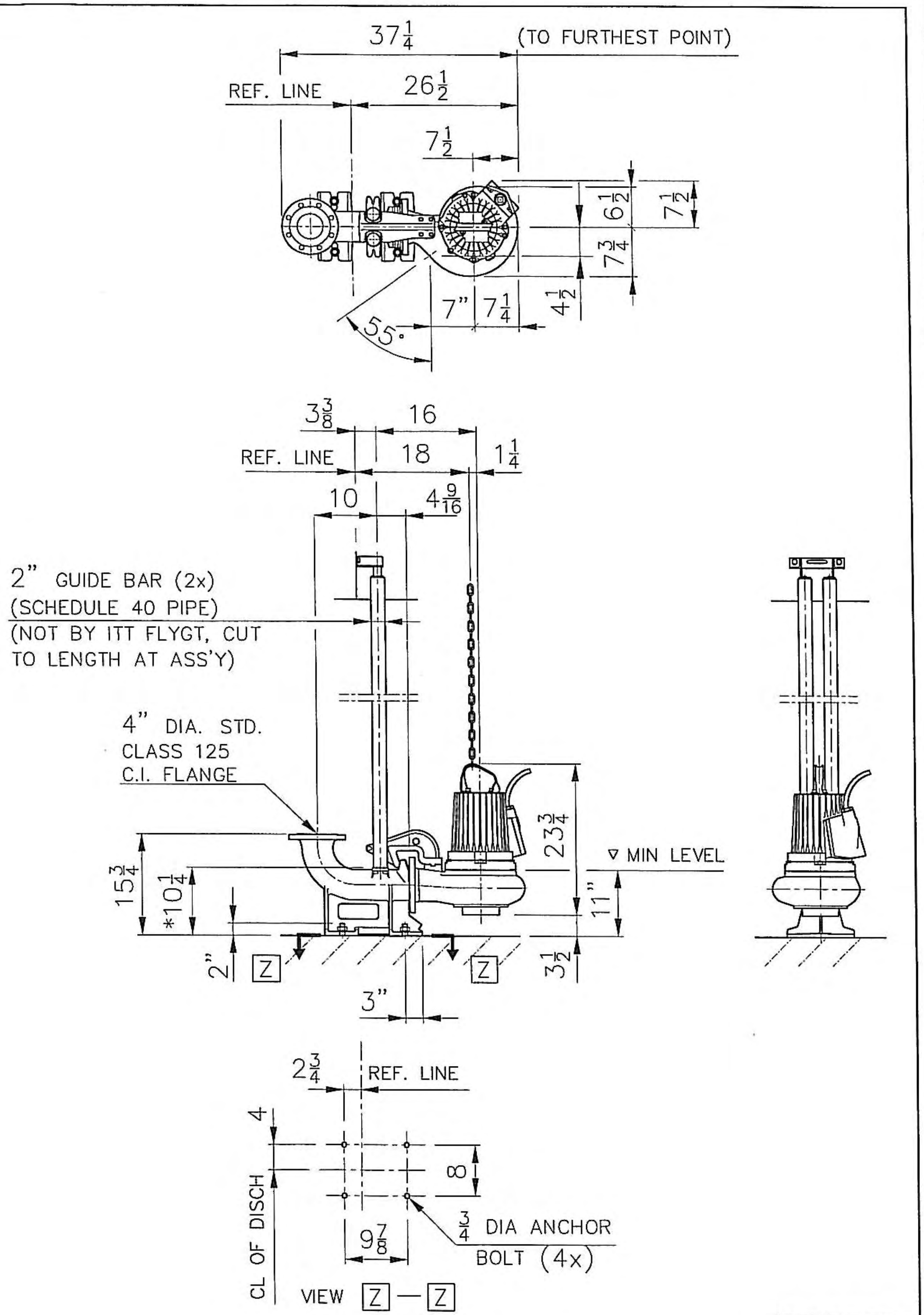
IMPELLER
The impeller(s) shall be of gray cast iron, ASTM A-48 Class 35B, dynamically balanced, semi-open, multivane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The screw-shaped leading edges of the impeller shall be hardened to Rc 45 and shall be capable of handling solids, fibrous material, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impellers shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

VOLUTE/SUCTION COVER
Pump volute shall be a single-piece grey cast iron, ASTM A-45, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have an integral spiral-shaped sharp-edged groove that is cast into the suction cover. The spiral groove shall provide the sharp edge across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The internal volute bottom shall provide effective sealing between the multi-vane semi-open impeller and the volute.

PROTECTION
All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 125°C (260°F) the thermal switches shall open, stop the motor and activate an alarm.

A leakage sensor shall be available as an option to detect water in the stator chamber. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and send an alarm both local and/or remote.

The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS shall be designed to be mounted in any control panel.



ALL DIMENSIONS IN INCHES

* DIMENSION TO ENDS OF GUIDE BARS

Weight (LBS)	
Pump	Disch
240	80

FLYGT AUTOCAD DRAWING	Denomination: Dimensional drwg NP 3102 MT 4"/ 4"	Drawn by Sors	Checked by RB	Date 000905
		Scale		Reg no 5399
		660 23 00		

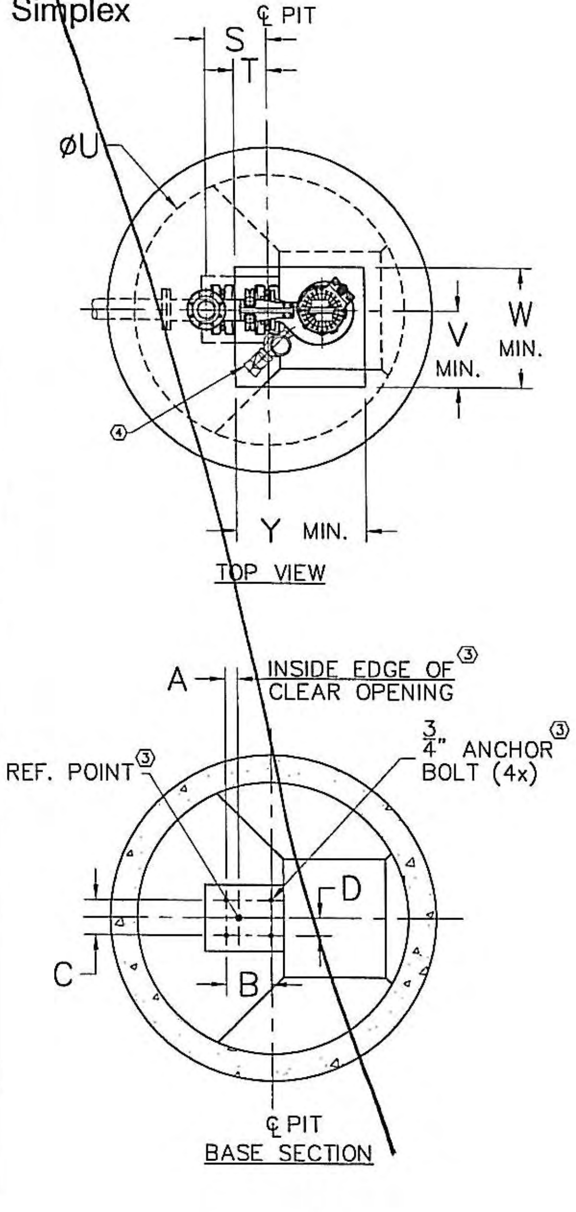
CP/NP-3102

e-Catalog	FLYGT	**Lift Station Dimensions**	Issued: 5/06	Supersedes: 7/05

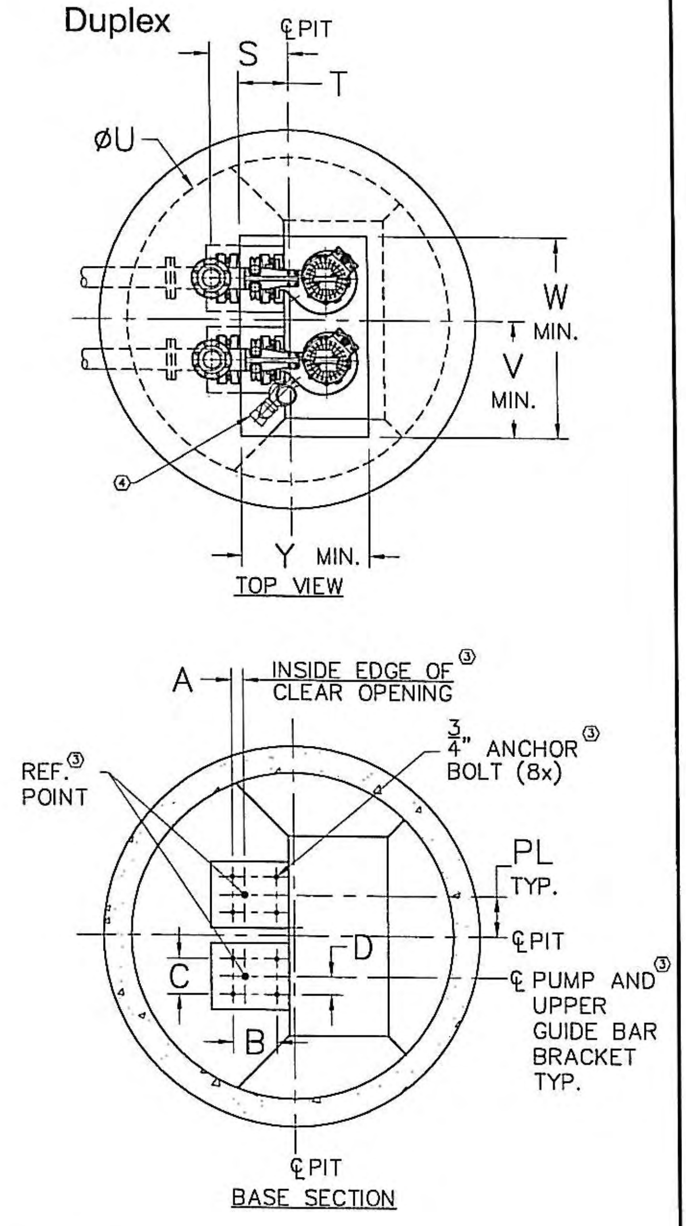
NOTES:

1. CONFIGURATION AND DIMS. SHOWN ARE SUGGESTED REQUIREMENTS ONLY. ALL DETAILS, INCLUDING SIZING OF PIT, TYPE, LOCATION AND ARRANGEMENT OF VALVES AND PIPING, ETC. ARE TO BE SPECIFIED BY THE CONSULTING ENGINEER AND ARE SUBJECT TO THEIR APPROVAL.
2. REFERENCE GENERIC DUPLEX LIFT STATION LAYOUT FOR ELEVATION VIEW.
3. LOCATE ANCHOR BOLTS USING INSIDE EDGE OF CLEAR OPENING AND PUMP CENTERLINE AS REFERENCE POINT. BOLT LOCATIONS MUST BE HELD TO MAINTAIN EXACT POSITION OF PUMP TO CLEAR OPENING.
4. ~~ITT FLYGT MIX FLUSH VALVE~~

Simplex



Duplex



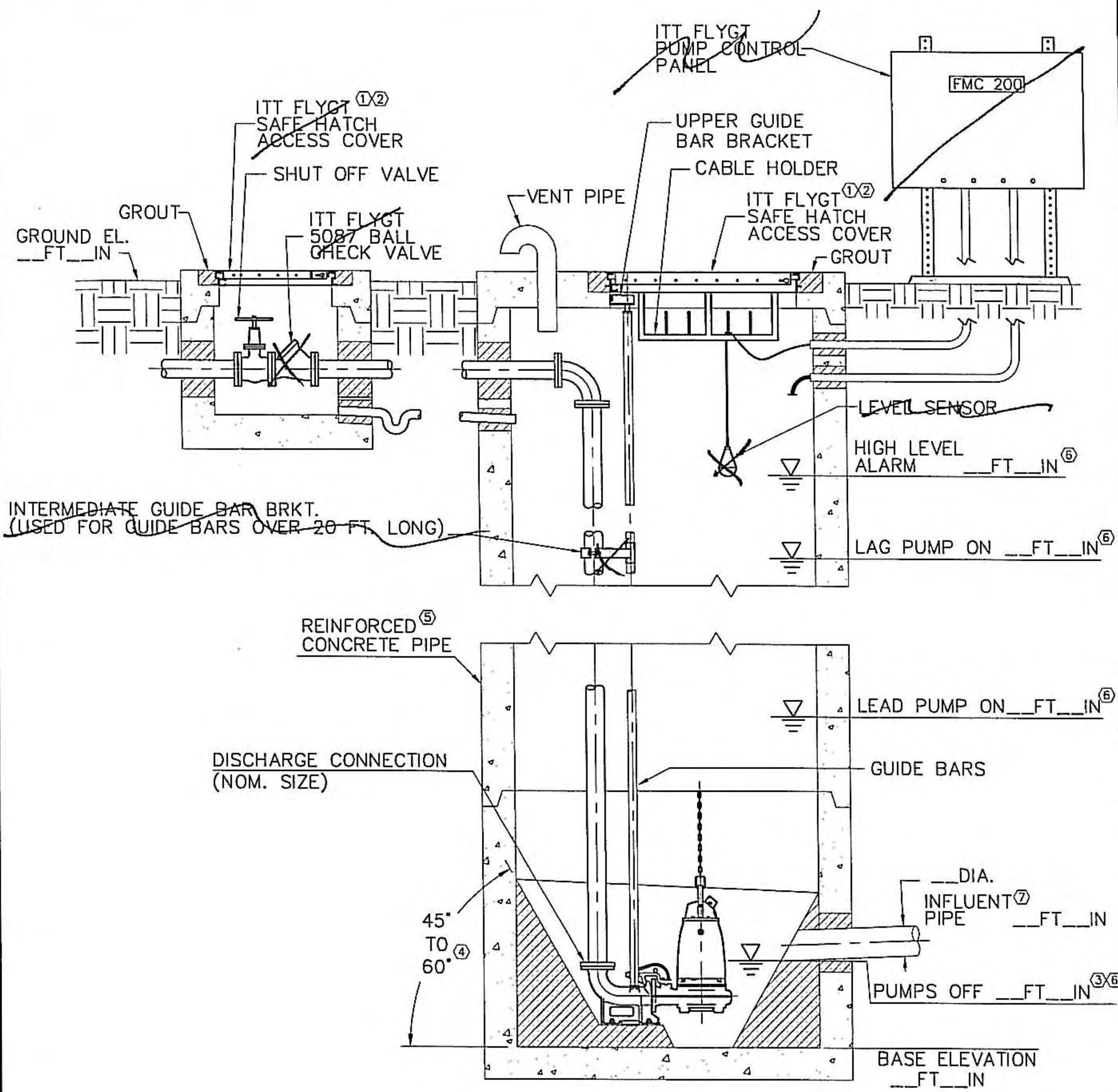
ALL DIMENSIONS ARE IN INCHES

MODEL	NOM. SIZE	VERSION					SIMPLEX						DUPLEX						
			A	B	C	D	S	T	U	V	W	Y	S	T	U	PL	V	W	Y
~~CP/NP~~	~~3"~~	~~HT/SH~~	2 3/8	9 7/8	8	4	15 5/8	9 1/2	60	17	26 1/2	28 1/2	19 3/8	13 1/4	72	9	26	44 1/2	28 1/2
CP/NP	4"	MT	2 3/4	9 7/8	8	4	13 3/4	7 1/4	60	17	26 1/2	28 1/2	17 1/2	11	72	9	26	44 1/2	28 1/2
~~CP/NP~~	~~4"~~	~~LT~~	2 3/4	9 7/8	8	4	13 3/4	7 1/4	60	16	25 1/2	28 1/2	17 1/2	11	72	9	25	43 1/2	28 1/2
~~CP/NP~~	~~6"~~	~~LT~~	4 1/4	11	10	5	11	3 3/8	60	17 1/2	27	28 1/2	14 3/8	6 3/4	72	9	26 1/2	45	28 1/2
~~CP~~	~~8"~~	~~LT~~	5 1/2	11	10	5	8 7/8	0	60	17 1/2	27	28 1/2	11 3/8	2 1/2	72	9	26 1/2	45	28 1/2

652017A

Generic Duplex Lift Station Layout

e-Catalog	FLYGT	**Lift Station Guide Lines**	Issued: 9/05	Supersedes: 5/05



○ NOTES:

1. COVER SHOWN IS A STANDARD DUTY SAFE HATCH WITH ANGLE FRAME. FOR DIMENSIONS ON ACCESS COVERS WITH SAFE HATCH OR WITHOUT SAFE HATCH AS WELL AS HEAVY DUTY OR OTHER TYPES, CONSULT ITT FLYGT.
2. INSTALL ACCESS COVERS PER MANUFACTURER'S INSTRUCTIONS.
3. MIN. LIQUID LEVEL MUST NOT FALL BELOW TOP OF VOLUTE.
4. 60° RECOMMENDED.
5. OTHER MATERIALS AVAILABLE. CONSULT ITT FLYGT.
6. ITT FLYGT LIQUID LEVEL CONTROL MONITIORING SYSTEM.
7. GOOD DESIGN PRACTICE DICTATES THAT INFLUENT PIPE ELEVATIONS HIGHER THAN LWL SHOULD BE AVOIDED DUE TO RISK OF AIR ENTRAINMENT, UNLESS SPECIAL ARRANGEMENTS ARE MADE.

682033A

11060-A MOTOR DATA FORM

PROJECT: WYCKOFF GROUNDWATER **OWNER:** CORPS OF ENGINEERS

Equipment Name: NP3102X-463 Equipment Number(s): 40P1501, 40P1502

Site Location: Sump Pumps No. 1 & 2

Nameplate Markings

Mfr: Flygt Model: 3102 Frame: N/A HP: 5.0

Volts: 460 Phase: 3 RPM: 1745 Service Factor: 1.15

FLA: 6.8 LRA: 42 Freq: 60Hz Ambient Temp Rating: 40 °C

Time Rating: Continuous (NEMA MG1-10.35) Design Letter: B (NEMA MG-1.16)

KVA Code Letter: H Insulation Class: H

The following information is required for explosion proof motors only:

A. Approved by FM for installation in Class 1 Div. 1

B. FM frame temperature code _____ Group _____ Atmosphere _____
(NEC Tables 500-s and 500-s(b))

The following information is required for high efficiency motors only:

A. Guaranteed minimum efficiency 85%
(NEMA MG1-1253b)

B. Nameplate or nominal efficiency _____

Data Not Necessarily Marked on Nameplate

Type of Enclosure: Submersible Enclosure Material: Cast Iron

Temp Rise: 80 °C (NEMA MG1-12.41,42)

Space Heater Included? ☐ Yes ☒ No

If Yes: _____ Watts _____ Volts

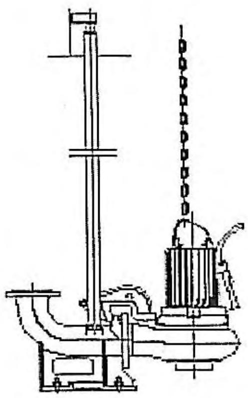
Type of rotor winding over-temperature protection, if specified:

Stator thermal switches

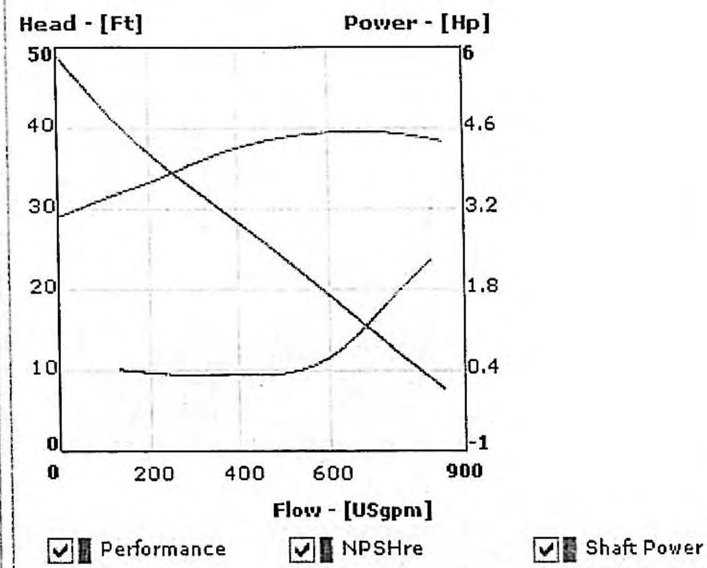
Use the space below to provide additional information on other motor modifications, if specified:

PRODUCT: NP 3102 MT

Product picture



Curves ⊕ **Enlarge**



Pump Data

Curve Id: 63-463-00-3703	Impeller: 463	Poles: 4 - pole	Motor: 18-11-4AL	Frequency: 60 Hz

Motor Data

Rated output power Hp (kW)	Ø	Nominal voltage (V)	Full load current (A)	Locked rotor current (A)	Locked rotor kVA	Locked rotor code letter kVA/Hp	Poles/rpm
~~5 (3.7)~~	~~3~~	~~230~~	~~14~~	~~83~~	~~33~~	~~H~~	~~4/1745~~
5 (3.7)	3	460	6.8	42	33	H	4/1745

Pump motor Hp	Efficiency			Power factor		
	100% load	75% load	50% load	100% load	75% load	50% load
5	85	85	83.5	0.81	0.75	0.63

Cable Data

HP	Cables	Volts	Max. length (Ft)	Cable size/Nominal OD.	Conductors (In one cable)	Type	Part number
5	1	~~230~~ 460	~~165~~ 690	#12/7 0.83"-(21.0mm)	(3) 12 AWG (PWR) (2) 12 AWG (CTRL) (1) 12 AWG (GND) (1) 12 AWG (GC)	STD	942104

Available Discharge Connection Outlet Size

Outlet Drilled Flange	4"

Warm Liquid Data

Rtd. Amb. Temp.	Rtd. Curr.(1)	Rtd. Curr.(2)	De-rated Shaft Power
70° C / 158° F	6.8 A	14 A	4.9 Hp

SUBCAB® 4GX/SUBCAB® AWG, 6-leads, Y

3085, 3102, 3127

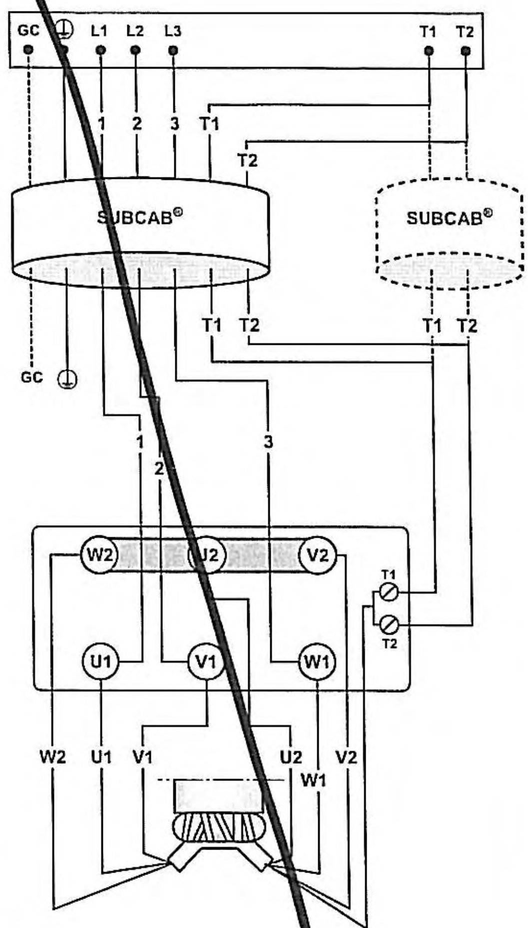


Bild 85a

Mains	SUBCAB® Lead	SUBCAB® AWG Lead	Terminal board
L1	brown	red	U1
L2	black	black	V1
L3	grey	white	W1
⏚	yellow/green	yellow/green	⏚
Groundcheck GC		yellow	
Control	**SUBCAB® Cable lead**	**SUBCAB® AWG Cable lead**	**Terminal board**
T1	T1	orange	T1
T2	T2	blue	T2

Stator leads connection: Stator lead	Terminal board
U1, red	U1
W2, black	W2
V1, brown	V1
U2, green	U2
W1, yellow	W1
V2, blue	V2

SUBCAB® 4GX/SUBCAB® AWG, 6-leads, D

~~3085~~, 3102, ~~3127~~

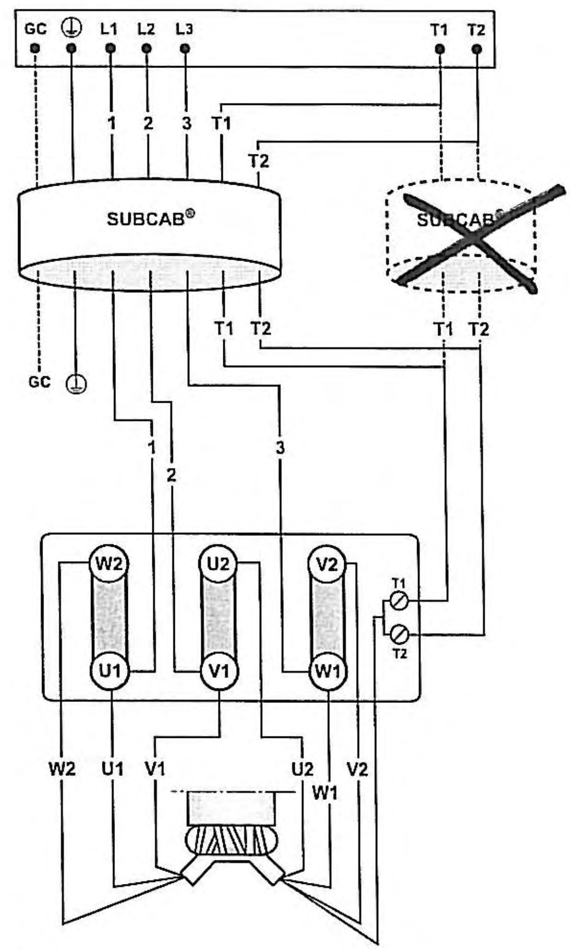


Bild 85b

Mains	SUBCAB® Lead	SUBCAB® AWG Lead	Terminal board
L1	brown	red	U1
L2	black	black	V1
L3	grey	white	W1
⏚	yellow/green	yellow/green	⏚
Groundcheck GC		yellow	
Control	**SUBCAB® Cable lead**	**SUBCAB® AWG Cable lead**	**Terminal board**
T1	T1	orange	T1
T2	T2	blue	T2

Stator leads connection: Stator lead	Terminal board
U1, red	U1
W2, black	W2
V1, brown	V1
U2, green	U2
W1, yellow	W1
V2, blue	V2

ITT FLYGT

Standard
1997-06

Standard Paint: Epoxy Coating
Application: Primed parts of cast iron and steel.

	Technical Data and Chemical Composition
Part Number	**Special**
Colour	Blue
Binder	High Molecular Epoxy resin
Pigment	Depending on color
Solvent	Aromatic Hydrocarbons
Gloss	Semi-glossy
Primer Coat	1 Layer Zinc Rich Primer
Finish Coats	Three, Duasolid Epoxy Resin
Film Thickness Dry/Coat	5 MDFTPC, 15 total
Drying time at 23 deg C, 50% rel. humidity and good ventilation. According to SS18 41 53 Note! Temp of material.	Dust Dry 60 minutes Dry to Handle 7 hours Thoroughly Dry 35 hours
Methods of application	Brush, spraying, high pressure spraying

SECTION THREE:

- INSTALLATION, CARE AND MAINTENANCE

Installation, care and maintenance

~~3085~~/3102/~~3127~~

Flygt

ITT Industries

892062/11

CONTENTS

SAFETY

This manual contains basic information on the installation, operating and maintenance and should be followed carefully. It is essential that these instructions are carefully read before installation or commissioning by both the installation crew as well as those responsible for operation or maintenance. The operating instructions should always be readily available at the location of the unit.

Identification of safety and warning symbols

General Danger:

Non-observance given to safety instructions in this manual, which could cause danger to life have been specifically highlighted with this general danger symbol.

High Voltage:

The presence of a dangerous voltage is identified with this safety symbol.

WARNING! Non-observance to this warning could damage the unit or affect its function

Qualifications of personnel

An authorized (certified) electrician and mechanic shall carry out all work.

Safety regulations for the owner/operator

All government regulations, local health and safety codes shall be complied with.

All dangers due to electricity must be avoided (for details consult the regulations of your local electricity supply company).

Unilateral modification and spare parts manufacturing

Modifications or changes to the unit/installation should only be carried out after consulting with ITT Flygt.

Original spare parts and accessories authorized by the manufacturer are essential for compliance. The use of other parts can invalidate any claims for warranty or compensation.

Dismantling and re-assembly

If the pump has been used to pump hazardous media, care must be taken that, when draining the leakage, personnel and environment are not endangered.

All waste and emissions such as used coolant must be appropriately disposed of. Coolant spills must be cleaned up and emissions to the environment must be reported.

The pumping station must be kept tidy and in good order at all times.

All government regulations shall be observed.

The pictures in this manual may differ somewhat from the delivered pump depending on the hydraulic end configuration.

SAFETY

NOTES FOR EX-PRODUCTS

— Only Ex-approved pumps may be used in an explosive or flammable environment.

— Do not open the pump when an explosive gas atmosphere may be present.

— Before starting work on the pump, make sure that the pump and the control panel are isolated from the power supply and can not be energized. This applies to the control circuit as well.

— All mechanical work on the explosion-proof motor section must be performed by personnel authorized by ITT Flygt.

— Electrical connection on the explosion-proof motor must be made by authorized personnel.

— Thermal contacts must be connected to protection circuit intended for that purpose according to the approval of the product.

— The pump may be used only in accordance with the approved motor data stated on the data plates.

— Intrinsically safe circuits are normally required (Ex i) for the automatic level control system by level regulator if mounted in zone 0.

— Do not open the pump when an explosive gas atmosphere may be present.

— This equipment must be installed in conformity to prescriptions in international or national rules (IEC/EN 60079-14).

— The maintenance operation must be made in conformity to the international or national standards (IEC/EN 60079-17).

— The yield stress of fastener elements in the product must be in conformity with the value specified in the table for "Material of fastener" on the approval drawing or the parts specified in the part list for the product.

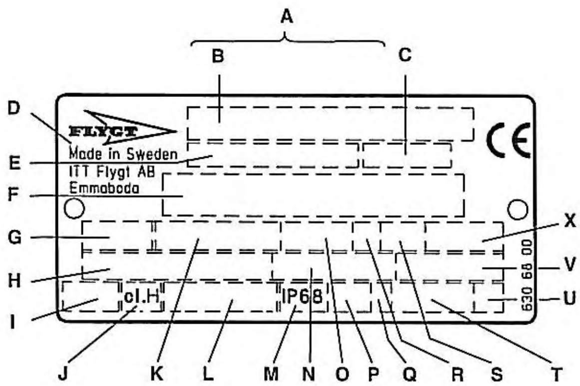
— According to the ATEX directive the Ex-pump must never run dry or snore. Permitted minimum water level, see dimensional drawing for the pump.

— Besides, the user must know about the risks due the electric current and the chemical and physical characteristics of the gas and/or vapours present in hazardous areas.

— ITT Flygt disclaims all responsibility for work done by untrained, unauthorized personnel.

DATA PLATE INTERPRETATION

General data plate

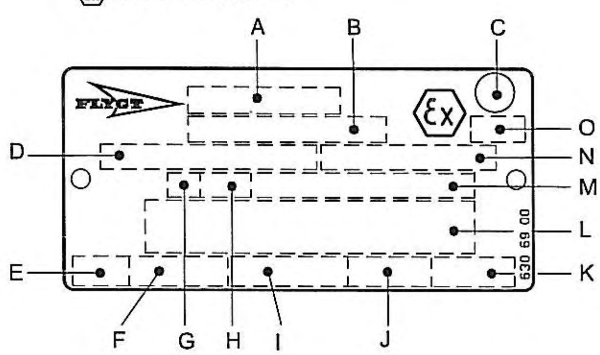


A Serial number
B Product code + Number
C Curve code / Propeller code
D Country of origin
E Product number
F Additional information
G Phase; Type of current; Frequency
H Rated voltage
I Thermal protection
J Thermal class
K Rated shaft power
L International standard
M Degree of protection
N Rated current
O Rated speed
P Max. submergence
Q Direction of rotation: L=left, R=right
R Duty class
S Duty factor
T Product weight
U Locked rotor code letter
V Power factor
X Max. ambient temperature

Approval plates

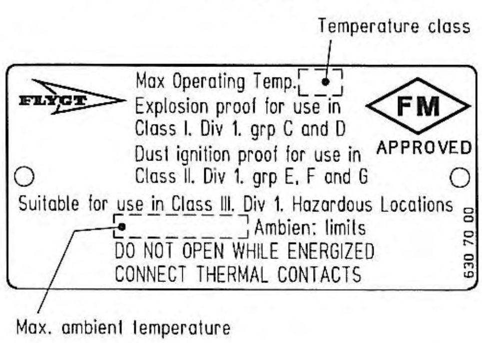
These approval plates apply to an explosion-proof submersible Flygt pump.
The plates are used together with the general data plate on the pump.

EN: European Norm
ATEX Directive
EN 50014, EN 50018, EN 1127-1
⟨Ex⟩ II 2 G EEx dII T4



A Approval
B Approval authority + Approval Number
C Approval for Class I
D Approved drive unit
E Stall time
F Starting current / Rated current
G Duty class
H Duty factor
I Input power
J Rated speed
K Controller
L Additional information
M Max. ambient temperature
N Serial number
O ATEX marking

FM: Factory Mutual
Class I Div. I Grp C and D
Class II and III Div. I Grp E, F and G



PRODUCT DESCRIPTION

Introduction

Thank you for buying a submersible ITT Flygt pump. In this Installation, Care and Maintenance manual you will find general information on how to install and service the 3085, 3102 or 3127 pump to give it a long and reliable life. In the Parts List you will find all the specific technical data for your pump.

Application

This Installation, Care and Maintenance manual applies to a submersible ITT Flygt pump. If you have bought an Ex-approved pump (please see approval plate on your pump or Parts List) special handling instructions apply as described in this document.

Depending on the hydraulic end, the pump is intended to be used for:

— pumping of waste water

— pumping of light liquid manure and urine

— pumping of sludge

— pumping of ground water

— pumping of sewage if the solids need to be cut into small pieces.

The pumps must not be used in highly corrosive liquids. See pH limits below.

The pump is available for permanent installation in a sump or portable installation with hose connection and stand.

In some applications, the pump is also available for a dry stationary installation on a base stand directly connected to the inlet and outlet lines.

For further information on applications, contact your nearest ITT Flygt representative.

Specific technical data

For specific technical data regarding your pump, please see Parts List.

General technical data

Liquid temperature: max. 40°C (104°F). The pump can be operated at full load only if at least half the stator housing is submerged.

The pump can be equipped for operation at temperatures up to 90°C (195°F). At increased temperatures, the pump must be completely submerged when operated at full load.

Higher temperatures than 40°C (104°F) are not permitted for Ex-approved pumps.

Liquid density: max. 1100 kg/m^3 (9.2 lb per US gal.)

The pH of the pumped liquid: 5.5 - 14 (cast iron pumps).

The pH of the pumped liquid: 3—14 (stainless steel pumps).

Depth of immersion: max. 20 m (65 ft).

— **In some installations and at certain operating points on the performance curve, the noise level of 70 dB or the noise level specified for the actual pump may be exceeded.**

— **NOTE for Ex-version page 3.**

Warranty claim

ITT Flygt pumps are high quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, please contact your ITT Flygt representative.

GENERAL DESIGN OF A FLYGT PUMP

Design

The pump is a submersible, electric motor-driven product.

1. Impeller

The pump is available with a wide range of impellers for different applications and capacities.

2. Shaft seals

The pump has two mechanical face seals – one inner and one outer, with an intermediate oil housing.

3. Shaft

The shaft is delivered with the rotor as an integral part.

Shaft material: stainless steel.

4. Bearings

The support bearing of the rotor consists of a single-row ball bearing.

The main bearing of the rotor consists of a two-row angular contact ball bearing.

5. Oil housing

The oil lubricates and cools the seals and acts as a buffer between the pump housing and the electric motor.

6. Motor

Squirrel-cage 1-phase or 3-phase induction motor for 50 Hz or 60 Hz.

The motor can be started by direct on-line or star-delta starting.

The motor can be run continuously or intermittently with a maximum of 15 evenly spaced starts per hour.

ITT Flygt motors are tested in accordance with IEC 34-1.

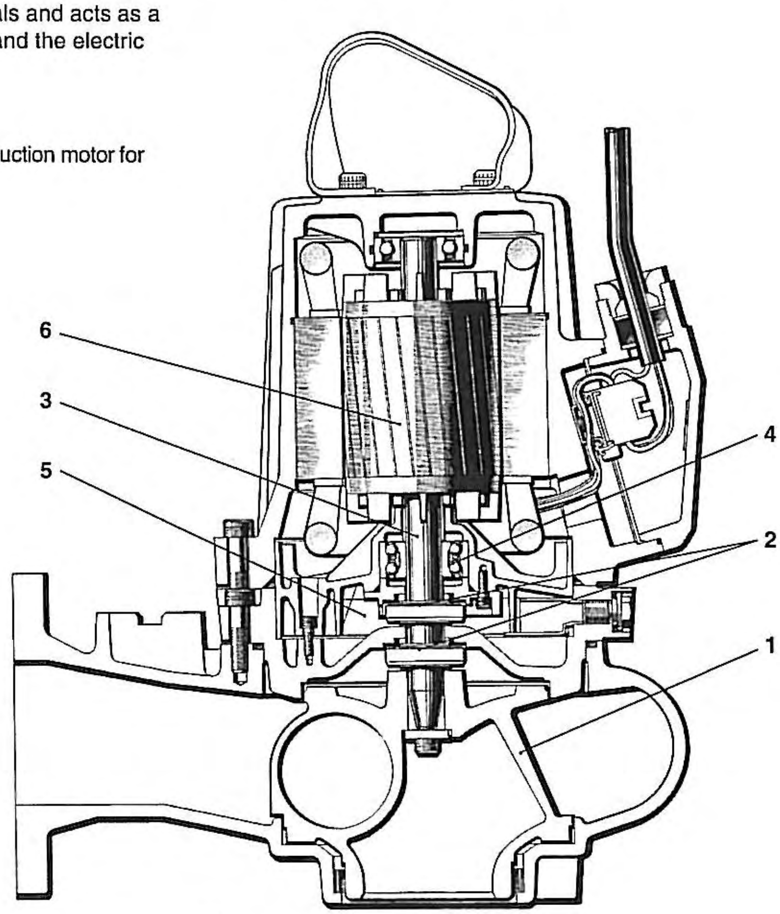
The stator is insulated in accordance with class H (180°C, 360°F). The motor is designed to deliver its rated output at ± 5% variation from the rated voltage. Without overheating the motor, ± 10% variation from the rated voltage can be accepted provided that the motor does not run continuously at full load. The motor is designed to operate at a voltage imbalance of up to 2% between the phases.

Monitoring equipment

The stator incorporates thermal contacts connected in series.

The pump can be equipped with sensors for sensing water in the oil* and/or stator housing.

*Not applicable to Ex-approved pumps.



INSTALLATION

Handling equipment

Lifting equipment is required for handling the pump.

- **Stay clear of suspended loads.**
- **Always lift the pump by its lifting handle - never by the motor cable or the hose.**

The minimum height between the lifting hook and the floor shall be sufficient to lift the pump out of the sump.

The lifting equipment shall be able to hoist the pump straight up and down in the sump, preferably without the need for resetting the lifting hook.

Oversize lifting equipment could cause damage if the pump should stick when being lifted.

Make sure that the lifting equipment is securely anchored.

General recommendations

To ensure proper installation, please see the dimensions on the dimensional drawing in the Parts List.

NOTE! The end of the cable must not be submerged. It must be above flood level, as water may penetrate through the cable into the junction box or the motor.

Check that the lifting handle and chain are in good condition.

For automatic operation of the pump (level control), it is recommended that the level regulators be used at low voltage. The data sheet delivered with the regulators gives the permissible voltage. Local rules may specify otherwise.

Clean out all debris from the sump before the pump is lowered down and the station is started.

NOTE for Ex version page 3.

Safety precautions

In order to minimize the risk of accidents in connection with the service and installation work, the following rules should be followed:

1. Never work alone. Use a lifting harness, safety line and a respirator as required. Do not ignore the risk of drowning!
2. Make sure there are no poisonous gases within the work area.
3. Check the explosion risk before welding or using electric hand tools.
4. Do not ignore health hazards. Observe strict cleanliness.
5. Bear in mind the risk of electrical accidents.
6. Make sure that the lifting equipment is in good condition.
7. Provide a suitable barrier around the work area, e.g a guard rail.
8. Make sure you have a clear path of retreat!
9. Use safety helmet, safety goggles and protective shoes.
10. All personnel who work with sewage systems must be vaccinated against diseases to which they may be exposed.
11. A first-aid kit must be close at hand.
12. Note that special rules apply to installation in explosive athmosphere.

Follow all other health and safety rules and local codes and ordinances.

ELECTRICAL CONNECTIONS

- **Before starting work on the pump, make sure that the pump and the control panel are isolated from the power supply and cannot be energized.**
- **If the pump is equipped with automatic level control, there is a risk of sudden restart.**
- **All electrical equipment must be earthed. This applies to both pump equipment and any monitoring equipment. Failure to heed this warning may cause a lethal accident. Make sure that the earth lead is correctly connected by testing it.**
- **If persons are likely to come into physical contact with the pump or pumped media (liquid), e.g on con-struction sites and farms, the earthed (grounded) socket must have an additional earth-(ground-) fault protection device (GFI) connected.**
  When pumping near a lake (jetties, beaches, ponds, fountains etc) a safety-distance of at least 20 m (65 ft) between the person and the pump is applicable.
  The pump must never be placed directly into a swimming pool. If used in connection with swimming pools, special safety regulations apply.

NOTE for Ex version page 3.

ELECTRICAL CONNECTIONS

All electrical work shall be carried out under the supervision of an authorized electrician.

Local codes and regulations shall be complied with.

Check on the data plate which voltage supply is valid for your pump.

Check that the main voltage and frequency agree with the specifications on the pump data plate.

If the pump can be connected to different voltages, the connected voltage is specified by a yellow sticker.

Connect the motor cable to the starter equipment as illustrated in the wiring diagrams.

Conductors that are not in use must be isolated.

The cable should be replaced if the outer sheath is damaged. Contact an ITT Flygt service shop.

Make sure that the cable does not have any sharp bends and is not pinched.

Under no circumstances may the starter equipment be installed in the sump.

NOTE! For safety reasons, the earth conductor should be approx. 50 mm (2.0") longer than the phase conductors. If the motor cable is jerked loose by mistake, the earth conductor should be the last conductor to come loose from its terminal. This applies to both ends of the cable.

Thermal contacts are incorporated in the stator. The thermal contacts can be connected to max 250 V, breaking current max 4 A. ITT Flygt recommends that they be connected to 24 V over separate fuses to protect the other automatic equipment.

Make sure that the pump is correctly earthed (grounded).

When using a variable-frequency-drive (VFD) the shielded cable (type NSSHÖU.../3E+St) should be used. Contact your ITT Flygt representative and ask your VFD-supplier for electrical limitations.

Remember that the starting current in direct on-line starting can be up to six times higher than the rated current. Make sure that the fuses or circuit breakers are of the proper rating.

The Parts List gives rated current. Fuse rating and cable shall be selected in accordance with local rules and regulations. Note that with long cables, the voltage drop in the cable must be taken into consideration, since the motor's rated voltage is the voltage that is measured at the terminal board in the pump.

The overload protection (motor protection breaker) for direct on-line starting shall be set to the motor rated current as given on the data plate.

Check the phase sequence in the mains with the phase sequence indicator.

If intermittent operation is prescribed (see Data Plate), the pump shall be provided with control equipment that provides such operation.

Single phase operation

The ITT Flygt single phase pumps must be equipped with a starter which has start and run capacitors.

A special ITT Flygt designed starter is required for the operation of single phase pumps. The connection of the motor cable to the starter is shown in the wiring diagram.

NOTE! It is not possible to change the direction of rotation of a single phase pump by changing the cable conductors on the starter. Please contact your nearest ITT Flygt representative.

Monitoring equipment

A plate in the junction box shows if the pump is equipped with sensors.

CLS-30 is a leakage sensor for sensing water in the oil housing and initiates an alarm when the oil contains 30% water. Oil change is recommended after the alarm. If the sensor initiates an alarm shortly after the oil is changed, contact your nearest ITT Flygt representative. The CLS sensor is installed in the bearing housing and goes down into the oil housing. The sensor is not applicable to Ex-approved pumps.

CLS sensor body made of glass. Handle with care.

The **FLS** sensor consists of a small float switch for sensing water in the stator housing. Its design makes it suitable for pumps in vertical installations. The FLS sensor is installed in the bottom of the stator housing.

The two sensors, CLS and FLS, can be used in the same pump. They are connected in parallel. Follow the instructions for monitoring equipment.

The **MiniCas II** is a monitoring relay to which CLS and/or FLS are connected.

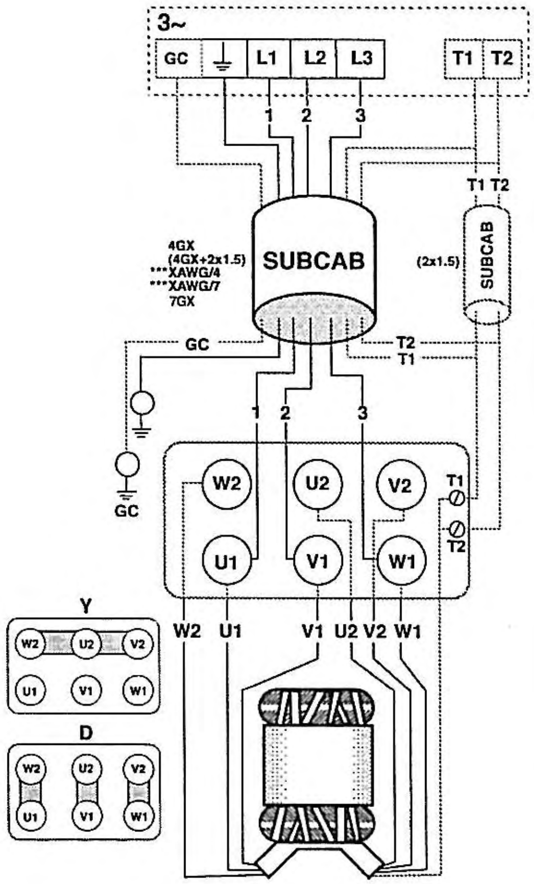
Check:

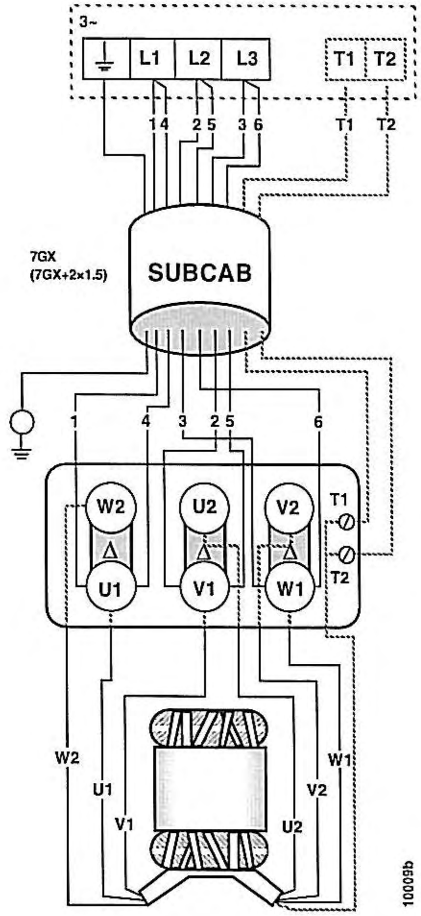
— signals and tripping function.

— that relays, lamps, fuses and connections are intact.

Replace defective equipment.

CABLE CHART





3-phase, direct-on-line starting

	Conductors	Connection starter
SUBCAB 4Gx ***SUBCAB xAWG/4 H07RN-F4Gx BIHF 4Gx silicon	1 brown ***red 2 blue ***white 3 black ***black yellow/green	L1 L2 L3 earth
SUBCAB 4Gx+2x1,5	1 brown 2 blue 3 black yellow/green T1 black T2 black	L1 L2 L3 earth T1* T2*
SUBCAB 7Gx H07RN-F7Gx SO7E6E5-F7x2.5	1 black 2 black 3 black 4 black 5 black 6 black yellow/green	L1 L2 L3 T1* T2* cut off earth
For Canada/USA ***SUBCAB xAWG/7	red white black yellow yellow/green orange blue	L1 L2 L3 GC** earth T1* T2*

Stator leads

U1 = red	V2 = blue
V1 = brown	W2 = black
W1 = yellow	U2 = green

3-phase, direct-on-line Δ, 2 // connected cores

	Conductors	Connection starter
SUBCAB 7Gx SO7E6E5-F7x2.5	1 black 2 black 3 black 4 black 5 black 6 black yellow/green	L1 L2 L3 L1 L2 L3 earth
SUBCAB 7Gx+2x1,5	1 black 2 black 3 black 4 black 5 black 6 black T1 black T2 black yellow/green	L1 L2 L3 L1 L2 L3 T1* T2* earth

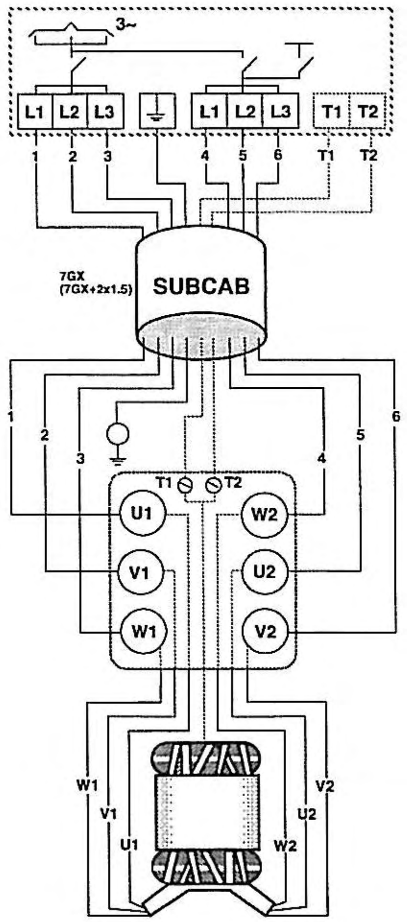
Stator leads

U1 = red	V2 = blue
V1 = brown	W2 = black
W1 = yellow	U2 = green

* Terminal for connection of thermal contacts in the motor and monitoring equipment.
** GC = Ground Check
*** SUBCAB/AWG

SUBCAB is a registered trademark of ITT Flygt AB for electrical cables.

CABLE CHART



3-phase, star-delta starting

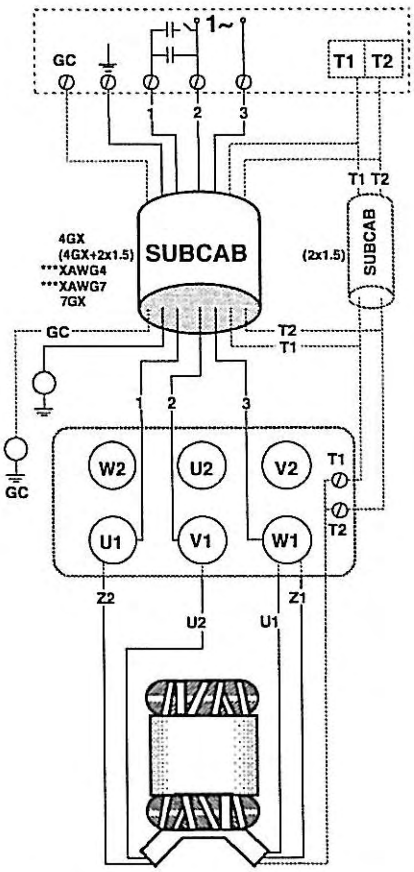
	Conductors	Connection starter
SUBCAB7Gx	1 black	L1
HCR SO7E6E5-F7x2.5	2 black	L2
	3 black	L3
	4 black	L1
	5 black	L2
	6 black	L3
	yellow/green	earth
SUBCAB7Gx+2x1,5	1 black	L1
	2 black	L2
	3 black	L3
	4 black	L1
	5 black	L2
	6 black	L3
	T1 black	T1*
	T2 black	T2*
	yellow/green	earth

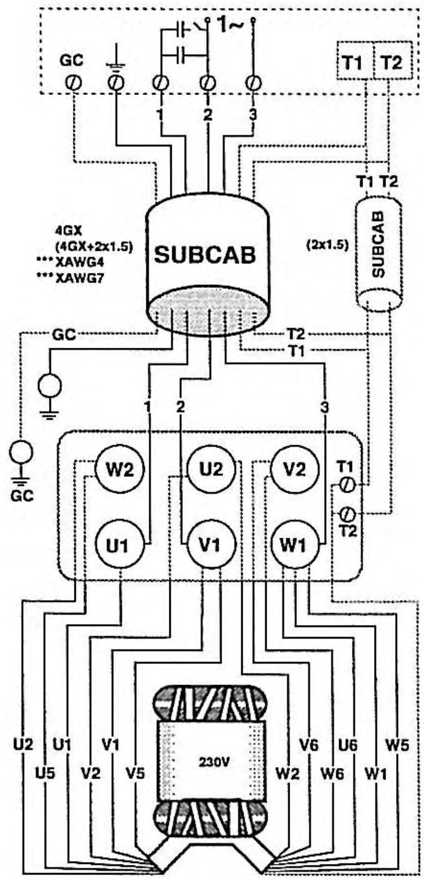
Stator leads		
	U1 = red	V2 = blue
	V1 = brown	W2 = black
	W1 = yellow	U2 = green

* Terminal for connection of thermal contacts in the motor and monitoring equipment.

SUBCAB is a registered trademark of ITT Flygt AB for electrical cables.

CABLE CHART





Single phase

	Conductors	Connection starter
SUBCAB 4Gx ***SUBCAB xAWG/4 HØ7RN-F4Gx BIHF 4Gx silicon	1 brown ***red 2 black ***black 3 blue ***white yellow/green	1 2 3 earth
SUBCAB 4Gx+2x1,5	1 brown 2 black 3 blue yellow/green T1 black T2 black	1 2 3 earth T1* T2*
SUBCAB 7Gx	1 black 2 black 3 black 4 black 5 black 6 black yellow/green	1 2 3 T1* T2* cut off earth
For Canada/USA ***SUBCAB xAWG/7	red black white yellow yellow/green orange blue	1 2 3 GC** earth T1* T2*

Stator leads

U1 = red	U2 = brown
Z1 = yellow	Z2 = black

* Terminal for connection of thermal contacts in the motor and monitoring equipment.
** GC = Ground Check
*** SUBCAB/AWG

Stator leads

U1 = red	U5 = red
V1 = brown	V5 = brown
W1 = yellow	W5 = yellow
U2 = green	U6 = green
V2 = blue	V6 = blue
W2 = black	W6 = black

TRANSPORTATION AND STORAGE

The pump can be transported and stored in a vertical or horizontal position.

— **Always lift the pump by its lifting handle – never by the motor cable or the hose.**

— **Make sure that the pump cannot roll or fall over and injure people or damage property.**

The pump is frostproof as long as it is operating or is immersed in the liquid. If the pump is raised when the temperature is below freezing, the impeller may freeze.

The pump shall be run for a short period after being raised in order to discharge all remaining water.

A frozen impeller can be thawed by allowing the pump to stand immersed in the liquid for a short period before it is started. Never use a naked flame to thaw the pump.

For longer periods of storage, the pump must be protected against moisture and heat. The impeller should be rotated occasionally (for example every other month) to prevent the seals from sticking together.

After a long period of storage, the pump should be inspected before it is taken into operation. Pay special attention to the seals and the cable entry.

Follow the instructions under the heading "Before starting".

OPERATION

Before starting

— **Before starting work on the pump, make sure that the pump is isolated from the power supply and cannot be energized.**

— **Make sure that the pump cannot roll or fall over and injure people or damage property.**

Check that the visible parts on the pump and installation are undamaged and in good condition.

Check the oil level in the oil housing.

Remove the fuses or open the circuit breaker and check that the impeller can be rotated freely.

Check that the monitoring equipment (if any) works.

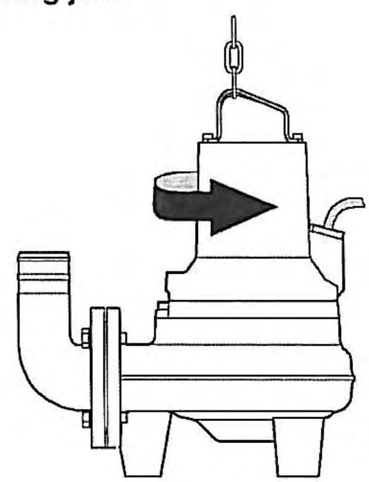
Check the direction of rotation. The impeller shall rotate clockwise, as viewed from above. When started, the pump will jerk in the opposite direction to the direction in which the impeller rotates. See the figure.

In the case of dry installation, check the direction of rotation through the inlet elbow access cover.

Transpose two phase leads if the impeller rotates in the wrong direction (3 ~).

In some installations the pump surface and the surrounding liquid may be hot. Bear in mind the risk of burn injuries.

Starting jerk



Watch out for the starting jerk, which can be powerful.

CARE AND MAINTENANCE

Before starting work on the pump, make sure that the pump is isolated from the power supply and cannot be energized.

This applies to the control circuit as well.

NOTE for Ex version page 3.

Make sure that the pump cannot roll or fall over and injure people or damage property.

The following points are important in connection with work on the pump:

— Make sure that the pump has been thoroughly cleaned.

— Beware of the risk of infection.

— Follow local safety regulations.

The pump is designed for use in liquids which can be hazardous to health. In order to prevent injury to the eyes and skin, observe the following points when working on the pump:

— Always wear goggles and rubber gloves.

— Rinse the pump thoroughly with clean water before starting work.

— Rinse the components in water after dismantling.

— The oil housing may be under pressure. Hold a rag over the oil screw (oil plug) to prevent splatter.

Proceed as follows if hazardous chemicals have splashed into your eyes:

— Rinse your eyes immediately in running water for 15 minutes. Hold your eyelids apart with your fingers.

— Contact an eye specialist.

On your skin:

— Remove contaminated clothes.

— Wash your skin with soap and water.

— Seek medical attention, if required.

Inspection

Regular inspection and preventive maintenance ensure more reliable operation.

The pump should be inspected at least once a year, but more frequently under severe operating conditions.

Under normal operating conditions, the pump should have a major overhaul in a service shop at least every third year for permanent installation and every year for portable pumps. This requires special tools and should be done by an authorized service shop.

If the seals have been replaced an inspection of the oil is recommended after one week of operation.

NOTE! Regular check of the condition of the lifting handle and chain is important.

Inspection of hot water applications

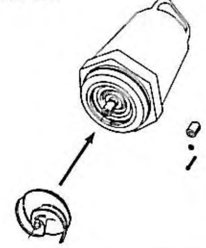
Pumps in hot water applications shall undergo inspection or overhaul at a service shop as follows, depending on the time they have been submerged in the hot water:

Temp.	Mode of operation	Inspection	Shop overhaul
≤70°C (160°F)	Continuous	1000 hours	4000 hours
≤70°C (160°F)	Intermittent	twice a year	once a year
≤90°C (195°F)	Cont./Int.	6 times a year	twice a year

N-type impeller - replacing and setting clearance

Warning! The impellers may have very sharp edges. Use protective gloves.

N3085/3102



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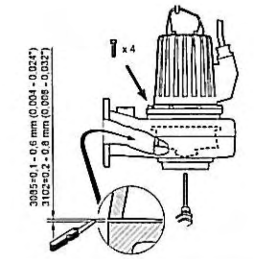

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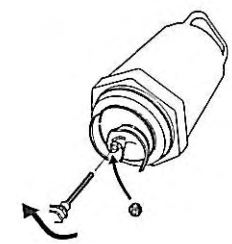

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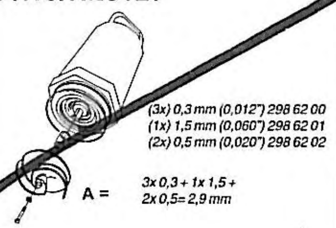
NP/NS/NL3127



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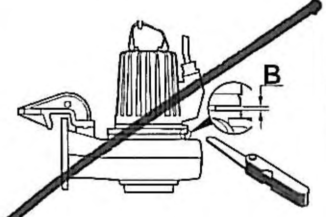

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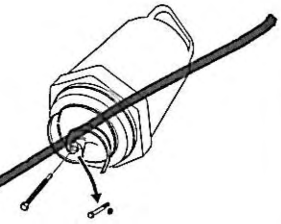

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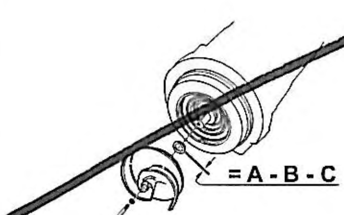

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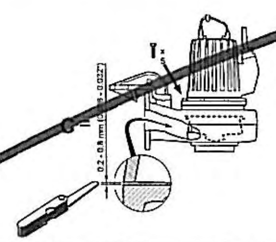

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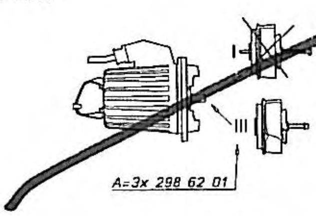
NT3127



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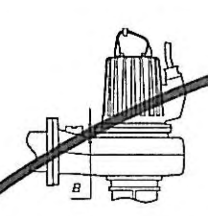

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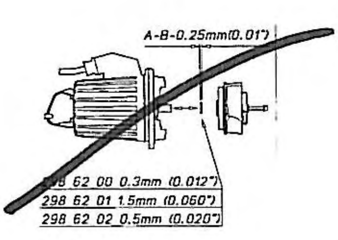

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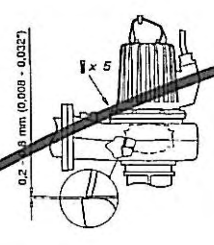
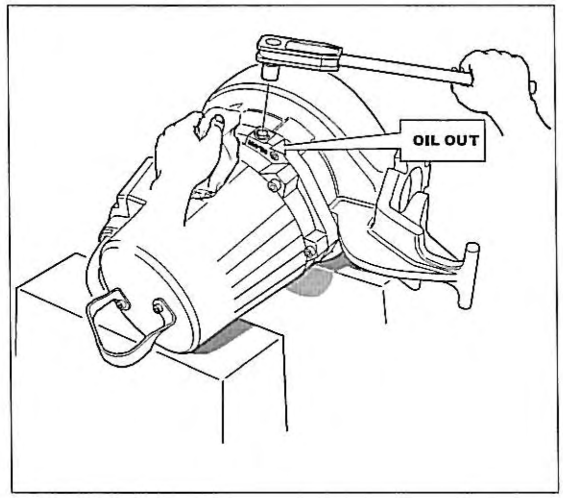


4.

OIL CHANGE

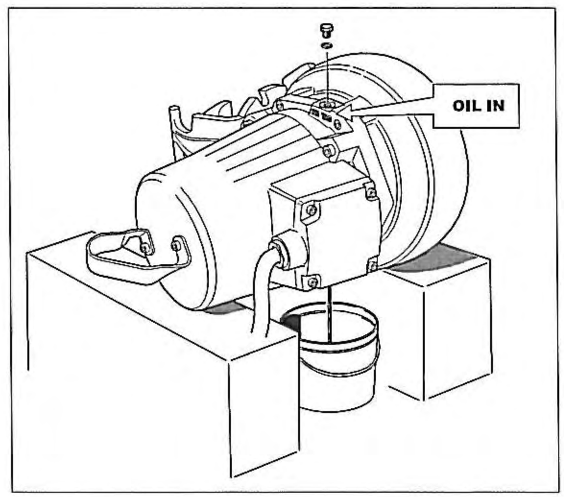
The oil housing may be under pressure. Hold a rag over the oil plug to prevent splatter.

1. Lay the pump on its side on a bench or over two supports. Unscrew the oil housing screw (oil plug) marked "oil out". Emptying the oil must be done through the "oil out" hole.



2. Turn the pump. Unscrew the "oil in" oil hole screw/ plug. In order to drain out all oil, the pump must be raised upright for a short while during drainage.

3. Replace the O-rings under the oil housing screws (plugs) with new ones.

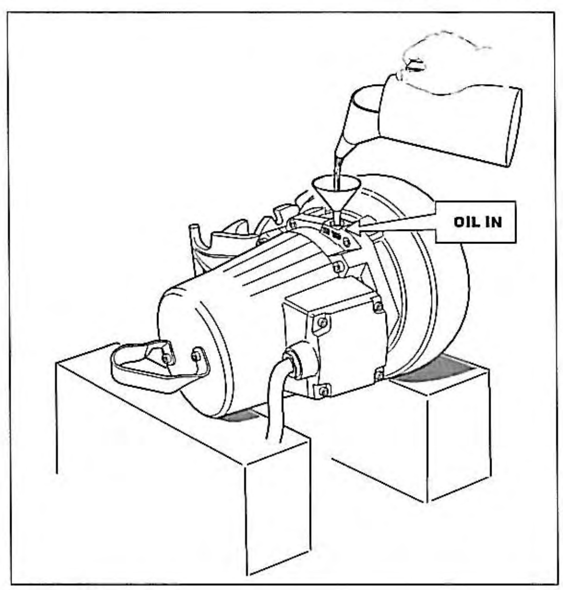


4. Install the "oil out" screw/plug and fill with oil through the other hole. It is important that the oil be added through the hole marked "oil in" since the oil housing must contain some air for pressure equalization. The pump should be tilted slightly and put down again horizontally in order to get the full amount of oil in.

   A paraffin oil with viscosity close to ISO VG15 is recommended (e.g. Mobil Whiterex 309). The pump is delivered from factory with this type of oil.

   In applications where poisonous properties are of less concern, a mineral oil with viscosity up to ISO VG32 can be used.

Approx. oil quantity		
	l	US quarts
3085	1.0	1.1
3085.280/290	0.8	0.8
3102	1.0	1.1
3127	2.0	2.1



FLYGT

www.flygt.com

3085/3102/3127.01.11. Eng.10M.10.02 Printed in Sweden 892062

SECTION FOUR:

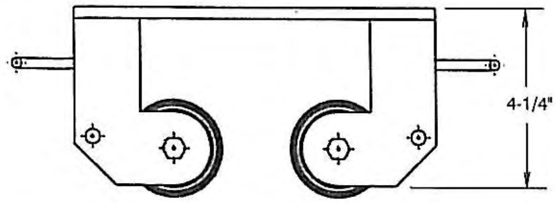
- UPPER GUIDE BAR BRACKETS
- FLUID LEAKAGE SENSORS
- GRIP-EYE LIFTING SYSTEM
- ZINC ANODES

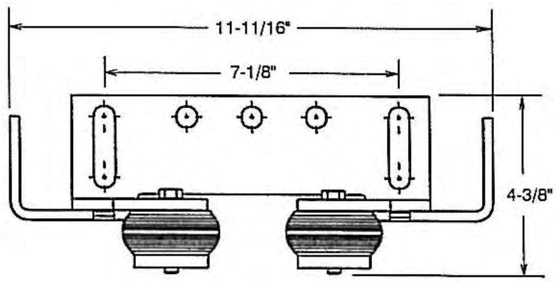
Upper Guide Bar Brackets

FLYGT | **Accessories** | Issued: 8/06 | Supersedes: 6/06

2" UPPER GUIDE BAR BRACKET

~~613 68 00 - Galvanized Steel~~
613 68 04 - 316 Stainless Steel

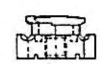


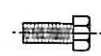


Note: use with 2" nominal guide bars

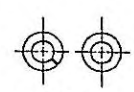
MOUNTING HARDWARE
14-59 00 00 (stainless steel)

3/8"-16 LATERAL NUT
14-46 37 05





HEX. HEAD BOLT (2),
3/8"-16 x 7/8"
14-46 20 25

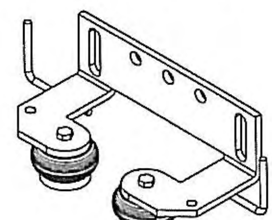


3/8" PLAIN WASHER (2)
14-46 50 07

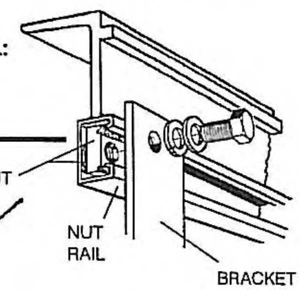
3/8" LOCK WASHER (2)
14-46 50 67

Standard for the following pumps:

DP-3068
CP-3076
DP-3080
~~BP/CP/DP/FP/NP-3085~~
CP/FP/NP-3102
~~CP-3126~~
CP/FP/NP-3127
CP/FP-3152
NP-3153
NP-3171
HP-5520, 5530, 5540

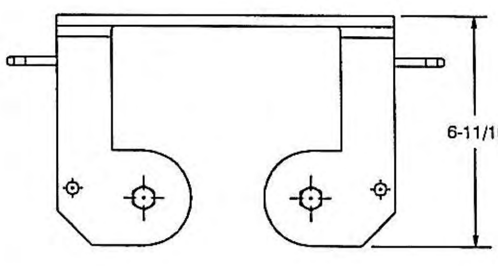


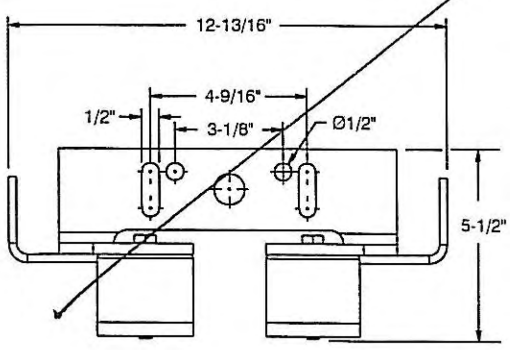
OPTIONAL:
NUT RAIL FEATURE



3" UPPER GUIDE BAR BRACKET

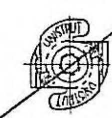
661 54 00 - Galvanized Steel
661 54 01 - 316 Stainless Steel



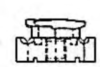


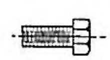
Note: use with 3" nominal guide bars

MOUNTING HARDWARE
14-59 00 00 (stainless steel)

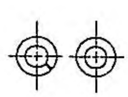


3/8"-16 LATERAL NUT
14-46 37 05





HEX. HEAD BOLT (2),
3/8"-16 x 7/8"
14-46 20 25

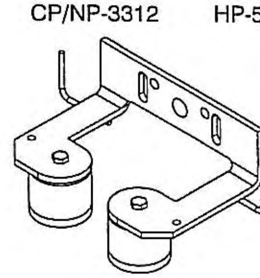


3/8" PLAIN WASHER (2)
14-46 50 07

3/8" LOCK WASHER (2)
14-46 50 67

Standard for the following pumps:

CP-3170	CP-3351
NP-3171	CP/NP-3356
CP/HP-3201	CP/NP-3400
NP-3202	CP-3501
CP/NP/RP-3231	CP-3531
CP-3240	CP-3602
CP/NP/RP-3300	CP-3800
NP-3301	HP-5550
CP/NP-3306	HP-5560
CP/NP-3312	HP-5570



Flygt Monitoring Devices

Leakage Sensors

FLYGT | **Controls** | Issued: 6/94 | Supersedes: 6/90

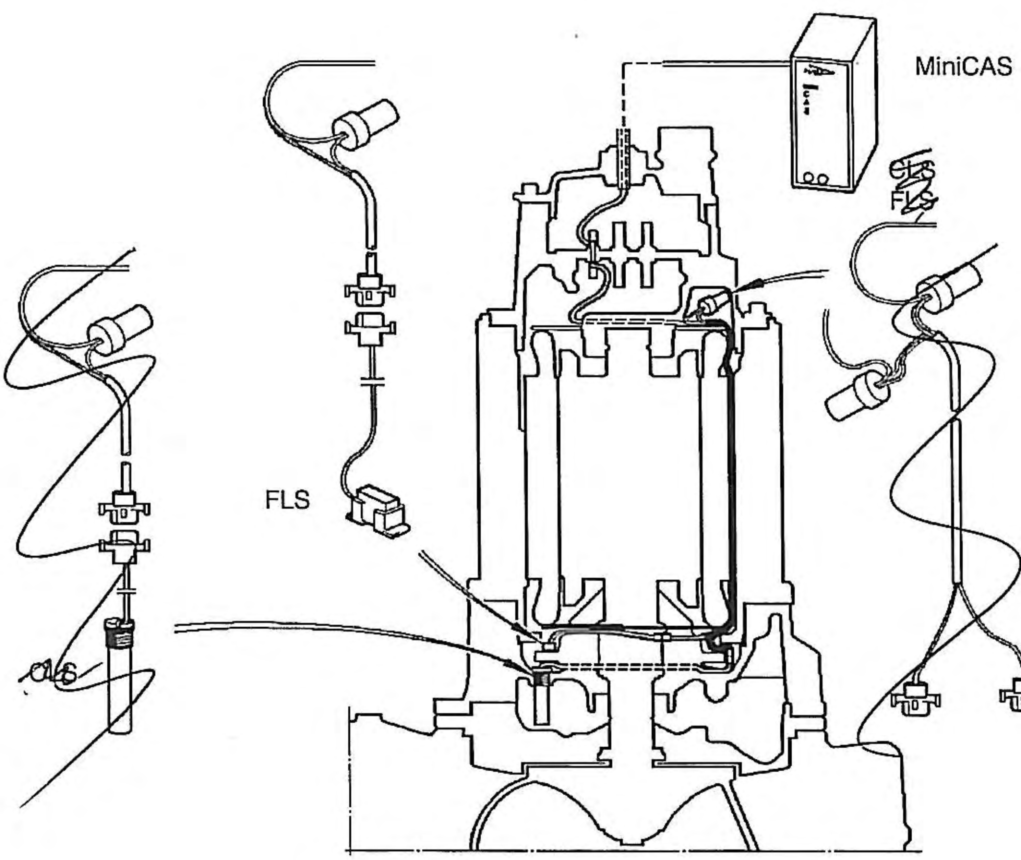
Select Flygt pumps are available with leakage sensors for sensing the presence of water in the oil and/or stator housing. A plate in the junction box indicates that the pump is equipped with sensors.

The FLS sensor is a miniature float switch for the detection of water and/or oil in the stator housing. Due to its design, it is meant to be used for pumps that will be oriented in the standard vertical position. The FLS sensor is mounted in the bottom of the stator housing. The FLS is the only sensor that can be used for intrinsically safe designs which is required for explosion-proof installations.

The FLS is connected to the MiniCAS (Control and Status) monitoring unit. The FLS is wired in series with the thermal switches, thus, eliminating additional control leads. The MiniCAS unit monitors the current allowable to flow from both the temperature switches and FLS sensor. On the front of the MiniCAS there are two indication lamps, one for supply and temperature and one for leakage. Only two wires are needed between the pump and the MiniCAS.

The CLS-30 is a capacitive type leakage sensor for the detection of water in the oil casing. This sensor actuates an alarm when the oil contains 30% water. The CLS-30 sensor is mounted in the bearing cage and sticks into the oil casing. The FLS and CLS sensors can be used together in the same pump, connected in parallel. The parallel connected sensors are then connected in series with the thermal switches and finally connected to the MiniCAS unit.

A typical connection of FLS and CLS sensors to a MiniCAS is shown below.

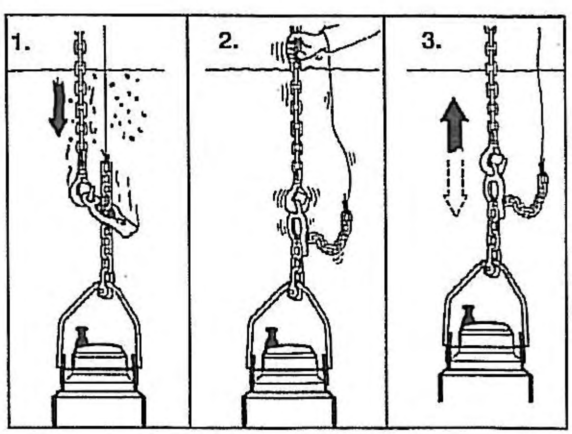


ITT Flygt Grip-eye Lifting System

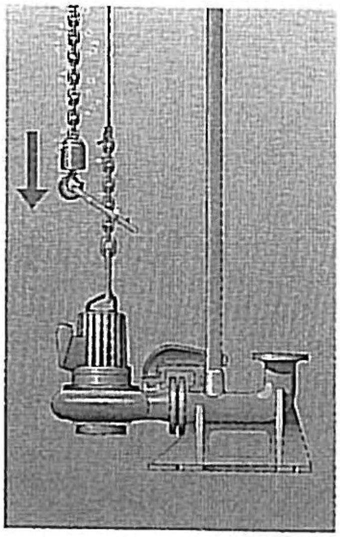
An optional accessory to the ITT Flygt submersible pump line is the patented Flygt Grip-eye System. The system consists of a short section of stainless steel chain (approximately 18-inches) attached to the pump handle via a stainless steel shackle, a guide cable made of stainless steel in a length appropriate to the specific wet well and attached to the stainless chain via a stainless Quick Link, and the Grip-eye device (made of a wrought alloy steel). A hoist is also needed but is not part of the Grip-eye lifting system.

The operation of the Flygt Grip-eye system is as follows:

1. Connect the small eye of the Grip-eye to the end of the hoist cable.
2. Slip the end of the guide cable through the large eye of the Grip-eye. The guide cable simply acts as a guide for the Grip-eye on its way down to the short length of the pump lifting chain.
3. While keeping the guide line taut, proceed to lower the Grip-eye until it is well positioned over the pump lifting chain.
4. Release the tension on the guide line. The lifting chain will now take a position to become engaged in the Grip-eye.
5. Gradually take up tension on the hoist cable and the Grip-eye will make a positive grip on the pump lifting chain. Continue hoisting until the pump is clear of the station.



THIS IS HOW YOU LIFT



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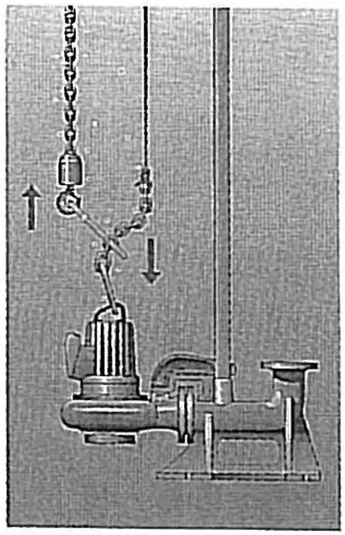

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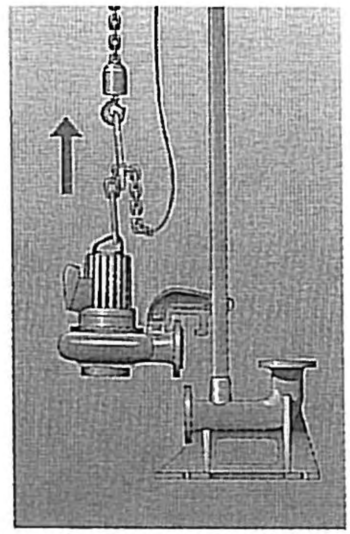
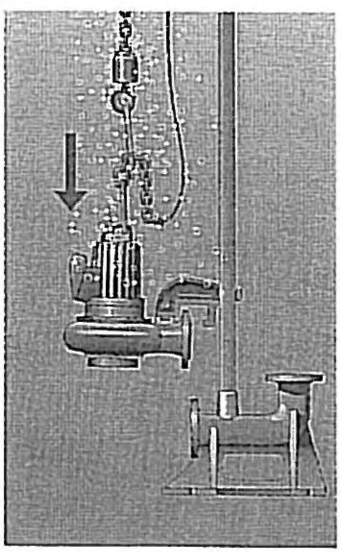


3.

THIS IS HOW YOU LOWER



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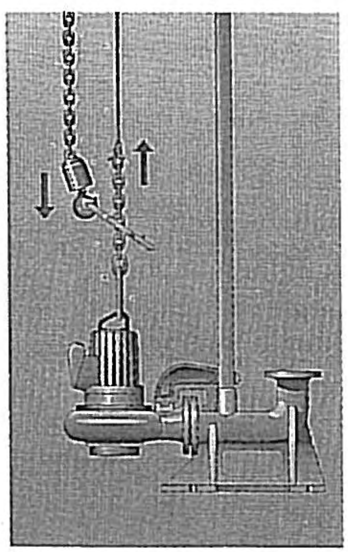

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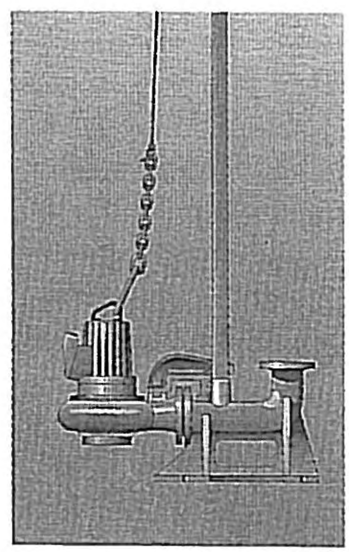


3.

Zinc Anodes
(For ~~CP, CS/DP, DF, DS/HS~~/NP, ~~NS~~ pump protection)

	Accessories	Issued: 10/00	Supersedes: 4/86

In order to improve the corrosion resistance of our cast iron pumps, a cathodic protection arrangement by means of sacrificial zinc anodes has been developed for 3080 to 3602.

Zinc anodes may be used within the intermediate area of liquid aggressiveness where more precious materials cannot be economically justified for the customer.

Limitation

Except for the properties of materials used, inner and outer surface areas of the pumps, liquid speed etc., - i.e. factors known to the design engineer - quite a few varying factors such as resistivity, salt content, oxygen content, pH and temperature of the liquid will affect anode consumption speed.

Therefore, calculations are based on a 2-year anode life span, 100 cm resistivity and 0.5 percent salt content of the liquid. Resistivity should not exceed 200 cm since current distribution will be insufficient. It should be emphasized that the resistivity limit may be exceeded in the brackish waters of deltas.

Anodes may <u>not</u> be mounted on the motors of FM Approved Explosion-proof pumps.

Inspection

For reasons mentioned earlier it is difficult to predict anode consumption speed. Therefore, it is advisable to inspect the anodes one, three and six months after installation and thus estimate when anodes are due to be replaced.

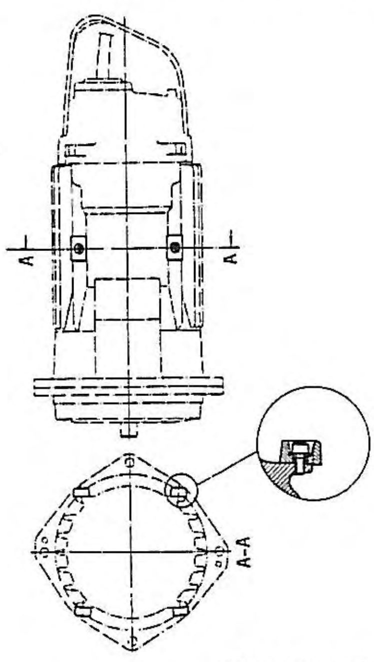
Replacement

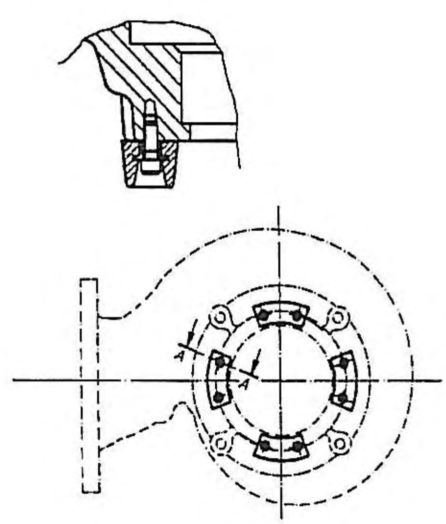
The zinc anodes should be replaced when 75% of their volume is consumed.

Content

Each zinc anode set contains an appropriate number of anodes and fasteners and an assembly instruction.

Motor End





Hydraulic End

Typical anode placement

Zinc Anodes
(For ~~CP, CS/DP, DF, DS/HS~~/NP,~~NS~~ pump protection)

	Accessories	Issued: 6/07	Supersedes: 7/06

Pump Model	Performance	Hydraulic End Anode Set P/N	Motor End Anode Set P/N
CF/CS 3045 DF/DS 3045	HT MT	------------- -------------	554 85 00 554 85 00
DF/DS 3057 CF/CS 3057	MT HT	------------- -------------	554 85 00 554 85 00
DF/DS 3068 CF 3068	MT HT	------------- -------------	554 85 00 554 85 00
DP/DS 3080	MT, HT, ST	443 01 00	-------------
CP/CS/NP/NS 3085	MT LT HT	665 90 04 665 90 00 665 90 01	665 90 05**
DP/DS 3085	MT, HT	665 90 03	
~~CP/CS~~/NP/~~NS~~ 3102	MT ~~LT~~ ~~HT~~	665 90 07 ~~665 90 06~~ ~~665 90 09~~	665 90 18**
CP/CS/DS/NP/ NS 3127	MT LT HT	665 90 09 665 90 09 665 90 09	665 90 18**
DP 3127		665 90 11	
HS 3127	HT	665 90 29	
CP/CS 3152	MT LT 8" LT 10" HT	650 61 03 665 90 11 650 61 06 665 90 11	665 90 24 665 90 10*
DP/DS 3152		665 90 11	
HP/HS 3152	MT	665 90 11	
FP/FS 3152	LT HT	665 90 25 665 90 26	
NP/NS 3153	MT LT/4P LT/6P HT	671 56 03 671 56 02 671 56 01 671 56 03	671 56 00

Pump Model	Performance	Hydraulic End Anode Set P/N	Motor End Anode Set P/N
CP/CS 3170	MT LT HT	650 61 03 650 61 06 650 61 03	665 90 31 665 90 15*
NP/NS 3171	MT LT HT	671 56 02 671 56 05 671 56 03	671 56 04
CP/CS 3201	MT LT 10" LT 12" HT	665 90 17 650 61 06 650 61 08 650 61 03	665 90 31 665 90 15*
HP/HS 3201		650 61 03	
NP/NS 3202	MT LT HT	671 56 08 671 56 07 671 56 10	671 56 06
CP/CS/NP/NS 3300	MT, LT	665 90 28	665 90 16
RP/RS 3300		665 90 21	650 61 10
NP/NS 3301	MT LT/6P LT/8P HT	671 56 14 671 56 13 671 56 12 671 56 15	671 56 11

* With Cooling Jacket

** **Zinc anodes are not to be Installed on the motor of FM versions of this pump model.**

Contact Factory for anode availability and installation instructions on large drive pumps.

SECTION FIVE:

- ITT FLYGT WARRANTY

ITT FLYGT WARRANTY

GENERAL:
For the period defined, ITT FLYGT offers a commercial warranty to the original End Purchaser against defects in workmanship and/or material. Warranty covers parts and labor at a rate outlined in **ADDENDUM – A.** ITT FLYGT products will be covered when applied in compliance with the requirements of the ITT FLYGT Catalog and the ITT FLYGT Technical Manual specifications and used for mixing and/or pumping of Qualified Liquids.

CONDITIONS:
ITT FLYGT will pay the cost of replacement parts and labor, provided that the product, with cable attached, is returned prepaid to an Authorized ITT FLYGT Service Facility for repairs. Coverage for replacement of parts and labor will be provided at the rate as shown in **ADDENDUM - A** for the period indicated. Coverage will begin from date of shipment or date of a valid Start-up. In cases where the Start-up date is used as the beginning of the warranty, a Start-up Report completed by an approved service technician from an ITT FLYGT Authorized Service Facility and must be received by the ITT FLYGT Area Service Manager within thirty (30) days of the initial onset of the unit placed into service or the beginning of the warranty coverage will default to the product ship date. Start-up must occur within one (1) year from date of shipment from ITT FLYGT or warranty will automatically default to ship date as start of warranty. (See **STORAGE** section) Warranty coverage will be calculated from the determined start date to the date that the defective product and/or warranty claim is received by an ITT FLYGT Authorized Service Facility. (See **TIME** section)

A copy of Electrical System Schematics of the control used (including Control's Bill of Material) and, if requested, a copy of the Start-up Report may be required to support any Warranty Claims submitted for approval. ITT FLYGT retains the exclusive right to replace, repair or grant credit for product submitted under this warranty. In the event that the product is replaced, warranty on the replacement product will be equal to the balance remaining on the original product or ninety (90) days, which ever is greater.

This Warranty shall not apply to any Product or Part of Product which has been subjected to misuse, accident, negligence, used in a manner contrary to ITT FLYGT's printed instructions or damaged due to a defective power supply, improper electrical protection, faulty installation or repair, an act of God, an act of war or by an act of terrorism.

This warranty is exclusive of costs for standard and/or scheduled maintenance performed and for parts that, by virtue of their operation, require replacement through normal wear (aka: Wear Parts).

Wear Parts being described as Cutters, Cutting Plates, Impellers, Agitators, Diffusers, Wear Rings (Stationary or Rotating), Volutes (when used in an abrasive environment), oil, grease and/or any items deemed as necessary to perform normal maintenance on ITT FLYGT equipment will not be included in this warranty unless a defect in material or workmanship can be determined by ITT FLYGT.

STORAGE:
Should a delay occur between ship date and the date of start-up, maintenance as outlined in ITT FLYGT's *Care & Maintenance Manual* must be performed by the "CONTRACTOR" and/or "OWNER" during any such period of storage. Documentation providing proof and outlining what maintenance was performed must be provided to ITT FLYGT or its representative within thirty (30) days of said maintenance, or the ITT FLYGT warranty may be considered void.

TIME:
Unless otherwise specified by ITT FLYGT US Corporate Headquarters, the beginning of this warranty will be determined by one of the following: time from date of original ship date from a ITT Flygt Authorized Facility or time from date of start-up and shall be determined by the date in which either event took place, to the date that the defective product (or Warranty Claim) is received by ITT FLYGT, or its authorized service facility. Note: Date of Start-up must include an ITT FLYGT Start-up Report submitted to ITT FLYGT by a qualified representative of an ITT FLYGT Authorized Service Facility within thirty (30) days of actual start-up in order to qualify.

ITT

Engineered for life

ITT FLYGT WARRANTY

IMPORTANT: FOR WARRANTY PURPOSES, MONITORING DEVICES PURCHASED WITH UNITS FOR PROTECTION MUST BE CONNECTED AND UTILIZED. FAILURE TO DO SO WILL RENDER THIS WARRANTY NULL AND VOID.

ITT FLYGT NEITHER ASSUMES, NOR AUTHORIZES ANY PERSON OR COMPANY TO ASSUME FOR ITT FLYGT, ANY OTHER OBLIGATION IN CONNECTION WITH THE SALE OF ITS EQUIPMENT. ANY ENLARGEMENT OR MODIFICATION OF THIS WARRANTY BY A DISTRIBUTOR, OR OTHER SELLING AGENT SHALL BECOME HIS EXCLUSIVE RESPONSIBILITY.

THE WARRANTIES MADE HEREIN BY ITT FLYGT ARE IN LIEU OF ANY AND ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED AND THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY EXPRESSLY DISCLAIMED. ITT FLYGT ASSUMES NO LIABILITY FOR LOSS OF USE OR FOR ANY DIRECT, INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND IN RESPECT TO THE USE OR OPERATION OF ITT FLYGT PRODUCTS, OR ANY EQUIPMENT OR ACCESSORIES IN CONNECTION THEREWITH.

ITT FLYGT WILL NOT BE HELD RESPONSIBLE FOR TRAVEL EXPENSES, RENTED EQUIPMENT, OUTSIDE CONTRACTOR'S FEES, EXPENSES PERFORMED BY AN UNAUTHORIZED REPAIR SHOP, UNAUTHORIZED ALTERATIONS, OR FOR PUMPS USED WITHOUT ITT FLYGT SUPPLIED CABLE OR CONTROLS UNLESS IT CAN BE PROVEN SUCH ANCILLARY EQUIPMENT IS SUITABLE FOR THE PURPOSE AND EQUAL TO ITT FLYGT CABLES OR CONTROLS THAT WOULD ORIGINALLY BE SUPPLIED WITH THE TYPE OF EQUIPMENT IN USE. REIMBURSEMENT COSTS FOR CRANES AND/OR ANY SPECIAL EQUIPMENT USED IN CONJUNCTION FOR THE REMOVAL OR REINSTALLATION OF ANY ITT FLYGT EQUIPMENT WILL NOT COVERED UNDER THIS WARRANTY.

WITHOUT THE EXPRESSED PERMISSION IN WRITING FROM THE FLYGT-US HEADQUARTERS, PRODUCT EXPORTED OUTSIDE U.S. BORDERS WILL RENDER THIS WARRANTY NULL AND VOID.

It is agreed by the owner of the product that Periodic Maintenance (PM) will be performed as prescribed in accordance with ITT FLYGT's *Operations & Maintenance Manual* during the period of the warranty as outlined in **ADDENDUM – A**. Not maintaining and/or performing a maintenance regiment, as outlined in the *Operating & Maintenance Manual*, may be considered reason render this warranty null and void.

A written record, hereby known as "the log", will be associated with each unit serial number and must be maintained by the organization having product maintenance responsibility. The log must record each PM activity during the life of the warranty. Other information in the log shall include, but is not limited to, any repairs that were performed on the unit, or verification that a Flygt authorized Service Contract is in force during the life of the warranty and is available for review and/or auditing. Failure to maintain a maintenance record log may render this warrant null and void. Such logs must be made available for auditing by ITT FLYGT.

Customers and/or service personnel claiming to be unaware or unable to acknowledge the existence of the contents of this warranty does not constitute alteration of the conditions as outlined in this document. Owners of Flygt products have certain rights under this warranty and may have other rights dictated by the laws within the state in which this product is purchased.

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ITT FLYGT WARRANTY

ADDENDUM - A

PRODUCT	PRODUCT SERIES AND CONFIGURATION	Months 1-12	Months 13-18	Months 19-36	Months 37-39	Months 40-60
Axial Flow/ Mixed Flow/ Centrifugal Pumps & Mixers	3000 Series: CP, NP, DP, CT, NT, CZ, LL, 7000 Series, PL, 4000 Series, SR, PP	100%		50%		25%
Permanent Controls	Permanent	100%				
Abrasion/Corrosion Resistant/ Chopper/ Grinder Pumps	3000 Series: MP, MF, MH, FS, FP, HP, HS, 5000 Series: HP, HS	100%				
Dewatering Pumps	2000 Series: BS, 3000 Series: CS, NS, DS	100%				
Hydroejectors/ Aerators	HE, JA	100%				
Accessories	Permanent/Portable	100%				
Portable Controls	Portable	100%				
Small Pumps	C/D 3045 ~ 3057, SX.	100%				
Parts - *		100%				

* - Parts used in a repair that fail are warranted for the failed part only – no labor.

ITT

Engineered for life

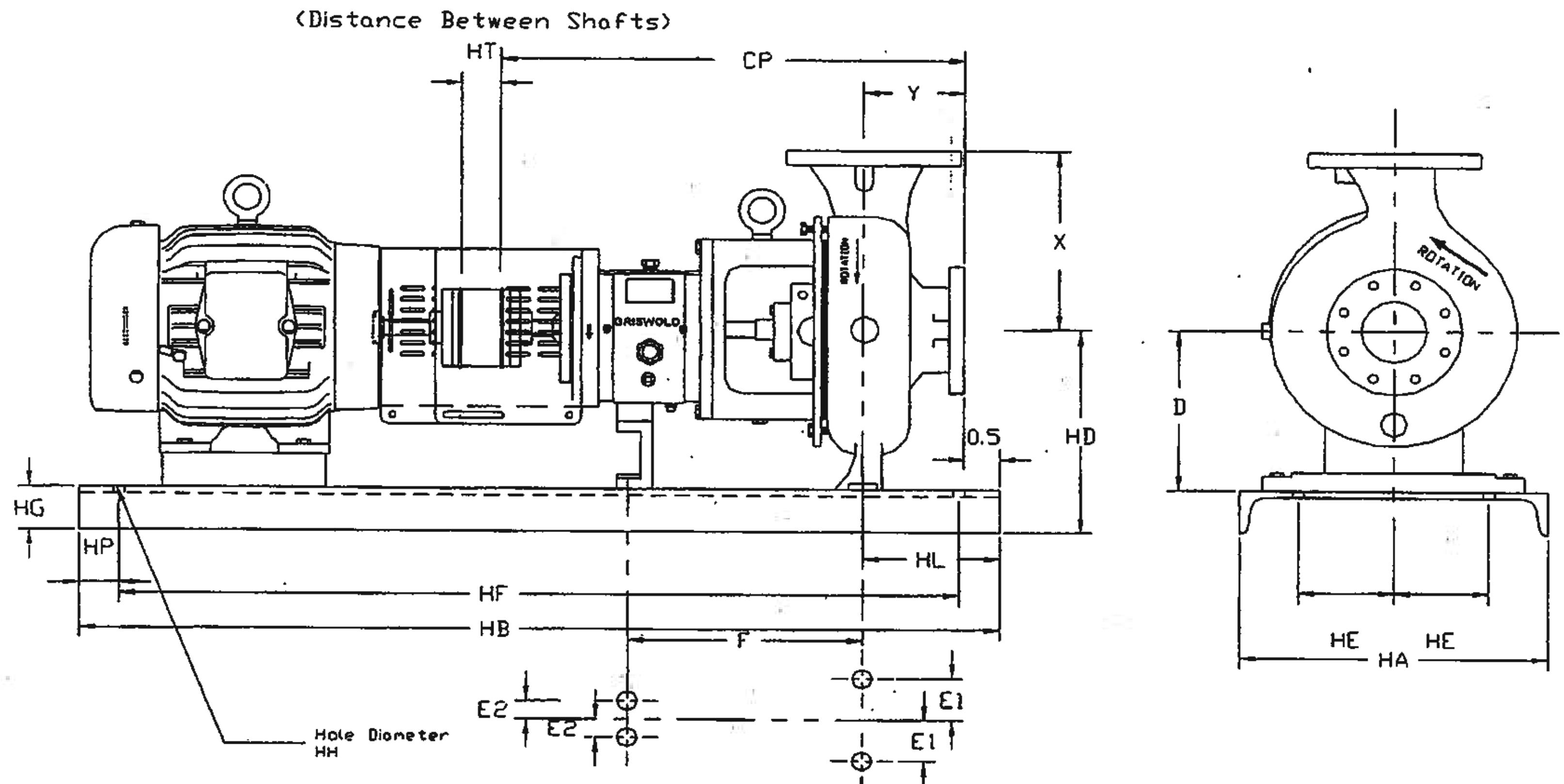
Volume II

11312 - Filter Feed Pumps 50P1241/50P1242

Attachment 2.3

1.3.A.1.d

FILTER FEED 50P1241; 50P1242



Pump End Mounting Holes

Pump End Dimensions

Model	Pump Size & Designation	Suc.	150# Drilling	Disch.	150# Drilling	D	X	CP	E1	E2	F	Y
811S	1 1/2 x 1 - 8AA	1.5	(4) 5/8 Holes on 3.875BC	1	(4) 5/8 Holes on 3.125BC	5.25	6.5	17.5	3	0	7.25	4

Steel Base Plate Dimensions

Max Nema Frame	ANSI Baseplate #	HA	HB	HT (min)	HD max (D+HG)	HE	HF	HG (max)	HH	HL	HP
256T	148	15	48	3.5	9.38	6	45.5	4.13	0.75	4.5	1.25

WEG	No.:
	Date: 7/17/2007

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	:
Product line	: IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Frame	: 213T
Output	: 7.5 HP
Frequency	: 60 Hz
Poles	: 2
Full load speed	: 3530
Slip	: 1.94 %
Voltage	: 460 V
Full load current	: 8.63 A
Locked rotor current	: 69.0 A
Locked rotor current (Il/In)	: 8.0
No-load current	: 3.50 A
Full load torque	: 11.0 lb.ft
Locked rotor torque	: 260 %
Breakdown torque	: 340 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 26 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: 40
Altitude	: 1000 m
Degree of Protection	: IP55
Approximate weight	: 167 lb -
Moment of inertia	: 0.57664 sq.ft.lb
Noise level	: 72 dB(A)

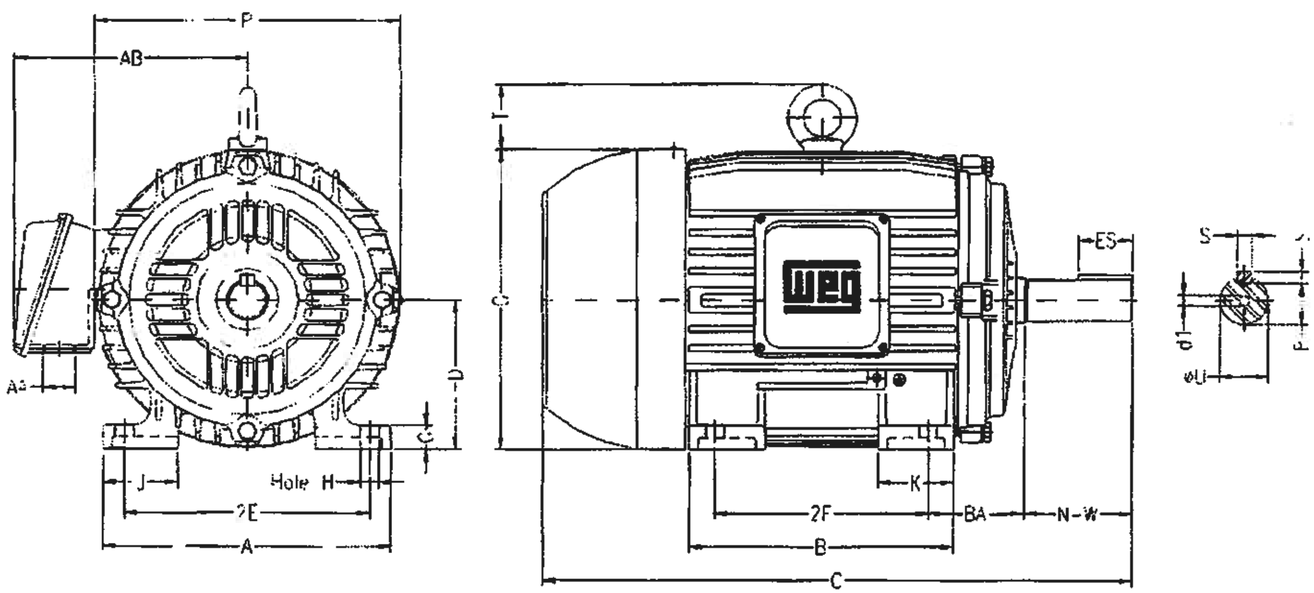
	D.E.	N.D.E.
Bearings	6308 C3	6207 C3
Regreasing interval	18447 h	20000 h
Grease amount	11 g	7 g

Load	Power factor	Efficiency (%)
100%	0.88	91.0
75%	0.82	90.2
50%	0.72	88.5

Filter Feed
50P1241 & 50P1242
Motor model # 00736ST3QIE213T

Performed by:	Checked:

Version



2E 8.500	2F 5.500	H 0.406	BA 3.500	A 9.764
B 7.362	C 18.021	D 5.250	G 0.827	J 2.008
K 2.165	O 10.841	P 10.630	T 1.772	ES 2.480
S 0.313	N-W 3.375	U 1.375	R 1.203	AB —
AA NPT 1	d1 A4			

Notes: Filter Feed

50P1241 & 50P1242 Motor model # 00736ST3QIE213T

Performed by:

Checked:

Customer:

IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Three-phase induction motor

Frame 213T - IP55

7/18/2007

Version

1.3.A.1.f, d

1.3.A.1.c

PRIMARY Design Point

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

FILTER FEED 50P1241 & 50P1242

Pump:

Size: 1.5x1-8 AA
Type: 811-ANSI
Synch speed: 3600 rpm
Speed: 3500 rpm
Dia: 6.02 in
Curve: G-3604
Impeller:
Specific Speeds:
Ns: --
Nss: 6693
Dimensions:
Suction: 1.5 in
Discharge: 1 in

Pump Limits:

Temperature: -- °F
Pressure: -- psi g
Sphere size: 0.344 in
Power: -- hp
Eye area: -- in²

Search Criteria:

Flow: 70 US gpm
Head: 158 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: -- ft
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: TEFC
Size: 7.5 HP
Speed: 3600
Frame: 213T
Sizing criteria: Max Power on Design Curve

Data Point

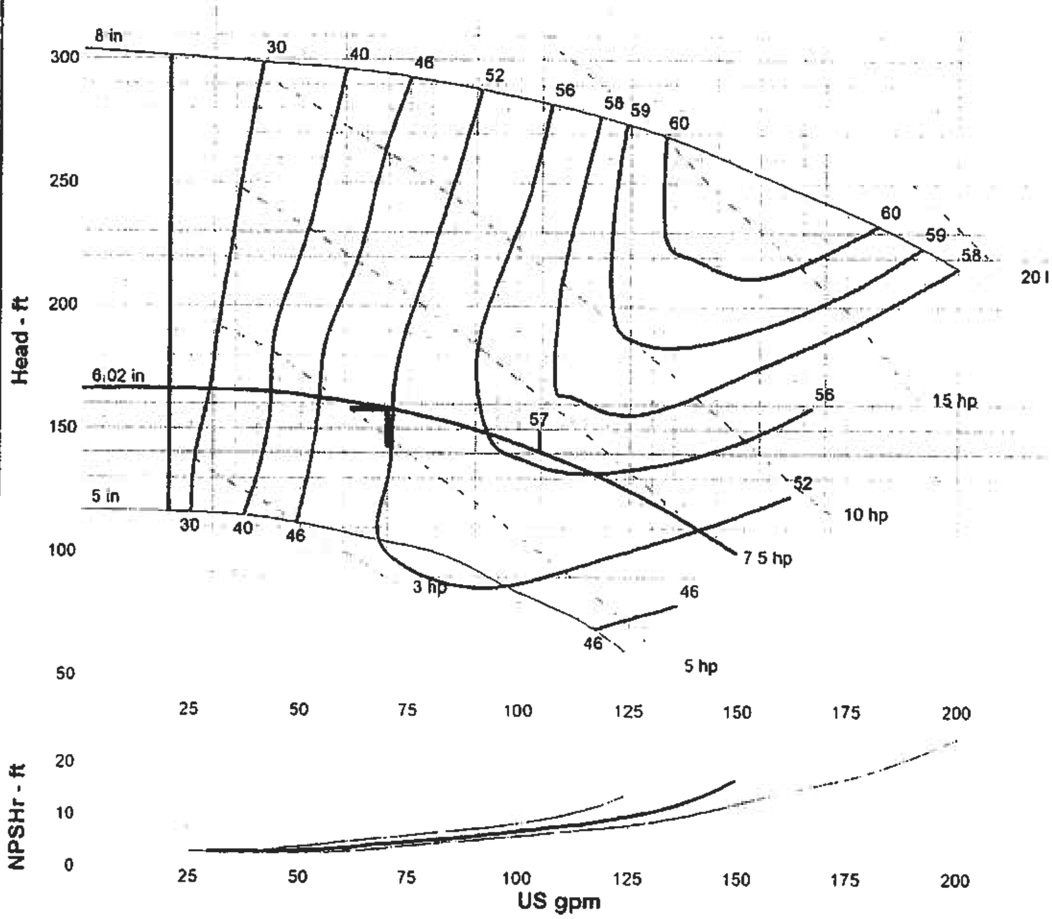
Flow: 70 US gpm
Head: 158 ft
Eff: 52%
Power: 5.42 hp
NPSHr: 4.54 ft

Design Curve

Shutoff head: 166 ft
Shutoff dP: 71.8 psi
Min flow: 20 US gpm
BEP: 57% @ 105 US gpm
NOL power:
7.68 hp @ 150 US gpm

Max Curve

Max power:
18.8 hp @ 200 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
84	3500	152	54	5.9	5.63
70	3500	158	52	5.42	4.54
56	3500	162	47	4.9	3.49
42	3500	165	39	4.45	3
28	3500	166	29	4.04	3

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

1.3.A.1.c

Secondary Design Point (1)

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

FILTER FEED 50P1241 & 50P1242

Pump:

Size: 1.5x1-8 AA
Type: 811-ANSI
Synch speed: 1800 rpm
Curve: G-1804
Specific Speeds:
Dimensions:
Speed: 1580 rpm
Dia: 6.02 in
Impeller:
Ns: ---
Nss: 6693
Suction: 1.5 in
Discharge: 1 in

Pump Limits:

Temperature: --- °F
Pressure: --- psi g
Sphere size: 0.344 in
Power: --- hp
Eye area: --- in²

Search Criteria:

Flow: 11 US gpm
Head: 34.2 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: --- ft
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: TEFC
Size: 7.5 HP
Speed: 1800
Frame: 213T
Sizing criteria: Max Power on Design Curve

---- Data Point ----

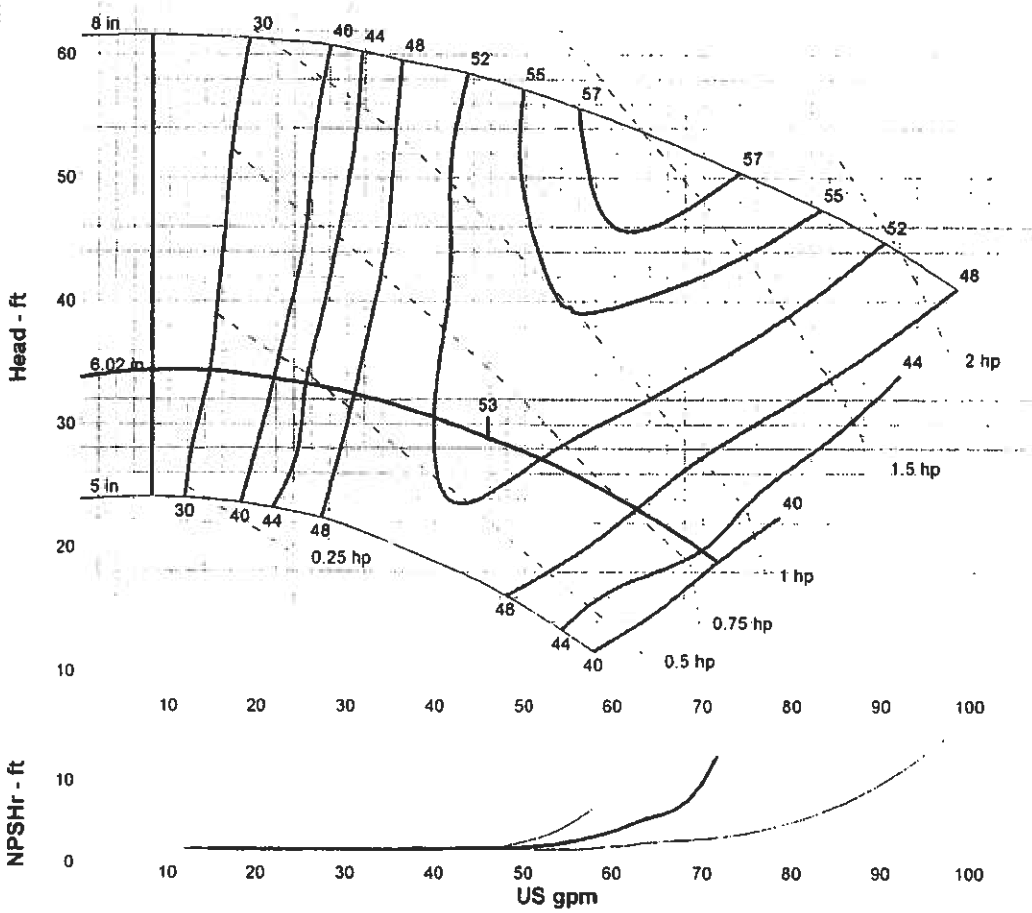
Flow: 11 US gpm
Head: 34.2 ft
Eff: 25%
Power: 0.399 hp
NPSHr: 1.7 ft

---- Design Curve ----

Shutoff head: 33.8 ft
Shutoff dP: 14.6 psi
Min flow: 8 US gpm
BEP: 53% @ 45.8 US gpm
NOL power:
0.851 hp @ 71.6 US gpm

---- Max Curve ----

Max power:
2.12 hp @ 98.4 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
84	1580	---	---	---	---
70	1580	19.7	44	0.799	9.97
56	1580	25.6	50	0.715	3.2
42	1580	29.9	52	0.605	1.77
28	1580	32.9	46	0.505	1.7

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

SECONDARY DESIGN POINT (2)

FILTER FEED 50P1241 & 50P1242

Pump:

Size: 1.5x1-8 AA
Type: 811-ANSI
Synch speed: 3600 rpm
Curve: G-3604
Specific Speeds:
Dimensions:

Speed: 2040 rpm
Dia: 6.02 in
Impeller:
Ns: ---
Nss: 6693
Suction: 1.5 in
Discharge: 1 in

Pump Limits:

Temperature: --- °F
Pressure: --- psi g
Sphere size: 0.344 in

Power: --- hp
Eye area: --- in²

Search Criteria:

Flow: 84 US gpm
Head: 36 ft

Fluid:

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: --- ft

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: TEFC
Sizing criteria: Max Power on Design Curve

Size: 7.5 HP
Speed: 3600
Frame: 213T

Data Point

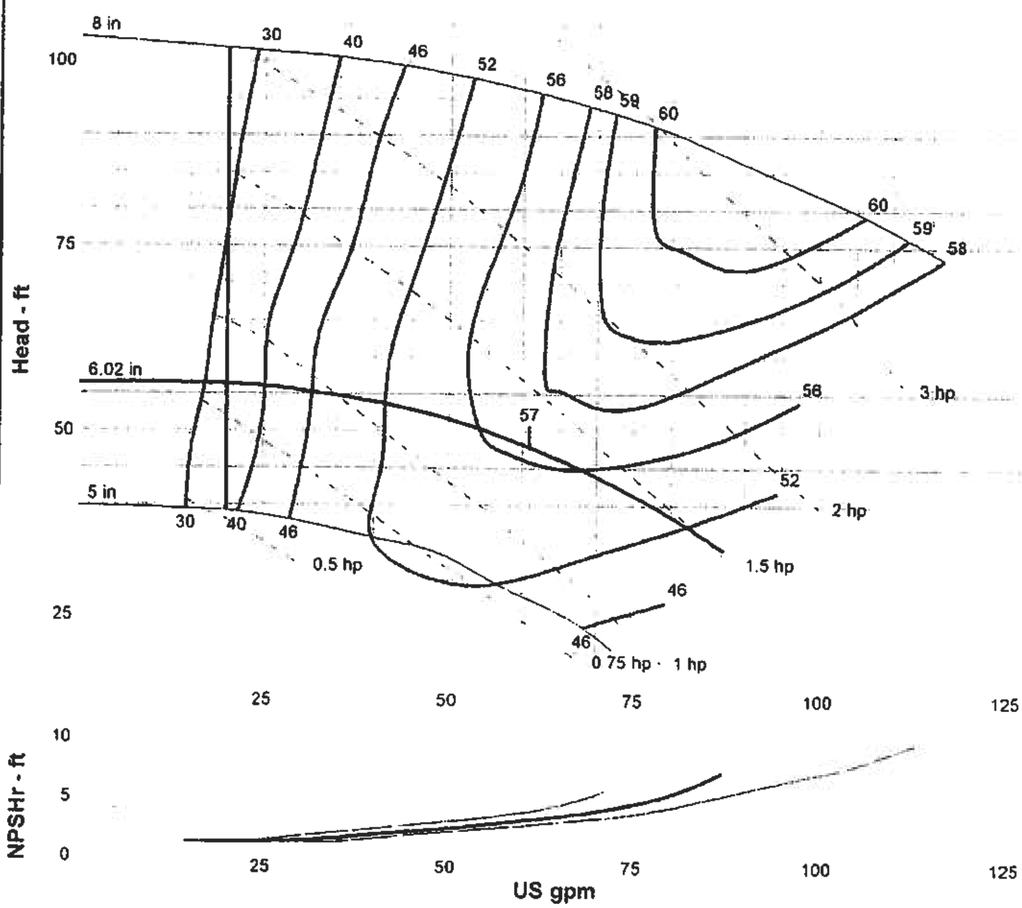
Flow:	84 US gpm
Head:	36 ft
Eff:	51%
Power:	1.5 hp
NPSHr:	6.26 ft

Design Curve

Shutoff head: 56.4 ft
Shutoff dP: 24.4 psi
Min flow: 20 US gpm
BEP: 57% @ 60.9 US gpm
NOL power:
1.52 hp @ 87.1 US gpm

Max Curve

Max power:
3.72 hp @ 117 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
84	2040	36	51	1.5	6.26
70	2040	43.8	55	1.39	3.98
56	2040	49.7	56	1.25	2.8
42	2040	53.6	52	1.09	1.98
28	2040	55.7	43	0.919	1.33

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

MAINTENANCE SUMMARY FORM - 11312

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: FILTER FEED PUMPS 811S 1.5 x 1.8

2. MANUFACTURER: GRISWOLD

3. EQUIPMENT/TAG NUMBER(S): 50P1241 & 50P1242

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 423 LBS.

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 7.5 HP, 460V, 3 PH, 3600 RPM, 1.15 Service Factor

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Cascade Machinery & Electric, Inc.

a. Name: _____ Telephone: 206-762-0500

b. Address: 4600 East Marginal Way South, PO Box 3575 Seattle, WA 98124

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

*NOTE: Maintenance and monitoring intervals should be shortened in severe service locations

Maintenance Operation Comments	**Frequency***	**Lubricant (If Applicable)**
Bearing and Lubricant Condition: bearing temperatures, lubricant level, and vibration. Oil level should be mid-point of the bulls eye sight glass. Lubricant should be clear with no signs of frothing.	Routinely	✦
Shaft seal condition: Mechanical seals should show no signs of leakage	Routinely	
Overall pump vibration, check bearing alignment	Routinely	
Pump discharge pressure – a gradual decrease in developed head can indicate the need for Impeller adjustment	Annually	
Check foundation and hold down bolts	Quarterly	

Oil change	Quarterly or after 2000 hrs. of operation, which ever comes first.	✦
Shaft alignment	Quarterly	
Pump flow rate	Annually	
Motor Amp Drain	Annually	
Vibration signature	Annually	
Motor Bearing Lubrication	15,700 hrs. of service	❋

8. LUBRICANT LIST

Reference Symbol	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**Or Equal**
✦	ISO Grade VG 68 or equal	Chevron GTS Oil 68	Exxon Terrestic 68 or Nuto 68	Mobil DTE Heavy-Medium	Philips Mangus 315
✦	Shell Tellus Oil 68	Sunoco Sunvis 968	Amoco Industrial 68	Royal Purple – Synfilm GT VG 68	
❋	PolyRex EM Grease ESSO/EXXON				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

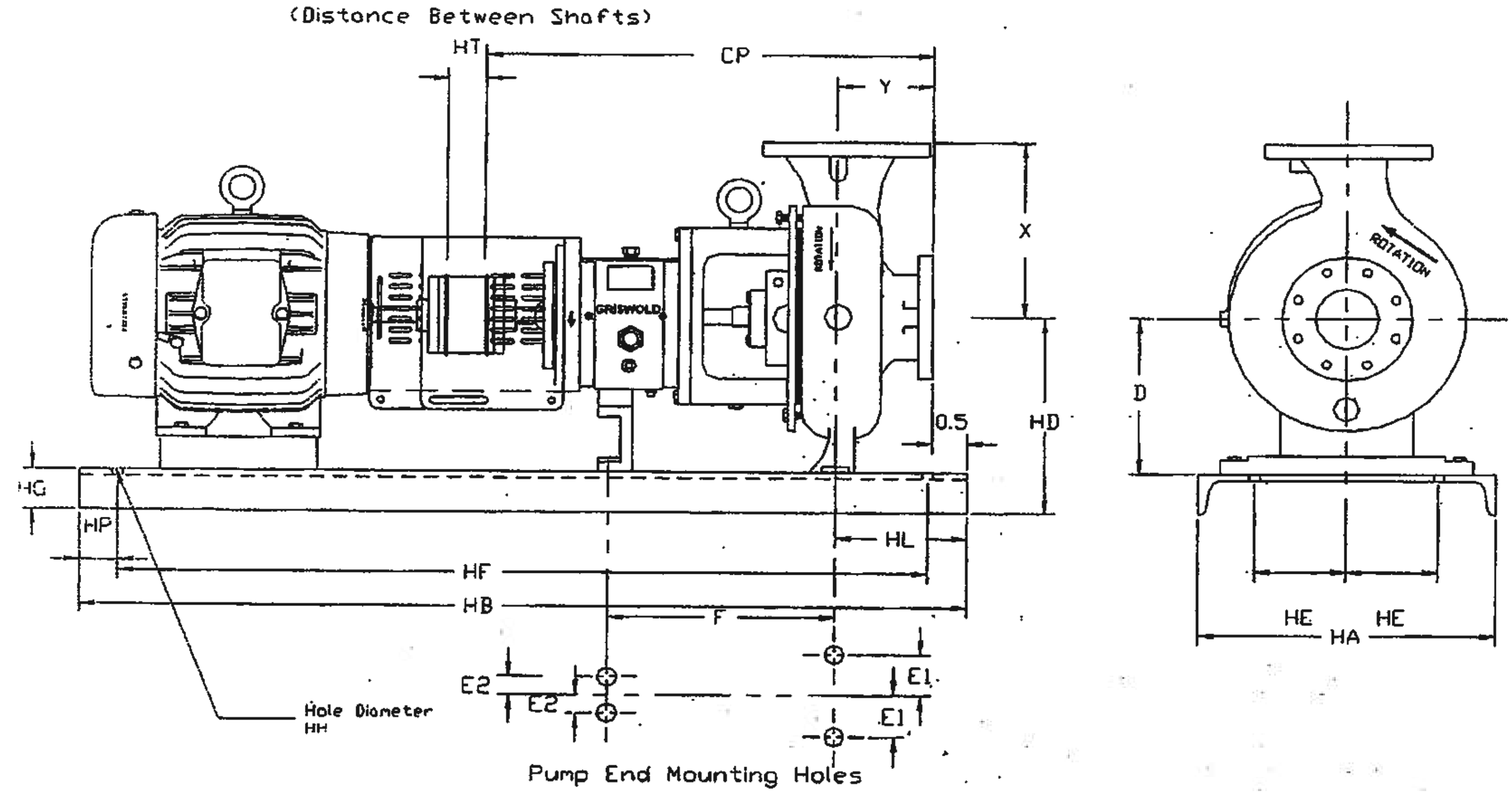
Part No.	Description	Unit	Quantity	Unit Cost
21280-40-91	Impeller	Each	1	560.00
22049-4-1	Shaft Seal	Each	1	229.25
RK-3196S	Repair Kit	Each	1	137.75
K-3196S-8	Maintenance Kit	Each	1	32.50
Note: Identify parts provided by this Contract with two asterisks.				

Volume II

11312 - Backwash Pumps 50P1351/50P1352

Attachment 2.4

BACKWASH 50P1351, 50P1352



Pump End Dimensions

Model	Pump Size & Designation	Suc.	150# Drilling	Disch.	150# Drilling	D	X	CP	E1	E2	F	Y
811M	4 x 3 - 10 A70	4	(8) 3/7 Holes on 7.50BC	3	(4) 3/4 Holes on 6.0BC	8.25	11	23.5	4 7/8	3 5/8	12.5	4

Steel Base Plate Dimensions

Max Nema Frame	ANSI Baseplate #	HA	HB	HT (min)	HD max (D+HG)	HE	HF	HG (max)	HH	HL	HP
286T	258	18	58	3.5	13	7.5	55.5	4.75	1	4.5	1.25

	No.:
	Date: 7/17/2007

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	:
Product line	: IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Frame	: 254T
Output	: 15 HP
Frequency	: 60 Hz
Poles	: 4
Full load speed	: 1765
Slip	: 1.94 %
Voltage	: 460 V
Full load current	: 18.0 A
Locked rotor current	: 124 A
Locked rotor current (Il/In)	: 6.9
No-load current	: 8.00 A
Full load torque	: 44.0 lb.ft
Locked rotor torque	: 250 %
Breakdown torque	: 250 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 33 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: 40
Altitude	: 1000 m
Degree of Protection	: IP55
Approximate weight	: 281 lb
Moment of inertia	: 2.6198 sq.ft.lb
Noise level	: 69 dB(A)

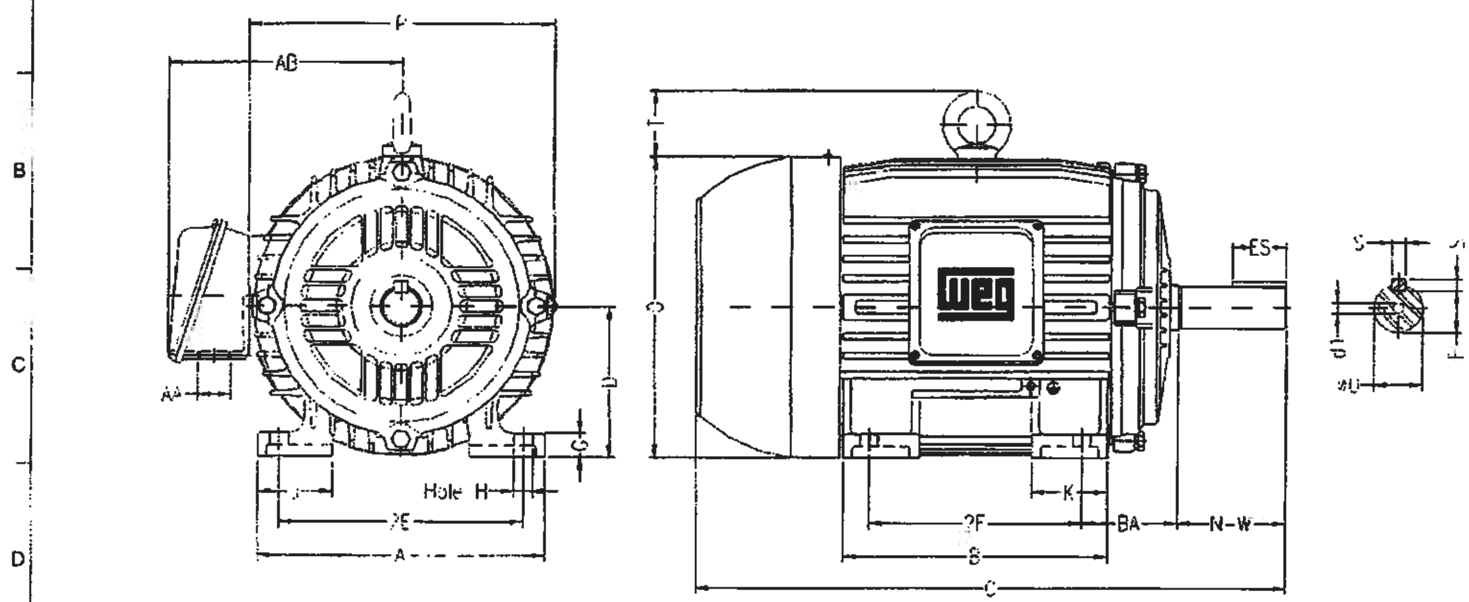
	D.E.	N.D.E.
Bearings	6309 C3	6209 C3
Regreasing interval	20000 h	20000 h
Grease amount	13 g	9 g

Load	Power factor	Efficiency (%)
100%	0.83	92.4
75%	0.77	92.4
50%	0.67	91.5

Backwash
50P1351 & 50P1352
Motor model # 01518ST3QIE254T

Performed by:	Checked:

Version



2E 10.000	2F 8.252	H 0.531	BA 4.250	A 12.126
B 10.000	C 23.213	D 6.250	G 0.817	J 2.520
K 2.559	O 12.431	P 12.283	T 2.087	ES 2.756
S 0.375	N-W 4.000	U 1.625	R 1.406	AB —
AA NPT 1 1/2	d1 A4			

Notes: Backwash

50P1351 & 50P1352 Motor model # 01518ST3QIE254T

Performed by:

Checked:

Customer:

IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Three-phase induction motor

Frame 254T - IP55

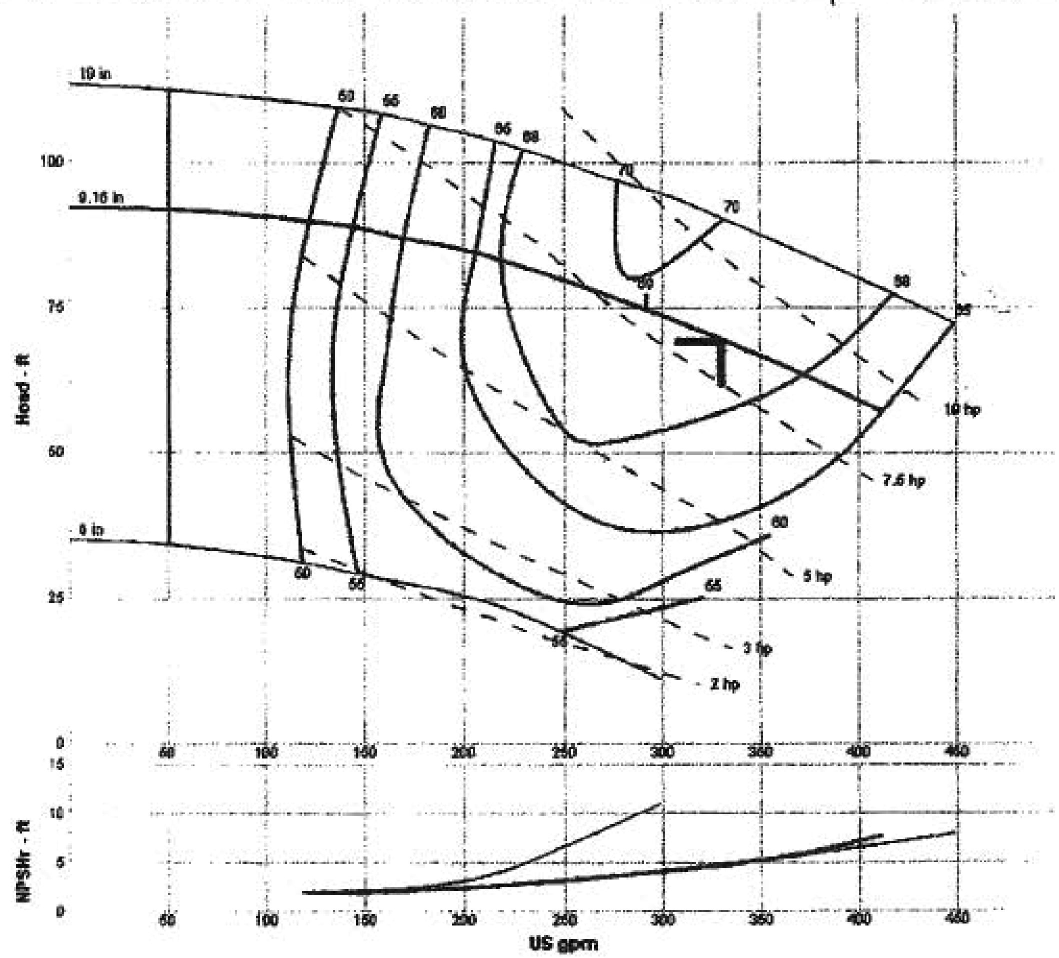
7/18/2007

Version

Primary Design Point

50P1351 & 50P1352

BACKWASH



Request for Quote

Submit your selection to Griswold Pump.

Pump

Type	811-ANSI
Size	4x3-10 A70
Curve	G-1813
Speed	1750 rpm
Diameter	9.16 in

Display Options

- Manufacturer settings
- Custom

Multiple Pumps

Number of pumps 1

Parallel / Series

Multiple Speeds (rpm)

800 rpm - 2400 rpm

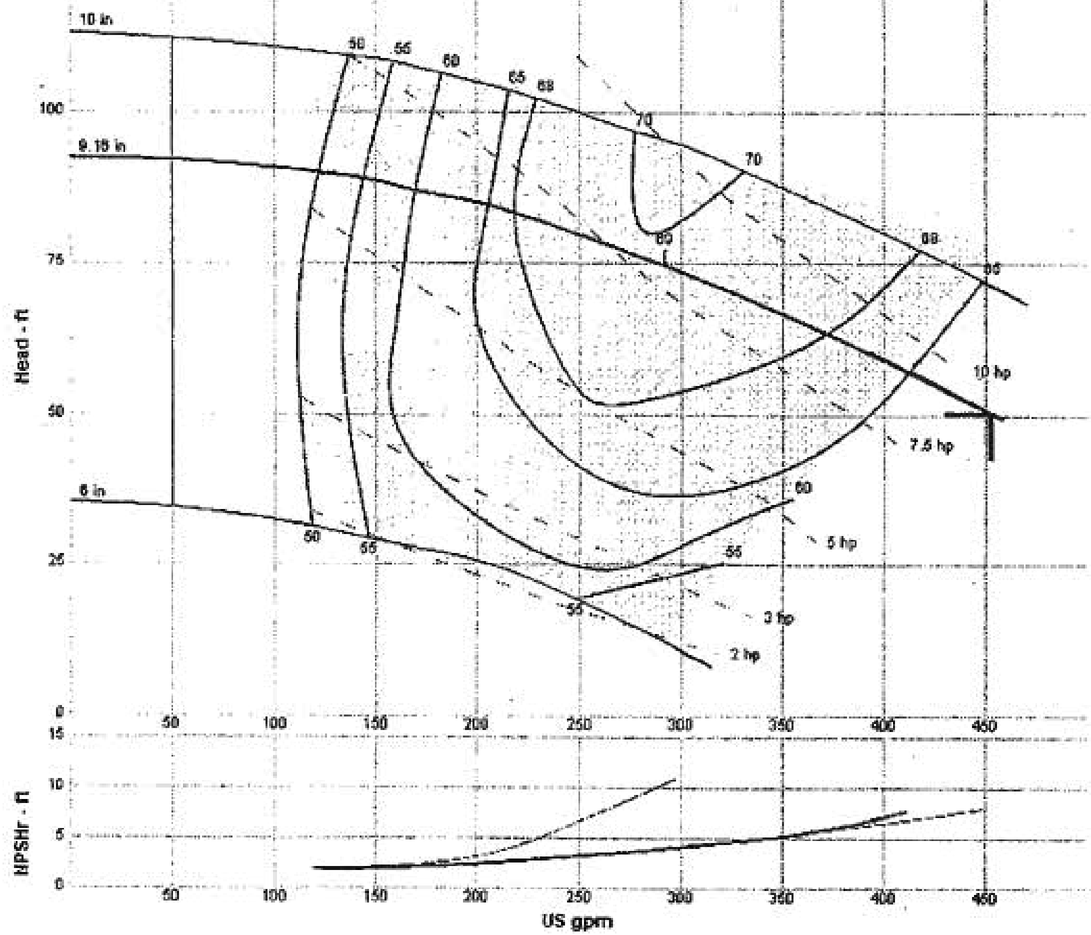
Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
→ 330 US gpm	→ 69.2 ft	69 %	69 %	4.95 ft	8.31 hp	15 hp	215T	50 US gpm	0.625 in

ITEM #3

1.3.A.1.a.c.

SECONDARY DESIGN POINT (1)

BACKWASH 50P1351 ; 50P1352



Page 6

Request for Quote

Submit your selection to Griswold Pump.

Pump

Type	811-ANSI
Size	4x3-10 A70
Curve	G-1813
Speed	1750 rpm
Diameter	9.16 in

Retrawl Reset

Display Options

- Manufacturer settings
- Custom

Multiple Pumps

Number of pumps 1

- Parallel
- Series

Multiple Speeds (rpm)

800 rpm - 2400 rpm

Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
452 US gpm	50	---	69 %	---	---	15 hp	254T	50 US gpm	0.625 in

Secondary Design Point (2)

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

BACKWASH 50P1351 & 50P1352

Size: 4x3-10 A70
Type: 811-ANSI
Synch speed: 1800 rpm
Curve: G-1813
Specific Speeds:
Dimensions:

Speed: 1760 rpm
Dia: 9.16 in
Impeller:
Ns: —
Nss: 10841
Suction: 4 in
Discharge: 3 in

Temperature: — °F
Pressure: — psi g
Sphere size: 0.625 in

Power: — hp
Eye area: — in²

Flow: 73 US gpm ← Head: 91.9 ft ←

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: — ft

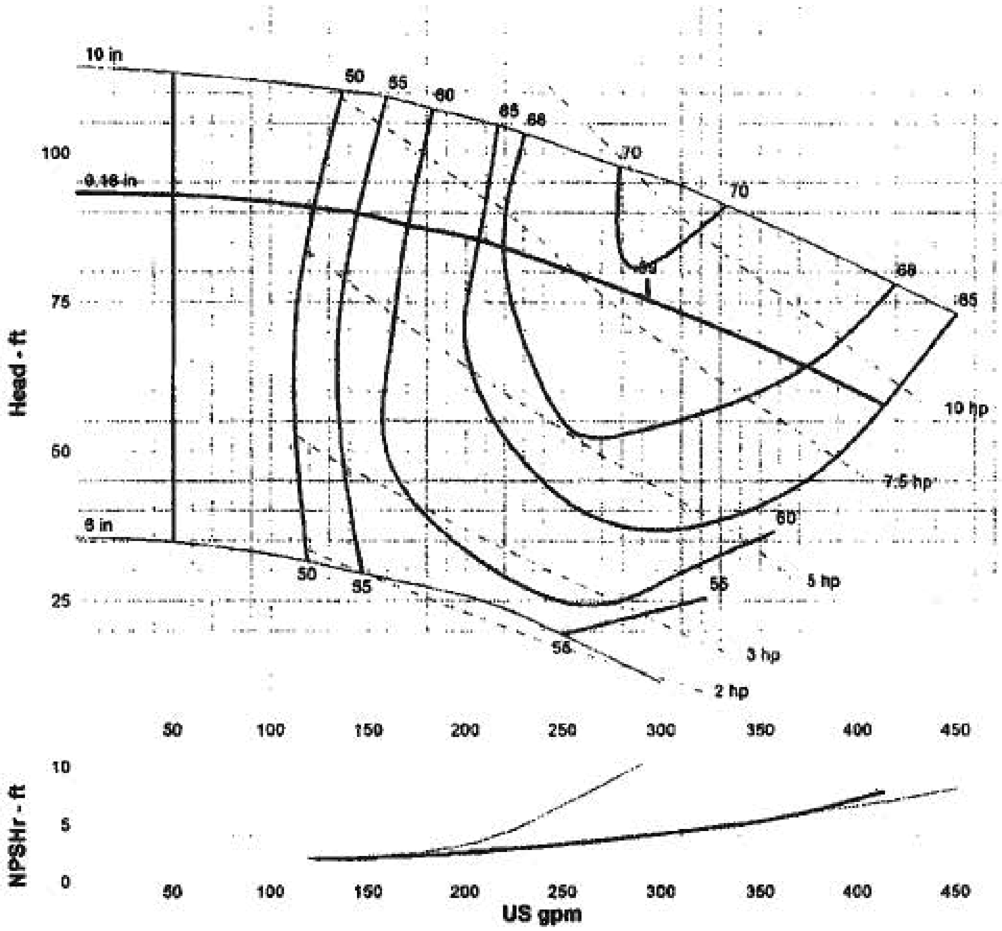
Temperature: 60 °F
Vapor pressure: 0.2583 psi a
Atm pressure: 14.7 psi a

Standard: NEMA
Enclosure: TEFC
Size 15 hp
Speed: 1800
Frame: 215T
Sizing criteria: Max Power on Design Curve

Flow: 73 US gpm
Head: 91.9 ft
Eff: 39%
Power: 4.84 hp
NPSHr: 2.01 ft

Shutoff head: 93.3 ft
Shutoff dP: 40.3 psi
Min flow: 50 US gpm
BEP: 69% @ 293 US gpm
NOL power:
9.27 hp @ 413 US gpm

Max power:
12.8 hp @ 451 US gpm



Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
396	1760	60.5	66	9.11	7.04
330	1760	70.3	69	8.44	4.94
264	1760	78.9	69	7.58	3.54
198	1760	86	64	6.72	2.51
132	1760	90.5	52	5.76	2.02

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

MAINTENANCE SUMMARY FORM - 11312

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: BACKWASH PUMPS 1 & 2, TYPE 811-4x3-10

2. MANUFACTURER: GRISWOLD

3. EQUIPMENT/TAG NUMBER(S): 50P1351 & 50P1352

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 814 LBS.

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 15 HP, 460V, 3 PH, 1800 RPM, 1.15 Service Factor

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Cascade Machinery & Electric, Inc.

a. Name: _____ Telephone: 206-762-0500

b. Address: 4600 East Marginal Way South, PO Box 3575 Seattle, WA 98124

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

*NOTE: Maintenance and monitoring intervals should be shortened in severe service locations

Maintenance Operation Comments	**Frequency***	**Lubricant (If Applicable)**
Bearing and Lubricant Condition: bearing temperatures, lubricant level, and vibration. Oil level should be mid-point of the bulls eye sight glass. Lubricant should be clear with no signs of frothing.	Routinely	✦
Shaft seal condition: Mechanical seals should show no signs of leakage	Routinely	
Overall pump vibration, check bearing alignment	Routinely	
Pump discharge pressure – a gradual decrease in developed head can indicate the need for Impeller adjustment	Annually	
Check foundation and hold down bolts	Quarterly	

Oil change	Quarterly or after 2000 hrs. of operation, which ever comes first.	✦
Shaft alignment	Quarterly	
Pump flow rate	Annually	
Motor Amp Drain	Annually	
Vibration signature	Annually	
Motor Lubrication	20,000 hrs. of service	❋

8. LUBRICANT LIST

Reference Symbol	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**Or Equal**
✦	ISO Grade VG 68 or equal	Chevron GTS Oil 68	Exxon Terrestic 68 or Nuto 68	Mobil DTE Heavy-Medium	Philips Mangus 315
✦	Shell Tellus Oil 68	Sunoco Sunvis 968	Amoco Industrial 68	Royal Purple – Synfilm GT VG 68	
❋	PolyRex EM Grease ESSO/EXXON				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
21273-60-91	Impeller	Each	1	947.75
2213-4-1	Shaft Seal	Each	1	351.65
RK-3196-M	Repair Kit	Each	1	276.25
K-3196M-8	Maintenance Kit	Each	1	40.50

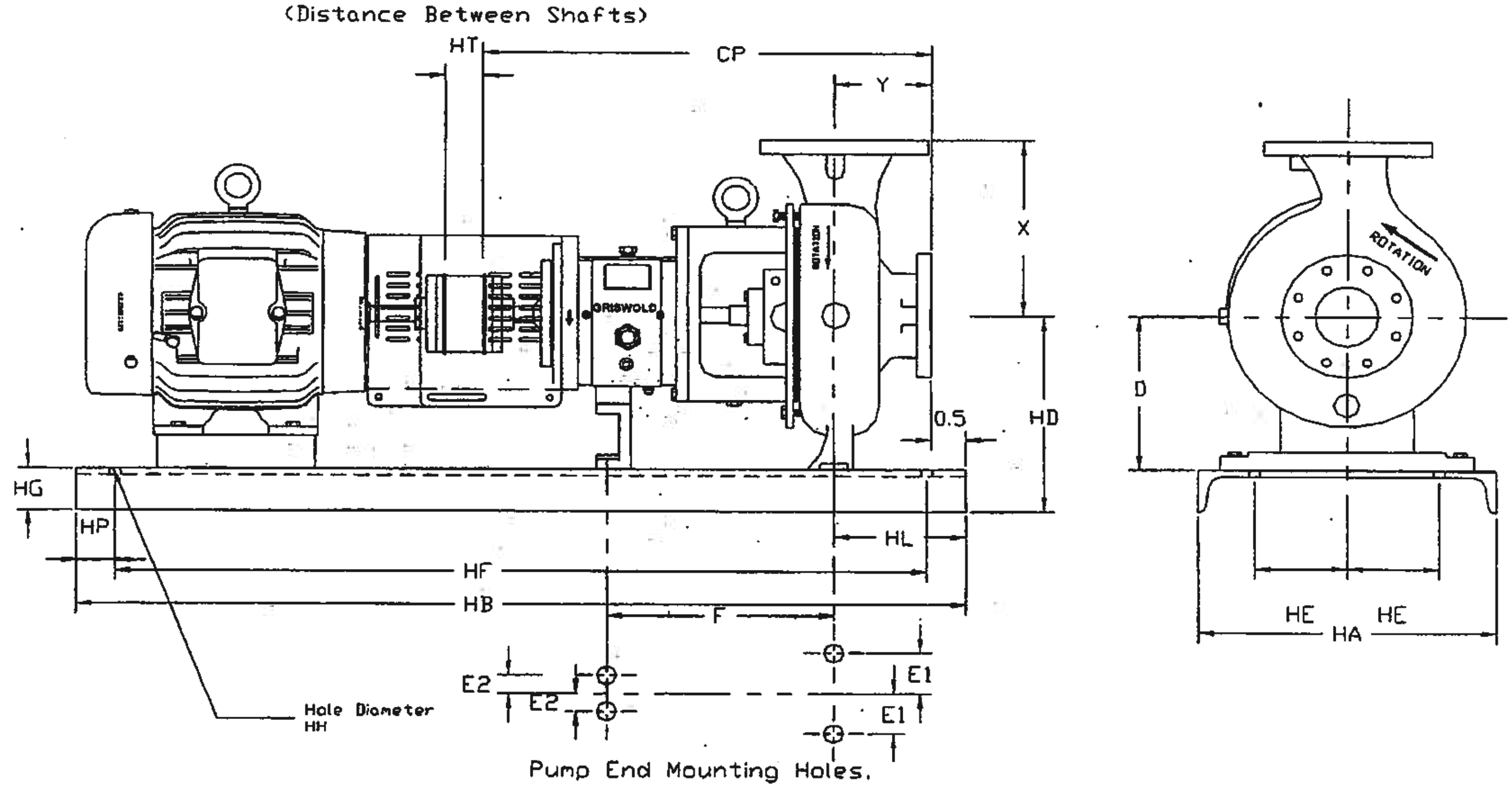
Note: Identify parts provided by this Contract with two asterisks.

Volume II

11312 - Decant Pumps 50P1391/50P1392

Attachment 2.5

DECANT 50P1391 & 50P1392



Pump End Dimensions

Model	Pump Size & Designation	Suc.	150# Drilling	Disch.	150# Drilling	D	X	CP	E1	E2	F	Y
811$ LF	1 1/2 x 1 - 8AA	1.5	(4) 5/8 Holes on 3.875BC	1	(4) 5/8 Holes on 3.125BC	5.25	6.5	17.5	3	0	7.25	4

Steel Base Plate Dimensions

Max Nema Frame	ANSI Baseplate #	HA	HB	HT (min)	HD max (D+HG)	HE	HF	HG (max)	HH	HL	HP
184T	139	12	39	3.5	9	4.5	36.5	3.75	0.75	4.5	1.25

WEG	No.:
	Date: 7/18/2007

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	:
Product line	: IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Frame	: 143T
Output	: 1 HP
Frequency	: 60 Hz
Poles	: 4
Full load speed	: 1765
Slip	: 1.94 %
Voltage	: 460 V
Full load current	: 1.43 A
Locked rotor current	: 12.5 A
Locked rotor current (Il/In)	: 8.8
No-load current	: 0.850 A
Full load torque	: 2.94 lb.ft
Locked rotor torque	: 290 %
Breakdown torque	: 400 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 20 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: 40
Altitude	: 1000 m
Degree of Protection	: IP55
Approximate weight	: 47 lb
Moment of inertia	: 0.11960 sq.ft.lb
Noise level	: 51 dB(A)

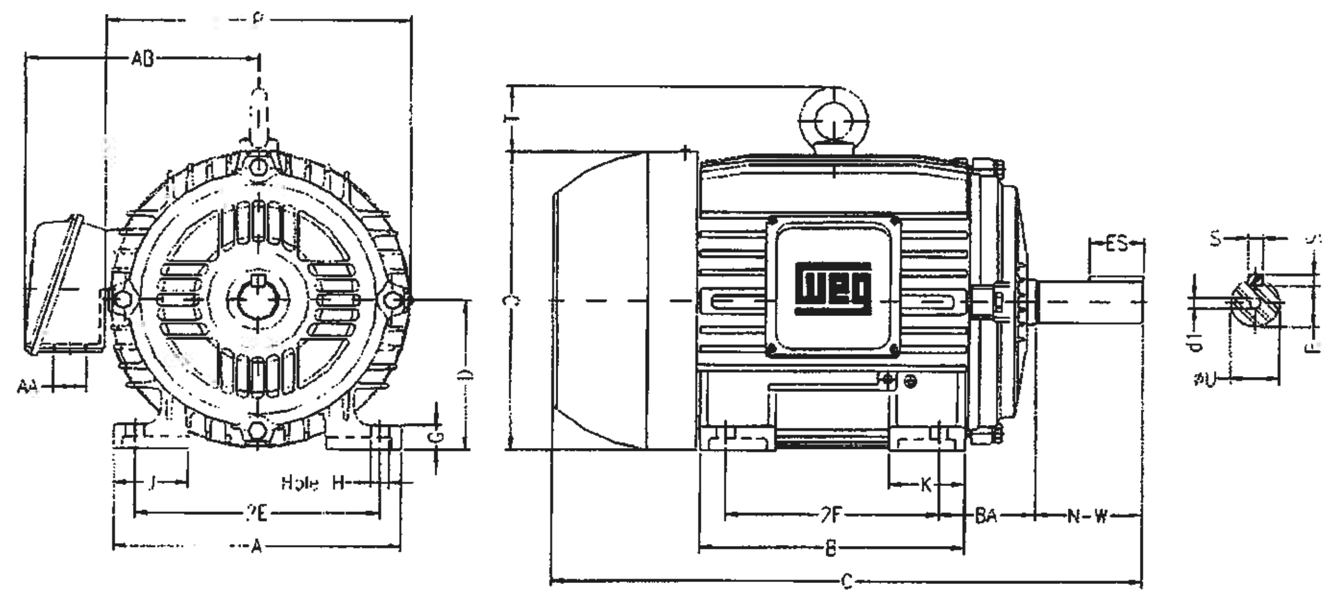
	D.E.	N.D.E.
Bearings	6205 C3	6204 C3
Regreasing interval	20000 h	20000 h
Grease amount	4 g	4 g

Load	Power factor	Efficiency (%)
100%	0.77	85.5
75%	0.71	84.0
50%	0.58	80.0

Decant
50P1391 & 50P1392
Motor model # 00118ST3QIE143T

Performed by:	Checked:

Version



2E 5.500	2F 4.000	H 0.344	BA 2.250	A 6.457
B 5.157	C 12.346	D 3.500	G 0.547	J 1.498
K 1.654	O 7.000	P 7.047	T -7	ES 1.575
S 0.187	N-W 2.250	U 0.875	R 0.786	AB 6.102
AA NPT 3/4	d1 A4			

1.3.A.1.a,c

PRIMARY DESIGN POINT

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 5/11/2007

DECANT 50P1391 & 50P1392

Pump:

Size: 1.5x1-8 AA
Type: 811LF-ANSI
Synch speed: 1800 rpm
Speed: 1750 rpm
Dia: 5.18 in
Curve: GLF-1804
Impeller:
Specific Speeds:
Ns: ---
Nss: ---
Dimensions:
Suction: 1.5 in
Discharge: 1 in

Pump Limits:

Temperature: --- °F
Pressure: --- psi g
Sphere size: --- in
Power: --- hp
Eye area: --- in²

Search Criteria:

Flow: 10 US gpm
Head: 29 ft

Fluid:

FROTH EFFLUENT
SG: 1
Viscosity: 1.3 cP
NPSHa: --- ft
Temperature: 55 °F
Vapor pressure: 1 psi a
Atm pressure: 14.7 psi a

Motor:

Standard: NEMA
Enclosure: TEFC
Size: 1 HP
Speed: 1800
Frame: 143T
Sizing criteria: Max Power on Design Curve

Pump Operating Point:

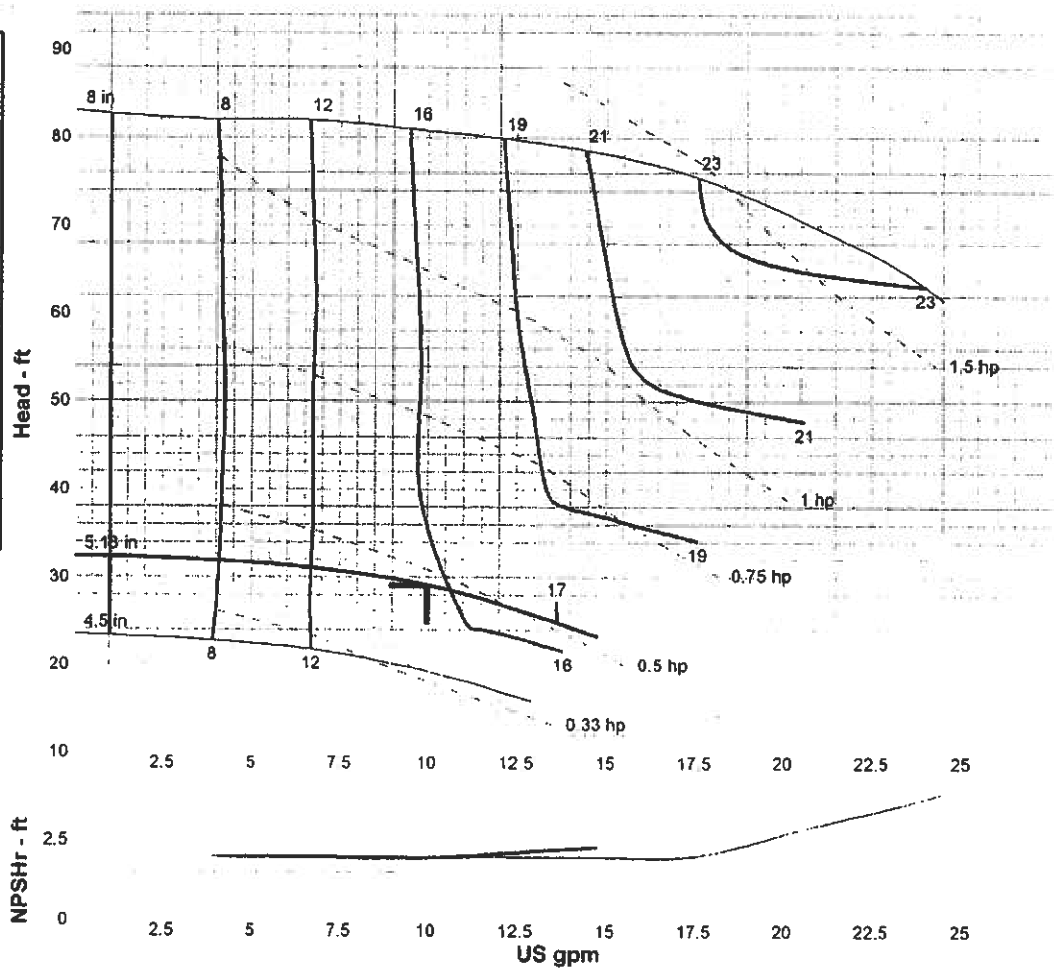
Flow: 10 US gpm
Head: 29 ft
Eff: 15%
Power: 0.472 hp
NPSHr: 2 ft

Pump Design Curve:

Shutoff head: 32.4 ft
Shutoff dP: 14 psi
Min flow: 1 US gpm
BEP: 17% @ 13.6 US gpm
NOL power:
0.521 hp @ 14.8 US gpm

Max Curve:

Max power:
1.66 hp @ 24 US gpm



Performance Evaluation:

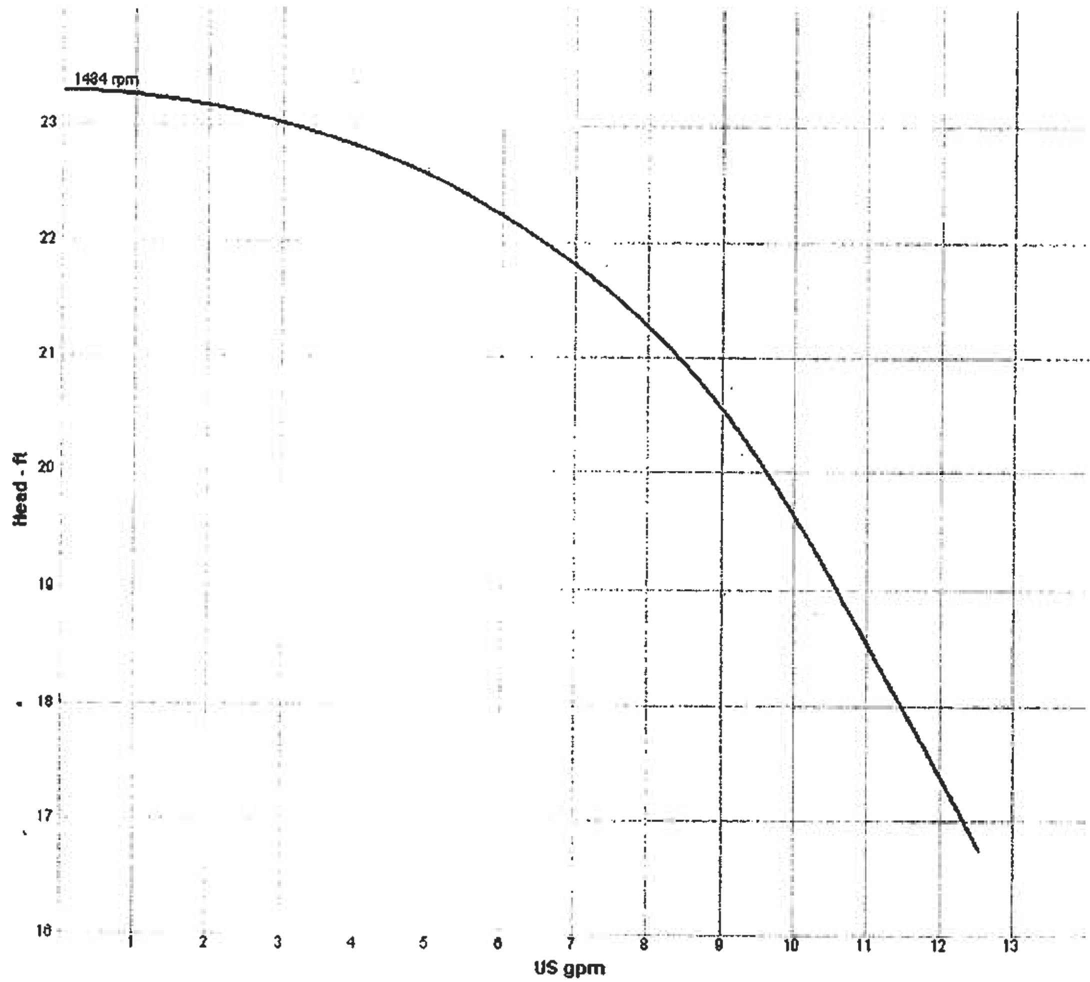
Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
12	1750	26.9	16	0.494	2.1
10	1750	29	15	0.472	2
8	1750	30.2	13	0.451	2
6	1750	31.3	11	0.43	2
4	1750	31.9	8	0.41	2

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

SECONDARY DESIGN POINT.

DECANT 50P1391 & 50P1392



Request for Quote

Submit your selection to Griswold Pump

Pump

Type	811LF-ANSI
Size	1.5x1-8 AA
Curve	GLF-1804
Speed	1750 rpm
Diameter	5.18 in

Redraw Reset

Display Options ?

- (•) Manufacturer settings
- ( ) Custom

Multiple Pumps

Number of pumps 1

(•) Parallel ( ) Series

Multiple Speeds (rpm)

800 rpm - 2400 rpm

1484

Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
10 US gpm	29 ft	15 %	17 %	2 ft	0.472 hp	1 HP	143T	1 US gpm	---

1,3,A.1.a,c

MAINTENANCE SUMMARY FORM - 11312

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: DECANT PUMPS 1 & 2, TYPE 811LF- 1.5 x 1-8
2. MANUFACTURER: GRISWOLD
3. EQUIPMENT/TAG NUMBER(S): 50P1391 & 50P1392
4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 232 LBS.
5. NAMEPLATE DATA (hp, voltage, speed, etc.): .75 HP, 460V, 3 PH, 1800 RPM, 1.15 Service Factor
6. MANUFACTURER'S LOCAL REPRESENTATIVE: Cascade Machinery & Electric, Inc.
   a. Name: _____ Telephone: 206-762-0500
   b. Address: 4600 East Marginal Way South, PO Box 3575 Seattle, WA 98124

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.
*NOTE: Maintenance and monitoring intervals should be shortened in severe service locations

Maintenance Operation Comments	Frequency*	Lubricant (If Applicable)
Bearing and Lubricant Condition: bearing temperatures, lubricant level, and vibration. Oil level should be mid-point of the bulls eye sight glass. Lubricant should be clear with no signs of frothing.	Routinely	✦
Shaft seal condition: Mechanical seals should show no signs of leakage	Routinely	
Overall pump vibration, check bearing alignment	Routinely	
Pump discharge pressure – a gradual decrease in developed head can indicate the need for Impeller adjustment	Annually	
Check foundation and hold down bolts	Quarterly	

Oil change	Quarterly or after 2000 hrs. of operation, which ever comes first.	✦
Shaft alignment	Quarterly	
Pump flow rate	Annually	
Motor Amp Drain	Annually	
Vibration signature	Annually	
Motor Lubrication	20,000 hrs. of service	❋

8. LUBRICANT LIST

Reference Symbol	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**Or Equal**
✦	ISO Grade VG 68 or equal	Chevron GTS Oil 68	Exxon Terrestic 68 or Nuto 68	Mobil DTE Heavy-Medium	Philips Mangus 315
✦	Shell Tellus Oil 68	Sunoco Sunvis 968	Amoco Industrial 68	Royal Purple – Synfilm GT VG 68	
❋	PolyRex EM Grease ESSO/EXXON				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
21280-40-91	Impeller	Each	1	560.00
22049-4-1	Shaft Seal	Each	1	229-25
RK-3196-S	Repair Kit	Each	1	137.75
K-3196S-8	Maintenance Kit	Each	1	32.50

Note: Identify parts provided by this Contract with two asterisks.

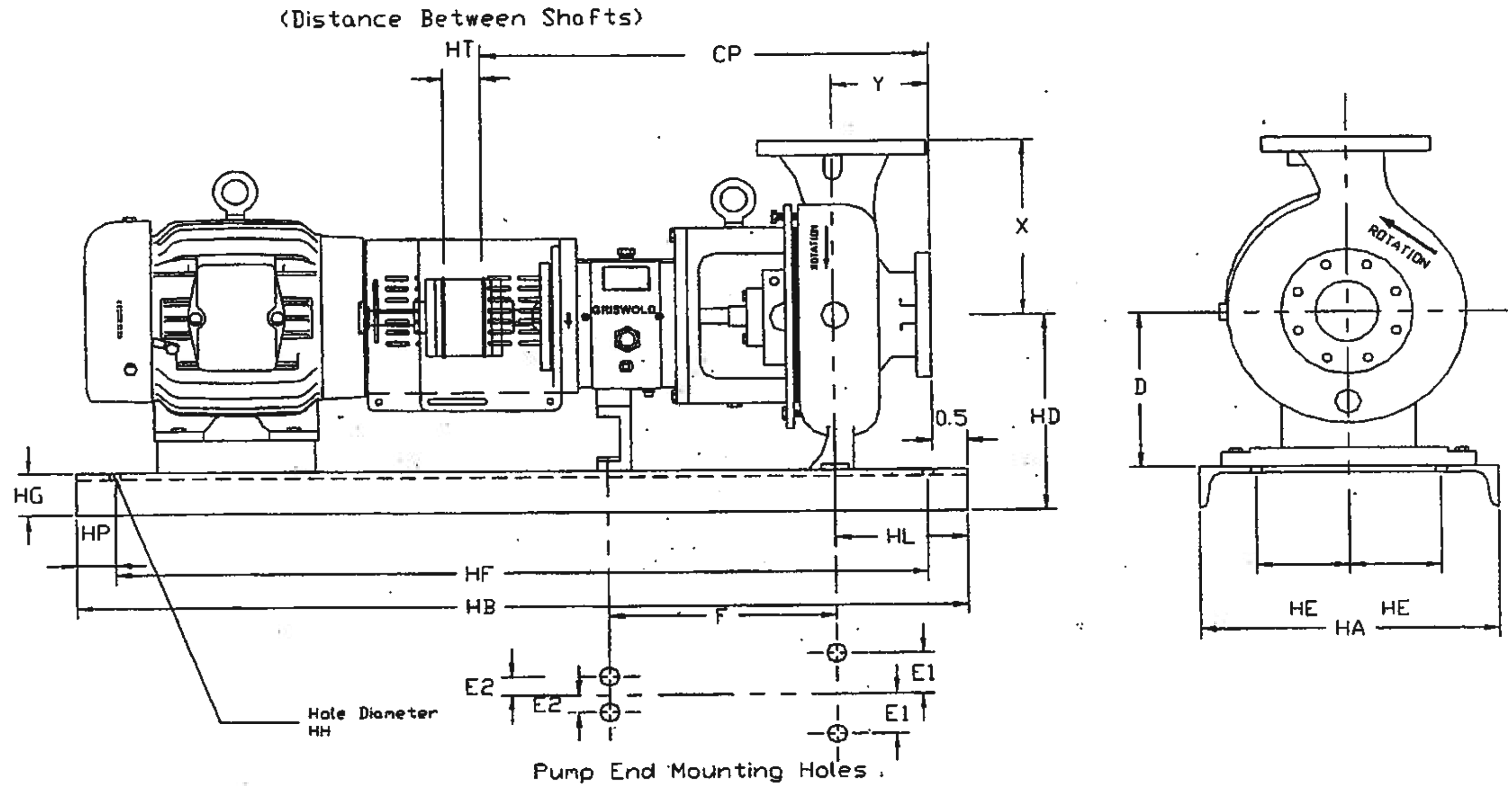
Volume II

11312 - Backwash Recycle Pump 50P1461

Attachment 2.6

312 1.3 A 1 d

BACKWASH RECYCLE 50P1461



Pump End Dimensions

Model	Pump Size & Designation	Suc.	150# Drilling	Disch.	150# Drilling	D	X	CP	E1	E2	F	Y
811S	3 x 2 - 6AC	3	(4) 3/4 Holes on 6.0BC	2	(4) 5/8 Holes on 4.75BC	5.25	6.5	17.5	3	0	7.25	4

Steel Base Plate Dimensions

Max Nema Frame	ANSI Baseplate #	HA	HB	HT (min)	HD max (D+HG)	HE	HF	HG (max)	HH	HL	HP
184T	139	12	39	3.5	9	4.5	36.5	3.75	0.75	4.5	1.25

No.:	
Date: 7/18/2007	

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	:
Product line	: IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Frame	: 145T
Output	: 2 HP
Frequency	: 60 Hz
Poles	: 4
Full load speed	: 1755
Slip	: 2.50 %
Voltage	: 460 V
Full load current	: 2.63 A
Locked rotor current	: 20.7 A
Locked rotor current (Il/In)	: 7.9
No-load current	: 1.29 A
Full load torque	: 5.90 lb.ft
Locked rotor torque	: 250 %
Breakdown torque	: 320 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 12 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: 40
Altitude	: 1000 m
Degree of Protection	: IP55
Approximate weight	: 54 lb
Moment of inertia	: 0.15947 sq.ft.lb
Noise level	: 51 dB(A)

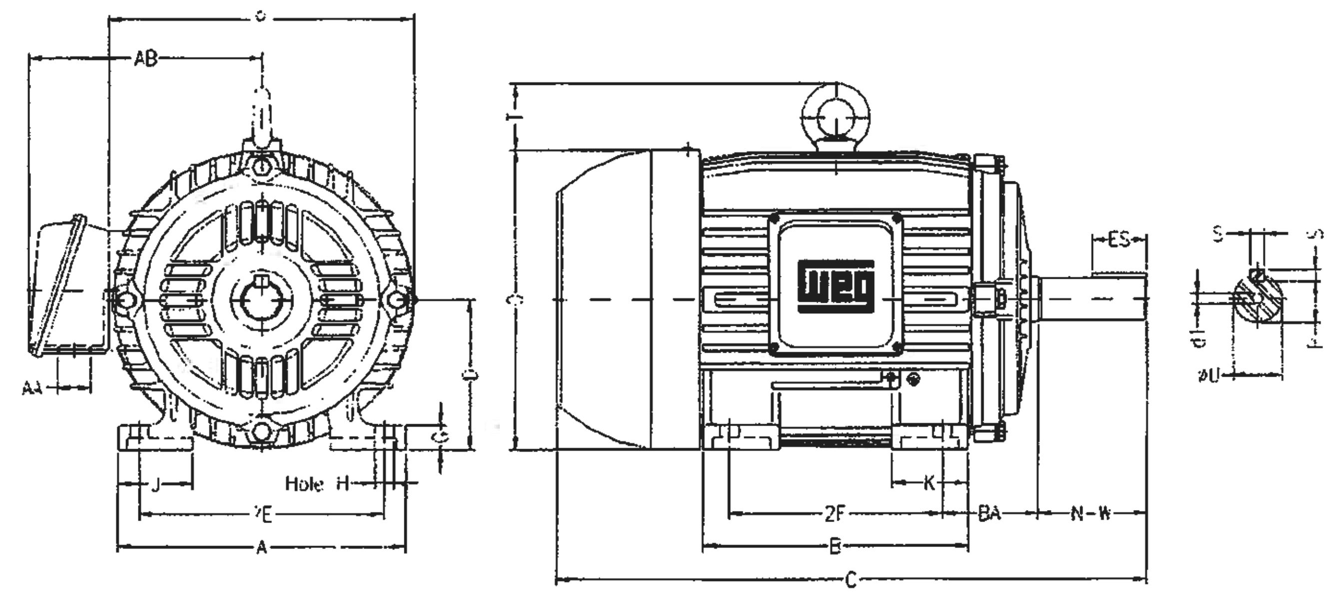
	D.E.	N.D.E.
Bearings	6205 C3	6204 C3
Regreasing interval	20000 h	20000 h
Grease amount	4 g	4 g

Load	Power factor	Efficiency (%)
100%	0.83	86.5
75%	0.76	87.5
50%	0.64	85.5

Backwash Recycle
50P1461
Motor model # 00218ST3QIE145T

Performed by:	Checked:

Version



Notes: Backwash Recycle
50P1461 Motor model # 00218ST3QIE145T

Performed by:

Checked:

Customer:

IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

2E 5.500	2F 5.000	H 0.344	BA 2.250	A 6.457
B 6.142	C 13.346	D 3.500	G 0.547	J 1.496
K 1.654	O 7.000	P 7.047	T -7	ES 1.575
S 0.187	N-W 2.250	U 0.875	R 0.765	AB 6.102
AA NPT 3/4	d1 A4			

Three-phase induction motor
Frame 145T - IP55

7/18/2007

Version

Primary Design Point

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

BACKWASH RECYCLE 50P1461

Size: 3x2-6 S	
Type: 811-ANSI	Speed: 1750 rpm
Synch speed: 1800 rpm	Dia: 5.38 in
Curve: G-1803	Impeller:
Specific Speeds:	Ns: ---
	Nss: 8473
Dimensions:	Suction: 3 in
	Discharge: 2 in

Temperature: --- °F	Power: --- hp
Pressure: --- psi g	Eye area: --- in²
Sphere size: 0.375 in	

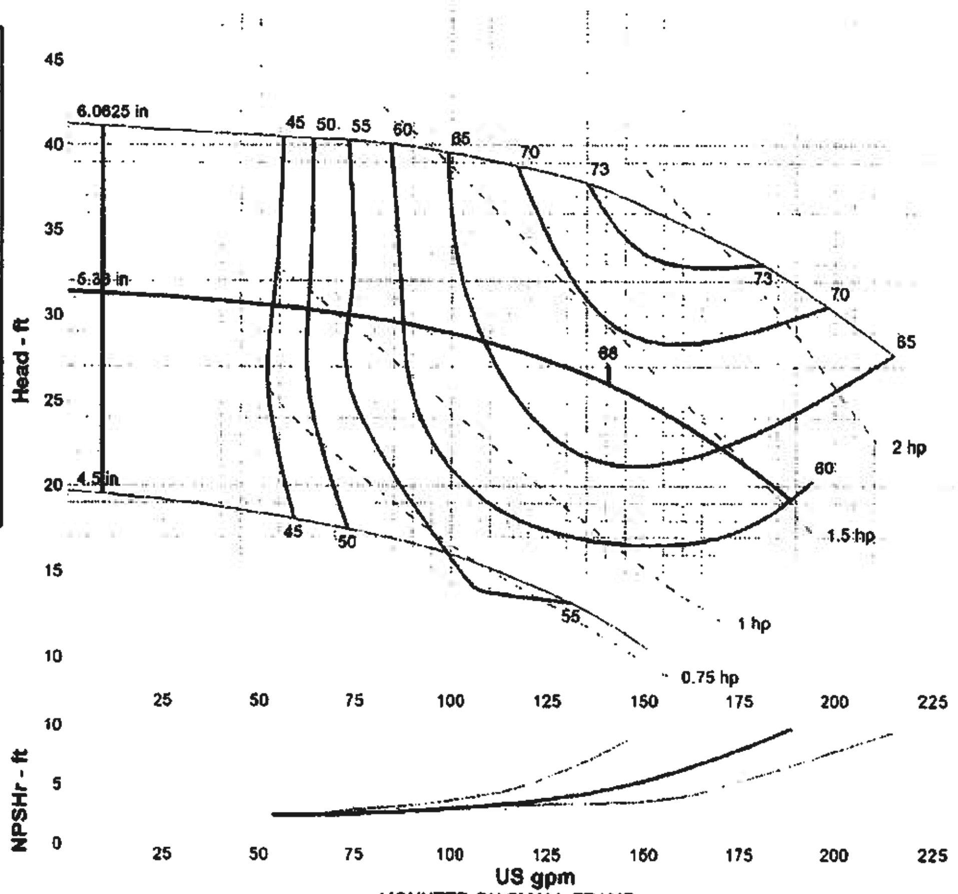
Flow: 115 US gpm ← Head: 28 ft ←

Water	Temperature: 60 °F
SG: 1	Vapor pressure: 0.2563 psi a
Viscosity: 1.105 cP	Atm pressure: 14.7 psi a
NPSHa: --- ft	

Standard: NEMA	Size: 2 hp ←
Enclosure: TEFC	Speed: 1800
	Frame: 145T

Sizing criteria: Max Power on Design Curve

Flow:	115 US gpm
Head:	28 ft
Eff:	66%
Power:	1.23 hp
NPSHr:	3.56 ft
Shutoff head:	31.4 ft
Shutoff dP:	13.6 psi
Min flow:	9 US gpm
BEP:	68% @ 141 US gpm
NOL power:	1.54 hp @ 189 US gpm
Max power:	2.31 hp @ 215 US gpm



MOUNTED ON SMALL FRAME

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
138	1750	26.2	68	1.35	4.56
115	1750	28	66	1.23	3.56
92	1750	29.3	61	1.11	2.88
69	1750	30.2	53	0.989	2.55
46	1750	30.7	41	0.877	2.49

PUMP-FLO 9

Selected from catalog: Griswold Pumps.60 Vers: 1.6

Secondary Design Point

Pump Data Sheet - Griswold Pump Company

Company: Griswold Pump Co
Name: Benjie Donovan
Date: 7/18/2007

BACKWASH RECYCLE 50P1461

Size: 3x2-6 S
Type: 811-ANSI
Synch speed: 1800 rpm
Speed: 1750 rpm
Dia: 5.38 in
Curve: G-1803
Impeller:
Specific Speeds:
Ns: --
Nss: 8473
Dimensions:
Suction: 3 in
Discharge: 2 in

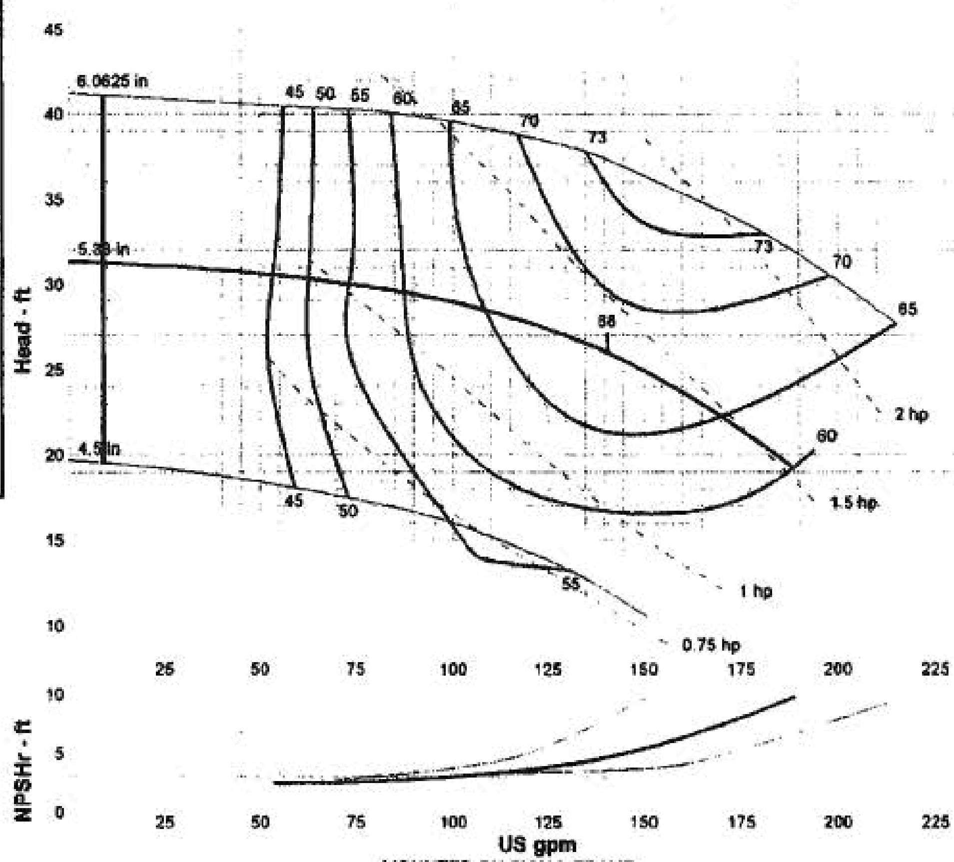
Temperature: -- °F
Pressure: -- psi g
Sphere size: 0.375 in
Power: -- hp
Eye area: -- in²

Flow: 148 US gpm
Head: 25.1 ft

Water
SG: 1
Viscosity: 1.105 cP
NPSHa: -- ft
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Standard: NEMA
Enclosure: TEFC
Size: 2 hp
Speed: 1800
Frame: 145T
Sizing criteria: Max Power on Design Curve

Flow:	148 US gpm
Head:	25.1 ft
Eff:	67%
Power:	1.39 hp
NPSHr:	5.37 ft
Shutoff head:	31.4 ft
Shutoff dP:	13.6 psi
Min flow:	9 US gpm
BEP:	68% @ 141 US gpm
NOL power:	1.54 hp @ 189 US gpm
Max power:	2.31 hp @ 215 US gpm



MOUNTED ON SMALL FRAME

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
138	1750	26.2	68	1.35	4.56
115	1750	28	66	1.23	3.56
92	1750	29.3	61	1.11	2.88
69	1750	30.2	53	0.989	2.55
46	1750	30.7	41	0.877	2.49

MAINTENANCE SUMMARY FORM - 11312

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: BACKWASH RECYCLE PUMP 1, TYPE 811- 3 x 2-6

2. MANUFACTURER: GRISWOLD

3. EQUIPMENT/TAG NUMBER(S): 50P1461

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 240 LBS.

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 2 HP, 460V, 3 PH, 1800 RPM, 1.15 Service Factor

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Cascade Machinery & Electric, Inc.

a. Name: _____ Telephone: 206-762-0500

b. Address: 4600 East Marginal Way South, PO Box 3575 Seattle, WA 98124

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

*NOTE: Maintenance and monitoring intervals should be shortened in severe service locations

Maintenance Operation Comments	**Frequency***	**Lubricant (If Applicable)**
Bearing and Lubricant Condition: bearing temperatures, lubricant level, and vibration. Oil level should be mid-point of the bulls eye sight glass. Lubricant should be clear with no signs of frothing.	Routinely	✦
Shaft seal condition: Mechanical seals should show no signs of leakage	Routinely	
Overall pump vibration, check bearing alignment	Routinely	
Pump discharge pressure – a gradual decrease in developed head can indicate the need for Impeller adjustment	Annually	
Check foundation and hold down bolts	Quarterly	

Oil change	Quarterly or after 2000 hrs. of operation, which ever comes first.	✦
Shaft alignment	Quarterly	
Pump flow rate	Annually	
Motor Amp Drain	Annually	
Vibration signature	Annually	
Motor Lubrication	20,000 hrs. of service	❋

8. LUBRICANT LIST

Reference Symbol	MFR (Name)	MFR (Name)	MFR (Name)	MFR (Name)	Or Equal
✦	ISO Grade VG 68 or equal	Chevron GTS Oil 68	Exxon Terrestic 68 or Nuto 68	Mobil DTE Heavy-Medium	Philips Mangus 315
✦	Shell Tellus Oil 68	Sunoco Sunvis 968	Amoco Industrial 68	Royal Purple – Synfilm GT VG 68	
❋	PolyRex EM Grease ESSO/EXXON				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
21335-20-91	Impeller	Each	1	517.85
22049-4-1	Shaft Seal	Each	1	229.25
RK-3196-S	Repair Kit	Each	1	137.75
K-3196S-6	Maintenance Kit	Each	1	30.60
Note: Identify parts provided by this Contract with two asterisks.				

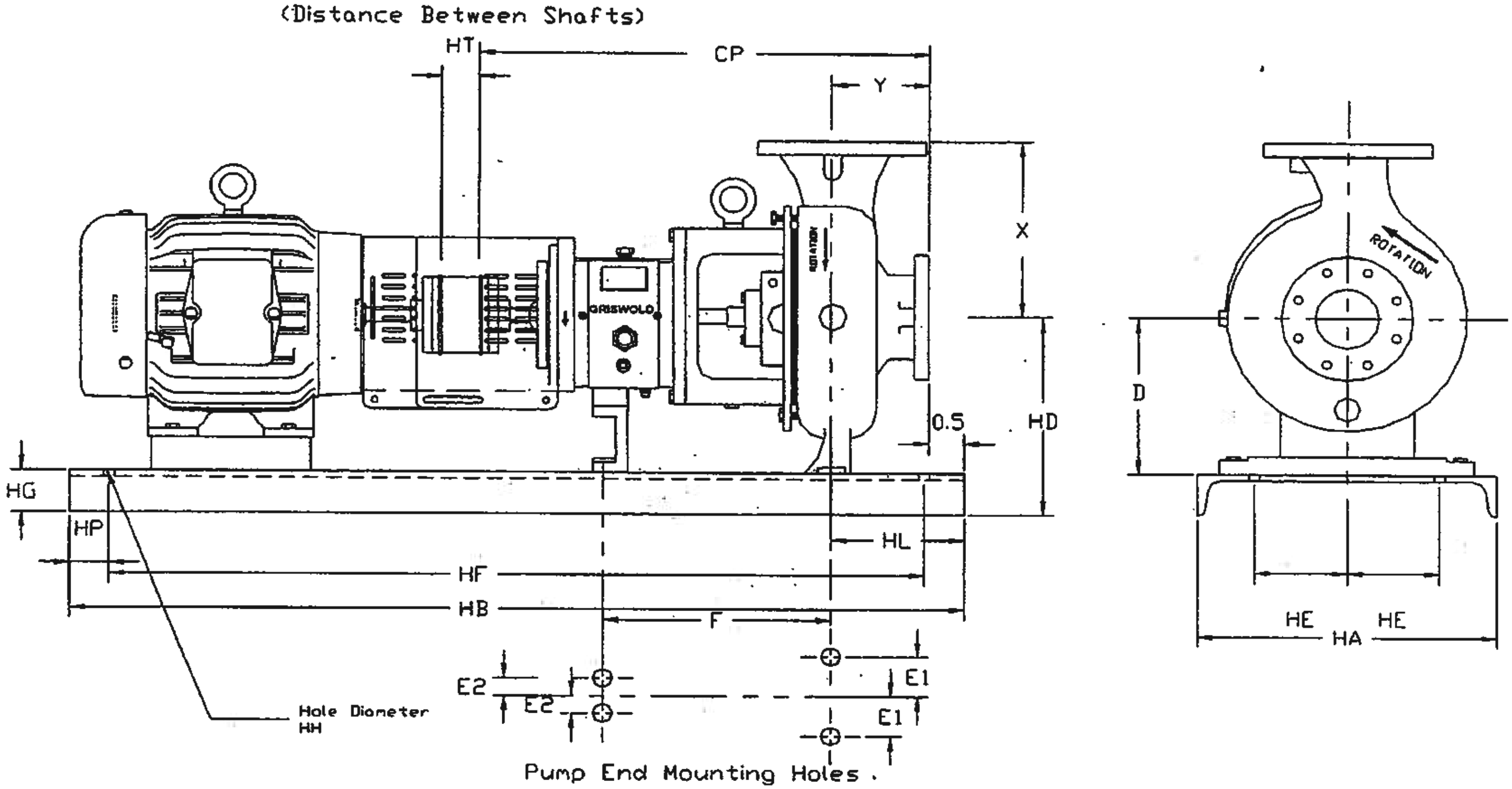
Volume II

11312 - Storm Water Recycle Pump 50P1541

Attachment 2.7

13312 1.3 A 1 a
13312 1.3 A 1 c

STORMWATER 50P1541



Pump End Dimensions

Model	Pump Size & Designation	Suc.	150# Drilling	Disch.	150# Drilling	D	X	CP	E1	E2	F	Y
811S	3 x 1 1/2 - 6AB	3	(4) 3/4 Holes on 6.0BC	1.5	(4) 5/8 Holes on 3.875BC	5.25	6.5	17.5	3	0	7.25	4

Steel Base Plate Dimensions

Max Nema Frame	ANSI Baseplate #	HA	HB	HT (min)	HD max (D+HG)	HE	HF	HG (max)	HH	HL	HP
184T	139	12	39	3.5	9	4.5	36.5	3.75	0.75	4.5	1.25

WEG

No.:	
Date:	7/18/2007

DATA SHEET
Three-phase induction motor - Squirrel cage rotor

Customer	
Product line	IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

Frame	: 143T
Output	: 1 HP
Frequency	: 60 Hz
Poles	: 4
Full load speed	: 1765
Slip	: 1.94 %
Voltage	: 460 V
Full load current	: 1.43 A
Locked rotor current	: 12.5 A
Locked rotor current (Il/In)	: 8.8
No-load current	: 0.850 A
Full load torque	: 2.94 lb.ft
Locked rotor torque	: 290 %
Breakdown torque	: 400 %
Design	: B
Insulation class	: F
Temperature rise	: 80 K
Locked rotor time	: 20 s (hot)
Service factor	: 1.25
Duty cycle	: S1
Ambient temperature	: 40
Altitude	: 1000 m
Degree of Protection	: IP55
Approximate weight	: 47 lb
Moment of inertia	: 0.11960 sq.ft.lb
Noise level	: 51 dB(A)

	D.E.	N.D.E.
Bearings	6205 C3	6204 C3
Regreasing interval	20000 h	20000 h
Grease amount	4 g	4 g

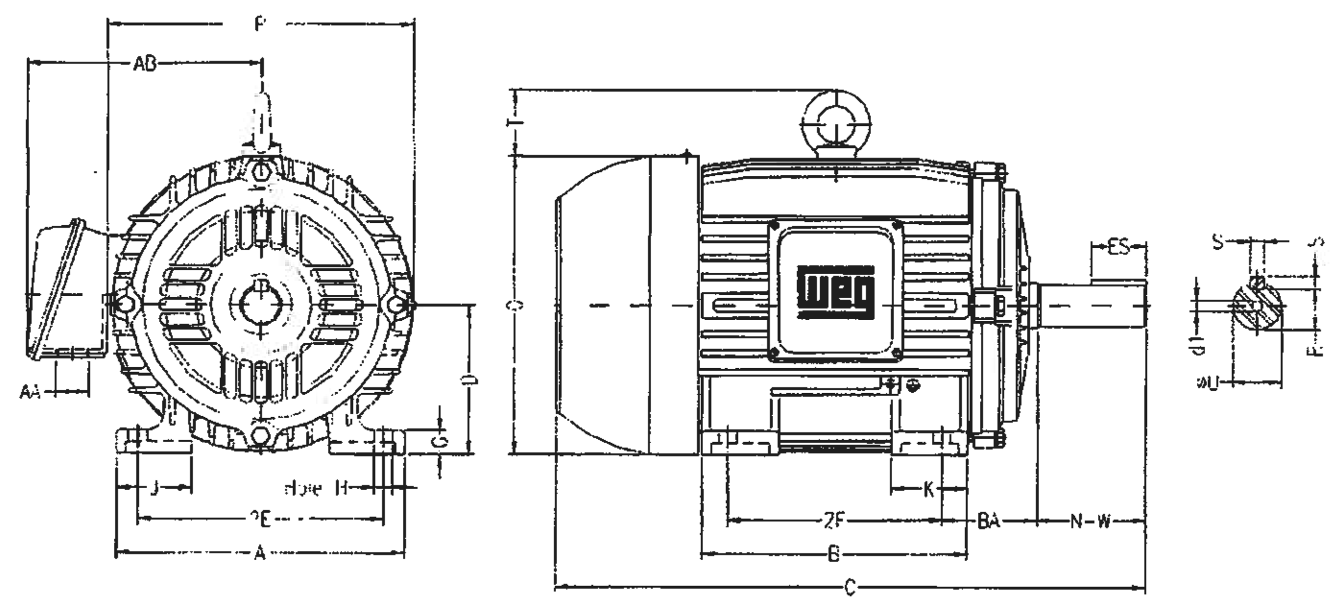
Load	Power factor	Efficiency (%)
100%	0.77	85.5
75%	0.71	84.0
50%	0.58	80.0

Stormwater Recycle
50P1541
Motor model # 00118ST3QIE143T

Performed by:	Checked:

Version

1/3.A.1/a,d



Notes: Stormwater Recycle
50P1541 Motor model # 00118ST3QIE143T

Performed by:

Checked:

Customer:

IEEE 841 - TEFC (IPW55) - Three-Phase - NEMA Premium

2E 5.500	2F 4.000	H 0.344	BA 2.250	A 6.457
B 5.157	C 12.346	D 3.500	G 0.547	J 1.496
K 1.654	O 7.000	P 7.047	T -7	ES 1.575
S 0.187	N-W 2.250	U 0.875	R 0.765	AB 6.102
AA NPT 3/4	d1 A4			

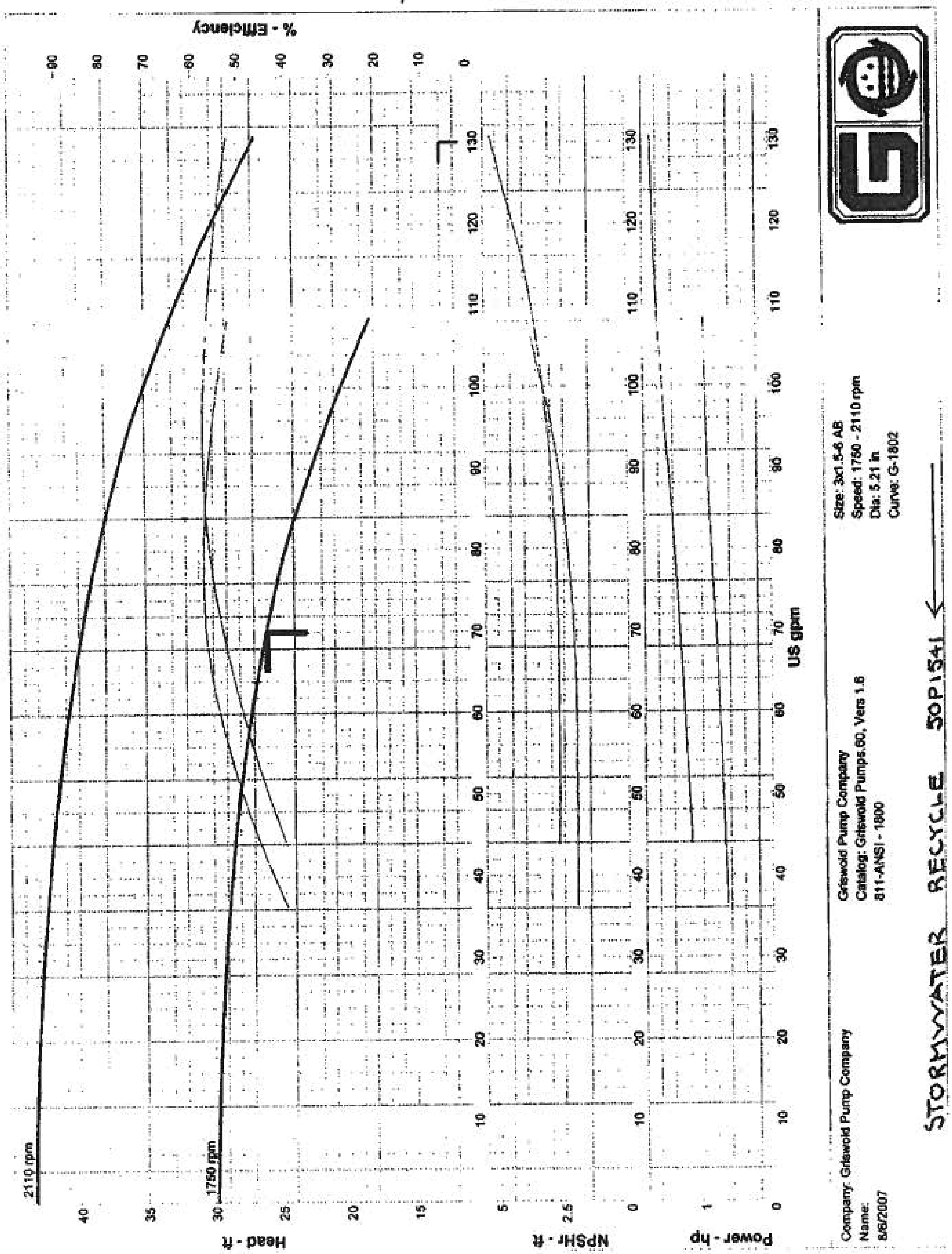
Three-phase induction motor
Frame 143T - IP55

7/18/2007

Version

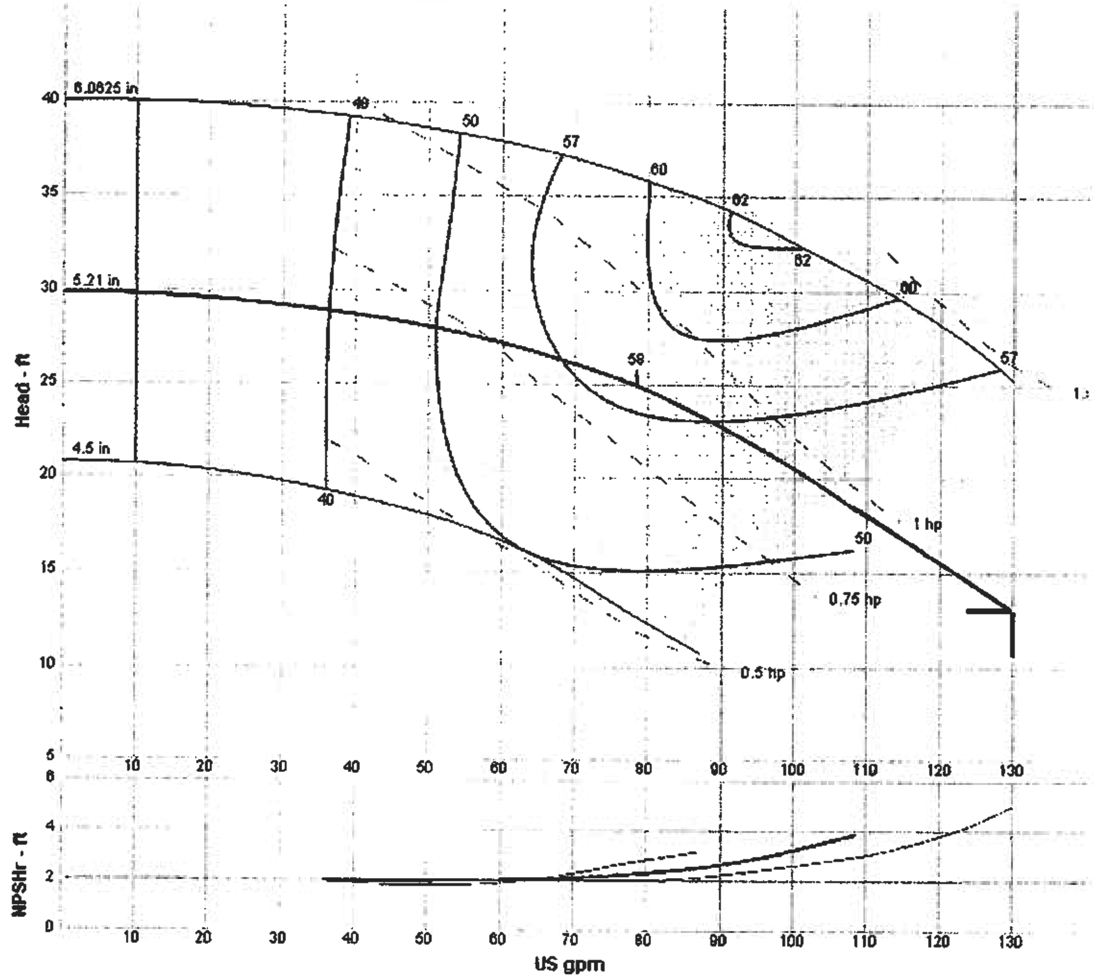
1.3.A.1.a,c

PRIMARY DESIGN POINT



1.3.A.1.a, c

STORMWATER 50P1541 SECONDARY DESIGN POINT



Request for Quote

Submit your selection to Griswold Pump

Pump

Type	811-ANSI
Size	3x1.5-6 AB
Curve	G-1802
Speed	1750 rpm
Diameter	5.21 in

Display Options ?

- Manufacturer settings
- Custom

Multiple Pumps

Number of pumps 1

- Parallel
- Series

Multiple Speeds (rpm)

800 rpm - 2400 rpm

Flow	Head	Eff	BEP	NPSHr	Power	Motor	Frame	Min flow	Sphere
130 US gpm	13	---	58 %	---	---	1 hp	143T	10 US gpm	0.4375 in

MAINTENANCE SUMMARY FORM - 11312

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: STORMWATER RECYCLE PUMP 1, TYPE 811- 3 x 1.5-6

2. MANUFACTURER: GRISWOLD

3. EQUIPMENT/TAG NUMBER(S): 50P1541

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): 224 LBS.

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 1 HP, 460V, 3 PH, 1800 RPM, 1.15 Service Factor

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Cascade Machinery & Electric, Inc.

a. Name: _____ Telephone: 206-762-0500

b. Address: 4600 East Marginal Way South, PO Box 3575 Seattle, WA 98124

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

*NOTE: Maintenance and monitoring intervals should be shortened in severe service locations

Maintenance Operation Comments	**Frequency***	**Lubricant (If Applicable)**
Bearing and Lubricant Condition: bearing temperatures, lubricant level, and vibration. Oil level should be mid-point of the bulls eye sight glass. Lubricant should be clear with no signs of frothing.	Routinely	✦
Shaft seal condition: Mechanical seals should show no signs of leakage	Routinely	
Overall pump vibration, check bearing alignment	Routinely	
Pump discharge pressure – a gradual decrease in developed head can indicate the need for Impeller adjustment	Annually	
Check foundation and hold down bolts	Quarterly	

Oil change	Quarterly or after 2000 hrs. of operation, which ever comes first.	✦
Shaft alignment	Quarterly	
Pump flow rate	Annually	
Motor Amp Drain	Annually	
Vibration signature	Annually	
Motor Lubrication	20,000 hrs. of service	❋

8. LUBRICANT LIST

Reference Symbol	MFR (Name)	MFR (Name)	MFR (Name)	MFR (Name)	Or Equal
✦	ISO Grade VG 68 or equal	Chevron GTS Oil 68	Exxon Terrestic 68 or Nuto 68	Mobil DTE Heavy-Medium	Philips Mangus 315
✦	Shell Tellus Oil 68	Sunoco Sunvis 968	Amoco Industrial 68	Royal Purple – Synfilm GT VG 68	
❋	PolyRex EM Grease ESSO/EXXON				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

Part No.	Description	Unit	Quantity	Unit Cost
21293-20-91	Impeller	Each	1	477.00
22049-4-1	Shaft Seal	Each	1	229.25
RK-3196-S	Repair Kit	Each	1	137.75
K-3196S-6	Maintenance Kit	Each	1	30.60

Note: Identify parts provided by this Contract with two asterisks.

Volume II

11315 - DAF Feed Pump 50P1101/50P1102

Attachment 2.8

MAINTENANCE SUMMARY FORM – 11315 (includes 1.03.B.6, Item 14)

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: DAF Feed Pumps No. 1 and 2

2. MANUFACTURER: NETZSCH- NEMO Pump, Model NM053SY01L07V

3. EQUIPMENT/TAG NUMBER(S) : 50P1101, and 50P1102

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS):

5. NAMEPLATE DATA (hp, voltage, speed, etc.):

6. MANUFACTURER'S LOCAL REPRESENTATIVE: Triangle Pump & Equipment, Inc.

a. Name: David Flack Telephone: 503-656-1473

b. Address: 14940 SE 82nd Drive, PO Box 950, Clackamas, OR 97015

7. MAINTENANCE REQUIREMENTS –

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. If training is required, it can be provided by the manufacturer/representative. Furthermore, it is the responsibility of the end user to ensure that personnel fully understand the operating instructions.

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
Pumps – should be rinsed or cleaned	As needed to remove buildup of medium deposits	N/A
Pump Lubrication – does not require frequent lubrication		
Lubricating the Pin joint with SM-Pin Seals – It is advisable to change the oil and check the seals of the pin joints.	-When replacing worn joints -When disassembling the pump Amount: 1.22 fl oz. per joint	● With SM-pin joint seal (8235) of EDPM ◘
Shaft Sealing through Single Mechanical Seal – If excessive leaks occur the spring tension and the seal surfaces should be checked,	Replace seal as necessary.	N/A
Motor Cleanliness – motor should be kept clean and free from dust, debris and oil. A jet of compressed air can be used to remove non-abrasive dust from the fan cover and	Monthly or as required by conditions	N/A

any accumulated grime from the fan and cooling fins. Terminal boxes should be cleaned and their terminals free from oxidation, in perfect mechanical condition and all unused space dust free.		
Motor Lubrication: Motor noise should be measured to check for unusual noises. A uniform hum is a sign that the bearing is running perfectly.	Periodically when motor is overhauled or disassembled	■ (Lithium based Grease)
V-Belts	Quarterly	N/A
V-Belts Drives, sheave alignment and bearing wear	Quarterly	N/A

8. LUBRICANT LIST

Reference Symbol	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**MFR (Name)**	**Or Equal**
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				
●	SHELL Omala 460				
◘	Klubersynth GH 6-320				
■	ESSO Alvania R3	ESSO Beacon 2	Atlantic Litholine 2	Texaco Multi-Fak 2	

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY - 1.03.B.6, Item 14

Part No.	Description	Unit	Quantity	Unit Cost
107171	3VX850 Cogged Drive Belt	Each	2	18.87
NDB4825456	Coupling Rod	Each	1	418.25
NDB4958699	Rotor	Each	1	1387.05
Viton NDB4955093	Stator	Each	1	434.10
512279	Ring Retainer / Circlip	Each	2	5.00
NDB4825299	Conn. Rod Pin	Each	2	57.35
892841	Pin Retainer Sleeve	Each	1	80.00
862347	Pin Retainer Sleeve	Each	1	95.90
877421	Clamp Ring	Each	2	39.15
516041	O-ring	Each	1	12.35
517020	O-ring	Each	4	12.95
591718	O-ring	Each	1	5.00
Viton 879897	SM Seal	Each	2	93.85
PZ3756375	Pencil Anode	Each	4	3.25
BH5375	Brass Head	Each	4	3.20
Note: Identify parts provided by this Contract with two asterisks.				

NETZSCH, Incorporated
Exton, Pennsylvannia

Test Records		**Job No.:**
NETZSCH Pump Type:	**NM053SY01L07V**	**MAC 201-10032-07**

Customer: Holmes Mechanical

Order No. : 4094-791

PUMP DATA

Machine No.:	18088		Test Pressure:	Standard
Stator Quality:	VI			
Arrangement:	a.)Horizontal	SUCTION LEFT		
	b.) Vertical			
Suciton Flange Dia.:	4"		nom. pressure:	125#
Discharge Flange Dia.:	3"		nom. pressure:	125#
Remarks:				

DRIVER DATA

Manufacturer:	WEG	Type:	ET
Horsepower:	3	Protection:	1.25
Rated Speed:	1760		
Service Voltage:	460	Rated Voltage:	460
Frequency:	60 (Hz)	Phase:	3
Serial No.:	BR97148		
Preformance Curve No.:			
Remarks:			

INTERMEDIATE TRANSMISSION

Manufacturer:	N/A	Type:	
Serial No.:		Ratio:	
		Efficiency:	
		Output Speed:	

NETZSCH, Incorporated
Exton, Pennsylvannia

Test Results

Fluid: Water

Temperature: 62.3°F

Direction of Rotation: CCW

Service Voltage: 460

Barometer: 30.21

Peak Torque: 0

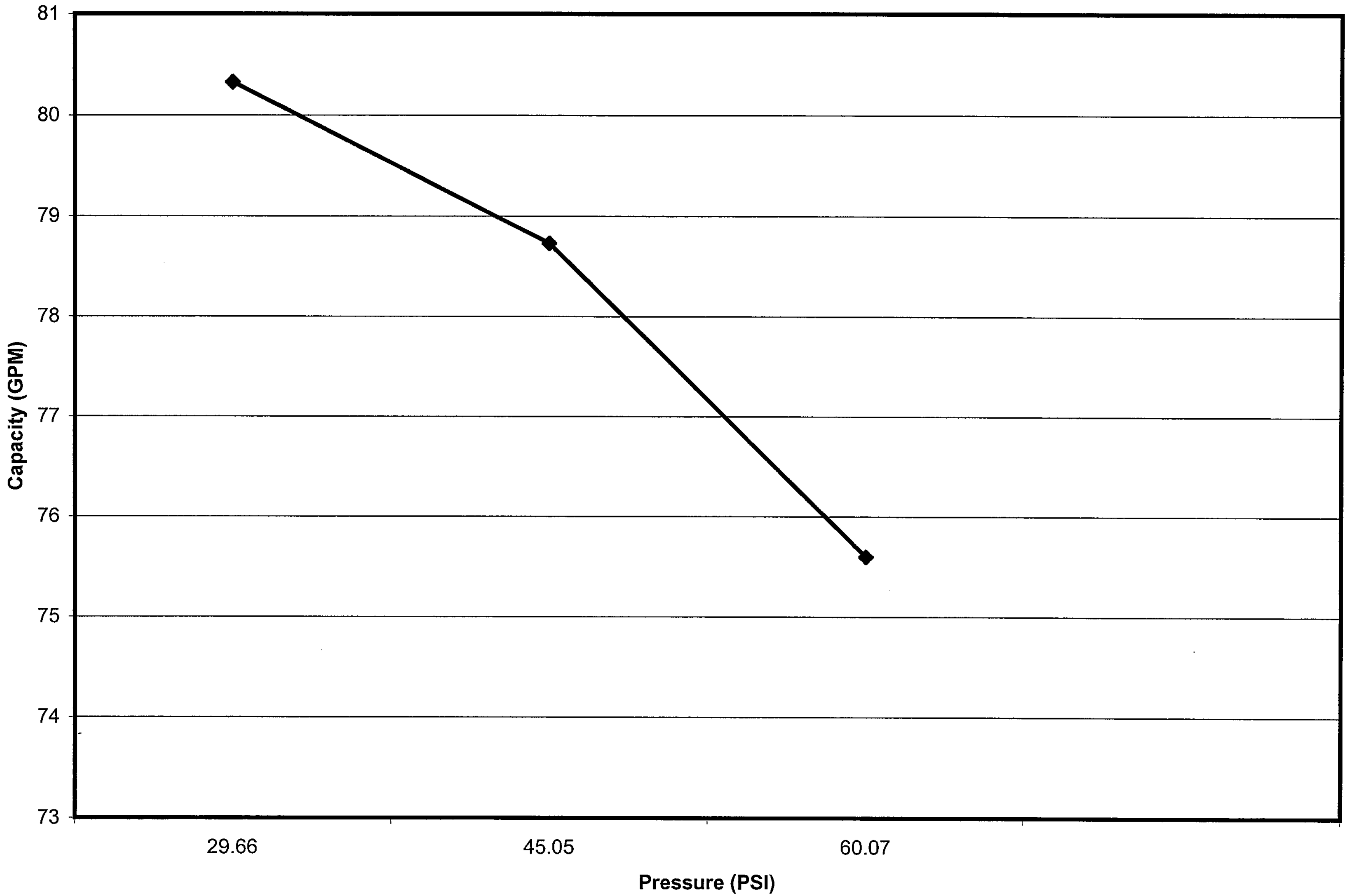
	Constant Pressure				Constant Speed			
Speed (RPM)					261.94	259.54	257.86	
Suction Pressure (PSIG)					1.40	1.40	1.40	
Outlet Pressure (PSIG)					31.06	46.45	61.47	
Diff. Pressure (PSIG)					29.66	45.05	60.07	
Capacity (GPM)					80.33	78.73	75.60	
Power Input (HP)					2.44	2.91	3.38	
Pump Efficiency (%)					56.97%	71.11%	78.39%	
AMP Draw					3.23	3.85	4.48	
Specific Gravity								
Vapor Pressure (PSIG)								
Pump Torqu (FT/lbs)								

Internal Remarks:

Tester: Harry J Smith

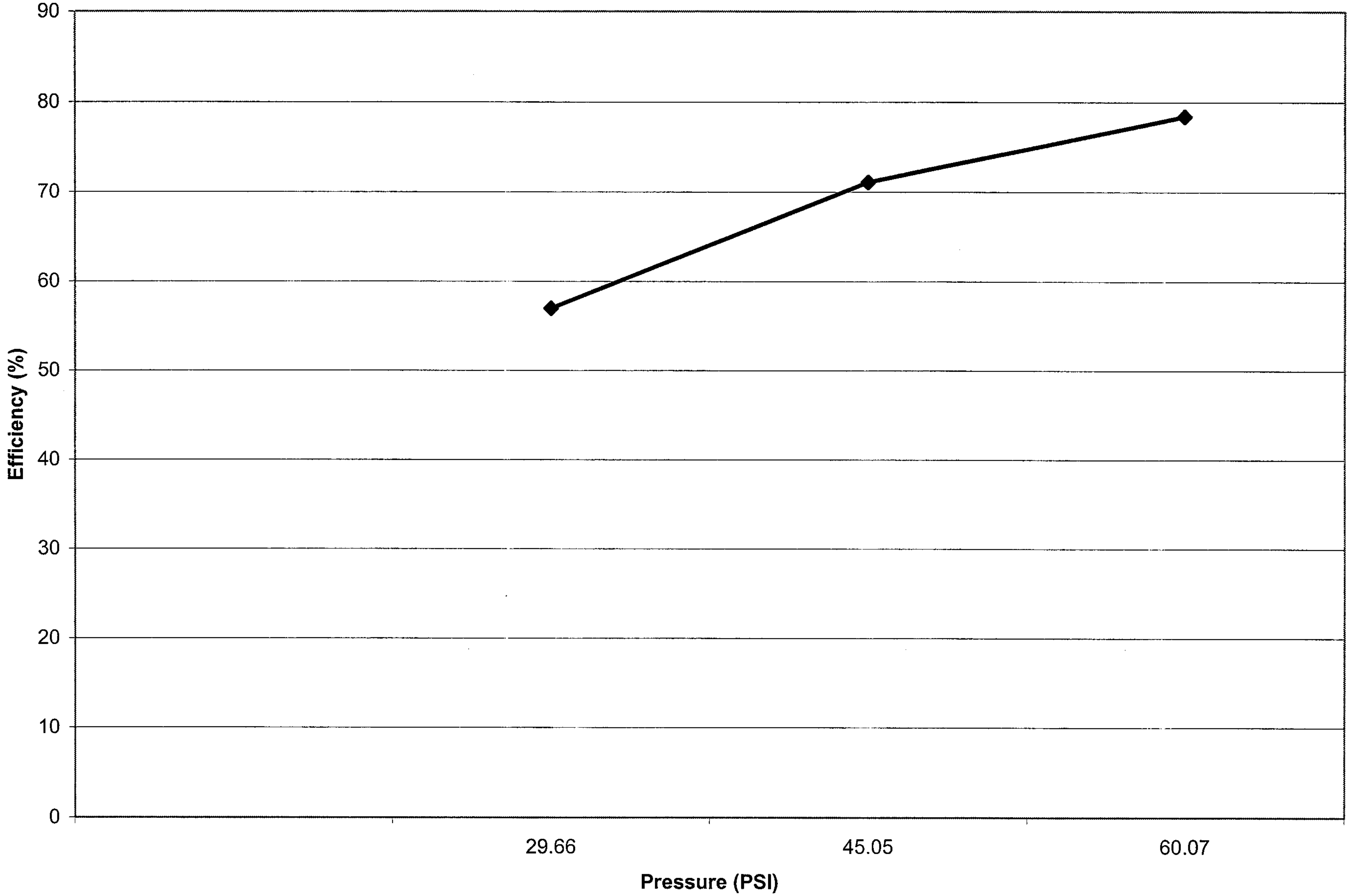
Date: 2-13-08

CAPACITY

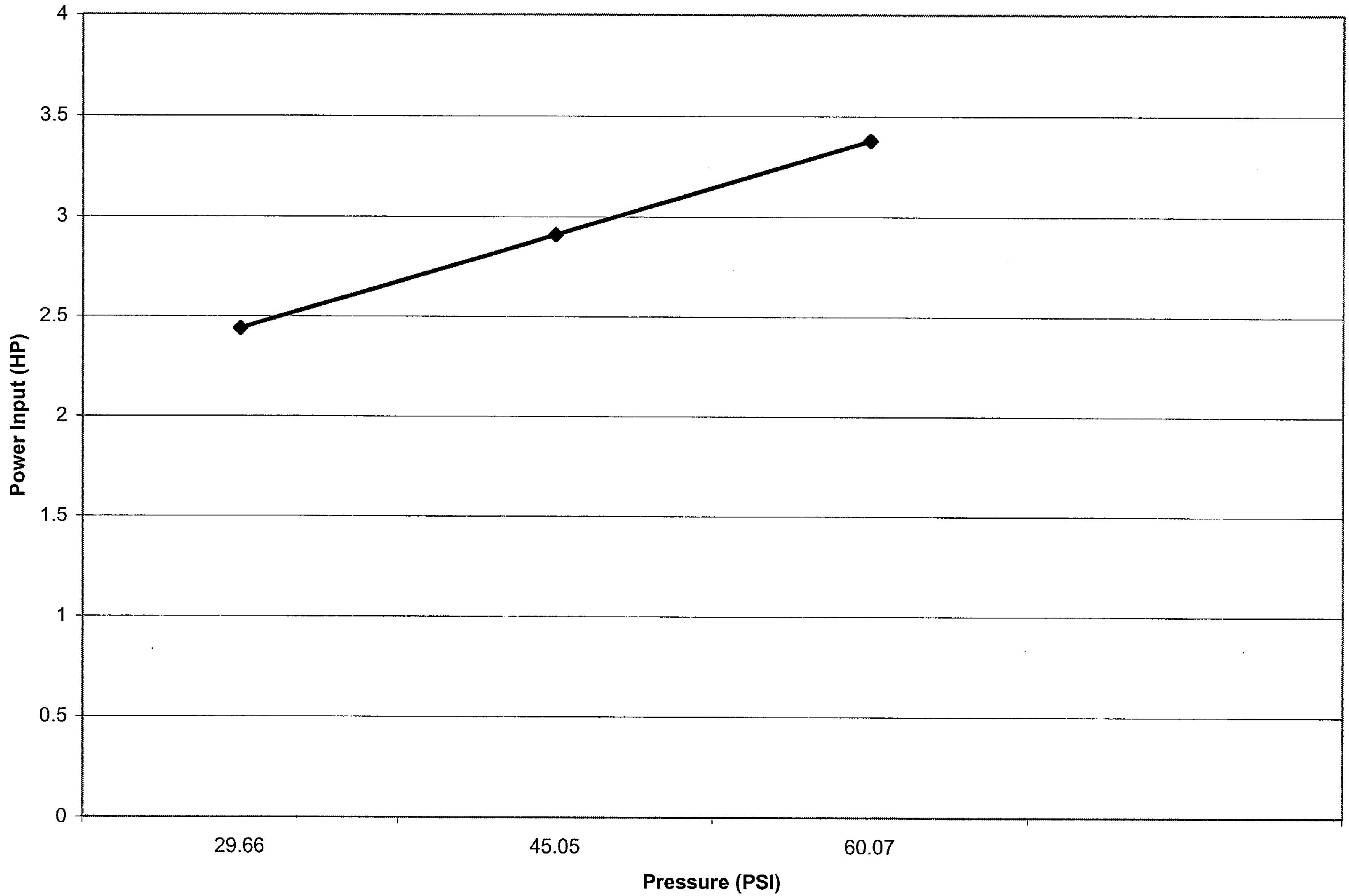


81
80
79
78
77
76
75
74
73
Capacity (GPM)
29.66
45.05
60.07
Pressure (PSI)

EFFICIENCY


Efficiency (%)
90
80
70
60
50
40
30
20
10
0
29.66
45.05
60.07
Pressure (PSI)

POWER INPUT (HP)



NETZSCH, Incorporated
Exton, Pennsylvannia

Test Records		**Job No.:**
NETZSCH Pump Type:	**NM053SY01L07V**	**MAC 201-10032-07**

Customer: Holmes Mechanical

Order No. : 4094-791

PUMP DATA

Machine No.:	18089		Test Pressure:	Standard
Stator Quality:	VI			
Arrangement:	a.)Horizontal	SUCTION LEFT		
	b.) Vertical			
Suciton Flange Dia.:	4"		nom. pressure:	125#
Discharge Flange Dia.:	3"		nom. pressure:	125#
Remarks:				

DRIVER DATA

Manufacturer:	WEG	Type:	ET
Horsepower:	3	Protection:	1.25
Rated Speed:	1760		
Service Voltage:	460	Rated Voltage:	460
Frequency:	60 (Hz)	Phase:	3
Serial No.:	BR97159		
Preformance Curve No.:			
Remarks:			

INTERMEDIATE TRANSMISSION

Manufacturer:	N/A	Type:	
Serial No.:		Ratio:	
		Efficiency:	
		Output Speed:	

NETZSCH, Incorporated
Exton, Pennsylvannia

Test Results

Fluid: Water

Temperature: 62.4°F

Direction of Rotation: CCW

Service Voltage: 460

Barometer: 30.21

Peak Torque: 0

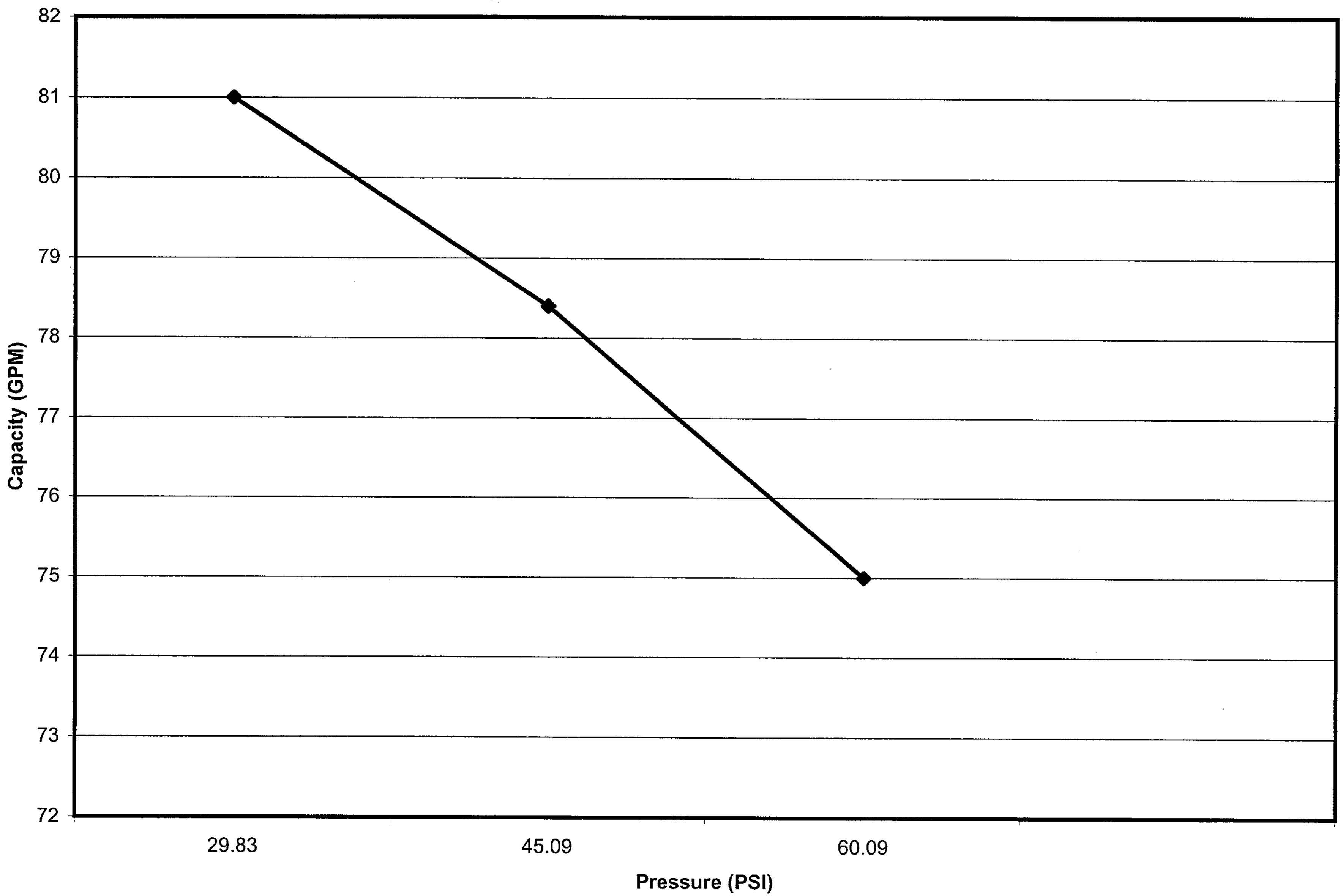
	Constant Pressure				Constant Speed			
Speed (RPM)					260.98	259.54	258.03	
Suction Pressure (PSIG)					1.40	1.40	1.40	
Outlet Pressure (PSIG)					31.23	46.49	61.49	
Diff. Pressure (PSIG)					29.83	45.09	60.09	
Capacity (GPM)					81.00	78.40	75.00	
Power Input (HP)					2.50	2.97	3.44	
Pump Efficiency (%)					56.39%	69.44%	76.44%	
AMP Draw					3.33	3.96	4.58	
Specific Gravity								
Vapor Pressure (PSIG)								
Pump Torqu (FT/lbs)								

Internal Remarks:

Tester: Harry J Sunk Jr

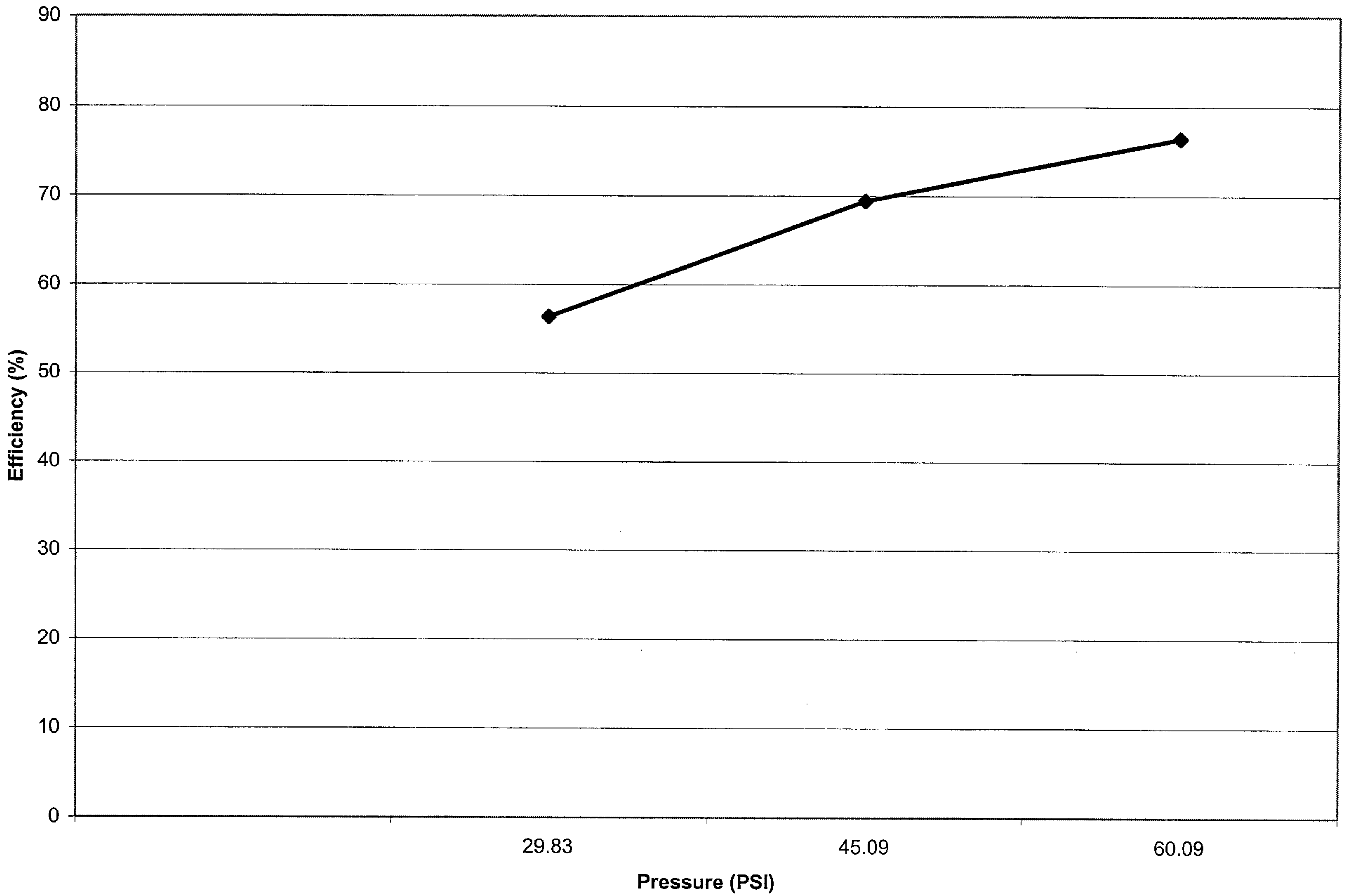
Date: 2-13-08

CAPACITY



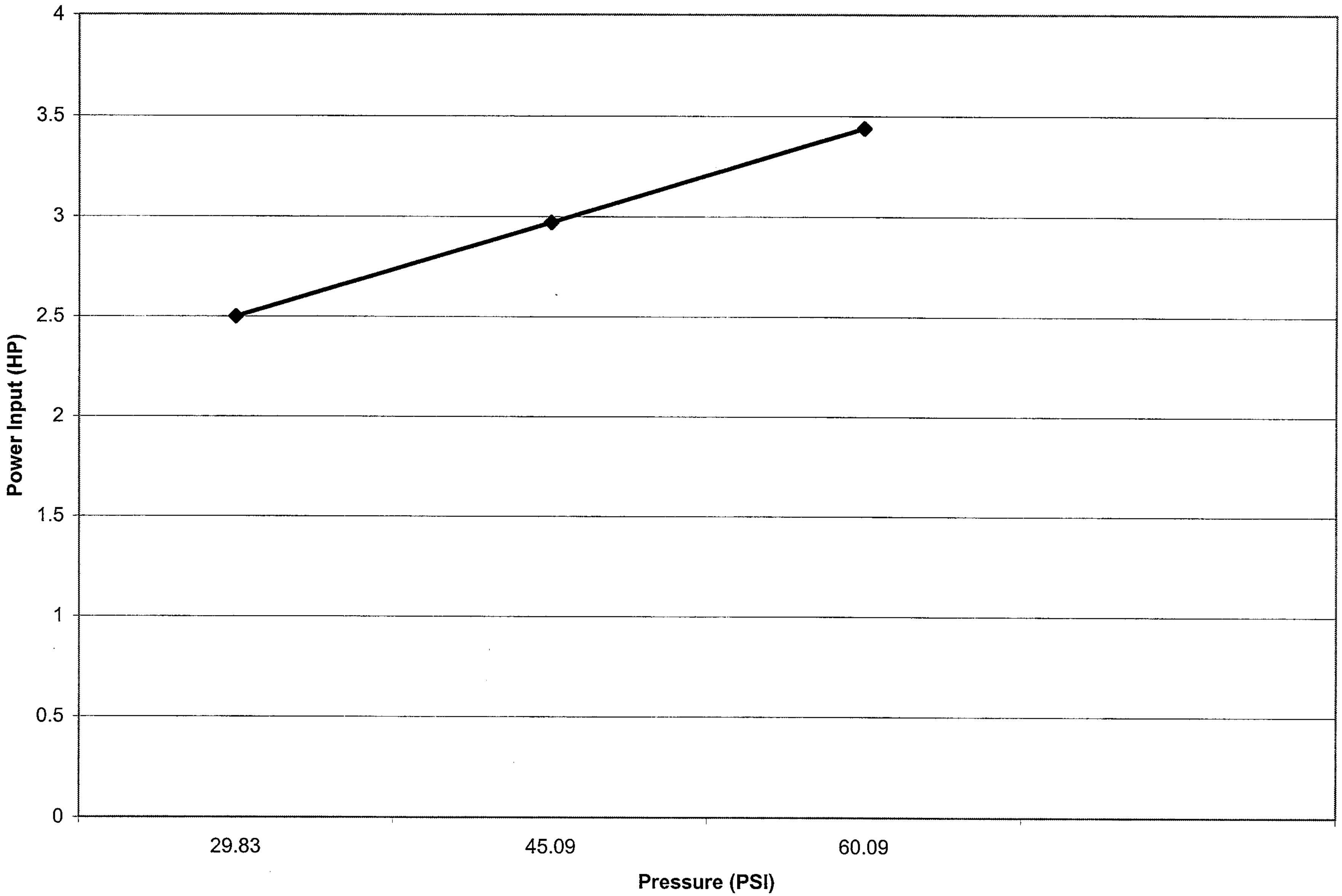
82
81
80
79
78
77
76
75
74
73
72
Capacity (GPM)
29.83
45.09
60.09
Pressure (PSI)

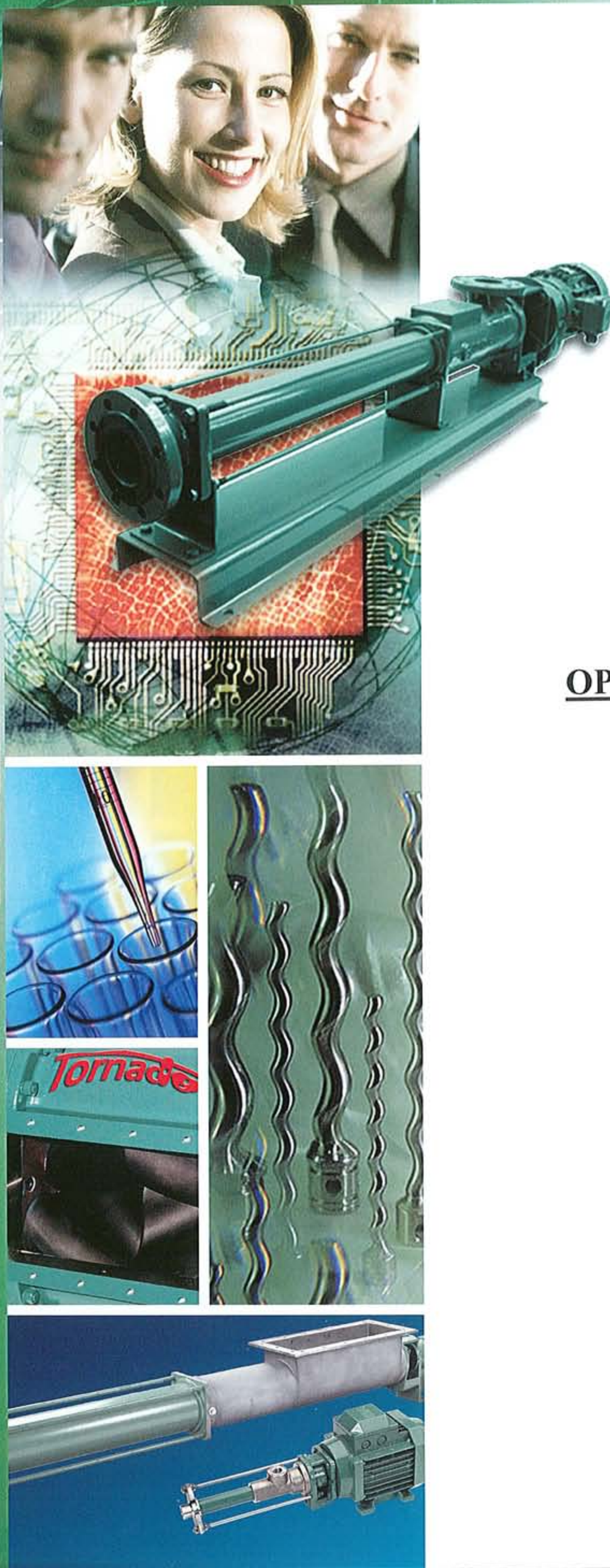
EFFICIENCY



90
80
70
60
50
40
30
20
10
0
Efficiency (%)
29.83
45.09
60.09
Pressure (PSI)

POWER INPUT (HP)





NETZSCH The Heart of Your Process

Individual Solutions for Your Pumping Needs

OPERATIONS & MAINTENANCE MANUAL

PROJECT: WYCKOFF

EQUIPMENT SPECIFICATION:
Progressing Cavity Pumps
Section 11315

NETZSCH MODEL:
NM053SY01L07V
DAF Feed Pumps No. 1 & 2

NETZSCH JOB#:
MAC201-10032/07

NETZSCH

OPERATIONS & MAINTENANCE MANUAL

PROJECT:
WYCKOFF

EQUIPMENT SPECIFICATION SECTION:
PROGRESSING CAVITY PUMPS
SECTION:11315

CONTRACTOR:
Holmes Mechanical Inc
10890 Old Farm Rd NW
Silverdale, WA98383
PH: 360-698-1977
FX: 360-698-1843

MANUFACTURER:
NETZSCH, Inc.
119 Pickering Way
Exton, PA 19341
PH: 610-363-8010
FX: 610-363-0971

MANUFACTURER's REPRESENTATIVE:
Triangle Pump & Equipment, Inc.
14940 S.E. 82nd Drive
PO Box 950
Clackamas, OR, 97015
PH: 503-656-1473
FX: 503-656-2037

O&M MANUAL

WYCKOFF

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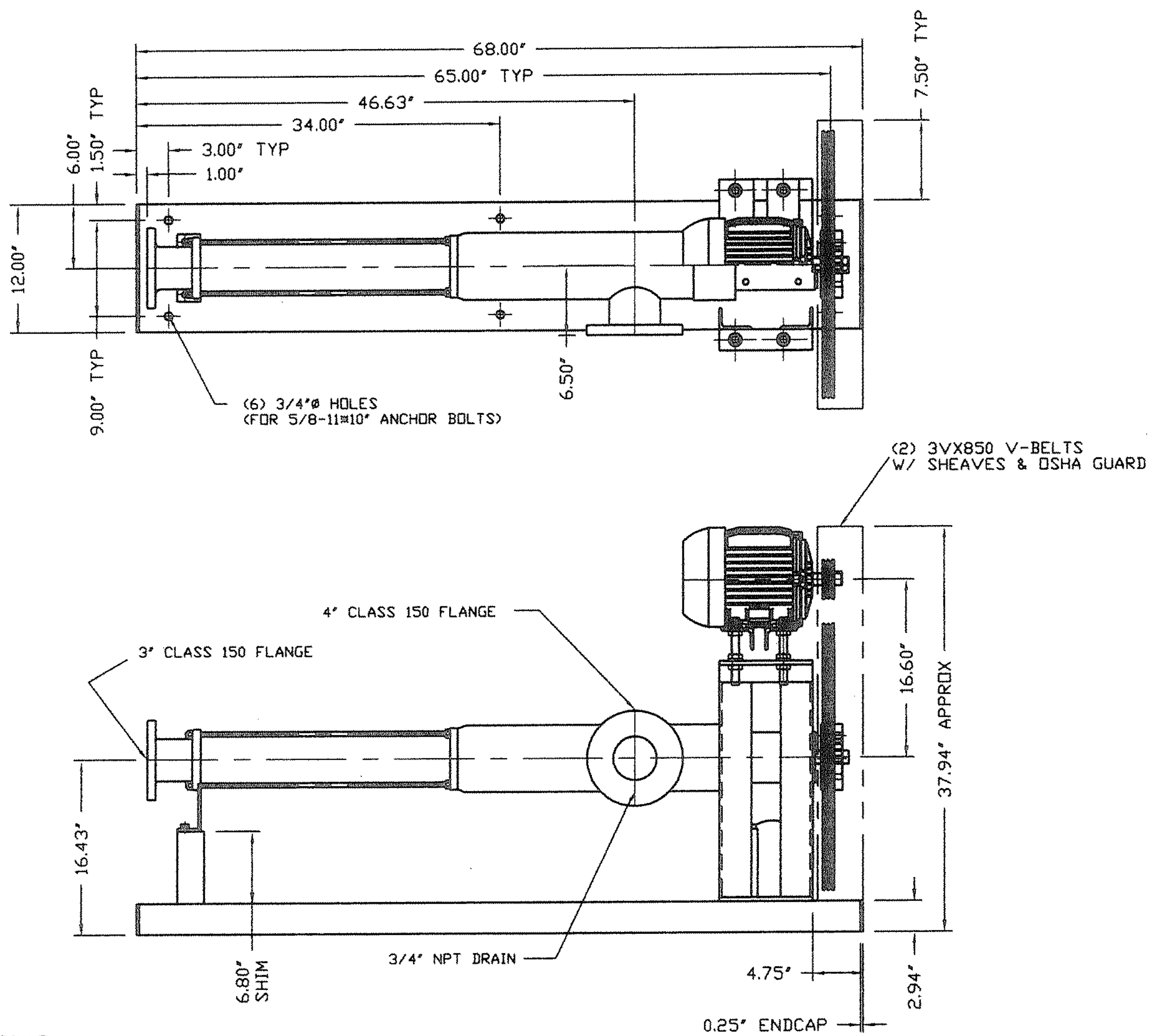


QUANTITY- TWO (2)

DESIGN DATA:

CAPACITY- 80 GPM
MATERIAL- DAF INFLUENT (50% SEA WATER)
DISCHARGE PRESSURE- 5 PSI
OPERATING SPEED- 260 RPM

MATERIALS OF CONSTRUCTION:

PUMP BODY- 316 SS
INTERNALS- 316 SS
ROTOR- 316 SS
STATOR- FLUOROELASTONER (VITON)
JOINTS- PIN TYPE UNIVERSAL
SHAFT SEAL- JOHN CRANE TYPE 680 SINGLE MECH SEAL

MOTOR DATA:

TYPE- A-C MOTOR
MFR- WEG
1800 RPM 3.0 HP 1.25 SF
3 PHASE 60 HERTZ 460 VOLTS
CLASS F INSULATION FRAME 182t
ENCLOSURE- CISD-TEFC

NOTES:

1. (1) PUMP AS SHOWN (1) PUMP OPPOSITE HAND
2. TAG PUMPS – 50P1101, 50P1102
3. PUMP WEIGHT: 550lbs

NOTES:

A) DO NOT SCALE.
B) TOLERANCE ± 0.25"
C) ALL DIMENSIONS ARE IN INCHES.
D) BASEPLATE FABRICATION- 316 STAINLESS STEEL

JOB# MAC2011003207

PROPRIETARY: DRAWING MAY NOT BE USED OR REPRODUCED WITHOUT WRITTEN AUTHORIZATION OF NETZSCH INCORPORATED

REV.	DESCRIPTION	BY	DATE	APP'D
2	CHANGED MOTOR TO 1800 RPM	TH	[illegible]	TH
4	RELEASE TO MFG	TH	[illegible]	TH
3	REVISED BASE MAT'L TO 316 SS & MTR SF TO 1.25	TH	[illegible]	TH

NETZSCH INCORPORATED
EXTON, PA. 19341-1393

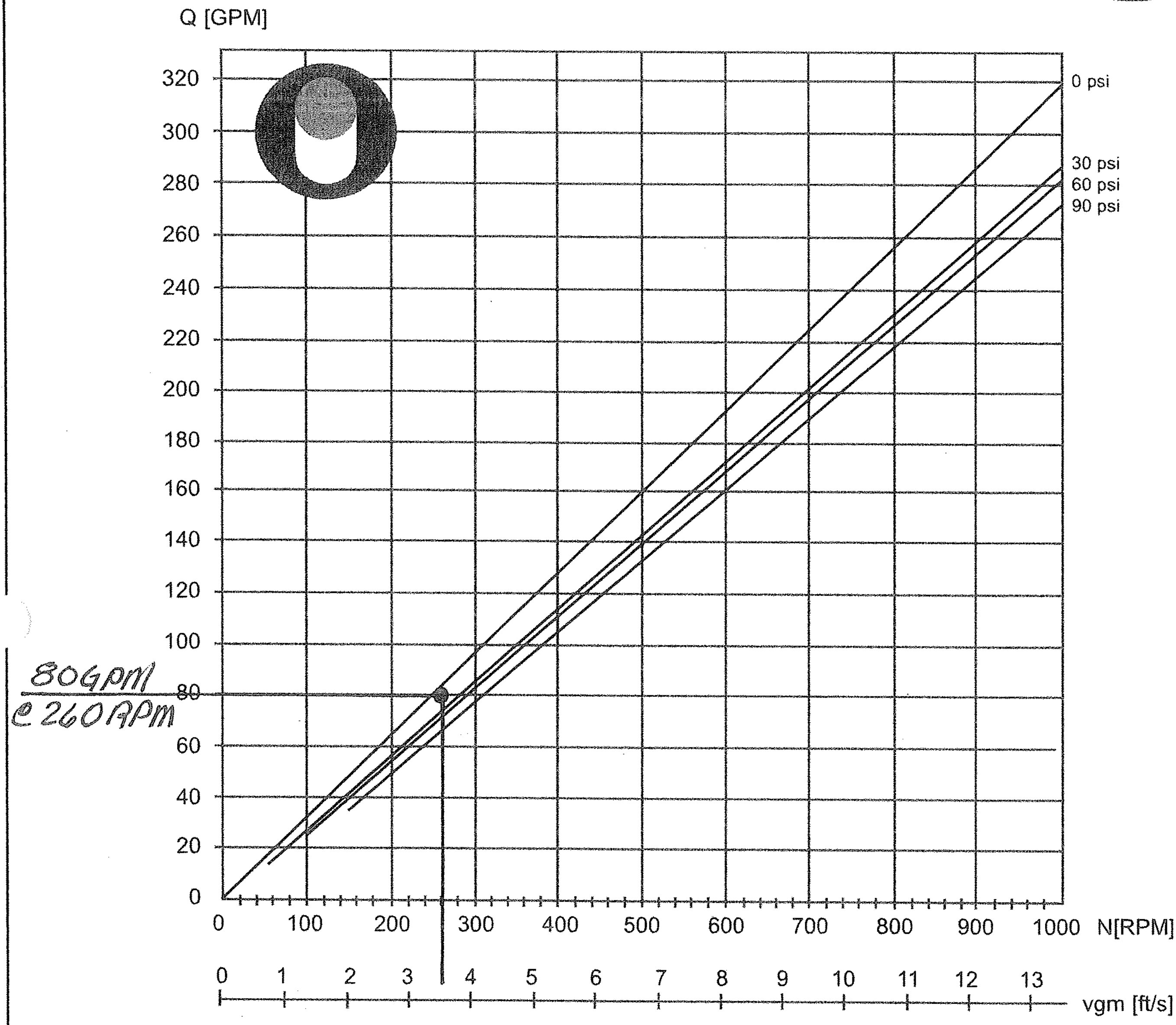
TITLE NM053SY01L07V/ DAF FEED PUMP NO. 1 & NO. 2

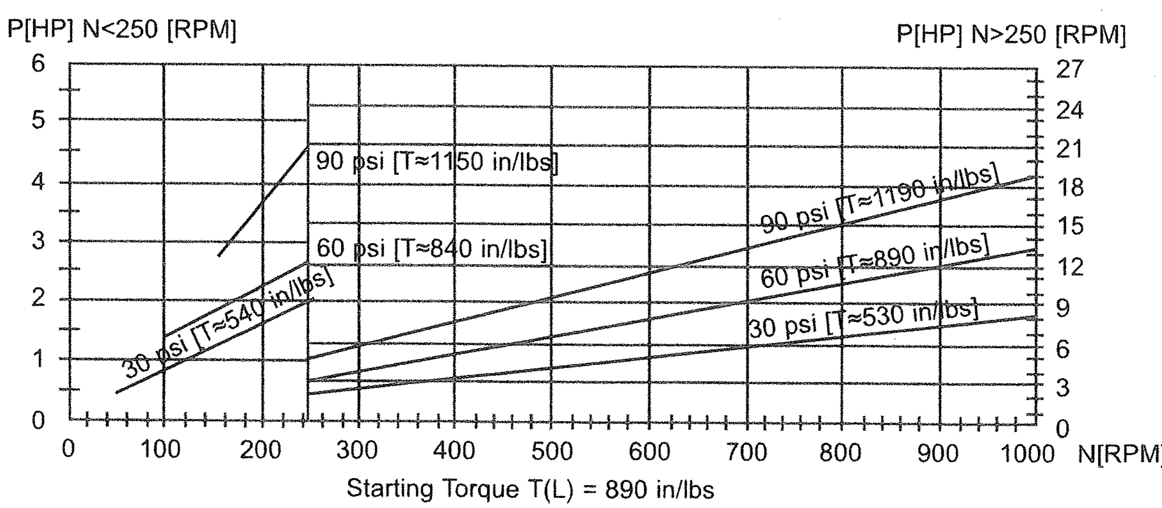
DRAWN TH DATE 05/02/07 | CHK'D DATE
PLOT SCALE: 1:12 | APP'D DATE / /
ORDER NUMBER 4094-791 | SIZE B | DRAWING NUMBER 31331214 | SHT REV
PROJECT WYCKOFF

Performance Curve
NEMO®-Pump NM 053*1L

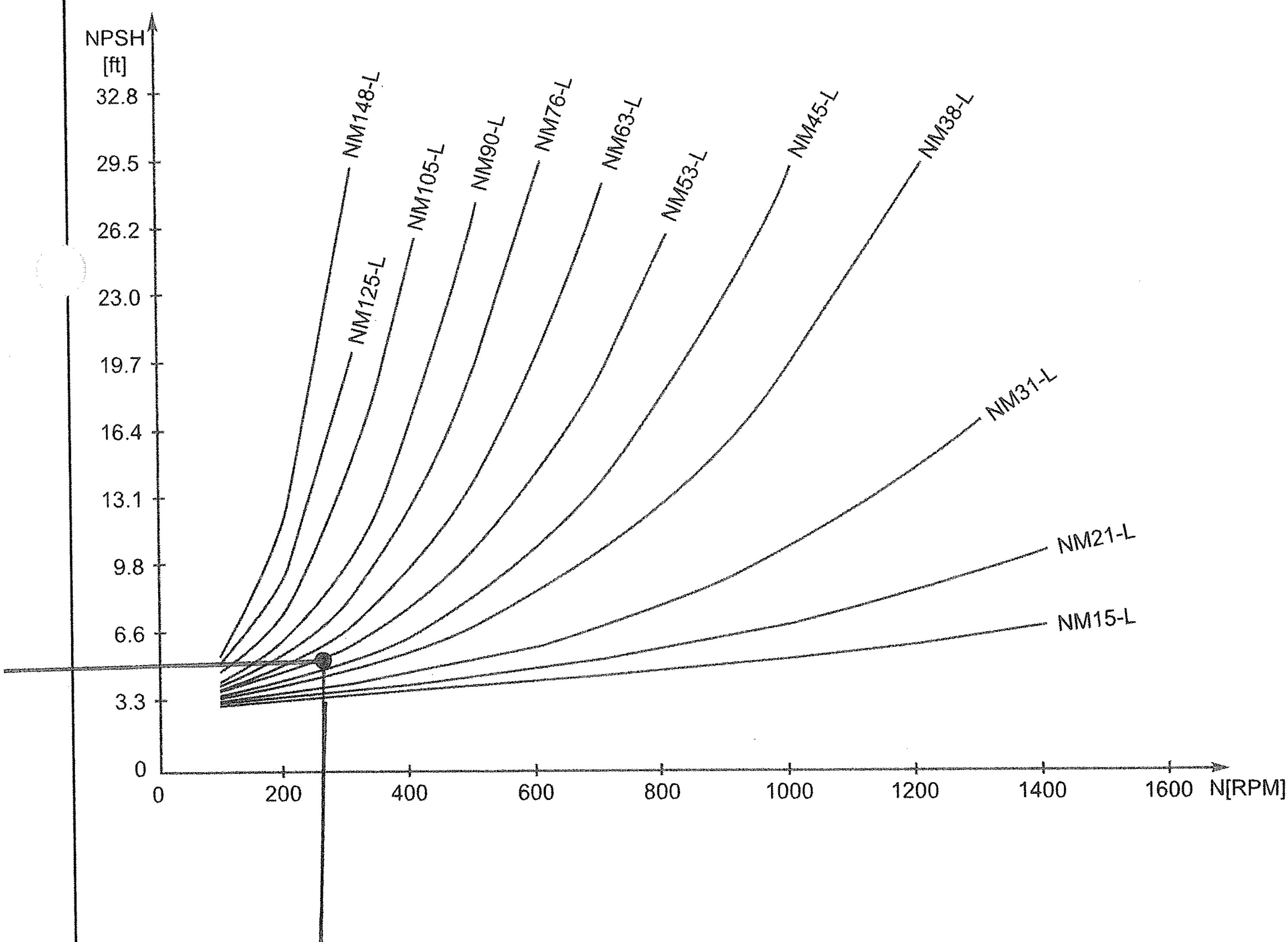
Data based on water at 65°F

NETZSCH

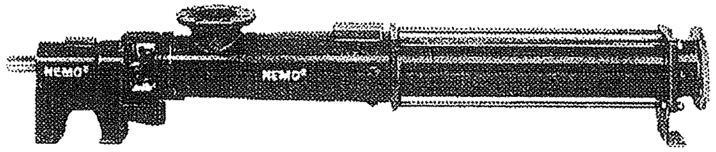




NEMO® Pump
NPSH Requirements - L Geometry



Operating and Maintenance Instructions



NETZSCH

NEMO®-Pump

Model Number
NM053SY01L07V

Sales Order/Job Number
MAC201-10032/07
24466

Machine Number

Date of issue
JAN 08

Important Note

These operating instructions are designed to familiarize the user with the machine and its designated use.

The Instruction Manual

- Contains important information on how to operate the machine safely, properly and efficiently. Observing these instructions help to avoid danger, to reduce repair costs and downtimes and to increase the reliability and life of the machine;
- Must always be available wherever the machine is in use.
- Must be read and applied by any **person in charge** of carrying out work with and on the machine, such as:

Operation including setting up, troubleshooting in the course of work, evacuation of production waste, care and disposal of fuels and consumables

Maintenance (servicing, inspection, and/or repair)

Transport; shall be completed by the end user and authorized personnel with the national requirements in force for the prevention of accidents and the environmental protection.

In addition to the operating instructions and to the mandatory rules and regulations for accident prevention and environmental protection in the country and place of use of the machine, the generally recognized technical rules for safe and proper working must also be observed.

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Quality Pays For Itself NETZSCH

NETZSCH

TABLE OF CONTENTS

SECTION 0

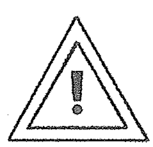
1 Safety Precautions

These operating instructions contain essential information which should be observed during installation, operation and maintenance. These operating instructions should be read and understood by the engineer, as well as other responsible operators before assembly and operation. Operating instructions should always be readily available wherever the machine is being used.

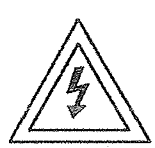
The general safety rules detailed under "Safety Precautions", plus the safety precautions set by the end user, must be followed.

1.1 Symbols Relating to Safety Precautions in the Operating Instructions

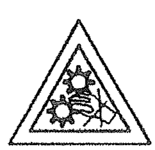
Personal injury, damage to machines or contamination of the environment can result if the safety precautions contained in this document are not strictly enforced. Following are signs commonly used to signify areas of danger:



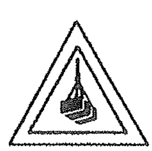
Safety Sign
Danger to General Public



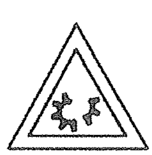
Safety Sign
Electrical Hazard



Danger from Possible Injury by Machinery



Danger from Suspended Loads



Damage to Machinery

Continued on Section 1.OR

SECTION 1.OR

1 SAFETY PRECAUTIONS

Warning or indication plates attached to the pump which show the correct direction of rotation (or fluid connections) must always be kept in readable condition.

1.2 Qualifications and Training of Personnel

All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user. If training of personnel is required, it can be provided by the manufacturer/representative. Furthermore, it is the responsibility of the end user to ensure that personnel fully understands the operating instructions.

1.3 Non-Observance of Safety Precautions

Non-observance of the safety rules can result in personal injury, damage to machines or contamination of the environment. Non-observance can void product warranty.

Non-observance can also result in the following:

- Premature failure of components or machine/equipment malfunction.
- Danger to personnel from electrical, mechanical or chemical hazards.
- Danger to the environment from leakage of dangerous materials.

Continued on Section 1.1

1.4 Safe Operation

The safety precautions outlined in these operating instructions, the existing national regulations on accident prevention and the end user's own operating and safety regulations **must be observed.**

1.5 Safety Precautions

- Hot or cold machine components must be insulated or shielded.
- Guards covering moving parts (i.e. shafts, couplings) must not be removed while machines are in operation.
- Leakage of dangerous materials (i.e. explosives, toxins or hot materials) from the shaft sealing area should be properly contained.
- In order to prevent electrical hazards, applicable local and/or federal regulations must be adhered to.

1.6 Safety Precautions for Maintenance, Inspection and Installation Work

The end user must ensure that all maintenance, inspection and installation work is performed by authorized and qualified personnel who understand the operating instructions and are properly trained.

Work on a pump/machine should only be performed when it is disconnected from its power source, pressure has been relieved, and the complete unit has returned to room temperature. It is imperative that these procedures are adhered to before attempting work on the machine.

Pumps or units which transfer dangerous substances must be decontaminated.

Immediately following maintenance work, all safety and protection equipment must be re-installed and safety trips must be tested.

Refer to Section 5.0, "Start-up," before restarting machine/pump.

1.7 Unauthorized Use of Spare Parts and/or Modifications to the Pump

Modifications to the machines and/or its components are permitted only with the manufacturer's consent. Original spare parts and accessories authorized by the manufacturer ensure safety. The use of other components revokes any warranty and liability for consequences which may result.

1.8 Improper Application

Machinery is only guaranteed safe for the use specified.

This machinery was manufactured in accordance to the specifications and the conditions specified by the end user. The machine should not be operated in any way that exceeds design capacities.

1.9 Specific Points for the Use of NEMO® Pumps

NEMO® Pumps should only be used for the application for which they were sold.

If you wish to change the pumping medium, you should check with either the supplier or manufacturer to ensure that the pump will be suitable for the new medium. This is especially important with aggressive, poisonous or otherwise dangerous media.

Criteria for the selection of a pump includes:

1. Compatibility between the medium to be pumped and the materials of all wetted pump parts.

2. Compatibility between elastomeric components and mechanical seal faces.

3. The pressure and temperature rating of the pump.

NEMO® Pumps are of positive displacement progressing cavity design, and have the potential to generate very high pressure.

Continued on Section 1.1R

SECTION 1.1R

1 SAFETY PRECAUTIONS

A blockage or closure of a valve in the discharge line can cause a pressure rise **higher than the installation can withstand.** A substantial pressure increase can result in the bursting of pipes and/or damage to other components of pump or drive systems. Extreme caution must be used, especially when dangerous media is present.

Appropriate safety equipment must be installed (i.e.: an emergency stop button, a pressure relief valve or rupture disc).

During maintenance and repair work on the pump, please note the following:

1. No one other than those involved with maintenance and repair should have access to power supply.
2. When dismantling the pump, follow the instructions for handling the medium (e.g.: protective clothing, no smoking, etc.)
3. Before putting the pump back into operation, ensure that all guards and other safety devices (e.g.: drive belt and coupling protection) are properly re-installed.

Always keep safety in mind during operation, maintenance and installation of equipment. Please adhere to applicable federal and local rules and regulations.

Continued on Section 1.2

1.10 Notes on Inspection and Repair

It is the responsibility and obligation of all commercial businesses to enforce safety in the workplace, regulations governing dangerous materials, accident prevention and environmental protection at all times.

People along with the environment must be protected from adverse effects caused by contact with dangerous materials.

The procedures for proper handling, containment and/or disposal of all hazardous materials, including wastewater, must be strictly enforced.

Important:

A Material Safety Data Sheet must accompany any machine/part and a Safety Conformity Certificate must be completed prior to inspection or repair. Please make a duplicate copy and leave the original in the Operation and Maintenance manual.

Where special safety precautions are necessary, in addition to careful emptying and cleaning of the machinery, the necessary information must be given.

Inspection or repair of machinery containing radioactive medium will only be performed by authorized personnel under protection and supervision of the owner.

The Safety Conformity Certificate is part of the inspection/repair service. We reserve the right to refuse acceptance of this order/service for other reasons.

Continued on Section 1.3

Safety Conformity Certificate

This completed Safety Conformity Certificate and a Material Safety Data Sheet must accompany the machine and its accessories when returned to the manufacturer for repair/inspection services.

Pump Model Number ____________
Job Number ____________
Date of Manufacture ____________ Equipment Return Authorization # ____________
Machine Number ____________

Was carefully emptied and cleaned, both inside and out, in preparation for shipment. ☐ Yes ☐ No

Precautions with regard to health and the environment are to be observed. ☐ Yes ☐ No

This machine came into contact with media hazardous to health and the environment. ☐ Yes ☐ No

The following additional precautions are necessary with regard to the handling of media and the disposal of waste: ____________

____

We confirm the above information is accurate and complete, and shipment will be in accordance with legal requirements:

Company
____________ Telephone No.: ____________
____________ Fax No.: ____________

Address
____
____

Name ____________ Date: ____________

Position: ____________

____
Company Stamp/Signature

2 Description

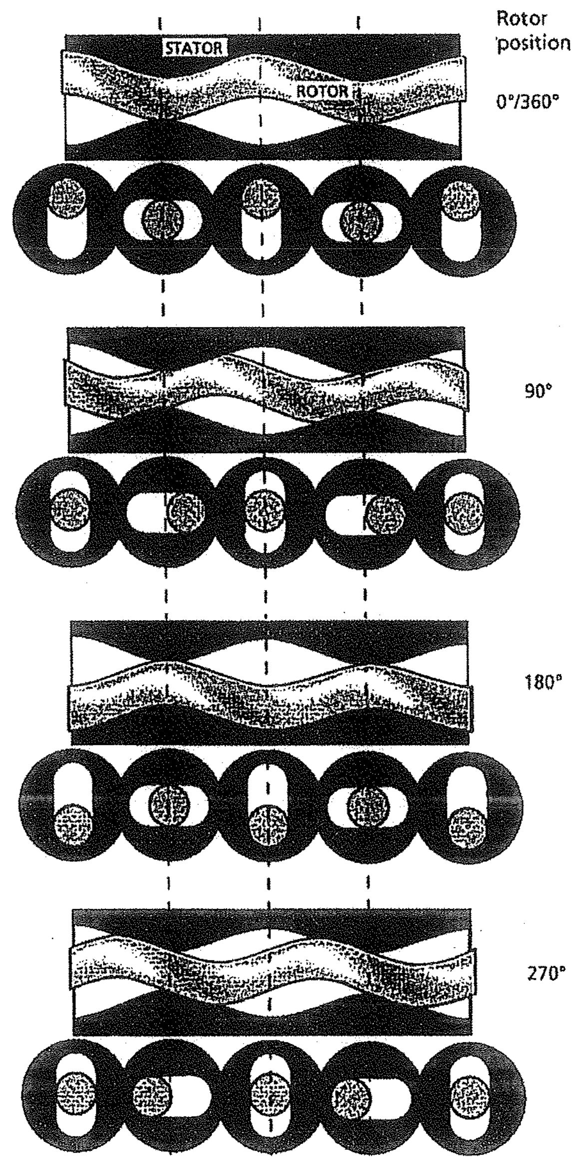
The NEMO® Pump is a positive displacement, progressing cavity-type pump.

The main components of the pump (which was invented by Professor Rene' Moineau) are: a rotating part, called the rotor; and a stationary part, called the stator.

The rotor has a single helix shape and is normally made of a metallic material. The stator is formed as a double-helix with twice the pitch of the rotor and is normally an elastomer. The interference (compression) fit between the rotor and stator creates a series of sealed chambers called cavities. When the rotor turns inside the stator, the medium moves continuously from the inlet to the outlet of the cavities.

The NEMO® Pump principle utilizes many positive characteristics of other pump types:

- Like centrifugal pumps, NEMO® Pumps have no suction or pressure valves, but do have a stable flow rate in proportion to the number of revolutions.
- Like piston pumps, NEMO® Pumps have a suction lift up to 28'. Vacuum capacity is 24-25'.
- Like membrane and peristaltic pumps, NEMO® Pumps can transport all types of media including inhomogeneous, gaseous and abrasive media; as well as those that are not of a liquid consistency, or contain solids and/or fibrous material.
- Like gear pumps and screw pumps, NEMO® Pumps are capable of handling high-viscosity media.
- Like piston, membrane, gear or screw pumps, NEMO® Pumps can be used for metering applications.



Length and cross-sections of the rotor and stator during a rotation.

Continued on Section 2.0R

2.2 General Data

Noise Emissions:

The maximum noise emission level permitted at a workplace is 85 dB (A).

Noise level's are measured in accordance with OSHA CFR 1910.95 to assure that the pump does not exceed 85 dB (A).

Noises generated by the drive and pipes are not included in the above emission value.

In order to maintain a noise emission level of ≤ 85 dB (A), the pump must be securely mounted and not allowed to cavitate.

3 Packaging, Transportation, Storage

3.1 Packaging and Transportation

NEMO® Pumps are shipped on skid-mounted wood-framed cardboard enclosures, unless the customer specifies otherwise.

The packages are labeled with any special handling instructions.

Upon receipt, inspect the pump for any transportation damage.

Claims for damages should be reported to the **freight carrier immediately.**

Uncrated horizontal pumps should be lifted using the bolt holes of the frame or the lifting lugs attached to the baseplate.

Vertical pumps should be lifted by using the bolt-down holes, or lifting lugs attached to the mounting plate.

Use caution when lifting top-heavy pumps. The center of gravity may be above the points where the lifting gear is attached. If this is the case, secure additionally to **prevent tipping over!**

Vertical pumps should be stored horizontally **only**, unless they are <u>secured vertically.</u> **This will prevent hazards of tipping!**

Avoid suspending the complete pump unit by the eye bolts of the motor or gear box. These eye bolts should be used for lifting the motor and/or the gear box only.

As when operating any type of equipment, exercise caution and adhere to all applicable instructions, rules and regulations.

Due to the variety of possible pump designs and applications, only general instructions can be given here. These should be adequate for experienced assembly or transportation personnel.

When in doubt, contact the supplier for more detailed information.

Continued on Section 3.0R

When moving the pump or unit on wheels, strictly adhere to the following:

- Lock out the motor drive to protect against unintended start-up.
- Move the pump unit carefully and slowly, especially where the ground is uneven. **Hazards of tipping!**
- The pump should be stored in a stable position with wheels or rollers locked or otherwise secured.
- Be careful not to allow flexible piping to bend or become kinked. Obstruction of flow will cause excessive discharge pressure.
- Where necessary, secure the pump unit with additional support blocks.

3.2 Storage

Pumps are packaged for transportation and short-term storage. In cases of prolonged storage, the pumps should be protected as follows until installation:

- **Stator:**
  When stored for a long period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set). This will increase the required starting torque. For this reason, the stator should be removed and stored in a cool, dry place in an air-tight package and protected from light.
- **Shaft Sealing by packing gland:**
  Remove the packing gland and protect the exposed shaft surface with protective grease or oil.
- **Pump parts in stainless steel:** No protection necessary.
- **Other non-protected pump parts:** Protect with grease or oil.
- **Drives:** Observe the instructions of the drive supplier.

Store Room

The environment in which rubber products are being kept must be cool, dry, free of dust and well ventilated, and must not be stored in the open.
Rubber products should be kept in surroundings not having less than minus 10° C (14° F) and not more than plus 15° C (59° F).
Store rooms should not be damp, and it must be ensured that there will be no condensation.
Recommended relative humidity is < 65%.
Rubber products must be protected against light, particularly direct sunlight or artificial light having a high UV portion.
Rubber products should be kept in a sealed package.
As ozone is very aggressive and harmful there should be no store room used which houses equipment likely to produce ozone, i.e. electric motors or other equipment which might bring about sparks or other electrical discharges.
There must be no solvents, oil, grease, lubricants or any chemicals kept in the store room.

- **Rotor**

  Support with wooden blocks and protect against damage from mechanical impact. For tool steel rotors (material number 1.2436): coat the surfaces with protective grease to avoid rusting.

- **Shaft Sealing by packing gland**

  Remove the gland and coat exposed shaft surface with grease or oil.

- **Pump parts in stainless steel**

  No grease coating necessary.

- **Other, non-coated pump parts**

  Protect with grease or oil.

- **Drives**

  Observe instructions of the drive supplier.

4 INSTALLATION INSTRUCTIONS

4 Installation

If the NEMO® Pump was stored and the rotor grease protected:
Remove the grease before installing the stator.
Clean the rotor thoroughly in order to avoid contamination of the stator and the pumping medium.

Verify all hardware has been properly installed and fastened.

4.1 Direction of Rotation

The direction of rotation of the pump is given on the name plate.

4.2 Pressure

Maximum permissible pressure inside the pump housing (A) is 6 bar.

The maximum permissible pressure inside the end flange (B) is 12 bar.

Type key

Example: NM 031 S Y 02 S 12 (bar) B

- Series — NM
- **Pump Size** — 031
- Drive End — S
- Execution — Y
- **Number of stages** — 02
- Geometry — S
- max. permissible pressure differential (counter clockwise rotation) — 12 (bar)
- Joint Type — B

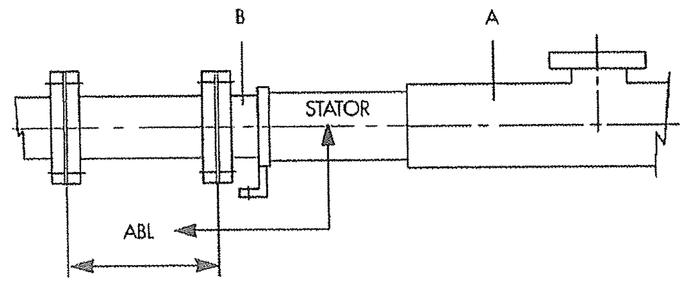
4.3 Shaft Sealing

◆ Where applicable, ensure that adequate supply lines for the buffer, flushing or quenching fluid for the shaft seals are connected **before** the pump is put into **operation.** For more details see Section 7.4!

Continued on Section 4.0R

4.4 Piping System

- Arrange suction and discharge pipes so that when the pump is not running, the medium is still present. Sufficient medium should remain inside in order to lubricate the pump during restart.
- Clean the pipe work and rinse thoroughly before installing the pump.
- See chart below for recommended disassembly (ABL) dimensions.



Disassembly length ABL in mm:

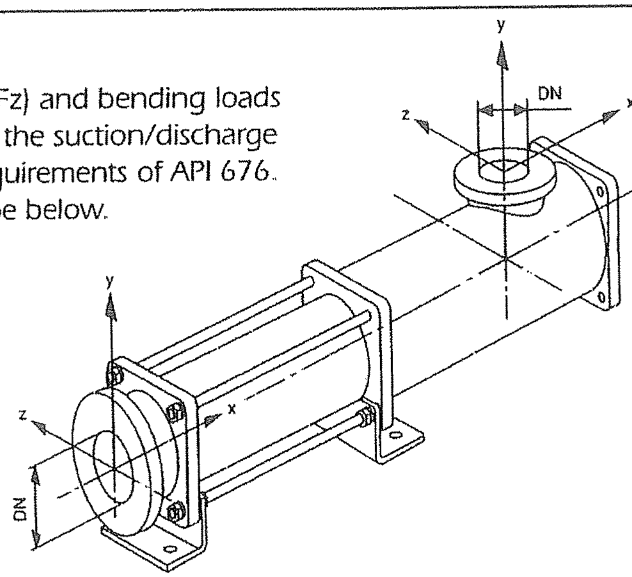
Pump size	Number of Stages							
	1*	2	3	4	6	8	10	12
015	160	160	230	310	460	610	770	920
021	230	230	340	450	670	880	1100	1310
031	310	310	450	590	880	1160	1440	1730
038	430	430	630	830	1230	1630	2030	2430
045	500	500	730	960	1430	1890	2350	2820
053	600	600	880	1170	1730	2290	2860	3420
063	690	690	1010	1330	1980	2620	3270	3910
076	800	800	1170	1540	2280	3030	3770	4520
090	950	950	1390	1840	2720	3610	4500	
105	1180	1180	1740	2300	3410	4520		
125	1400	1400	2060	2720	4040			
148	1680	1680	2470	3260				
180	1910	1910						

*This dimension applies to 1L geometry, 2 through12 refer to S geometry

SECTION 4.1

4 INSTALLATION INSTRUCTIONS

The twisting loads (Fx, Fy, Fz) and bending loads (Mx, My, Mz) permitted for the suction/discharge flange comply with the requirements of API 676. They are shown in the talbe below.



Pump type NM	Standard nominal diameter DN	F_x, F_y, F_z lbs.	M_x, M_y, M_z in/lbs.
003 005 008 011	FNPT	38	NPT joints must not be assembled with loads which may result in over tightening or loosening these joints
015 021	FNPT	95	
31	2"	152	3080
38	2.5"	191	3828
45 53	3"	229	4576
63	4"	305	6116
76	6"	382	7612
90 105	6"	458	9152
125	8"	611	12,188
148	10"	764	15,224
180	10"	764	15,224

5 Start-up

NEMO® Progressing Cavity Pumps must be operated with the following precautions:

Never run the pump dry!
Even a few rotations in dry condition will damage the stator.

If the rotor was protected with grease for long-term storage:
Thoroughly clean the rotor to prevent damage caused by interaction of the grease, stator material and medium.

- Before initial start-up, regardless of rotation, make sure the pump housing and suction piping are filled with medium. If medium is high in viscosity, it may be necessary to prime the pump with a compatible liquid. Priming of the pump is necessary to lubricate the stator.

NEMO® Pumps are positive displacement progressing cavity pumps and have the potential to generate very high pressure capable of bursting vessels or pipes.

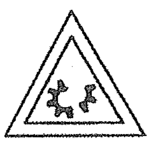
Excessive pressure can overload the drive train (shaft, connecting rod, joints, rotor) or exceed pressure limitations of the housings and their connections, resulting in damage or breakage. Refer to Section 4.4 of this manual for housing pressure limitations.

Never run the pump with an inlet or outlet valve closed.

- Open valves and vents before starting the pump!

- Turn pump motor on and off briefly to check direction of rotation.

6 Temporary Shutdown



- Following the temporary shutdown, the pump should be emptied and rinsed when:
  - the pump is installed in a location inside or outside where the medium has the potential to freeze.
  - the medium has a tendency to solidify or harden.
  - the medium tends to build up or become tacky on the shaft sealing area.

- **Stator:**

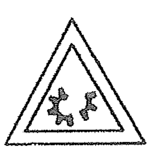
When stored for an extended period, the elastomer along the contact line between the rotor and stator may become temporarily distorted (compression-set).

This will increase the required starting torque. For this reason, the stator should be removed and stored in a cool, dry place in an air-tight package and protected from light.

- **Rotor:**

Support with wooden blocks and cover to protect from mechanical damage, after the stator has been removed.

Rotors made with Tool Steel (Material number 1.2436)
Should be protected against corrosion with protective grease.



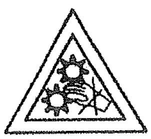
Prior to installation, thoroughly clean rotor to prevent damage caused by interaction of the grease, stator material and medium.

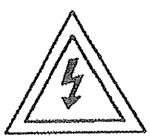
- **Stand-by Pump:**

A stand-by pump is sometimes installed to eliminate downtime. Stand-by pumps should be operated occasionally to keep properly conditioned for use.

7 Maintenance

7.1 Pumps in General





- The pumps should be regularly rinsed or cleaned if deposits of medium are likely to build up.

  If the pump needs to be disassembled, ensure that the pump and motor are switched off and cannot be turned on accidentally (eg. by removing the fuse).

7.2 Lubrication

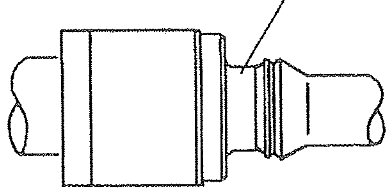
The NEMO® Pump does not require frequent lubrication.

- Maintenance and lubrication of the drive should be carried out according to the drive manufacturers instructions.

7.3 Lubricating the Pin Joints with SM-Pin Joint Seals

- It is advisable to change the oil and check the seals of the pin joints:
  - when replacing worn joint parts
  - when disassembling the pump for any reason

Joint basic size series NM	Quantity of oil per joint cm³	fl oz.
NM 003-011	1	0.0338
NM 015	1.5	0.05
NM 021	2	0.067
NM 031	5	0.17
NM 038	15	0.51
NM 045	22	0.75
NM 053	36	1.22
NM 063	78	2.64
NM 076	165	5.60
NM 090	205	6.93
NM 105	450	15.20



Continued on Section 7.2R

Lubricating Oil:

Industrial Application	Designation DIN 51502	Permitted Product
Viton And General Industry	CLP 460 With SM-PIN Joint Seal VITON	"SHELL" Omala 460 (or equivalent)
	~~with SM-pin joint seal (8235) of EPDM~~ ~~CLP PG 320~~	~~prescribed:~~ ~~KLUBERSYNTH GH 6-320~~

7.4 Shaft Sealing through Single Mechanical Seal

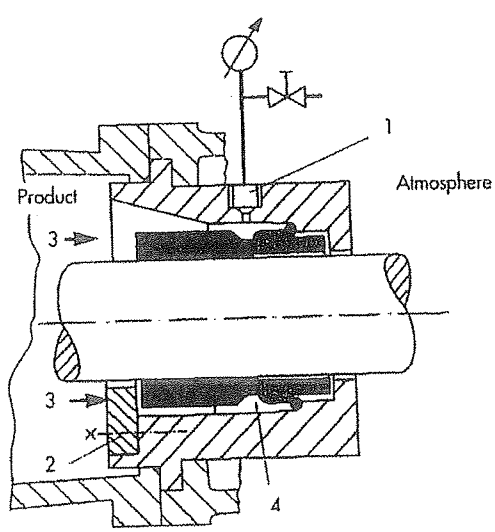
- The seal specification of a NEMO® Pump is noted on the order acknowledgement.
- Pumps fitted with direction dependent seals should **never** be run in the opposite direction of the rotation arrow.
- If excessive leaks occur the spring tension and the seal surfaces should be checked, replace the seal, if necessary.

Single mechanical seals usually work without any additional equipment. Their application range can be increased by operating them with a flushing or cooling system.

Flushing

Medium containing high solids should be flushed as follows:
A clear rinse (1) is fed in near the area of the sliding surface. An additional throttle seal (2) can be built in. This keeps the contaminated medium (3) away from the seals (4) if:

- sufficient flush (1) is added
- the pressure of the flush (1) is greater than the pressure of the medium (3).



8 Trouble-Shooting

8.1 Trouble-Shooting Guide

The following chart lists possible problems and corresponding solutions:

8.2 Determining the Kind of Problem and the Possible Cause

- The column describing a possible problem shows one or more boxes marked with an "X."

- On the corresponding lines, you will find the possible reasons/causes and some hints how to handle the problem. Thus, the actual cause of the problem can be narrowed down and eventually detected.

◆ The table helps to identify the problem and offers a possible solution. For more complicated problems, consult the manufacturer.

Continued on Section 8.0R

TROUBLE-SHOOTING GUIDE

A good service life can be expected if the pump is used in accordance with your specified application and maintained in accordance with this manual. If operating problems arise, use this chart as a guide in locating the problem.

Possible Problem												
Pump will not start	No suction capability	Discharge output low	Discharge pressure low	Discharge output fluctuates	Pump is noisy	Pump jammed	Drive overloaded	Stator service life too short	Rotor service life too short	Shaft seal leaks	POSSIBLE CAUSE	See Next Page for Corrective Action.
X							X				Pump or stator is new, to much static friction.	1
X		X	X				X				Power supply incorrect; drive not properly wired.	2
		X					X	X	X		Discharge pressure too high.	3
X						X	X				Foreign matter or debris in pump.	4
X						X	X	X	X		Temperature of pumped liquid too high; stator swells.	5
X						X	X	X			Stator swells due to chemical attack, unsuitable elastomer.	6
X						X	X	X			Liquid contains too many solids, causing blockages.	7
X						X	X	X	X	X	Liquid settles and hardens at pump shut-down.	8
		X	X	X							Air in suction piping.	9
	X	X	X	X							Suction pipe leaks.	10
	X	X	X	X							Shaft sealing leaks.	11
		X	X								Pump speed too low.	12
	X	X	X								Undersized rotor; operating temperature not reached.	13
		X	X	X	X			X	X		Discharge too high or suction head too low (cavitation).	14
		X	X		X	X	X	X	X		Pump running dry.	15
	X	X	X		X						Stator worn out.	16
	X	X	X		X			X	X		Stator material brittle.	17
	X	X	X		X			X			Rotor worn out.	18
					X						Joints worn.	19
					X						Pump and drive out of alignment.	20
					X						Elastomer in coupling worn out.	21
					X					X	Pump bearings worn.	22
							X				Pump speed too high.	23
							X				Viscosity too high.	24
							X				Specific gravity too high.	25
							X			X	Stuffing box not properly tightened.	26
										X	Incorrect packing.	27
										X	Wrong direction of rotation.	28
	X									X	Stationary or rotating face of mechanical seal worn.	29
										X	O-Rings in mechanical seal worn or damaged.	30

CORRECTIVE ACTION

1	Fill pump and turn by hand. If necessary, use glycerine to lubricate stator.
2	Check motor nameplate data. Test voltage, phase and frequency.
3	Measure actual discharge pressure and compare to your specification.
4	Remove debris and correct any damage.
5	If liquid temperature cannot be reduced, use an undersized rotor.
6	Check specified application, If necessary, change stator material.
7	Increase liquid-to-solids ratio.
8	Clean pump and rinse out after each use.
9	Increase NPSHA; eliminate leaks (see No. 10).
10	Check seals; tighten piping connections.
11	Packing: tighten stuffing box or replace packing. Mech. seal: replace rings or seals; remove deposits.
12	If drive is variable speed, increase speed at pump.
13	Heat pump (stator) to operating temperature.
14	Reduce suction losses; lower liquid temperature; install pump at lower elevation.
15	Fill pump; provide dry run protection; relocate suction piping.
16	Replace stator.
17	Replace stator, check specified application; change stator material of construction if necessary.
18	Replace rotor; determine cause; change rotor material of construction if necessary.
19	Replace necessary parts; seal and refit carefully.
20	Re-align pump and drive.
21	Replace coupling elastomer; re-align.
22	Replace bearings, lubricate and seal. For high temperature, check bearing tolerances and lubrication.
23	If drive is variable, set at lower speed.
24	Measure viscosity and compare to specified viscosity.
25	Measure specific gravity and compare to specified specific gravity.
26	Service stuffing box; replace worn shafts.
27	Change packing material.
28	Reverse polarity of drive motor.
29	Rework or replace seal faces.
30	Replace o-rings; check specified application. Change o-ring material of construction if necessary.

9 Removal and Assembly of End Flange, Stator and Pump Housing

The pump with attached pipework should be empty and must have cooled off!

- Disconnect the pipework on the suction side and pressure side of the pump.
- Remove securing hardware, from support feet to baseplate.
- Remove the hex nuts (3020) with spring washers (3015).
- Remove the end flange (2035) from the stator (3005).
- Remove the stator (3005).
- Remove the pump housing (2010) from drive stool (0085) or bearing housing (0005).

Reassemble in reverse order.

- Installing the stator (3005) will be easier when using glycerine as a lubricant.
- Ensure during refitting that gasket (8110) is in perfect condition and will seat properly.

Torque values for hex nuts (2030):

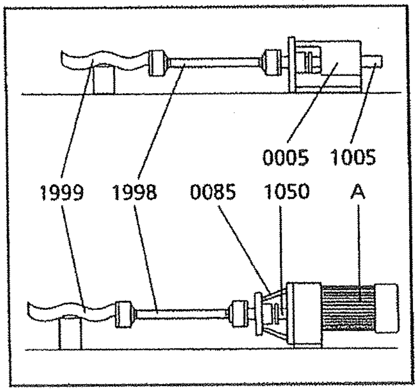
Size	M6	M8	M10	M12	M16	M20	M24	M30
Required torque in/lbs.	70	132	264	396	660	704	880	1056

10 Disassembly and Assembly of the Rotating Parts with Pin Joints with SM-Pin Joint Seal

10.1 Removal of Rotor and Coupling Rod

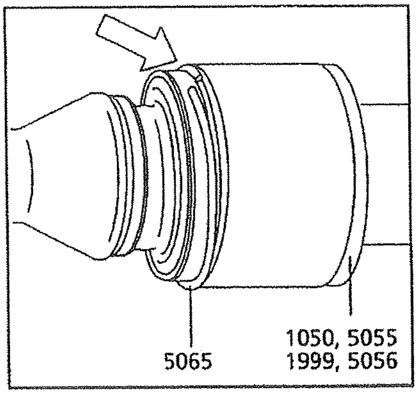
Where a pump is fitted with a ceramic rotor (1999) the following operations should be carried out with great care.
Do not use any force or sharp tools! Special care must be taken to prevent vibrations or impact by a hammer.

For removal of the rotor (1999) and coupling rod (1998) the pin joints should be dismantled as follows:



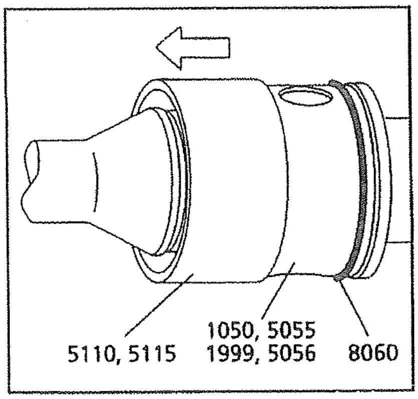
- Place the dismantled unit – consisting of bearing housing (0005) with drive shaft (1005) or drive stool (0085) with drive (A) and connecting shaft (1050), coupling rod (1998) and rotor (1999) – on the workbench with a wooden block supporting the rotor (1999).

- Push circlip (5065) out of its groove and slip off over the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056).



- **Pumps fitted with a ceramic rotor (1999):**
  Carefully turn safety sleeve (5110, 5115) with a squeeze belt wrench, and remove.
  The following method should **not** be employed for pumps fitted with a **ceramic** rotor.

  Pumps fitted with a metallic rotor (1999):
  If necessary hit the edge of sleeve (5110, 5115) at an angle with the help of a wooden block and a plastic hammer. Taking care not to damage the O-rings (8060)!

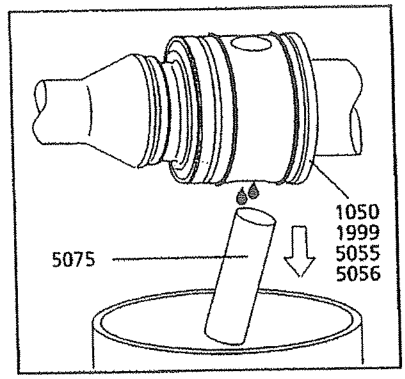


Continued on Section 10.0R

SECTION 10.0R

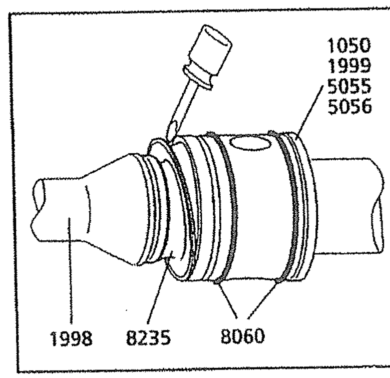
10 DISASSEMBLY AND ASSEMBLY OF THE ROTATING PARTS

- Press the pin (5075) out of the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056). If necessary use a hammer and a thin cylindrical pin (DIN 6450 C).
Drain the oil into a receptacle.



Use caution for pumps with ceramic rotors!

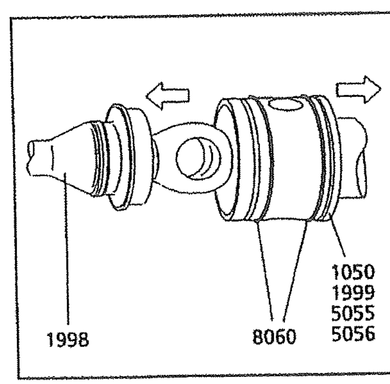
Where a pin (5075) may not come out easily, the metallic head of rotor (1999) should be supported on wooden blocks. Then the pin (5075) can be driven out with the help of a pin punch (DIN 6450 C). This should be done **with care**, holding the ceramic rotor with your hands.
Please dispose of this oil in the proper manner.



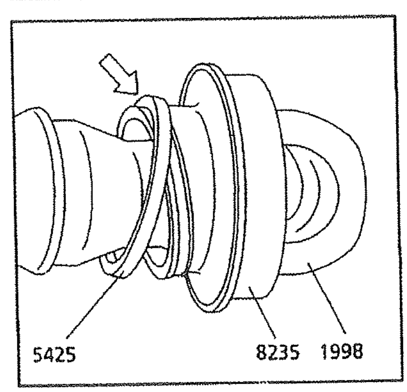
- Using a screwdriver, carefully remove the SM-pin joint seal (8235) from the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056).

Taking care not to damage the SM-pin joint seal (8235)!

- Pull apart the rotor (1999)/coupling rod (1998)/drive shaft (1005) or connecting shaft (1050) with adapter (5055, 5056) assembly. Remove the O-rings (8060).



- Push the SM-pin joint seal (8235) towards the head of coupling rod (1998). In the narrow coupling rod section press the clamp ring (5425) out of the groove of the seal. Then slip the SM-pin joint seal (8235) and clamp ring (5425) off over the head of the coupling rod (1998).



- Where an adapter (5055, 5056) is fitted:
See Page 10.3, Section 10.3:
Removal and Fitting of Adapters.

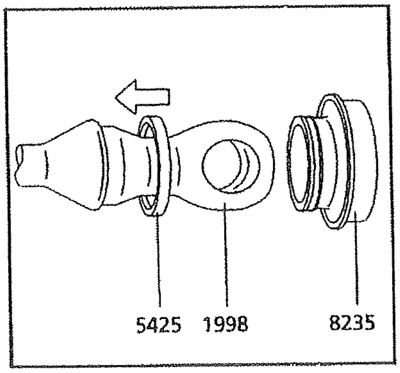
Continued on Section 10.1

10.2 Assembling the Rotor and Coupling Rod

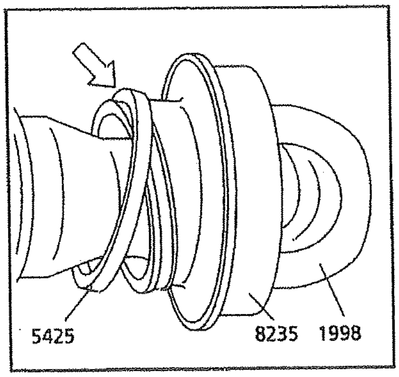
For fitting the rotor (1999) with coupling rod (1998), the two pin joints should be assembled as follows:

- If an adapter (5055, 5056) is installed: See Page 10.3, Section 10.3 – Fitting and Removal of Adapters.

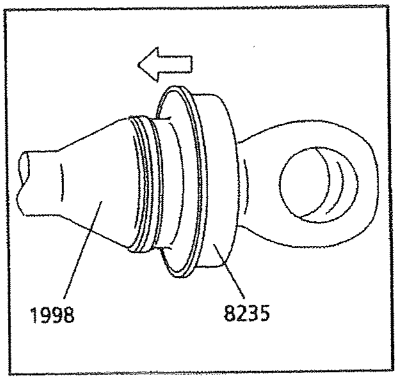
- Slip the clamp ring (5425) over the head of coupling rod (1998).



- Push the SM-pin joint seal (8235) over the head of coupling rod (1998) toward its narrow section, there squeezing the clamp ring (5425) into the groove of the SM-pin joint seal (8235).



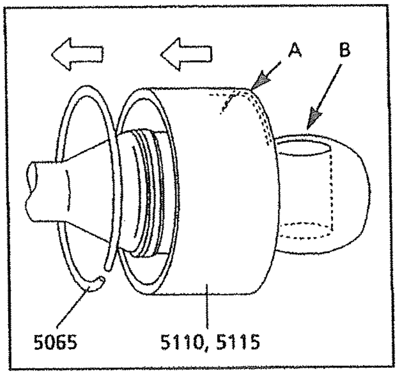
- Push the SM-pin joint seal (8235) with the correctly placed clamp ring (5425) up to the shoulder of coupling rod (1998).



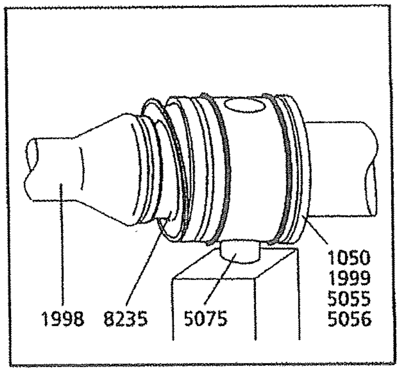
Continued on Section 10.1R

10 DISASSEMBLY AND ASSEMBLY OF THE ROTATING PARTS

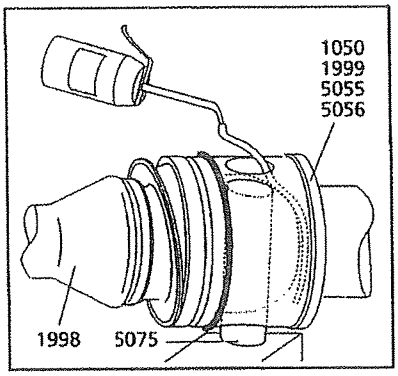
- Slip the circlip (5065) on to the coupling rod (1998). Slide the sleeve (5110) or (5115) on to coupling rod (1998) so the inside diameter of chamfering (A) is being placed towards the coupling rod (1998) extension. Chamfering (A) will later on ease the installation over the O-rings (8060).
  Orient the head of coupling rod (1998) until it is in vertical position for the bore (B) for the pin (5075).



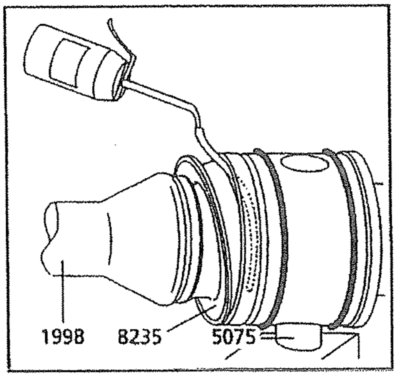
- Slide the coupling rod (1998) with SM-pin joint seal (8235) into the bore of rotor (1999), connecting shaft (1050) or adapter (5055, 5056) and insert the pin (5075) from below and push up to the upper edge of coupling rod (1998).
  Support the pin (5075) against dropping out.
  Slide the SM-pin joint seal (8235) into the rotor (1999), connecting shaft (1050)/ or adapter (5055, 5056) only from below, and in a slightly slanted position.



- For lubrication, use an oil can which should be fitted with a thin plastic hose having an outside diameter of not more than 4 mm.
  Insert this hose into the upper oil port opening in the rotor (1999), connecting shaft (1050) or adapter (5055, 5056). Then slide the hose end past the coupling rod (1998) all the way down to the bottom section of the rotor head (1999) or connecting shaft (1050) or adapter (5055, 5056).
  Slowly fill with lubricating oil up to the filling port.

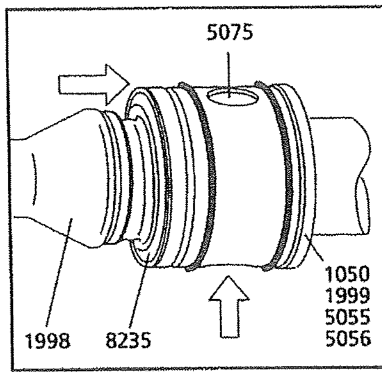


- Pull the hose out.
  Then insert the hose end through the small gap on the topside of Sm-pin joint seal (8235) and guide it down to the bottom of the hollow space between coupling rod (1998) and SM-pin joint seal (8235). Slowly fill with lubricating oil up to the gap.

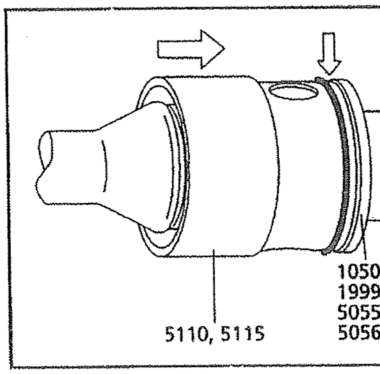


Continued on Section 10.2

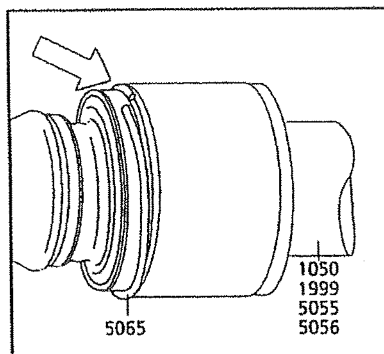
- Pull the hose out.
  Push the pin (5075) entirely into the bore of head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056) and retain in place.
  Only now, press the SM-pin joint seal (8235) into the bore of head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056) and push up to the shoulder. Wipe off excess oil. Use this oil for lubricating the O-rings (8060).



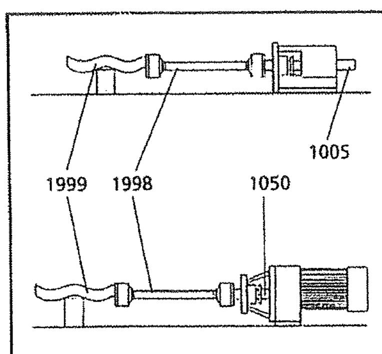
- Slip the sleeve (5110) or (5115), with its chamfering (A) forward, on to the head of rotor (1999), connecting shaft (1050) or adapter (5055, 5056) and push up to the shoulder.



- Place the circlip (5056) into its groove on the rotor head (1999), connecting shaft (1050) or adapter (5055, 5056) and carefully snap in place.



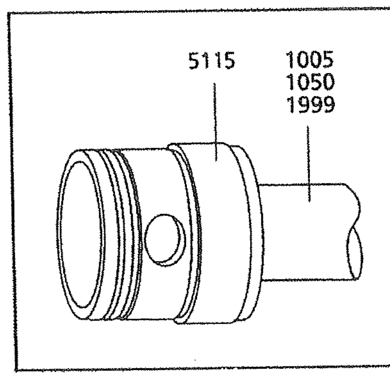
- Drive shaft (1005) or connecting shaft (1050) with adapter (5055, 5056), coupling rod (1998) and rotor (1999) are now joined by means of the two pin joints. Pump housing (2035), stator (3005) and end stud (2005) may now be fitted.



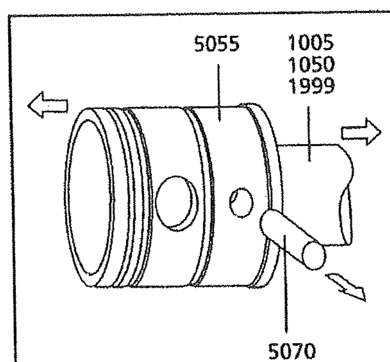
10.3 Disassembly and Reassembly of the Adapters

If a pump is fitted with adapters (5055) either on the drive shaft (1005) or connecting shaft (1050) and rotor (1999), these adapters should be removed as follows:

- Remove the second sleeve (5115) where this has not been taken off earlier when dismantling the joint.

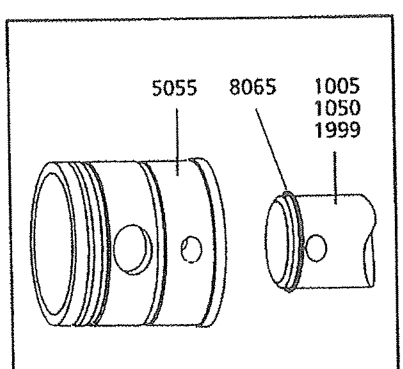


- Then drive the pin (5070) out of the adapter (5055).



- Now remove the adapter (5055) from drive shaft (1005) or connecting shaft (1050) and rotor (1999).

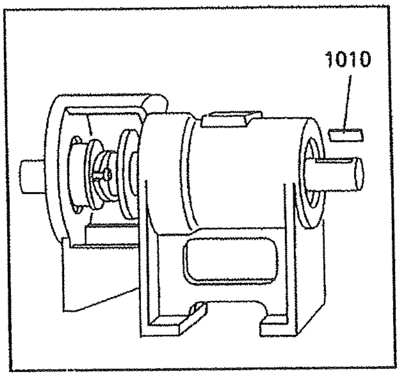
  Remove O-ring (8065).



11 Disassembly and Assembly of the Bearings

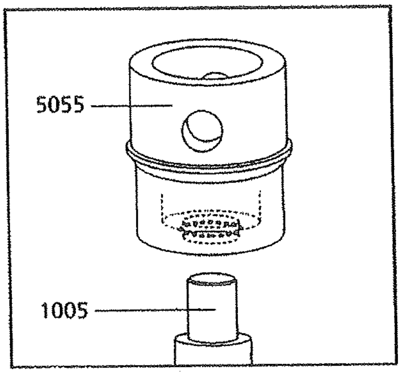
11.1 For drive shaft removal:

- Remove key (1010).

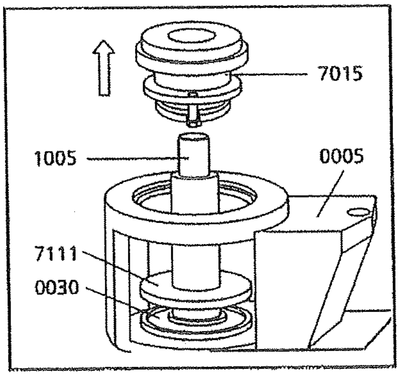


- If an adapter (5055) exists and had not yet been removed together with the joints:

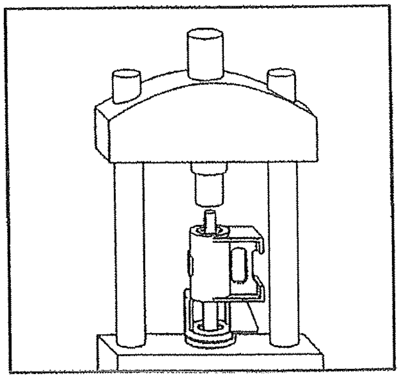
  Removal of the adapter according to
  - Page 10.3, Section 10.3 with pin joints.
  - Page 10.5, Section 10.6 with gear joints.



- Remove stuffing box housing (7015) from bearing housing (0005) and slip off from drive shaft (1005).
- For pumps equipped with a different type of shaft sealing, with for instance a mechanical seal, please follow the Instructions under Sections 7 and 12.
- Remove thrower (7111) from drive shaft (1005). Remove lip seal (0030) and substitute a new one every time during refitting.



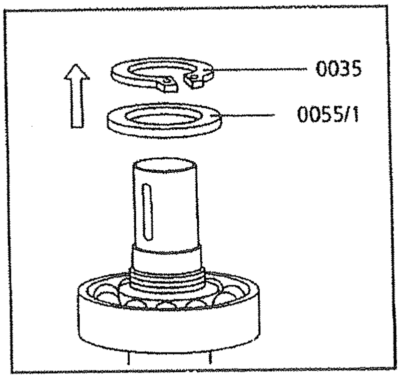
- Then, remove circlip (0135) as well as second spacer ring (0065/2).
- Press drive shaft (1005) with roller bearings (0020, 0110) out of bearing housing (0005) or apply a standard puller-device.
- Press lip seal (0041) out of bearing housing (0005) and substitute a new one every time during refitting.



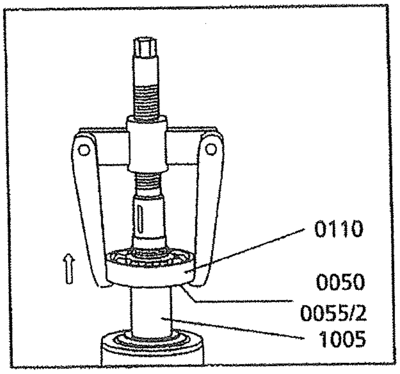
SECTION 11.0R	11 DISASSEMBLY AND ASSEMBLY OF THE BEARINGS

11.2 For removal of bearings from drive shaft:

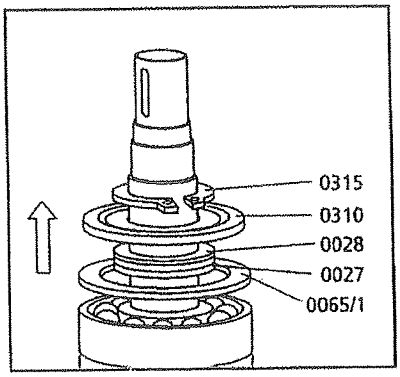
- Remove circlip (0035).
- Remove first spacer ring (0055/1).



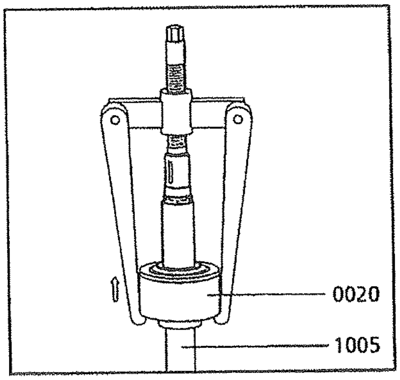
- Pull roller bearing (0110) off from drive shaft (1005).
- Remove grease retaining ring (0050) and second spacer ring (0055/2).



- Remove circlip (0315), grease retaining rings (0310) and also shim rings (0027) and (0028).
- Remove first spacer ring (0065/1).



- Pull roller bearing (0020) off from drive shaft (1005).



Continued on Section 11.1

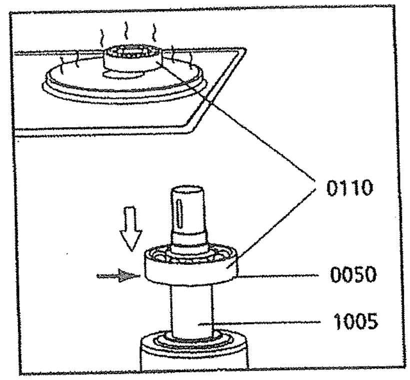
11 DISASSEMBLY AND ASSEMBLY OF THE BEARINGS

- Heat roller bearing (0110) up to about 100°C, e.g. on a cooktop.

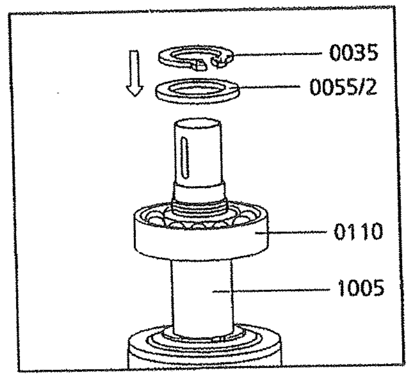
- Spread trade recommended "anti-stick paste" on drive shaft (1005) bearing seats to avoid frictional corrosion, also for easier demounting later on.

Please wear heat-proof gloves!

- Push roller bearing (0110) over drive shaft (1005) until it touches the grease retaining ring (0050).

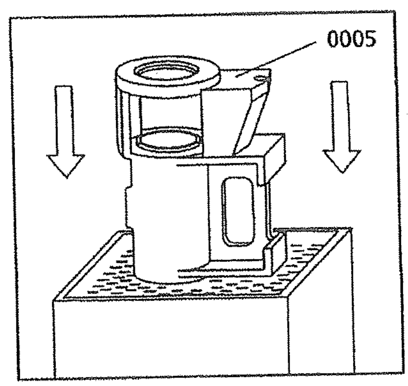


- Apply grease on roller bearing (0110). Fill all hollow spaces!
- Place second spacer ring (0055/2) until it touches the roller bearing (0110) on drive shaft (1005).
- Place circlip (0035) on drive shaft (1005) and push until it touches the second spacer ring (0055/2) on drive shaft (1005) and snap into its groove all around.
- Before fitting pre-assembled drive shaft (1005) into the bearing housing (0005), the shaft must be totally cooled.

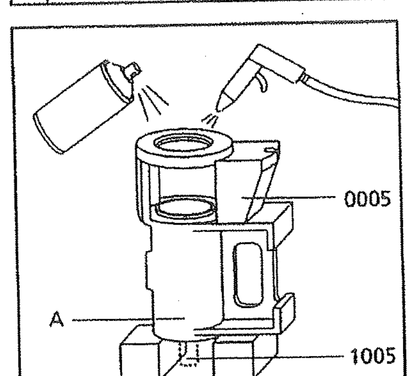


11.4 For fitting pre-assembled drive shaft into bearing housing:

- Spray anti-corrosion oil (as commercially available) on the inside of bearing housing (0005) and heat for instance in the waterbath to a temperature of 50 - 70°C.
Thoroughly prepare all subsequent activities and carry through without delay! The bearing housing (0005) should not cool off too much, otherwise the fitting of the bearings might become difficult! Please wear heat-proof gloves!

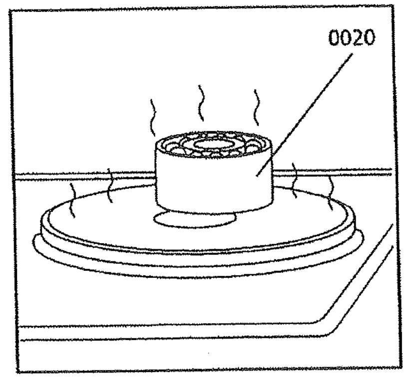


- With the drive side (A) at the bottom, place vertically and clamp bearing housing (0005) in a vice, or support it on wooden blocks. At the drive side (A) of bearing housing (0005), there should be ample space for the protruding end of drive shaft (0005) by means of compressed air and again treat inside with anti-corrosion oil.



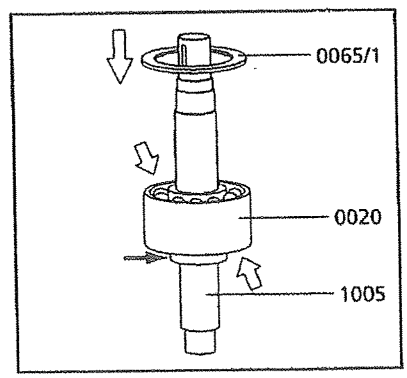
Continued on Section 11.2

11.3 For pre-assembly of drive shaft:

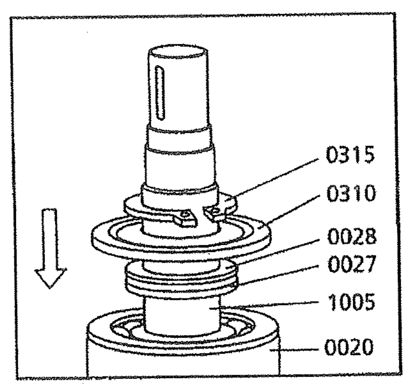


- Heat up roller bearing (0020) to about 100° C, e.g. on a cooktop.
- Spread trade recommended "anti-stick paste" on drive shaft (1005) bearing seats to avoid frictional corrosion, also for easier demounting later on.

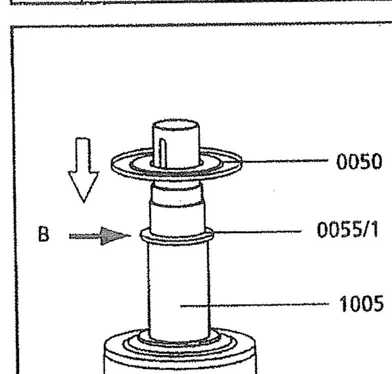
Please wear heat-proof gloves!



- Push roller bearing (0020) up to shoulder (A) on to drive shaft (1005).
- Apply grease on to both sides of roller bearing (0020). Fill all hollow spaces!
- From the drive side, slip first spacer ring (0065/1) over drive shaft (1005) and place on roller bearing (0020).



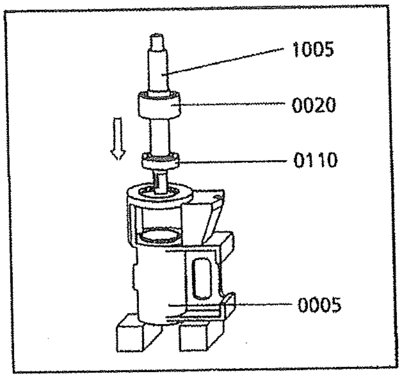
- Push shim rings (0027) and (0028), also grease retaining ring (0310), until they touch the inner raceway of the roller bearing (0020) on drive shaft (1005). Pay attention to correct orientation of grease retaining ring (0310).
- Push circlip (0315) until it touches the grease retaining ring (0310) on drive shaft (1005) and snap it into its groove all around.



- Slip first spacer ring (0055/1) over drive shaft (1005) until it touches the smaller shoulder (B).
- Slip grease retaining ring (0050) over drive shaft (1005) until it touches the first spacer ring (0055/1). Pay attention to its correct orientation. Please compare sectional drawing NM...!

Continued on Section 11.1R

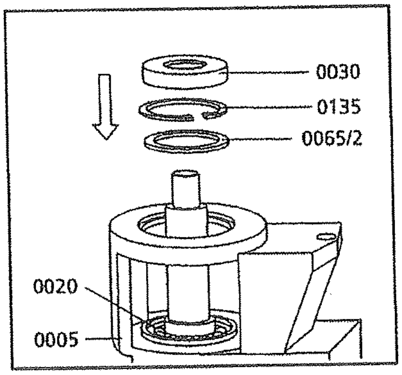
- Insert pre-assembled drive shaft (1005) with roller bearings (0020, 0110) from above into bearing housing (0005) until it touches the stop of roller bearing (0020) at first spacer ring (0065/1).
  Do not interrupt this "insertion" procedure!
  For bigger pumps (size NM 063...and larger) use a crane.



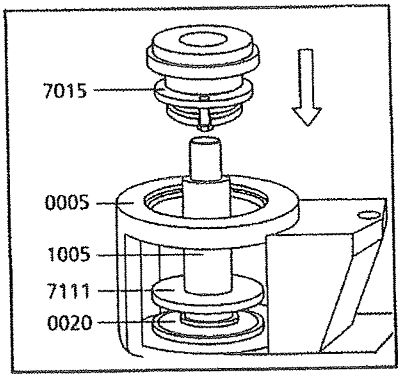
- Place second spacer ring (0065/2) on roller bearing (0020).

- Insert circlip (0135) into bearing housing (0005) and snap it into its groove all around.

- Insert a new lip seal (0030) into bearing housing (0005). Pay attention to correct orientation, The spiral ring must point to the inside of roller bearing (0020). Compare sectional drawing NM.....



- Push thrower (7111) on to drive shaft (1005) in a distance of about 5 to 10 mm to bearing housing (0005).
- Place pre-assembled stuffing box housing (7015) with inserted front/rear packing (7040, 7045) on to drive shaft (1005) and insert into bearing housing (0005).
  For pumps equipped with a different type of shaft sealing, with for instance a mechanical seal, please follow the Instructions under Sections 7 and 12.

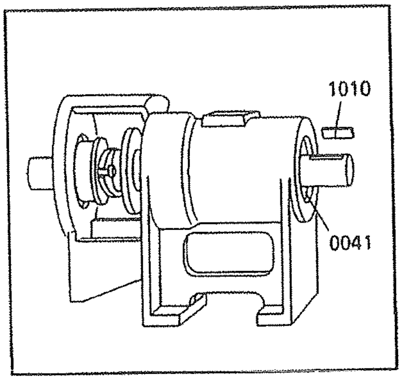


- Insert lip seal (0041) into bearing housing (0005).

- Take care of correct orientation. The spiral ring must point to the inside of roller bearing (0110). Compare section drawing NM...!

- Fit in key (1010).

- If an adapter (5055) exists:
  Fitting of the adapter according to
  - Page 10.3, Section 10.3 with pin joints.
  - Page 10.5, Section 10.6 with gear joints.



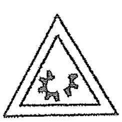
12 Removal and Installation of the Mechanical Seal

- **Carefully** slide out mechanical seal housing (7005) together with the parts of the mechanical seal contained in it from connecting shaft (1050) or drive shaft (1005).

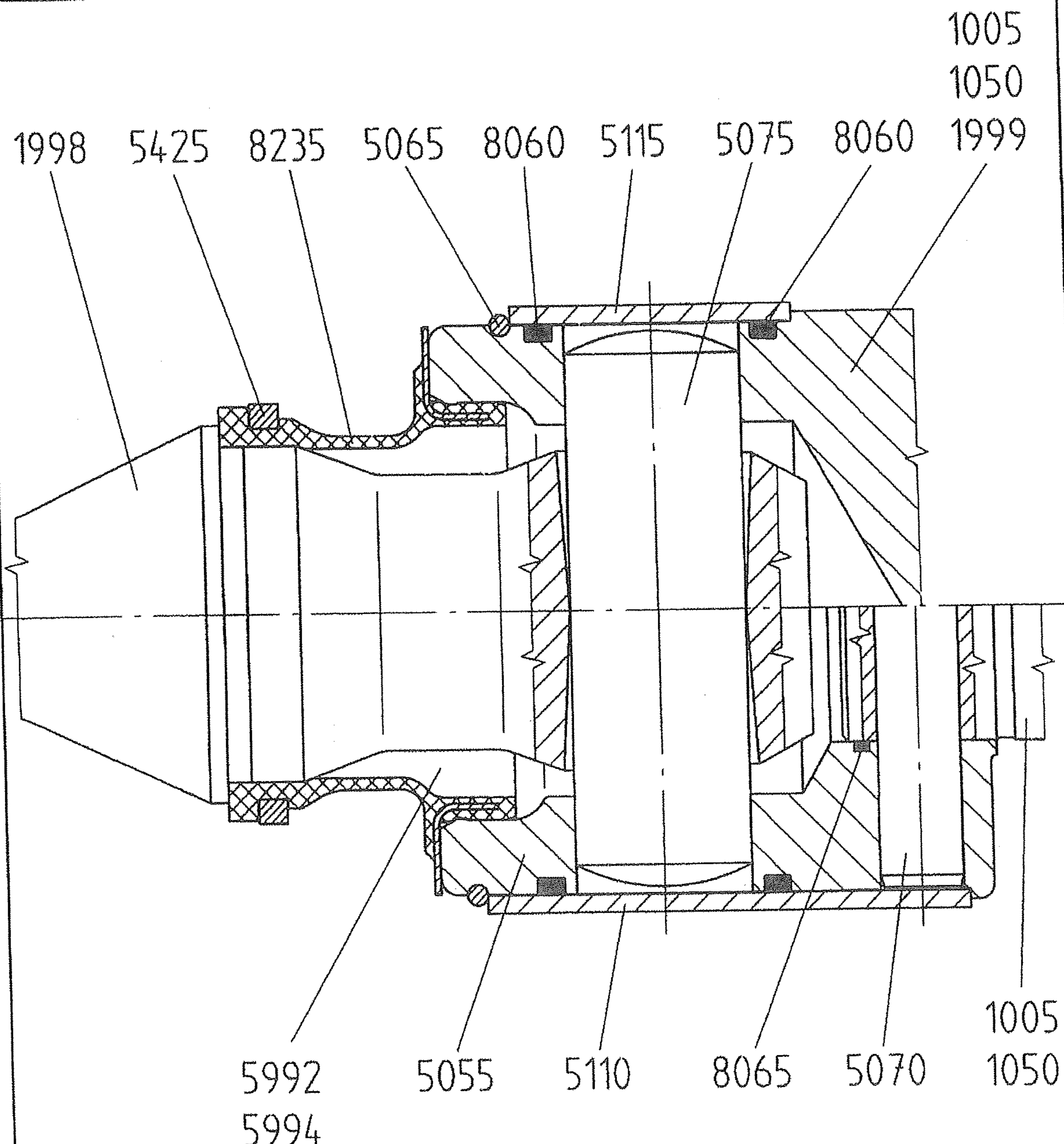
- **Carefully** push mechanical seal (7010) stationary seat out of mechanical seal housing (7005).

Refitting is a simple reversal of the above procedure.

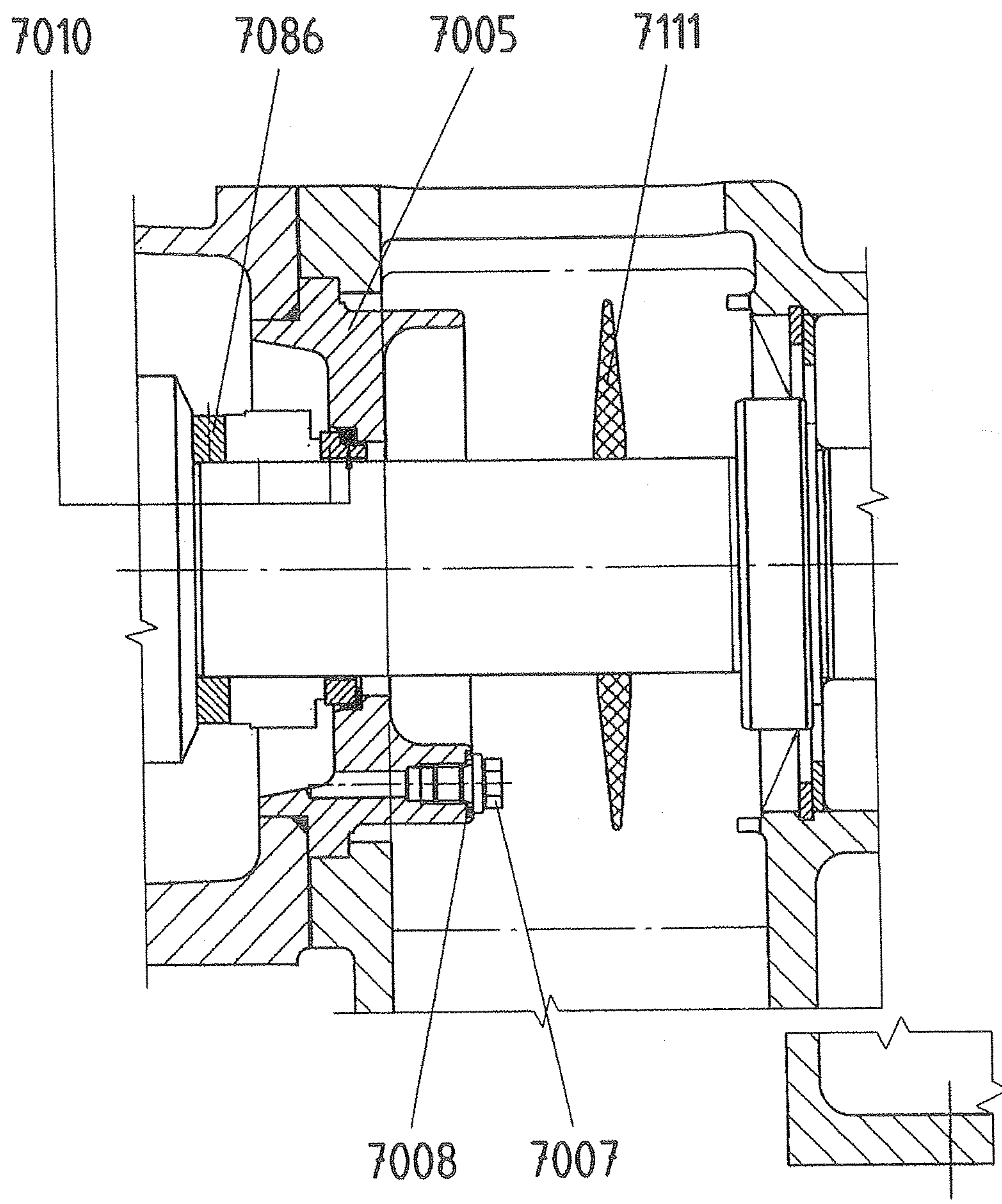
- To reduce frictional forces during seal assembly, apply some glycerine to the shaft and the seal housing in the area of the gaskets.



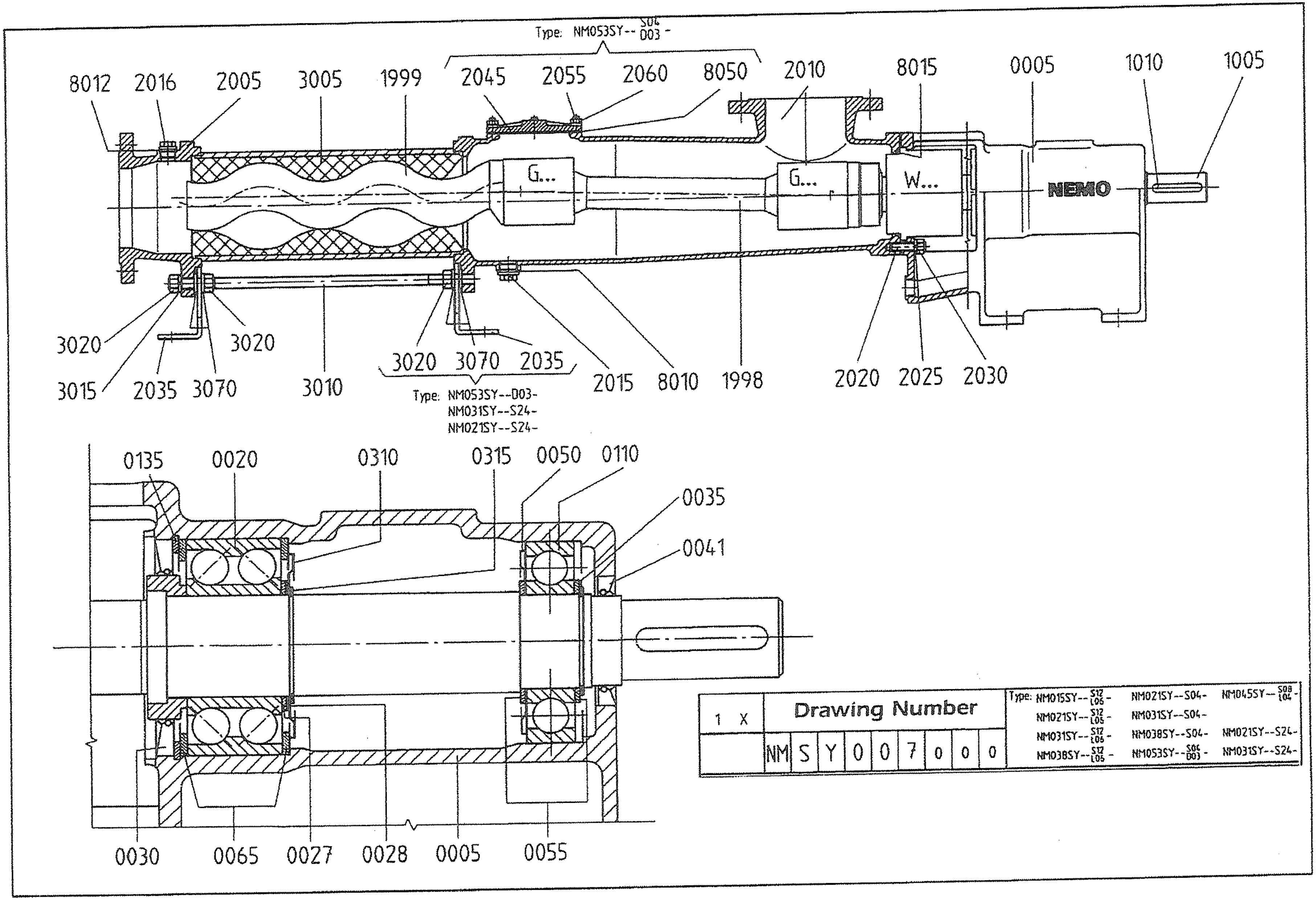
Ensure that the distribution of pressure is uniform when inserting the pressure sensitive counter rings. When inserting larger rings, use a suitable mandrel. Do not allow any foreign objects to get between the sliding surfaces.



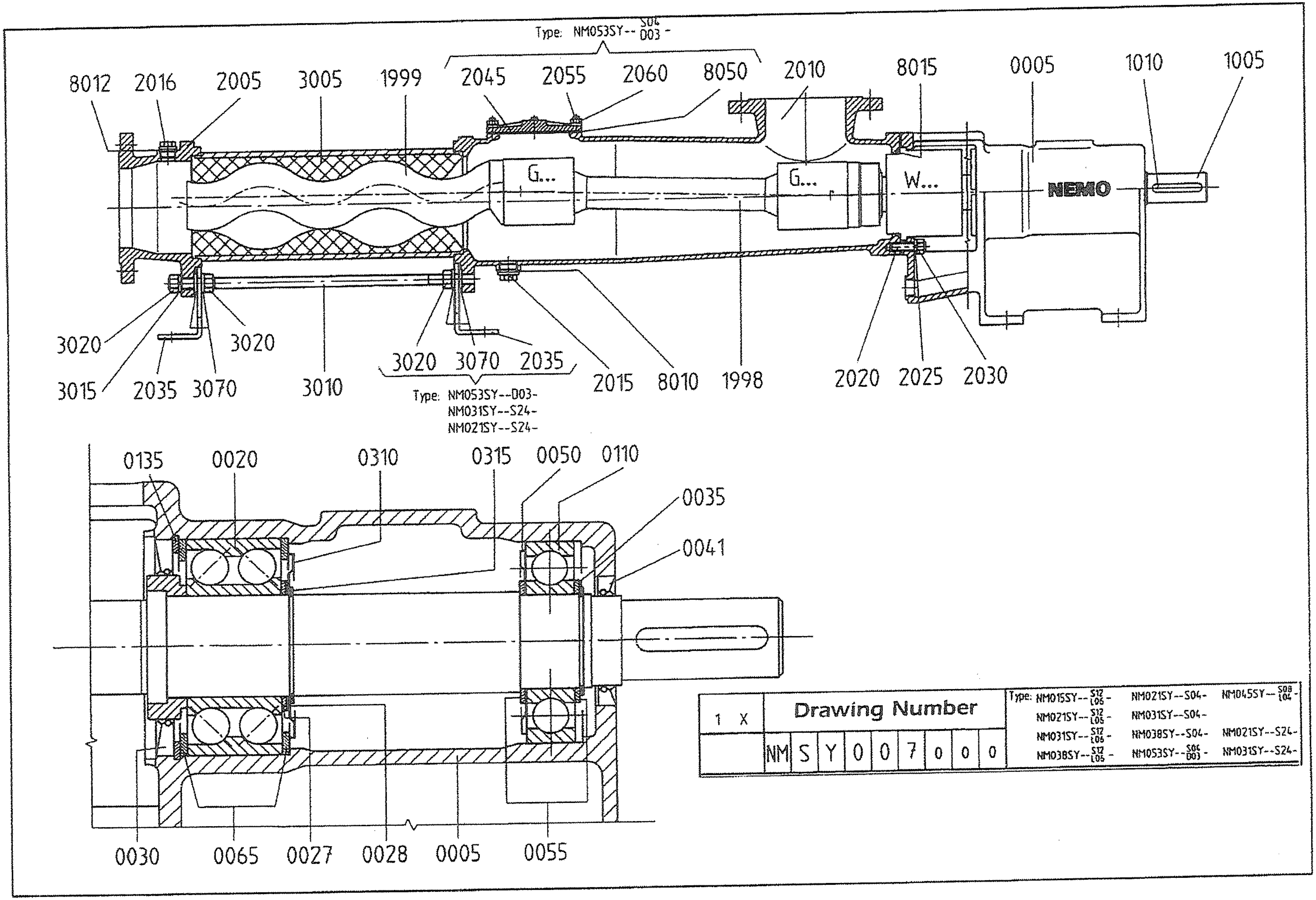
1 : x	Drawing Number	**Sealed Pin Joint**	Type: NM021 - NM053
	G 0 5 7 0 0 0		N...15 - N...100



1 : X	Drawing Number W 1 2 4 0 0 0	Mechanical Seal Burgmann Type MG1	Type: NM015S – NM105S



1 X	Drawing Number									Type:
	NM	S	Y	0	0	7	0	0	0	NM015SY-- S12/L06 - ; NM021SY-- S12/L06 - ; NM031SY-- S12/L06 - ; NM038SY-- S12/L06 - ; NM021SY--S04- ; NM031SY--S04- ; NM038SY--S04- ; NM053SY-- S06/D03 - ; NM045SY-- S08/L04 - ; NM021SY--S24- ; NM031SY--S24-


Type: NM053SY-- S04 D03 -
8012
2016
2005
3005
1999
2045
2055
2060
8050
2010
8015
0005
1010
1005
G...
G...
W...
NEMO
3020
3015
2035
3070
3020
3010
3020 3070 2035
Type: NM053SY--D03- NM031SY--S24- NM021SY--S24-
2015
8010
1998
2020
2025
2030
0135
0020
0310
0315
0050
0110
0035
0041
0030
0065
0027
0028
0005
0055
1 X
Drawing Number
NM S Y 0 0 7 0 0 0
Type: NM015SY-- S12 L05 - NM021SY--S04- NM045SY-- S08 L04 -
NM021SY-- S12 L05 - NM031SY--S04-
NM031SY-- S12 L05 - NM038SY--S04- NM021SY--S24-
NM038SY-- S12 L05 - NM053SY-- S06 D03 - NM031SY--S24-

14 Recommended Spare Parts

(Pump with pin joints with SM-seal)

In general, we have all spare parts subject to wear in stock. Our subsidiaries and exclusive representatives also hold a certain stock. We recommend to keep an amount of spare parts, corresponding to the pump, in stock on site as follows:

Pieces Large Set	Pieces Small Set	Position Number	Designation
1	1	3005	stator
2	2	8005*	gasket
1	1	8015	O-ring
1	–	1998	coupling rod
2	–	5075	pin
2	–	8235	SM-seal
4	–	8060	O-ring
1	–	8065	O-ring
2	–	5065	circlip
1	–	5110	sleeve
1	–	5115	sleeve
1	–	1999	rotor
2	–	5425	clamp ring

To ensure that you receive the part quickly, please provide the following information with your order. Also, please specify the model number of your pump.

Either: 1. a. Part number per the parts drawing
b. Job number (see pump nameplate)

or: 2. a. Part number per the parts drawing
b. Pump machine number. The machine number is stamped on both the pump nameplate and the bearing housing (0005) or drive stool (0085).

or: 3. Identification number of part (Note: The I.D. Number is a six digit number which describes the part, pump size, and materials of construction).

* This gasket is only used with rigid material stators (i.e. metal, PTFE, plastics)

NETZSCH Incorporated
119 Pickering Way ▪ Exton, PA 19341
610.363.8010 ▪ Fax: 610.363.0971
E-mail: nemopump@netzschusa.com
www.netzschusa.com

Material IM053SY01L07V-09D GG/4021/1045 VC E/P-SM
Document
Matchcode :

St	Item	Basic data text 1 / Basic data text 2 / Basic data text 3 / Basic data text 4	Quant	BUM	Material	Storage bin / Basic material / Document	Matchcode / Material type
1	0005	BRG HSG NM053S 0.6025	1.000	PC	892387	PR 22F BEARING HOUSIN 892863	KAUF F
1	0020	BEARING ANTIFRICTION 3309B-TVH-C3 D628	1.000	PC	691207-NEMO	6/097 ANTIFRICTION B	KAUF F
1	0027	DISK SPACER 45*55*2 D988	1.000	PC	691208-NEMO	3/206 DISK SPACER	KAUF F
1	0028	DISK SPACER 45*55*1.5 D988	1.000	PC	691209-NEMO	3/205 DISK SPACER	KAUF F
1	0030	GREASE SEAL AS 65*100*10 D3760 NBR	1.000	PC	691210-NEMO	6/364 GREASE SEAL	KAUF F
1	0035	BRG RTNR 40*1.75 D471	1.000	PC	512052	6/212 BEARING RETAIN	KAUF F
1	0041	GREASE SEAL AS 35*62*7 D3760	1.000	PC	677352	6/362 GREASE SEAL	KAUF F
1	0050	BRG COV NM045-02S 6308 AV N61100 ST	1.000	PC	514062	3/066A BEARING COVER	KAUF F
1	0055	BRG RTNR S40*50*2.5 D988	2.000	PC	512255	3/203 BEARING RETAIN	KAUF F
1	0065	SPACER BRG HSG RM26 S80*100 DIN 988	2.000	PC	512151	3/204 SPACER BEARING	KAUF F
1	0110	BEARING ANTIFRICTION 6308*C3 D625	1.000	PC	691212-NEMO	6/097 ANTIFRICTION B	KAUF F
1	0135	BRG RTNR 100*3 D472	1.000	PC	512098	3/204 BEARING RETAIN	KAUF F

Material IM053SY01L07V-09D GG/4021/1045 VC E/P-SM
Document
Matchcode :

St	Item	Basic data text 1 Basic data text 2 Basic data text 3 Basic data text 4	Quant	BUM	Material	Storage bin Basic material Document	Matchcode Material type
1	0310	RING RTNR GREASE 6309 JV N61150 ST	1.000	PC	686884	3/068 RING RETAINER	KAUF F
1	0315	BRG RTNR 45*1.75 D471	1.000	PC	512004	6/213 BEARING RETAIN	KAUF F
1	1005	SHAFT DRIVE NM053SY 1.4021 NON-PLTD	1.000	PC	157876	3/277 DRIVE SHAFT 157662	KAUF F
1	1010	KEY A10*8*63 D6885 ST	1.000	PC	470318	3/145 KEY	KAUF F
1	1998	CONN ROD NM053——14V P 1.4021	1.000	PC	NDB4825456	3/004 CONNECTING ROD NMP5025672	KAUF F
1	1999	ROTOR NM053-1L07 P 1045 VCP	1.000	PC	NDB4958699	PR 2H ROTOR	KAUF F
1	2005	DISCH CSTG NM053-14 0.6025 3"-125# ANSI	1.000	PC	NMP5024905	PR 21F END FLANGE	KAUF F
1	2010	SUCT HSG NM053-14 0.6025 4"-125# ANSI	1.000	PC	NMP5024884	SUCTION HOUSIN NMP5024884	KAUF F
1	2015	PLUG DRAIN 0.75Z NPT ANSI SEE 649103	3.000	PC	594982	6/024 DRAIN PLUG SEE	KAUF F
1	2016	PLUG DRAIN .50NPT ANSI COUNTERSUNK	1.000	PC	595218	3/151L	B2.1 5.8 KAUF F
1	2020	STUD M12*35 D939	4.000	PC	518652	3/153 STUD	KAUF F
1	2025	WASHER LOCK A12MM D127 A4 S/S 502016	4.000	PC	502200	6/034 WASHER LOCK	KAUF F

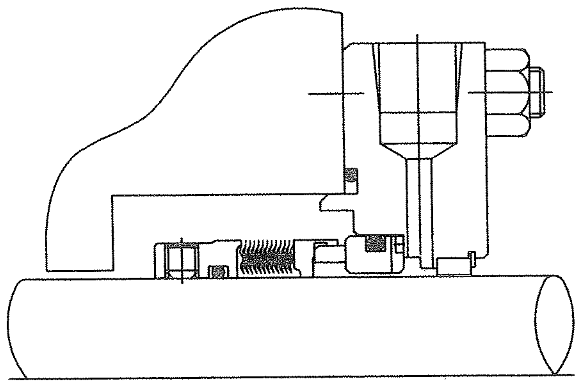
Material NM053SY01L07V-09D GG/4021/1045 VC E/P-SM
Document
Matchcode :

St	Item	Basic data text 1 Basic data text 2 Basic data text 3 Basic data text 4	Quant	BUM	Material	Storage bin Basic material Document	Matchcode Material type
1	2030	NUT HEX M12 D934 A4-70	4.000	PC	501062	3/151C NUT	KAUF F
1	2035	SUCT HSG SPRT NM053-12 ST	1.000	PC	892747	3/331 SUCTION HOUSIN	KAUF F
1	2045	C.O. PORT COVERS NM038-105 GG25	2.000	PC	886966	PR 1F CLEAN OUT PORT 886966	KAUF F
1	2055	STUD M10*25 DIN 939 STL BLK	12.000	PC	508100	3/387 STUD	KAUF F
1	2060	NUT HEX M10 D937 1.4571	12.000	PC	501061	3/151C NUT	M10 D934 1.4571 KAUF F
1	3005	STATOR NM053-01L SBE/ST SEE 958842	1.000	PC	NDB4955093	PR 14FL&R STATOR SEE 958	KAUF F
1	3010	THRU BOLT NM053-04 ST M12*653 STEEL	4.000	PC	NDB4955120	3/339 THRU BOLT	M12*653 KAUF F
1	3015	WASHER LOCK A12MM D127 A4 S/S 502016	4.000	PC	502200	6/034 WASHER LOCK	KAUF F
1	3020	NUT HEX M12 D934 A4-70	6.000	PC	501062	3/151C NUT	KAUF F
1	3070	DISK/WASHER A13 D125 A4	1.000	PC	502151	3/152 DISK/WASHER	KAUF F
1	5055	ADAPTER NM053B P 1.4021 SUB 892379	1.000	PC	NDB4825455	3/161 ADAPTER SUB 89 892379	KAUF F
1	5065	RING RTNR 1.4401 NL40	2.000	PC	512279	6/214 RING RETAINER 850150/A	KAUF F

Material M053SY01L07V-09D GG/4021/1045 VC E/P-SM
Document
Matchcode :

St	Item	Basic data text 1 Basic data text 2 Basic data text 3 Basic data text 4	Quant	BUM	Material	Storage bin Basic material Document	Matchcode Material type
1	5070	CONN ROD PIN B12.0H8*65 1.4571	1.000	PC	678958	3/139 CONNECTING ROD	KAUF F
1	5075	CONN ROD PIN NM053 1.4320 WN 0140F1	2.000	PC	NDB4825299	3/140 CONNECTING ROD	KAUF F
1	5110	PIN RTNR 1.4571 76*71*72 NM053,063-B	1.000	PC	892841	3/095 PIN RETAINER	KAUF F
1	5115	PIN RTNR 1.4571 NL40A	1.000	PC	862347	3/095 PIN RETAINER 862347/A	KAUF F
1	5425	RING CLAMPING NE40A 1.4571	2.000	PC	877421	3/074 CLAMPING RING	KAUF F
1	5435	BUSHING WEAR WN0142 F1 AISI D6 NM053	2.000	PC	NDB4825305	3/382 BUSHING WEAR	KAUF F
1	5440	BUSHING WEAR WN0141 F1 AISI D6 NM053	4.000	PC	NDB4825302	3/382 BUSHING WEAR	KAUF F
1	8015	O-RING 100*3 NB70 D3770 100X03 NB70 D3770	1.000	PC	516041	6/191 O-RING D3770	100X03 KAUF F
1	8050	GASKET NM038-105 PERBUNAN	2.000	PC	886976	6/220 GASKET 886976	KAUF F
1	8060	O-RING 65*3.5 NBR D3770	4.000	PC	517020	6/206 O-RING D3770	065X03.5 KAUF F
1	8065	O-RING 32*3 NBR70 D3770 032X03 NBR70 D3770	1.000	PC	591718	6/188 O-RING D3770	032X03 KAUF F
1	8235	PIN JOINT SM SEAL NM053/NL40A 1.4401/VI	2.000	PC	879897	6/352 SM-PIN JOINT S	KAUF F

Type 670/680/ECS™
(Emission Containment Seal)
Sealol® Metal Bellows Seal
Installation Instructions



Foreword

These instructions are provided to familiarize the user with the seal and its designated use. The instructions must be read and applied whenever work is done on the seal, and must be kept available for future reference.

ATTENTION These instructions are for the installation and operation of a seal as used in rotating equipment and will help to avoid danger and increase reliability. The information required may change with other types of equipment or installation arrangements. These instructions must be read in conjunction with the instruction manuals for both the pump and any ancillary equipment.

If the seal is to be used for an application other than that originally intended or outside the recommended performance limits, John Crane must be contacted before its installation and use.

Any warranty may be affected by improper handling, installation, or use of this seal. Contact the Company for information as to exclusive product warranty and limitations of liability.

If questions or problems arise, contact your local John Crane Sales/Service Engineer or the original equipment manufacturer, as appropriate.

ATTENTION John Crane mechanical seals are precision products and must be handled appropriately. Take particular care to avoid damage to lapped sealing faces and to flexible sealing rings. Do not excessively compress the seal before or during installation.

Safety Instructions

1. The following designations are used in the installation instructions to highlight instructions of particular importance.

   NOTE: Refers to special information on how to install or operate the seal most efficiently.

   ATTENTION Refers to special information or instructions directed towards the prevention of damage to the seal or its surroundings.

   ⚠ Refers to mandatory instructions designed to prevent personal injury or extensive damage to the seal or its surroundings.

2. Installation, removal and maintenance of the seal must be carried out only by qualified personnel who have read and understood these installation instructions.
3. The seal is designed exclusively for sealing rotating shafts. The manufacturer cannot be held liable for use of the seal for purposes other than this.
4. The seal must only be used in technically perfect condition, and must be operated within the recommended performance limits in accordance with its designated use set out in these installation instructions.
5. If the pumped fluid is hazardous or toxic, appropriate precautions must be taken to ensure that any seal leakage is adequately contained. Further information on sealing hazardous or toxic fluids should be obtained from John Crane prior to seal installation.
6. Fluorocarbon components should never be burned or incinerated as the fumes and residues are highly toxic. If fluorocarbons are accidentally heated above 400°C/750°F, they can decompose. Therefore, protective gloves should be worn as hydrofluoric acid may be present.
7. PTFE components should never be burned or incinerated as the fumes are highly toxic.

Before Starting the Equipment

1. Check the pump at the coupling for proper alignment of the driver or motor.
2. Ensure that the gland plate nuts/bolts are securely tightened according to the pump manual instructions, and that all screws are securely fastened.
3. Complete the assembly of the pump, and turn the shaft (by hand if possible) to ensure free rotation.
4. Consult all available equipment operating instructions to check for correctness of all piping and connections, particularly regarding seal recirculation/flush, heating or cooling requirements, and services external to the seal.

   ATTENTION This mechanical seal is designed to operate in a liquid so the heat energy it creates is adequately removed. Therefore, the following check should be carried out not only after seal installation, but also after any period of equipment inactivity.

5. Check that the seal chamber fluid lines are open and free of any obstruction, and ensure that the seal chamber is properly vented and filled with liquid - refer to the pump instruction manual.

ATTENTION Dry-running - often indicated by a squealing noise from the seal area - will cause overheating and scoring or other damage to the sealing surfaces, resulting in excessive leakage or a much shortened seal life.

⚠ **Before start-up, ensure that all personnel and assembly equipment have been moved to a safe distance so there is no contact with rotating parts on the pump, seal, coupling, or motor.**

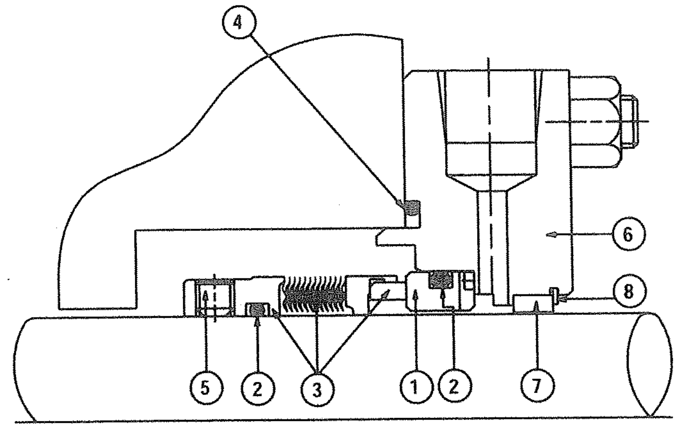
WARNING: **Seal installation should be handled only by qualified personnel. If questions arise, contact the local John Crane Sales/Service Engineer. Improper use and/or installation of this product could result in injury to the person and/or harmful emissions to the environment, and may affect any warranty on the product. Please contact the company for information as to exclusive product warranty and limitations of liability.**

General Instructions

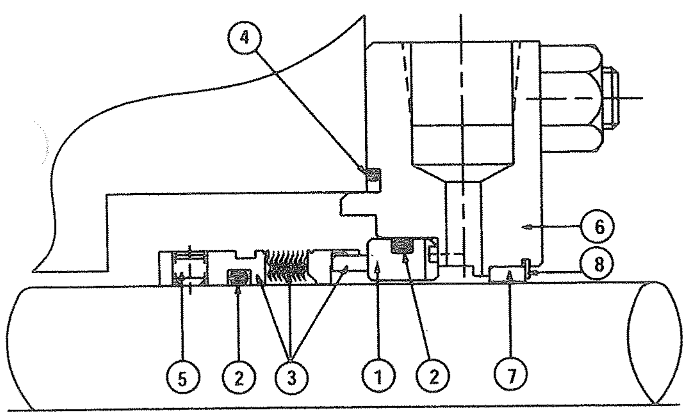
1. Study the Engineering layout drawing to confirm the proper seal arrangement for the pump being used.
2. To assure satisfactory operation, handle seal with care. Take particular caution to see that the lapped sealing faces are not scratched or marred.

Part Name	
1 Mating Ring	9 Spacer Ring
2 O-Ring	10 Wave Spring
3 Rotary Seal Assembly	11 Compression Ring
4 O-Ring or Gasket	12 Bellows Assembly
5 Set Screws	13 Insert
6 Gland Plate Assembly	14 ECS Housing
7 Bushing	15 Metal Damper
8 Retaining Ring	16 Spacer

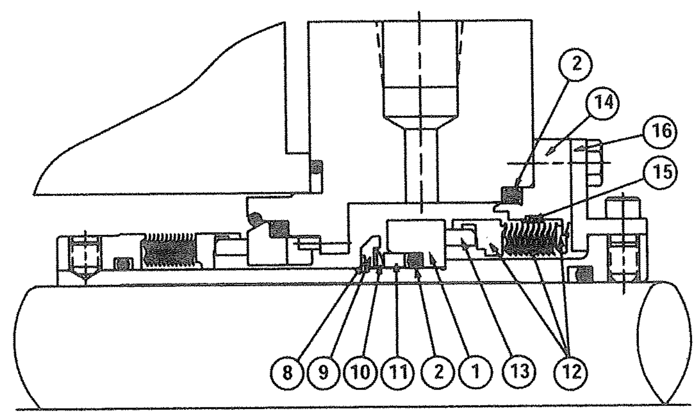
Typical Type 670 Seal Arrangement



Typical Type 680 Seal Arrangement

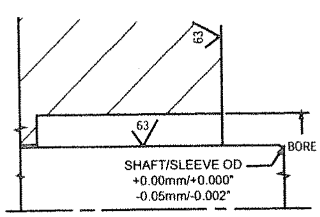


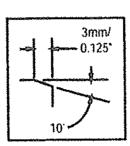
Typical Type 670/ECS Seal Arrangement



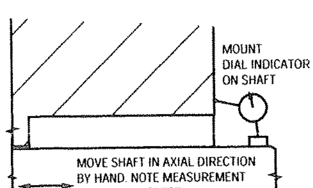
Preparing the Equipment

1. Check seal chamber dimensions and finishes.

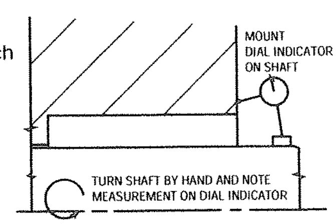




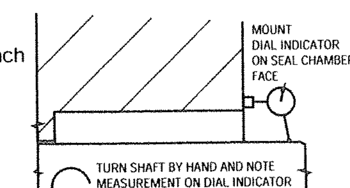
2. Measure axial end play (0.13mm/0.005" FIM max.).



3. Determine squareness of seal chamber face to shaft (0.001mm per mm/0.001"per inch of shaft diameter FIM max.), and shaft concentricity to the seal chamber.



4. Measure shaft runout (0.001mm per mm/0.001"per inch of shaft diameter FIM max.).



NOTE: If measured dimensions exceed those values given, correct the equipment to meet specifications prior to seal installation.

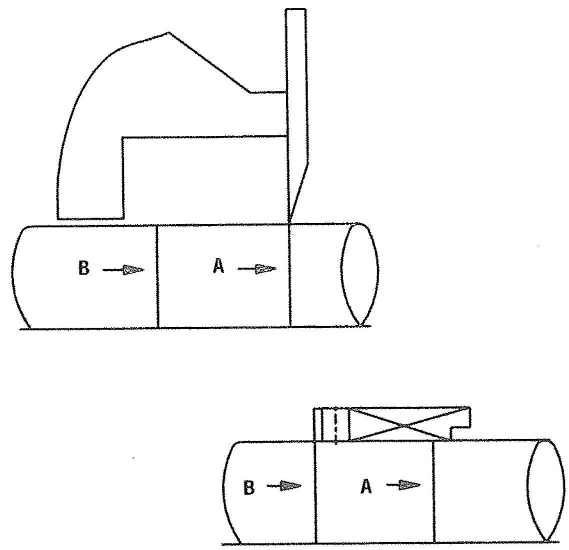
Component Seals

Setting the Seal

1. [illegible]h the seal chamber and shaft/sleeve in their correct operating [illegible]sitions, use a straight edge to scribe the position of the seal chamber [illegible]ace onto the shaft/sleeve at A. Use machinist's blue to make the scribe easier to see.

2. Again remove the pump housing. From the installation drawing, determine the distance from the seal chamber face to the seal set length, and scribe line B onto the shaft sleeve at this distance.

3. Without disturbing the scribe line B, wipe the shaft/sleeve clean and apply a lubricant which is compatible with the sealed fluid and the gasketing materials.



Type 670/680 Dimensional Data (metric)

Sealol Dash No.	Shaft Size A	B	C	D	E	F	Set Screw Size/Qty	
670/680	670/680	670/680	670/680	670/680	670/680	670/680	670	680
-024	24	38.10	29.79	34.93	4.5	30.00	M5 x 3	M5 x 3
-025	25	39.00	30.50	35.68	4.5	30.00	M5 x 3	M5 x 3
-028	28	42.00	33.50	38.68	5.5	·32.50	M5 x 3	M5 x 3
-030	30	44.00	35.50	40.68	5.1	32.50	M5 x 3	M5 x 3
-032	32	46.02	38.51	43.66	5.1	32.50	M5 x 3	M5 x 3
[illegible]	33	47.00	38.20	44.63	4.5	32.50	M5 x 3	M5 x 3
[illegible]	35	49.20	41.68	46.86	4.5	32.50	M5 x 3	M5 x 3
[illegible]	38	52.37	43.59	50.04	5.2	34.00	M6 x 3	M6 x 3
[illegible]	40	55.55	46.76	53.21	5.2	34.00	M6 x 3	M6 x 3
-043	43	58.72	49.94	56.39	5.2	34.00	M6 x 3	M6 x 3
-045	45	58.72	49.94	56.39	5.2	34.00	M6 x 3	M6 x 3
-048	48	61.90	53.09	59.56	5.0	34.00	M6 x 3	M6 x 3
-050	50	65.07	56.29	62.76	5.2	34.50	M6 x 3	M6 x 3
-053	53	68.25	59.44	65.91	5.2	34.50	M6 x 3	M6 x 3
-055	55	71.00	62.00	68.45	4.6	34.50	M6 x 3	M6 x 3
-058	58	74.60	65.79	72.29	6.6	39.50	M6 x 3	M8 x 3
-060	60	74.60	65.79	72.29	6.6	39.50	M6 x 3	M8 x 3
-063	63	80.95	70.87	78.64	6.6	39.50	M6 x 3	M8 x 3
-065	65	84.12	74.04	81.81	6.0	39.50	M6 x 3	M8 x 3
-068*	68	87.30	77.22	85.01	5.1	37.50	--	M8 x 3
-070	70	87.30	77.22	85.01	8.2	45.00	M6 x 3	M8 x 3
-075	75	95.25	84.38	92.13	7.8	45.00	M6 x 3	M8 x 3
-080	80	98.43	87.30	95.81	6.7	44.50	M6 x 4	M8 x 3
-085	85	104.78	93.65	102.16	6.7	44.50	M6 x 4	M8 x 3
-090	90	107.95	96.82	105.33	9.0	49.50	M6 x 4	M8 x 3
-095	95	114.30	103.17	111.68	9.0	49.50	M6 x 4	M8 x 3
-100	100	120.65	109.52	118.03	9.0	49.50	M6 x 4	M8 x 3

(Dimensional data in millimeters)

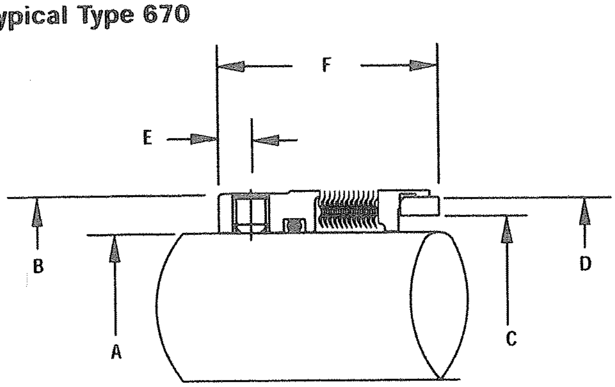
*670 is not available in 68mm size

Type 670/680 Dimensional Data (inch)

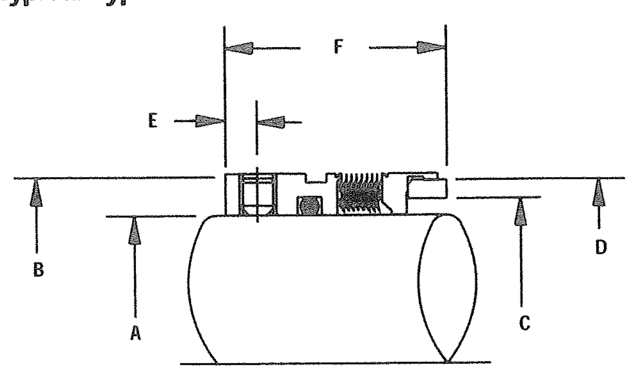
Sealol Dash No.	Shaft Size A	B	C	D	E	F	Set Screw Size/Qty
670/680	670/680	670/680	670/680	670/680	670/680	670/680	670/680
-16	1.000	1.562	1.235	1.439	0.17	1.250	#10-24 x 3
-18	1.125	1.687	1.362	1.566	0.17	1.250	#10-24 x 3
-20	1.250	1.812	1.516	1.720	0.17	1.312	#10-24 x 3
-22	1.375	1.937	1.641	1.846	0.20	1.437	1/4-20 x 3
-24	1.500	2.062	1.716	1.971	0.20	1.437	1/4-20 x 3
-26	1.625	2.187	1.841	2.096	0.20	1.437	1/4-20 x 3
-28	1.750	2.312	1.966	2.221	0.20	1.437	1/4-20 x 3
-30	1.875	2.437	2.090	2.346	0.22	1.500	1/4-20 x 3
-32	2.000	2.562	2.216	2.472	0.22	1.500	1/4-20 x 3
-34	2.125	2.687	2.340	2.597	0.22	1.500	1/4-20 x 3
-36	2.250	2.812	2.466	2.723	0.22	1.562	1/4-20 x 3
-38	2.375	2.937	2.590	2.848	0.22	1.562	1/4-20 x 3
-40	2.500	3.187	2.790	3.098	0.22	1.562	1/4-20 x 3
-42	2.625	3.312	2.915	3.223	0.22	1.625	1/4-20 x 3
-44	2.750	3.437	3.040	3.349	0.22	1.625	1/4-20 x 3
-46	2.875	3.625	3.196	3.504	0.22	1.687	1/4-20 x 3
-48	3.000	3.750	3.322	3.629	0.22	1.687	1/4-20 x 3
-50	3.125	3.875	3.437	3.774	0.22	1.750	1/4-20 x 3
-52	3.250	4.000	3.562	3.899	0.22	1.750	1/4-20 x 3
-54	3.375	4.125	3.687	4.024	0.22	1.750	1/4-20 x 3
-56	3.500	4.250	3.812	4.149	0.22	1.875	1/4-20 x 3
-58	3.625	4.375	3.937	4.274	0.22	1.875	1/4-20 x 3
-60	3.750	4.500	4.062	4.399	0.22	1.875	1/4-20 x 3
-62	3.875	4.625	4.187	4.524	0.22	1.875	1/4-20 x 3
-64	4.000	4.750	4.312	4.649	0.22	1.875	1/4-20 x 3

(Dimensional data in inches)

Typical Type 670

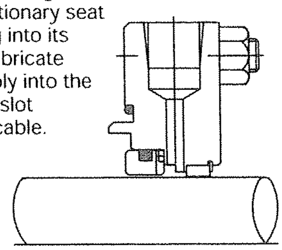


Typical Type 680

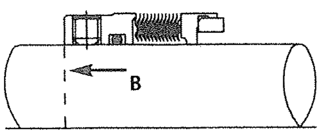


Installing The Seal

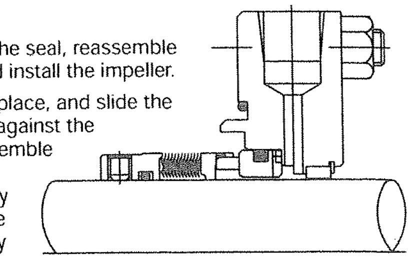
1. Unwrap the mechanical seal components, taking care not to scratch or damage the seal faces. (If a block style stationary seat is supplied, first install the stationary o-ring into its groove in the gland counterbore.) Lightly lubricate the stationary o-ring and press the assembly into the gland plate counterbore, ensuring that the slot engages the drive pin in the gland, if applicable. Carefully slide the complete gland assembly, including the gland gasket, onto the shaft as far away as possible from the seal chamber.



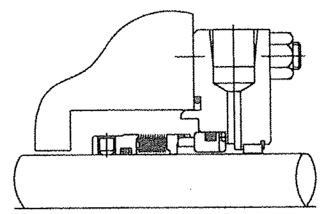
2. Lightly lubricate the o-ring and slide the rotating assembly onto the shaft/sleeve, being careful not to damage the o-ring. Referring to the assembly drawing, the back of the rotary seal assembly with scribe line B, and tighten the set screws evenly. (Once tightened, set screws should not be re-used. If you must loosen the set screws for any reason, replace them before repeating step 2.)



3. Being careful not to damage the seal, reassemble the seal chamber housing and install the impeller. Ensure the gland gasket is in place, and slide the gland assembly into position against the face of the seal chamber. Assemble the gland bolts finger tight. Continue tightening alternately until secure. Do not distort the gland by overtightening. Verify the gland is concentric with the shaft sleeve to prevent possible damage due to rubbing.



4. Complete reassembly of the pump, frequently turning the shaft by hand to check for free rotation.



If the shaft will not turn, seal has been improperly set.

ATTENTION

Refer to assembly drawing and/or pump manual for piping connections and coupling alignment. Proceed as indicated.

Cartridge Seals and ECS™

Installing the Seal in an Overhung Pump

1. Disassemble the seal chamber housing. Wipe the shaft/sleeve clean and apply a lubricant which is compatible with the sealed fluid and the gasketing materials. Take the complete cartridge assembly from its package. Do not disassemble or alter the unit.
2. Slide the complete cartridge assembly as far as possible onto the shaft/sleeve, towards the bearings. Be careful not to damage the o-ring inside the cartridge sleeve.

   Reassemble the seal chamber housing and the impeller. Complete all required axial adjustments to the pump rotating assembly.
3. With the gland gasket in place, slide the complete assembly into position against the face of the seal chamber. Assemble the gland bolts finger tight. Continue tightening alternately until secure. Do not distort the gland by overtightening.
4. Leave the eccentric washers or shipping clips in place to maintain the setting position of the cartridge seal.
5. If the assembly drawing calls for holes or countersinks to be drilled under the cartridge sleeve set screws, remove the set screws and mark their location. Unbolt the cartridge gland, remove the impeller, seal chamber housing, and cartridge assembly. Drill the shaft/sleeves in the positions marked. Repeat steps 1-4.
6. Tighten the cartridge sleeve set screws evenly. (If the shaft/sleeve has been drilled, ensure that the set screws align with the appropriate drilled holes.)
7. Remove the shipping clips, or rotate the eccentric washers 180° to clear the slot in the cartridge sleeve.
8. Complete reassembly of the pump, frequently turning the shaft by hand to check for free rotation, if the shaft will not turn, the seal has been improperly set.

ATTENTION

Refer to assembly drawing and/or pump manual for piping connections and coupling alignment. Proceed as indicated.

Installing the Seal Between Bearings

1. Disassemble the bearings and bearing housings. Wipe the shaft/sleeve clean and apply a lubricant which is compatible with the sealed fluid and the gasketing materials. Take both complete cartridges from their packages. Do not disassemble or alter the units.
2. Slide the complete cartridge assemblies onto the shaft/sleeves, being careful not to damage the o-rings inside the cartridge sleeves.

   Reassemble the bearing housings and bearings, and complete all required axial adjustments to the pump rotating assembly.
3. With the gland gasket in place, slide the complete assembly into position against the face of the seal chamber. Assemble the gland bolts finger tight. Continue tightening alternately until secure. Do not distort the gland by overtightening.
4. Leave the eccentric washers or shipping clips in place to maintain the setting position of the cartridge seal.
5. If the assembly drawing calls for holes or countersinks to be drilled under the cartridge sleeve set screws, remove the set screws and mark their location. Unbolt the cartridge gland, remove the bearings, bearing housings, and cartridge assemblies. Drill the shaft/sleeves in the positions marked. Repeat steps 1-4.
6. Tighten the cartridge sleeve set screws evenly. (If the shaft/sleeve has been drilled, ensure that the set screws align with the appropriate drilled holes.)
7. Remove the shipping clips, or rotate the eccentric washers 180° to clear the slot in the cartridge sleeve.
8. Complete reassembly of the pump, frequently turning the shaft by hand to check for free rotation, if the shaft will not turn, the seal has been improperly set.

ATTENTION

Refer to assembly drawing and/or pump manual for piping connections and coupling alignment. Proceed as indicated.

Decommissioning The Equipment

1. Ensure that the equipment is electrically isolated.

⚠ If the equipment has been used on toxic or hazardous fluids, ensure that the equipment is correctly decontaminated and made safe prior to commencing work. Remember, fluid is often trapped during draining and may exist outside the seal. The equipment instruction manual should be consulted to check for any special precautions.

2. Ensure that the equipment is isolated by the appropriate valves. Check that the fluid is drained and pressure is fully released.

Maintenance

No maintenance of a seal is possible while installed. Therefore, it is recommended that a spare seal unit and mating ring be held in stock to allow immediate replacement of a removed seal.

It is recommended that used seals be returned to a John Crane Seal Rebuilding Center, as rebuilding to as-new specifications must be carried out by qualified personnel.

⚠ It is the responsibility of the equipment user to ensure that any, parts being sent to a third party have appropriate safe handling instructions externally attached to the package.

Quality Assurance

This seal has been assembled in accordance with John Crane Quality Assurance Standards, and with proper maintenance and use will give safe and reliable operation to the maximum recommended performance as shown in any relevant approved John Crane publication.

Ordering Information

1. Cartridge Seal size = solid shaft or sleeve OD.
2. Select single (670/680) or single with quench (670Q/680Q) arrangement.
3. Determine whether standard or enlarged seal chamber configuration is required.
4. For other material combinations or size considerations, consult the local John Crane Sales/Service Engineer.

Materials of Construction - Standard

Bellows:	670: Alloy C-276 (UNS N10276) 680: Alloy 20 (UNS N08022)
Adaptive Hardware:	670: Alloy C-276 (UNS N10276) 680: Alloy 20 (UNS N08022)
Faces:	Carbon Graphite, Tungsten Carbide, Silicon Carbide
Static Seals:	PTFE-Encapsulated Fluorocarbon, EPR, Nitrile, Fluorocarbon, Perfluoroelastomer

Operating (non-concurrent) Limits

Pressure:	Internal Mounting:	20 bar/300 psi
	External Mounting:	5 bar/75 psi
Temperature:	-75°C to 200°C/-100°F to 400°F	
Speed:	To 25 m/s / 4,500 sfpm	

ECS™ Materials of Construction

Bellows:	Inconel® 718, Alloy C-276 (UNS N10276) Monel®, AM350
Adaptive Hardware:	300 Series Stainless Steel
Faces:	Carbon Graphite vs. Silicon Carbide
Static Seals:	Fluorocarbon

Inconel and Monel are registered trademarks of Inco Alloys International, Inc.

ECS™ Operating (non-concurrent) Limits

Pressure:	Dynamic:	To 20 bar g/300 psig
	Containment:	To 31 bar g/450 psig
	Cavity:	To 1 bar g/15 psig
Temperature:	To 204°C/400°F	
Speed:	To 50 m/s / 10,000 sfpm	

John Crane

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1-847-967-2400
1-847-967-3915
800-SEALING

Europe, Middle East, Africa
Slough, UK

Tel: 44-1753-224000
Fax: 44-1753-224224

Latin America
São Paulo, Brazil

Tel: 55-11-3049-9900
Fax: 55-11-3849-8270

Asia Pacific
Singapore

Tel: 65-222-9161
Fax: 65-223-5085

For your nearest John Crane facility, please contact one of the locations above.

If the products featured will be used in a potentially dangerous and/or hazardous process, your John Crane representative should be consulted prior to their selection and use. In the interest of continuous development, John Crane Companies reserve the right to alter designs and specifications without prior notice. It is dangerous to smoke while handling products made from PTFE. Old and new PTFE products must not be incinerated.

 Print 12/00

www.johncrane.com

ISO Certified

11315-3 1.03.B.7, 1.04.A
Items 15, 17: Special Tools List / Special Tools Provided

ITEM	Description	Unit	Quantity
109082	Dodge Tension Check Tool	Each	1
1340K27	Oil Fill Tube	Each	1

PROGRESSING CAVITY PAINT SPECIFICATION

Surface Prep: All surfaces to be dry and free of dirt, oil, grease, and loose particles. All surfaces to be painted will be prepared according to SSPC-SP-10.

Paint System: Tnemec –Series 97 Zinc-Rich Primer
Tnemec-Series 66 Hi-Build Epoxoline
Tnemec-Series 73-Endura-Shield

Physical Data: Primer Type: Series 97-Aromatic Urethane
Volume Solids -Primer: 63.0+/- 2.0% (mixed)
Dry Film per 1 coat-Primer: 3.0 mils
Finish Coat Type: Series 66- Polyamidoamine Epoxy
Volume Solids-Finsh: 56.0+/-2.0% (mixed)
Dry Film per 1 coat: 4.0 mils
Top Coat Type; Series 73-Aliphatic Acrylic Polyurethane
Volume Solids-Finish:58.0 +/- 2.0% (mixed)
Dry Filn per 1 coat: 3 mils

Application: Method - Primer: Conventional Air Spray
Thinner – Primer,Finish,Top: No 2, 4, 42
Drying Time - Primer:1 hrs - handle
Drying Time-Finish Coat: 10 hrs-handle
Drying Time: 5-8 hrs- handle

See Tnemec data sheets for additional information

Tneme-Zinc 90-97 & H90-97

11315 1.03.A.1.h

PRODUCT PROFILE

GENERIC DESCRIPTION Aromatic Urethane, Zinc-Rich

COMMON USAGE An advanced technology, two-component, moisture-cured, zinc-rich primer providing extraordinary pefor-mance. It's user friendly and rapid curing so chemical- and corrosion-resistant topcoats can be applied the "same-day." Also used for field touch-up of inorganic zinc coating. Application methods, for 90-97 only, include "dry-fall" under certain conditions (see Application). H90-97 is HAPS compliant for use in-shop.

ZINC DUST CONTENT 83% by weight in dried film

COLOR 90-97 Reddish-gray

SPECIAL QUALIFICATIONS Series 90-97 meets **AISC** requirements of a Class B surface with a mean slip coefficient no less than 0.50 and a tension creep not in excess of .005 inches (.13 mm).

Tneme-Zinc uses a zinc dust which meets the requirements of **ASTM D 520 Type III** and contains less than .002% lead. This level qualifies it to be classed as "non-lead" (less than 0.06% lead by weight) as de-fined in Part 1303 of the Consumer Product Safety Act Regulations. Conforms to **SSPC Paint 20, Type II.**

PERFORMANCE CRITERIA Extensive test data available. Contact your Tnemec representative for specific test results.

TNEMEC ®

COATING SYSTEM

TOPCOATS Series 1, 6, 25, 27, 46H-413, 66, L69, L69F, N69, N69F, 73, 104, 113, 114, 115, 161, 394, 1074, 1075
Note: Certain topcoat colors may not provide one-coat hiding depending on method of application. Contact your Tnemec representative.

SURFACE PREPARATION

Severe Exposure: SSPC-SP10 Near-White Blast Cleaning
Moderate Exposure: SSPC-SP6 Commercial Blast Cleaning.

TECHNICAL DATA

VOLUME SOLIDS 63.0 ± 2.0% (mixed)

RECOMMENDED DFT 2.5 to 3.5 mils (65 to 90 microns) per coat.

CURING TIME
Without 44-710

Temperature*	To Handle	To Recoat
75°F (24°C)	1 hour	4 hours
65°F (18°C)	1½ hours	5 hours
55°F (11°C)	2 hours	6 hours
45°F (7°C)	2½ hours	7 hours
35°F (2°C)	3 hours	8 hours

* 50% relative humidity. Curing time will vary with surface temperature, humidity and film thickness.

With 44-710 Reference the 44-710 Urethane Accelerator product data sheet.

VOLATILE ORGANIC COMPOUNDS

	Unthinned	Thinned 2.5% (No. 2 or 3 Thinner)	Thinned 10% (No. 2 or 3 Thinner)	Thinned 15% (No. 62 Thinner)
90-97	2.68 lbs/gallon (321 grams/litre)	2.79 lbs/gallon (334 grams/litre)	3.10 lbs/gallon (371 grams/litre)	
H90-97	2.72 lbs/gallon (325 grams/litre)			2.72 lbs/gallon (325 grams/litre)
HAPS (H90-97)	1.84 lbs/gals solids			1.84 lbs/gal solids

THEORETICAL COVERAGE 1,011 mil sq ft/gal (24.8 m²/L at 25 microns). See APPLICATION for coverage rates.

NUMBER OF COMPONENTS Two: Part A and Part B

PACKAGING Four-Gallon and One-Gallon Kits: Consist of one premeasured container of liquid (Part A) and one pre-measured container of powder (Part B). When mixed, yields four gallons (15.1L) or one gallon (3.79L).

NET WEIGHT PER GALLON 23.94 ± 0.60 lbs (10.86 ± .27 kg)

STORAGE TEMPERATURE Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE Dry (Continuous) 250°F (121°C) Intermittent 300°F (149°C)

SHELF LIFE Part A: 12 months at recommended storage temperature.
Part B: 24 months at recommended storage temperature.

FLASH POINT - SETA 90-97 Part A: 78°F (26°C) H90-97 Part A: 108°F (42°C) Part B: N/A

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

90-97 & H90-97 Tneme-Zinc

11315 1.03.A.1.h

APPLICATION

CAUTION! Dry overspray can be wiped or washed from most surfaces. Satisfactory dry-fall performance depends upon height of work, weather conditions and equipment adjustment. Low temperature is of particular concern. Test for each application as follows: Spray from 15 to 25 feet towards paint container. The material then should readily wipe off. **Note:** Heat can fuse-dry overspray to surfaces. Always clean dry overspray from hot surfaces before fusing occurs. Be aware that surface temperatures can be higher than air temperatures.

COVERAGE RATES

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
Suggested	3.0 (75)	5.0 (125)	337 (31.3)
Minimum	2.5 (65)	4.0 (100)	404 (37.5)
Maximum	3.5 (90)	5.5 (140)	289 (26.9)

Allow for overspray and surface irregularities. Film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING Always use the entire contents of A and B components. Use an air-driven power mixer and keep material under constant agitation while mixing. Slowly sift powder (Part B) into liquid (Part A).
-Do Not Reverse This Procedure- Adjust mixer speed to break up lumps and mix until the two components are thoroughly blended. Strain through a 35 to 50 mesh (300 to 600 microns) screen before using. For spray application, keep under low RPM agitation to prevent settling. For brush or roller application, stir frequently to prevent settling. Do not use mixed material beyond pot life limits.

POT LIFE 8 hours at 77°F (25°C) and 50% R.H.
Caution: This product cures with moisture acting as a catalyst. Incorporation of moisture or moisture laden air (humidity) during use will shorten pot life. Avoid continual agitation at high RPM. When feasible keep containers of mixed material covered during use.

THINNING **90-97:** For spray, thin up to 10% or ¾ pint (380 mL) per gallon with No. 2 Thinner if temperatures are below 80°F (27°C). Thin up to 10% or ¾ pint (380 mL) per gallon with No. 3 Thinner if temperatures are above 80°F (27°C). For brush or roller, thin up to 10% or ¾ pint (380 mL) with No. 3 Thinner.

H90-97: For air spray, thin up to 15% per gallon with No. 62 Thinner. For airless spray, brush or roller, thin up to 10% per gallon with No. 62 Thinner.

SURFACE TEMPERATURE Minimum 35°F (2°C) Maximum 120°F (49°C) Maximum for Brush & Roller 100°F (38°C)
The surface should be dry and at least 5°F (3°C) above the dew point.

AMBIENT HUMIDITY Minimum 40% Maximum 90%

APPLICATION EQUIPMENT **Note:** When finish coats are white or light colors, best hiding of this dark color primer can be achieved by spray application.

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure (1)	Pot Pressure
DeVilbiss* JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	40-50 psi (2.8-3.4 bar)	10-20 psi (0.7-1.4 bar)

(1) Atomizing Pressure for H90-97 is 50-70 psi (3.4-4.8 bar).
* (with heavy mastic spring) Low temperatures or longer hoses will require additional pressure. Use pressure pot equipped with an agitator and keep pressure pot at same level or higher than the spray gun. Compressed air must be dry.

Airless Spray

Tip Orifice	Atomizing Pressure (2)	Mat'l Hose ID	Manifold Filter
0.017"-0.021" (430-535 microns) Reversible Tip	2400-3000 psi (165-207 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

(2) Atomizing Pressure for H90-97 is 3500-4500 (241-310 bar).
Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Keep material agitated to prevent settling.
Roller: Use 1/4" or 3/8" (6.4 mm or 9.5 mm) synthetic woven nap roller covers. Stir material frequently or keep under agitation to prevent settling.
Brush: Use high quality natural or synthetic bristle brushes.

CLEANUP Flush and clean all equipment immediately after use with the recommended thinner or xylene.

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PRINTED IN USA
(YDAT097) 90-97 & H90-97

Hi-Build Epoxoline SERIES 66

11315 1.03.A.1.h

TNEMEC®

PRODUCT PROFILE

GENERIC DESCRIPTION	Polyamide Epoxy
COMMON USAGE	Industry standard for epoxy coatings for over 30 years. Known for its forgiving application characteristics in adverse and varied conditions, and for benchmark performance.
COLORS	Refer to Tnemec Color Guide. **Note:** Epoxies chalk with extended exposure to sunlight and may yellow on aging. Lack of ventilation, incomplete mixing, miscatalyzation or the use of heaters that emit carbon dioxide and carbon monoxide during application and initial stages of curing may accelerate any potential yellowing.
FINISH	Satin
SPECIAL QUALIFICATIONS	Meets the performance requirements of **AWWA C 210** (not for potable water contact). Contact your Tnemec representative for system recommendations.
PERFORMANCE CRITERIA	Extensive test data available. Contact your Tnemec representative for specific test results.

COATING SYSTEM

PRIMERS	**Steel:** Self-priming or Series 1, 20, FC20, 37H, N69, 90, 91-H_2O, 161, 530, 594 **Galvanized Steel and Non-Ferrous Metal:** Self-priming **Concrete:** Self-priming, 54-660, 201, 216, 218 **CMU:** 54-562, 54-660, 130, 216, 218 **Drywall:** 51-792 for dry interior environments
TOPCOATS	46H-413, 66, N69, 73, 84, 104, 113, 114, 161, 175, 262, 265, 290, 291, 1070, 1071, 1072, 1074, 1075, 1077, 1078. Refer to COLORS on applicable topcoat data sheets for additional information. **Note: A maximum recoat time may apply depending on the topcoat specified. Refer to the applicable topcoat product sheet for information on product specific maximum recoat times.**

SURFACE PREPARATION

STEEL	**Immersion Service:** SSPC-SP10/NACE 2 Near-White Blast Cleaning **Non-Immersion Service:** SSPC-SP6/NACE 3 Commercial Blast Cleaning
PRIMED STEEL	**Immersion Service:** Scarify the Series 66 prime coat surface by abrasive-blasting with a fine abrasive before topcoating if: (a) the 66 prime coat has been in exterior exposure for 60 days or longer and 66, 46H-413, N69 or 161 is the specified topcoat; (b) the 66 prime coat has been in exterior exposure for 14 days or longer and Series 104 is the specified topcoat; (c) the 66 prime coat has been in exterior exposure for 7 days or longer and Series 262 or 265 is the specified topcoat.
GALVANIZED STEEL & NON-FERROUS METAL	Surface preparation recommendations will vary depending on substrate and exposure conditions. Contact your Tnemec representative or Tnemec Technical Services.
CAST/DUCTILE IRON	Contact your Tnemec representative or Tnemec Technical Services.
CONCRETE	Allow new concrete to cure 28 days. For optimum results and/or immersion service, abrasive blast referencing SSPC-SP13/NACE 6 Surface Preparation of Concrete and Tnemec's Surface Preparation and Application Guide.
CMU	Allow mortar to cure for 28 days. Prepare in accordance with SSPC-SP13/NACE 6 to level protrusions and mortar spatter, and remove other contaminants.
PAINTED SURFACES	**Non-Immersion Service:** Ask your Tnemec representative for specific recommendations.
ALL SURFACES	Must be clean, dry and free of oil, grease and other contaminants.

TECHNICAL DATA

VOLUME SOLIDS* — 56.0 ± 2.0% (mixed)

RECOMMENDED DFT — 2.0 to 6.0 mils (50 to 150 microns) per coat. **Note: Number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.**

CURING TIME

Temperature	To Touch	To Handle	To Recoat	Immersion
75°F (24°C)	2 hours	10 hours	12 hours	7 days

Curing time varies with surface temperature, air movement, humidity and film thickness.
Ventilation: When used as a tank lining or in enclosed areas, provide adequate ventilation during application and cure. Reference guidelines contained in the latest edition of AWWA D 102.

VOLATILE ORGANIC COMPOUNDS*

Unthinned	Thinned 5%	Thinned 10%
3.04 lbs/gallon (364 grams/litre)	3.22 lbs/gallon (385 grams/litre)	3.39 lbs/gallon (406 grams/litre)

THEORETICAL COVERAGE*	898 mil sq ft/gal (22.0 m^2/L at 25 microns). See APPLICATION for coverage rates.
NUMBER OF COMPONENTS	Two: Part A and Part B
PACKAGING	5 gallon (18.9L) pails and 1 gallon (3.79L) cans — Order in multiples of 2.
NET WEIGHT PER GALLON*	12.50 ± 0.25 lbs (5.67 ± .11 kg) (mixed)

Published technical data and instructions are subject to change without notice. The online catalog at www.tnemec.com should be referenced for the most current technical data and instructions or you may contact your Tnemec representative for current technical data and instructions.

SERIES 66 Hi-Build Epoxoline

11315 1.03.A.1.h

TECHNICAL DATA continued

STORAGE TEMPERATURE — Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE — (Dry) Continuous 250°F (121°C) Intermittent 275°F (135°C)

SHELF LIFE — Part A: 24 months; Part B: 12 months at recommended storage temperature.

FLASH POINT - SETA — Part A: 82°F (28°C) Part B: 64°F (18°C)

HEALTH & SAFETY — Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

APPLICATION

COVERAGE RATES*

	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
Suggested	4.0 (100)	7.0 (180)	225 (20.9)
Minimum	2.0 (50)	3.5 (90)	450 (41.8)
Maximum	6.0 (150)	10.5 (265)	150 (13.9)

Note: The above reflects the total range to which Series 66 can be applied for specific applications. To insure the proper thickness and number of coats is specified for certain substrates and exposures, consult the Tnemec Guide Specifications and/or contact your Tnemec representative. **Note:** Roller or brush application may require two or more coats to obtain recommended film thickness. Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING — Power mix contents of each container, making sure no pigment remains on the bottom. Pour a measured amount of Part B into a clean container large enough to hold both components. Add an equal volume of Part A to Part B while under agitation. Continue agitation until the two components are thoroughly mixed. Do not use mixed material beyond pot life limits. **Note:** Both components should be above 50°F (10°C) prior to mixing. For application to surfaces between 50°F to 60°F (10°C to 16°C), allow mixed material to stand thirty (30) minutes and restir before using. For optimum application properties, blended components should be above 60°F (16°C). Mixing ratio is one to one by volume.

POT LIFE — 20 hours at 50°F (10°C) 10 hours at 77°F (25°C) 4 hours at 100°F (38°C)

THINNING — Use No. 4 Thinner. For air spray, thin up to 10% or ¾ pint (380 mL) per gallon. For airless spray, roller or brush, thin up to 5% or ¼ pint (190 mL) per gallon.

SURFACE TEMPERATURE — Minimum 50°F (10°C) Maximum 135°F (57°C)

The surface should be dry and at least 5°F (3°C) above the dew point. Coating will not cure below minimum surface temperature.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	75-100 psi (5.2-6.9 bar)	10-20 psi (0.7-1.4 bar)

Low temperatures or longer hoses require higher pot pressure.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.015"-0.019" (380-485 microns)	1800-3000 psi (124-207 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Note: Application over inorganic zinc-rich primers: Apply a wet mist coat and allow tiny bubbles to form. When bubbles disappear in 1 to 2 minutes, apply a full wet coat at specified mil thickness.
Roller: Roller application optional when environmental restrictions do not allow spraying. Use 3/8" or 1/2" (9.5 mm to 12.7 mm) synthetic nap covers.
Brush: Recommended for small areas only. Use high quality natural or synthetic bristle brushes.

CLEANUP — Flush and clean all equipment immediately after use with the recommended thinner or MEK.

*Values may vary with color.

TNEMEC COMPANY INCORPORATED
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PRINTED IN USA
(YDAT065) 66

Endura-Shield® SERIES 73

11315 1.03.A.1.h

PRODUCT PROFILE

GENERIC DESCRIPTION Aliphatic Acrylic Polyurethane

COMMON USAGE A coating highly resistant to abrasion, wet conditions, corrosive fumes, chemical contact and exterior weathering. High build quality combines with project specific primers for two-coat, labor saving systems. NOT FOR IMMERSION SERVICE.

COLORS Refer to Tnemec Color Guide. **Note:** Certain colors may require multiple coats depending on method of application and finish coat color. When feasible, the preceding coat should be in the same color family (blue, gray, etc.), but noticeably different.

FINISH Semi-gloss

SPECIAL QUALIFICATIONS Series 73 meets the accelerated weathering requirements of SSPC Paint Standard 36.

PERFORMANCE CRITERIA Extensive test data available. Contact your Tnemec representative for specific test results.

TNEMEC®

COATING SYSTEM

PRIMERS **Steel:** Series 1, 20, 27, 37H, 66, L69, L69F, N69, N69F, 90-97, 91-H_2O, 94-H_2O, 135, L140, L140F, N140, N140F, 161, 394
Galvanized Steel & Non-Ferrous Metal: Series 27, 66, L69, L69F, N69, N69F, 161
Concrete: 54-660, 66, L69, L69F, N69, N69F, 161
CMU: 54-660
Note: Series 135 exterior exposed more than two months, or Series N69 or N140 exterior exposed more than three months must first be scarified or reprimed with themselves. Brush blasting with fine abrasive is the preferred method of scarification.

TOPCOATS Series 76, 700, 701, 1070, 1071, 1072, 1074, 1074U, 1075U, 1077, 1078, optional when extended weatherability is desired.

SURFACE PREPARATION

ALL SURFACES Must be clean, dry and free of oil, grease and other contaminants.
See primer product data sheet for surface preparation recommendation.

TECHNICAL DATA

VOLUME SOLIDS* 58.0 ± 2.0% (mixed)

RECOMMENDED DFT 2.0 to 5.0 mils (50 to 125 microns) per coat. **Note: Number of coats and thickness requirements will vary with substrate, application method and exposure. Contact your Tnemec representative.**

CURING TIME

Temperature	To Touch	To Handle	To Recoat
75°F (24°C)	1 hour	5-8 hours	12 hours

Curing time varies with surface temperature, air movement, humidity and film thickness.
Note: For faster curing and low-temperature applications, add No. 44-710 Urethane Accelerator; see separate product data sheet.

VOLATILE ORGANIC COMPOUNDS* / **HAPS**

	Unthinned	Thinned 10% (Max) (No. 39 Thinner)	Thinned 10% (Max) (No. 42 Thinner)	Thinned 10% (Max) (No. 56 Thinner)
VOLATILE ORGANIC COMPOUNDS*	2.70 lbs/gallon (325 grams/litre)	3.06 lbs/gallon (367 grams/litre)	3.11 lbs/gallon (372 grams/litre)	2.77 lbs/gallon (331 grams/litre)
HAPS	0.35 lbs/gal solids	0.34 lbs/gal solids	0.35 lbs/gal solids	0.34 lbs/gal solids

THEORETICAL COVERAGE* 930 mil sq ft/gal (22.8 m²/L at 25 microns).

NUMBER OF COMPONENTS Two: Part A and Part B

PACKAGING

	PART A (Partially filled)	PART B (Partially filled)	When Mixed
5 Gallon Kit	5 gallon pail	½ gallon can	5 gallons (18.9L)
1 Gallon Kit	1 gallon pail	1 quart can	1 gallon (3.79L)

NET WEIGHT PER GALLON* 12.13 ± 0.25 lbs (5.50 ± .11 kg)

STORAGE TEMPERATURE Minimum 20°F (-7°C) Maximum 110°F (43°C)

TEMPERATURE RESISTANCE (Dry) Continuous 250°F (121°C) Intermittent 275°F (135°C)

SHELF LIFE Part A: 24 months at recommended storage temperature.
Part B: 12 months at recommended storage temperature.

FLASH POINT - SETA Part A: 55°F (13°C) Part B: 112°F (43°C)

HEALTH & SAFETY Paint products contain chemical ingredients which are considered hazardous. Read container label warning and Material Safety Data Sheet for important health and safety information prior to the use of this product. **Keep out of the reach of children.**

Published technical data and instructions are subject to change without notice. The online catalog at www.tnemec.com should be referenced for the most current technical data and instructions or you may contact your Tnemec representative for current technical data and instructions.

11315 1.03.A.1.h

APPLICATION

COVERAGE RATES*

	Conventional Build (Spray, Brush or Roller)			High-Build (Spray Only)		
	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)	Dry Mils (Microns)	Wet Mils (Microns)	Sq Ft/Gal (m^2/Gal)
Suggested	2.5 (65)	4.5 (115)	372 (34.6)	4.0 (100)	7.0 (180)	233 (21.6)
Minimum	2.0 (50)	3.5 (90)	465 (43.2)	3.0 (75)	5.0 (125)	310 (28.8)
Maximum	3.0 (75)	5.0 (125)	310 (28.8)	5.0 (125)	8.5 (215)	186 (17.3)

(1) Can be spray applied at 3.0 to 5.0 mils (75 to 125 microns) DFT per coat when extra protection or the elimination of a coat is desired.
(2) Can be sprayed, brushed or rolled at 2.0 to 3.0 mils (50 to 75 microns) DFT per coat for use in systems requiring a conventional build topcoat.
Allow for overspray and surface irregularities. Wet film thickness is rounded to the nearest 0.5 mil or 5 microns. Application of coating below minimum or above maximum recommended dry film thicknesses may adversely affect coating performance.

MIXING
Stir contents of the container marked Part A, making sure no pigment remains on the bottom. Add the contents of the can marked Part B to Part A while under agitation. Continue agitation until the two components are thoroughly mixed. When used with 44-710 Urethane Accelerator, first blend 44-710 into Part A under agitation; continue as above. Do not use mixed material beyond pot life limits. **Caution:** Part B is moisture-sensitive and will react with atmospheric moisture. Keep unused material tightly closed at all times.

POT LIFE
8 hours at 40°F (4°C) — 4 hours at 77°F (25°C) — 2 hours at 100°F (38°C)

THINNING
For air spray, thin up to 10% or ¾ pint (380 mL) per gallon by volume with No. 42 Thinner if temperatures are below 80°F (27°C), use No. 48 Thinner for temperatures above 80°F (27°C). Thin up to 5% or ¼ pint (190 mL) per gallon for airless spray. For brush or roller, thin 5% to 10% or ¼ to ¾ pint (190 to 380 mL) per gallon with No. 39 Thinner. Thinning is required for proper brush or roller application. **Caution:** Do not add thinner if more than thirty (30) minutes have elapsed after mixing. **Note:** A maximum of 10% of No. 56 Thinner may be used to comply with VOC regulations.

SURFACE TEMPERATURE
Minimum 35°F (2°C) — Maximum 120°F (49°C)
The surface should be dry and at least 5°F (3°C) above the dew point.
Cure time necessary to resist direct contact with moisture at surface temperature:

40°F (4°C): 24 to 40 hours	50°F (10°C): 18 to 26 hours	60°F (16°C): 12 to 16 hours
70°F (21°C): 4 to 8 hours	90°F (32°C): 2 to 4 hours	100°F (38°C): 2 to 3 hours

If the coating is exposed to moisture before the preceding cure parameters are met, dull, flat or spotty-appearing areas may develop. Actual times will vary with air movement, film thickness and humidity.

APPLICATION EQUIPMENT

Air Spray

Gun	Fluid Tip	Air Cap	Air Hose ID	Mat'l Hose ID	Atomizing Pressure	Pot Pressure
DeVilbiss JGA	E	765 or 704	5/16" or 3/8" (7.9 or 9.5 mm)	3/8" or 1/2" (9.5 or 12.7 mm)	75-90 psi (5.2-6.2 bar)	10-20 psi (0.7-1.4 bar)

Low temperatures or longer hoses require higher pot pressure.

Airless Spray

Tip Orifice	Atomizing Pressure	Mat'l Hose ID	Manifold Filter
0.013"-0.017" (330-430 microns)	2700-3300 psi (186-228 bar)	1/4" or 3/8" (6.4 or 9.5 mm)	60 mesh (250 microns)

Use appropriate tip/atomizing pressure for equipment, applicator technique and weather conditions.
Roller: Use 1/4" to 3/8" (6.4 mm to 9.5 mm) synthetic woven nap roller cover. Do not use long nap roller covers. **Note:** Two coats are required to obtain dry film thickness above 3.0 mils (75 microns).
Brush: Recommended for small areas only. Use high qualaity natural or synthetic bristle brushes.
Note: Two or more coats may be required to obtain recommended film thicknesses.

CLEANUP
Flush and clean all equipment immediately after use with the recommended thinner or MEK.

*Values may vary with color.

Progressing Cavity Pump Test Procedure
Fixed Speed Drive

The following items are to be checked prior to testing:

1. Alignment of pump and drive (direct connected)
2. Clearance, alignment, and proper belt tensioning for v-belts and sheaves.
3. Electrical connections-i.e.-proper voltage and wiring.
4. Direction of rotation.

During testing, the following will be observed and recorded:

1. All applicable drive and pump data.
2. Pump operating speed.
3. Discharge test pressure.
   Single stage: 30 and 60 PSI
   2-Stage: 60 and 120 PSI
   4-Stage: 120 and 240 PSI
4. Capacity
5. Amp draw

Grounds for rejection:

1. Capacity ± 5% of expected flow indicated on curve.
2. Excessive noise or vibration.
3. Poor workmanship.
4. Alignment, clearance or improper mounting of the drive.

Progressing Cavity Pump Quality Assurance

Castings:

1. All castings are visually checked for any defects and quality of machining.
2. Acceptable castings are then precision inspected for proper tolerance.

Hardware:

1. All hardware, before installation in the pumps, is visually checked for defects, i.e. bad threads, poor machining, etc.
2. Acceptable hardware is checked with plug and ring gauges for proper sizes and threading.

Internal Parts:

1. All internal pump parts are visually checked for any defects and quality of machining during the assembly process.
2. Acceptable parts are then precision inspected for proper tolerance. Parts machined by NETZSCH Inc. are magna fluxed and dye penetrant tested.

Assembly:

1. Approved parts are assembled and visually inspected for proper assembly in strict conformance to NETZSCH assembly instructions.
2. Assembled pumps are tested in accordance with applicable test procedures.
3. Tested pumps are then painted.
4. Prior to shipping, the complete pump unit is inspected for Appearance and visually inspected for proper paint coverage, proper identification and tagging, dimensional corrections and pump positioning.
5. Acceptable pumps units are then crated and shipped.

NETZSCH Progressing Cavity NEMO® PUMPS

LIMITED WARRANTY

The Company will repair or replace, at its option, defects or deficiencies in material or workmanship developing within one year from start-up or 18 months from date of delivery. Written notice of such defects and/or deficiencies must be received and substantiated by the Company within the Warranty period.

Correction of such defects by repair or replacement, F.O.B. factory, shall constitute fulfillment of the guarantee. The return of all parts submitted under this guarantee must be authorized by the Company and transportation prepaid by the shipper. The Company has no liability for any repairs made outside the Company's factory, unless with prior written consent.

The guarantee will not be applicable unless the apparatus has been properly cared for and operated under normal conditions nor will the Company be responsible for damage resulting from improper storage or handling prior to placing the apparatus in service.

The Guarantee of the Company on purchased items, assemblies or accessories which are installed as a separable unit shall not extend beyond the guarantee made by the manufacturer of the component.

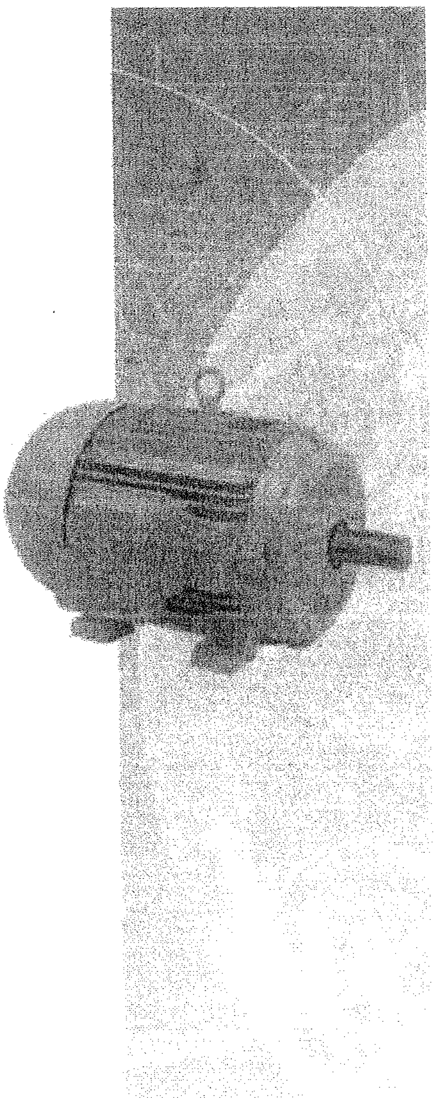
THE WARRANTY DOES NOT EXTEND TO, AND NETZSCH INCORPORATED SHALL HAVE NO LIABILITY FOR, ANY INCIDENTAL, SPECIAL, OR CONSEQUENTIAL LOSS, COST, EXPENSE, LIABILITY OR DAMAGE, WHETHER DIRECT OR INDIRECT, IN CONNECTION WITH OR ARISING OUT OF THE SUPPLY OF THIS EQUIPMENT. OUR LIABILITY ARISING OUT OF THE SUPPLY OF THIS EQUIPMENT OR ITS USE SHALL NOT IN ANY CASE EXCEED THE COST OF CORRECTING DEFECTS IN THE EQUIPMENT OF ITS INSTALLATION AS STATED ABOVE AND, UPON THE EXPIRATION OF THE PERIOD STATED ABOVE, ALL SUCH LIABILITIES SHALL TERMINATE.

Except for the express warranty above set forth the Company makes no warranty, express or implied, and makes no warranty of fitness for a particular use.

MOTOR DATA

The following motor will be supplied:
A WEG 3hp, 1800rpm, 3/60/460vac
TEFC, 182T frame, 1.25 sf, Cl-F ins.
IEEE 841 high efficiency mill & chem.
duty motor, cat# 00318ST3QIE182T.

INSTALLATION AND MAINTENANCE MANUAL FOR NEMA LOW VOLTAGE ELECTRIC MOTORS

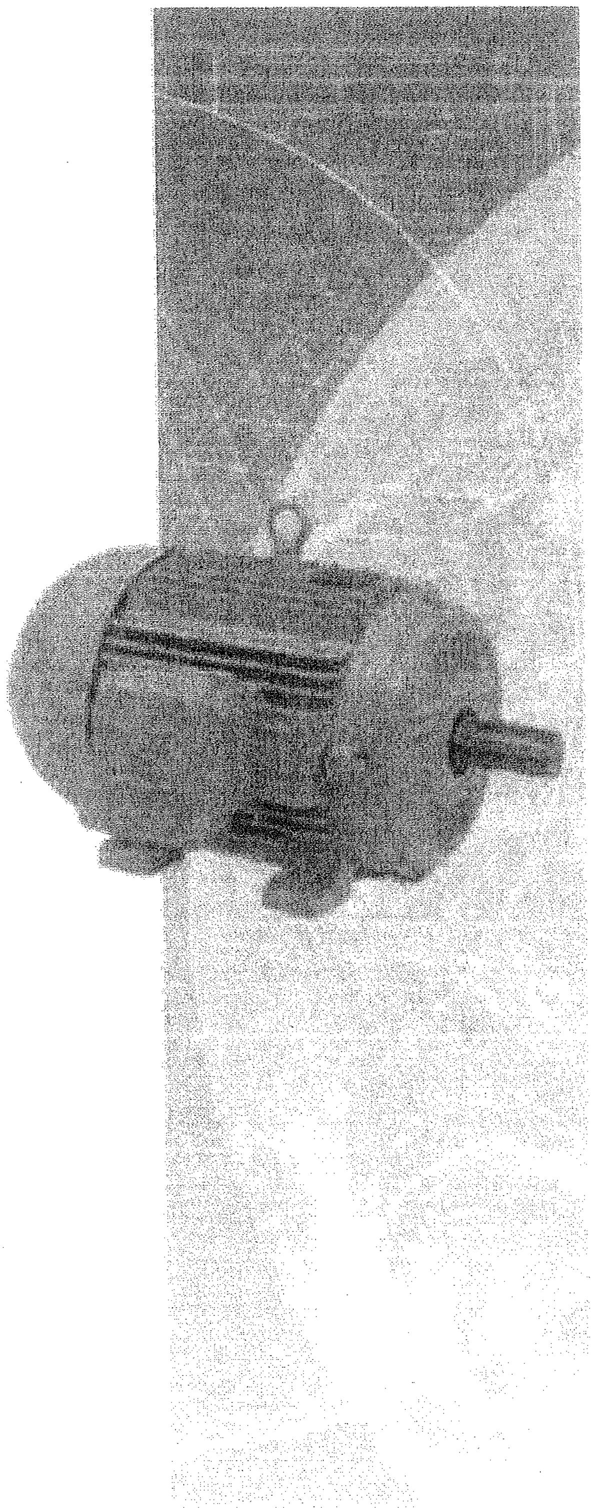


The electric motor is the item of equipment most widely used by man in his pursuit of progress, as virtually all machines and many renowned inventions depend upon it.
By virtue of the prominent role the electric motor plays in the comfort and welfare of mankind, it must be regarded and treated as a prime 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:

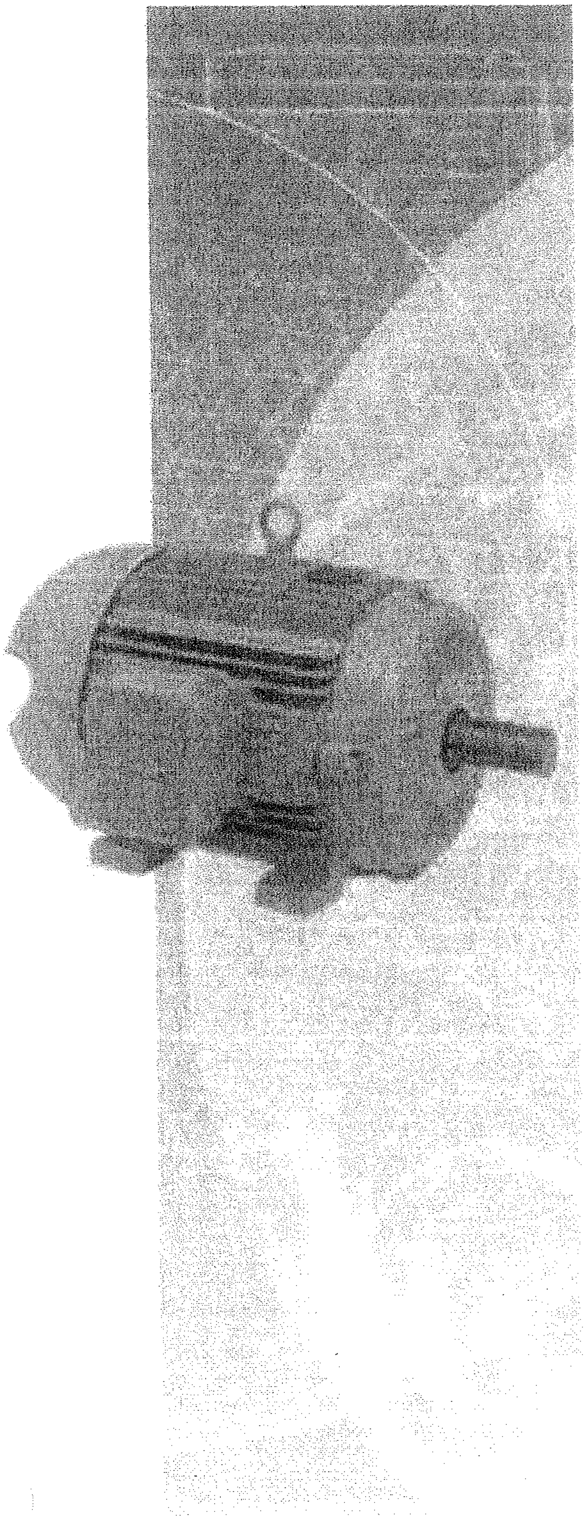
THE ELECTRIC MOTOR!

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 M W 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 M W
Correction to 40°C .

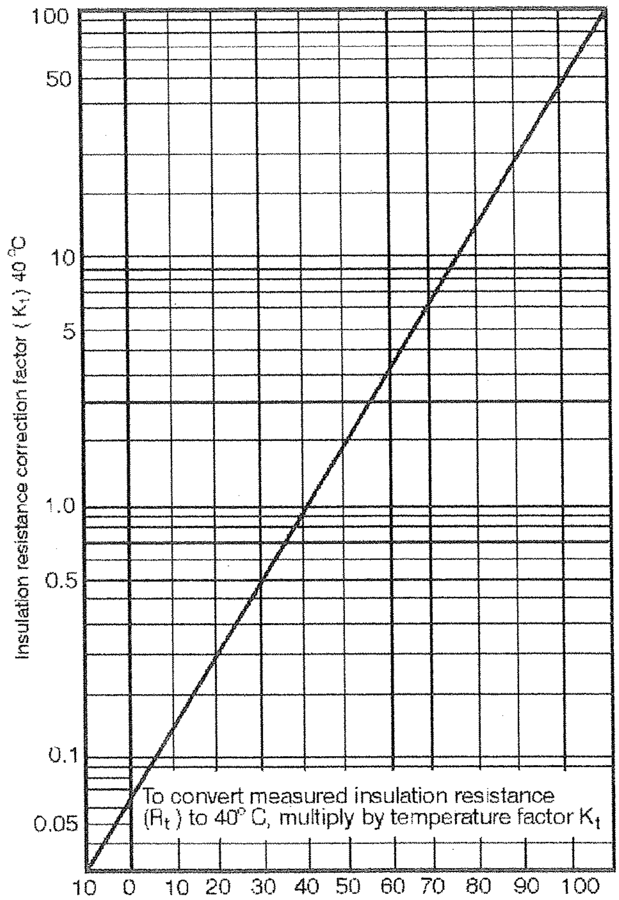
$$R_{40°C} = R_{50°C} \times K_{50°C}$$
$$R_{40°C} = 1.02 \times 1.3$$
$$R_{40°C} = 1.326 \text{ M W}$$

The minimum resistence Rm will be:

$$Rm = Vn + 1$$
$$Rm = 0.440 + 1$$
$$Rm = 1.440 \text{ M W}$$

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.

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.

Winding Temperature (°C)
$$R_{40°C} = R_t \times K_{t\,40°C}$$

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:

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

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

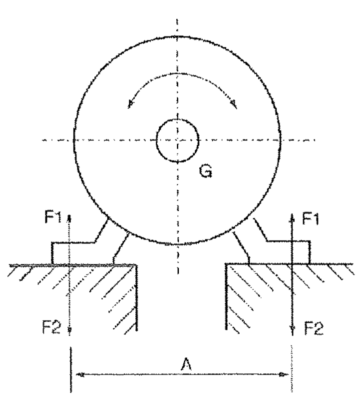


Figure 3.1 - Base stresses

Where:

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

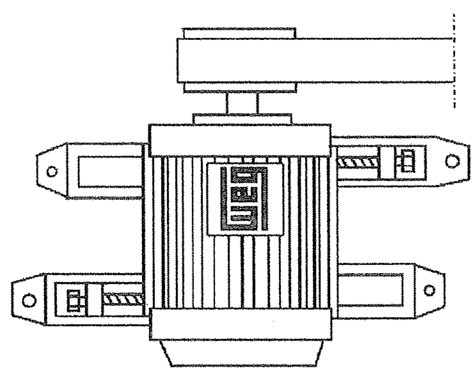
Sunken bolts or metallic base plates should be used to secure the motor to the base.

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.

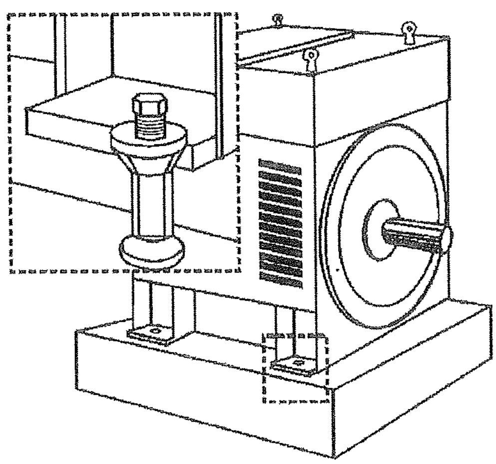
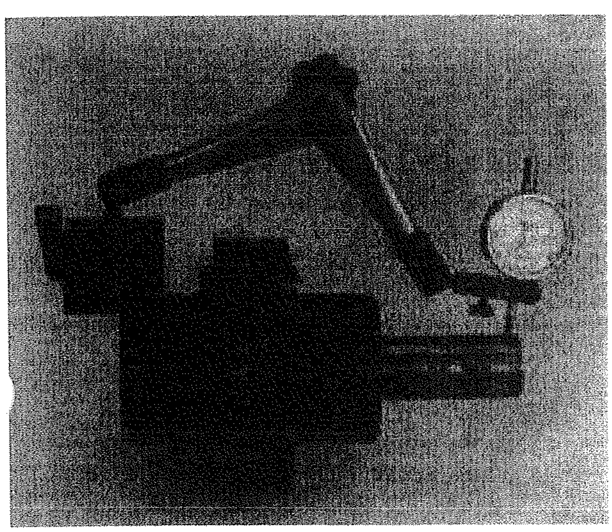


Figure 3.3 - Motor mounted on a concrete base with foundation studs

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.

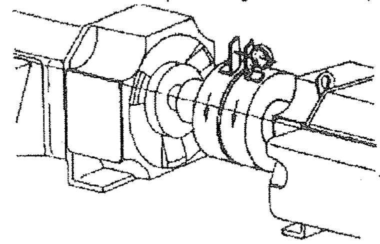
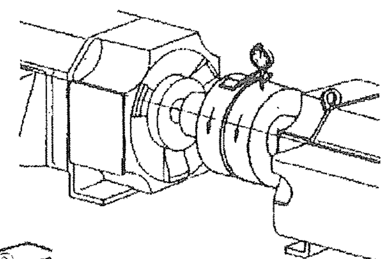


Figure 3.6a - Deviation from parallel

Figure 3.6b - Deviation from concentricity



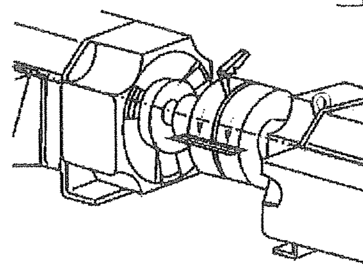


Figure 3.6c - Alignment with a steel ruler

3.1.4 Coupling

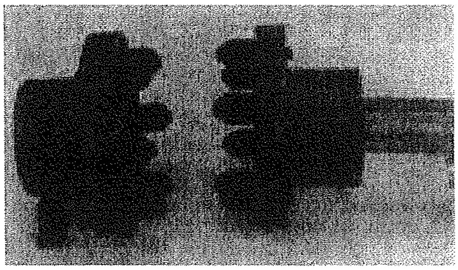
a) Direct Coupling

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

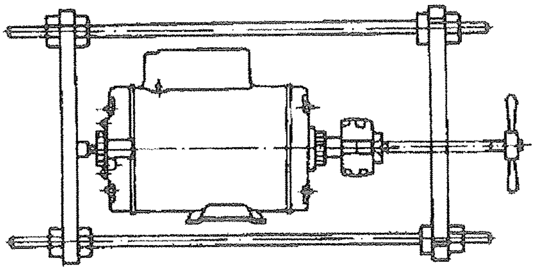
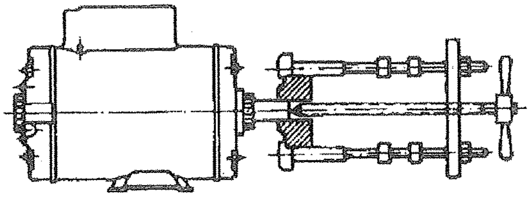


Figure 3.8a - Pulley extractor



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.

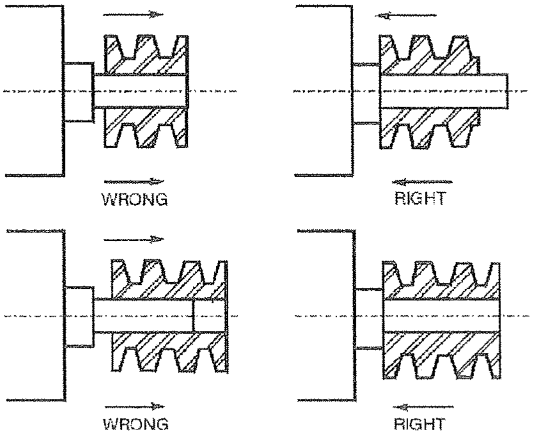


Figure 3.9 - Correct positioning of pulley on the shaft

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

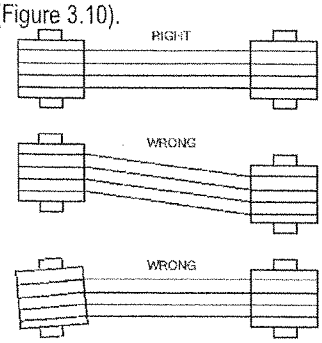


Figure 3.10 - Correct pulley alignment

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.

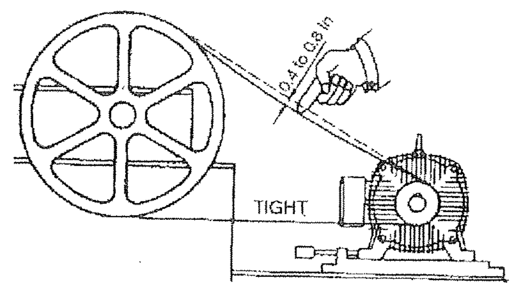
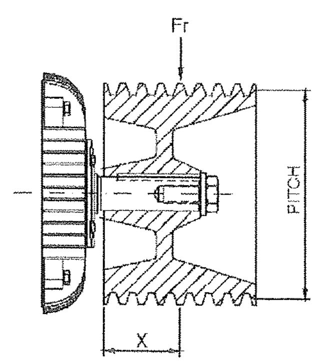


Figure 3.11 - Belt tensions

***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.

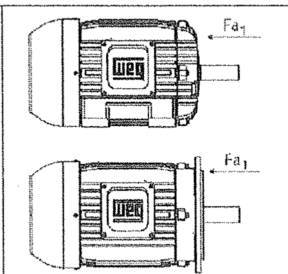
***Table 2** - Maximum acceptable radial load (Lbf)*

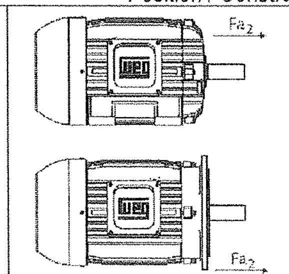
Nema 56 Motors	Saw Arbor Motors			
Frame	Radial Force (Lbf)			
	Poles	Distance X		
		1	1,18	2
56A	II	88	-	59
	IV	88	-	59
56B	II	88	-	59
	IV	86	-	59
56D	II	127	-	70
	IV	141	-	70

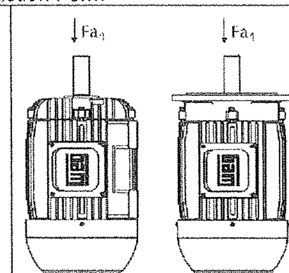
80 LMS	II	-	355	-
80 MMS	II	-	359	-
80 SMS	II	-	357	-
90 LMS	II		427	-
	IV	-	555	-

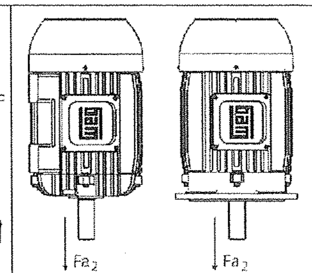
Table 3 *- Maximum acceptable axial load (Lbf)*

IP55 Totally Enclosed Motors - 60Hz
Position / Construction Form



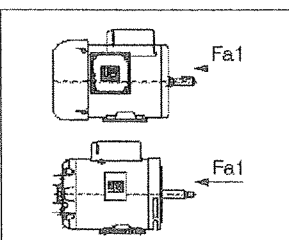


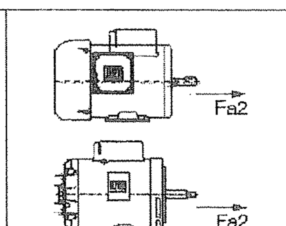


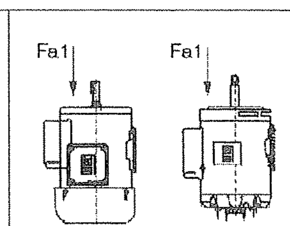


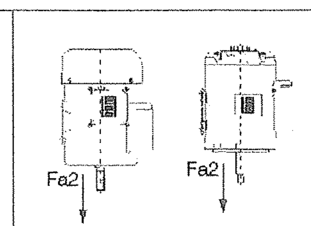
FRAME	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII	II	IV	VI	VIII
140	103	141	167	187	112	152	185	207	99	132	158	178	105	143	174	198
W 180	108	145	180	202	154	209	255	286	94	130	165	183	141	194	240	269
180	149	207	249	286	269	370	443	500	136	189	229	266	253	352	421	480
W 210	196	264	326	368	329	447	544	610	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.

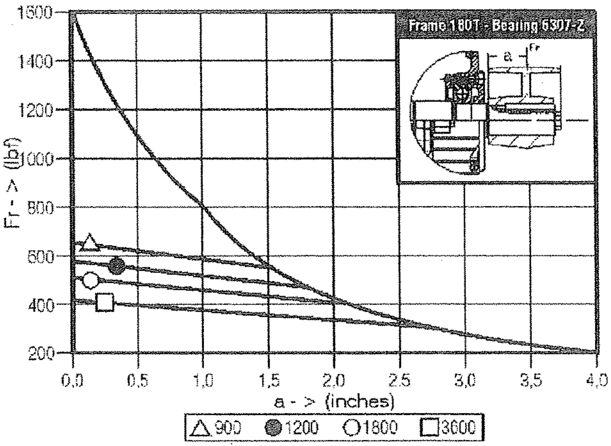
Where: X - Half of pulley width (inches)
Fr - Maximum radial load in relation to the diameter and pulley width.

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

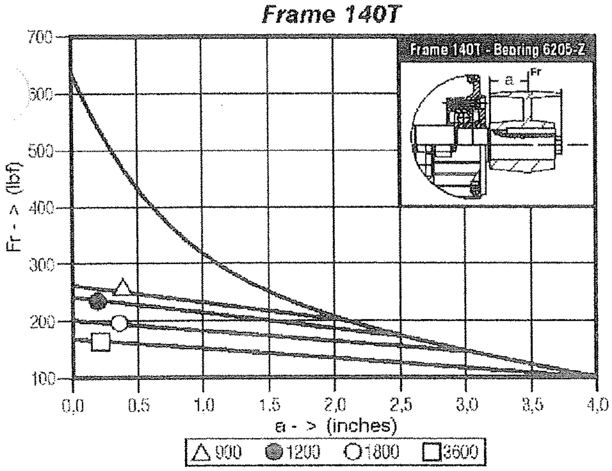
Frame : 145T
Fr : 110Lb
X : 2 inches

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

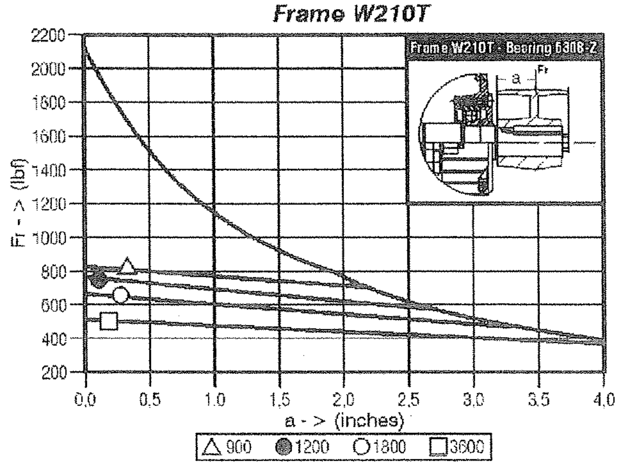
Frame 180T



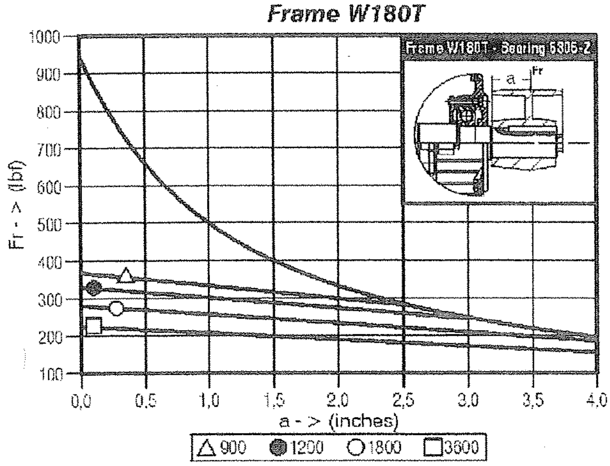
Frame 140T



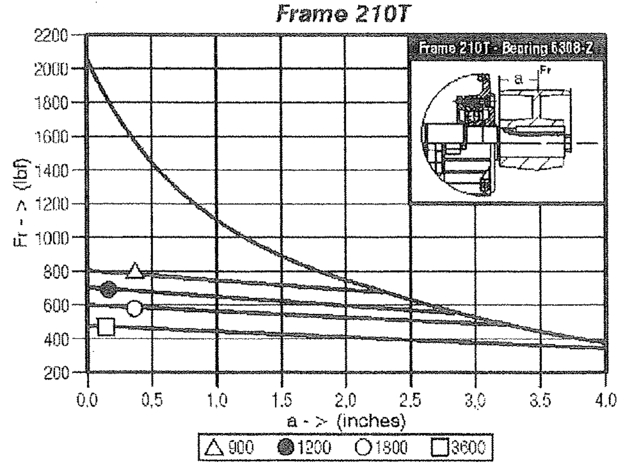
Frame W210T



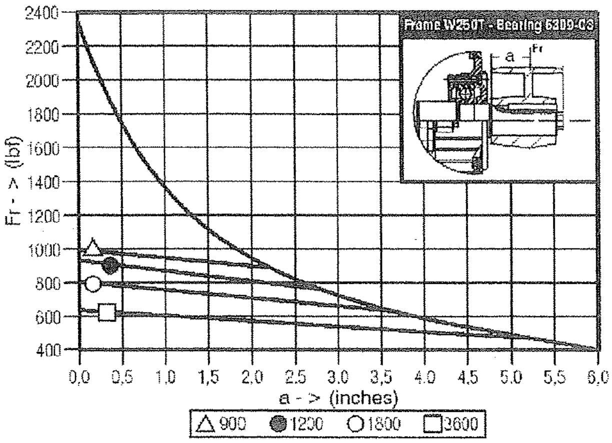
Frame W180T



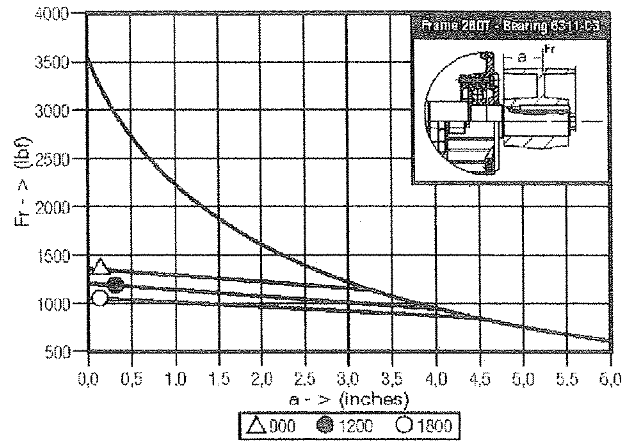
Frame 210T



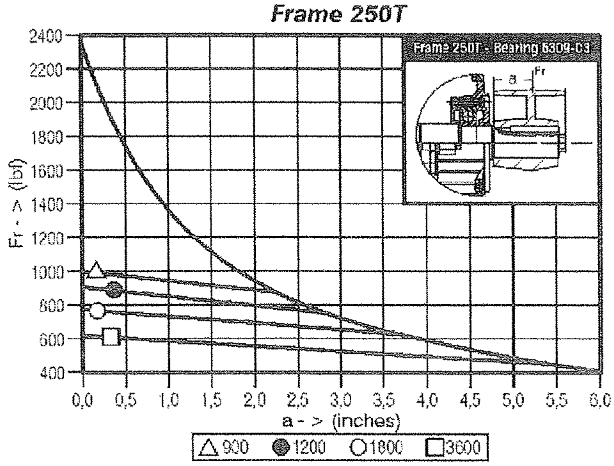
Frame W250T



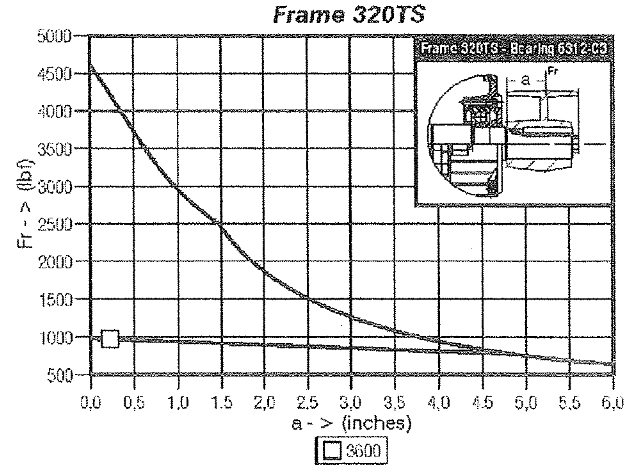
Frame 280T



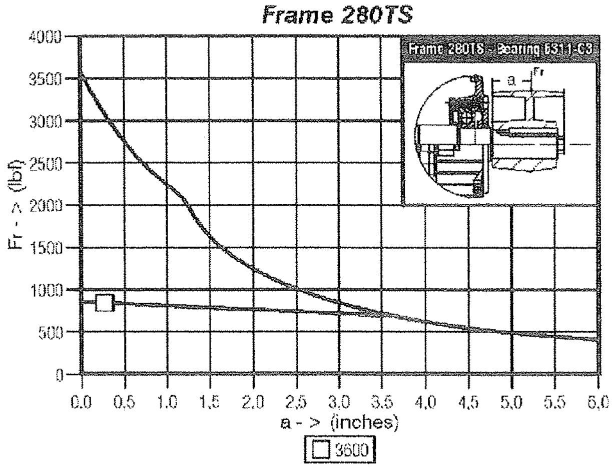
Frame 250T



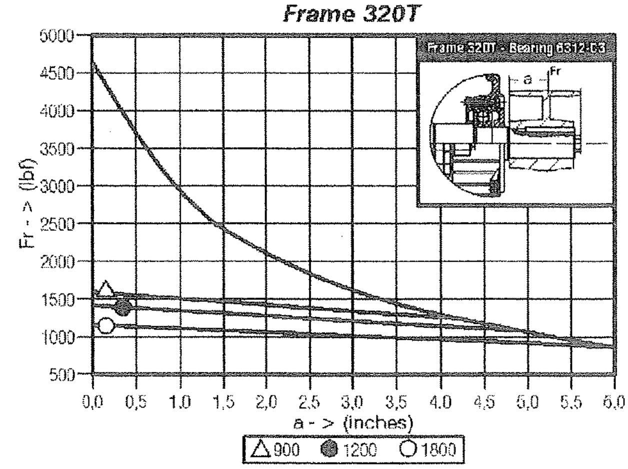
Frame 320TS



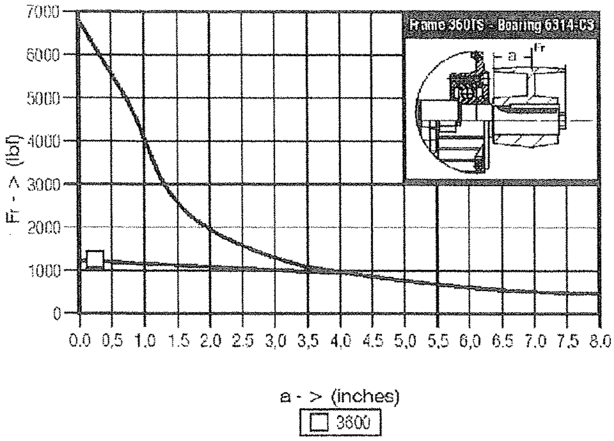
Frame 280TS



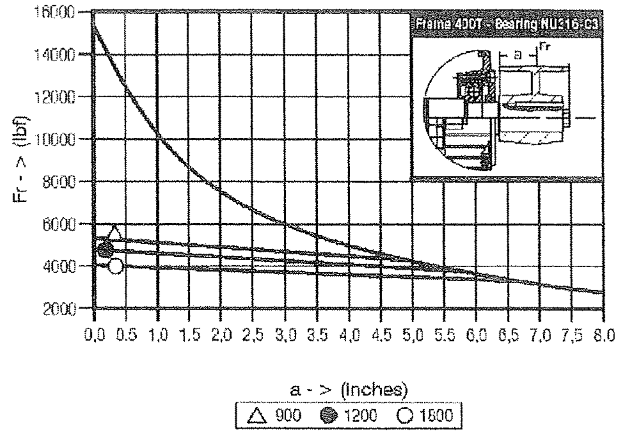
Frame 320T



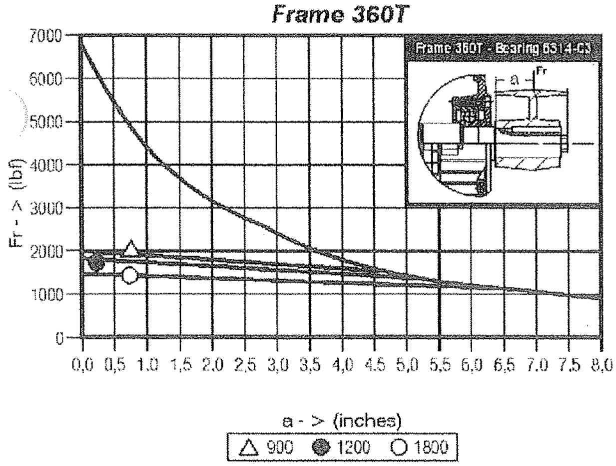
Frame 360TS



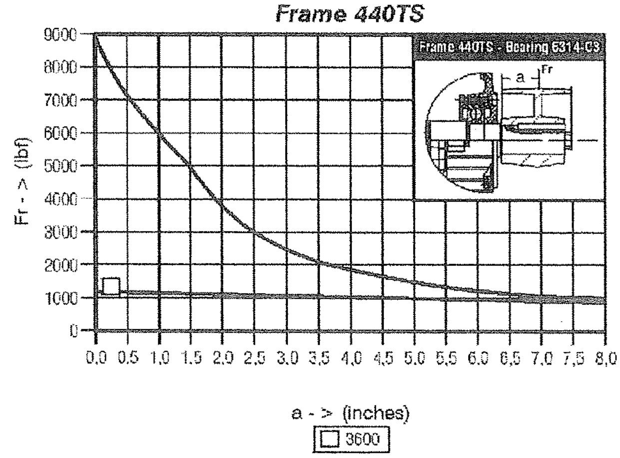
Frame 400T



Frame 360T



Frame 440TS



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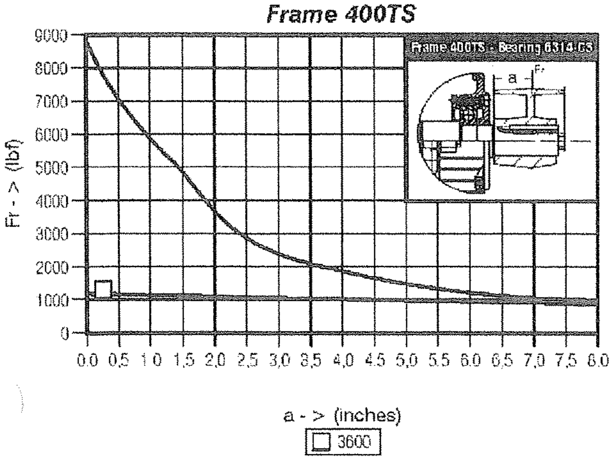
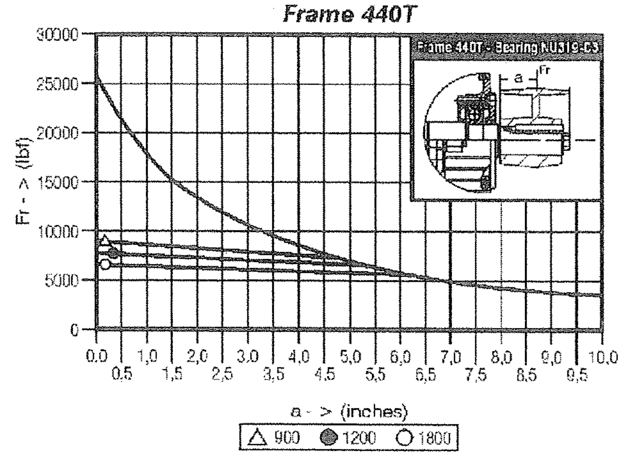
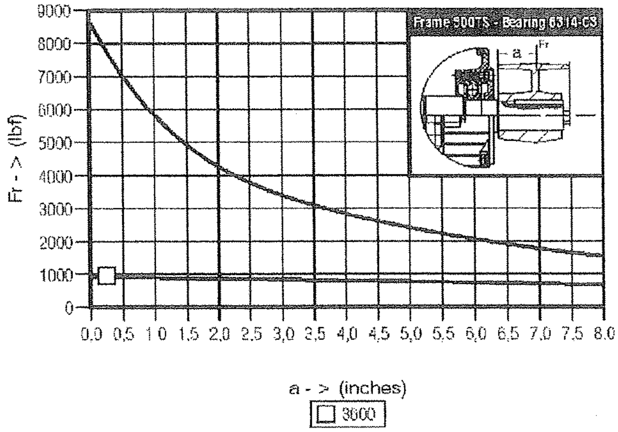


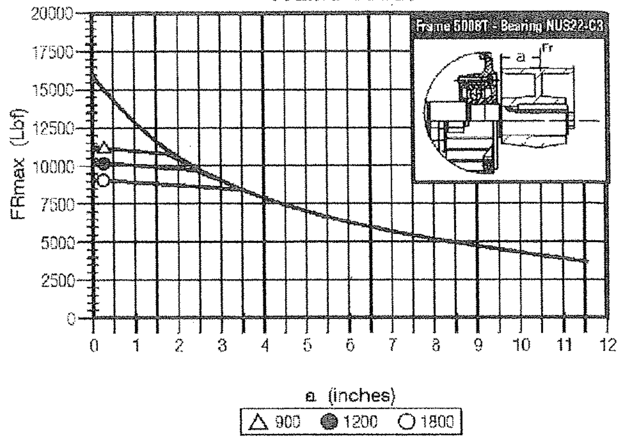
Frame 440T



Frame 500TS



Frame 5008T



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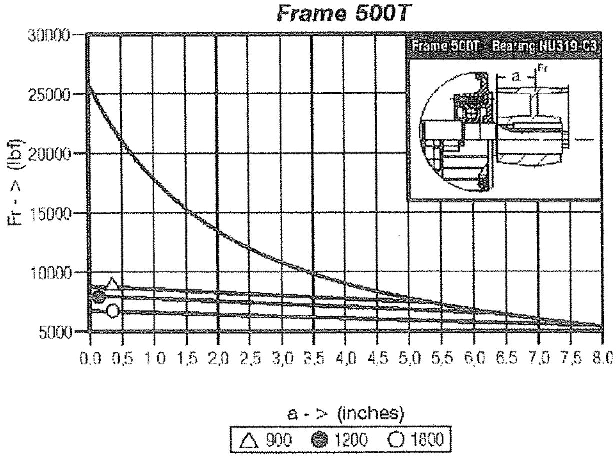
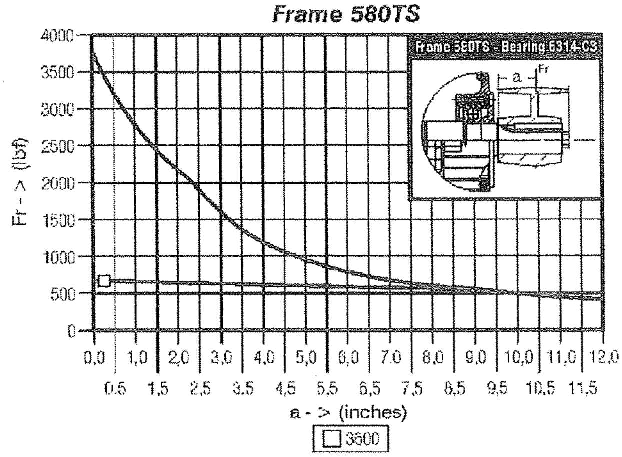
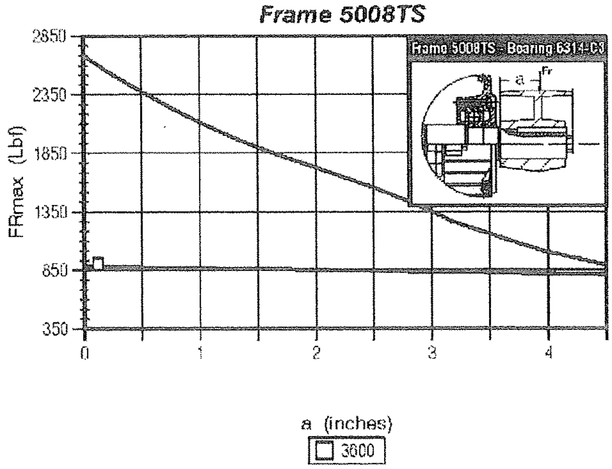


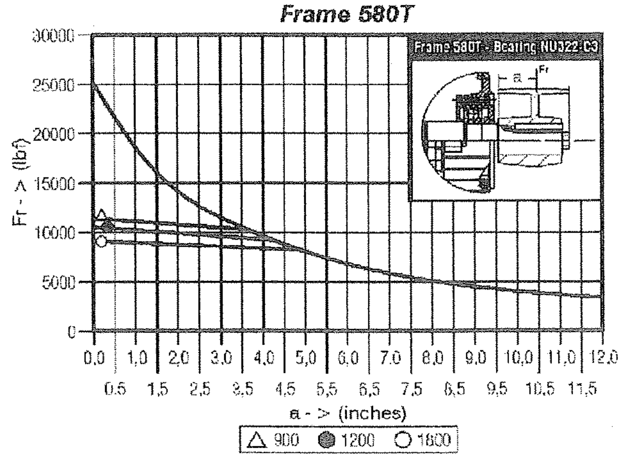
Frame 580TS



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 Table 7.

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

Duty Classification \ Motor short time rating	5min	15min	30 at 60min	Conti-nuous
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.

***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.

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 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;

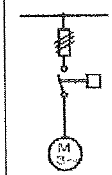
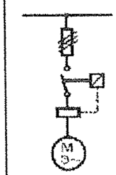
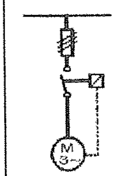
e) Check the motor for proper grounding. Providing that there are no specifications calling for ground-insulated installation, the motor must be grounded in accordance with prevalent standard for grounding electrical machines. The screw identified by the symbol ⏚ should be used for this purpose.
This 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;

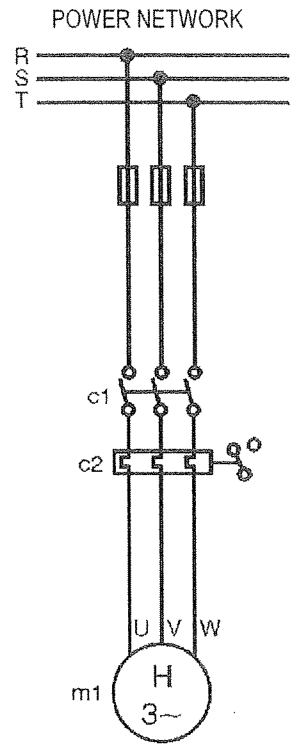
***Table 9** - Comparison between motor protection system*

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. Exececcive voltage fluctuation	○	●	●
8. Frequency fluctuation on main supply	○	●	●
9. Excessive ambient temperature	○	●	●
10. External heating caused by bearings, belts, pulleys etc.	○	○	●
11. Obstructed ventilation	○	○	●

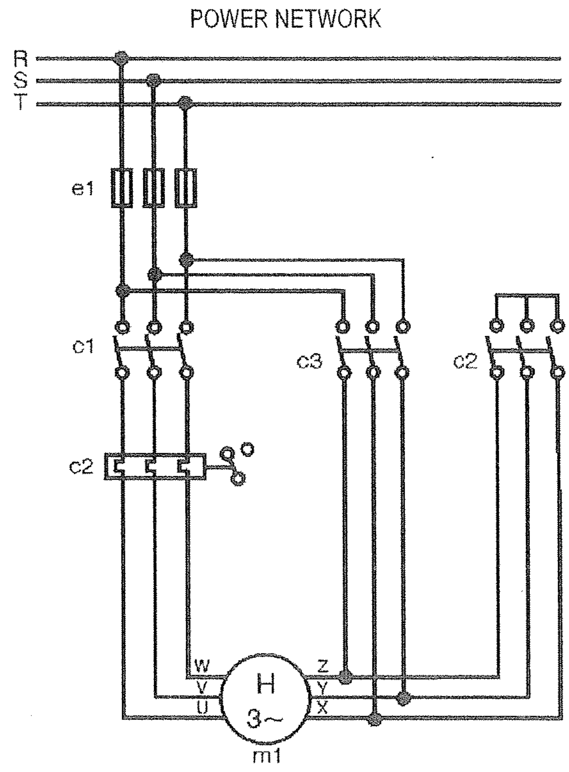
Caption: ○ unprotected
◧ partially protected
● totally protected

CONNECTION DIAGRAMS

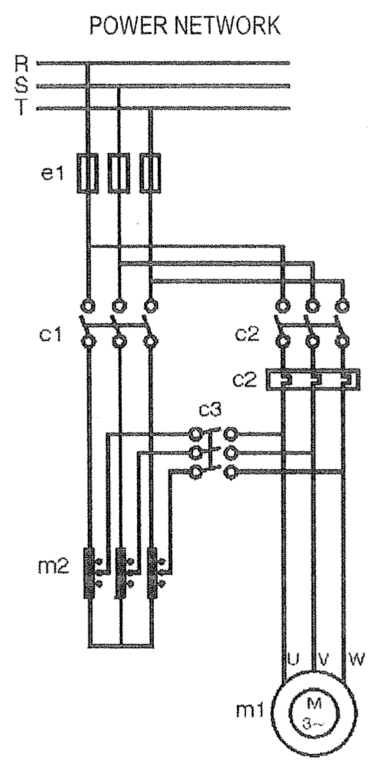
a) Direct starting



b) Star-Delta starting



c) Auto-transformer starting



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.

a) 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 11** - Bearing specifications by type of motor*

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

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

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

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

Table 12 - Bearing lubrication intervals and amount of grease

1 - SINGLE-ROW FIXED BALL BEARINGS

Bearings		Lubrication intervals (running hours)												
		II Pole		IV Pole		VI Pole		VIII Pole		X Pole		XII Pole		
Characteristics	Ref.	60Hz 3600 rpm	50Hz 3000 rpm	60Hz 1800 rpm	50Hz 1500 rpm	60Hz 1200 rpm	50Hz 1000 rpm	60Hz 900 rpm	50Hz 750 rpm	60Hz 720 rpm	50Hz 600 rpm	60Hz 600 rpm	50Hz 500 rpm	Amount of grease (oz)
	6200	12500	13800											0,07
	6201	11700	13000	16600	18400									0,07
	6202	10500	11900	15400	17100	19500								0,07
	6203	9800	11200	14500	16200	18500								0,11
6	6204	8700	10100	13300	14800	17100	19100				> 20000			0,14
2	6205	8000	9400	12600	14100	16200	18200	19300						0,14
	6206	7300	8700	12000	13400	15400	17200	18300						0,18
S	6207	6600	8100	11400	12700	14500	16300	17300	19200					0,25
E	6208	5900	7400	10800	12000	13700	15300	16300	18200					0,29
R	6209	5300	6900	10400	11600	13400	15000	16000	17800					0,29
I	6210	4900	6400	9700	11000	12900	14600	15600	17300					0,32
E	6211	4300	5900	9500	10900	12700	14400	15300	17000					0,39
S	6212	3800	5400	9300	10300	12400	14300	15200	16500					0,46
	6213	3100	4900	8900	10100	12200	14000	14800	16100					0,50
	6214	1100	2000	4100	5000	5900	6500	6900	7600					0,54
	6215	1000	1800	4400	5000	5600	6300	6700	7600					0,61
	6216	700	1600	4100	4700	5700	6500	6800	7500					0,68
	6304	8700	10100	13300	14800	17100	19100							0,14
	6305	8000	9400	12600	14100	16200	18200	19300						0,21
	6306	7300	8700	12000	13400	15400	17200	18300				> 20000		0,25
	6307	6600	8100	11400	12700	14500	16300	17300	19200					0,32
	6308	5900	7400	10800	12000	13700	15300	16300	18200	18600				0,39
6	6309	5300	6900	10400	11600	13400	15000	16000	17800	18200	19900			0,46
3	6310	4900	6400	9700	11000	12900	14600	19500	17300	17700	19500	19500		0,54
	6311	4300	5900	9500	10900	12700	14400	15300	17000	17400	19000	19000		0,64
S	6312	3800	5400	9300	10300	12400	14300	15200	16500	16800	18200	18200		0,75
E	6313	3100	4900	8900	10100	12200	14000	14800	16100	16400	17900	17900	19700	0,86
R	6314	1100	2000	4100	5000	5900	6500	6900	7600	7700	8600	8600	9600	0,96
I	6315	1000	1800	4400	5000	5600	6300	6700	7600	7900	8900	8900	9900	1,07
E	6316	700	1600	4100	4700	5700	6500	6800	7500	7700	8500	8500	9500	1,22
S	6317	800	1300	3900	4700	5600	6300	6700	7400	7500	8300	8300	9300	1,32
	6318	-	1000	3800	4600	5500	6200	6600	7200	7400	8200	8200	9100	1,47
	6319	-	800	3700	4500	5400	6100	6500	7100	7300	8000	8000	8900	1,61
	6320	-	-	3600	4300	5300	6000	6300	7000	7100	7900	7900	8800	1,82
	6321	-	-	3400	4200	5100	5800	6200	6800	7000	7800	7800	8700	2,00
	6322	-	-	3100	4000	5000	5700	6100	6700	6900	7700	7700	8600	2,14

1) Lubrication periodicity valid for NLG 1 and lithium based bearing lubricant.
2) Bearings for motors of X and XII poles - Lubrication Intervals > 20,000.

Table 13 - Bearing lubrication intervals and amount of grease

2 - CYLINDRICAL ROLLER BEARINGS

Bearings Characteristics	Ref.	Lubrication intervals (running hours) II Pole 60Hz 3600 rpm	II Pole 50Hz 3000 rpm	IV Pole 60Hz 1800 rpm	IV Pole 50Hz 1500 rpm	VI Pole 60Hz 1200 rpm	VI Pole 50Hz 1000 rpm	VIII Pole 60Hz 900 rpm	VIII Pole 50Hz 750 rpm	X Pole 60Hz 720 rpm	X Pole 50Hz 600 rpm	XII Pole 60Hz 600 rpm	XII Pole 50Hz 500 rpm	Amount of grease (oz)
	NU309	2800	4000	8300	9500	10700	11800	12500	14100	14500	16300	16300	18200	0,46
N	NU310	2400	3600	7900	9100	10300	11400	12200	13700	14000	15800	15800	17700	0,54
U	NU311	2000	3200	7400	8700	10000	11000	11800	13300	13600	15400	15400	17200	0,64
	NU312	1600	2700	6900	8300	9600	10700	11400	12800	13200	14900	14900	16800	0,75
3	NU313	1500	2500	6600	8100	9400	10500	11200	12700	13000	14700	14700	16500	0,86
	NU314	700	1100	3100	3900	4600	5200	5500	6200	6400	7200	7200	8100	0,96
	NU315	-	900	2900	3800	4500	5100	5500	6200	6300	7100	7100	7900	1,07
S	NU316	-	800	2800	3600	4400	5000	5400	6100	6200	7000	7000	7800	1,22
E	NU317	-	600	2600	3500	4300	4900	5300	6000	6100	6900	6900	7700	1,32
R	NU318	-	-	2100	3300	4300	4900	5300	5900	6000	6700	6700	7500	1,47
I	NU319	-	-	2300	3200	4100	4700	5100	5800	6000	6700	6700	7500	1,61
E	NU320	-	-	2000	3000	4000	4700	5000	5700	5900	6600	6600	7300	1,82
S	NU321	-	-	1900	2800	4000	4600	4900	5600	5700	6500	6500	7200	2,00
	NU322	-	-	1900	2600	3900	4400	4800	5500	5600	6400	6400	7100	2,14

1) Lubrication periodicity valid for NLG 1 and 2 lithium based bearing lubricant.

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.
The temperature of bearings lubricated as recommended under item 4.2.2 should not exceed 70°C.
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 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.
A lithium based grease is commonly used for the lubrication of electric motor bearings as it has good mechanical stability, is insoluble in water and has a drip point of approximately 200°C.
This grease should never be mixed with sodium or calcium based greases.

GREASES FOR MOTOR BEARINGS

For operating temperatures from - 20 to 130°C			
Frame	**Supplier**	**Grease**	**Temperature range**
143T-215T	Esso	Alvania R3	-20 to 130°C
254T to 586/7	Shell	Unirex N2	-30 to 165°C

Substitutes

Supplier	Grease	Temperature Range
Mobil	Mobilith SHC100	-40 to 177°C
ESSO	Beacon 2	-20 to 130°C
Atlantic	Litholine 2	-20 to 130°C
Texaco	Multifak 2	-20 to 130°C
Molikote	BG 20	-45 to 180°C
Inisilkon	L5012	-20 to 200°C

Note: When changing lubricant, please follow manfacturers instructions

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.

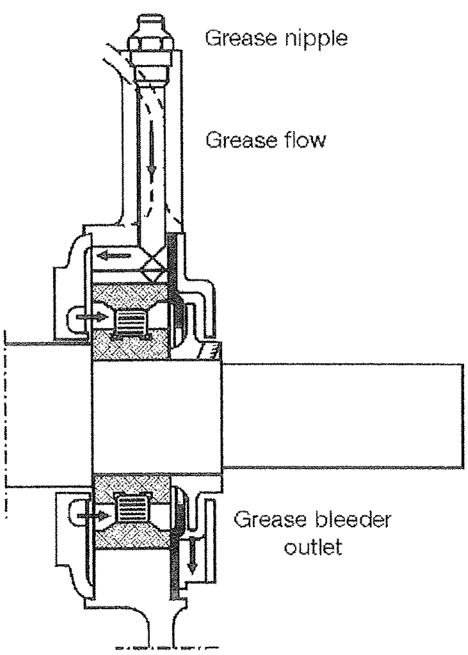
Cleaning and Lubrication of Bearings

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.

running 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 otor 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



the bearing case and hence into the motor.

Figure 4.1 - Bearings and lubrication system

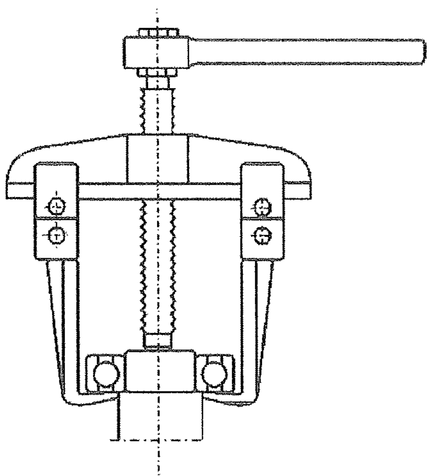
Nipples must be clean prior to introduction of grease to avoid entry of any alien bodies into the bearing.
For lubricating use only a manual grease gun.

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 (Ist layer) and an Epoxy resin (ISO 340) mixed with ground quartz (2nd 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 CO_2 extinguishers should be used - never water.

5.1 Standard Three-Phase Motor Failures

ving to the widespread usage of asynchronous three-phase ..otors 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.

.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. One 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

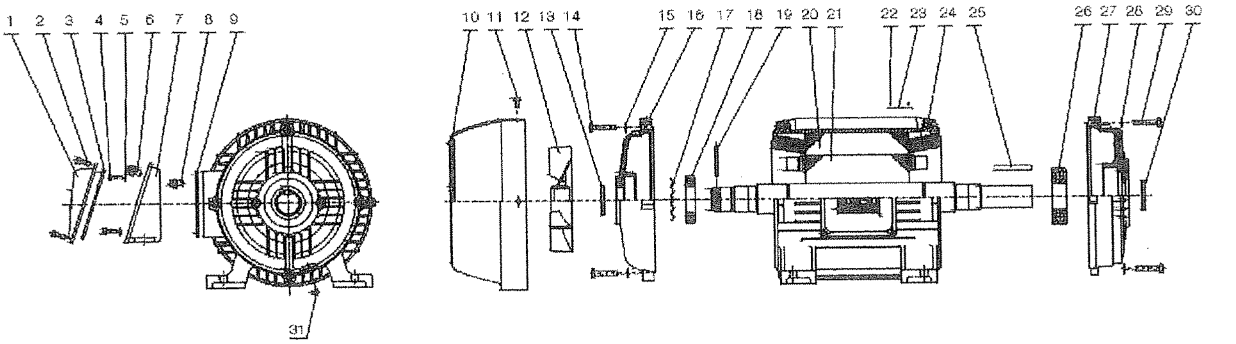
Damage to bearing and fracture in shafts often ensue from inadequate fitting of pulleys, couplings or pinions. There parts "knock" when rotating. The defect is recognized by the scratches that appear on the shaft or the eventual scalelike flaking of the shaft end.
Keyways with edges pitted by loosely 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	1.No voltage supply 2. Low voltage supply 3. Wrong control connections 4. Loose connection at some terminal lug 5. 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	1. Unbalance 2. Distorted shaft 3. Incorrect alignment 4. Uneven air gap 5. Dirt in the air gap 6. Extraneous matter stuck between fan and motor casing 7. Loose motor foundation 8. 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.
)verheating of bearings	1. Excessive grease 2. Excessive axial or radial strain on belt 3. Deformed shaft 4. Rough bearing surface 5. Loose or poorly fitted motor end shields 6. Lack of grease 7. Hardened grease cause locking of balls 8. 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	1. Unbalanced rotor 2. Dirty or worn bearing 3. Bearing rings too tight on shaft and/or bearing housing 4. 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	1. Obstructed cooling system 2. Overload 3. Incorrect voltages and frequecies 4. Frequent inversions 5. Rotor dragging on stator 6. 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.

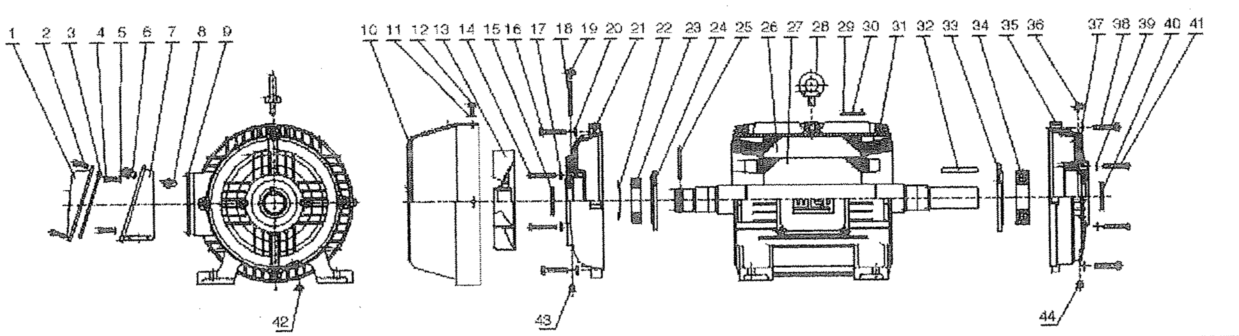
6. Spare Parts and Component Terminology

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



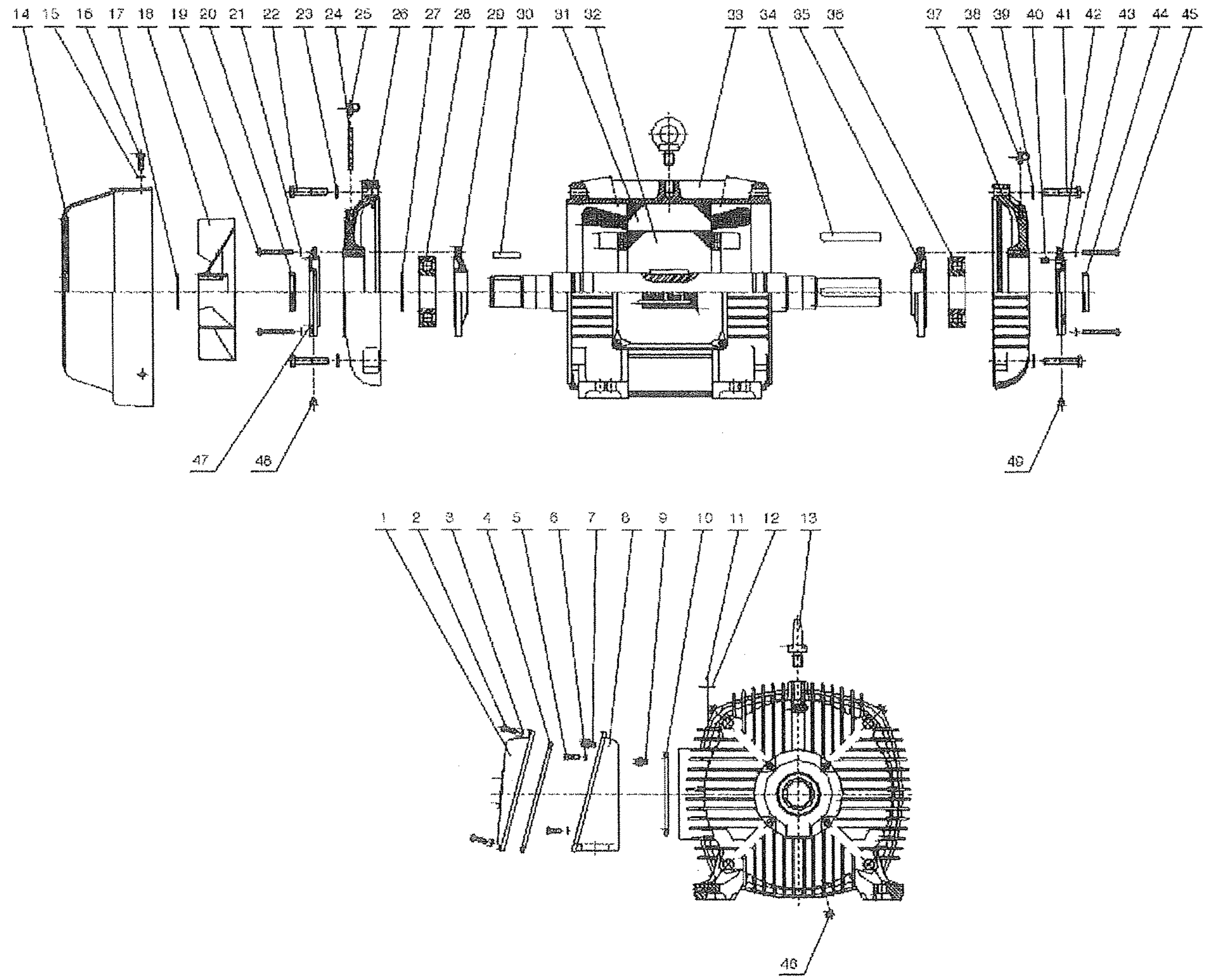
Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover gasket
4	Terminal box fixing bolt
5	Terminal box fixing washer
6	Terminal box grounding lug
7	Terminal box
8	Frame grounding lug
9	Terminal box o'ring gasket
10	Fan cover
11	Fan cover fixing bolt
12	Fan
13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



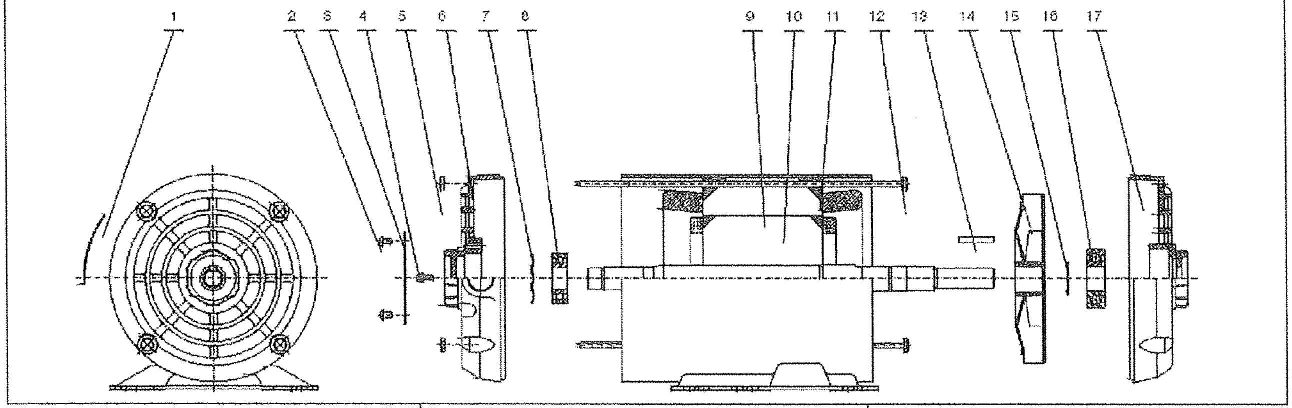
Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover gasket
4	Terminal box fixing bolt
5	Terminal box fixing washer
6	Terminal box grounding lug
7	Terminal box
8	Frame grounding lug
9	Terminal box o'ring gasket
10	Fan cover
11	Fan cover washer
12	Fan cover fixing 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



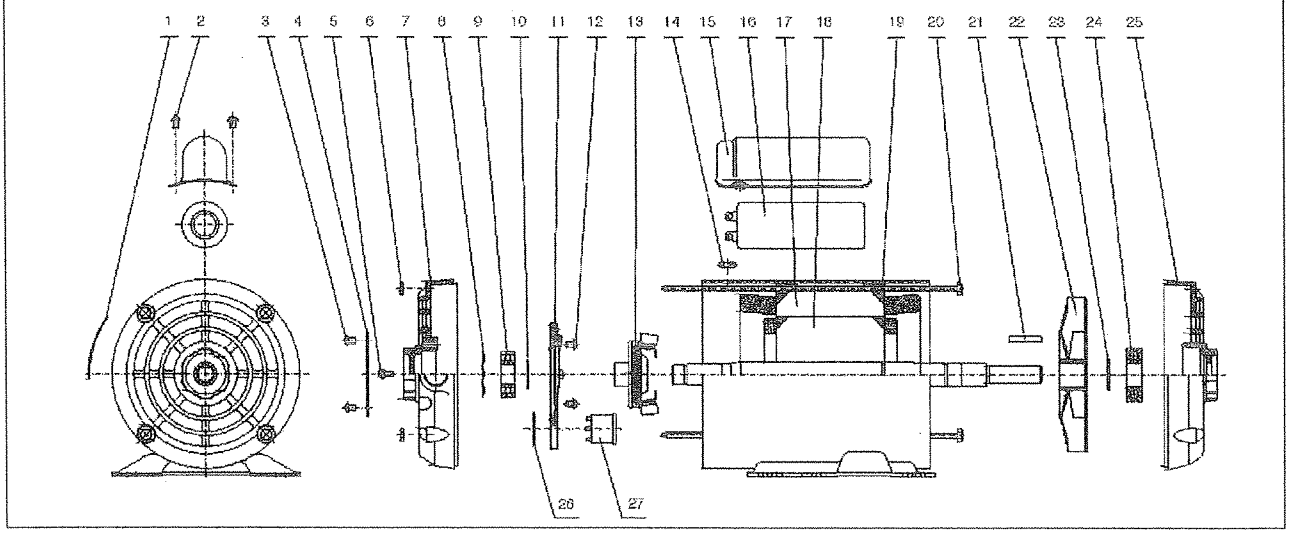
Part Nr.	Description
1	Terminal box cover
2	Terminal box cover fixing bolt
3	Terminal box cover washer
4	Terminal box cover gasket
5	Terminal box fixing bolt
6	Terminal box fixing washer
7	Terminal box grounding lug
8	Terminal box
9	Frame grounding lug
10	Terminal box o'ring gasket
11	Nameplate fixing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

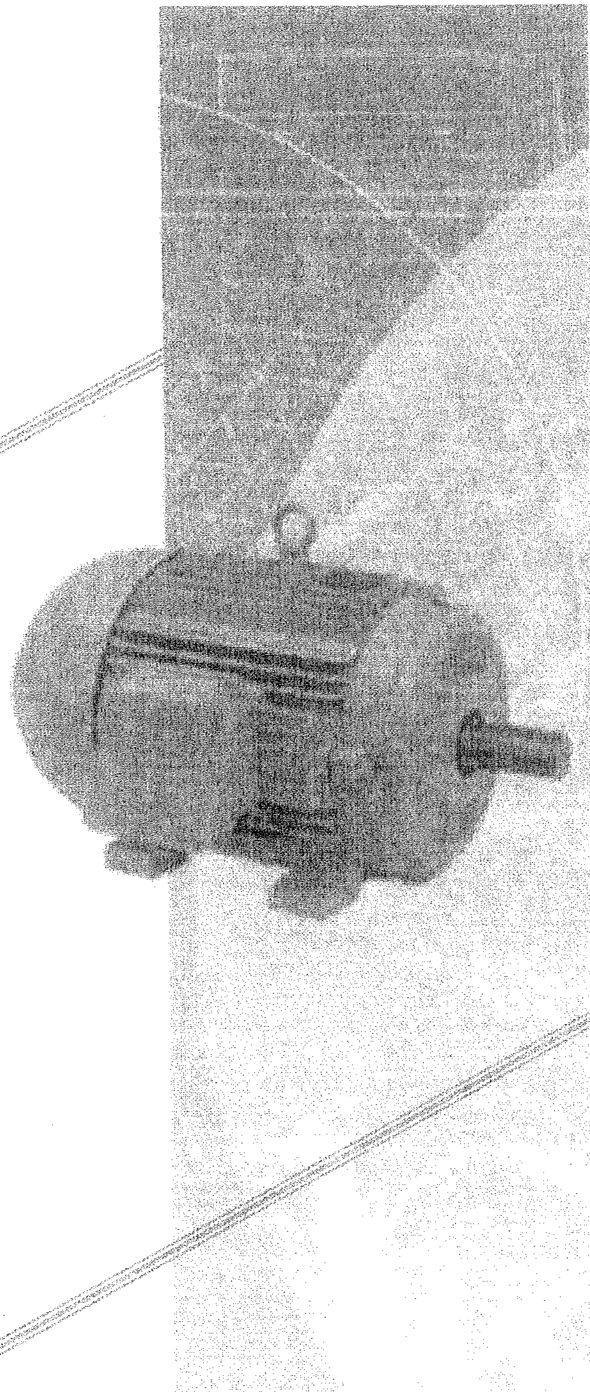


Part Nr.	Description
1	Sticker
2	Capacitor cover fixing bolt
3	Terminal box cover fixing bolt
4	Terminal box cover
5	Grounding lug
6	Through bolt fastening nut
7	Non-drive endshield
8	Spring washer
9	Non-drive and bearing
10	Non-drive and bearing fastening washer
11	Stationary switch
12	Stationary switch 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:

NOTES:



THE FOLLOWING INSTALLATION AND MAINTENANCE MANUALS ARE AVAILABLE

Low and High Voltage Large Motors Induction, Slip Ring, H Line, M Line, A Line

DC Motors

Tacho Generator Dynamo

Generators "GTA" Line

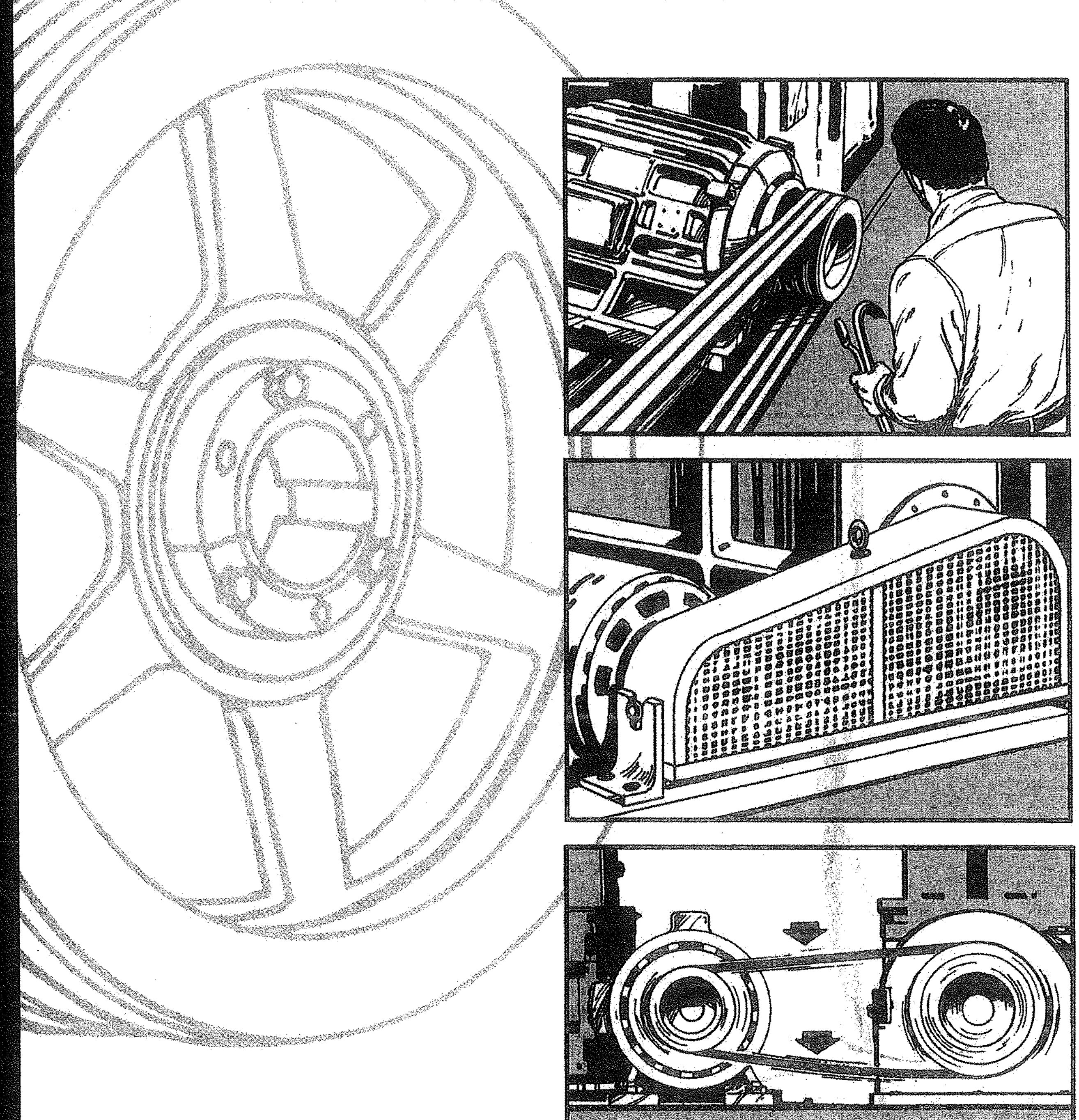
YOU CAN REQUEST THE ABOVE MANUALS FROM YOUR NEAREST WEG SALES OFFICE.

WEG Electric Motors Corp.
2100 Brighton-Henrietta Townline Road
Rochester NY 14623
PHONE: 716-240-1000
FAX: 716-240-1034

DRIVE COMPONENTS

DODGE®
Move *faster* with the *World* Leader.™

V-BELT DRIVE
INSTALLATION AND MAINTENANCE TIPS



Rockwell Automation
Dodge

DODGE® V-Belt Drive Installation and Maintenance Tips

Installation and Practical Maintenance Tips for V-Belts

In many of the jobs you do, you're faced with a choice: do it **quickly** or do it **safely**. However, the tips in this manual can help you achieve both in working with your V-belt drives.

Unlike much of the complicated equipment in use today, V-belt drives can be maintained properly without an armful of instruments and tools. In fact, you can cover most situations by using a few items which you can carry in your pocket.

Naturally, this simplified maintenance also has an important influence on your safety picture. With V-belt drives, it's easy to combine effective maintenance with sound safety practices. In fact, you will find that the **safest** way to do a job is simply to use good common sense and do it the **easy** way.

To achieve these goals, the subjects listed below will be discussed on the following pages:

- **Safety**
- **Proper installation of belts and sheaves**
- **Inspection of drives**
- **Troubleshooting**
- **Recognizing and identifying service problems**

Make Sure the Drive Design Is Correct

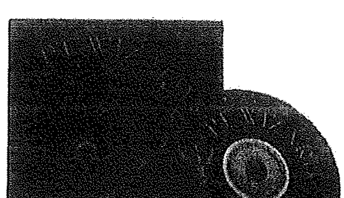
DODGE® SOFTWARE™
Computer Selection of DODGE V-Drives

VIA-VISA®

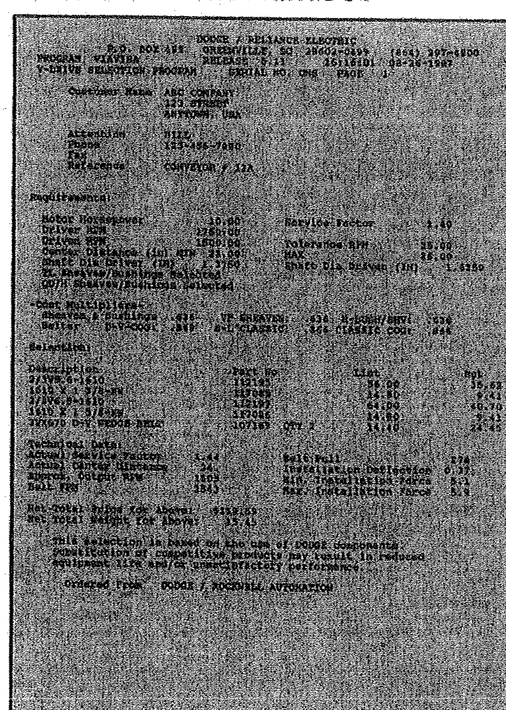
The DODGE VIA-VISA program provides the user with the technical expertise of DODGE Engineering by virtue of this easy-to-use computer program. All relevant data for up to ten alternate drive selections is presented in a format that allows quick accurate analysis, whether based upon lowest price, minimum bearing load, highest service factor, etc.

VIA-VISA also calculates speed-up drives or drives for nonstandard motor speeds. The most appropriate selection can then be specified using the computer printout, which contains sheave, bushing and belt sizes and part numbers.

The VIA-VISA program is available as part of the DODGE PT WIZARD™ CD-ROM. For more information on how to purchase PT WIZARD, call 864-232-6681.



SAMPLE VIA-VISA PRINTOUT



DODGE / RELIANCE ELECTRIC

Customer Name ABC COMPANY

ANYTOWN, USA

Requirements:

Motor Horsepower

Driver RPM

Driven RPM

Service Factor

Selection:

Description Part No List

Technical Data:

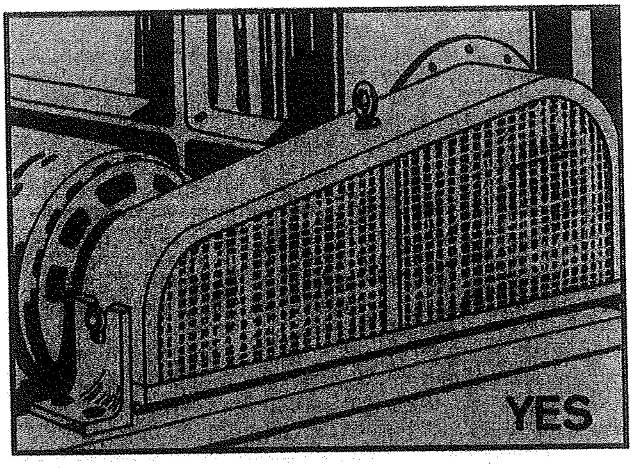
This selection is based on the use of DODGE components. Substitution of competitive products may result in reduced equipment life and/or unsatisfactory performance.

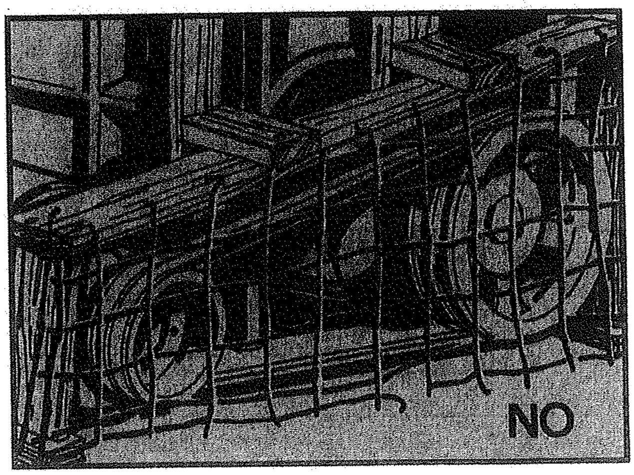
Ordered From DODGE / ROCKWELL AUTOMATION

Practicing Common Sense Precautions

WARNING

Do not operate V-drive when belt guard is not in place. Failure to have belt guarded can result in severe personal injury.





Keep drives guarded properly

Regulatory agencies*, insurance firms and other safety authorities require drive guards. A make-shift, partial guard can often be more dangerous than no guard at all, since it gives you a false sense of security and encourages unsafe actions.

Of course, provisions can—and should—be made for proper ventilation and inspection by the use of grills. Besides being a safety asset, a good guard also helps make your maintenance job easier by protecting the drive from weather, debris and tampering.

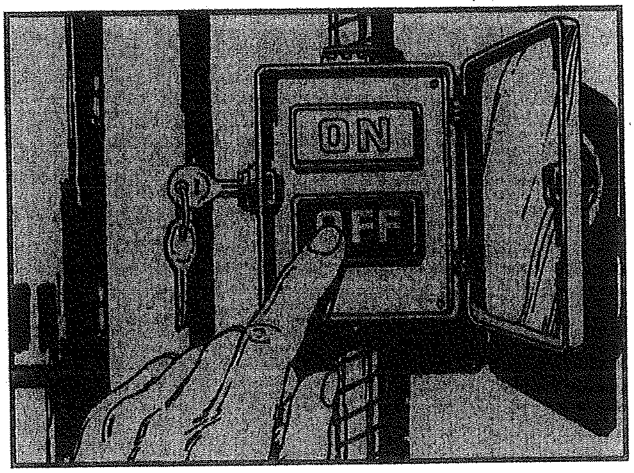
DODGE offers a complete line of V-belt, chain and coupling guards. Refer to the DODGE Engineering Catalog for specification details.

*See OSHA Standards for Federal drive guard requirements.

Always turn equipment "off" for maintenance

WARNING

Turn off and lock out power to machinery before working on V-belt drive. Failure to do so can result in serious personal injury.

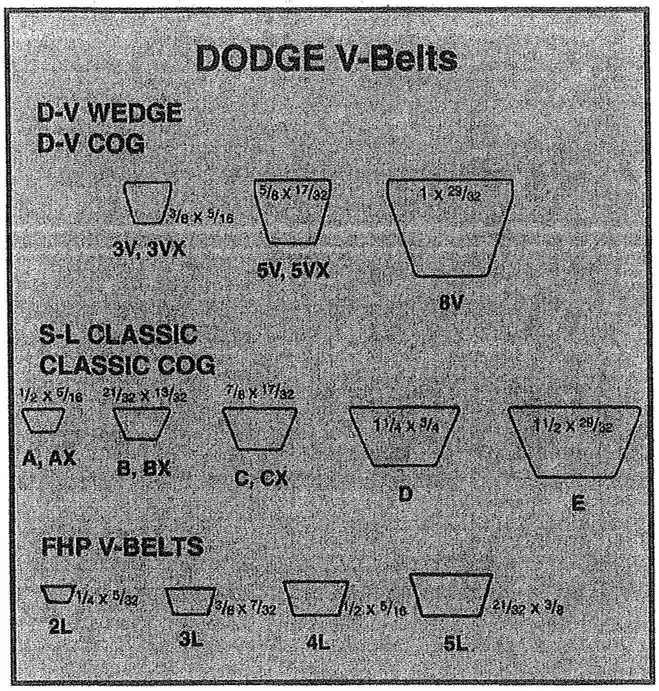


Make sure equipment is turned off whenever you work on a drive, even if you're only going to touch it briefly. Tag equipment with a warning sign to indicate "down for maintenance" so that someone else won't turn the machine on before you are ready. Put a padlock on the controls, **and take the key.**

Make sure all machine components are in a "safe" position. Disengage, lock out or block machine components to prevent inadvertent rotation of V-drive while maintenance is being performed. Always follow manufacturers' recommendations for safe maintenance practices.

As you can see, basic V-belt drive safety is largely a matter of common sense. You'll find this same common sense action will help make your maintenance job both safe and easy. In fact, both V-belt maintenance and safety boil down to a few simple steps involving proper installation, inspection and sound corrective action outlined on the following pages.

Before installing a new set of V-belts make sure you have the right type



Shown at left are standard types of V-Belts in general industrial use today: the A, B, C, D and E sections; the narrow 3VX, 5V, 5VX and 8V sections, and the light duty sections. Normally you will know which type to use. But if you are not sure (for example, if the labels on the old belts used on the drive are illegible), measure the top width of the old belts carefully—or use DODGE belt and sheave gauges. These are shown on page 5.

As you can see by looking at the nominal dimensions, there is some possibility of confusion. For example, top widths of the B and 5V sections are very close. But the 5V is considerably thicker, and the groove angles of the sheaves are different. If you try to use the one cross section on a drive designed for the other, you won't get proper belt life.

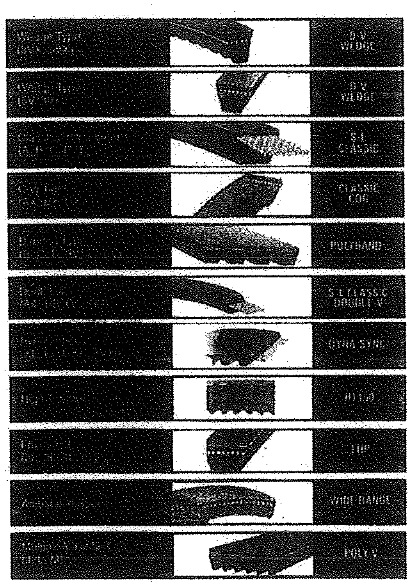
Also, you'll notice that the 4L and 5L light duty sections are very close to the A and B sections, but again, groove angles may be different. **Never** use light duty belts on heavy duty industrial applications, even if they **seem** to fit the sheave grooves. The light duty belts have characteristics which are ideally suited for their own type of applications such as light machinery and appliances—but they aren't built for heavy duty jobs.

NOTE: DODGE D-V WEDGE line consists of:
3VX—molded notch all lengths.
5VX—molded notch lengths up through 5VX2000. All longer lengths are standard 5V construction, unnotched.
8V—standard, unnotched construction.
For simplicity, the sheave groove dimensions are referred to as 3V, 5V, 8V.

Always use a matched set of new belts from one manufacturer

DODGE V-Belts
Matched to RMA/MPTA Standards

Now a technological breakthrough that eliminates belt matching. Belts are matched when you get them—stay matched throughout their life on your drive!



When installing new belts on a drive, always replace **all** the belts. Old belts have naturally become slightly worn or stretched from use. If old and new belts are mixed, the new belts will be tighter, will carry more than their share of the load, and will probably fail before their time.

NOTE: Before installing belts, be sure the set is **matched** properly (if multiple set), and be sure it is the proper size and cross section.

Belts from different manufacturers can have different characteristics. Even slight differences cause the belts to work against each other, resulting in unusual strain and short life.

The best way to assure well-matched belts is to order them from your DODGE distributor.

YOUR BEST BET: USE DODGE MATCHED BELTS

All D-V WEDGE, S-L CLASSIC & CLASSIC COG belts of the same cross section and length designation will match with any other like belt supplied by DODGE.

Tips on Safe Procedures for:

– Removing worn V-belts
– Inspecting sheaves and components
– Installing and tensioning new V-belts

Removing Worn Belts

> WARNING
> **Turn off and lock out power to machinery before working on V-belt drive. Failure to do so can result in serious personal injury.**

Most drives have two sheaves, one on the motor and one on the driveN machine. The motor base usually has slotted holes to allow for adjustment toward and away from the driveN machine. Loosen the motor hold down bolts and move the motor **toward** the driveN machine to the inner end of the adjustment to release tension on the belts. Use a pry bar against the motor base, if needed. The belts should now be quite loose. If the drive has an idler instead of an adjustable motor base, loosen the hold down bolts and swing the idler away from the belts, allowing them to hang loose. **Be sure to use all the adjustment in the drive to loosen belts completely.**

Now remove the belts carefully from each sheave. Do not move motor or machine after belt removal.

WARNING—AVOID SERIOUS INJURY

Do not pry belts OFF drive or attempt to roll them OFF by rotating sheaves. Doing this can result in serious personal injury.

Inspecting Sheaves and Components

Check the sheaves carefully for worn grooves or damage. (Safety tip: Always use gloves or a cleaning rag when checking the inside of grooves to avoid being cut by nicks or burrs.)

Sometimes you can actually see the worn areas in the groove sidewall, but a more dependable way is to use the Sheave Gauge. (This can be ordered from your DODGE Field Engineer.) Select the proper gauge and place it in the groove.

If the sheave is satisfactory, this is a good time to check alignment. Readjust, if needed. (See page 4 for suggestions.)

If sheaves are worn excessively, remove them and replace with new ones. See page 5 for installation tips.

Worn sheaves can seriously shorten the life of V-belts, especially the joined, POLYBAND® form. The POLYBAND belts will ride lower in the grooves, forcing the tie band against the sheave land. This will reduce the wedging effect, or if severe enough, cut the tie band, destroying the advantage of a joined belt.

If original sheaves are satisfactory, or if new ones have been installed, put new belts on the drive as shown below.

NOTE: While drive is shut down, inspect all other drive components such as shafts, bearings and guards. Repair or replace damaged and worn parts.

Installing and Tensioning the New V-Belts

With the sheaves or idler moved to minimum center distance for belt removal as described above, the new belts can be easily placed over the sheaves and dropped into the grooves. (If motor has been moved, readjust it to provide slack for easy installation.)

Tension Your Drive Properly

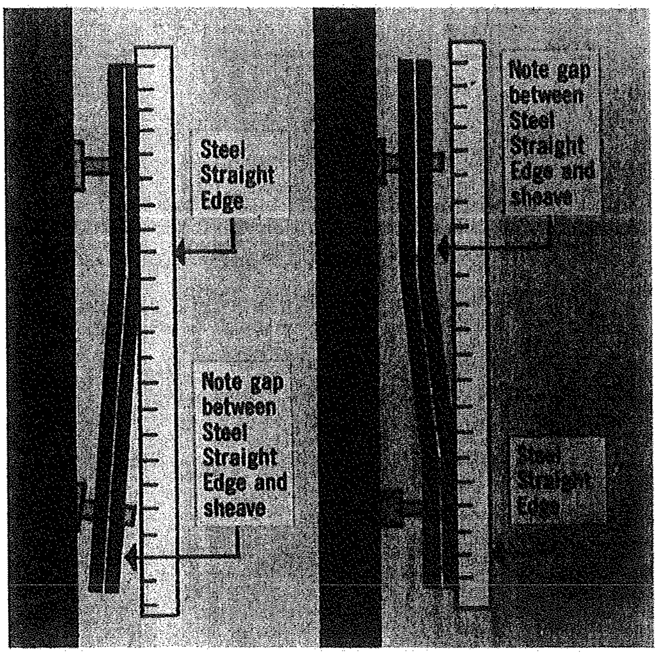
Your final installation step is to tension your drive properly for trouble-free service. In general, a few simple rules will eliminate tension problems:

- The best tension for a V-belt is the **lowest** tension at which the belts will not slip under full load.
- Simply take up the drive until the belts are snug in the grooves. (Check sheave alignment as shown on page 4.) Run the drive for about 15 minutes to "seat" the belts. If the belts slip, tighten them until they no longer slip at peak load.
- Remember, too much tension shortens belt and bearing life.
- Check tension at the end of the first day's operation. Check it periodically thereafter and make any necessary adjustments.

Although tension of a V-belt drive is usually not critical, accurate tensioning can help assure proper drive performance. We realize that many experienced maintenance men have developed a "feel" for belt tension — but because of improved materials now being used by many manufacturers, today's belt can "feel" considerably different on the drive. Therefore, if a numerical method is desired use the simple method described on page 6.

Keep take-up rails and motor base free of dirt, rust and grit, and lubricate them lightly from time to time on your regular maintenance rounds. That way, when you're ready to install new belts, it'll be **easier** to do it the **safe** way.

Check sheave mounting and alignment

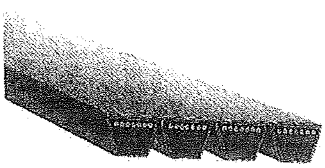


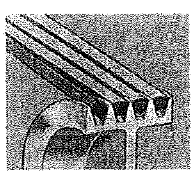
V-belt drives do not require alignment to as close tolerances as most other types of drives—but unless the belts enter and leave the sheaves in a relatively straight line, wear is accelerated.

The two most common causes of misalignment are shown at left: (a) the shafts of the driveR and driveN machines are not parallel, and (b) the sheaves are not located properly on the shafts. To check alignment all you need is a straight-edge or, for drives with longer centers, a steel tape. If these aren't available, you can, as a last resort, even use heavy string. Just line the straight-edge or tape along the outside face of both sheaves as shown in the illustration. Misalignment will show up as a gap between the sheave face and straight-edge, or perhaps as a "break" in the tape or string. Make sure that the width of the outside land is equal on both sheaves when using this method.

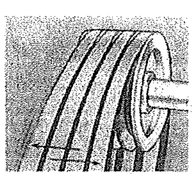
A third cause of misalignment is "tilted" or improperly mounted sheaves. The best way to prevent this is to follow the mounting steps shown on page 5. Sheaves that are already installed can be checked for "tilt" by using a spirit level.

DODGE POLYBAND Belts Ideal on Problem Drives

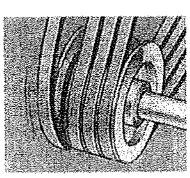




• NO TURN OVER



• NO WHIP



• NO JUMP OFF

The POLYBAND belt was developed to solve troublesome problems on those drives where belts whip, turn over or come off drives.

POLYBAND belts stay on the drive—thus eliminating downtime as well as the maintenance cost involved in reinstalling belts on the sheaves. The new belt consists of multiple V-belts permanently vulcanized together with a tie band to minimize the possibility of its turning over or coming off the sheaves.

POLYBAND Belt Sizes

POLYBAND belts have standard dimensions for B, C, D and E and 3VX, 5VX, 5V and 8V in DYNA-V® cross sections. Spacing between strands is the same as RMA standard spacing for multiple groove sheaves. Their use is not recommended in deep grove or badly worn sheaves.

POLYBAND Belt Installation

The same procedure is used with POLYBAND belts as is recommended for single strand belts. Never "pry" or "crow bar" belts onto a drive.

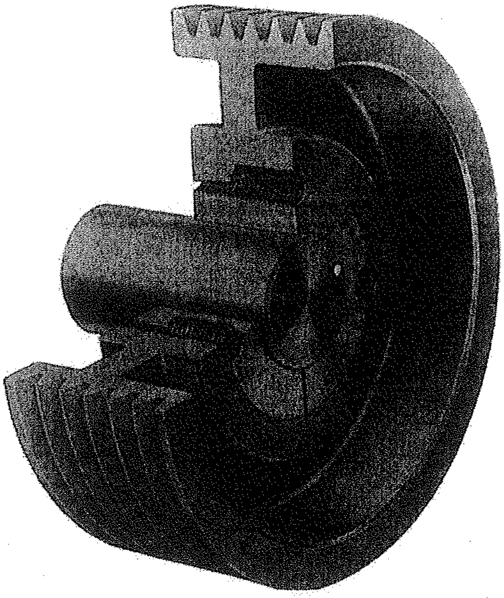
POLYBAND Belt Tensioning

General tensioning principles which apply to single belts also apply to POLYBAND belts. Tensioning information for new and replacement POLYBAND belts will be the same as single belts.

The only special consideration which must be given in properly tensioning a POLYBAND belt is that the entire belt must be deflected uniformly. This can be accomplished by placing a rigid bar, which will extend across the width of the belt, between the tension tester and the belt.

Tips on Proper Sheave Mounting

If the sheaves need replacing, they are attached to the motor shaft and driven machine shaft with bushings as follows:



TAPER-LOCK®

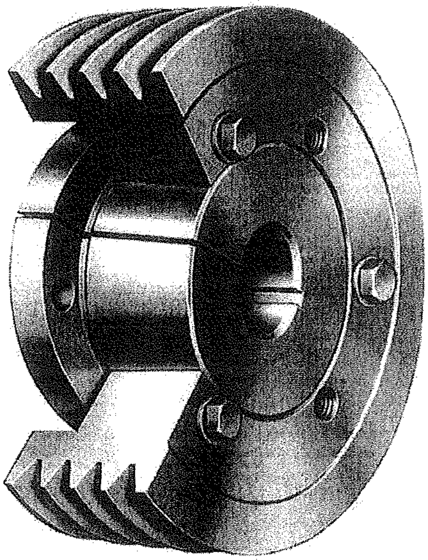
Insert bushing in sheave. Match holes (not threads) and slip entire unit onto shaft.

Put screws into the holes that are threaded in the sheave only. Align the sheave and tighten screws. As the bushing is wedged inward it contracts and grips the shaft.

IMPORTANT—
With either type of sheave, always make sure that the mating surfaces of the sheave and hub are free of all foreign substances such as dirt, grease or paint.

After sheaves and bushings are on the shaft, align them before final tightening. Install belts.

QD*



Slide QD hub on shaft, flange end first. Assemble key. Position QD hub on shaft. Tighten setscrew over key "hand tight" with standard Allen wrench only. Do not use excessive force.

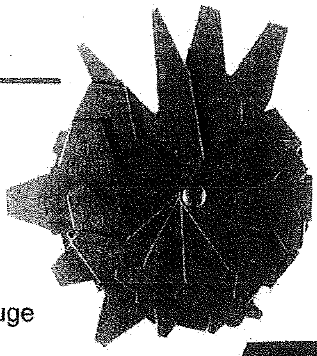
Slide large end of sheave taper bore into position over cone, aligning pullup bolt holes in sheave, and tapped holes in flange of hub. Assemble pullup bolts and lock washers.

Tighten bolts alternately and evenly. Do not use extensions on wrench handles. There should be a gap between the face of the sheave hub and the flange of the QD hub to ensure a satisfactory cone grip and press fit. **This gap must not be closed.**

(In addition to this standard mounting arrangement, most sheaves using "J" hub and smaller may have bolts inserted through hub flange into rim to provide alternate hub locations.)

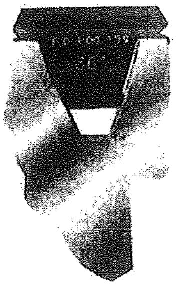
*QD is a registered trademark of Emerson.

V-Belt Tools



Belt and Sheave Gauges

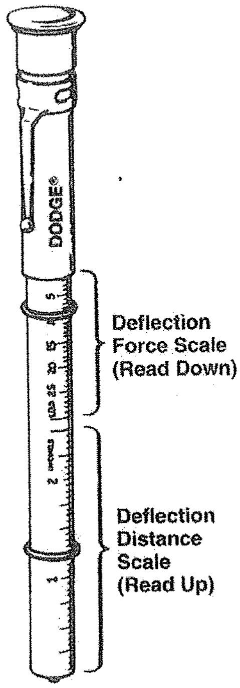
The complete belt set includes three belt gauges: one for A, B and C sections; one for D and E sections; and one for 3V, 5V and 8V sections (includes D-V COG molded notch). To determine proper belt section, simply place the old belt in the gauge as far as it will go, and read the section marked on the gauge.



The complete set of sheave gauges include one for each heavy duty V-belt section (A, B, C, D, E and 3V, 5V, 8V). Each gauge includes a template for all standard angles used with that section and sheave diameter, clearly marked for easy identification. For example: C — 34°, P.D. 6.00-7.99; 36°, P.D. 8.00-12.00; 38°, P.D. over 12.00.

To check sheave grooves for wear, simply select the proper gauge, find the correct template for the sheave diameter used and insert the template in the sheave groove until the rim of the gauge butts against the sheave land. Worn grooves will show up as in the illustration at right. If you can detect significant wear along the side of the grooves, poor V-belt life would probably result.

How to Use DODGE Tension Tester



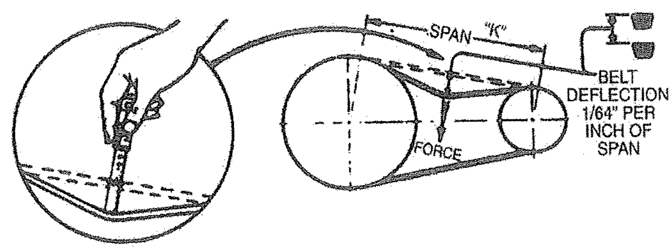
The method described below will give accurate tensioning values using either a spring scale or, for greater speed and convenience, DODGE Tension Tester. Tension Testers may be ordered through your DODGE Distributor. The method should be used **only** if:

- The drive has been selected from Stock Drive Tables of the DODGE Engineering Catalog.
- The number of belts on the drive conforms to recommendations in the manuals.

(Note: For drives not meeting these requirements, consult the tension section of the appropriate DODGE design manual.)

1. Measure the span length K.
2. At center of span K apply force, with DODGE Tension Tester perpendicular to the span, large enough to deflect one belt on the drive 1/64" per inch of span length from its normal position. Determine amount of deflection **distance** on lower linear scale of Tension Tester by sighting straight across top(s) of belt(s) on drive. Straight-edge laid across belts can help ensure accuracy of reading. Scale is divided in 1/16" increments.
3. Find amount of deflection force on upper scale of Tension Tester. The Sliding Rubber "O-Ring" slides down scale as tool compresses—stays down for accurate reading of pounds pressure. Read at top edge of ring. (Slide ring up before reusing.)
4. Compare deflection force with range of forces in tables below. If less than minimum recommended deflection force, belts should be tightened. If more than maximum recommended deflection force, drive is tighter than necessary.

NOTE: There will normally be a rapid drop in tension during the "run-in" period. Tension new drives with a 1/3 greater deflection force than the maximum force recommended. Check tension again at the end of first day's operation.



Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force: S-L Classic Uncogged POLYBAND*, Normal	S-L Classic Uncogged POLYBAND*, New Belt	Classic Cog Cogged POLYBAND*, Normal	Classic Cog Cogged POLYBAND*, New Belt
A, AX	3.0-3.6	1000-2500	3.7	5.5	4.1	6.1
		2501-4000	2.8	4.2	3.4	5.0
	3.8-4.8	1000-2500	4.5	6.8	5.0	7.4
		2501-4000	3.8	5.7	4.3	6.4
	5.0-7.0	1000-2500	5.4	8.0	5.7	9.4
		2501-4000	4.7	7.0	5.1	7.6
B, BX	3.4-4.2	860-2500			4.9	7.2
		2501-4000			4.2	6.2
	4.4-5.6	860-2500	5.3	7.9	7.1	10.5
		2501-4000	4.5	6.7	7.1	9.1
	5.8-8.6	860-2500	6.3	9.4	8.5	12.6
		2501-4000	6.0	8.9	7.3	10.9
C, CX	7.0-9.0	500-1740	11.5	17.0	14.7	21.8
		1741-3000	9.4	13.8	11.9	17.5
	9.5-16.0	500-1740	14.1	21.0	15.9	23.5
		1741-3000	12.5	18.5	14.6	21.6
D	12.0-16.0	200- 850	24.9	37.0		
		851-1500	21.2	31.3		
	18.0-20.0	200- 850	30.4	45.2		
		851-1500	25.6	38.0		

Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force: D-V Wedge, Uncogged POLYBAND*, Normal	D-V Wedge, Uncogged POLYBAND*, New Belt	D-V Wedge, Cogged POLYBAND*, Normal	D-V Wedge, Cogged POLYBAND*, New Belt
3V, 3VX	2.2-2.4	1000-2500			3.3	4.9
		2501-4000			2.9	4.3
	2.65-3.65	1000-2500	3.6	5.1	4.2	6.2
		2501-4000	3.0	4.4	3.8	5.6
	4.12-6.90	1000-2500	4.9	7.3	5.3	7.9
		2501-4000	4.4	6.6	4.9	7.3
5V, 5VX	4.4-6.7	500-1749			10.2	15.2
		1750-3000			8.6	13.2
		3001-4000			5.6	8.5
	7.1-11.3	500-1740	12.7	18.9	14.8	22.1
		1741-3000	11.2	16.7	13.7	20.1
	11.8-16.0	500-1740	15.5	23.4	17.1	25.5
		1741-3000	14.6	21.8	16.8	25.0
8V, 8VX	12.5-17.0	200- 850	33.0	49.3		
		851-1500	26.8	39.9		
	18.0-22.4	200- 850	39.6	59.2		
		851-1500	35.3	52.7		

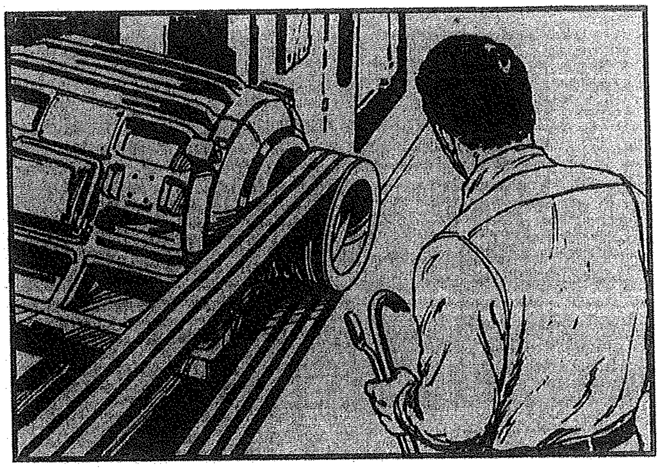
POLYBAND Plus Belt Deflection Force (lbs.)
(Force in pounds for one belt only)

Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force*: Normal	Belt Deflection Force*: New Belt
5VF	7.1-10.9	200- 700	21.1	30.9
		701-1250	18.0	26.3
		1251-1900	16.7	23.4
		1901-3000	15.8	23.0
5VF	11.8-16.0	200- 700	26.8	39.5
		701-1250	23.5	34.7
		1251-2100	22.7	33.3
8VF	12.5-20.0	200- 500	44.7	65.8
		501- 850	38.5	56.6
		851-1150	35.2	51.6
		1151-1650	33.5	49.0
8VF	21.2-25.0	200- 500	65.9	97.6
		501- 850	61.2	90.6
		851-1200	57.0	84.3

*In tensioning DODGE POLYBAND belt, multiply the pounds of deflection force as shown in the table by the number of belts in the band. The tension tester can be applied as indicated above to deflect the entire POLYBAND belt, providing a small board or metal plate is placed on top of the band so that all belts in the band are deflected a uniform amount. A straight-edge can be laid across the sheaves to use as a reference for measuring deflection. If the deflection force exceeds 35 pounds (the maximum reading on the tester); use a large spring scale or consult your DODGE representative.

Inspection

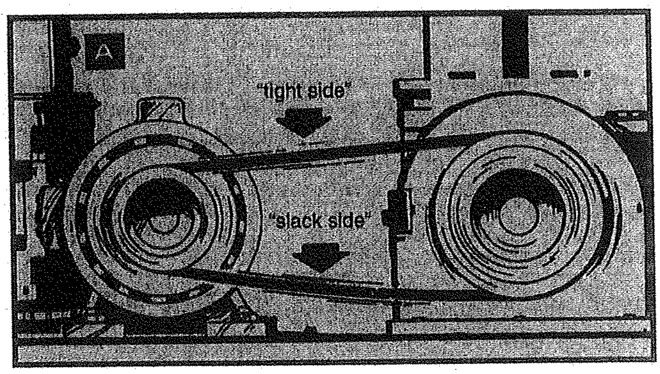
If you've followed proper installation procedures, you're already 90% in the clear because a properly installed V-belt drive is a remarkably trouble-free piece of equipment. But to make sure your drive **keeps** working properly, make a quick inspection as part of your regular maintenance schedule.



While the drive is running...

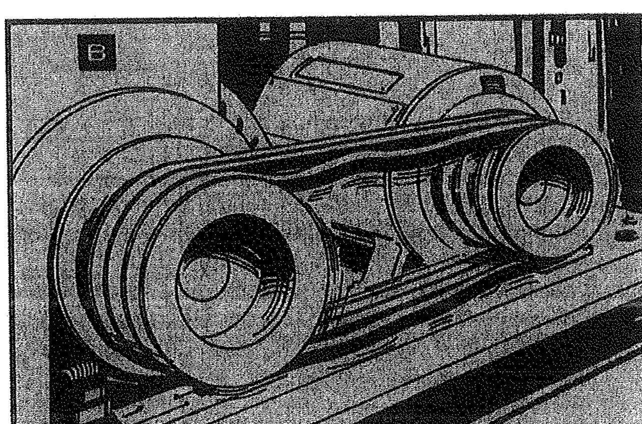
Much of this inspection is simply a matter of using your eyes and ears whenever you are around the drive. Start by listening for sounds that might mean trouble. For example:

- Slapping of belts against the drive guard or some other obstruction. This could be caused by an improperly placed guard—or by loose belts or excessive vibration.
- Squealing of belts as they run. This is usually caused by poorly tensioned belts—or by foreign material in the sheave grooves.

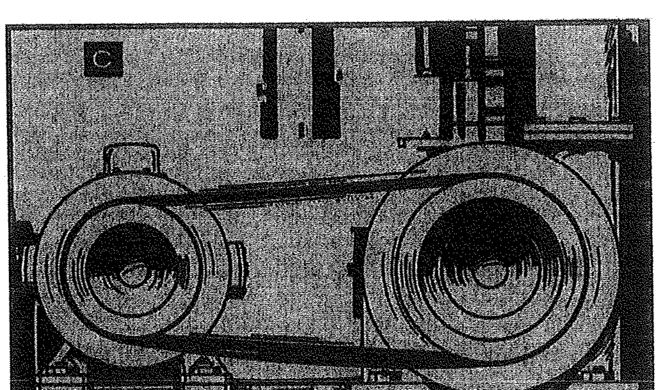


Also watch the drive while it runs. Although multiple belt drives run with some variation, all the belts should be running at about the same tension, with a "tight side" and a "slack side" as shown on drive "A" at right. If one or more belts are **too** loose, as on drive "B", or too tight, drive "C", chances are that you have one of these problems:

- Worn sheaves: check for sheave groove wear, using DODGE sheave gauges.
- Improper tension: the drive may be poorly tensioned, exaggerating normal length variations.
- Damaged belt: remove the loose belt and inspect it throughout its length to make sure it has not been accidentally broken internally
- Improper matching: if none of these seem to be the case, check your belt set to make sure the matching numbers fall within allowable limits. Better yet, install a new set of DODGE V-belts to assure proper matching and load sharing of the belts.



NOTE: In most illustrations throughout this catalog, safety guards have been removed for photographic purposes.



Trouble Shooters' Guide

Trouble Area and Observation	Cause	Remedy

Belt Stretch Beyond Take Up

Trouble Area and Observation	Cause	Remedy
Belts stretch unequally.	Misaligned drive, unequal work done by belts.	Realign and retension drive.
	Belt tensile member broken from improper installation.	Replace all belts with new matched set, **properly** installed.
All belts stretch about equally.	Insufficient takeup allowance.	Check takeup and follow allowance in DODGE Engineering Catalog.
	Greatly overloaded or underdesigned drive.	Redesign using DODGE Engineering Catalog or VIA-VISA software.*

Short Belt Life

Trouble Area and Observation	Cause	Remedy
Relatively rapid failure; no visible reason.	Tensile members damaged through improper installation.	Replace with all new DODGE belts properly installed.
	Worn sheave grooves (check with groove gauge).	Replace sheaves.
	Underdesigned drive.	Redesign using DODGE Engineering Catalog or VIA-VISA software.*
Sidewalls soft and sticky. Low adhesive between cover plies. Cross section swollen.	Oil or grease on belts or sheaves.	Remove source of oil or grease. Clean belts and grooves with cloth moistened with non-flammable, non-toxic degreasing agent or commercial detergent and water.
Sidewalls dry and hard. Low adhesion between cover plies. Bottom of belt cracked.	High temperatures.	Remove source of heat. Ventilate drive better.
Deterioration of rubber compounds used in belt.	Belt dressing.	Never use dressing on V-belts. Clean belts and grooves with cloth moistened with non-flammable, non-toxic degreasing agent or commercial detergent and water. Tension drive properly to prevent slip.
Extreme cover wear.	Belts rub against belt guard or other obstruction.	Remove obstruction or align drive to give needed clearance.
Spin burns on belt.	Belts slip under starting or stalling load.	Tighten drive until slipping stops.
Bottom of belt cracked.	Too small sheaves.	Redesign for larger sheaves using DODGE Engineering Catalog or VIA-VISA software.*
Broken belts.	Object falling into or hitting drive.	Replace with new matched set of belts. Provide shield for drive.

* See inside front cover.

If your V-belt drive is properly designed and properly installed, it needs very little maintenance. Occasionally, however, a drive may be accidentally damaged or knocked out of adjustment. Changing operating requirements or environmental conditions may lead to problems. This guide is designed to help you discover these problems before they cause machine downtime—and to help you correct them quickly.

Trouble Area and Observation	Cause	Remedy
Belt Turnover		
	Excess lateral belt whip.	Use DODGE POLYBAND belt.
	Foreign material in grooves.	Remove material— shield drive.
	Misaligned sheaves.	Realign the drive.
	Worn sheave grooves (check with groove gauge).	Replace sheave.
	Tensile member broken through improper installation.	Replace with new DODGE belt set properly installed.
	Incorrectly placed flat idler pulley.	Carefully align flat idler on slack side of drive as close as possible to driveR sheave.
Belt Noise		
	Belt slip.	Retension drive until it stops slipping.
Improper Driven Speed		
Incorrect driveR - driveN ratio.	Design error.	Use correct sheave sizes.
Spin burns on belt.	Belt slip.	Retension drive until belt stops slipping.
Hot Bearings		
Drive over tensioned.	Worn grooves—belts bottoming and will not transmit power until over tensioned.	Replace sheaves. Tension drive properly.
	Improper tensioning.	Retension drive.
Sheaves too small.	Motor manufacturer's sheave diameters not followed.	Redesign drive using DODGE manuals or VIA-VISA software.*
Poor bearing condition.	Underdesigned bearings or poor bearing maintenance.	Observe recommended bearing design and maintenance.
Sheaves out too far on shaft.	Error or obstruction problem.	Place sheaves as close as possible to bearings. Remove any obstruction preventing this.
Drive under tensioned.	Belts slipping and causing heat buildup.	Retension drive.

Service Guide

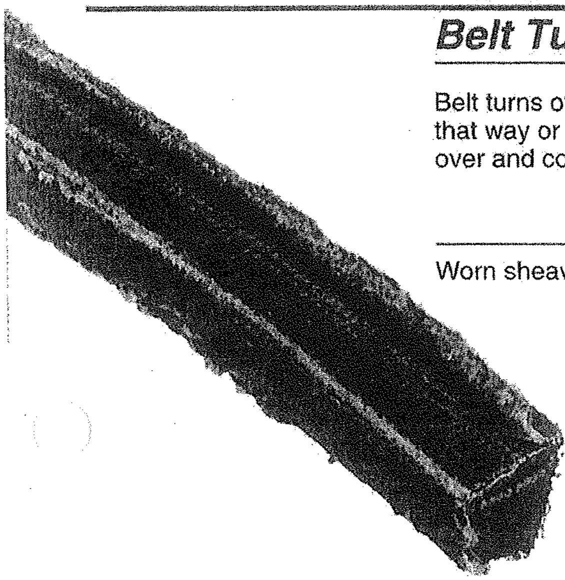
Belt Wear Recognition (Single Strand Belts)

The following pages illustrate various types of belt failure, describe the belt condition or operation and list the possible causes and suggested remedies. It provides a means of rapid recognition of a belt problem and determining a means of correction.

The material covered in this section is in the following order:
- Single Strand Belt Problems.
- POLYBAND Belts and Problems.

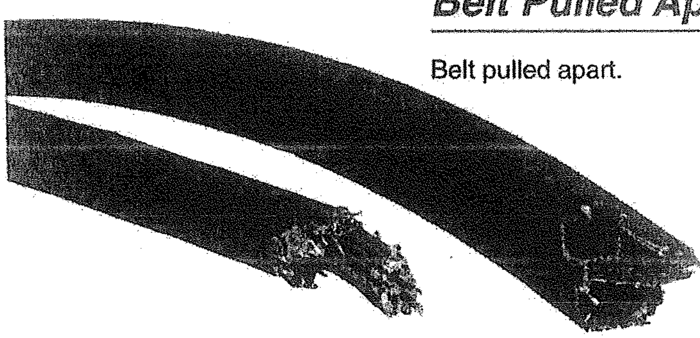
We suggest that you acquaint the customer with the probable cause of failure and recommend the necessary correction to obtain maximum life of the replacement part.

Belt Turnover Pattern



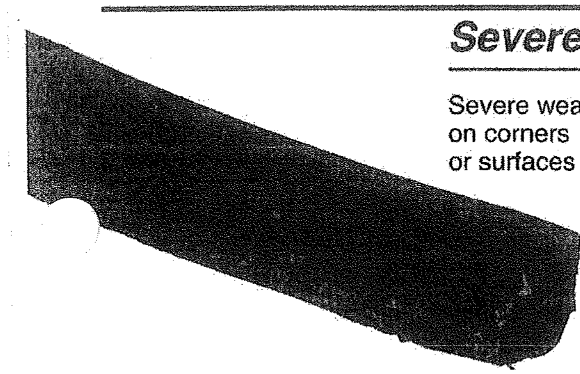
Trouble Area and Observstion	Cause	Remedy
Belt turns over and runs that way or it may turn over and come off.	Foreign material in grooves.	Remove material—shield drive.
	Misaligned sheaves.	Realign the drive.
Worn sheave grooves.	Worn sheave grooves.	Replace sheave.
	Tensile member broken through improper installation.	Replace with new belt(s) properly installed.
	Incorrectly aligned idler pulley.	Carefully align idler, checking alignment with drive loaded and unloaded.

Belt Pulled Apart



Trouble Area and Observstion	Cause	Remedy
Belt pulled apart.	Extreme shock load.	Remove cause of shock load.
	Belt came off drive.	Check drive alignment, foreign material in drive, insure proper tension and drive alignment.

Severe Corner & Surface Wear Patterns



Trouble Area and Observstion	Cause	Remedy
Severe wear on corners or surfaces of belt.	Belt rubbing on some obstruction.	Remove obstruction or align drive to give needed clearance.

Trouble Area and Observstion	Cause	Remedy

Worn Side Pattern

Sides worn.	Constant slip.	Retension drive until belt stops slipping.
	Misalignment.	Realign sheaves.
	Worn sheaves.	Replace with new sheaves.
	Incorrect belt.	Replace with new belt.

Bottom & Sides Burned

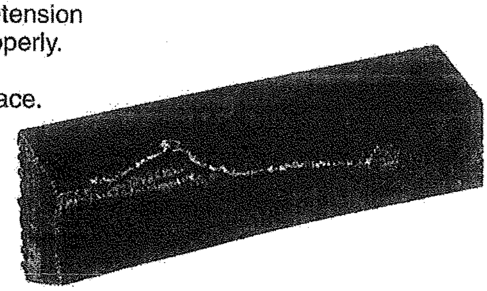
Sides and bottom of belt burned.	Belt slipping under starting or stalling load.	Replace belt and tighten drive until slipping stops.
	Worn sheaves.	Replace sheaves.

Band Sidewall Flaking, Sticky or Swollen

Band (cover) has flaked off and the sides or sidewalls are soft and sticky. Low adhesion between cover plies. Cross section swollen.	Oil or grease on belts or sheaves.	Remove source of oil or grease. Clean belts and grooves with cloth moistened with non-flammable, non-toxic degreasing agent or commercial detergent and water.

Belt Cut on Bottom

Belt cut on bottom.	Belt ran over sheave and came off.	Check drive tension and alignment—retension and align drive properly.
	Foreign material fell into belt drive making belt come off.	Shielding not in place.
	Belt forced over the sheave flange during installation without slacking off the drive.	Install new belts properly. Slack off belt drive.



Service Guide

Belt Wear Recognition (Single Strand Belts)

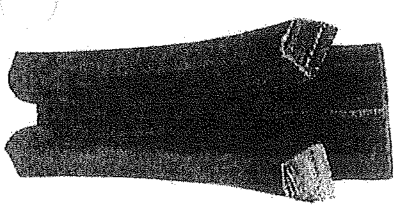
Trouble Area and Observstion	Cause	Remedy

Bottom of Belt Cracking

Trouble Area and Observstion	Cause	Remedy
Bottom of belt cracking.	Belt slipping, causing heat buildup and gradual hardening of undercord.	Install new belt, tension to prevent slip.
	Idler installed in wrong side of belt.	Refer to the Trouble-Shooter's Guide for V-Belts on pages 8 and 9 or contact your DODGE fieldman.
	Improper storage.	Refer to belt storage.

(POLYBAND Belts)

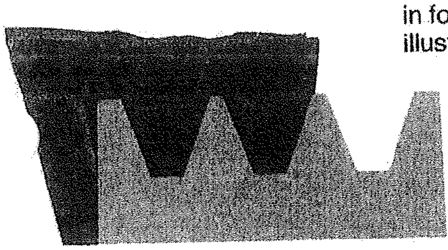
Tie Band Separation



Trouble Area and Observstion	Cause	Remedy
Tie band separating from belts.	Worn sheaves.	Gauge sheave grooves and replace with standard groove sheaves.

Belt Riding Outside Sheave Groove

Trouble Area and Observstion	Cause	Remedy
POLYBAND with one strand riding outside sheave grooves. NOTE: Distinct groove in sidewall of outside belt. NOTE: If above belt were permitted to run in this position, progressive failure would result as shown in following two illustrations.	Possible mis-alignment, lack of tension or foreign object forced belt from sheave grooves.	Properly align drive, retension and remove any interference from foreign object.

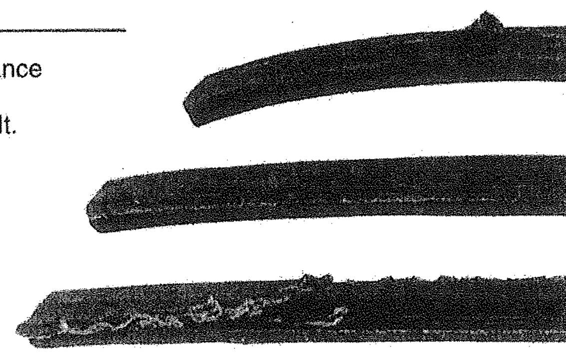


One Belt Separated from Tie Band

Trouble Area and Observstion	Cause	Remedy
Outside belt and belt adjacent to it have started to separate from POLYBAND belt.	POLYBAND belt has jumped one groove forcing outside belt out of sheave. Improper tension, misalignment or foreign object struck belt and forced it from normal path.	Replace POLYBAND belt and seat properly in aligned grooves. Tension properly.

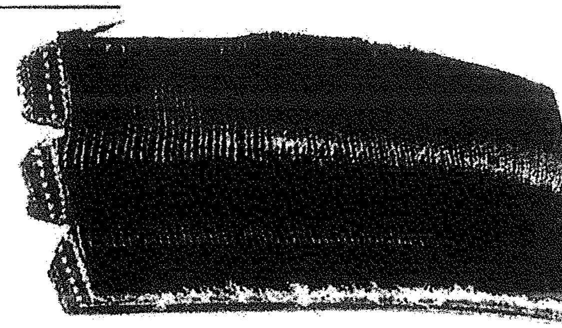
All Belts Separated from Tie Band

Belts have separated completely.	Riding outside and above sheave grooves.	Proper maintenance of drive and installation of belt.
	Too loose, contacting shielding.	Adjust shields.
	Worn idler pulley.	Replace.



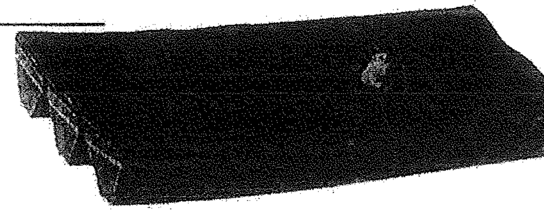
Top of Tie Band Frayed or Damaged

Top of tie band frayed or damaged.	Obstruction on machine interfering with normal operation of belt.	Realign drive and remove obstruction.



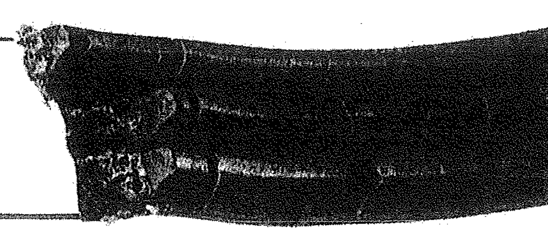
Top of Tie Band Blistered or Perforated

Large holes or blisters appear on tie band.	Trash and foreign material accumulating between belts of PowerBand.	Check shielding on drive.



Bottom of Belt Cracking

Bottom of belt cracking.	Belt slipping causing heat buildup and gradual hardening of undercord.	Check tension of POLYBAND belt.



DODGE® Drive Components

Drive components are the vital connection between your main frame and motor. DODGE is your performance connection providing the full range of innovative, quality products you can depend on to get the job done. DODGE, the single source for all your drive components, with products that deliver performance when you need it. DODGE. The performance connection.

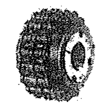
- Clean, Compact Design
- An Industry Standard for over 40 Years
- Easy-on, Easy-off
- 8° Taper—Grips Tight, Holds Tight, Runs True, No Wobble
- Total System Concept Bushings, Hubs, Adapters and Products
- World-Wide Acceptance and Availability
- Flush Mounting — No Protruding Parts

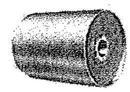
TAPER-LOCK Bushings Used in all of these Quality Products...

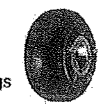
Dry Fluid Drives

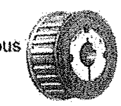


Roller Chain Sprockets


Chain Couplings


Conveyor Pulleys

Flexible Cushion Couplings


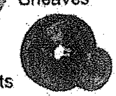
Synchronous Pulleys



V-Belt Sheaves

Flexible Disc Couplings



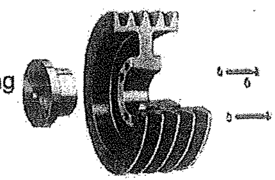
Rigid Couplings

HT Sprockets


QD BUSHINGS

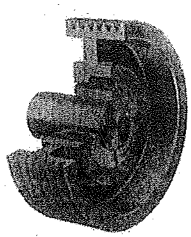
Now available from DODGE ...

- Conventional and Reverse Mounting
- Easy-on, Easy-off
- Secure Mounting on Shaft

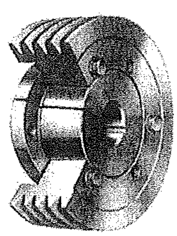


DODGE SHEAVES

TAPER-LOCK Sheaves



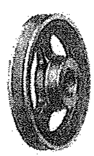
QD Sheaves

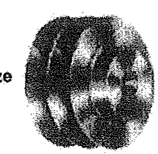


- **3V** Narrow Groove DYNA-V
- **5V** Narrow Groove DYNA-V
- **8V** Narrow Groove DYNA-V
- **A/B** Classical Groove Dual Duty
- **B** Classical Groove
- **C** Classical Groove
- **D** Classical Groove

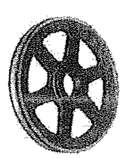
FHP Light Duty Sheaves

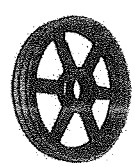
Bored-to-Size


One Groove


Two Groove

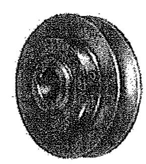
"H" Taper Bushed

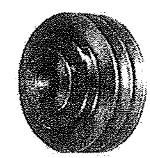

One Groove


Two Groove

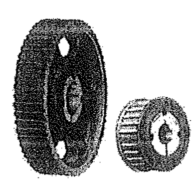
Type H Bushings for Light Duty Sheaves

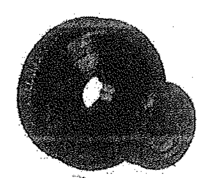
FHP One and Two Groove Variable Pitch Sheaves





Synchronous Belt Sprockets


DYNA-SYNC®


HT150

DODGE/P.O. Box 499/6040 Ponders Court/Greenville, S.C. 29602-0499/864-297-4800/FAX: 864-281-2318

This material is not intended to provide operational instructions. Appropriate Rockwell Automation instruction manuals and precautions should be studied prior to installation, operation or maintenance of equipment

Rockwell Automation Dodge

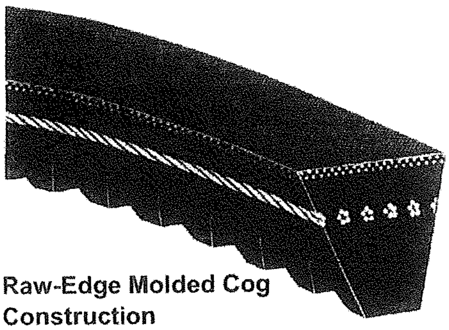
Printed in U.S.A.

A-530-3

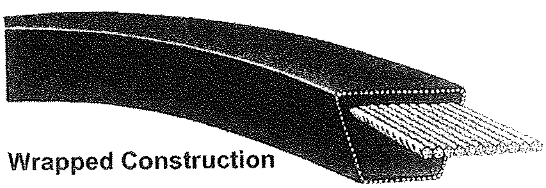
9/97 20M-K

TORQUE-TAMER
Bushings
V-Drives
FHP
Drives Component Accessories

D-V Wedge Narrow Belts

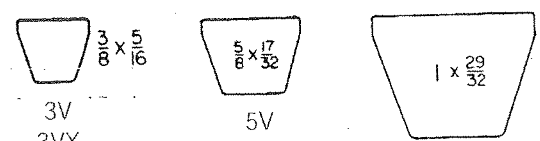


Raw-Edge Molded Cog Construction



Wrapped Construction

- Oil Resistant and Static Conducting
- Permits Compact, Lighter Weight Drives
- Hi-Strength Tension Member Delivers Maximum Power with Minimum Stretch
- Built for Long-Term Dimensional Stability.
- Matched to MPTA/RMA Standards. No additional matching or Matching Codes required.



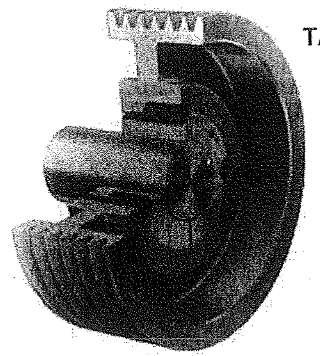
3V 3VX | 5V 5VX | 8V 8VX

3VX				5VX, 5V								8VX, 8V			
Belt No.	Part No.	Wt.	Lgth. Δ	Belt No.	Part No.	Wt.	Lgth. Δ	Belt No.	Part No.	Wt.	Lgth. Δ	Belt No.	Part No.	Wt.	Lgth. Δ
3VX250	**107150**	0.11	25	5VX450		0.51	45	5VX900	**107180**	1.04	90	8VX1000	**107200**	2.97	100
3VX265	**107220**	0.11	27	5VX470		0.54	47	5VX930		1.07	93	8VX1060	**107219**	3.50	106
3VX280	**107151**	0.12	28	5VX490		0.56	49	5VX950	**107195**	1.10	95	8VX1120	**107201**	3.35	112
3VX300	**107229**	0.12	30	5VX500	**107175**	0.57	50	5VX960		1.11	96	8VX1180	**107240**	3.65	118
3VX315	**107152**	0.14	31.5	5VX510		0.59	51	5VX1000	**107181**	1.16	100	8VX1250	**107202**	3.98	125
3VX335	**107230**	0.14	33.5	5VX530	**107233**	0.61	53	5VX1030		1.18	103	8VX1320	**107241**	4.05	132
3VX355	**107153**	0.16	35.5	5VX540		0.63	54	5VX1060	**107196**	1.23	106	8VX1400	**107203**	4.16	140
3VX375	**107166**	0.16	37.5	5VX550		0.63	55	5VX1080		1.24	108	8VX1500	**107242**	4.69	150
3VX400	**107154**	0.16	40	5VX560	**107176**	0.64	56	5VX1120	**107182**	1.30	112	8VX1600	**107204**	5.30	160
3VX425	**107167**	0.17	42.5	5VX570		0.66	57	5VX1150		1.33	115	8VX1700	**107243**	5.27	170
3VX450	**107155**	0.54	45	5VX580		0.67	58	5VX1160		1.34	116	8VX1800	**107205**	5.73	180
3VX475	**107221**	0.20	47.5	5VX590		0.68	59	5VX1180	**107197**	1.37	118	8VX1900	**107244**	5.81	190
3VX500	**107156**	0.22	50	5VX600	**107234**	0.69	60	5VX1230		1.42	123	8VX2000	**107206**	6.05	200
3VX530	**107222**	0.21	53	5VX610		0.70	61	5VX1250	**107183**	1.45	125	8V2120	**107245**	6.80	212
3VX560	**107157**	0.22	56	5VX630	**107177**	0.73	63	5VX1320	**107224**	1.53	132	8V2240	**107207**	7.25	224
3VX600	**107168**	0.24	60	5VX650		0.75	65	5VX1400	**107184**	1.62	140	8V2360	**107215**	7.65	236
3VX630	**107158**	0.27	63	5VX660		0.75	66	5VX1500	**107225**	1.74	150	8V2500	**107208**	7.97	250
3VX670	**107169**	0.29	67	5VX670	**107235**	0.77	67	5VX1600	**107185**	1.86	160	8V2650	**107246**	8.52	265
3VX710	**107159**	0.31	71	5VX680		0.78	68	5VX1700	**107226**	1.97	170	8V2800	**107209**	8.95	280
3VX750	**107170**	0.30	75	5VX690		0.80	69	5VX1800	**107186**	2.10	180	8V3000	**107216**	10.05	300
3VX800	**107160**	0.33	80	5VX710	**107178**	0.82	71	5VX1900	**107227**	2.20	190	8V3150	**107210**	10.50	315
3VX850	**107171**	0.39	85	5VX730		0.84	73	5VX2000	**107187**	2.30	200	8V3350	**107247**	11.20	335
3VX900	**107161**	0.38	90	5VX740		0.85	74	5V2120	**107228**	2.50	212	8V3550	**107211**	11.90	355
3VX950	**107172**	0.40	95	5VX750	**107193**	0.87	75	5V2240	**107188**	2.60	224	8V3750	**107218**	12.60	375
3VX1000	**107162**	0.44	100	5VX780		0.90	78	5V2360	**107236**	2.74	236	8V4000	**107212**	13.40	400
3VX1060	**107223**	0.44	106	5VX800	**107179**	0.92	80	5V2500	**107189**	2.84	250	8V4250	**107248**	14.20	425
3VX1120	**107163**	0.46	112	5VX810		0.93	81	5V2650	**107237**	2.99	265	8V4500	**107213**	15.10	425
3VX1180	**107231**	0.50	118	5VX830		0.96	83	5V2800	**107190**	3.10	280	8V4750	**107217**	15.50	475
3VX1250	**107164**	0.54	125	5VX840		0.97	84	5V3000	**107238**	3.60	300	8V5000	**107214**	16.00	500
3VX1320	**107232**	0.57	132	5VX850	**107194**	0.98	85	5V3150	**107191**	3.80	315	----	----	----	----
3VX1400	**107165**	0.62	140	5VX860		0.99	86	5V3350	**107239**	4.00	335	----	----	----	----
3VX1500	**107173**	0.56	150	5VX880		1.02	88	5V3550	**107192**	4.30	355	----	----	----	----

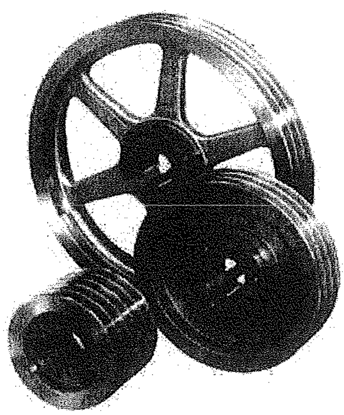
Δ Outside circumference in inches.

SHEAVES PAGES PT7-3	SELECTION: WEDGE PAGES PT7-42	SELECTION: CLASSICAL PAGES PT7-84	ENGINEERING/TECHNICAL PAGES PT7-124

TAPER-LOCK and QD Sheaves



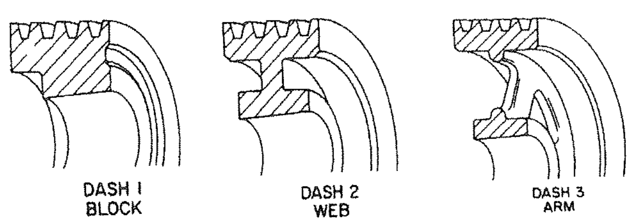
TAPER-LOCK Sheaves



QD Sheaves

Sheaves are manufactured in DODGE plants under strict quality control assurances. Precision machining meets or exceeds joint RMA/MPTA industry standards for smooth operation plus extended belt life. DODGE manufactures all sheaves in plants certified to ISO 9002 Quality Standards.

Sheave Construction



Type 1 Type 2 Type 3

DODGE stock sheaves are manufactured from high quality gray iron. They are given a corrosion-resistant finish before packaging and shipping. Sheave construction follows the general format illustrated above:smaller sheaves are of the block construction, intermediate sizes of the web type, and large sheaves of the arm- type construction.

Sheave Balance

Balance of stock sheaves is suitable for most applications up to a rim speed of 6500 FPM. Dynamic (two-plane) balance is available at extra charge for applications that are more sensitive to vibration. Dynamic balance is recommended for operation above 6500 FPM.

V-Drive Advantages

- Isolates shock loads and vibration.
- Misalignment capability.
- Drive ratios of 6:1 or more possible.
- Stock drive selections up to:
  1100 design HP at 1180 RPM
  800 design HP at 1770 RPM
- Low maintenance.
- No lubrication required.
- Quiet operation:Motors, etc. are normally at a higher db level than V-Drives.
- Efficiency of 95% typical.

Computer Selection

For fast, accurate evaluation of viable V-Drive alternatives, use the DODGE VIA-VISA software program for your PC. Just type the required information on the user-friendly input screen and let the computer do the rest. All the significant data on the drive combinations is presented:Cost, RPM, shaft loading, installation tension, face width and diameter, etc. This is shown in a format that allows you to select the best drive for the application. See page PT7-123 for complete information on VIA-VISA.

WARNING

Stock sheaves are manufactured from gray iron, which is suitable for operation up to 6500 feet per minute rim speed (e.g. 14, max. dia. on a 1750 RPM motor). Operation above this rim speed may cause sheave failure resulting in personnel and/or equipment damage.

Refer to the Made-To-Order sheave section for constructions that are suitable for operation at higher rim speeds.

ARAMIDE CORD BELTS WARNING:

Because of the high horsepower rating of Aramide (Kevlar) cord belts, stock sheaves can not be used. Contact DODGE for made to order high capacity sheaves.

INSTALLING/TENSIONING V-DRIVES

INSTALLING A DRIVE

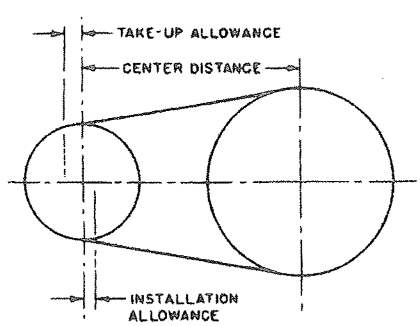
Check Condition of Sheaves–Before a new set of V-belts are installed, check the condition of the sheaves. Dirty or rusty sheaves impair the drive's efficiency and abrade the belts, which result in premature failure.

Worn sheaves shorten belt life as much as 50% if the grooves are worn to where the belt bottoms, slippage may result and burn the belts. If the sidewalls are "dished out," the bottom shoulder ruins the belts prematurely by wearing off the bottom corners.

Check Sheave Alignment–Sheave adjustment should be checked by placing a straight edge or tight cord across the sheave faces so that it touches all four points of contact. Ordinarily, a misalignment of more than one-half of one degree (one-eighth inch in one foot) will adversely affect belt life. Improper sheave alignment produces uneven wear on one side of the belt, causes the belt to roll over in the sheaves or throws all the load on one side of the belt, stretching or breaking the cords on that side.

INSTALLATION AND TAKE-UP ALLOWANCES

After calculating a center distance from a standard pitch length, make provision for adjusting the center distance as in sketch below, to allow for installation of the belts without injury, for tensioning, and for maintenance of proper tension throughout the life of the belt. (Refer to Tables 11 or 12 for values).



Placing Belts on Sheaves–Shorten the center distance of the drive until the belts can be put on the sheaves without forcing. Forcing the belts can cause internal injury to the belts.

Belt Selection–For maximum service, replace V-belt drives with a complete new matched set of belts or use the new Matchmaker belts.

Never employ a used belt as a replacement for a unit of a set. Used belts, normally, are worn in cross-section and stretched. A new belt so applied will ride higher in the sheave, travel faster and operate at a much higher tension than the used belts. The cord center may be ruptured, allowing the new belt to elongate. Shortly after this occurs it will cease to accept its full share of the load, leaving the drive under-belted. Thus, the new belt is wasted. Belts of different manufacturers should not be mixed for the same reasons.

Table 11-Center Distance Allowance for Narrow Belt Installation and Take-Up

Nom. Belt Lgth. in Inches	Min. Installation Allowance (in inches) (Below Center)						Min. Take-up Allowance (Above Center)
	3V Dyna-V	3V Poly-band	5V Dyna-V	5V Poly-band	8V Dyna-V	8V Poly-band	
Up to & incl. 47.5	.05	1.2	...	...	...	...	1.0"
50-71	0.8	1.4	1.0	2.1	...	...	1.2
75-106	0.8	1.4	1.0	2.1	1.5	3.4	1.5
112-125	0.8	1.4	1.0	2.1	1.5	3.4	1.8
132-170	0.8	1.4	1.0	2.1	1.5	3.4	2.2
180-200	...	...	1.0	2.1	1.8	3.6	2.5
212-236	...	...	1.2	2.4	1.8	3.6	3.0
250 & 265	...	...	1.2	2.4	1.8	3.6	3.2
280 & 300	...	...	1.2	2.4	1.8	3.6	3.5
315-355	...	...	1.2	2.4	2.0	4.0	4.0
375	...	...	...	...	2.0	4.0	4.5
400-560	...	...	...	...	2.0	4.0	5.5

INSTALLING/TENSIONING V-DRIVES

Table 12 - Center Distance Allowance for Classical Belt Installation and Take-up

Nom. Belt Lgth. in Inches	Min. Installation Allowance (in inches) (Below Center)							Min. Take-up Allowance (Above Center)
	A	B	B Poly-band	C	C Poly-band	D	D Poly-band	
26-37	0.75	1.00	1.50	1.50	...	...	...	1.00"
38-59	0.75	1.00	1.50	1.50	2.00	...	...	1.50
60-89	0.75	1.25	1.61	1.50	2.00	...	...	2.00
90-119	1.00	1.25	1.61	1.50	2.00	...	...	2.50
120-157	1.00	1.25	1.81	1.50	2.11	2.0	2.00	3.00
158-194	...	1.25	1.81	2.00	2.20	2.00	3.00	3.50
195-239	...	1.50	1.81	2.00	2.31	2.00	3.20	4.00
240-269	...	1.50	2.00	2.00	2.50	2.50	3.20	4.50
270-329	...	1.50	2.20	2.00	2.50	2.50	3.50	5.00
330-419	...	...	...	2.00	2.70	2.50	3.60	6.00
420 & Over	...	...	...	2.50	2.90	3.00	4.10	1-1/2% of belt lgth.

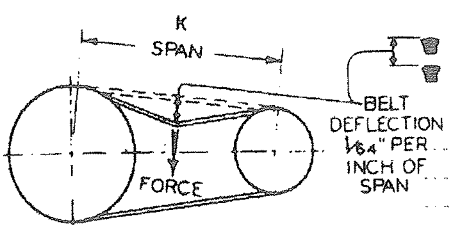
TENSIONING A DRIVE

General Rules of Tensioning–

1. Ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
2. Check tension frequently during the first 24-48 hours of run-in operation.
3. Over tensioning shortens belt and bearing life.
4. Keep belts free from foreign material which may cause slip.
5. Make V-Drive inspection on a periodic basis. Tension when slipping. Never apply belt dressing as this will damage the belt and cause early failure.

SIMPLE TENSIONING PROCEDURE

1. Measure the span length, K
2. At the center of the span (K) apply a force (perpendicular to the span) large enough to deflect the 1/64, for every inch of span length. For example, one deflection of a 100 inch span would be 100/64 or 1-9/16 inches.



3. Compare the force you have applied with the values given in Tables 13 or 14. If the force is between the values for normal tension, and 1-1/2 times normal ten sion, the drive tension should be satisfactory. A force below the value for normal tension indicates an under-tensioned drive. If the force exceeds the value for 1-1/2 times normal tension, the drive is tighter than it needs to be.

For V-Belt Tension Testers, See Page PT7-123.

After the proper operating tension has been applied to the belts, a double-check should be made of the following:

a. Parallel postion of the sheave shafts.

b. Correct alignment of sheave grooves.

Installing/Tensioning V-Drives

Table 13-Belt Deflection Force (Check factory for conditions not covered in this table)

V-Belt Section	Small Sheave		Deflection Force In Lbs. For Drive Speed Ratio of:			
	Speed Range	Diameter	1.0	1.5	2.0	4.0 +
A (AP)	1800-3600	3.0	2.0	2.3	2.4	2.6
	1800-3600	4.0	2.6	2.8	3.0	3.3
	1800-3600	5.0	3.0	3.3	3.4	3.7
	1800-3600	7.0	3.5	3.7	3.8	4.3
B (BP)	1200-1800	4.6	3.7	4.3	4.5	5.0
	1200-18[illegible]	[illegible]	[illegible]	4.6	4.8	5.6
	1200-[illegible]	6.0	[illegible]	[illegible]	[illegible]	6.3
	1200-[illegible]	8.0	[illegible]	[illegible]	6.4	[illegible]
(CP)	[illegible]-1800	7.0	6.5	[illegible]	8.0	9.0
	900-1800	9.0	8.0	9.0	10.0	11.0
	900-1800	12.0	10.0	11.0	12.0	13.0
	700-1500	16.0	12.0	13.0	13.0	14.0
D (DP)	900-1500	12.0	13.0	15.0	16.0	17.0
	900-1500	15.0	16.0	18.0	19.0	21.0
	700-1200	18.0	19.0	21.0	22.0	24.0
	700-1200	22.0	22.0	23.0	24.0	26.0
AX	1800-3600	3.0	2.5	2.8	3.0	3.3
	1800-3600	4.0	3.3	3.6	3.8	4.2
	1800-3600	5.0	3.7	4.1	4.3	4.6
	1800-3600	7.0	4.3	4.6	4.8	5.3
BX	1200-1800	4.6	5.2	5.8	6.0	6.9
	1200-1800	5.0	5.4	6.0	6.3	7.1
	1200-1800	6.0	6.0	6.4	6.7	7.7
	1200-1800	8.0	6.6	7.1	7.5	8.2
CX	900-1800	7.0	10.0	11.0	12.0	13.0
	900-1800	9.0	11.0	12.0	13.0	14.0
	900-1800	12.0	12.0	13.0	13.0	14.0
	700-1500	16.0	13.0	14.0	14.0	15.0
DX	900-1500	12.0	16.0	18.0	19.0	20.0
	900-1500	15.0	19.0	21.0	22.0	24.0
	700-1200	18.0	22.0	24.0	25.0	27.0
	700-1200	22.0	25.0	27.0	28.0	30.0

Table 14-POLYBAND Plus Belt Deflection Force (lbs.) (Force is pounds for one belt only)

Cross Section	Small Sheave Diameter Range	RPM Range	Belt Deflection Force*	
			Normal	New Belt
5VF	7.1-10.9	200-700	21.1	30.9
		701-1250	18.0	26.3
		1251-1900	16.7	23.4
		1901-3000	15.8	23.0
5VF	11.8-16.0	200-700	26.8	39.5
		701-1250	23.5	34.7
		1251-2100	22.7	33.3
8VF	12.5-20.0	200-500	44.7	65.8
		501-850	38.5	56.6
		851-1150	35.2	51.6
		1151-1650	33.5	49.0
8VF	21.2-25.0	200-500	65.9	97.6
		501-850	61.2	90.6
		851-1200	57.0	84.3

* Multiply the force required for one belt by the number of belts in the Polyband Plus unit to get total force to apply.

Example:New 8VF drive with a small sheave dia. equal to 20".
The rpm of the sheave is 1000.
The belt to be installed is 8/8VF4000.
Total deflection force = table value x 8 = 51.6 x 8 = 413 lbs.

Belt Pull and Bearing Loads

Belt Pull Calculations–The following method of calcu lating belt pull is found to be the most convenient and ac curate for drives operating at design loads and tensions:

$$T_1 + T_2 = 33,000\,(2.5-G)\left(\frac{HP}{GV}\right)$$

WHERE:
T_1 = Tight side tension, pounds
T_2 = Slack side tension, pounds
HP = Design horsepower
V = Belt speed, feet per minute = (PD) (RPM) (.262)
G = Arc of contact correction factor

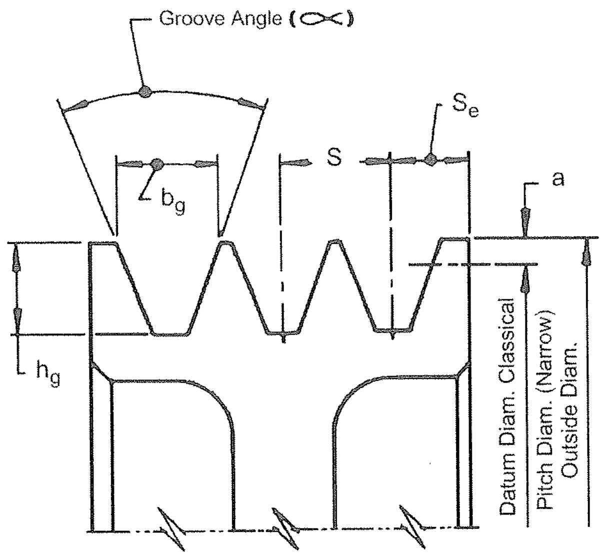
Arc of Contact Factors

$\frac{D-d}{C}$	Arc of Contact	Factor G	$\frac{D-d}{C}$	Arc of Contact	Factor G
.00	180°	1.00	.80	133°	.87
.10	174°	.99	.90	127°	.85
.20	169°	.97	1.00	120°	.82
.30	163°	.96	1.10	113°	.80
.40	157°	.94	1.20	106°	.77
.50	151°	.93	1.30	99°	.73
.60	145°	.91	1.40	91°	.70
.70	139°	.89	1.50	83°	.65

Arc of contact is on small sheave
d = Diam.of small sheave.
D = Diam. of large sheave.
C = Center distance.

TORQUE-TAMER | Bushings | V-Drives | FHP | Drives Component Accessories

V-Belt Sheave Groove Dimensions



Narrow

Belt Section	Outside Diameter Range	∝ ± 0.25	b_g ± .005	h_g Min.	a	S ± .015	Se	
3VX, 3V	LESS THAN 3.50 3.50 TO 6.00 6.01 to 12.00 Over12.00	36° 38° 40° 42°	.350	0.340	0.025	0.406	0.344	+.094 -.000
5VX, 5V	Less than 10.00 10.00 to 16.00 Over 16.00	38° 40° 42°	.600	0.590	.050	0.688	0.500	+.125 -.000
8VX, 8V	Less than 16.00 16.00 to 22.40 Over 22.40	38° 40° 42°	1.000	0.990	.100	1.125	0.750	+.250 -.000

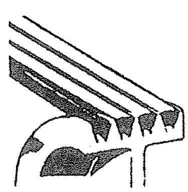
Classical

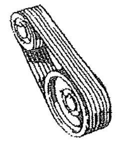
Belt Section	Pitch Diameter Min. Recom.	Pitch Diameter Range	m + 0.33	b_g		h_g Min.	2a ref *	S ± .025	Se	
AX, A	3.0	2.6 to 5.4 Over 5.4	34° 38°	.494 .504	±.005	.460	.125	.625	.375	+.090 -.062
BX, B	5.4	4.6 to 7.0 Over 7.0	34° 38°	.637 .650	±.006	.550	.175	.750	.500	+.120 -.065
A, B AX, BX	-	To 7.0 Over 7.0	34° 38°	.612 .625	±.006	.612	A (.634/.602) B (.333/.334)	.750	.500	+.120 -.065
CX, C	9.0	7.0 to 7.99 8.0 to 12.0 Over 12.0	34° 36° 38°	.879 .887 .895	±.007	.750	.200	1.000	.688	+.160 -.070
DX,D	13.0	12.0 to 12.9 13.0 to 17.0 Over 17.0	34° 36° 38°	1.259 1.271 1.283	±.008	1.020	.300	1.438	.875	+.220 -.080
E	21.0	18.0 to 24.0 Over 24.0	36° 38°	1.527 1.542	±.010	1.300	.400	1.750	1.125	+.250 -.000

Note–For complete manufacturing tolerances – see RMA, MPTA, Narrow/Classical V-belt Standards.
* Datum diameter, not pitch diameter.

BELTS PAGES PT7-28	SELECTION: WEDGE PAGES PT7-42	SELECTION: CLASSICAL PAGES PT7-84	ENGINEERING/TECHNICAL PAGES PT7-124

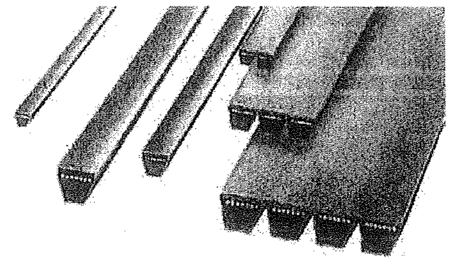
More Power and Life From V-Drives

TROUBLE AREA AND OBSERVATION	CAUSE	REMEDY
BELT STRETCH BEYOND TAKE-UP		
Belt stretch unequally.	Mis-aligned drive, unequal work done by belts.	Realign and re-tension drive.
All belts stretch about equally.	Belt tensile member broken from improper installation.	Replace all belts with new matched set properly installed.
	Insufficient take-up allowance.	Check take-up and follow allowance on page .
	Greatly overloaded or underdesigned drive.	Redesign.
SHORT BELT LIFE		
Relatively rapid failure; no visible reason.	Tensile members damaged through improper installation.	Replace with all new matched set, properly installed.
	Worn sheave grooves (check with groove gauge)	Replace sheaves.
	Under-designed drive.	Redesign.
Sidewalls soft and sticky. Low adhesion between cover plies. Cross-section swollen.	Oil or grease on belts or sheaves.	Remove source of oil or grease. Clean belts and grooves with cloth moistened with alcohol.
Sidewalls dry and hard. Low adhesion between cover plies. Bottom belt cracked.	High temperatures.	Remove source of heat. Ventilate drive better.
BELT TURN OVER 	Excess lateral belt whip.	Use Banded belt.
	Foreign material in grooves.	Remove material--shield drive.
	Mis-aligned sheaves.	Realign the drive.
	Worn sheave grooves (check with groove gauge).	Replace sheave.
	Tensile member broken through improper installation.	Replace with new matched set properly installed.
	Incorrectly placed flat idler pulley.	Carefully align flat idler on slack side of drive as close as possible to driver sheave.
DETERIORATION OF RUBBER COMPOUNDS USED IN BELT	Belt dressing.	Never use dressing on V-belts. Clean with cloth moistened with alcohol. Tension drive properly to prevent slip.
Extreme cover wear.	Belts rub against belt guard or other obstruction.	Remove obstruction or align drive to give needed clearance.
Spin burns on belt.	Belts slip under starting or stalling load.	Tighten drive until slipping stops.
Bottom of belt cracked.	Too small sheaves.	Redesign for larger sheaves.
Broken belts.	Object falling into or hitting drive.	Replace with new matched set of belts. Provide shield for drive.
IMPROPER DRIVEN SPEED		
Incorrect driveR-driveN ratio.	Design error.	Use correct sheave sizes.
Spin burns on belt.	Belt slip.	Re-tension drive until belt stops slipping.
BELT NOISE	Belt slip.	Re-tension drive until it stops slipping.
HOT BEARINGS		
Drive over-tensioned.	Worn grooves-belts bottoming and will not transmit power until over-tensioned.	Replace sheaves. Tension drive properly.
	Improper tensioning.	Re-tension drive.
Sheaves too small.	Motor manufacturers sheave diameters not followed.	Redesign drive.
Poor bearing condition.	Underdesigned bearing or poor bearing maintenance.	Observe recommended bearing design and maintenance.
Sheaves out too far on shaft.	Error or obstruction problem.	Place sheaves as close as possible to bearings. Remove any obstruction preventing this.
Drive under-tensioned.	Belts slipping and causing heat build-up.	Re-tension drive.



NOTES

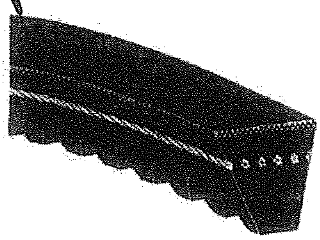
V-Belts



V-drives have been the mainstay of industrial power transmission for over 60 years. During this time, DODGE has been a major influence, designing and developing innovative concepts in V-belt sheaves and supplying the highest quality belts.

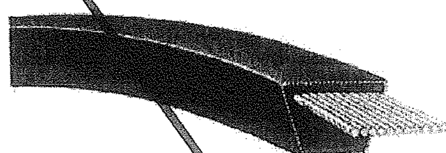
Today's V-drives offer quiet, efficient mechanical power transmission. They provide many thousands of hours of performance, even under conditions of shock load and normal drive misalignment. All of these benefits come at an economic value that is unsurpassed.

D-V WEDGE BELTS 3VX-[redacted]



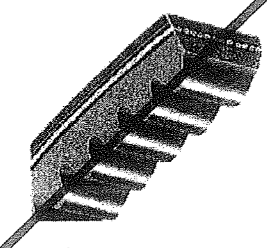
- Oil resistant and static conducting
- Permits compact, lighter weight drives
- High-strength tension member delivers maximum power with minimum stretch
- Built for long-term dimensional stability
- Molded cog construction under 200-inch belt length

S-L CLASSIC V-BELTS A-B-C-D-E



- Cable cord envelope construction
- Cool running and flexible
- Strong tensile cords minimize stretch
- Static conducting and heat and oil resistant
- More tolerant of shock loads

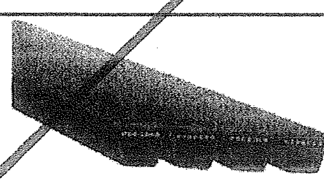
CLASSIC COG V-BELTS AX-BX-CX-DX



Deliver more horsepower and last longer than conventional belts...

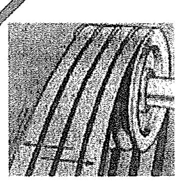
- Fully notched cogs for maximum flexibility
- High coefficient rubber edge
- Oil resistant and static conducting
- Proven energy-saving design
- Outlasts conventional belts
- Fewer belts required - drive weight is reduced

POLYBAND CLASSIC POLYBAND WEDGE V-BELTS

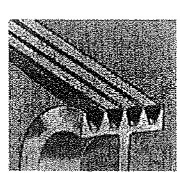


POLYBAND banded V-belts are engineered to handle those problem drives where vibration, sudden shock loads or misalignment causes belts to turn over, whip or jump off sheave. Two or more belts are inseparable joined together as one single unit. POLYBAND belts may be used without changing sheaves or altering the drive.

- NO JUMP OFF

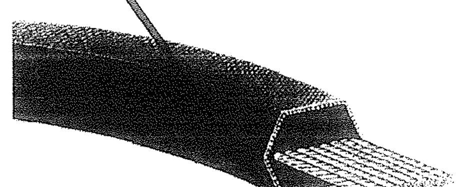


- NO WHIP



- NO TURN OVER

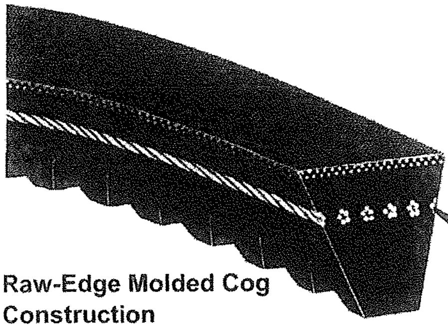
DOUBLE-V SEALED-LIFE (HEX)



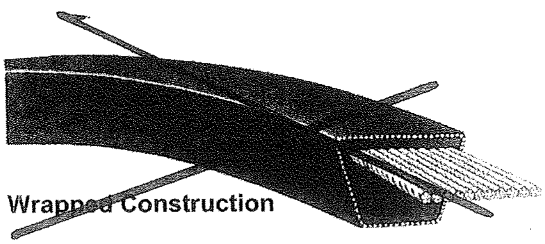
- For serpentine drives
- Transmits power from both sides of belt
- Standard AA, BB, CC cross sections
- Runs in standard classical sheaves
- Oil resistant and static conducting

SHEAVES PAGES PT7-3	SELECTION: WEDGE PAGES PT7-42	SELECTION: CLASSICAL PAGES PT7-84	ENGINEERING/TECHNICAL PAGES PT7-124

D-V Wedge Narrow Belts

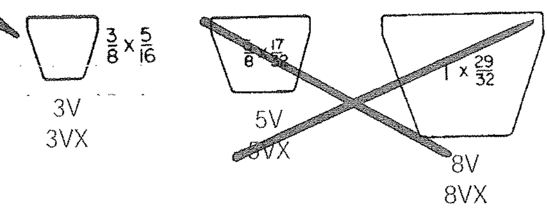


Raw-Edge Molded Cog Construction



Wrapped Construction

- Oil Resistant and Static Conducting
- Permits Compact, Lighter Weight Drives
- Hi-Strength Tension Member Delivers Maximum Power with Minimum Stretch
- Built for Long-Term Dimensional Stability.
- Matched to MPTA/RMA Standards. No additional matching or Matching Codes required.



3VX			
Belt No.	Part No.	Wt.	Lgth. Δ
3VX250	**107150**	0.11	25
3VX265	**107220**	0.11	27
3VX280	**107151**	0.12	28
3VX300	**107229**	0.12	30
3VX315	**107152**	0.14	31.5
3VX335	**107230**	0.14	33.5
3VX355	**107153**	0.15	35.5
3VX375	**107166**	0.16	37.5
3VX400	**107154**	0.16	40
3VX425	**107167**	0.17	42.5
3VX450	**107155**	0.54	45
3VX475	**107221**	0.20	47.5
3VX500	**107156**	0.22	50
3VX530	**107222**	0.21	53
3VX560	**107157**	0.22	56
3VX600	**107168**	0.24	60
3VX630	**107158**	0.27	63
3VX670	**107169**	0.29	67
3VX710	**107159**	0.31	71
3VX750	**107170**	0.30	75
3VX800	**107160**	0.35	80
3VX850	**107171**	0.39	85
3VX900	**107161**	0.38	90
3VX950	**107172**	0.40	95
3VX1000	**107162**	0.44	100
3VX1060	**107223**	0.44	106
3VX1120	**107163**	0.46	112
3VX1180	**107231**	0.50	118
3VX1250	**107164**	0.54	125
3VX1320	**107232**	0.57	132
3VX1400	**107165**	0.62	140
3VX1500	**107173**	0.56	150

5VX, 5V							
Belt No.	Part No.	Wt.	Lgth. Δ	Belt No.	Part No.	Wt.	Lgth. Δ
5VX450		0.51	45	5VX900	**107180**	1.04	90
5VX470		0.54	47	5VX930		1.07	93
5VX490		0.56	49	5VX950	**107195**	1.10	95
5VX500	**107175**	0.57	50	5VX960		1.11	96
5VX510		0.59	51	5VX1000	**107181**	1.16	100
5VX530	**107233**	0.61	53	5VX1030		1.18	103
5VX540		0.63	54	5VX1060	**107196**	1.23	106
5VX550		0.63	55	5VX1080		1.24	108
5VX560	**107176**	0.64	56	5VX1120	**107182**	1.30	112
5VX570		0.66	57	5VX1150		1.33	115
5VX580		0.67	58	5VX1160		1.34	116
5VX590		0.68	59	5VX1180	**107197**	1.37	118
5VX600	**107234**	0.69	60	5VX1230		1.42	123
5VX610		0.70	61	5VX1250	**107183**	1.45	125
5VX630	**107177**	0.73	63	5VX1320	**107224**	1.53	132
5VX650		0.75	65	5VX1400	**107184**	1.62	140
5VX660		0.75	66	5VX1500	**107225**	1.74	150
5VX670	**107235**	0.77	67	5VX1600	**107185**	1.86	160
5VX680		0.78	68	5VX1700	**107226**	1.97	170
5VX690		0.80	69	5VX1800	**107186**	2.10	180
5VX710	**107178**	0.82	71	5VX1900	**107227**	2.20	190
5VX730		0.84	73	5VX2000	**107187**	2.30	200
5VX740		0.85	74	5V2120	**107228**	2.50	212
5VX750	**107193**	0.87	75	5V2240	**107188**	2.60	224
5VX780		0.90	78	5V2360	**107236**	2.74	236
5VX800	**107179**	0.92	80	5V2500	**107189**	2.84	250
5VX810		0.93	81	5V2650	**107237**	2.99	265
5VX830		0.96	83	5V2800	**107190**	3.10	280
5VX840		0.97	84	5V3000	**107238**	3.60	300
5VX850	**107194**	0.98	85	5V3150	**107191**	3.80	315
5VX860		0.99	86	5V3350	**107239**	4.00	335
5VX880		1.02	88	5V3550	**107192**	4.30	355

8VX, 8V			
Belt No.	Part No.	Wt.	Lgth. Δ
8VX1000	**107200**	2.97	100
8VX1060	**107219**	3.50	106
8VX1120	**107201**	3.35	112
8VX1180	**107240**	3.65	118
8VX1250	**107202**	3.98	125
8VX1320	**107241**	4.05	132
8VX1400	**107203**	4.16	140
8VX1500	**107242**	4.69	150
8VX1600	**107204**	5.30	160
8VX1700	**107243**	5.27	170
8VX1800	**107205**	5.73	180
8VX1900	**107244**	5.81	190
8VX2000	**107206**	6.05	200
8V2120	**107245**	6.80	212
8V2240	**107207**	7.25	224
8V2360	**107215**	7.65	236
8V2500	**107208**	7.97	250
8V2650	**107246**	8.52	265
8V2800	**107209**	8.95	280
8V3000	**107216**	10.05	300
8V3150	**107210**	10.50	315
8V3350	**107247**	11.20	335
8V3550	**107211**	11.90	355
8V3750	**107218**	12.60	375
8V4000	**107212**	13.40	400
8V4250	**107248**	14.20	425
8V4500	**107213**	15.10	425
8V4750	**107217**	15.50	475
8V5000	**107214**	16.00	500
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Δ Outside circumference in inches.

SHEAVES PAGES PT7-3	SELECTION: WEDGE PAGES PT7-42	SELECTION: CLASSICAL PAGES PT7-84	ENGINEERING/TECHNICAL PAGES PT7-124

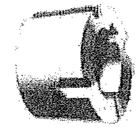
TAPER-LOCK Bushings - Stock Bore

TL Bush Size	BORE	P/N Integral Key	P/N Keyway	WT.	Bushing Keyway	Shaft Keyway REF	Key Size REF
1008	1/2"		119176	0.3	1/8 x 1/16	1/8 x 1/16	1/8 x 1/8
	9/16"		119177	0.3			
	5/8"		117073	0.3	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119179	0.2			
	3/4"	119180	117150	0.2			
	13/16"		119181	0.2			
	7/8"	119182	117074	0.2			
	15/16" #		119183	0.2	1/4 x 1/16	1/4 x 1/8	1/4 x 3/16 Δ
	1" #	119184	117151	0.2			
	14MM		119565	0.3	5 x 2.3MM	5 x 3.0MM	5 x 5MM
	16MM		119566	0.3			
	18MM		119575	0.3	6 x 2.8MM	6 x 3.5MM	6 x 6MM
	19MM		119569	0.3			
	20MM		119576	0.3			
	22MM		119577	0.2			
	24MM		119567	0.2	8 x 3.3MM	8 x 4MM	8 x 7
1108	1/2"		119365	0.3	1/8 x 1/4	1/8 x 1/4	1/8 x 1/8
	9/16"		119366	0.3			
	5/8"	119367	117075	0.3	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119368	0.2			
	3/4"		117152	0.2			
	13/16"		119370	0.2			
	7/8"	119371	117076	0.2			
	15/16"		119372	0.2	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1		117153	0.2			
	1-1/16" #		119374	0.2	1/4 x 1/16	1/4 x 1/8	1/4 x 3/16 Δ
	1-1/8" #		117077	0.2			
	14MM		119651	0.3	5 x 2.3MM	5 x 3.0MM	5 x 5MM
	16MM		119652	0.3			
	18MM		119653	0.3	6 x 2.8MM	6 x 3.5MM	6 x 6MM
	19MM		119570	0.3			
	20MM		119578	0.3			
	22MM		119580	0.3			
	24MM		119581	0.2	8 X 3.3MM	8 X 4MM	8 X 7MM
	25MM		119582	0.2			
1210	1/2"		119191	0.6	1/8 x 1/16	1/8 x 1/16	1/8 x 1/8
	9/16"		119192	0.6			
	5/8"		117078	0.6	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119194	0.5			
	3/4"	119195	117154	0.5			
	13/16"		119196	0.5			
	7/8"	119197	117079	0.5			
	15/16"		119198	0.5	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1"	119199	117155	0.5			
	1-1/16"		119200	0.4			
	1-1/8"	119201	117080	0.4			
	1-3/16"		117156	0.4			
	1-1/4"		117157	0.4			
	14MM		119583	0.6	5 x 2.3MM	5 x 3.0MM	5 x 5MM
	16MM		119654	0.6			
	18MM		119584	0.5	6 x 2.8MM	6 x 3.5MM	6 x 6MM
	19MM		119571	0.5			
	20MM		119585	0.5			
	22MM		119655	0.5			

Δ Key furnished for these sizes only.
+ These sizes are steel.
# Refer to torque capacity rating on page PT6-3. If Service Factor of 2.0 or greater is required, consult DODGE.

TL Bush Size	BORE	P/N Integral Key	P/N Keyway	WT.	Bushing Keyway	Shaft Keyway REF	Key Size REF
1210 (cont)	24MM		119586	0.5	8 X 3.3MM	8 X 4MM	8 X 7MM
	25MM		119587	0.4			
	28MM		119588	0.4			
	30MM		119589	0.4	8 X 3.3MM	8 X 4MM	8 x 7
1215	1/2"		119001	0.9	1/8 x 1/16	1/8 x 1/16	1/8 x 1/8
	9/16"		119002	0.9			
	5/8"		119003	0.8	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119004	0.8			
	3/4"		119005	0.8			
	13/16"		119006	0.8			
	7/8"		119007	0.8			
	15/16"		119008	0.8	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1"		119009	0.7			
	1-1/16"		119010	0.6			
	1-1/8"		119011	0.6			
	1-3/16"		119012	0.5			
	1-1/4"		119013	0.5			
1310	1/2"		119390	0.7	1/8 x 1/16	1/8 x 1/16	1/8 x 1/8
	9/16"		119391	0.7			
	5/8"		119392	0.7	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119393	0.7			
	3/4"		119394	0.7			
	13/16"		119395	0.7			
	7/8"		119396	0.7			
	15/16"		119397	0.6	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1"		119398	0.6			
	1-1/16"		119399	0.6			
	1-1/8"		119400	0.6			
	1-3/16"		119401	0.6			
	1-1/4"		119402	0.6			
	1-5/16" #		119403	0.6	5/16 x 5/32	5/16 x 5/32	5/16 x 5/16
	1-3/8" #		119404	0.6			
	1-7/16" +		119438	0.6	3/8 x 1/8	3/8 x 3/16	3/8 x 5/16 Δ
	14MM		119656	0.7	5 x 2.3MM	5 x 3.0MM	5 x 5MM
	16MM		119657	0.7			
	18MM		119658	0.7	6 x 2.8MM	6 x 3.5MM	6 x 6MM
	19MM		119572	0.7			
	20MM		119659	0.6			
	22MM		119660	0.6			
	24MM		119591	0.6	8 X 3.3MM	8 X 4MM	8 X 7MM
	25MM		119592	0.5			
	28MM		119593	0.5			
	30MM		119594	0.5			
	32MM		119595	0.4	10 X 3.3MM	10 X 5MM	10 X 8MM
	35MM		119596	0.4			
1610	1/2"		119211	0.9	1/8 x 1/16	1/8 x 1/16	1/8 x 1/8
	9/16"		119212	0.9			
	5/8"		117081	0.9	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	11/16"		119214	0.9			
	3/4"	119215	117158	0.9			
	13/16"		119216	0.9			
	7/8"	119217	117082	0.8			
	15/16"		117083	0.8	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1"	119219	117159	0.8			
	1-1/16"		119220	0.8			
	1-1/8"	119221	117084	0.7			
	1-3/16"		117160	0.7			
	1-1/4"	119223	117161	0.7			

T-L STOCK SIZES PAGE PT6-5	QD METRIC BORES PAGE PT6-22	QD HUBS PAGE PT6-25	T-L HUBS PAGE PT6-12



TAPER-LOCK Bushings - Stock Bore

TL Bush Size	BORE	P/N Integral Key	P/N Keyway	WT.	Bushing Keyway	Shaft Keyway REF	Key Size REF
	2-5/16"		119129	1.9	5/8 x 3/16	5/8 x 5/16	5/8 x 1/2 Δ
	2-3/8"		117098	1.9			
	2-7/16"+		117176	1.8			
	2-1/2" #		117099	1.8			
	2-5/8" +		117111	1.8			
	2-11/16"+		117115	1.8			
	14MM		119669	3.6	5 x 2.3MM	5 x 3.0MM	5 x 5MM
	16MM		119670	3.6			
	18MM		119671	3.5	6 x 2.8MM	6 x 3.5MM	6 x 6MM
	19MM		119672	3.4			
	20MM		119618	3.4			
	22MM		119619	3.3			
2517 (cont)	24MM		119620	3.3	8 X 3.3MM	8 X 4MM	8 X 7MM
	25MM		119621	3.2			
	28MM		119622	3.1			
	30MM		119623	3.1			
	32MM		119624	3	10 X 3.3MM	10 X 5MM	10 X 8MM
	35MM		119625	2.9			
	38MM		119626	2.9			
	40MM		119627	2.8	12 X 3.3MM	12 X 5MM	12 X 8MM
	42MM		119628	2.6			
	45MM		119629	2.5	14 X 3.8MM	14 X 5.5MM	14 X 9MM
	48MM		119630	2.4			
	50MM		119640	2.3			
	55MM		119641	2.0	16 X 4.3MM	16 X 6MM	16 X 10MM
	60MM		119642	1.7	18 X 4.4MM	18 X 7MM	18 X 11MM
	65MM		119643	1.4			

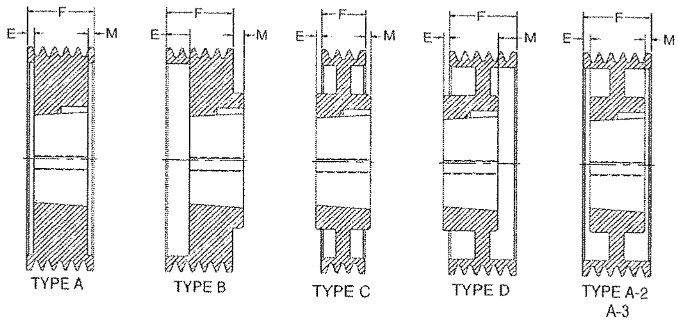
TL Bush Size	BORE	P/N Keyway	WT.	Bushing Keyway	Shaft Keyway REF	Key Size REF
	3/4	119304	4.9	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	7/8	119306	4.8			
	15/16	119307	4.8	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1	119308	4.8			
	1-1/8	119310	4.6			
	1-3/16	119311	4.5			
	1-1/4	119312	4.4			
	1-3/8	119314	4.2	5/16 x 5/32	5/16 x 5/32	5/16 x 5/16
	1-7/16	119315	4.2	3/8 x 3/16	3/8 x 3/16	3/8 x 3/8
	1-1/2	119316	4.0			
	1-5/8	119318	3.8			
2525	1-11/16	119319	3.8			
	1-3/4	119320	3.7			
	1-13/16	119321	3.2	1/2 x 1/4	1/2 x 1/4	1/2 x 1/2
	1-7/8	119322	3.4			
	1-15/16	119323	3.2			
	2	119324	3.1			
	2-1/8	119326	2.9			
	2-3/16	119327	2.5			
	2-1/4	119328	2.3			
	2-5/16	119329	2.0	5/8 x 3/16	5/8 x 5/16	5/8 x 1/2 Δ
	2-3/8	119330	2.0			
	2-7/16	119331	2.0			
	2-1/2	119332	2.0			

Δ Key furnished for these sizes only.
+ These sizes are steel.
# Refer to torque capacity rating on page PT6-3. If Service Factor of 2.0 or greater is required, consult DODGE.

TL Bush Size	BORE	P/N Keyway	WT.	Bushing Keyway	Shaft Keyway REF	Key Size REF
	7/8	117103	6.5	3/16 x 3/32	3/16 x 3/32	3/16 x 3/16
	15/16	117101	6.5	1/4 x 1/8	1/4 x 1/8	1/4 x 1/4
	1	117102	6.5			
	1-1/8	117104	6.4			
	1-3/16	117105	6.4			
	1-1/4	117106	6.3			
	1-5/16	117107	6.1	5/16 x 5/32	5/16 x 5/32	5/16 x 5/16
	1-3/8	117108	6.0			
	1-7/16	117109	6.0	3/8 x 3/16	3/8 x 3/16	3/8 x 3/8
	1-1/2	117110	5.9			
	1-9/16	117135	5.9			
	1-5/8	117112	5.9			
	1-11/16	117113	5.7			
	1-3/4	117114	5.6			
	1-13/16	117136	5.5	1/2 x 1/4	1/2 x 1/4	1/2 x 1/2
	1-7/8	117116	5.4			
	1-15/16	117117	5.3			
	2	117118	5.2			
	2-1/16	117119	5.0			
	2-1/8	117120	5.0			
	2-3/16	117121	4.9			
	2-1/4	117122	4.8			
	2-5/16	117137	4.6	5/8 x 5/16	5/8 x 5/16	5/8 x 5/8
	2-3/8	117124	4.5			
	2-7/16	117125	4.4			
	2-1/2	117126	4.3			
3020	2-5/8	117128	4.0			
	2-11/16	117129	3.9			
	2-3/4	117130	3.7			
	2-13/16	117139	3.7	3/4 x 1/8	3/4 x 3/8	3/4 x 1/2 Δ
	2-7/8	117132	3.6			
	2-15/16"#	117133	3.6			
	3" #	117134	3.4			
	3-1/8" +	117178	3.3	3/4 x 1/4	3/4 x 3/8	3/4 x 5/8 Δ
	3-3/16" +	117179	3.3			
	3-1/4" +	117180	3.3			
	24MM	119673	6.5	8 X 3.3MM	8 X 4MM	8 X 7MM
	25MM	119674	6.5			
	28MM	119675	6.4			
	30MM	119676	6.4			
	32MM	119677	6.3	10 X 3.3MM	10 X 5MM	10 X 8MM
	35MM	119678	6.0			
	38MM	119679	5.9			
	40MM	119680	5.9	12 X 3.3MM	12 X 5MM	12 X 8MM
	42MM	119681	5.8			
	45MM	119682	5.6	14 X 3.8MM	14 X 5.5MM	14 X 9MM
	48MM	119644	5.5			
	50MM	119645	5.2			
	55MM	119646	5.0	16 X 4.3MM	16 X 6MM	16 X 10MM
	60MM	119647	4.9	18 X 4.4MM	18 X 7MM	18 X 11MM
	65MM	119648	4.3			
	70MM	119649	3.7	20 X 4.9MM	20 X 7.5MM	20 X 12MM
	75MM	119650	3.5			

T-L STOCK SIZES PAGE PT6-5	QD METRIC BORES PAGE PT6-22	QD HUBS PAGE PT6-25	T-L HUBS PAGE PT6-12

3V TAPER-LOCK SHEAVES



1-Groove F = **

O.D.Δ	Part No.	Description	Wt.	Type‡	E	M
2.65	**112124**	1/3V2.65–1108	.75	A1	.06	0
2.8	**112125**	1/3V2.8–1108	.85	A1	.06	0
3.0	**112126**	1/3V3.0–1108	1.0	A1	.06	0
3.15	**112127**	1/3V3.15–1108	1.0	A1	.06	0
3.35	**112175**	1/3V3.35–1610	1.1	A1	.11	.05
3.65	**112176**	1/3V3.65–1610	1.3	A1	.11	.05
4.12	**112177**	1/3V4.12–1610	2.0	A1	.11	.05
4.5	**112178**	1/3V4.5–1610	2.3	A1	.11	.05
4.75	**112179**	1/3V4.75–1610	2.6	A1	.11	.05
5.0	**112180**	1/3V5.0–1610	2.9	A1	.11	.05
5.3	**112181**	1/3V5.3–1610	3.3	A1	.11	.05
5.6	**112182**	1/3V5.6–1610	3.7	A1	.11	.05
6.0	**112183**	1/3V6.0–1610	4.2	B1	0	.31
6.5	**112184**	1/3V6.5–1610	5.0	B1	0	.31
6.9	**112185**	1/3V6.9–1610	5.6	B1	0	.31
8.0	**112008**	1/3V8.0–2517	8.5	B1	0	1.06
10.6	**112009**	1/3V10.6–2517	14.0	B1	0	1.06
14.0	**112010**	1/3V14.0–2517	20.0	C3	0	.94
19.0	**112011**	1/3V19.0–3020	20.0	C3	0	.9[illegible]

** 2.65–3.15=0.94, 3.35–5.6=1.06, 6.0–10.6=0.69, 14.0=0.81, 19.0=1.09

2-Groove F = 1.09

O.D.Δ	Part No.	Description	Wt.	Type‡	E	M
2.65	**112128**	2/3V2.65–1108	0.75	A1	.06	.13
2.8	**112129**	2/3V2.8–1108	0.90	A1	.06	.13
3.0	**112186**	2/3V3.0–1210	1.4	A1	.11	.05
3.15	**112187**	2/3V3.15–1210	1.0	A1	.11	.05
3.35	**112188**	2/3V3.35–1610	1.5	A1	.11	.05
3.65	**112189**	2/3V3.65–1610	1.6	A1	.11	.05
4.12	**112190**	2/3V4.12–1610	2.1	A1	.11	.05
4.5	**112191**	2/3V4.5–1610	2.7	A1	.11	.05
4.75	**112192**	2/3V4.75–1610	3.1	A1	.11	.05
5.0	**112193**	2/3V5.0–1610	3.6	A1	.11	.05
5.3	**112194**	2/3V5.3–1610	4.2	A1	0	.05
5.6	**112195**	2/3V5.6–1610	4.8	A1	0	.05
6:0	**112196**	2/3V6.0–1610	5.8	A1	.09	0
6.5	**112197**	2/3V6.5–1610	7.0	A1	.09	0
6.9	**112198**	2/3V6.9–1610	8.0	A1	0	.09
8.0	**112023**	2/3V8.0–2517	11.0	B1	0	.66
10.6	**112024**	2/3V10.6–2517	15.0	B1	0	.66
14.0	**112025**	2/3V14.0–2517	22.0	C3	0	.66
19.0	**112026**	2/3V19.0–3020	22.0	C3	0	.91
25.0	**112027**	2/3V25.0–3020	30.0	C3	.125	.78

3-Groove F = 1.5[illegible]

O.D.Δ	Part No.	Description	Wt.	Type‡	E	M
2.65	**112130**	3/3V2.65–1108	1.0	A1	.06	.56
2.8	**112131**	3/3V2.8–1108	1.1	A1	.06	.56
3.0	**112199**	3/3V3.0–1210	1.8	A1	.11	.40
3.15	**112200**	3/3V3.15–1210	1.5	A1	.11	.40
3.35	**112201**	3/3V3.35–1610	1.8	A1	.11	.40
3.65	**112202**	3/3V3.65–1610	2.0	A1	.11	.40
4.12	**112203**	3/3V4.12–1610	2.6	A1	0	.50
4.5	**112204**	3/3V4.5–1610	3.2	A1	0	.50
4.75	**112205**	3/3V4.75–1610	3.7	A1	0	.50
5.0	**112206**	3/3V5.0–1610	4.2	A1	0	.50
5.3	**112207**	3/3V5.3–1610	4.8	A1	0	.50
5.6	**112208**	3/3V5.6–1610	5.5	A1	0	.50
6.0	**112038**	3/3V6.0–2517	7.4	B1	0	.25
6.5	**112144**	3/3V6.5–2517	9.1	B1	0	.25
6.9	**112145**	3/3V6.9–2517	10.0	B1	0	.25
8.0	**112039**	3/3V8.0–2517	15.0	B1	0	.25
10.6	**112040**	3/3V10.6–2517	18.0	C2	0	.25
14.0	**112041**	3/3V14.0–2517	25.0	C3	0	.25
19.0	**112042**	3/3V19.0–3020	34.0	C3	0	.50
25.0	**112043**	3/3V25.0–3020	36.0	C3	0	.50
33.5	**112044**	3/3V33.5–3020	53.0	C3	.25	.25

Δ Pitch diameter = O.D. – .05"

‡ **Type 1 = Block Type, 2 = Web, 3 = Arm** – See page PT7-3.

4-Groove F = 1.90

O.D.Δ	Part No.	Description	Wt.	Type‡	E	M
2.65	**112132**	4/3V2.65–1108	1.2	A1	.06	.97
2.8	**112133**	4/3V2.8–1108	1.3	A1	.06	.97
3.0	**112209**	4/3V3.0–1210	2.1	A1	.11	.80
3.15	**112210**	4/3V3.15–1210	1.9	A1	.11	.80
3.35	**112211**	4/3V3.35–1610	2.2	A1	.11	.80
3.65	**112212**	4/3V3.65–1610	2.0	A1	.11	.80
4.12	**112213**	4/3V4.12–1610	3.0	A1	0	.91
4.5	**112214**	4/3V4.5–1610	3.7	A1	0	.91
4.75	**112215**	4/3V4.75–1610	4.2	A1	0	.91
5.0	**112216**	4/3V5.0–1610	4.8	A1	0	.91
5.3	**112217**	4/3V5.3–1610	5.5	A1	0	.91
5.6	**112218**	4/3V5.6–1610	6.2	A1	0	.91
6.0	**112053**	4/3V6.0–2517	8.0	A1	0	.16
6.5	**112150**	4/3V6.5–2517	10.0	A1	0	.16
6.9	**112151**	4/3V6.9–2517	12.0	A1	0	.16
8.0	**112054**	4/3V8.0–2517	18.0	A1	0	.16
10.6	**112055**	4/3V10.6–2517	20.0	A2	0	.16
14.0	**112056**	4/3V14.0–2517	29.0	A3	0	.16
19.0	**112275**	4/3V19.0–3020	45.0	C3	0	.09
25.0	**112276**	4/3V25.0–3020	42.0	D3	.19	.09
33.5	**112059**	4/3V33.5–3030	73.0	C3	.55	.55

BELTS PAGES PT7-28	SELECTION: WEDGE PAGES PT7-42	SELECTION: CLASSICAL PAGES PT7-84	ENGINEERING/TECHNICAL PAGES PT7-124

Volume II

11318 - Oil Pump 50P1410 and Filtrate/Product Disposal Pump 50P1490

Attachment 2.9

11318 1.02.B.6 & 8
AIR DIAPHRAGM PUMP

P400/PV400

Advanced™ Series **METAL** Pumps

EOM
Engineering
Operation &
Maintenance

Advance your process

PRO-FLO®
PROGRESSIVE PUMP TECHNOLOGY

PRO-FLO V™
PROGRESSIVE PUMP TECHNOLOGY

CE

WILDEN®
A DOVER COMPANY

WIL-11100-E-05
REPLACES WIL-11100-E-04

WILDEN

PRO-FLO
PROGRESSIVE PUMP TECHNOLOGY

TABLE OF CONTENTS

Member of: Hydraulic INSTITUTE

Class I & II Ozone NON U.S. Clean Air Act Amendments of 1990 USE Depleting Substances

CAUTIONS—READ FIRST!

CAUTION: Do not apply compressed air to the exhaust port — pump will not function.

CAUTION: Do not over-lubricate air supply — excess lubrication will reduce pump performance. Pump is pre-lubed.

TEMPERATURE LIMITS:

Neoprene	–17.7°C to 93.3°C	0°F to 200°F
Buna-N	–12.2°C to 82.2°C	10°F to 180°F
EPDM	–51.1°C to 137.8°C	–60°F to 280°F
Viton®	–40°C to 176.7°C	–40°F to 350°F
Saniflex™	–28.9°C to 104.4°C	–20°F to 220°F
Polytetrafluoroethylene (PTFE)	4.4°C to 104.4°C	40°F to 220°F
Polyurethane	–12.2°C to 65.6°C	10°F to 150°F
Tetra-Flex™ PTFE w/Neoprene Backed	4.4°C to 107.2°C	40°F to 225°F
Tetra-Flex™ PTFE w/EPDM Backed	-10°C to 137°C	14°F to 280°F

NOTE: Not all materials are available for all models. Refer to Section 2 for material options for your pump.

CAUTION: When choosing pump materials, be sure to check the temperature limits for all wetted components. Example: Viton® has a maximum limit of 176.7°C (350°F) but polypropylene has a maximum limit of only 79°C (175°F).

CAUTION: Maximum temperature limits are based upon mechanical stress only. Certain chemicals will significantly reduce maximum safe operating temperatures. Consult Chemical Resistance Guide (E4) for chemical compatibility and temperature limits.

WARNING: Prevention of static sparking — If static sparking occurs, fire or explosion could result. Pump, valves, and containers must be grounded to a proper grounding point when handling flammable fluids and whenever discharge of static electricity is a hazard.

CAUTION: Do not exceed 8.6 bar (125 psig) air supply pressure.

CAUTION: The process fluid and cleaning fluids must be chemically compatible with all wetted pump components. Consult Chemical Resistance Guide (E4).

CAUTION: Do not exceed 82°C (180°F) air inlet temperature for Pro-Flo V™ models.

CAUTION: Pumps should be thoroughly flushed before installing into process lines. FDA and USDA approved pumps should be cleaned and/or sanitized before being used.

CAUTION: Always wear safety glasses when operating pump. If diaphragm rupture occurs, material being pumped may be forced out air exhaust.

CAUTION: Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from pump. Disconnect all intake, discharge and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container.

CAUTION: Blow out air line for 10 to 20 seconds before attaching to pump to make sure all pipeline debris is clear. Use an in-line air filter. A 5µ (micron) air filter is recommended.

NOTE: When installing PTFE diaphragms, it is important to tighten outer pistons simultaneously (turning in opposite directions) to ensure tight fit. (See torque specifications in Section 7.)

NOTE: Cast Iron PTFE-fitted pumps come standard from the factory with expanded PTFE gaskets installed in the diaphragm bead of the liquid chamber. PTFE gaskets cannot be re-used. Consult PS-TG for installation instructions during reassembly.

NOTE: Before starting disassembly, mark a line from each liquid chamber to its corresponding air chamber. This line will assist in proper alignment during reassembly.

CAUTION: Pro-Flo® pumps cannot be used in submersible applications. Pro-Flo V™ is available in both submersible and non-submersible options. Do not use non-submersible Pro-Flo V™ models in submersible applications. Turbo-Flo® pumps can also be used in submersible applications.

CAUTION: Tighten all hardware prior to installation.

WILDEN PUMP DESIGNATION SYSTEM

P400/AAAPP/VTS/VT/VT

P400/PV400 METAL

38 mm (1-1/2") Pump
Maximum Flow Rate:
443 LPM (117 GPM)

LEGEND

P400 / XXXXX / XXX / XX / XXX / XXXX

MODEL
WETTED PARTS & OUTER PISTON
AIR CHAMBERS
CENTER BLOCK
AIR VALVE
DIAPHRAGMS
VALVE BALLS
VALVE SEAT
O-RINGS
SPECIALTY CODE (if applicable)

MATERIAL CODES

MODEL
P400 = PRO-FLO®
PV400 = PRO-FLO V™

WETTED PARTS
AA = ALUMINUM / ALUMINUM
HH = ALLOY C / ALLOY C
SS = STAINLESS STEEL / STAINLESS STEEL

AIR CHAMBERS
A = ALUMINUM
C = PTFE COATED
N = NICKEL PLATED
S = STAINLESS STEEL (P400 only)
V = HALAR® COATED ALUMINUM (P400 only)

CENTER BLOCK
A = ALUMINUM (PV400 only)
C = PTFE COATED (PV400 only)
N = NICKEL PLATED (PV400 only)
P = POLYPROPYLENE (P400 only)

AIR VALVE
A = ALUMINUM (PV400 only)
C = PTFE COATED (PV400 only)
N = NICKEL PLATED (PV400 only)
P = POLYPROPYLENE (P400 only)

DIAPHRAGMS
BNS = BUNA-N (Red Dot)
BNU = BUNA-N, ULTRA-FLEX™
EPS = EPDM (Blue Dot)
EPU = EPDM, ULTRA-FLEX™
FSS = SANIFLEX™ [Hytrel® (Cream)]
NES = NEOPRENE (Green Dot)
NEU = NEOPRENE, ULTRA-FLEX™
PUS = POLYURETHANE (Clear)
TNU = PTFE W/NEOPRENE BACK-UP (White)
TSU = PTFE W/SANIFLEX™ BACK-UP (White)
VTS = VITON® (White Dot)
VTU = VITON®, ULTRA-FLEX™
WFS = WIL-FLEX™ [Santoprene (Orange Dot)]
XBS = CONDUCTIVE BUNA-N (Two Red Dots)

VALVE BALL
BN = BUNA-N (Red Dot)
EP = EPDM (Blue Dot)
FS = SANIFLEX™ [Hytrel® (Cream)]
NE = NEOPRENE (Green Dot)
PU = POLYURETHANE (Clear)
TF = PTFE (White)
VT = VITON® (Silver or White Dot)
WF = WIL-FLEX™ [Santoprene® (Orange Dot)]

VALVE SEAT
A = ALUMINUM
EP = EPDM (Blue Dot)
BN = BUNA-N (Red Dot)
FG = SANIFLEX™ [Hytrel® (Cream)]
H = ALLOY C
M = MILD STEEL
NE = NEOPRENE (Green Dot)
PU = POLYURETHANE (Clear)
S = STAINLESS STEEL
VT = VITON® (Silver or White Dot)
WF = WIL-FLEX™ [Santoprene (Orange Dot)]

VALVE SEAT O-RING
FS = FLUORO-SEAL™
TF = PTFE

SPECIALTY CODES

0044 Stallion® balls & seats ONLY
0100 Wil-Gard II™ 110V
0102 Wil-Gard II™ sensor wires ONLY
0103 Wil-Gard II™ 220V
0320 Submersible center block
0480 PCM I™ (sensor & wires)
0483 PCM I™ (module, sensor & wires)
0485 PCM I™ (module, sensor & wires), DIN flange
0504 DIN flange
0560 Split manifold
0564 Split manifold, inlet ONLY
0563 Split manifold, discharge ONLY

NOTE: MOST ELASTOMERIC MATERIALS USE COLORED DOTS FOR IDENTIFICATION.

NOTE: Not all models are available with all material options.

PRO-FLO®
PROGRESSIVE PUMP TECHNOLOGY

HOW IT WORKS—PUMP

The Wilden diaphragm pump is an air-operated, positive displacement, self-priming pump. These drawings show flow pattern through the pump upon its initial stroke. It is assumed the pump has no fluid in it prior to its initial stroke.

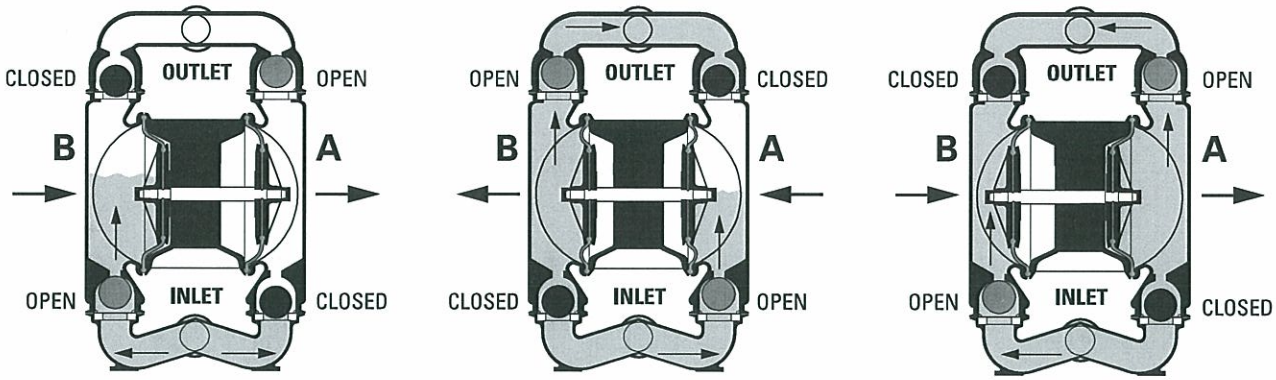


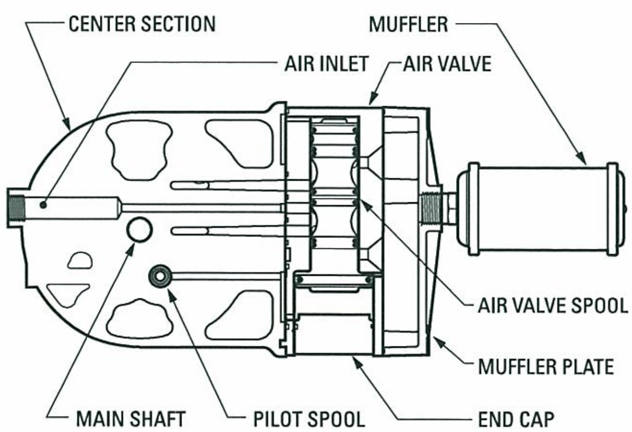
FIGURE 1 The air valve directs pressurized air to the back side of diaphragm A. The compressed air is applied directly to the liquid column separated by elastomeric diaphragms. The diaphragm acts as a separation membrane between the compressed air and liquid, balancing the load and removing mechanical stress from the diaphragm. The compressed air moves the diaphragm away from the center of the pump. The opposite diaphragm is pulled in by the shaft connected to the pressurized diaphragm. Diaphragm B is on its suction stroke; air behind the diaphragm has been forced out to atmosphere through the exhaust port of the pump. The movement of diaphragm B toward the center of the pump creates a vacuum within chamber B. Atmospheric pressure forces fluid into the inlet manifold forcing the inlet valve ball off its seat. Liquid is free to move past the inlet valve ball and fill the liquid chamber (see shaded area).

FIGURE 2 When the pressurized diaphragm, diaphragm A, reaches the limit of its discharge stroke, the air valve redirects pressurized air to the back side of diaphragm B. The pressurized air forces diaphragm B away from the center while pulling diaphragm A to the center. Diaphragm B is now on its discharge stroke. Diaphragm B forces the inlet valve ball onto its seat due to the hydraulic forces developed in the liquid chamber and manifold of the pump. These same hydraulic forces lift the discharge valve ball off its seat, while the opposite discharge valve ball is forced onto its seat, forcing fluid to flow through the pump discharge. The movement of diaphragm A toward the center of the pump creates a vacuum within liquid chamber A. Atmospheric pressure forces fluid into the inlet manifold of the pump. The inlet valve ball is forced off its seat allowing the fluid being pumped to fill the liquid chamber.

FIGURE 3 At completion of the stroke, the air valve again redirects air to the back side of diaphragm A, which starts diaphragm B on its exhaust stroke. As the pump reaches its original starting point, each diaphragm has gone through one exhaust and one discharge stroke. This constitutes one complete pumping cycle. The pump may take several cycles to completely prime depending on the conditions of the application.

PRO-FLO®
PROGRESSIVE PUMP TECHNOLOGY

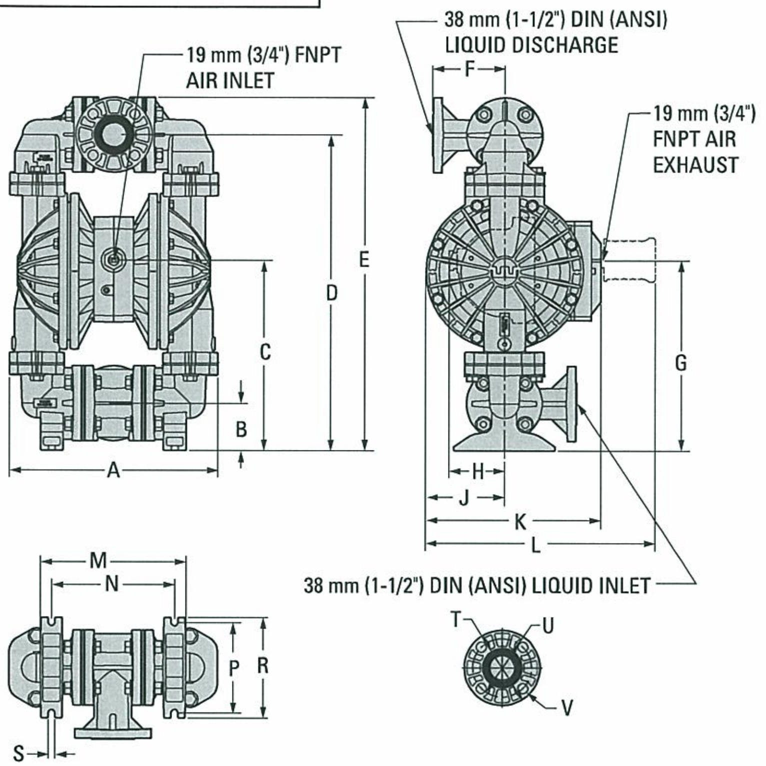
HOW IT WORKS—AIR DISTRIBUTION SYSTEM



The Pro-Flo® patented air distribution system incorporates two moving parts: the air valve spool and the pilot spool. The heart of the system is the air valve spool and air valve. This valve design incorporates an unbalanced spool. The smaller end of the spool is pressurized continuously, while the large end is alternately pressurized then exhausted to move the spool. The spool directs pressurized air to one air chamber while exhausting the other. The air causes the main shaft/diaphragm assembly to shift to one side — discharging liquid on that side and pulling liquid in on the other side. When the shaft reaches the end of its stroke, the inner piston actuates the pilot spool, which pressurizes and exhausts the large end of the air valve spool. The repositioning of the air valve spool routes the air to the other air chamber.

DIMENSIONAL DRAWINGS

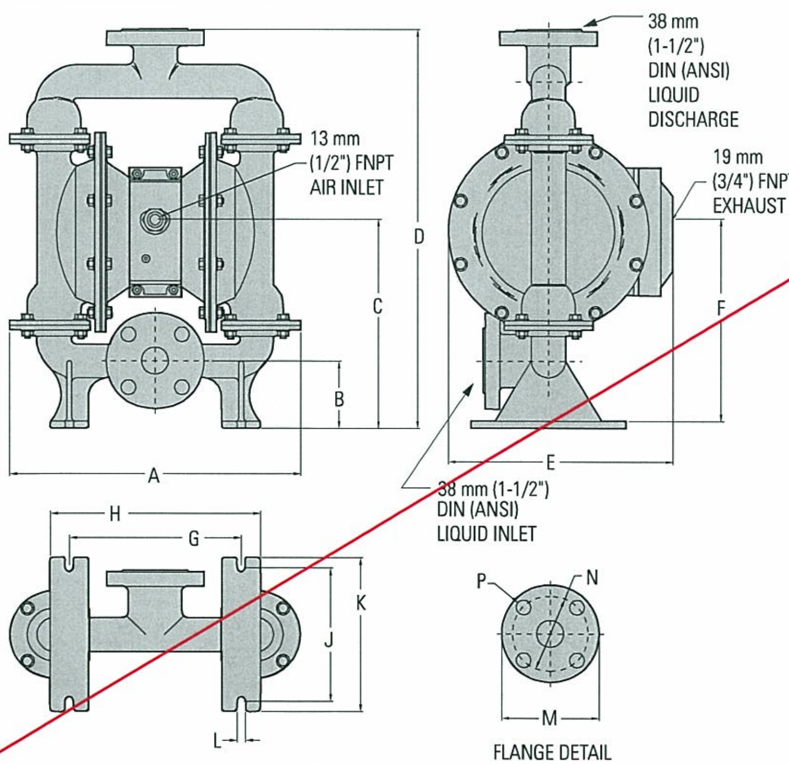
P400 Aluminum



DIMENSIONS

ITEM	METRIC (mm)	STANDARD (inch)
A	343	13.5
B	79	3.1
C	320	12.6
D	531	20.9
E	594	23.4
F	122	4.8
G	81	3.2
H	312	12.3
J	292	11.5
K	244	9.6
L	206	8.1
M	152	6.0
N	170	6.7
P	10	0.4
	DIN FLANGE	
R	110 DIA.	4.3 DIA.
S	150 DIA.	5.9 DIA.
T	18 DIA.	0.7 DIA.
	ANSI FLANGE	
R	98 DIA.	3.9 DIA.
S	127 DIA.	5.0 DIA.
T	16 DIA.	0.6 DIA.

P400 Stainless Steel/Alloy C

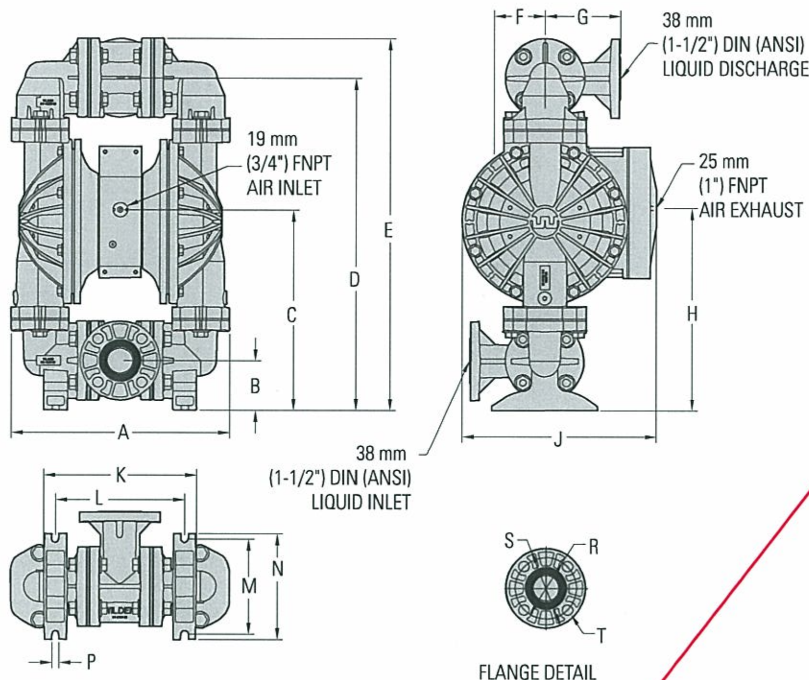


DIMENSIONS

ITEM	METRIC (mm)	STANDARD (inch)
A	384	15.1
B	89	3.5
C	277	10.9
D	528	20.8
E	292	11.5
F	277	10.9
G	224	8.8
H	274	10.8
J	178	7.0
K	203	8.0
L	10	0.4
	DIN FLANGE	
M	150 DIA.	5.9 DIA.
N	110 DIA.	4.3 DIA.
P	18 DIA.	0.7 DIA.
	ANSI FLANGE	
M	127 DIA.	5.0 DIA.
N	98 DIA.	3.9 DIA.
P	19 DIA.	0.7 DIA.

DIMENSIONAL DRAWINGS

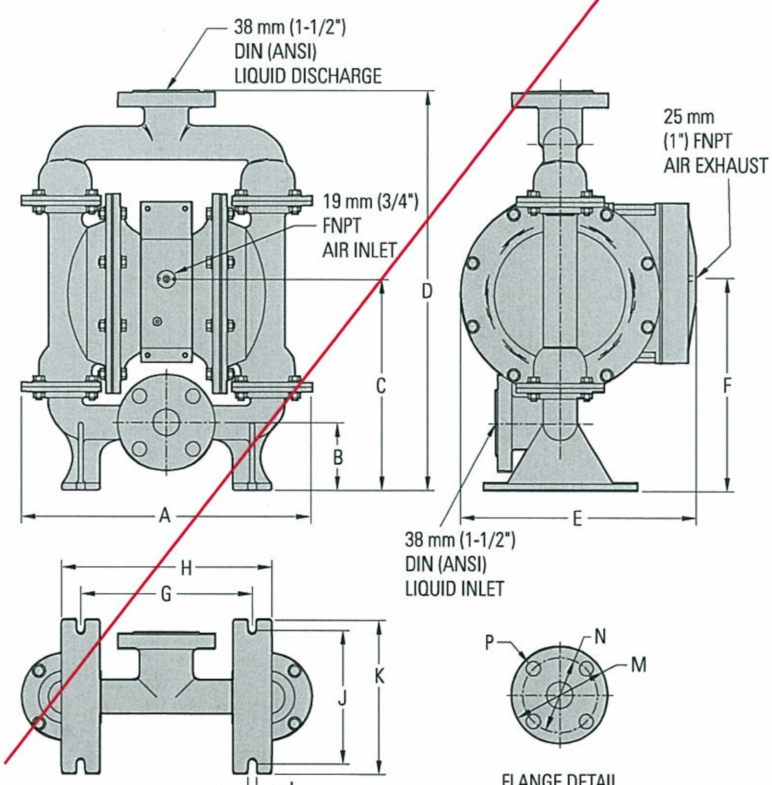
PV400 Aluminum



DIMENSIONS

ITEM	METRIC (mm)	STANDARD (inch)
A	343	13.5
B	79	3.1
C	323	12.7
D	531	20.9
E	594	23.4
F	122	4.8
G	81	3.2
H	325	12.8
J	310	12.2
K	284	11.2
L	206	8.1
M	152	6.0
N	170	6.7
P	10	0.4
	DIN (mm)	ANSI (inch)
R	110 DIA.	3.9 DIA.
S	150 DIA.	5.0 DIA.
T	18 DIA.	0.6 DIA.

PV400 Stainless Steel/Alloy C



DIMENSIONS

ITEM	METRIC (mm)	STANDARD (inch)
A	384	15.1
B	89	3.5
C	277	10.9
D	528	20.8
E	310	12.2
F	279	11.0
G	224	8.8
H	274	10.8
J	178	7.0
K	203	8.0
L	10	0.4
	DIN (mm)	ANSI (inch)
M	150 DIA.	5.0 DIA.
N	110 DIA.	3.8 DIA.
P	18 DIA.	0.6 DIA.

PERFORMANCE

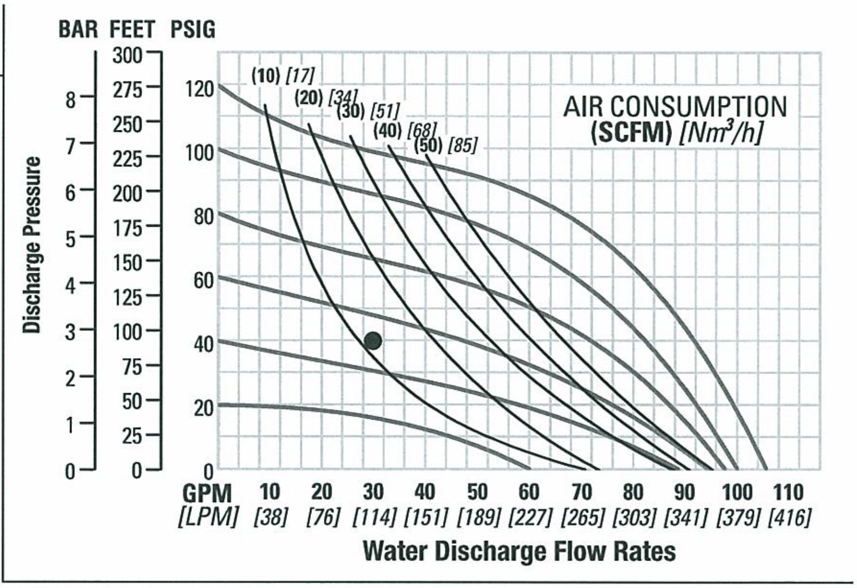
P400 ALUMINUM RUBBER-FITTED

Height ....594 mm (23.4")
Width ....343 mm (13.5")
Depth ....340 mm (13.4")
Est. Ship Weight....Aluminum 25 kg (55 lbs)
Air Inlet .... 13 mm (1/2")
Inlet.................................. 38 mm (1-1/2")
Outlet................................ 38 mm (1-1/2")
Suction Lift ....4.2 m Dry (13.6')
8.9 m Wet (29.5')
Displacement/Stroke...... 1.14 l (0.30 gal.)[1]
Max. Flow Rate.......... 401 lpm (106 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 114 lpm (30 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 3.4 bar (50 psig) and 20 Nm³/h (12 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

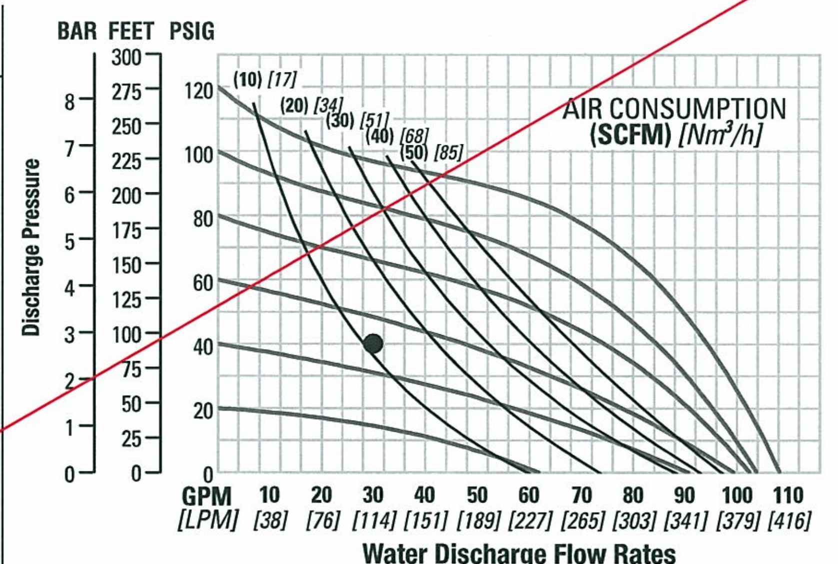
P400 ALUMINUM TPE-FITTED

Height ....594 mm (23.4")
Width ....343 mm (13.5")
Depth ....340 mm (13.4")
Est. Ship Weight....Aluminum 25 kg (55 lbs)
Air Inlet .... 13 mm (1/2")
Inlet..................................38 mm (1-1/2")
Outlet................................38 mm (1-1/2")
Suction Lift ....3.9 m Dry (13.0')
8.9 m Wet (29.5')
Displacement/Stroke...... 1.14 l (0.30 gal.)[1]
Max. Flow Rate...........409 lpm (108 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 114 lpm (30 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 3.5 bar (51 psig) and 20 Nm³/h (12 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

PERFORMANCE

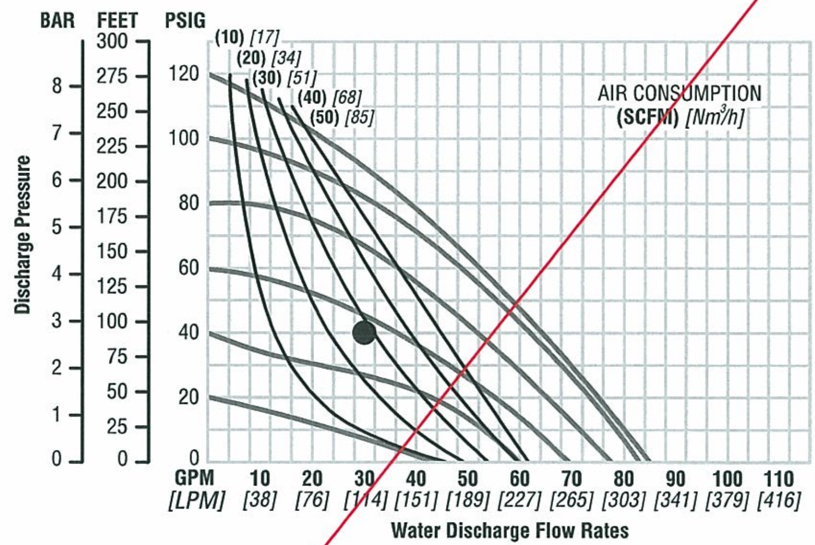
P400 ALUMINUM PTFE-FITTED

Height................................594 mm (23.4")
Width.................................343 mm (13.5")
Depth.................................340 mm (13.4")
Est. Ship Weight....Aluminum 25 kg (55 lbs)
Air Inlet.................................13 mm (1/2")
Inlet....................................38 mm (1-1/2")
Outlet.................................38 mm (1-1/2")
Suction Lift ....3.4 m Dry (11.3')
8.9 m Wet (29.5')
Displacement/Stroke ....0.57 l (0.15 gal.)[1]
Max. Flow Rate............ 329 lpm (87 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 114 lpm (30 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 3.8 bar (55 psig) and 46 Nm³/h (27 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

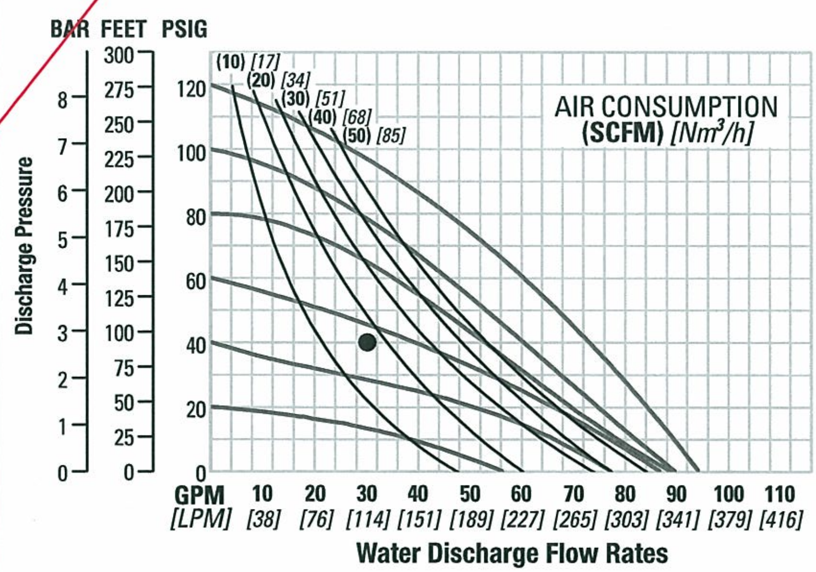
P400 ALUMINUM ULTRA-FLEX™-FITTED

Height................................594 mm (23.4")
Width.................................343 mm (13.5")
Depth.................................340 mm (13.4")
Est. Ship Weight....Aluminum 25 kg (55 lbs)
Air Inlet.................................13 mm (1/2")
Inlet....................................38 mm (1-1/2")
Outlet.................................38 mm (1-1/2")
Suction Lift ....4.2 m Dry (13.6')
8.9 m Wet (29.5')
Displacement/Stroke......0.79 l (0.21 gal.)[1]
Max. Flow Rate............ 360 lpm (95 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 114 lpm (30 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 3.8 bar (55 psig) and 20 Nm³/h (12 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

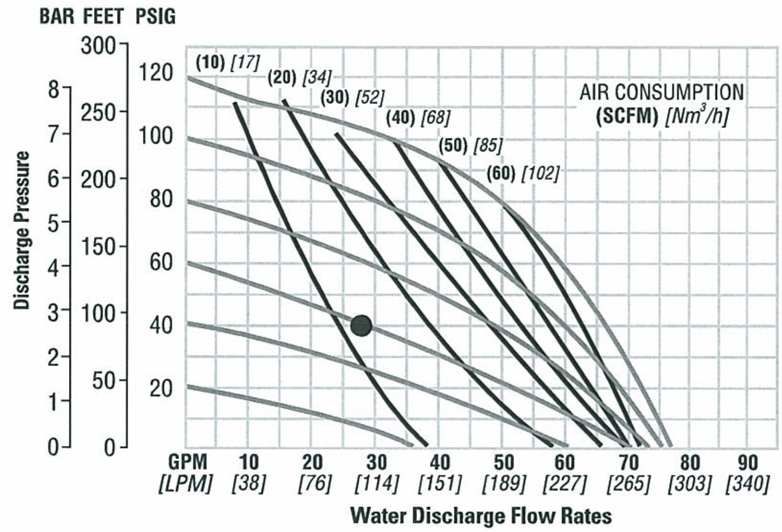
P400 STAINLESS STEEL RUBBER-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 295 mm (11.6")
Est. Ship Weight ....
316 Stainless Steel 35 kg (77 lbs)
Alloy C 38 kg (83 lbs)
Air Inlet .... 13 mm (1/2")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 5.8 m Dry (19.0')
7.9 m Wet (26.0')
Displacement/Stroke ..... 0.98 l (0.26 gal.)[1]
Max. Flow Rate .... 288 lpm (76 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 102 lpm (27 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 4.1 bar (60 psig) and 22 Nm³/h (13 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

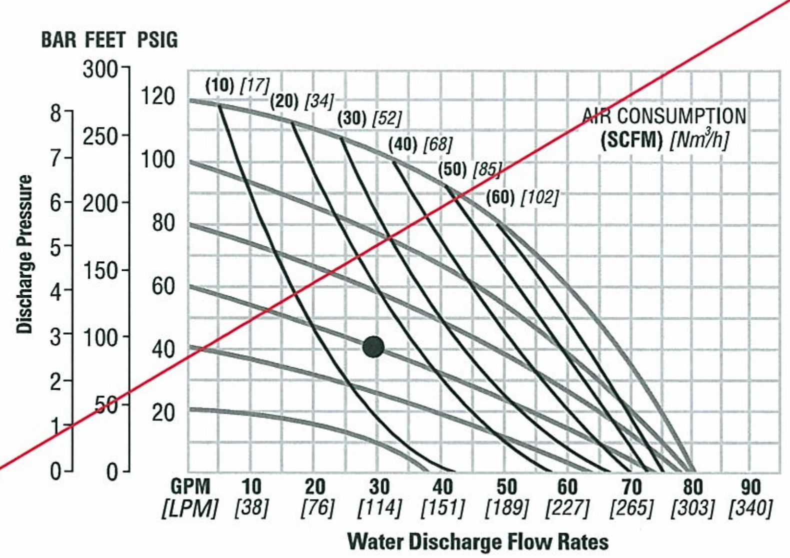
P400 STAINLESS STEEL TPE-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 295 mm (11.6")
Est. Ship Weight ....
316 Stainless Steel 35 kg (77 lbs)
Alloy C 38 kg (83 lbs)
Air Inlet .... 13 mm (1/2")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 5.2 m Dry (17.0')
8.8 m Wet (29.0')
Displacement/Stroke ...... 1.10 l (0.29 gal.)[1]
Max. Flow Rate .... 307 lpm (81 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 114 lpm (30 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 4.1 bar (60 psig) and 26 Nm³/h (15 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

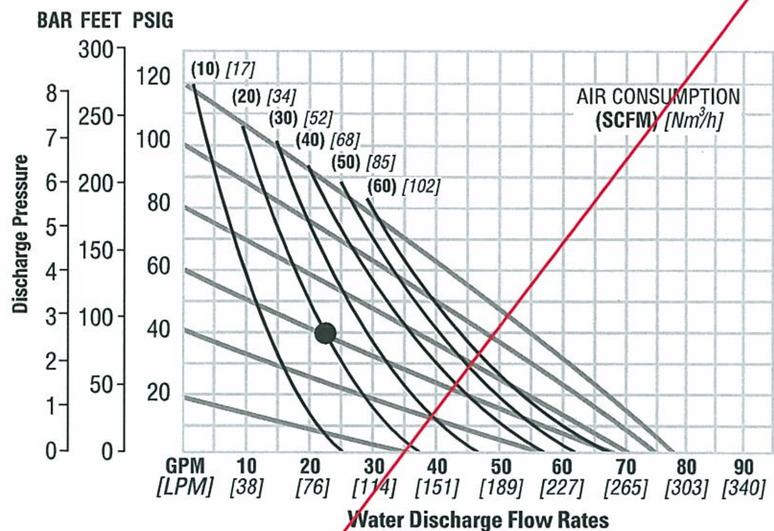
P400 STAINLESS STEEL PTFE-FITTED

Height ....528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 295 mm (11.6")
Est. Ship Weight ....
316 Stainless Steel 35 kg (77 lbs)
Alloy C 38 kg (83 lbs)
Air Inlet .... 13 mm (1/2")
Inlet ....38 mm (1-1/2")
Outlet ....38 mm (1-1/2")
Suction Lift ....3.7 m Dry (12.0')
8.5 m Wet (28.0')
Displacement/Stroke ......0.53 l (0.14 gal.)[1]
Max. Flow Rate ....295 lpm (78 gpm)
Max. Size Solids ....4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 83 lpm (22 gpm) against a discharge pressure head of 2.8 bar (40 psig) requires 4.1 bar (60 psig) and 34 Nm^3/h (20 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

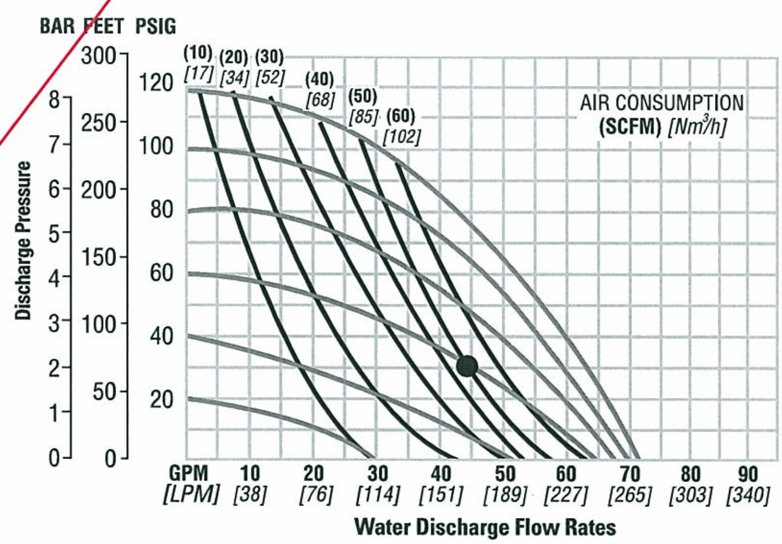
P400 STAINLESS STEEL ULTRA-FLEX™-FITTED

Height ....528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 295 mm (11.6")
Est. Ship Weight ....
316 Stainless Steel 35 kg (77 lbs)
Alloy C 38 kg (83 lbs)
Air Inlet .... 13 mm (1/2")
Inlet ....38 mm (1-1/2")
Outlet ....38 mm (1-1/2")
Suction Lift ....5.2 m Dry (17.0')
8.5 m Wet (28.0')
Displacement/Stroke ......0.76 l (0.20 gal.)[1]
Max. Flow Rate ....269 lpm (71 gpm)
Max. Size Solids ....4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 170 lpm (45 gpm) against a discharge pressure head of 2.1 bar (30 psig) requires 4.1 bar (60 psig) and 85 Nm^3/h (50 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

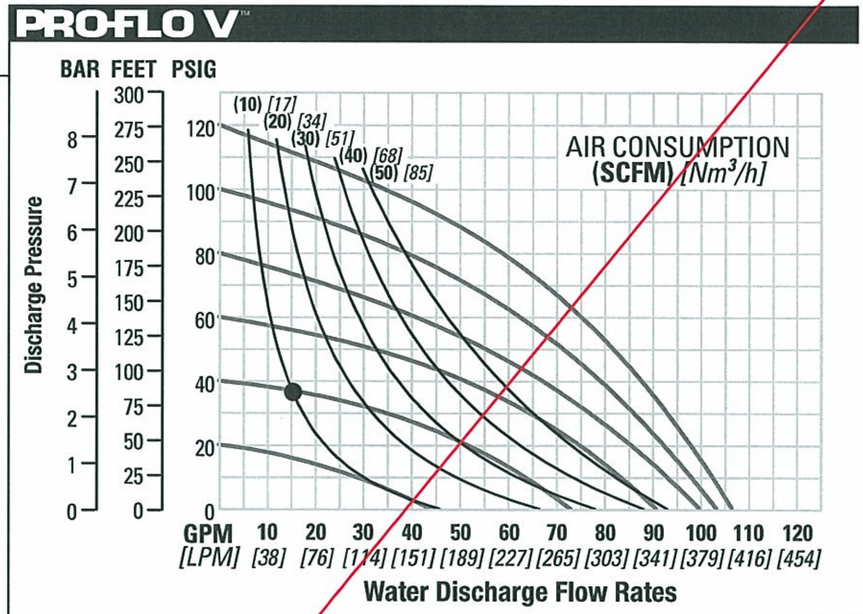
PV400 ALUMINUM RUBBER-FITTED

Height .... 594 mm (23.4")
Width .... 343 mm (13.5")
Depth .... 310 mm (12.2")
Est. Ship Weight....Aluminum 33 kg (72 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 5.2 m Dry (17.0')
9.5 m Wet (31.2')
Displacement/Stroke...... 1.17 l (0.31 gal.)[1]
Max. Flow Rate.......... 405 lpm (107 gpm)
Max. Size Solids................ 7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 57 lpm (15 gpm) against a discharge pressure head of 2.6 bar (38 psig) requires 2.8 bar (40 psig) and 17 Nm³/h (10 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

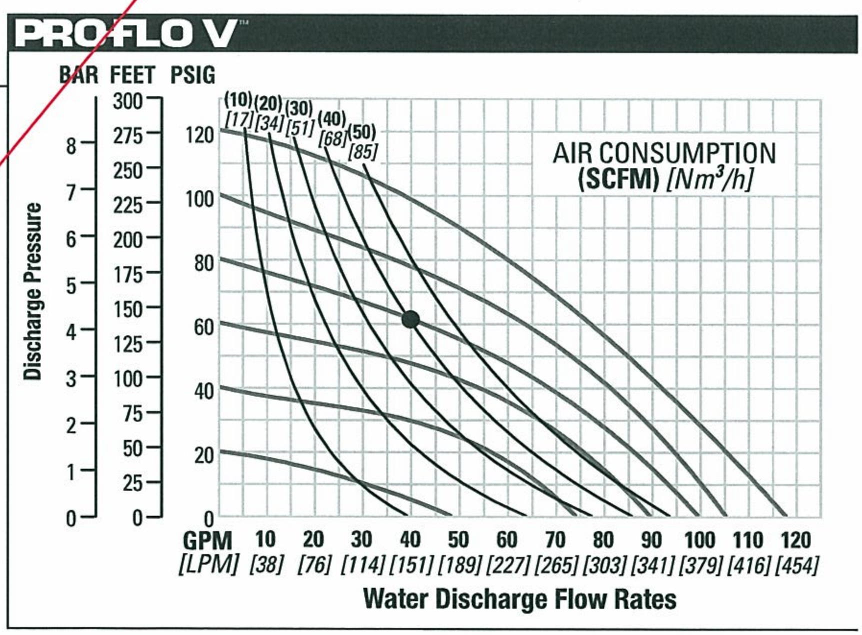
PV400 ALUMINUM TPE-FITTED

Height .... 594 mm (23.4")
Width .... 343 mm (13.5")
Depth .... 310 mm (12.2")
Est. Ship Weight....Aluminum 33 kg (72 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 5.2 m Dry (16.9')
9.5 m Wet (31.2')
Displacement/Stroke...... 1.21 l (0.32 gal.)[1]
Max. Flow Rate........... 443 lpm (117 gpm)
Max. Size Solids................ 7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 148 lpm (39 gpm) against a discharge pressure head of 4.3 bar (62 psig) requires 5.5 bar (80 psig) and 68 Nm³/h (40 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

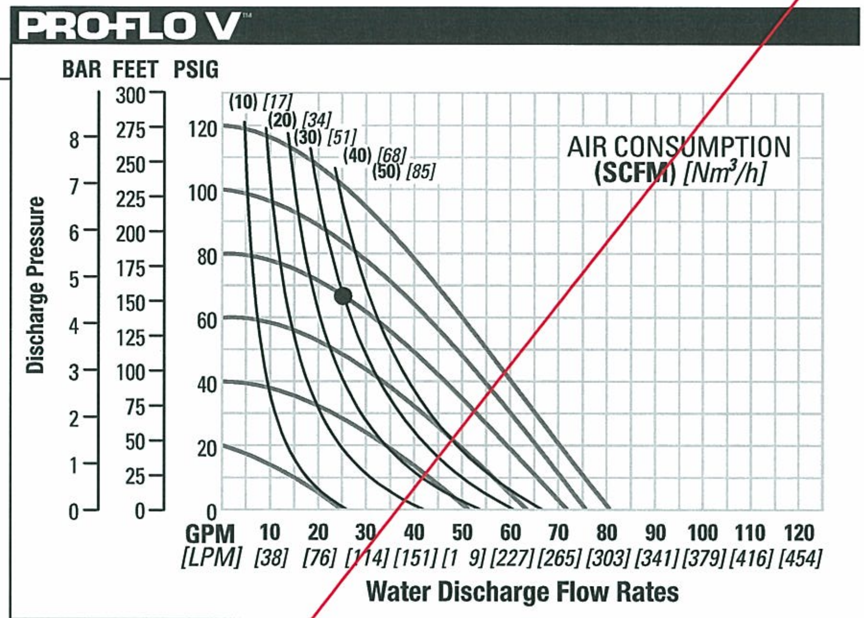
PV400 ALUMINUM PTFE-FITTED

Height................................594 mm (23.4")
Width.................................343 mm (13.5")
Depth.................................310 mm (12.2")
Est. Ship Weight....Aluminum 33 kg (72 lbs)
Air Inlet.................................19 mm (3/4")
Inlet....................................38 mm (1-1/2")
Outlet.................................38 mm (1-1/2")
Suction Lift ....4.7 m Dry (15.3')
9.5 m Wet (31.2')
Displacement/Stroke......0.61 l (0.16 gal.)[1]
Max. Flow Rate.............307 lpm (81 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 95 lpm (25 gpm) against a discharge pressure head of 4.7 bar (68 psig) requires 5.5 bar (80 psig) and 68 Nm³/h (40 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

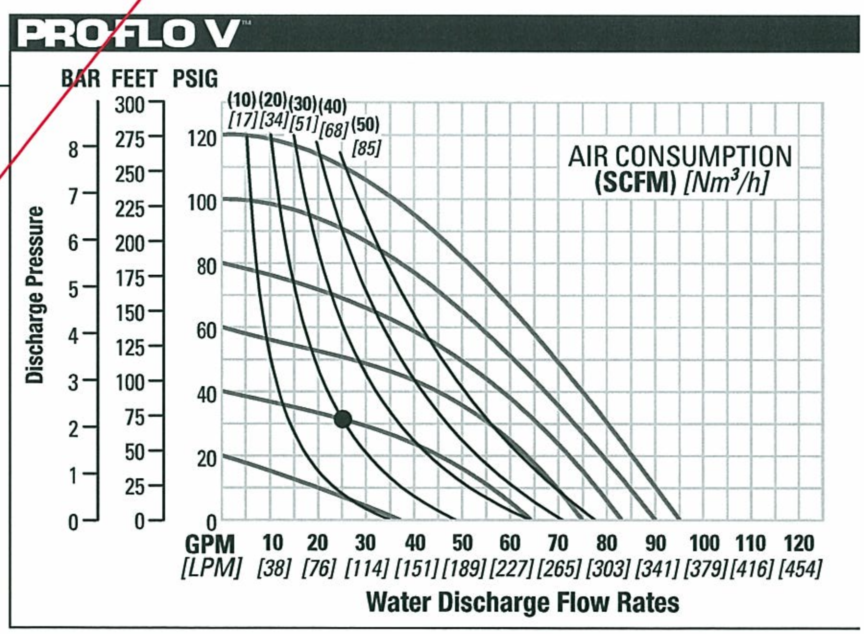
PV400 ALUMINUM ULTRA-FLEX™-FITTED

Height................................594 mm (23.4")
Width.................................343 mm (13.5")
Depth.................................310 mm (12.2")
Est. Ship Weight....Aluminum 33 kg (72 lbs)
Air Inlet.................................19 mm (3/4")
Inlet....................................38 mm (1-1/2")
Outlet.................................38 mm (1-1/2")
Suction Lift ....4.7 m Dry (15.5')
9.5 m Wet (31.2')
Displacement/Stroke..... 0.83 l (0.22 gal.)[1]
Max. Flow Rate............ 360 lpm (95 gpm)
Max. Size Solids................7.9 mm (5/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 95 lpm (25 gpm) against a discharge pressure head of 2.1 bar (31 psig) requires 4.1 bar (40 psig) and 34 Nm³/h (20 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

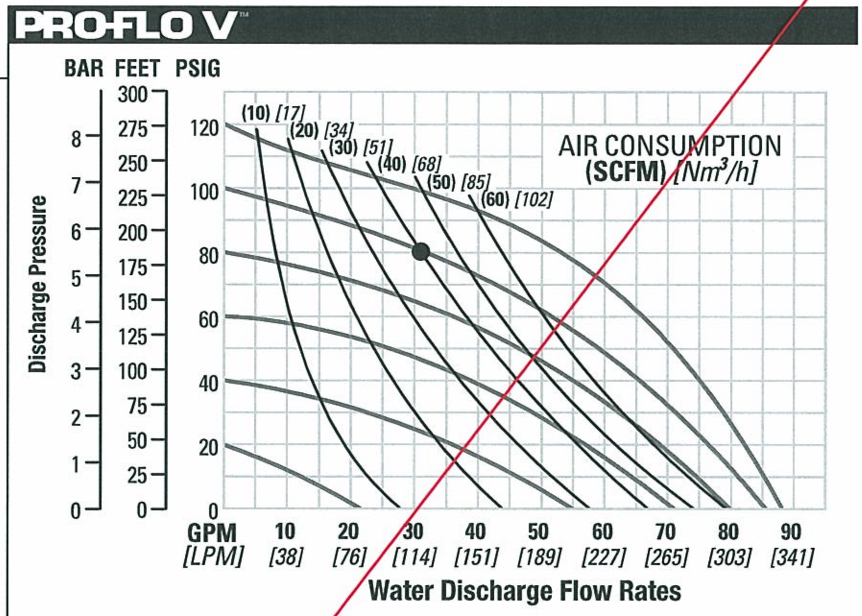
PV400 STAINLESS STEEL RUBBER-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 310 mm (12.2")
Est. Ship Weight ....
316 Stainless Steel 43 kg (94 lbs)
Alloy C 45 kg (100 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 7.3 m Dry (23.8')
9.5 m Wet (31.2')
Displacement/Stroke...... 1.10 l (0.29 gal.)[1]
Max. Flow Rate........... 333 lpm (88 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 117 lpm (31 gpm) against a discharge pressure head of 5.5 bar (80 psig) requires 6.7 bar (100 psig) and 68 Nm³/h (40 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

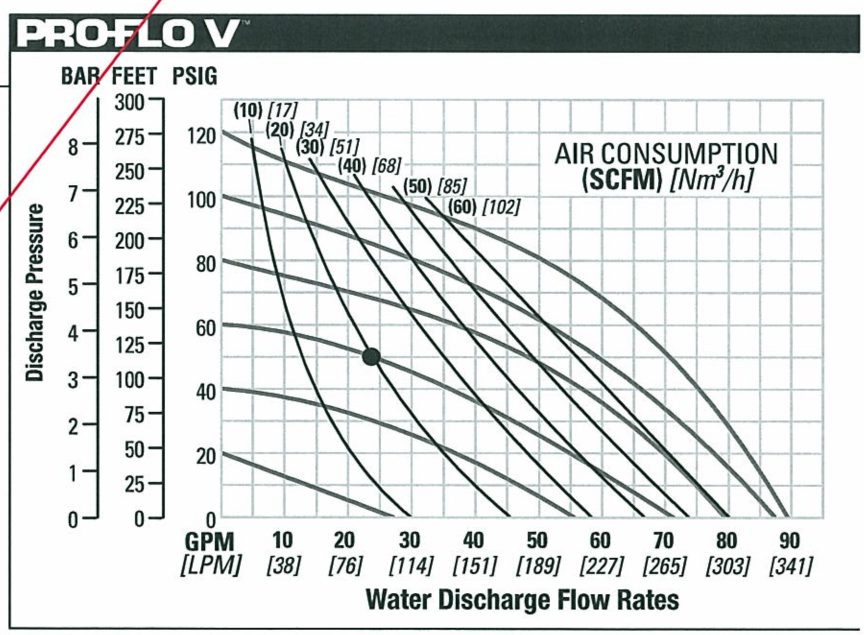
PV400 STAINLESS STEEL TPE-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 310 mm (12.2")
Est. Ship Weight ....
316 Stainless Steel 43 kg (94 lbs)
Alloy C 45 kg (100 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 6.4 m Dry (21.0')
9.5 m Wet (31.2')
Displacement/Stroke...... 1.14 l (0.30 gal.)[1]
Max. Flow Rate........... 337 lpm (89 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 91 lpm (24 gpm) against a discharge pressure head of 3.4 bar (50 psig) requires 4.1 bar (60 psig) and 34 Nm³/h (20 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

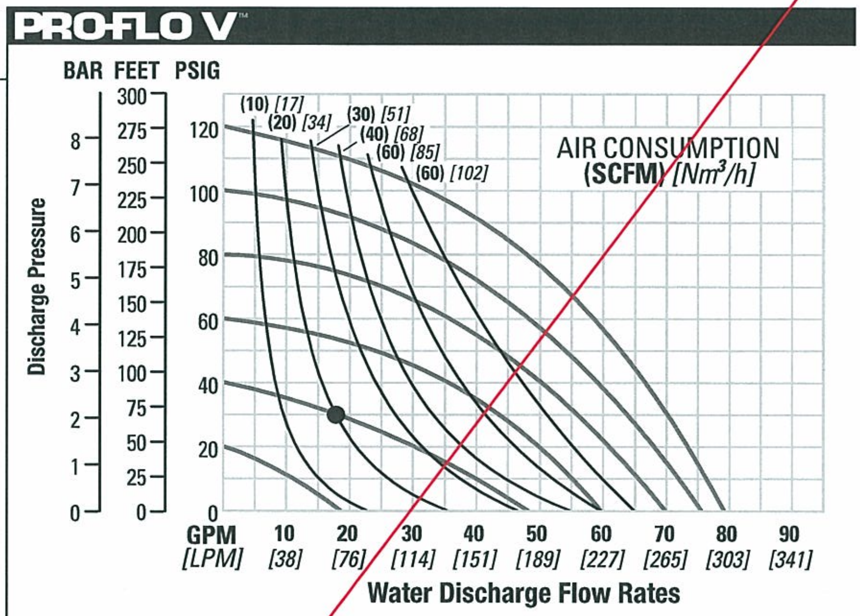
PV400 STAINLESS STEEL PTFE-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 310 mm (12.2")
Est. Ship Weight ....
316 Stainless Steel 43 kg (94 lbs)
Alloy C 45 kg (100 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 4.7 m Dry (15.3')
9.5 m Wet (31.2')
Displacement/Stroke ...... 0.61 l (0.16 gal.)[1]
Max. Flow Rate .... 299 lpm (79 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 64 lpm (17 gpm) against a discharge pressure head of 2.1 bar (30 psig) requires 2.8 bar (40 psig) and 34 Nm³/h (20 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.



Flow rates indicated on chart were determined by pumping water.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

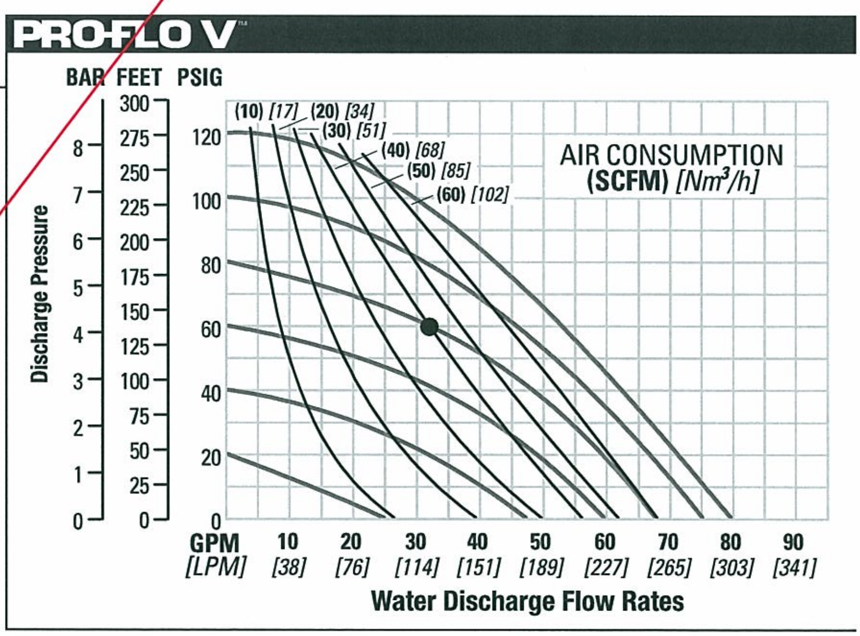
PV400 STAINLESS STEEL ULTRA-FLEX™-FITTED

Height .... 528 mm (20.8")
Width .... 384 mm (15.1")
Depth .... 310 mm (12.2")
Est. Ship Weight ....
316 Stainless Steel 43 kg (94 lbs)
Alloy C 45 kg (100 lbs)
Air Inlet .... 19 mm (3/4")
Inlet .... 38 mm (1-1/2")
Outlet .... 38 mm (1-1/2")
Suction Lift .... 6.3 m Dry (20.5')
9.5 m Wet (31.2')
Displacement/Stroke ...... 0.76 l (0.20 gal.)[1]
Max. Flow Rate .... 303 lpm (80 gpm)
Max. Size Solids .... 4.8 mm (3/16")

[1]Displacement per stroke was calculated at 4.8 bar (70 psig) air inlet pressure against a 2.1 bar (30 psig) head pressure.

Example: To pump 121 lpm (32 gpm) against a discharge pressure head of 4.1 bar (60 psig) requires 2.8 bar (40 psig) and 68 Nm³/h (40 scfm) air consumption.

Caution: Do not exceed 8.6 bar (125 psig) air supply pressure.

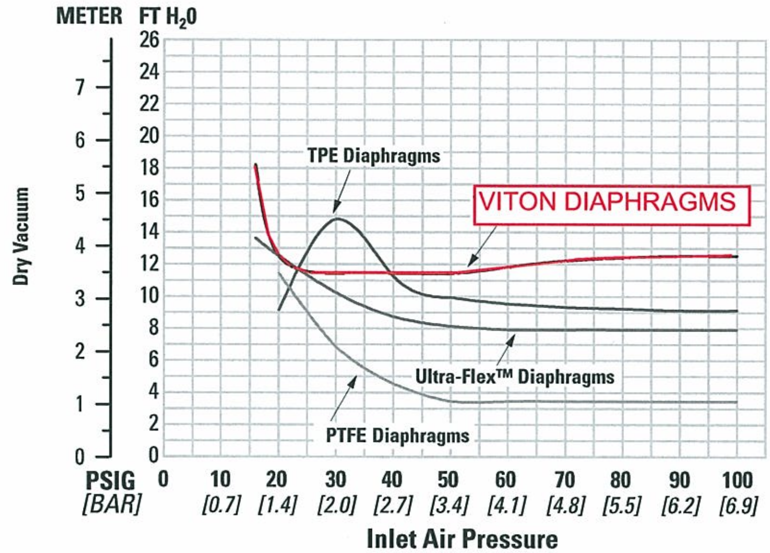


Flow rates indicated on chart were determined by pumping water.

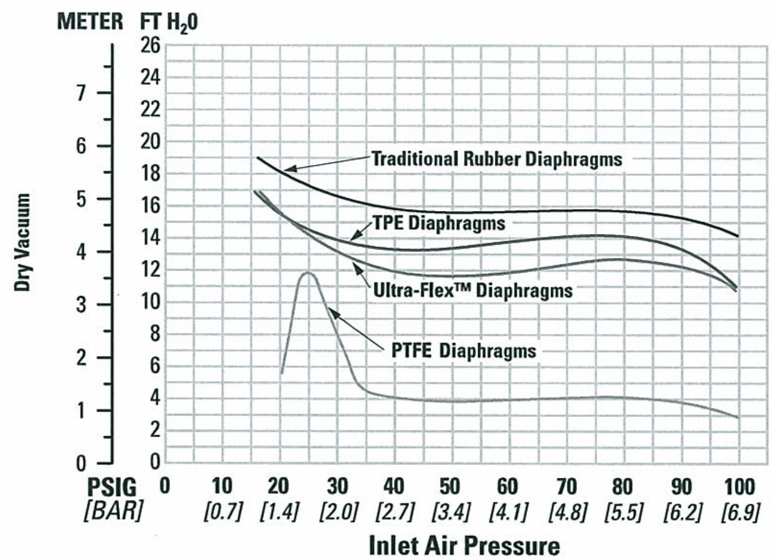
For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the center of the pump performance curve.

SUCTION LIFT CURVES

P400 ALUMINUM SUCTION LIFT CAPABILITY

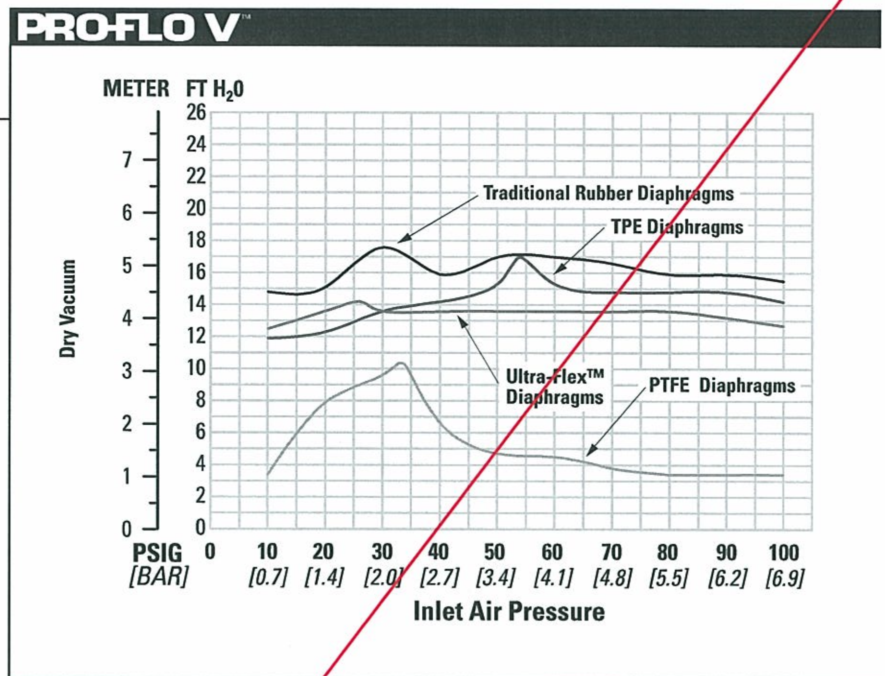


P400 STAINLESS STEEL & ALLOY C SUCTION LIFT CAPABILITY

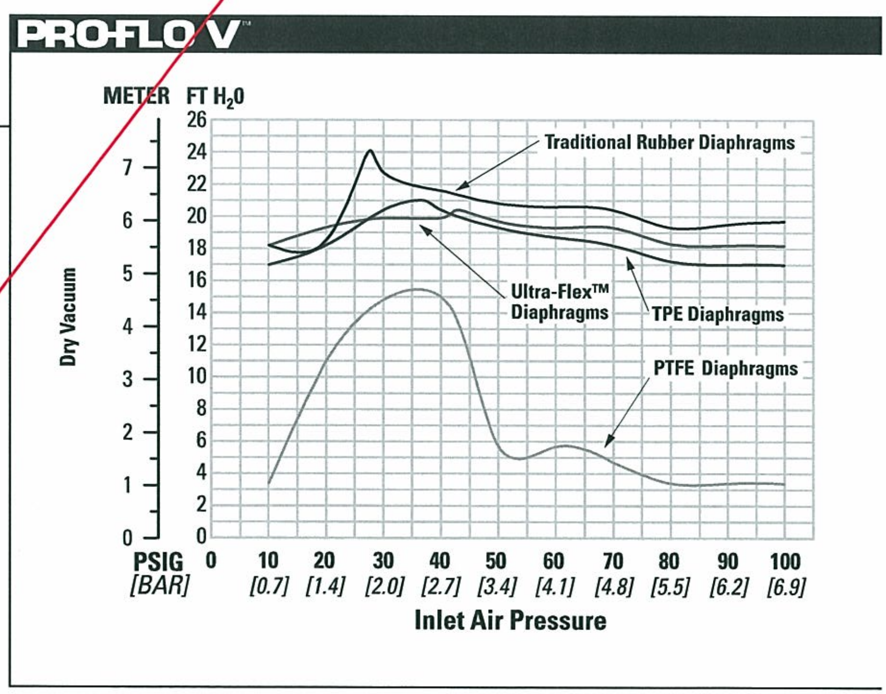


Suction lift curves are calibrated for pumps operating at 305 m (1,000') above sea level. This chart is meant to be a guide only. There are many variables which can affect your pump's operating characteristics. The number of intake and discharge elbows, viscosity of pumping fluid, elevation (atmospheric pressure) and pipe friction loss all affect the amount of suction lift your pump will attain.

PV400 ALUMINUM SUCTION LIFT CAPABILITY



PV400 STAINLESS STEEL & ALLOY C SUCTION LIFT CAPABILITY



Suction lift curves are calibrated for pumps operating at 305 m (1,000') above sea level. This chart is meant to be a guide only. There are many variables which can affect your pump's operating characteristics. The number of intake and discharge elbows, viscosity of pumping fluid, elevation (atmospheric pressure) and pipe friction loss all affect the amount of suction lift your pump will attain.

SUGGESTED INSTALLATION

Wilden pumps are designed to meet the performance requirements of even the most demanding pumping applications. They have been designed and manufactured to the highest standards and are available in a variety of liquid path materials to meet your chemical resistance needs. Refer to the performance section of this manual for an in-depth analysis of the performance characteristics of your pump. Wilden offers the widest variety of elastomer options in the industry to satisfy temperature, chemical compatibility, abrasion resistance and flex concerns.

The suction pipe size should be at least the equivalent or larger than the diameter size of the suction inlet on your Wilden pump. The suction hose must be non-collapsible, reinforced type as these pumps are capable of pulling a high vacuum. Discharge piping should also be the equivalent or larger than the diameter of the pump discharge which will help reduce friction losses. It is critical that all fittings and connections are airtight or a reduction or loss of pump suction capability will result.

INSTALLATION: Months of careful planning, study, and selection efforts can result in unsatisfactory pump performance if installation details are left to chance.

Premature failure and long term dissatisfaction can be avoided if reasonable care is exercised throughout the installation process.

LOCATION: Noise, safety, and other logistical factors usually dictate where equipment will be situated on the production floor. Multiple installations with conflicting requirements can result in congestion of utility areas, leaving few choices for additional pumps.

Within the framework of these and other existing conditions, every pump should be located in such a way that six key factors are balanced against each other to maximum advantage.

ACCESS: First of all, the location should be accessible. If it's easy to reach the pump, maintenance personnel will have an easier time carrying out routine inspections and adjustments. Should major repairs become necessary, ease of access can play a key role in speeding the repair process and reducing total downtime.

AIR SUPPLY: Every pump location should have an air line large enough to supply the volume of air necessary to achieve the desired pumping rate. Use air pressure up to a maximum of 8.6 bar (125 psig) depending on pumping requirements.

For best results, the pumps should use a 5µ (micron) air filter, needle valve and regulator. The use of an air filter before the pump will ensure that the majority of any pipeline contaminants will be eliminated.

SOLENOID OPERATION: When operation is controlled by a solenoid valve in the air line, three-way valves should be used. This valve allows trapped air between the valve and the pump to bleed off which improves pump performance. Pumping volume can be estimated by counting the number of strokes per minute and then multiplying the figure by the displacement per stroke.

MUFFLER: Sound levels are reduced below OSHA specifications using the standard Wilden muffler. Other mufflers can be used to further reduce sound levels, but they usually reduce pump performance.

ELEVATION: Selecting a site that is well within the pump's dynamic lift capability will assure that loss-of-prime issues will be eliminated. In addition, pump efficiency can be adversely affected if proper attention is not given to site location.

PIPING: Final determination of the pump site should not be made until the piping challenges of each possible location have been evaluated. The impact of current and future installations should be considered ahead of time to make sure that inadvertent restrictions are not created for any remaining sites.

The best choice possible will be a site involving the shortest and straightest hook-up of suction and discharge piping. Unnecessary elbows, bends, and fittings should be avoided. Pipe sizes should be selected to keep friction losses within practical limits. All piping should be supported independently of the pump. In addition, the piping should be aligned to avoid placing stress on the pump fittings.

Flexible hose can be installed to aid in absorbing the forces created by the natural reciprocating action of the pump. If the pump is to be bolted down to a solid location, a mounting pad placed between the pump and the foundation will assist in minimizing pump vibration. Flexible connections between the pump and rigid piping will also assist in minimizing pump vibration. If quick-closing valves are installed at any point in the discharge system, or if pulsation within a system becomes a problem, a surge suppressor (SD Equalizer®) should be installed to protect the pump, piping and gauges from surges and water hammer.

If the pump is to be used in a self-priming application, make sure that all connections are airtight and that the suction lift is within the model's ability. Note: Materials of construction and elastomer material have an effect on suction lift parameters. Please refer to the performance section for specifics.

When pumps are installed in applications involving flooded suction or suction head pressures, a gate valve should be installed in the suction line to permit closing of the line for pump service.

Pumps in service with a positive suction head are most efficient when inlet pressure is limited to 0.5–0.7 bar (7–10 psig). Premature diaphragm failure may occur if positive suction is 0.7 bar (10 psig) and higher.

SUBMERSIBLE APPLICATIONS: Pro-Flo V™ pumps can be used for submersible applications, when using the Pro-Flo V™ submersible option. Turbo-Flo™ pumps can also be used for submersible applications.

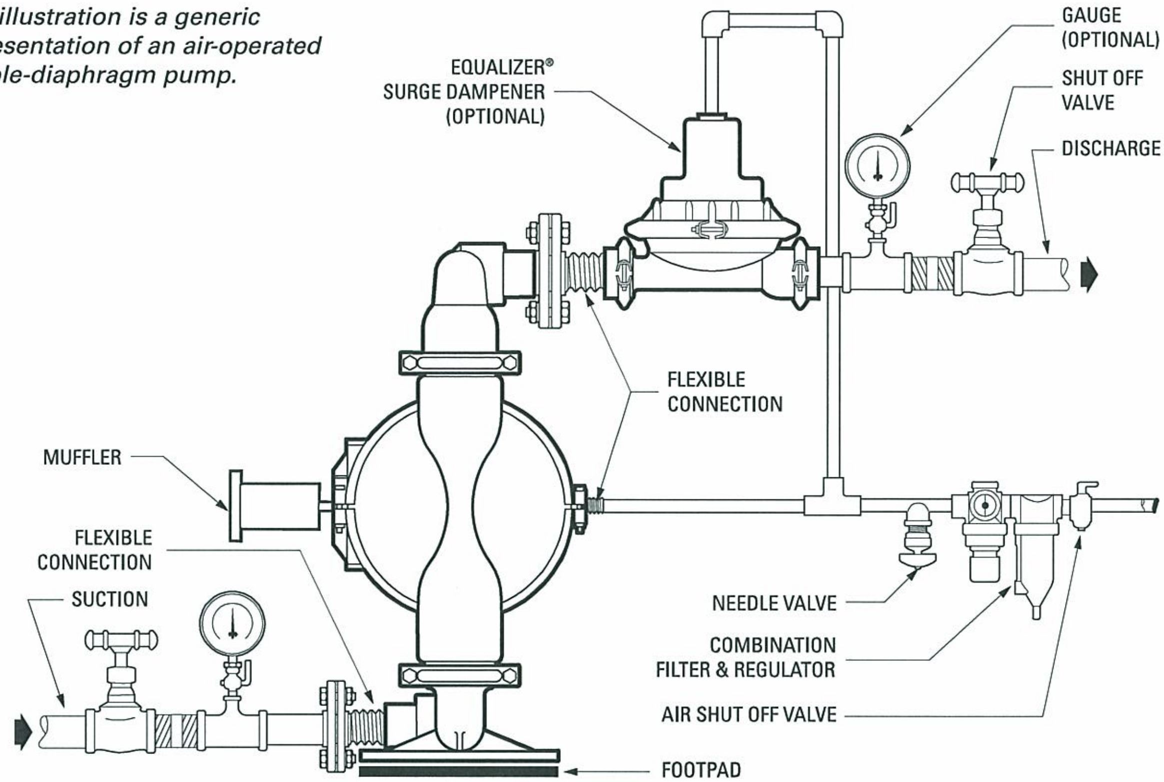
NOTE: Pro-Flo® and Accu-Flo™ pumps are not submersible.

ALL WILDEN PUMPS ARE CAPABLE OF PASSING SOLIDS. A STRAINER SHOULD BE USED ON THE PUMP INTAKE TO ENSURE THAT THE PUMP'S RATED SOLIDS CAPACITY IS NOT EXCEEDED.

CAUTION: DO NOT EXCEED 8.6 BAR (125 PSIG) AIR SUPPLY PRESSURE.

SUGGESTED INSTALLATION

This illustration is a generic representation of an air-operated double-diaphragm pump.



NOTE: In the event of a power failure, the shut off valve should be closed, if the restarting of the pump is not desirable once power is regained.

AIR OPERATED PUMPS: To stop the pump from operating in an emergency situation, simply close the shut off valve (user supplied) installed in the air supply line. A properly functioning valve will stop the air supply to the pump, therefore stopping output. This shut off valve should be located far enough away from the pumping equipment such that it can be reached safely in an emergency situation.

SUGGESTED OPERATION & MAINTENANCE

OPERATION: The P400 and PV400 are pre-lubricated, and do not require in-line lubrication. Additional lubrication will not damage the pump, however if the pump is heavily lubricated by an external source, the pump's internal lubrication may be washed away. If the pump is then moved to a non-lubricated location, it may need to be disassembled and re-lubricated as described in the ASSEMBLY/DISASSEMBLY INSTRUCTIONS.

Pump discharge rate can be controlled by limiting the volume and/or pressure of the air supply to the pump. An air regulator is used to regulate air pressure. A needle valve is used to regulate volume. Pump discharge rate can also be controlled by throttling the pump discharge by partially closing a valve in the discharge line of the pump. This action increases friction loss which reduces flow rate. (See Section 5.) This is useful when the need exists to control the pump from a remote location. When the pump discharge pressure equals or exceeds the air supply pressure, the pump will stop; no bypass or pressure relief valve is needed, and pump damage will not occur. The pump has reached a "deadhead" situation and can be restarted by reducing the fluid discharge pressure or increasing the air inlet pressure. The Wilden P800 and PV800 pumps run solely on compressed air and do not generate heat, therefore your process fluid temperature will not be affected.

MAINTENANCE AND INSPECTIONS: Since each application is unique, maintenance schedules may be different for every pump. Frequency of use, line pressure, viscosity and abrasiveness of process fluid all affect the parts life of a Wilden pump. Periodic inspections have been found to offer the best means for preventing unscheduled pump downtime. Personnel familiar with the pump's construction and service should be informed of any abnormalities that are detected during operation.

RECORDS: When service is required, a record should be made of all necessary repairs and replacements. Over a period of time, such records can become a valuable tool for predicting and preventing future maintenance problems and unscheduled downtime. In addition, accurate records make it possible to identify pumps that are poorly suited to their applications.

TROUBLESHOOTING

Pump will not run or runs slowly.

1. Ensure that the air inlet pressure is at least 0.4 bar (5 psig) above startup pressure and that the differential pressure (the difference between air inlet and liquid discharge pressures) is not less than 0.7 bar (10 psig).
2. Check air inlet filter for debris (see recommended installation).
3. Check for extreme air leakage (blow by) which would indicate worn seals/bores in the air valve, pilot spool, main shaft.
4. Disassemble pump and check for obstructions in the air passageways or objects which would obstruct the movement of internal parts.
5. Check for sticking ball check valves. If material being pumped is not compatible with pump elastomers, swelling may occur. Replace ball check valves and seals with proper elastomers. Also, as the check valve balls wear out, they become smaller and can become stuck in the seats. In this case, replace balls and seats.
6. Check for broken inner piston which will cause the air valve spool to be unable to shift.
7. Remove plug from pilot spool exhaust.

Pump runs but little or no product flows.

1. Check for pump cavitation; slow pump speed down to allow thick material to flow into liquid chambers.
2. Verify that vacuum required to lift liquid is not greater than the vapor pressure of the material being pumped (cavitation).
3. Check for sticking ball check valves. If material being pumped is not compatible with pump elastomers, swelling may occur. Replace ball check valves and seats with proper elastomers. Also, as the check valve balls wear out, they become smaller and can become stuck in the seats. In this case, replace balls and seats.

Pump air valve freezes.

1. Check for excessive moisture in compressed air. Either install a dryer or hot air generator for compressed air. Alternatively, a coalescing filter may be used to remove the water from the compressed air in some applications.

Air bubbles in pump discharge.

1. Check for ruptured diaphragm.
2. Check tightness of outer pistons (refer to Section 7).
3. Check tightness of fasteners and integrity of o-rings and seals, especially at intake manifold.
4. Ensure pipe connections are airtight.

Product comes out air exhaust.

1. Check for diaphragm rupture.
2. Check tightness of outer pistons to shaft.

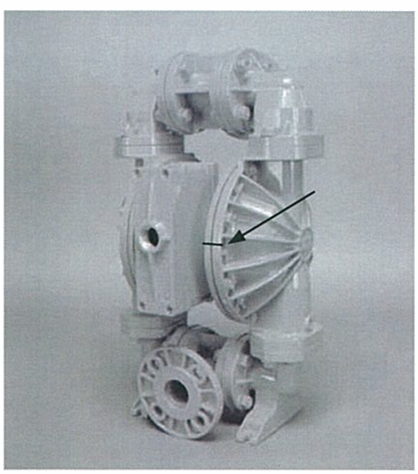
PUMP DISASSEMBLY

Tools Required:

- 3/4" Wrench
- 9/16" Wrench
- Adjustable Wrench
- Vise equipped w/ soft jaws (such as plywood, plastic or other suitable material)

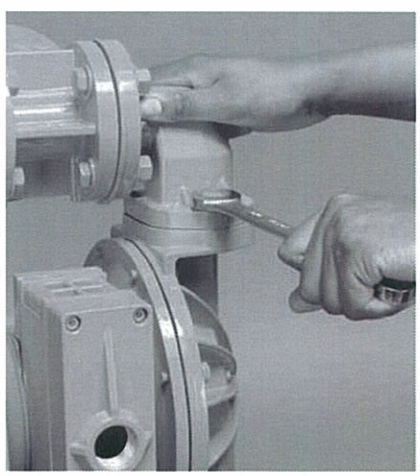
CAUTION: Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from the pump. Disconnect all intake, discharge, and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container. Be aware of any hazardous effects of contact with your process fluid.

NOTE: The model photographed for these instructions incorporates rubber diaphragms, balls, and seats. Models with PTFE diaphragms, balls and seats are the same except where noted.



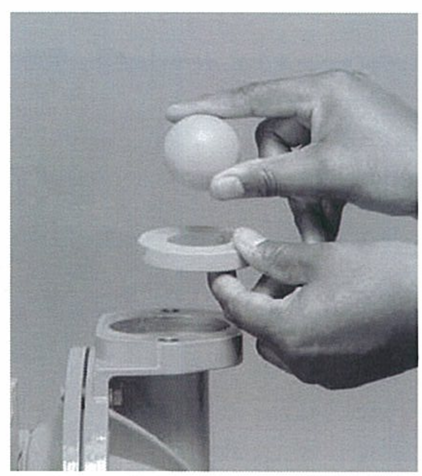
Step 1

Please note alignment marks on liquid chambers. Use to properly align center section with liquid chambers.



Step 2

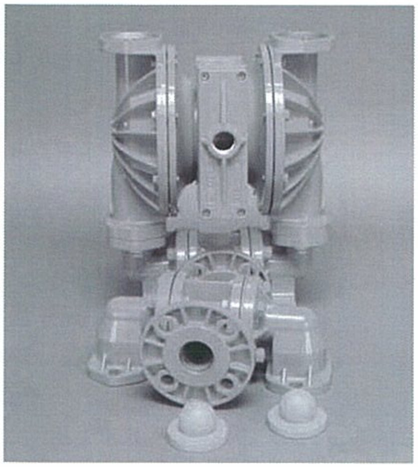
Using a 3/4" wrench, loosen the discharge manifold from the liquid chambers.



Step 3

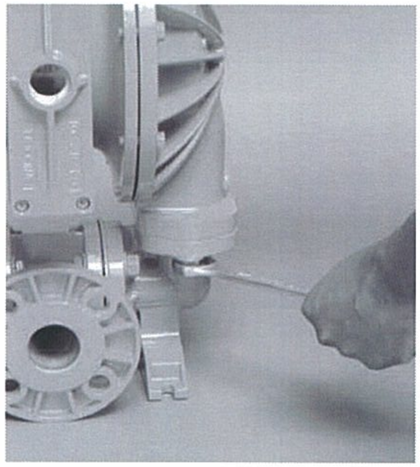
Remove the discharge manifold to expose the valve balls and valve seats.

PUMP DISASSEMBLY



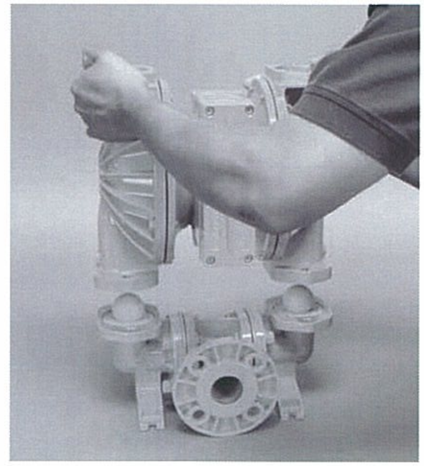
Step 4

After removing discharge valve balls and valve seats, from the discharge manifold and liquid chamber, inspect for nicks, gouges, chemical attack or abrasive wear. Note: Replace worn parts with genuine Wilden parts for reliable performance.



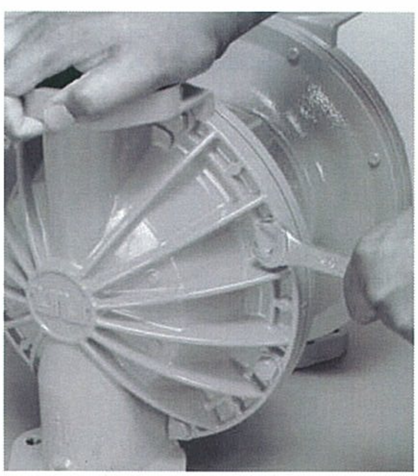
Step 5

Using a 3/4" wrench, loosen the inlet manifold from the liquid chambers.



Step 6

Remove the inlet valve balls and valve seats from the inlet manifold and inspect for nicks, gouges, chemical attack or abrasive wear.

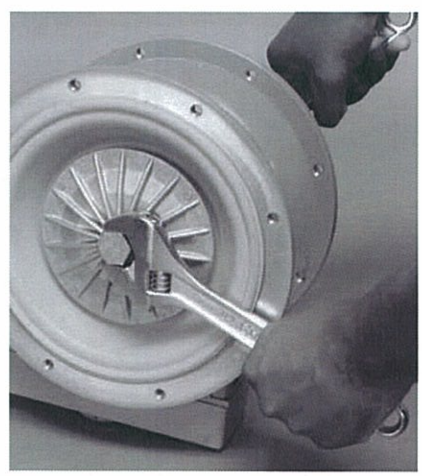


Step 7

Using a 9/16" wrench, remove the liquid chamber from the center section.

Step 8

The liquid chamber should be removed to expose the diaphragm and outer piston. Rotate center section and remove opposite liquid chamber.



Step 9

Using two adjustable wrenches or rotating both diaphragms by hand, remove the diaphragm assembly from the center section assembly.

PUMP DISASSEMBLY

Step 10

After loosening and removing the outer piston, the diaphragm assembly can be disassembled.

Step 11

To remove diaphragm assembly from shaft, secure shaft with soft jaws (a vise fitted with plywood, plastic or other suitable material) to ensure shaft is not nicked, scratched or gouged. Using an adjustable wrench, remove diaphragm assembly form shaft.

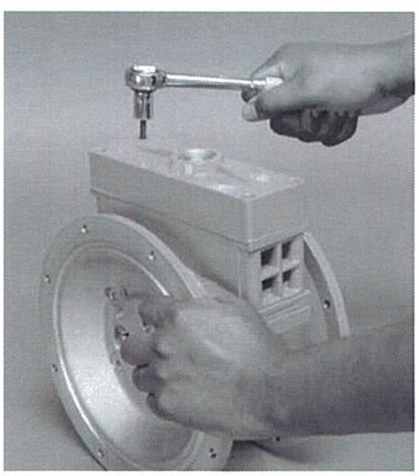
AIR VALVE / CENTER SECTION DISASSEMBLY

Tools Required:

- 3/16" Hex Head Wrench
- Snap Ring Pliers
- O-Ring Pick

CAUTION: Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from the pump. Disconnect all intake, discharge, and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container. Be aware of hazardous effects of contact with your process fluid.

The Wilden P400 and PV400 metal pumps utilize a revolutionary Pro-Flo® air distribution system. Proprietary composite seals reduce the coefficient of friction and allow the P400 and PV400 to run lube-free. Constructed of acetal, polypropylene or aluminum, the Pro-Flo® air distribution system is designed to perform in on/off, non-freezing, non-stalling, tough duty applications.

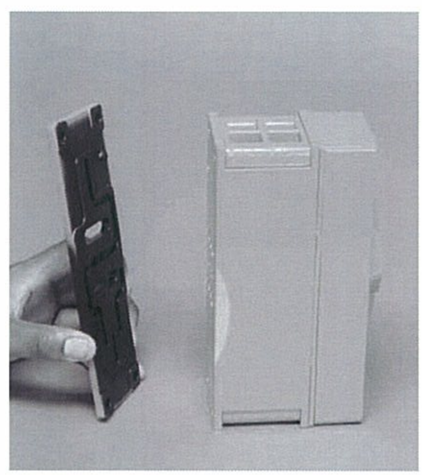


Step 1

Using a 3/16" Hex wrench, loosen air valve bolts.

Step 2

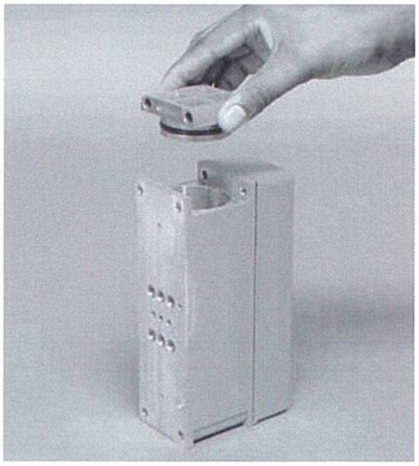
Remove muffler plate and air valve bolts from air valve assembly exposing muffler gasket for inspection. Replace if necessary.



Step 3

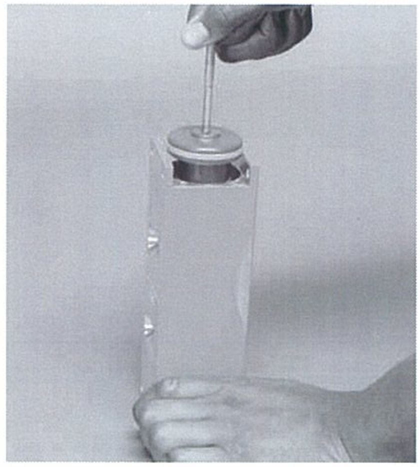
Lift away air valve assembly and remove air valve gasket for inspection. Replace if necessary.

AIR VALVE / CENTER SECTION DISASSEMBLY



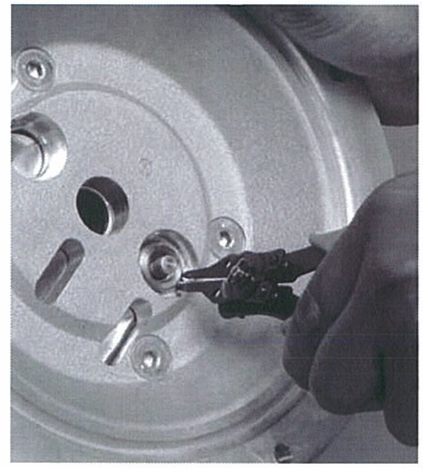
Step 4

Remove air valve end cap to expose air valve spool by simply lifting up on end cap once air valve bolts are removed. Note: Pro-Flo V™ air valve incorporates an end cap at both ends of the air valve.



Step 5

Remove the air valve spool from the air valve body by threading one air valve bolt into the end of the air valve spool and gently sliding the spool out of the air valve body. Inspect seals for signs of wear and replace entire assembly if necessary. Use caution when handling air valve spool to prevent damaging seals. Note: Seals should not be removed from assembly. Seals are not sold separately.

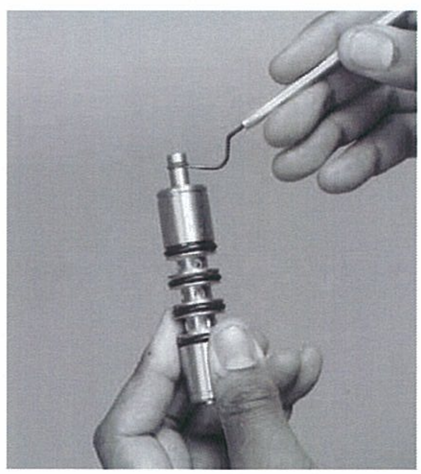


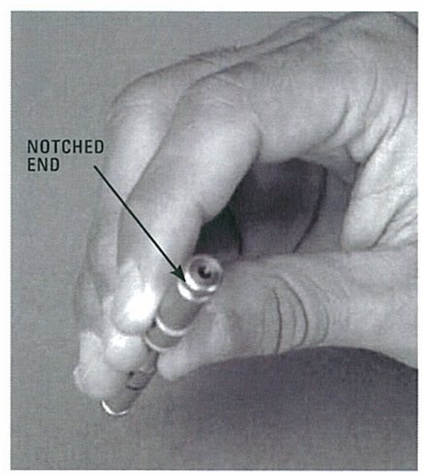
Step 6

Remove pilot sleeve retaining snap ring on both sides of center section with snap ring pliers.

Step 7

Remove pilot spool sleeve from center section.





Step 8

Using an o-ring pick, gently remove the o-ring from the opposite side of the "notched end" on one side of the pilot spool. Gently remove the pilot spool from pilot spool sleeve and inspect for nick, gouges and wear. Replace pilot sleeve or outer sleeve o-rings if necessary. During re-assembly, never insert the pilot spool into the sleeve with the "notched end" first, this end incorporates the urethane o-ring and will be damaged as it slides over the ports cut in the sleeve. Note: Seals should not be removed from pilot spool. Seals are not sold separately.

PRO-FLO®
PROGRESSIVE PUMP TECHNOLOGY

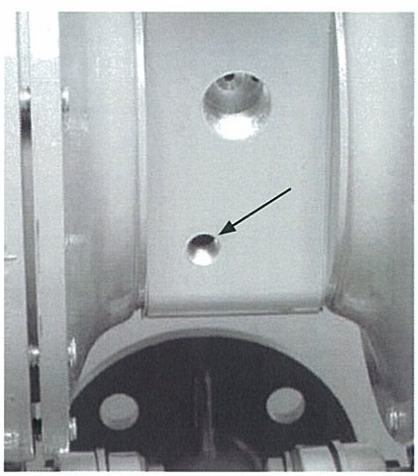
AIR VALVE / CENTER SECTION DISASSEMBLY

Step 9

Check center section seals for signs of wear. If necessary, remove seals with o-ring pick and replace.

PRO-FLO V™
PROGRESSIVE PUMP TECHNOLOGY

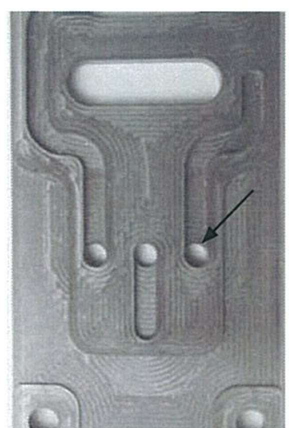
SUBMERSIBLE PRO-FLO V™



Step 1

Install a 1/4" NPT pipe plug (00-7010-08) into the pilot spool bleed port located at the front of the center block.

Non-Submersible



Submersible

Step 2

Next, install an optional submersible air valve gasket (04-2621-52). The submersible air valve gasket can be purchased as a spare part or included with the purchase of a new Pro-Flo V™ pump.

REASSEMBLY HINTS & TIPS

ASSEMBLY:

Upon performing applicable maintenance to the air distribution system, the pump can now be reassembled. Please refer to the disassembly instructions for photos and parts placement. To reassemble the pump, follow the disassembly instructions in reverse order. The air distribution system needs to be assembled first, then the diaphragms and finally the wetted path. Please find the applicable torque specifications on this page. The following tips will assist in the assembly process.

- Lubricate air valve bore, center section shaft and pilot spool bore with NLGI grade 2 white EP bearing grease or equivalent.
- Clean the inside of the center section shaft bore to ensure no damage is done to new seals.
- A small amount NLGI grade 2 white EP bearing grease can be applied to the muffler and air valve gaskets to locate gaskets during assembly.
- Make sure that the exhaust port on the muffler plate is centered between the two exhaust ports on the center section.
- Stainless bolts should be lubed to reduce the possibility of seizing during tightening.
- Use a mallet to tamp lightly on the large clamp bands to seat the diaphragm before tightening.

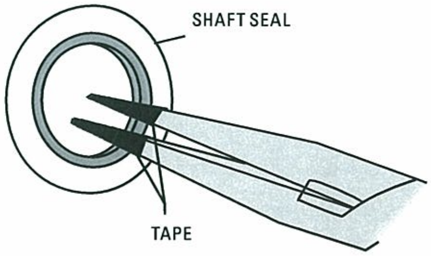
PRO-FLO® MAXIMUM TORQUE SPECIFICATIONS

Description of Part	Torque
Air Valve	5.1 N•m (45 in-lbs)
Air Chamber/Center Block	47.5 N•m (35 ft-lbs)
Liquid Chamber/Air Chamber, Stainless Steel Bolted Only	17.6 N•m (13 ft-lbs)
Outer Pistons, Rubber & PTFE	54.2 N•m (40 ft-lbs)
Outer Pistons, Ultra-Flex™	54.2 N•m (40 ft-lbs)

PRO-FLO V™ MAXIMUM TORQUE SPECIFICATIONS

Description of Part	Torque
Air Valve	13.6 N•m (120 in-lbs)
Air Chamber/Center Block	27.1 N•m (20 ft-lbs)
Liquid Chamber/Air Chamber, Stainless Steel Bolted Only	17.6 N•m (13 ft-lbs)
Outer Pistons, Rubber & PTFE	54.2 N•m (40 ft-lbs)
Outer Pistons, Ultra-Flex™	54.2 N•m (40 ft-lbs)

Figure A



SHAFT SEAL INSTALLATION:

PRE-INSTALLATION

- Once all of the old seals have been removed, the inside of the bushing should be cleaned to ensure no debris is left that may cause premature damage to the new seals.

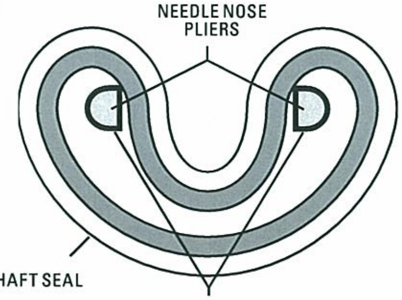
INSTALLATION

The following tools can be used to aid in the installation of the new seals:

Needle Nose Pliers
Phillips Screwdriver
Electrical Tape

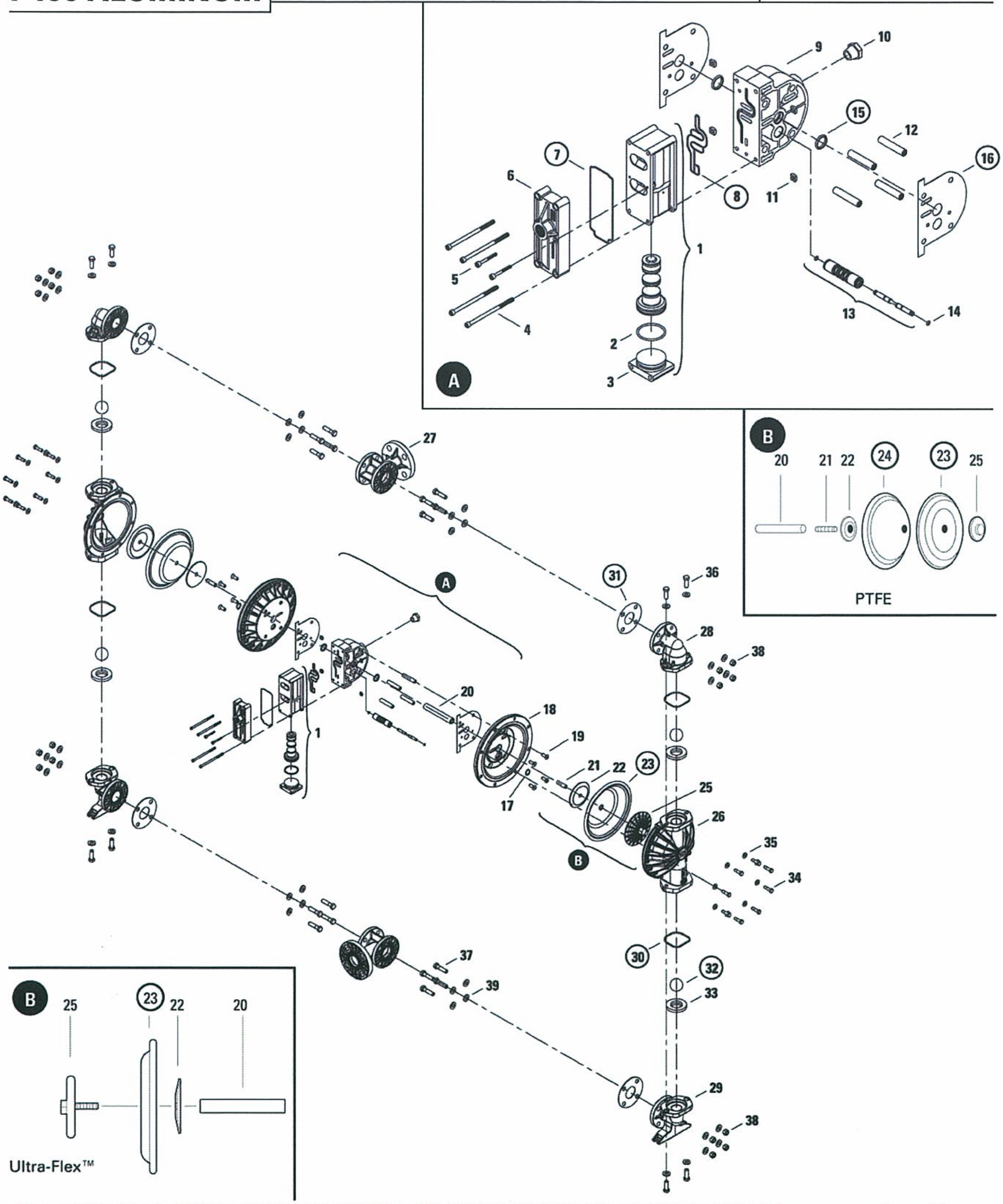
- Wrap electrical tape around each leg of the needle nose pliers (heat shrink tubing may also be used). This is done to prevent damaging the inside surface of the new seal.
- With a new seal in hand, place the two legs of the needle nose pliers inside the seal ring. (See Figure A.)
- Open the pliers as wide as the seal diameter will allow, then with two fingers pull down on the top portion of the seal to form kidney bean shape. (See Figure B.)
- Lightly clamp the pliers together to hold the seal into the kidney shape. Be sure to pull the seal into as tight of a kidney shape as possible, this will allow the seal to travel down the bushing bore easier.
- With the seal clamped in the pliers, insert the seal into the bushing bore and position the bottom of the seal into the correct groove. Once the bottom of the seal is seated in the groove, release the clamp pressure on the pliers. This will allow the seal to partially snap back to its original shape.
- After the pliers are removed, you will notice a slight bump in the seal shape. Before the seal can be properly resized, the bump in the seal should be removed as much as possible. This can be done with either the Phillips screwdriver or your finger. With either the side of the screwdriver or your finger, apply light pressure to the peak of the bump. This pressure will cause the bump to be almost completely eliminated.
- Lubricate the edge of the shaft with NLGI grade 2 white EP bearing grease.
- Slowly insert the center shaft with a rotating motion. This will complete the resizing of the seal.
- Perform these steps for the remaining seal.

Figure B



EXPLODED VIEW & PARTS LISTING

P400 ALUMINUM | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | EXPLODED VIEW



ALL CIRCLED PART IDENTIFIERS ARE INCLUDED IN REPAIR KITS (see section 9).

EXPLODED VIEW & PARTS LISTING

P400 ALUMINUM Rubber/TPE/PTFE/Ultra-Flex™-Fitted PARTS LISTING

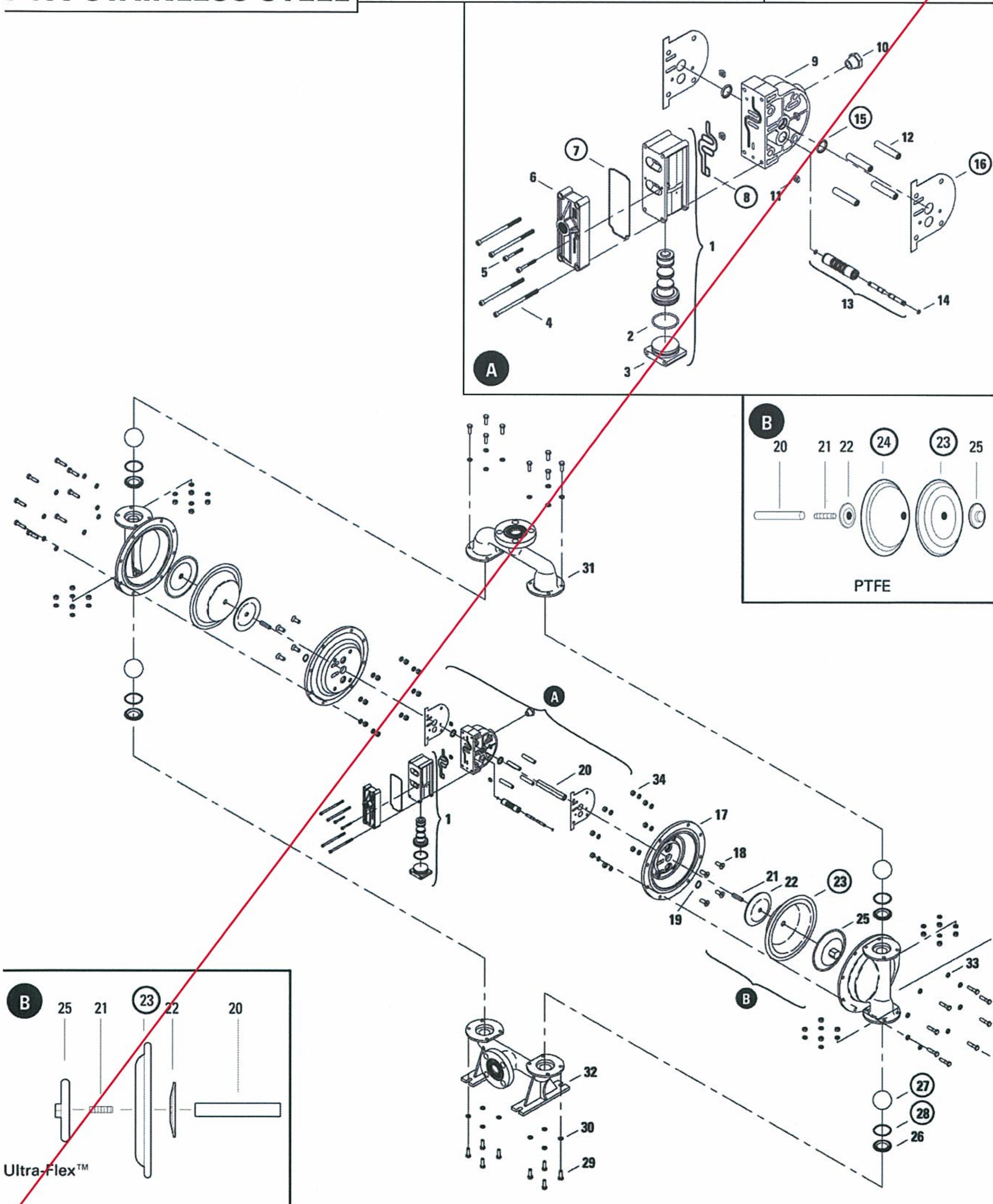
No.	Part Description	Qty.	Rubber/TPE-Fitted P400/AAAPP P/N	PTFE-Fitted P400/AAAPP P/N
1	**Pro-Flo® Air Valve Assembly**	**1**	**04-2000-20-700**	**04-2000-20-700**
2	O-Ring, End Cap	1	04-2390-52-700	04-2390-52-700
3	End Cap, Pro-Flo®	1	04-2330-20-700	04-2330-20-700
4	Screw, HHC, Air Valve (1/4" x 4-1/2")	4	01-6000-03	01-6000-03
5	Screw, SHCS (10-16 x 1-3/4")	2	04-6351-03	04-6351-03
6	Muffler Plate, Pro-Flo®	1	04-3180-20-700	04-3180-20-700
7	**Gasket, Muffler Plate**	**1**	**04-3500-52-700**	**04-3500-52-700**
8	**Gasket, Air Valve**	**1**	**04-2600-52-700**	**04-2600-52-700**
9	Center Block Assembly	1	04-3110-20	04-3110-20
10	Bushing, Reducer	1	04-6950-20-700	04-6950-20-700
11	Nut, Hex (1/4"-20)	4	00-6505-03	00-6505-03
12	Sleeve, Threaded, Pro-Flo® Center Block	4	04-7710-08	04-7710-08
13	**Removable Pilot Sleeve Assembly**	**1**	**04-3880-99**	**04-3880-99**
14	Pilot Spool Retaining O-Ring	2	04-2650-49-700	04-2650-49-700
15	**Shaft Seal**	**2**	**08-3210-55-225**	**08-3210-55-225**
16	**Gasket, Center Block, Pro-Flo®**	**2**	**04-3526-52**	**04-3526-52**
17	Retaining Ring	2	04-3890-03	04-3890-03
18	Air Chamber, Pro-Flo®, Bolted	2	04-3681-01	04-3681-01
19	Screw, HSFHS (3/8"-16 x 1")	8	71-6250-08	71-6250-08
20	Shaft, Pro-Flo®	1	04-3800-03-700	04-3820-03-700
	Shaft, Pro-Flo®, Ultra-Flex™	1	04-3830-03-700	N/A
21	Shaft Stud	2	08-6150-08	04-6150-08
22	Inner Piston	2	04-3700-01-700	04-3715-01
	Inner Piston, Ultra-Flex™	2	04-3760-01-700	N/A
23	**Diaphragm, Primary**	**2**	*	**04-1010-55**
24	**Diaphragm, Back-Up**	**2**	**N/R**	**04-1060-51**
25	Outer Piston	2	04-4552-01	04-4600-01
	Outer Piston, Ultra-Flex™	2	04-4560-01	N/A
26	Liquid Chamber, Bolted	2	04-4980-01	04-4980-01
27	Tee, Bolted	2	04-5180-01	04-5180-01
	DIN Flange (Not shown)		04-5185-01	04-5185-01
28	Discharge Elbow	2	04-5250-01	04-5250-01
29	Inlet Elbow	2	04-5210-01	04-5210-01
30	Outboard O-Ring	4	04-1370-55	04-1370-55
31	Tee Section Manifold Gasket	4	*	04-1325-55
32	**Ball, Valve**	**4**	*	**04-1080-55**
33	**Seat, Valve**	**4**	*	**04-1125-01**
	Valve Seat O-Ring (Not shown)	**4**	*	**04-1205-55**
34	Screw, HHC (3/8" - 16 x 1-1/4")	16	04-6140-08	04-6140-08
35	Washer (3/8")	16	15-6740-08-50	15-6740-08-50
36	Screw, SHC (1/2" - 13 x 1-1/2")	8	04-6180-08	04-6180-08
37	Screw, SHC (1/2" - 13 x 2")	16	04-6210-08	04-6210-08
38	Hex Nut (1/2" - 13)	16	15-6420-08	15-6420-08
39	Washer (1/2")	40	04-6730-08	04-6730-08
	Muffler (Not shown)	1	04-3510-99	04-3510-99

*See Section 9 — Elastomer Chart

All boldface items are primary wear parts.

EXPLODED VIEW & PARTS LISTING

P400 STAINLESS STEEL | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | EXPLODED VIEW



ALL CIRCLED PART IDENTIFIERS ARE INCLUDED IN REPAIR KITS (see section 9).

P400 STAINLESS STEEL Rubber/TPE/PTFE/Ultra-Flex™-Fitted | PARTS LISTING

No.	Item Description	Qty.	Rubber/TPE-Fitted P400/SSAPP P/N	Rubber/TPE-Fitted P400/HHAPP P/N	PTFE-Fitted P400/SSAPP P/N	PTFE-Fitted P400/HHAPP P/N
1	**Pro-Flo® Air Valve Assembly[1]**	**1**	**04-2000-20-700**	**04-2000-20-700**	**04-2000-20-700**	**04-2000-20-700**
2	O-Ring (-225), End Cap (1.859 x .139)	1	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700
3	End Cap, Pro-Flo®	1	04-2330-20-700	04-2330-20-700	04-2330-20-700	04-2330-20-700
4	Screw, HHC, Air Valve (1/4" x 4-1/2")	4	01-6000-03	01-6000-03	01-6000-03	01-6000-03
5	Screw, SHCS (10-16 x 1-3/4")	2	04-6351-03	04-6351-03	04-6351-03	04-6351-03
6	Muffler Plate, Pro-Flo®	1	04-3180-20-700	04-3180-20-700	04-3180-20-700	04-3180-20-700
7	**Gasket, Muffle Plate**	**1**	**04-3500-52-700**	**04-3500-52-700**	**04-3500-52-700**	**04-3500-52-700**
8	**Gasket, Air Valve**	**1**	**04-2600-52-700**	**04-2600-52-700**	**04-2600-52-700**	**04-2600-52-700**
9	Center Section Assembly	1	04-3110-20	04-3110-20	04-3110-20	04-3110-20
10	Bushing, Reducer, NPT/BSP Combo	1	04-6950-20-700	04-6950-20-700	04-6950-20-700	04-6950-20-700
11	Nut, Hex (1/4"-20)	4	00-6505-03	00-6505-03	00-6505-03	00-6505-03
12	Sleeve, Threaded, Pro-Flo® Center Block	4	04-7710-08	04-7710-08	04-7710-08	04-7710-08
13	**Removable Pilot Sleeve Assembly**	**1**	**04-3880-99**	**04-3880-99**	**04-3880-99**	**04-3880-99**
14	Pilot Spool Retaining O-Ring	2	04-2650-49-700	04-2650-49-700	04-2650-49-700	04-2650-49-700
15	**Shaft Seal**	**2**	**08-3210-55-225**	**08-3210-55-225**	**08-3210-55-225**	**08-3210-55-225**
16	**Gasket, Center Block, Pro-Flo®**	**2**	**04-3526-52**	**04-3526-52**	**04-3526-52**	**04-3526-52**
17	Air Chamber, Pro-Flo®	2	04-3685-01	04-3685-01	04-3685-01	04-3685-01
18	Screw, HSFHS (3/8"-16 x 1")	8	71-6250-08	71-6250-08	71-6250-08	71-6250-08
19	Retaining Ring	2	04-3890-03	04-3890-03	04-3890-03	04-3890-03
20	Shaft, Pro-Flo®	1	04-3800-03-700	04-3800-03-700	04-3820-03-700	04-3820-03-700
	Shaft, Ultra-Flex™	1	04-3830-03-700	04-3830-03-700	N/A	N/A
21	Shaft Stud	2	08-6150-08	08-6150-08	04-6150-08	04-6150-08
	Shaft Stud, Ultra-Flex™	2	04-6152-08	04-6152-08	N/A	N/A
22	Inner Piston	2	04-3700-01-700	04-3700-01-700	04-3715-01	04-3715-01
	Inner Piston, Ultra-Flex™	2	04-3760-01-700	04-3760-01-700	N/A	N/A
23	**Diaphragm**	**2**	*	*	**04-1010-55-42**	**04-1010-55-42**
24	**Back Up Diaphragm**	**2**	**N/R**	**N/R**	**04-1060-51**	**04-1060-51**
25	Outer Piston	2	04-4550-03	04-4550-04	04-4600-03	04-4600-04
	Outer Piston, Ultra-Flex™	2	02-4550-03	02-4550-04	N/A	N/A
26	**Valve Seat**	**4**	*	*	**04-1121-03**	**04-1121-04**
27	**Valve Ball**	**4**	*	*	**04-1080-55**	**04-1080-55**
28	**Valve Seat O-Ring**	**4**	*	*	**04-1200-55**	**04-1200-55**
29	Liquid Chamber	2	04-5000-03-42	04-5000-04-42	04-5000-03-42	04-5000-04-42
30	Discharge Manifold, ANSI	1	04-5020-03-42	04-5020-04-42	04-5020-03-42	04-5020-04-42
	Discharge Manifold, DIN	1	04-5020-03-43	04-5020-03-43	04-5020-03-43	04-5020-03-43
31	Inlet Manifold, ANSI	1	04-5080-03-42	04-5080-04-42	04-5080-03-42	04-5080-04-42
	Inlet Manifold, DIN	1	04-5080-03-43	04-5080-03-43	04-5080-03-43	04-5080-03-43
32	Screw, HHC (5/16" - 18 x 1")	16	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42
33	Flat Washer (5/16")	32	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42
34	Disc Spring Washer	32	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42
35	Hex Nut (5/16" - 18)	32	08-6400-03	08-6400-03	08-6400-03	08-6400-03
36	Screw, HHC (5/16" - 18 x 1-3/8")	16	08-6100-03	08-6100-03	08-6100-03	08-6100-03
	Muffler (Not Shown)	1	04-3510-99	04-3510-99	04-3510-99	04-3510-99

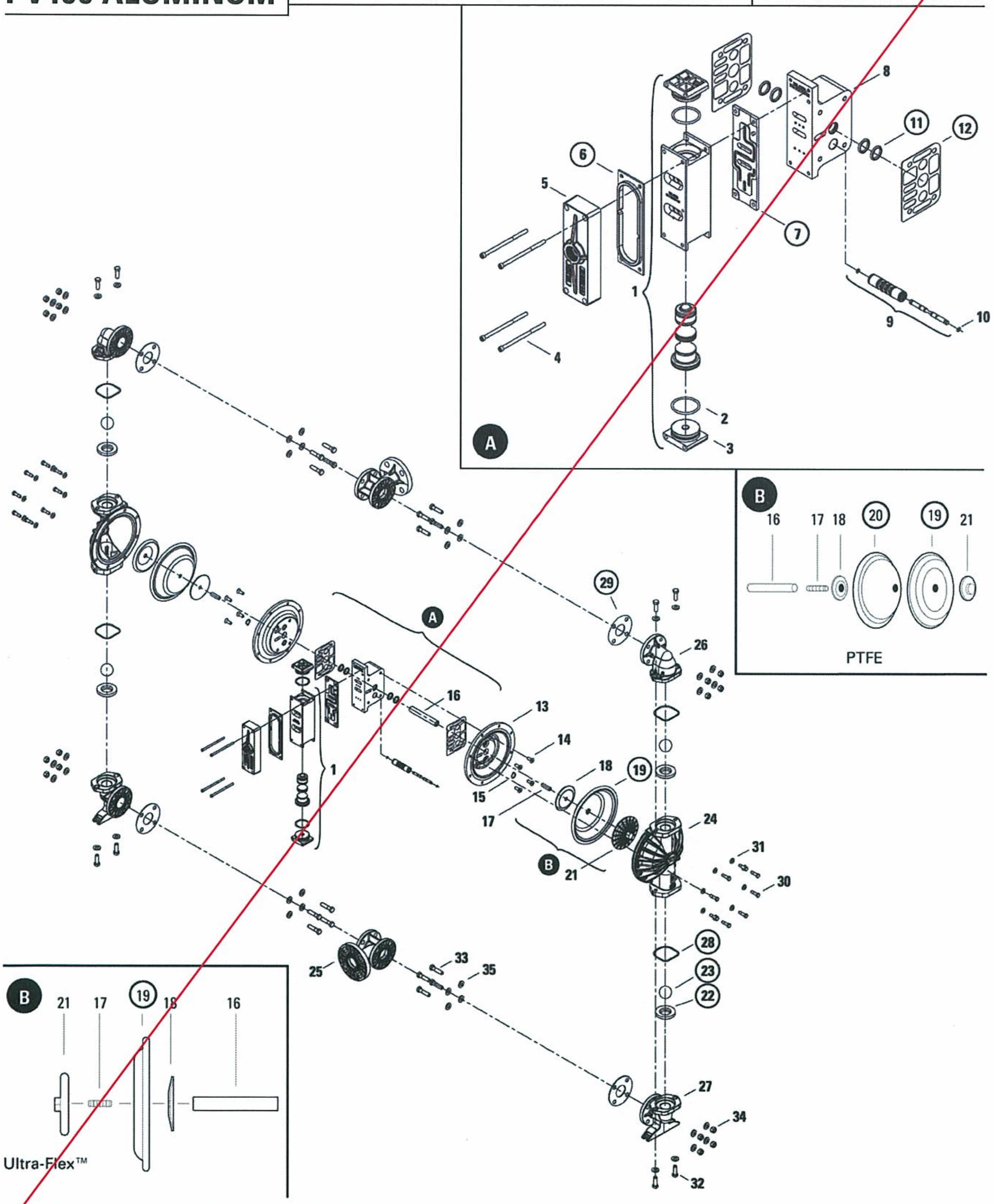
*See Section 9 - Elastomer Chart

[1]Air Valve Assembly includes item numbers 2 and 3.

All boldface items are primary wear parts.

EXPLODED VIEW & PARTS LISTING

PV400 ALUMINUM | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | EXPLODED VIEW



ALL CIRCLED PART IDENTIFIERS ARE INCLUDED IN REPAIR KITS (see section 9).

PV400 ALUMINUM | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | PARTS LISTING

No.	Part Description	Qty.	Rubber/TPE-Fitted PV400/AAAAA P/N	PTFE-Fitted PV400/AAAAA P/N
1	Pro-Flo® Air Valve Assembly[1]	1	04-2030-01	04-2030-01
2	O-Ring (-225), End Cap (1.859 x .139)	2	04-2390-52-700	04-2390-52-700
3	End Cap	2	04-2340-01	04-2340-01
4	Screw, SCH, Air Valve (1/4"-20 x 4-1/2")	4	01-6000-03	01-6000-03
5	Muffler Plate, Pro-Flo®	1	04-3185-01	04-3185-01
6	**Gasket, Muffler Plate, Pro-Flo®**	**1**	**04-3502-52**	**04-3502-52**
7	**Gasket, Air Valve, Pro-Flo®**	**1**	**04-2620-52**	**04-2620-52**
8	Center Block Assembly, Pro-Flo®	1	04-3120-01	04-3120-01
9	**Pilot Sleeve Assembly**	**1**	**04-3880-99**	**04-3880-99**
10	Pilot Spool Retaining O-Ring	2	04-2650-49-700	04-2650-49-700
11	**Shaft Seal**	**4**	**08-3210-55-225**	**08-3210-55-225**
12	Gasket, Center Block, Pro-Flo®	2	04-3528-52	04-3528-52
13	Air Chamber, Pro-Flo®	2	04-3690-01	04-3690-01
14	Screw, HSFHS (3/8"-16 x 1")	8	71-6250-08	71-6250-08
15	Retaining Ring	2	04-3890-03	04-3890-03
16	Shaft	1	04-3800-03-700	04-3820-03-700
	Shaft, Ultra-Flex™	1	04-3830-03-700	N/A
17	Shaft Stud	2	08-6150-08	04-6150-08
	Shaft Stud, Ultra-Flex™	2	N/A	N/A
18	Inner Piston	2	04-3700-01-700	04-3715-01
	Inner Piston, Ultra-Flex™	2	04-3760-01-700	N/A
19	**Diaphragm**	**2**	*	**04-1010-55**
20	**Diaphragm, Back-Up**	**2**	**N/A**	**04-1060-51**
21	Outer Piston	2	04-4552-01	04-4600-01
	Outer Piston, Ultra-Flex™	2	04-4560-01	N/A
22	**Seat, Valve**	**4**	*	**04-1125-01**
23	**Ball, Balve**	**4**	*	**04-1080-55**
	Valve Seat O-Ring (Not Shown)	**4**	*	**04-1205-55**
24	Liquid Chamber	2	04-4980-01	04-4980-01
25	Tee, ANSI	2	04-5180-01	04-5180-01
	Tee, DIN	2	04-5185-01	04-5185-01
26	Discharge Elbow	2	04-5250-01	04-5250-01
27	Inlet Elbow	2	04-5210-01	04-5210-01
28	Manifold O-Ring	4	04-1370-55	04-1370-55
29	Tee Section Manifold Gasket	4	*	04-1325-55
30	Screw, HHC (3/8"-16 x 1-1/4")	16	04-6140-08	04-6140-08
31	Washer (3/8")	16	15-6740-08-50	15-6740-08-50
32	Screw, HHC (1/2"-13 x 1-1/2")	8	04-6180-08	04-6180-08
33	Screw, HHC (1/2"-13 x 2")	16	04-6210-08	04-6210-08
34	Hex Nut (1/2"-13)	16	15-6420-08	15-6420-08
35	Washer (1/2")	40	04-6730-08	04-6730-08
	Muffler (Not Shown)	1	15-3510-99R	15-3510-99R

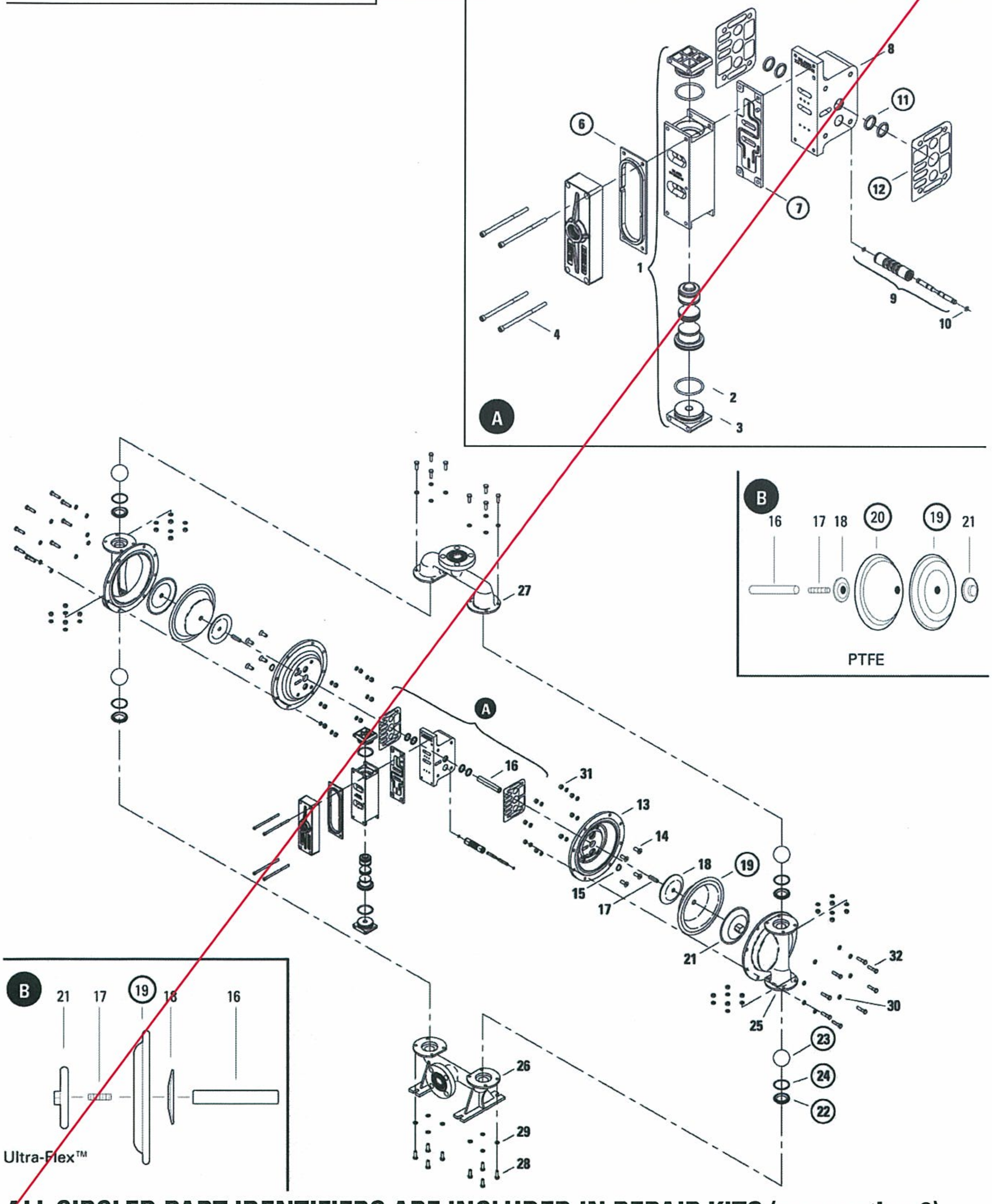
*See Section 9 — Elastomer Chart

[1] Air Valve Assembly includes item numbers 2 and 3.

All boldface items are primary wear parts.

EXPLODED VIEW & PARTS LISTING

PV400 STAINLESS STEEL | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | EXPLODED VIEW



ALL CIRCLED PART IDENTIFIERS ARE INCLUDED IN REPAIR KITS (see section 9).

PV400 STAINLESS STEEL | Rubber/TPE/PTFE/Ultra-Flex™-Fitted | PARTS LISTING

			Rubber/TPE-Fitted				PTFE-Fitted			
No.	Part Description	Qty.	PV400/SSAAA P/N	PV400/HHAAA P/N	PV400/SSSSS P/N	PV400/HHSSS P/N	PV400/SSAAA P/N	PV400/HHAAA P/N	PV400/SSSSS P/N	PV400/HHSSS P/N
1	Pro-Flo® Air Valve Assembly[1]	1	04-2030-01	04-2030-01	04-2030-03	04-2030-03	04-2030-01	04-2030-01	04-2030-03	04-2030-03
2	O-Ring (-225), End Cap (1.859 x .139)	2	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700	04-2390-52-700
3	End Cap	2	04-2340-01	04-2340-01	04-2340-03	04-2340-03	04-2340-01	04-2340-01	04-2340-03	04-2340-03
4	Screw, SCH, Air Valve (1/4"-20 x 4-1/2")	4	01-6000-03	01-6000-03	01-6000-03	01-6000-03	01-6000-03	01-6000-03	01-6000-03	01-6000-03
5	Muffler Plate, Pro-Flo®	1	04-3185-01	04-3185-01	04-3185-03	04-3185-03	04-3185-01	04-3185-01	04-3185-03	04-3185-03
6	**Gasket, Muffler Plate, Pro-Flo®**	**1**	**04-3502-52**	**04-3502-52**	04-3502-52	04-3502-52	**04-3502-52**	**04-3502-52**	04-3502-52	04-3502-52
7	**Gasket, Air Valve, Pro-Flo®**	**1**	**04-2620-52**	**04-2620-52**	04-2620-52	04-2620-52	**04-2620-52**	**04-2620-52**	04-2620-52	04-2620-52
8	Center Block Assembly, Pro-Flo®	1	04-3120-01	04-3120-01	04-3120-03	04-3120-03	04-3120-01	04-3120-01	04-3120-03	04-3120-03
9	**Pilot Sleeve Assembly**	**1**	**04-3880-99**	**04-3880-99**	04-3880-99	04-3880-99	**04-3880-99**	**04-3880-99**	04-3880-99	04-3880-99
10	**Pilot Spool Retaining O-Ring**	**2**	**04-2650-49-700**	**04-2650-49-700**	04-2650-49-700	04-2650-49-700	**04-2650-49-700**	**04-2650-49-700**	04-2650-49-700	04-2650-49-700
11	**Shaft Seal**	**4**	**08-3210-55-225**	**08-3210-55-225**	08-3210-55-225	08-3210-55-225	**08-3210-55-225**	**08-3210-55-225**	08-3210-55-225	08-3210-55-225
12	**Gasket, Center Block, Pro-Flo®**	**2**	**04-3528-52**	**04-3528-52**	04-3529-52	04-3529-52	**04-3528-52**	**04-3528-52**	04-3529-52	04-3529-52
13	Air Chamber, Pro-Flo®	2	04-3695-01	04-3695-01	04-3694-03	04-3694-03	04-3695-01	04-3695-01	04-3694-03	04-3694-03
14	Screw, HSFHS (3/8"-16 x 1")	8	71-6250-08	71-6250-08	71-6250-08	71-6250-08	71-6250-08	71-6250-08	71-6250-08	71-6250-08
15	Retaining Ring	2	04-3890-03	04-3890-03	04-3890-03	04-3890-03	04-3890-03	04-3890-03	04-3890-03	04-3890-03
16	Shaft	1	04-3800-03-700	04-3800-03-700	04-3800-03-700	04-3800-03-700	04-3820-03-700	04-3820-03-700	04-3820-03-700	04-3820-03-700
	Shaft, Ultra-Flex™	1	04-3830-03-700	04-3830-03-700	04-3830-03-700	04-3830-03-700	N/A	N/A	N/A	N/A
17	Shaft Stud	2	08-6150-08	08-6150-08	08-6150-08	08-6150-08	04-6150-08	04-6150-08	04-6150-08	04-6150-08
	Shaft Stud, Ultra-Flex™	2	04-6152-08	04-6152-08	04-6152-08	04-6152-08	N/A	N/A	N/A	N/A
18	Inner Piston	2	04-3700-01-700	04-3700-01-700	04-3700-01-700	04-3700-01-700	04-3715-01	04-3715-01	04-3715-01	04-3715-01
	Inner Piston, Ultra-Flex™	2	04-3760-01-700	04-3760-01-700	04-3760-01-700	04-3760-01-700	N/A	N/A	N/A	N/A
19	**Diaphragm**	**2**	*	*	*	*	**04-1010-55-42**	**04-1010-55-42**	04-1010-55-42	04-1010-55-42
20	**Diaphragm, Back-Up**	**2**	**N/A**	**N/A**	N/A	N/A	**04-1060-51**	**04-1060-51**	04-1060-51	04-1060-51
21	Outer Piston	2	04-4550-03	04-4550-04	04-4550-03	04-4550-04	04-4600-03	04-4600-04	04-4600-03	04-4600-04
	Outer Piston, Ultra-Flex™	2	02-4550-03	02-4550-04	02-4550-03	02-4550-04	N/A	N/A	N/A	N/A
22	**Seat, Valve**	**4**	*	*	*	*	**04-1121-03**	**04-1121-04**	04-1121-03	04-1121-04
23	**Ball, Balve**	**4**	*	*	*	*	**04-1080-55**	**04-1080-55**	04-1080-55	04-1080-55
24	**Valve Seat O-Ring**	**4**	*	*	*	*	**04-1200-55**	**04-1200-55**	04-1200-55	04-1200-55
25	Liquid Chamber	2	04-5000-03-42	04-5000-04-42	04-5000-03-42	04-5000-04-42	04-5000-03-42	04-5000-04-42	04-5000-03-42	04-5000-04-42
26	Inlet Manifold, ANSI	1	04-5080-03-42	04-5080-04-42	04-5080-03-42	04-5080-04-42	04-5080-03-42	04-5080-04-42	04-5080-03-42	04-5080-04-42
	Inlet Manifold, DIN	1	04-5080-03-43	04-5080-04-43	04-5080-03-43	04-5080-04-43	04-5080-03-43	04-5080-04-43	04-5080-03-43	04-5080-04-43
27	Discharge Manifold, ANSI	1	04-5020-03-42	04-5020-04-42	04-5020-03-42	04-5020-04-42	04-5020-03-42	04-5020-04-42	04-5020-03-42	04-5020-04-42
	Discharge Manifold, DIN	1	04-5020-03-43	04-5020-04-43	04-5020-03-43	04-5020-04-43	04-5020-03-43	04-5020-04-43	04-5020-03-43	04-5020-04-43
28	Screw, HHC (5/16" - 18 x 1")	16	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42	08-6180-03-42
29	Flat Washer (5/16")	32	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42	08-6730-03-42
30	Disc Spring Washer	32	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42	08-6810-03-42
31	Hex Nut (5/16" - 18)	32	08-6400-03	08-6400-03	08-6400-03	08-6400-03	08-6400-03	08-6400-03	08-6400-03	08-6400-03
32	Screw, HHC (5/16" - 18 x 1-3/8")	16	08-6100-03	08-6100-03	08-6100-03	08-6100-03	08-6100-03	08-6100-03	08-6100-03	08-6100-03
	Muffler (Not Shown)	1	15-3510-99R	15-3510-99R	15-3510-99R	15-3510-99R	15-3510-99R	15-3510-99R	15-3510-99R	15-3510-99R

*See Section 9 — Elastomer Chart

[1] Air Valve Assembly includes item numbers 2 and 3.

All boldface items are primary wear parts.

PRO-FLO

ELASTOMER OPTIONS

P400 & PV400 METAL

MATERIAL	DIAPHRAGMS (2)	ULTRA-FLEX™ DIAPHRAGMS (2)	BACKUP DIAPHRAGMS (2)	VALVE BALLS (4)	VALVE SEATS ALUM (4)	VALVE SEATS - SS & ALLOY C (4)	VALVE SEAT O-RINGS ALUM (4)	VALVE SEAT O-RINGS - SS & ALLOY C (4)	T-SECTION GASKET ALUM (4)
~~Polyurethane~~	~~04-1010-50~~	~~N/A~~	~~N/A~~	~~04-1080-50~~	~~04-1125-50~~	~~04-1120-50~~	~~N/A~~	~~N/A~~	~~04-1325-50~~
~~Neoprene~~	~~04-1010-51~~	~~04-1020-51~~	~~04-1060-51~~	~~04-1080-51~~	~~04-1125-51~~	~~04-1120-51~~	~~N/A~~	~~N/A~~	~~04-1325-51~~
~~Buna-N~~	~~04-1010-52~~	~~04-1020-52~~	~~N/A~~	~~04-1080-52~~	~~04-1125-52~~	~~04-1120-52~~	~~N/A~~	~~N/A~~	~~04-1325-52~~
~~EPDM~~	~~04-1010-54~~	~~04-1020-54~~	~~04-1060-54~~	~~04-1080-54~~	~~04-1125-54~~	~~04-1120-54~~	~~N/A~~	~~N/A~~	~~04-1325-54~~
Viton®	04-1010-53	04-1020-53	N/A	04-1080-53	04-1125-53	04-1120-53	N/A	N/A	04-1325-53
~~Saniflex™~~	~~04-1010-56~~	~~N/A~~	~~04-1060-56~~	~~04-1080-56~~	~~04-1125-56~~	~~04-1120-56~~	~~N/A~~	~~N/A~~	~~N/A~~
~~PTFE~~	~~04-1010-55~~[1]	~~N/A~~	~~N/A~~	~~04-1080-55~~	~~N/A~~	~~N/A~~	~~04-1205-55~~[2]	~~04-1200-55~~[2]	~~04-1325-55~~
~~Wil-Flex™~~	~~04-1010-58~~	~~N/A~~	~~N/A~~	~~04-1080-58~~	~~04-1125-58~~	~~04-1120-58~~	~~N/A~~	~~N/A~~	~~04-1325-58~~
~~Tetra-Flex™ PTFE w/Neoprene~~	~~04-1010-64~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Tetra-Flex™ PTFE w/EPDM~~	~~04-1010-81~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Fluoro-Seal™~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~04-1200-34~~[2]	~~N/A~~
~~Aluminum~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~04-1125-01~~	~~04-1121-01~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Stainless Steel~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~04-1125-03~~	~~04-1121-03~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Alloy C~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~04-1121-04~~	~~N/A~~	~~N/A~~	~~N/A~~
~~Mild Steel~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~04-1121-08~~	~~N/A~~	~~N/A~~	~~N/A~~

[1] Stainless Steel and Alloy C pumps use PTFE diaphragm p/n 04-1010-55-42.
[2] Used in conjunction with metallic valve seat.

P400 & PV400 METAL STALLION

Material	Diaphragms (2) P/N	Valve Balls (4) P/N	Valve Seats (4) P/N
~~Neoprene~~	~~04-1020-51~~	~~04-1080-51-50~~	~~04-1120-51-50~~
~~Buna-N~~	~~04-1020-52~~	~~04-1080-52-50~~	~~04-1120-52-50~~
~~EPDM~~	~~04-1020-54~~	~~04-1080-54-50~~	~~04-1120-54-50~~
Viton®	04-1020-53	04-1080-53-50	04-1120-53-50

ELASTOMER KITS OPTIONS

PRO-FLO®

DESCRIPTION	NEOPRENE	BUNA-N	VITON®	EPDM
~~Pro-Flo® Metal~~	~~04-9554-51~~	~~04-9554-52~~	~~04-9554-53~~	~~04-9554-54~~
Pro-Flo® Advanced™ Aluminum - P400 [1,2]	~~04-9559-51~~	~~04-9559-52~~	04-9559-53	~~04-9559-54~~
~~Pro-Flo® Metal (Ultra-Flex™)~~	~~04-9564-51~~	~~04-9564-52~~	~~04-9564-53~~	~~04-9564-54~~
~~Pro-Flo® Advanced™ Aluminum - P400 (Ultra-Flex™)~~[2]	~~04-9569-51~~	~~04-9569-52~~	~~04-9569-53~~	~~04-9569-54~~
~~DESCRIPTION~~	~~PTFE~~	~~WIL-FLEX™~~	~~SANIFLEX™~~	~~POLYURETHANE~~
~~Pro-Flo® Metal~~	~~N/A~~	~~04-9554-58~~	~~04-9554-56~~	~~04-9554-50~~
~~Pro-Flo® Advanced™ Aluminum - P400~~[1,2]	~~04-9559-55~~	~~04-9559-58~~	~~04-9559-56~~	~~04-9559-50~~
~~Pro-Flo® Advanced™ SS & Alloy C - P400 (PTFE)~~[1]	~~04-9570-55~~	~~N/A~~	~~N/A~~	~~N/A~~

~~PRO-FLO V™~~

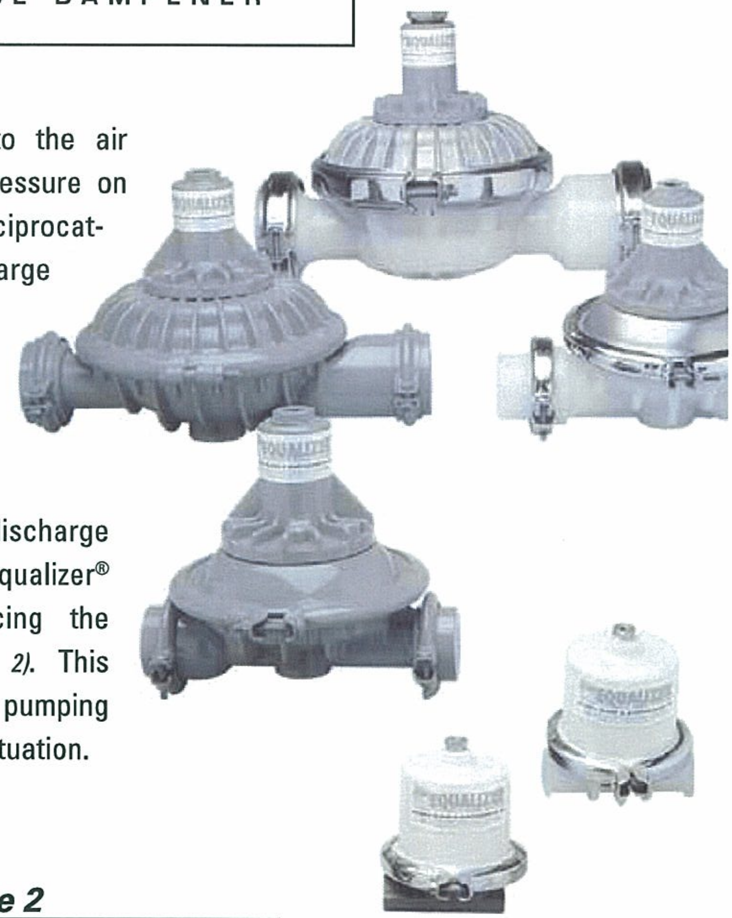
~~DESCRIPTION~~	~~NEOPRENE~~	~~BUNA-N~~	~~VITON®~~	~~EPDM~~
~~Pro-Flo V™ Metal~~	~~04-9582-51~~	~~04-9582-52~~	~~04-9582-53~~	~~04-9582-54~~
~~Pro-Flo V™ Advanced™ Aluminum - P400~~[1,2]	~~04-9583-51~~	~~04-9583-52~~	~~04-9583-53~~	~~04-9583-54~~
~~Pro-Flo V™ Metal (Ultra-Flex™)~~	~~04-9586-51~~	~~04-9586-52~~	~~04-9586-53~~	~~04-9586-54~~
~~Pro-Flo V™ Advanced™ Aluminum - P400 (Ultra-Flex™)~~[2]	~~04-9587-51~~	~~04-9587-52~~	~~04-9587-53~~	~~04-9587-54~~
~~DESCRIPTION~~	~~PTFE~~	~~WIL-FLEX™~~	~~SANIFLEX™~~	~~POLYURETHANE~~
~~Pro-Flo V™ Metal~~	~~N/A~~	~~04-9582-58~~	~~04-9582-56~~	~~04-9582-50~~
~~Pro-Flo V™ Advanced™ Aluminum - P400~~[1,2]	~~04-9583-55~~	~~04-9583-58~~	~~04-9583-56~~	~~04-9583-50~~
~~Pro-Flo V™ Advanced™ SS & Alloy C - P400 (PTFE)~~[1]	~~04-9588-55~~	~~N/A~~	~~N/A~~	~~N/A~~

[1] 38 mm (1-1/2") Advanced™ stainless steel and alloy C pump require special PTFE diaphragms (p/n 04-1010-55-42). 38 mm (1-1/2") Advanced™ aluminum pumps use standard PTFE diaphragms (p/n 04-1010-55).

[2] 38 mm (1-1/2") Advanced™ aluminum pumps use unique balls, seats and gaskets not found on Advanced stainless steel and alloy C pumps.

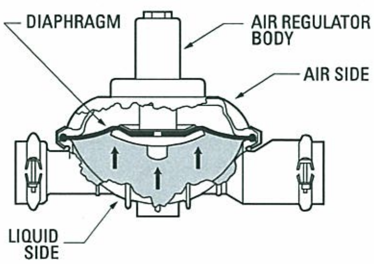
THE EQUALIZER®

WILDEN AUTOMATIC SURGE DAMPENER

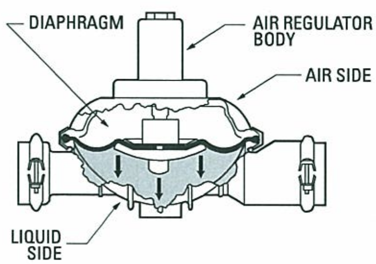


A compressed air line attached to the air regulator body sets and maintains pressure on the air side of the diaphragm. As a reciprocating pump begins its stroke, liquid discharge pressure increases which flexes the Equalizer® diaphragm inward (toward the air side). This action accumulates fluid in the liquid chamber *(phase 1)*. When the pump redirects its motion upon stroke completion, the liquid discharge pressure decreases allowing the Equalizer® diaphragm to flex outward displacing the fluid into the discharge line *(phase 2)*. This motion provides the supplementary pumping action needed to minimize pressure fluctuation.

Phase 1



Phase 2

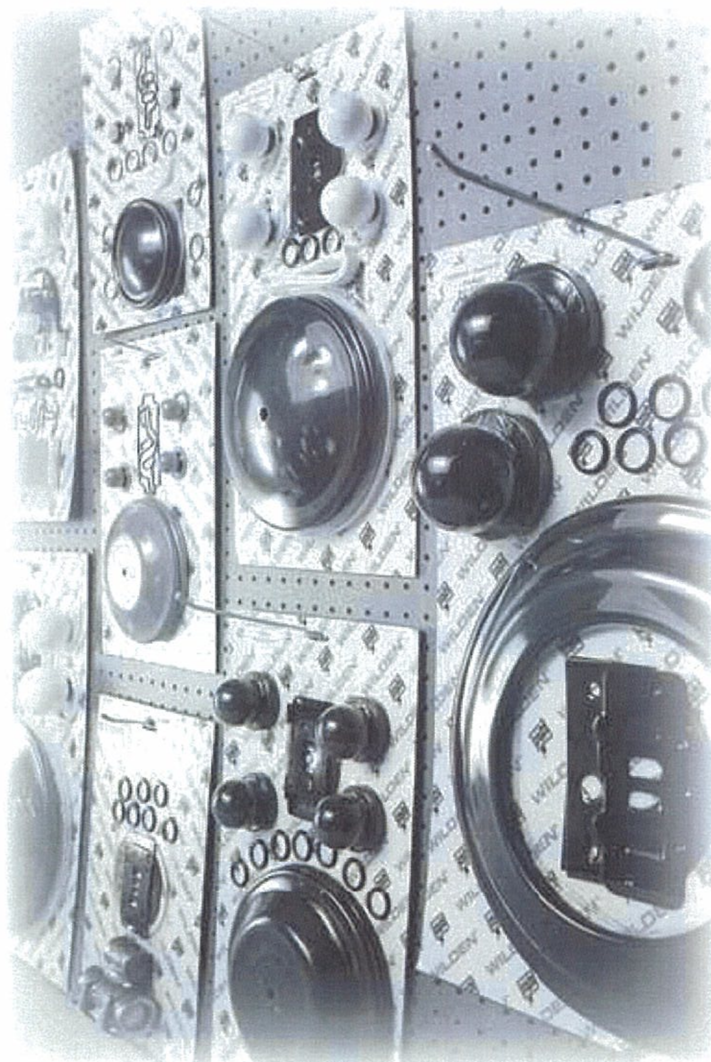


WILDEN®
A DOVER COMPANY

22069 VAN BUREN STREET • GRAND TERRACE, CA 92313-5607
(909) 422-1730 • FAX (909) 783-3440
www.wildenpump.com

Elastomer Kits
Your Solutions — Wrapped Up

Program Details:



- Elastomer & ADS Repair Kits
- All Sizes Available
- PTFE Rubber & TPE Elastomers
- One Part Number Simplifies Inventory
- Eliminates Order Errors
- Reduces Re-Build Time
- Rejuvenates Your Pump

NOTE: See Section 9.

WILDEN
A DOVER COMPANY
22069 VAN BUREN STREET • GRAND TERRACE, CA 92313-5607
(909) 422-1730 • FAX (909) 783-3440
www.wildenpump.com

WILDEN

WARRANTY

Each and every product manufactured by Wilden Pump and Engineering, LLC is built to meet the highest standards of quality. Every pump is functionally tested to insure integrity of operation.

Wilden Pump and Engineering, LLC warrants that pumps, accessories and parts manufactured or supplied by it to be free from defects in material and workmanship for a period of five (5) years from date of installation or six (6) years from date of manufacture, whichever comes first. Failure due to normal wear, misapplication, or abuse is, of course, excluded from this warranty.

Since the use of Wilden pumps and parts is beyond our control, we cannot guarantee the suitability of any pump or part for a particular application and Wilden Pump and Engineering, LLC shall not be liable for any consequential damage or expense arising from the use or misuse of its products on any application. Responsibility is limited solely to replacement or repair of defective Wilden pumps and parts.

All decisions as to the cause of failure are the sole determination of Wilden Pump and Engineering, LLC.

Prior approval must be obtained from Wilden for return of any items for warranty consideration and must be accompanied by the appropriate MSDS for the product(s) involved. A Return Goods Tag, obtained from an authorized Wilden distributor, must be included with the items which must be shipped freight prepaid.

The foregoing warranty is exclusive and in lieu of all other warranties expressed or implied (whether written or oral) including all implied warranties of merchantability and fitness for any particular purpose. No distributor or other person is authorized to assume any liability or obligation for Wilden Pump and Engineering, LLC other than expressly provided herein.

PLEASE PRINT OR TYPE AND FAX TO WILDEN

PUMP INFORMATION

Item # ______________________ Serial # ______________________

Company Where Purchased ______________________

YOUR INFORMATION

Company Name ______________________

Industry ______________________

Name ______________________ Title ______________________

Street Address ______________________

City ______________ State ________ Postal Code ________ Country ________

Telephone ____________ Fax ____________ E-mail ____________ Web Address ____________

Number of pumps in facility? ______________ Number of Wilden pumps? ______________

Types of pumps in facility (check all that apply): ☐ Diaphragm ☐ Centrifugal ☐ Gear ☐ Submersible ☐ Lobe

☐ Other ______________________

Media being pumped? ______________________

How did you hear of Wilden Pump? ☐ Trade Journal ☐ Trade Show ☐ Internet/E-mail ☐ Distributor

☐ Other ______________________

ONCE COMPLETE, FAX TO (909) 783-3440

NOTE: WARRANTY VOID IF PAGE IS NOT FAXED TO WILDEN

WILDEN PUMP & ENGINEERING, LLC

MAINTENANCE SUMMARY FORM - 11318

PROJECT: Wyckoff Replace Groundwater Treatment Plant CONTRACT NO.: W912DW-06-R-0014

1. EQUIPMENT ITEM: AIR OPERATED DIAPHRAGM PUMP

2. MANUFACTURER: WILDEN , MODEL P400, 04-10973

3. EQUIPMENT/TAG NUMBER(S): 50P1510

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS): _____

5. NAMEPLATE DATA (hp, voltage, speed, etc.): 15 GPM, Total Dynamic Head 11ft., Suction Lift 20 ft., Air Consumption 10 CFM 18PSI, Max shutoff pressure (ft.) 50

6. MANUFACTURER'S LOCAL REPRESENTATIVE: ARGO INTERNATIONAL, INC.

a. Name: Steve Telephone: 503-794-9686

b. Address: 13481 SE JOHNSON RD. PORTLAND, OR 97222

7. MAINTENANCE REQUIREMENTS

Qualifications and Training of Personnel: All personnel responsible for service, maintenance, inspection, installation and operation must have the appropriate training. Responsibility and supervision of personnel must be strictly enforced by the end user.

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
Inspect visible parts for wear	Quarterly	n/a
P400 is Pre-lubricated, requires no inline lubrication		n/a
Insure Proper Air Pressure	As need to control discharge flow rate.	n/a
Check pipes, valves & equipment	Annually	

8. LUBRICANT LIST –N/A

Reference Symbol	MFR (Name)	MFR (Name)	MFR (Name)	MFR (Name)	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				
Not Applicable					

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY

WILDEN OIL PUMP #P400-04-10973 - PRIMARY WEAR PARTS

Part No.	Description	Unit	Quantity	Unit Cost
04-2000-20-700	Pro-Flo Valve Assembly	Each	1	
04-3500-52-700	Gasket, Muffler	Each	1	
04-2600-52-700	Gasket, Air Valve	Each	1	
04-3880-99	Removable Pilot Sleeve Assembly	Each	1	
08-3210-55-225	Shaft Seal	Each	2	
04-3526-52	Gasket, Center Block, Pro-Flo	Each	2	
04-1010-55	Primary Diaphragm	Each	2	
04-1060-51	Backup Diaphragm	Each	2	
04-1080-55	Ball Valve	Each	4	
04-1125-01	Valve Seat	Each	4	
04-1205-55	Valve Seat O-Ring	Each	4	

Note: Identify parts provided by this Contract with two asterisks.

HOLMES MECHANICAL, INC.
PHONE (360) 698-1977
FAX (360) 698-1843

11318 1.02.B.8, Item 14 Comment Response

The term "Rubber-Fitted" on the Pump Performance Curve chart refers to all of the rubber types available. See attached catalog sheet for types included in this group. We are supplying Viton for this application.

10890 OLD FRONTIER RD. NW
SILVERDALE, WA 98383

Progressive DIAPHRAGM TECHNOLOGY

DIAPHRAGM CONSIDERATIONS				
FLEX LIFE	CHEMICAL RESISTANCE	TEMPERATURE LIMITATIONS	ABRASION RESISTANCE	INITIAL COST

THERMOPLASTIC ELASTOMER (TPE)

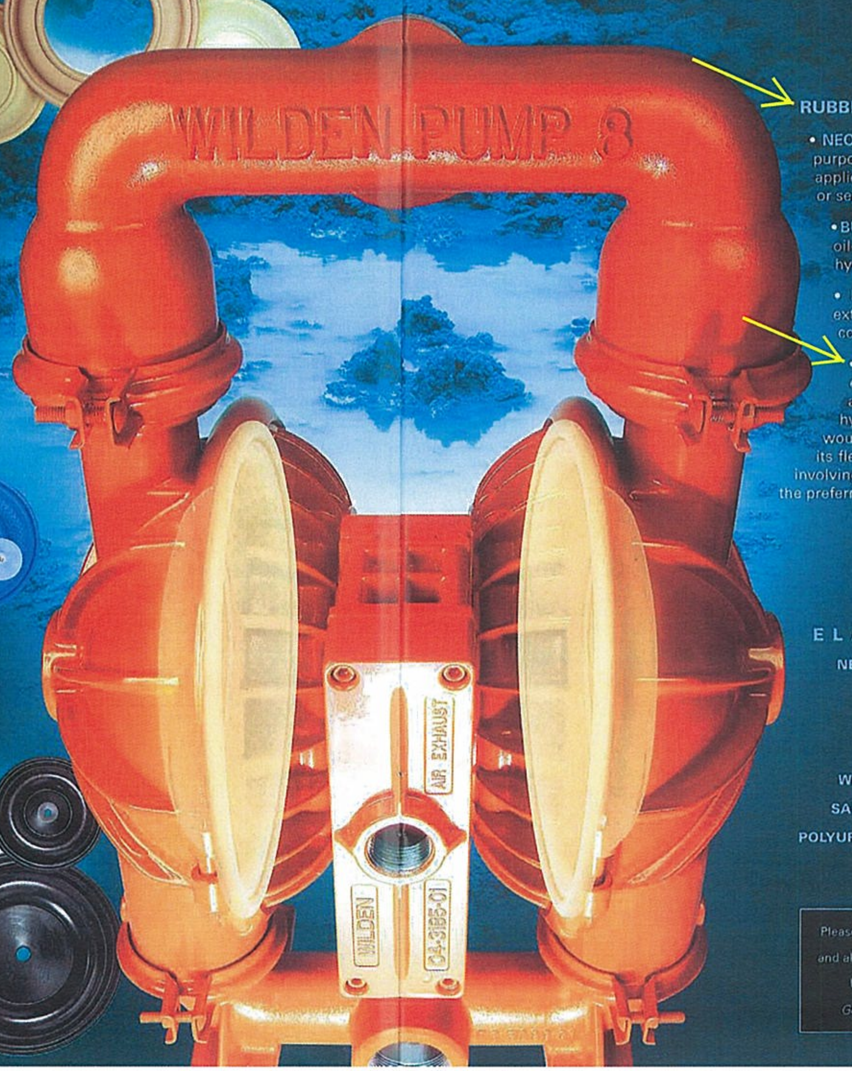
- **POLYURETHANE:** An excellent general purpose diaphragm for use in non-aggressive applications. This material exhibits exceptional flex life and durability. Wilden's most economical diaphragm.
- **WIL-FLEX™:** Made of Santoprene®, this diaphragm is an excellent choice as a low cost alternative to PTFE in many acidic and caustic applications such as sodium hydroxide, sulfuric or hydrochloric acids. Exhibits excellent abrasion resistance and durability at a cost comparable to neoprene.
- **SANIFLEX™:** Made of Hytrel™, this diaphragm exhibits excellent abrasion resistance, flex life and durability. This material is FDA approved for food processing applications. An outstanding general purpose diaphragm as well.

PTFE ELASTOMERS

- **PTFE:** Excellent choice when pumping highly aggressive fluids such as aromatic or chlorinated hydrocarbons, acids, caustics, ketones and acetates. Wilden's PTFE diaphragms exhibit good flex life.
- Wilden also offers PTFE integral piston diaphragms that offer superior product containment. The smooth contoured shape makes this diaphragm an excellent choice for sanitary or ultra pure applications.

ULTRA-FLEX™ DIAPHRAGM TECHNOLOGY

- Guaranteed longer life - If longer life is not experienced, Wilden will send you a new set of Ultra-Flex™ diaphragms free of charge.
- Convolute shape, altered fabric placement, and unique hardware work together to decrease the unit loading on the diaphragm and distribute stress.
- **MATERIAL OPTIONS:** Neoprene, Buna-N, EPDM, Viton®

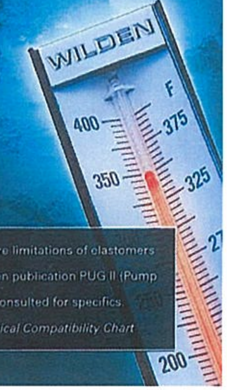


RUBBER ELASTOMERS

- **NEOPRENE:** An excellent general purpose diaphragm for use in non-aggressive applications such as water-based slurries, well water or sea water. Exhibits excellent flex life and low cost.
- **BUNA-N:** Excellent for applications involving petroleum/oil-based fluids such as leaded gasolines, fuel oils, hydraulic oils, kerosene, turpentine's and motor oils.
- **EPDM:** Excellent for use in applications requiring extremely cold temperatures. May also be used as a low cost alternative for pumping dilute acids or caustics.
- **VITON®:** Excellent for use in applications requiring extremely hot temperatures. May also be used in aggressive fluids such as aromatic or chlorinated hydrocarbons and highly aggressive acids. PTFE would normally be used with these aggressive fluids as its flex life is better than Viton®. However, in applications involving suction lift outside the range of PTFE, Viton® will be the preferred choice for highly aggressive fluids.

ELASTOMER TEMPERATURE LIMITS:

NEOPRENE:	-17.7°C to 93.3°C	(0°F to 200°F)
BUNA-N:	-12.2°C to 82.2°C	(10°F to 180°F)
EPDM:	-51.1°C to 137.8°C	(-60°F to 280°F)
VITON®:	-40°C to 176.7°C	(-40°F to 350°F)
WIL-FLEX™:	-40°C to 107.2°C	(-40°F to 225°F)
SANIFLEX™:	-28.9°C to 104.4°C	(-20°F to 220°F)
POLYURETHANE:	-12.2°C to 65.6°C	(10°F to 150°F)
PTFE:	4.4°C to 104.4°C	(40°F to 220°F)



Please verify the chemical resistance capabilities and temperature limitations of elastomers and all other pump components prior to pump installation. Wilden publication PUG II (Pump Users Guide II) and the On-line Chemical guide should be consulted for specifics.

Go to www.wildenchemicalguide.com for your Wilden Chemical Compatibility Chart

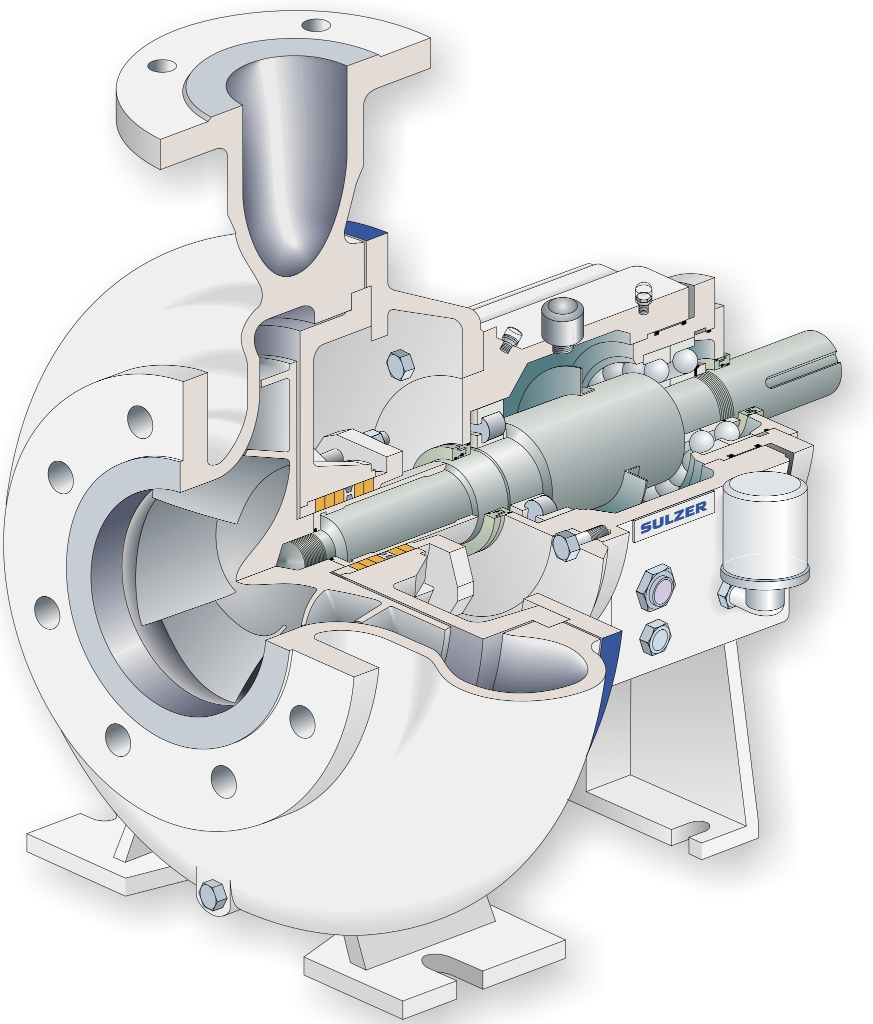
Volume II

11500 - Recirculation Pump for DAF Unit 50P1135

Attachment 2.10

SULZER

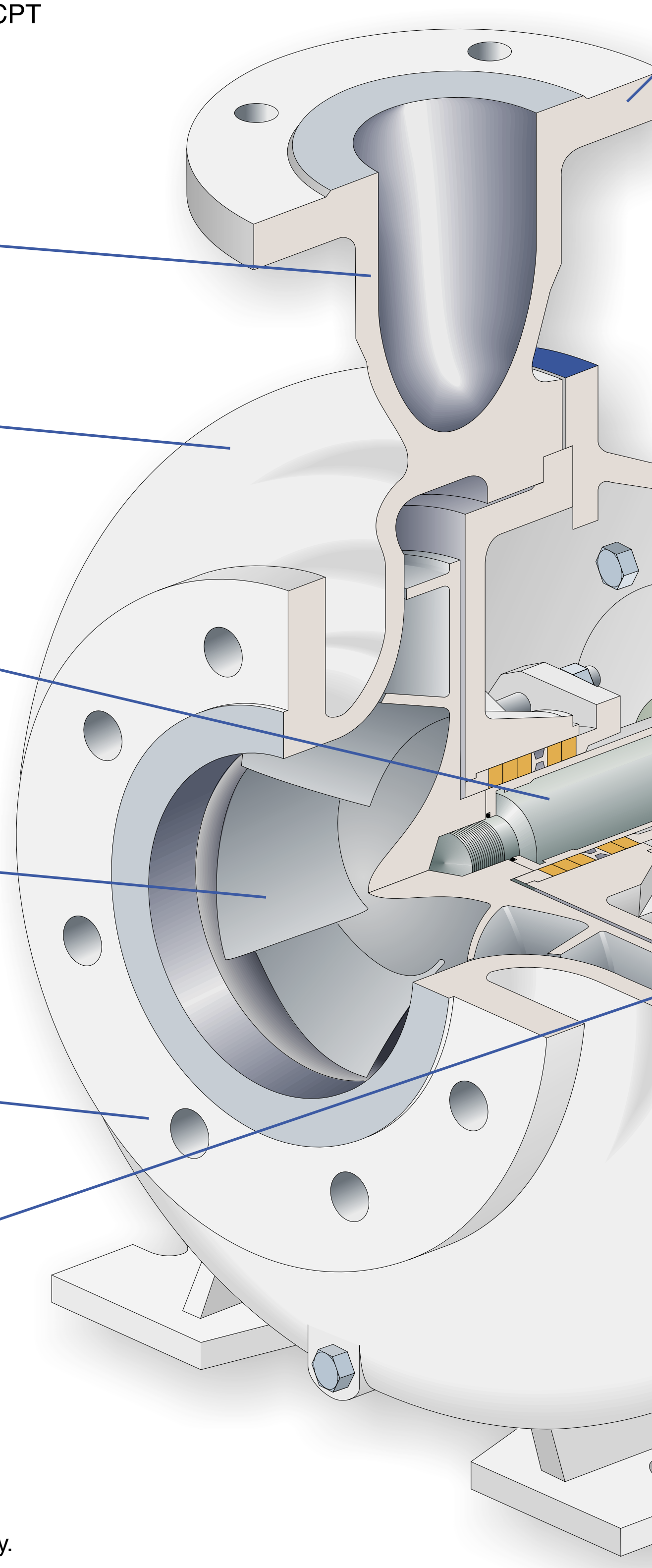
CPT ANSI Process Pumps



The Heart of Your Process

There Are Two Sides to Every Story: Inside and Outside

On the outside, the CPT offers special features that simplifies maintenance and adjustments. The real difference between the CPT and other ANSI pumps, however, is what you'll find inside. For example, the standard CPT wet-end components are cast in duplex stainless steel (unless specified otherwise). Another example is our heavy-duty bearing unit, designed for long life and tough applications. As you can see, our CPT ANSI process pump gains its advantage from the inside-out.



Centerline Discharge

- Back pull-out design allows maintenance of the rotating assembly without disturbing the piping
- Provides self-venting for air elimination
- Equalizes distribution of pipe stress through integral feet

Heavywalled Casing

- Computer generated hydraulics
- Corrosion allowance for extended wear

Large Diameter Shaft

- Low shaft deflection (.002")
- Improved bearing and mechanical seal life
- Solid shaft or hook sleeve design available
- Duplex stainless steel standard

Semi-Open Impeller

- Optimal computer generated hydraulics
- Investment casting guarantees smooth surfaces
- Back pump-out vanes for control of stuffing box pressure and axial thrust
- Handles solids and fibrous materials
- Teflon®* impeller o-ring

Sulzer Quality Castings

- Precision cast parts utilizing the latest casting techniques
- Full range of materials from Ductile, Duplex stainless steel to 654 SMO™
- ISO 9001:2000 approved manufacturing processes

Sealing Versatility

- A variety of rear covers/stuffing box designs are available to meet process requirements
- Packing
- Mechanical seal
  - Large bore
  - Taper bore (cast-in ribs for flow enhancement)
- Dynamic seal

* Teflon® is a registered trademark of E.I. Du Pont De Nemours & Company.

Flanges
- Meets ASME/ANSI B16.5
- Class 150 RF Standard, Optional: Class 300 RF

Bearing Housing Adapter
- Ductile iron for strength and safety
- Jacking bolts for ease of disassembly
- Rabbeted fit to bearing housing assures accurate alignment

Bearing Monitor
- Taps as standard

Impeller Clearance Adjustment
- Quick and accurate impeller adjustments without the use of a feeler gauge or removal pump
- Assures concentricity and bearing alignment throughout the impeller's adjustable range
- No snap ring required to hold bearing

Heavy Duty Bearings
- Bearing life exceeds all ANSI requirements
- Inboard cylindrical roller bearings for maximum radial load carrying capabilities
- Angular contact thrust bearing locked into position, carries radial and axial loads extending service life

Inpro VBX/Labyrinth Bearing Isolators
- Inboard and outboard bearing protection
- Isolates bearings from environmental contamination
- Multi-port for proper drainage
- Bronze standard (non-metallic available)
- Cooler running bearing unit

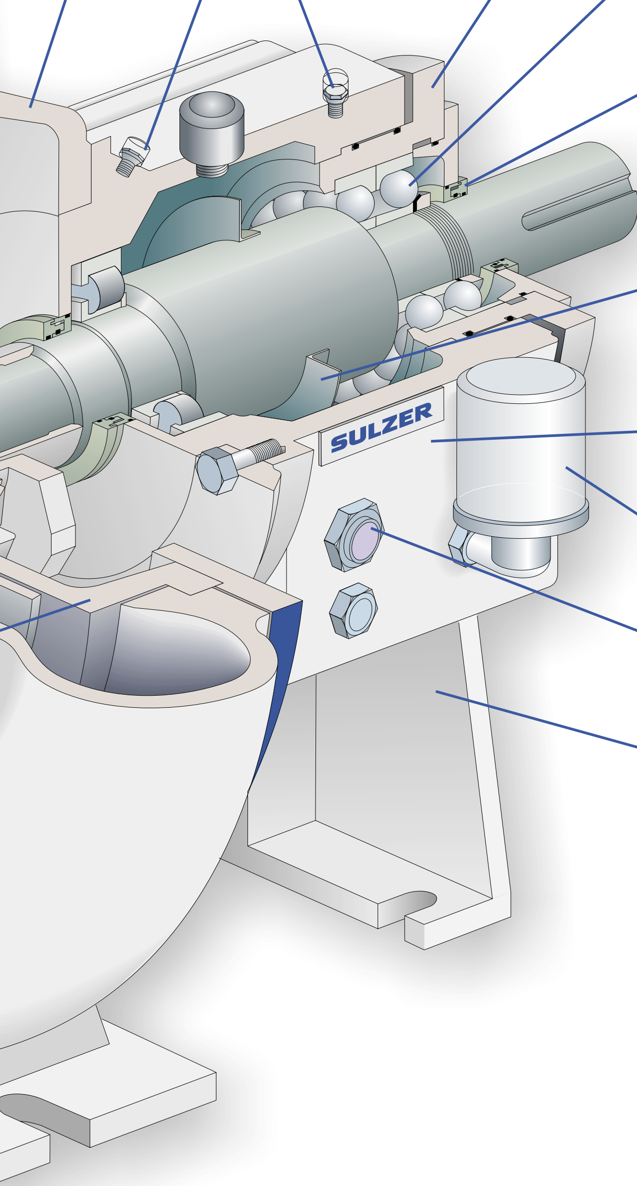
Splash Lubrication
- Directs oil to thrust bearing for efficient cooling and improved lubrication
- Designed for high load applications

Large Capacity Oil Sump
- Improved oil circulation and cooling
- Magnetic oil drain plugs (optional)
- Extra-large, multiple oil return slots
- Optional bearing unit cooling

Constant Level Oiler Available

Over Sized Sight Glass
- Located on each side of the bearing unit

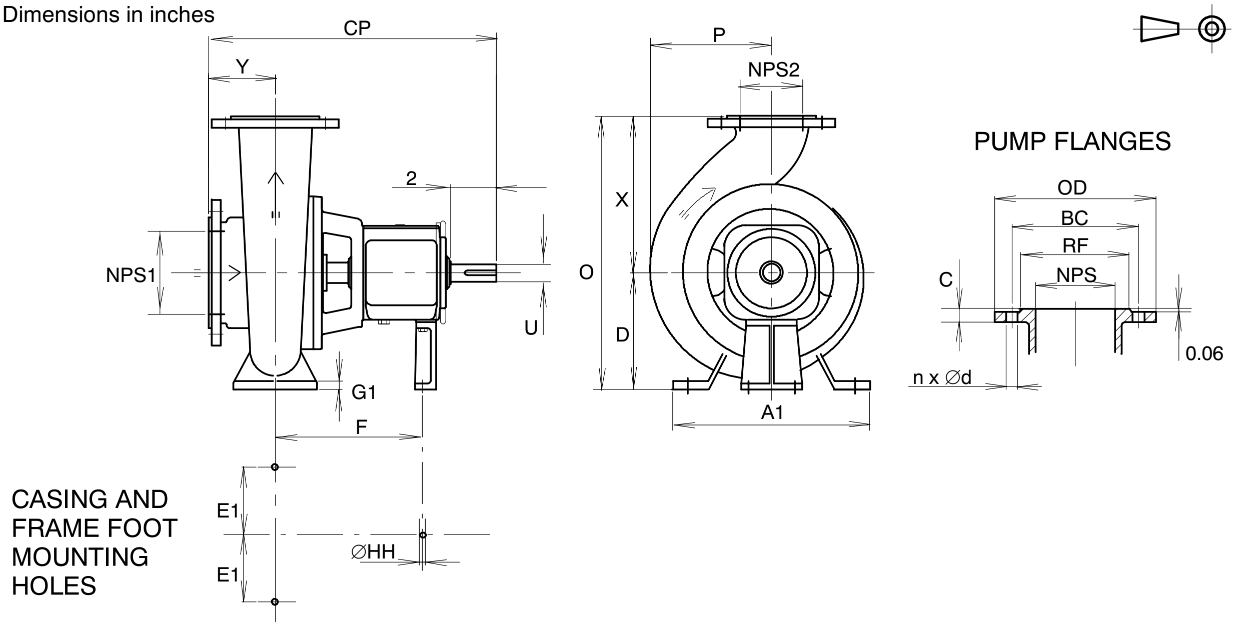
Rigid Bearing Housing Support Foot
- Improved mounting stability
- Fully machined mounting surfaces assures accurate alignment



CPT11-1 ... CPT12-1B

Bare Pump

Dimensions in inches

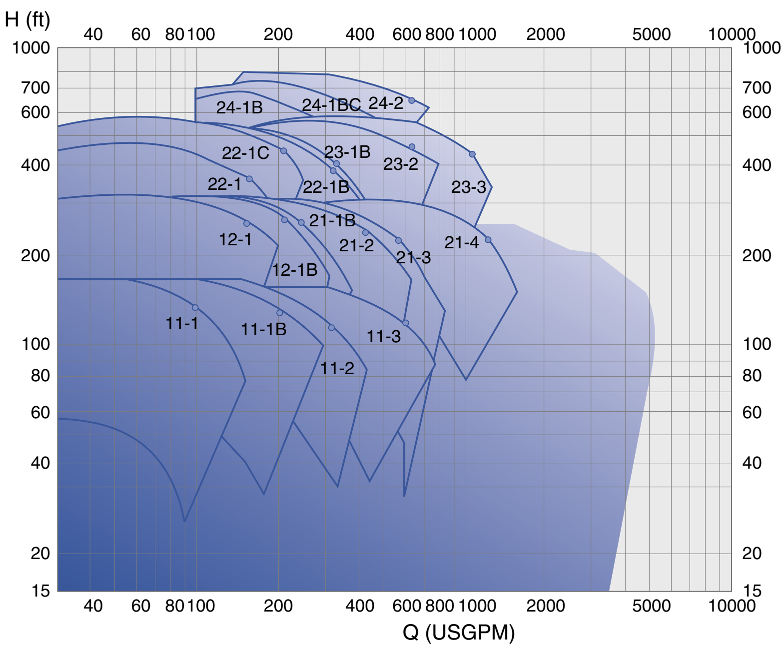


DIMENSIONS																
Type	NPS1	NPS2	CP	D	E1	F	HH	O	P	U Dia.	U Keyway	X	Y	A1	G1	Weight lbs
11-1	1 1/2	1	17 1/2	5 1/4	3	7 1/4	5/8	11 3/4	4 1/32	7/8	3/16x3/32x1 1/4	6 1/2	4	7 1/2	3/8	110
11-1B	3	1 1/2	17 1/2	5 1/4	3	7 1/4	5/8	11 3/4	4 1/4	7/8	3/16x3/32x1 1/4	6 1/2	4	7 1/2	3/8	120
11-2	3	2	17 1/2	5 1/4	3	7 1/4	5/8	11 3/4	5 1/4	7/8	3/16x3/32x1 1/4	6 1/2	4	7 1/2	3/8	125
11-3	4	3	18	7	3	7 3/4	5/8	15 1/2	6	7/8	3/16x3/32x1 1/4	8 1/2	4	7 1/2	7/16	165
12-1	1 1/2	1	17 1/2	5 1/4	3	7 1/4	5/8	11 3/4	5 1/4	7/8	3/16x3/32x1 1/4	6 1/2	4	7 1/2	3/8	125
12-1B	3	1 1/2	17 1/2	5 1/4	3	7 1/4	5/8	11 3/4	5 1/4	7/8	3/16x3/32x1 1/4	6 1/2	4	7 1/2	3/8	135

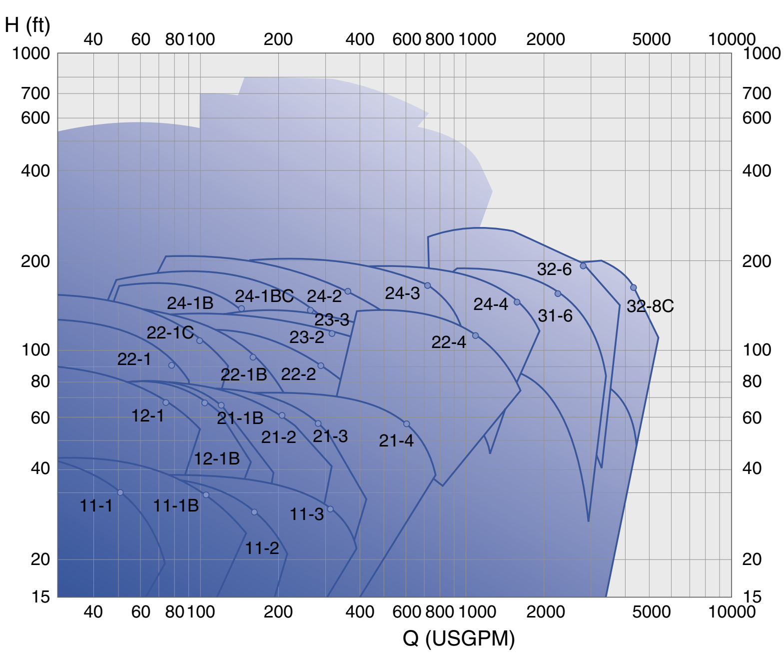
DRILLING OF FLANGES												
NPS	ASME B 16.5 Class 150 (SS) ASME B 16.42 Class 150 (DI)						ASME B 16.5 Class 300 (SS)					
	OD	RF	C	BC	d	n	OD	RF	C	BC	d	n
1	4.25	2.00	0.56	3.12	0.62	4	4.88	2.00	0.69	3.50	0.75	4
1 1/2	5.00	2.88	0.69	3.88	0.62	4	6.12	2.88	0.81	4.50	0.88	4
2	6.00	3.62	0.75	4.75	0.75	4	6.50	3.62	0.88	5.00	0.75	8
3	7.50	5.00	0.94	6.00	0.75	4	8.25	5.00	1.12	6.62	0.88	8
4	9.00	6.19	0.94	7.50	0.75	8	10.00	6.19	1.25	7.88	0.88	8

Hydraulic Coverage

Capacity Range 3600 rpm, open impeller



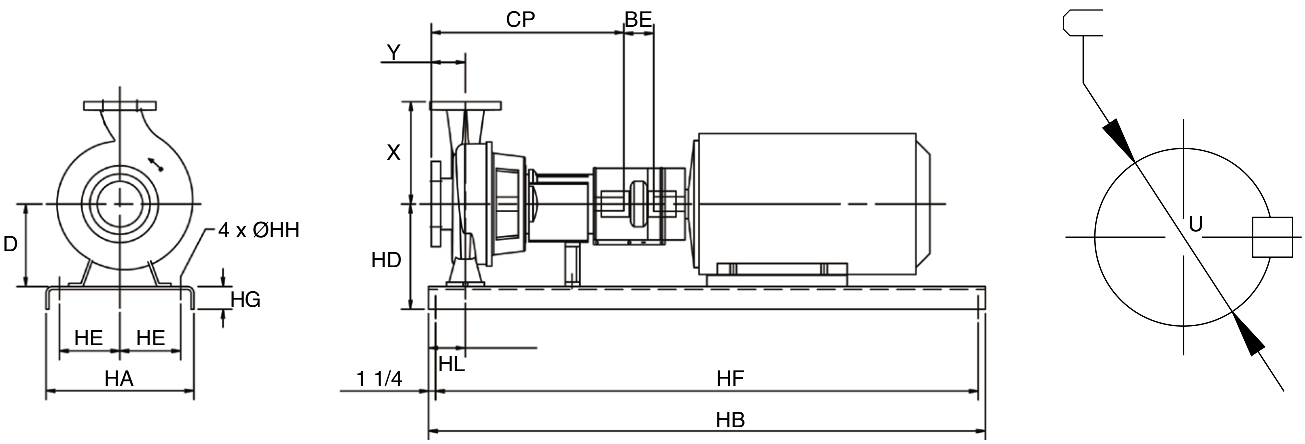
Capacity Range 1800 rpm, open impeller



● Best efficiency point

CPT	Designation
11-1	1.5 x 1 x 6
11-1B	3 x 1.5 x 6
11-2	3 x 2 x 6
11-3	4 x 3 x 6
12-1	1.5 x 1 x 8
12-1B	3 x 1.5 x 8
21-1B	3 x 1.5 x 8.5
21-2	3 x 2 x 8.5
21-3	4 x 3 x 8.5
21-4	6 x 4 x 8.5
22-1	2 x 1 x 10
22-1C	2 x 1 x 10C*
22-1B	3 x 1.5 x 10
22-2	3 x 2 x 10
22-4	6 x 4 x 10
23-1B	3 x 1.5 x 11
23-2	3 x 2 x 11
23-3	4 x 3 x 11
24-1B	3 x 1.5 x 13
24-1BC	3 x 1.5 x 13C*
24-2	3 x 2 x 13
24-3	4 x 3 x 13
24-4	6 x 4 x 13
31-6	8 x 6 x 13
32-6	8 x 6 x 15
32-8C	10 x 8 x 15C*
32-8	10 x 8 x 15

Dimensions



CPT Pump Dimensions

Group	Pump	Size	CP	Y	X	BE	D	ØU
1	11-1	1.5x1x6	17.5	4	6.5	3.875	5.25	7/8
	11-1B	3x1.5x6	17.5	4	6.5	3.875	5.25	7/8
	11-2	3x2x6	17.5	4	6.5	3.875	5.25	7/8
	11-3**	4x3x6	18	4	8.5	3.875	7	7/8
	12-1	1.5x1x8	17.5	4	6.5	3.875	5.25	7/8
	12-1B	3x1.5x8	17.5	4	6.5	3.875	5.25	7/8
2	21-1B	3x1.5x8.5	23.5	4	8.5	3.875	8.25	1 3/8
	21-2	3x2x8.5	23.5	4	9.5	3.875	8.25	1 3/8
	21-3	4x3x8.5	23.5	4	11	3.875	8.25	1 3/8
	21-4	6x4x8.5	23.5	4	11	3.875	8.25	1 3/8
	22-1	2x1x10	23.5	4	8.5	3.875	8.25	1 3/8
	22-1C	2x1x10C*	23.5	4	8.5	3.875	8.25	1 3/8
	22-1B	3x1.5x10	23.5	4	8.5	3.875	8.25	1 3/8
	22-2	3x2x10	23.5	4	9.5	3.875	8.25	1 3/8
	22-4	6x4x10	23.5	4	13.5	3.875	10	1 3/8
	23-1B	3x1.5x11	23.5	4	10.5	3.875	10	1 3/8
	23-2	3x2x11	23.5	4	11.5	3.875	10	1 3/8
	23-3	4x3x11	23.5	4	12.5	3.875	10	1 3/8
	24-1B	3x1.5x13	23.5	4	10.5	3.875	10	1 3/8
	24-1BC	3x1.5x13C*	23.5	4	10.5	3.875	10	1 3/8
	24-2	3x2x13	23.5	4	11.5	3.875	10	1 3/8
	24-3	4x3x13	23.5	4	12.5	3.875	10	1 3/8
	24-4	6x4x13	23.5	4	13.5	3.875	10	1 3/8
3	31-6	8x6x13	33.875	6	16	5.25	14.5	2 3/8
	32-6	8x6x15	33.875	6	18	5.25	14.5	2 3/8
	32-8C	10x8x15C*	33.875	6	19	5.25	14.5	2 3/8
	32-8	10x8x15	33.875	6	19	5.25	14.5	2 3/8

CPT Base Dimensions (not for construction)

Group	Base	Max motor frame	HA	HB	HE	HF	ØHH	HL	HG max	HD max
1	139	184T	15	39	4.5	36.5	3/4	4.5	3.75	9
	148	256T	18	48	6	45.5	3/4	4.5	4.13	10.5
	153	326TS	21	53	7.5	50.5	3/4	4.5	4.75	12.88
2	245	184T	15	45	4.5	42.5	3/4	4.5	3.75	12/13.75***
	252	215T	18	52	6	49.5	3/4	4.5	4.13	12.38/14.13***
	258	286T	21	58	7.5	55.5	1	4.5	4.75	13/14.75***
	264	365T	21	64	7.5	61.5	1	4.5	4.75	13/14.75***
	268	405TS	26	68	9.5	65.5	1	4.5	4.75	14.75
	280	449TS	26	80	9.5	77.5	1	4.5	4.75	15.25
3	368	286T	26	68	9.5	65.5	1	6.5	4.75	18.75
	380	405T	26	80	9.5	77.5	1	6.5	4.75	18.75
	398	449T	26	98	9.5	95.5	1	6.5	4.75	18.75

* Designates higher hydraulic range.
** Note that CPT 11-3 is not part of ANSI specification and may have different dimensions.
*** Note that numbers depend on pump size D=8.25”/D=10”.

Materials

A-890 grade 3A Alloy

Sulzer CPT ANSI pumps are frequently used in services where resistance to both corrosion and abrasion is necessary. That is why the standard stainless steel chosen for wet-end pump components is ASTM A-890 Grade 3A.

This duplex cast steel (ferritic austenitic) with high molybdenum and nitrogen content:

- Offers corrosion resistance superior to conventional cast 316SS (CF-8M) and equal to or better than 317SS (CG-8M).
- Provides excellent abrasion resistance (230 BHN) that, when used in mildly abrasive services, may last 30% to 40% longer than 316SS.
- Features clearly superior mechanical properties over austenitic alloys and is comparable to most duplex alloys including CD4-MCu and SS2205.

CPT Material Mechanical Properties

Common name	ASTM	Mechanical properties			
		Tensile	Yield	Elong %	Hardness
Cast iron	A278 CL200	29			170-220
CD6MN	A890-3A	95	65	25	180-260
2205	A890-4A	90	60	25	180-260
5A	A890-5A	100	75	18	180-260
CD4MCuN	A890-1B	100	70	16	160-200
Ductile iron	A395	60	40	18	160
329SS	AISI329	87-116	58	18	180-260
316SS	A743 CF-8M	70	30	30	150-190
317SS	A743 CG-8M	75	35	25	150-190
Alloy 20	A743-CN-7M	62	25	35	130-170
654 SMO*	"A240,480,358"	109	62	40	190-220

CPT Material Chemical Properties

Common name	Chemical analysis									
	Cr	Ni	Mo	Cu	Si	Mn	C	N	PRE	ASTM
Cast iron					1.7-2.4	0.4-0.09	3.2-3.7		NA	A278 CL200
CD6MN	24.0-27.0	4.0-6.0	1.75-2.5		0.04	1	0.06	0.15-0.25	35.60	A890-3A
2205	21.0-23.5	4.5-6.5	2.5-3.5	1.0 max	0.02	1.5	0.03	0.1-0.3	35.10	A890-4A
5A	24.0-26.0	6.0-8.0	4.0-5.0		1.0	1.5	0.03	0.1-0.3	43.00	A890-5A
CD4MCuN	24.5-26.5	4.6-6.0	1.75-2.25	2.75-3.25	1.0	1.0	0.4	0.15	35.30	A890-1B
Ductile iron					2.0-2.8	0.2-0.7	3.1-3.7		NA	A395
329SS	24.0-27.0	4.5-7.0	2.5-3.0		1.0				34.08	AISI329
316SS	18.0-21.0	9.0-12.0	2.0-3.0		2.0		0.08		27.50	A743 CF-8M
317SS	18.0-21.0	9.0-13.0	3.0-4.0		1.5		0.08		30.90	A743 CG-8M
Alloy 20	19.0-21.0	27.5-30.5	2.0-3.0	3.0-4.0	1.0	1.7	0.07		30.00	A743 CN-7M
654 SMO*	24.0-25.0	21.0-23.0	" 7.0-8,0"	0.30-0.60	0.5	2.0-4.0	0.02	0.45-0.55	56.1	A240.480,358

* AVESTA 654 SMO is a trademark owned by Outokumpu Stainless which has granted Sulzer Pumps licence to produce this material.

Corrosion Resistance

Pitting and crevice corrosion that occurs in metals are of particular interest in stainless steel.

The Pitting Resistance Equivalence (PRE*) is an index that can help identify an alloy's susceptibility to these forms of corrosion. The higher the PRE* number, the greater the metal's resistance to pitting and crevice corrosion.

ASTM	PRE*
A890-3A	35.6
A743 CF-8M	27.5
CD4MCu	35.30
AISI329	34.08
A743 CN-7M	30.0
A743 CG-8M	35.10

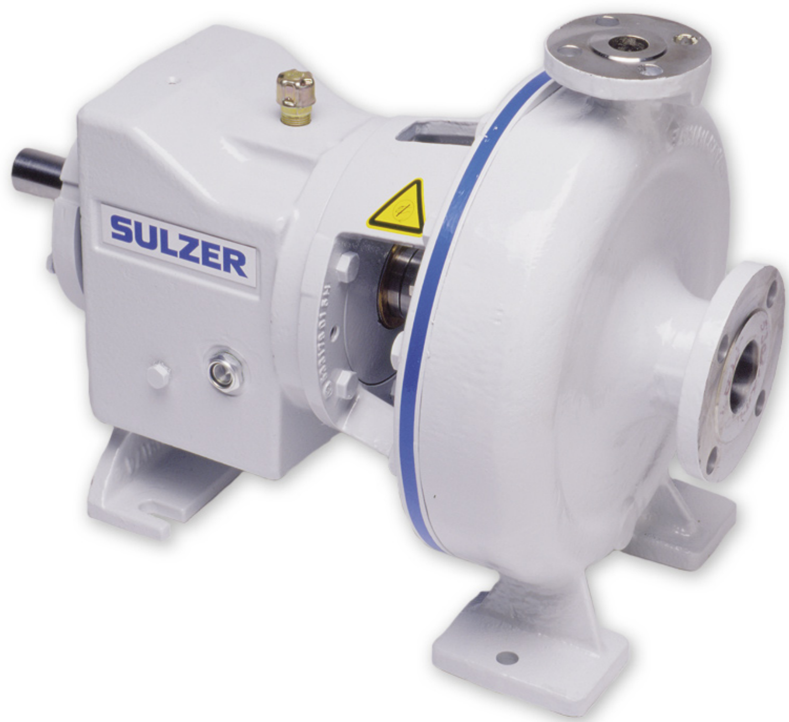
*(PRE = Cr% + 3.3 Mo% + 16 x N%)

Heat Treatment

All A-890 Grade 3A castings are solution annealed to maximize corrosion resistance and mechanical properties. This heat treatment consists of heating to and holding at 1950°F minimum for a prescribed time period followed by a rapid water quench.

Welding

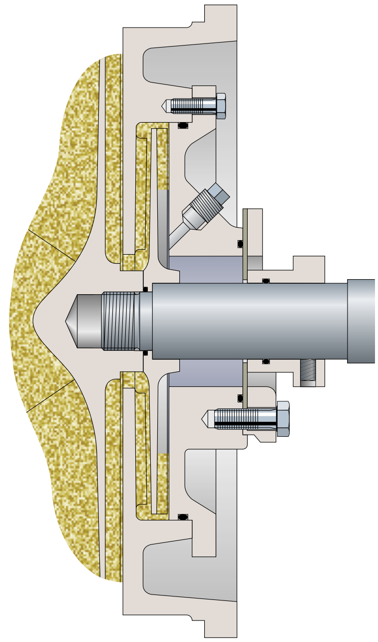
A-890 Grade 3A is a readily weldable metal provided a matching weld filler is used.



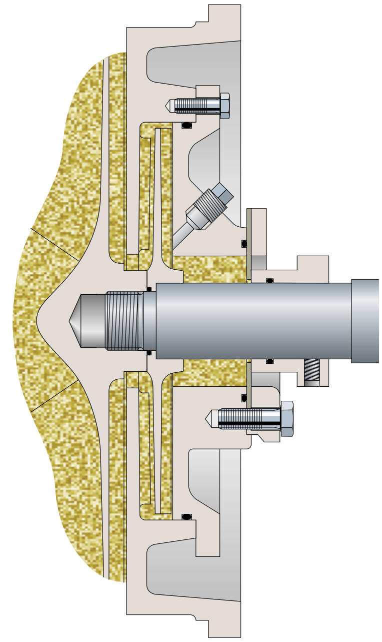
Shaft Sealing

Dynamic Seal

Sulzer Pumps' dynamic seal uses an expeller to move liquid back into the volute casing and away from the stuffing box when the pump is running. When the pump stops, liquid flows back into the stuffing box, forcing closed an elastomeric static seal to prevent leakage. No outside flush required. Saves water, piping costs and eliminates packing maintenance.



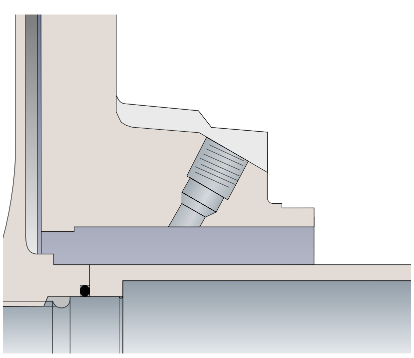
Sulzer Dynamic Seal running



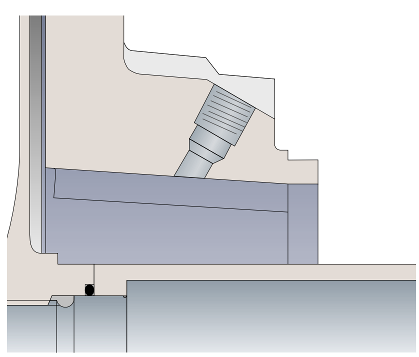
Sulzer Dynamic Seal stopped

Seal Chambers

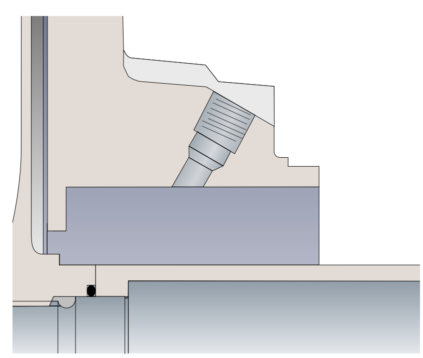
The CPT design offers a variety of seal chambers. Each is designed to help you tailor your CPT pump to your specific process requirements without sacrificing reliability and longevity. If you're not exactly sure which configuration is best for your processes, our engineers will be happy to work with you. We'll analyze your hydraulic requirements and recommend a system.



Standard Bore Box accommodates most single component and cartridge mechanical seals as well as standard packing.



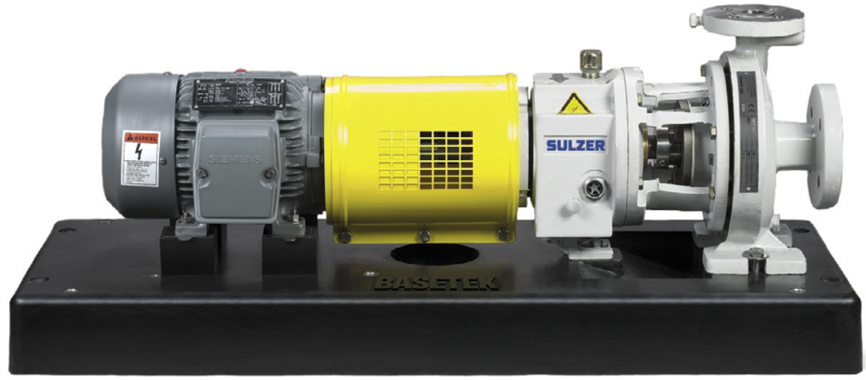
Tapered and Ribbed Bore Box features a seal chamber designed for single and double mechanical seals. The cast ribs inside the stuffing box convert circular flow into axial flow, reducing wear and extending longevity.



Large Bore Box is designed for seals with large gland bolt circles. It accommodates most single and double mechanical seals, as well as cartridge or component seals. The oversized chamber helps reduce running temperatures while improving lubrication and circulation.

Baseplate Options

Sulzer produces rigid baseplate designs that resist the distortion which can cause pump/motor misalignment. Our baseplates require minimal maintenance and are corrosion resistant for severe environments. Sulzer Pumps offers a complete range of mounting systems to meet your requirements. Optional V-belt and custom designs are also available. Contact your local Sulzer representative for details.

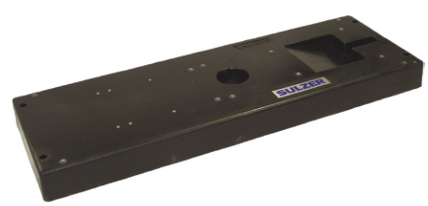


Standard Baseplate (Style 1)

Sulzer Pumps standard formed steel baseplate meets ANSI specifications for pump/motor mounting. A single grout hole and epoxy paint are standard. An optional stainless steel catch basin or all stainless steel construction is available.

Non-Metallic Baseplate

Nothing compares to the Sulzer Polymer Composite baseplate design. The polymer baseplate is provided with a standard guaranteed surface flatness of 0.015” or 0.005” end-to-end, carbon or SS inserts, leveling holes and machined riser blocks. The polymer baseplate is the best value in the industry.



Drip-Lip Baseplate (Style 3)

The Drip-lip baseplate with welded end caps and optional center I-Beam support includes a sloped drainage channel to a welded drain connection making this an excellent upgrade to the standard baseplate. Options include motor adjustment bolts, additional grout vent holes and all stainless steel construction.

PIP Baseplate

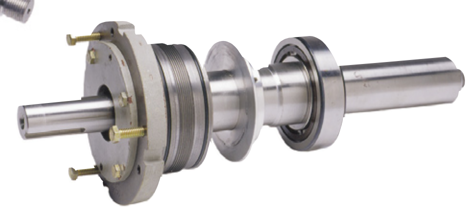
This baseplate is designed to current PIP requirements and is standard with grout hole, raised mounting pads machined to 0.002 in/ft surface flatness, motor alignment bolts, additional welded supports, sloped full drain rim, lifting lugs and continuous welded steel construction. Options include leveling screws, stilt and spring mounting and all stainless steel construction.

Bearing Unit

The bearing unit is built as standard for high load applications. Some applications push a power end beyond ANSI design limits.

Examples are:
1) operation at reduced flows
2) pumping high specific gravity liquids
3) overhung belt drives

The bearing unit features as standard:
- Splash oil lubrication
- Thrust bearing is duplex angular contact bearing design
- Radial bearing is cylindrical roller bearing design
- Large oil capacity to reduce temperature
- Inpro VBX/labyrinth bearing isolators
- Grease lubrication available as an option



Impeller Clearance Adjustment

- Quick and accurate impeller adjustments without the use of a feeler gauge or removal of pump
- Assures concentricity and bearing alignment throughout the impeller's adjustable range
- No snap ring required to hold bearing

Remanufactured Bearing Unit Exchange Program

At Sulzer Process Pumps we are dedicated to providing rapid turn around, high quality remanufactured bearing units. Operators can put equipment repaired by us back into service confident in the knowledge that it is “good as new”.

Customer

Sulzer Process Pumps Service Center

Maintaining and Improving Pump Performance

The continuous availability and high operating performance of pumps is the key target for our customer support service organization. Through our highly experienced personnel and application knowledge, we provide a full range of innovative service solutions to our customers to keep their pumps running including;

- Spare Parts
- Field Service
- Repair Services
- Retrofits
- Maintenance Agreements

With services ranging in scope from supplying a spare part to value added services. A dedicated team of CSS specialists based at either our manufacturing facilities or one of over 50 service centers located around the world is dedicated to maintaining the performance of our customers pumps and associated equipment.

This service is not just limited to Sulzer products, all the pumps our customers operate can benefit from the support of Sulzer CSS specialists.

SULZER

Sulzer Pumps
Sulzer Process Pumps (US) Inc.
155 Ahlstrom Way (29640)
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SULZER

CPT Chemical Process Pumps

Installation, Operation and Maintenance Instructions

Version 03 > / 20051101 / Replaces 20041101 / en / **N15251**

Contents

SULZER

Intended use

20020501 / en / **N15252**

Contents *Page*

1 General

The pump and its accessories may only be used for the purpose for which they have been supplied. The intended use is given in the order specification and in the following instructions concerning the main pumping parameters and mechanical durability. If the intended use changes, the user must make sure that the pump can be used in the new application and, if necessary, obtain the manufacturer's permission for the change.

Table 1 Intended use in the process

Application data:	Sources:
Pumped liquid and its properties (chemicals, solids, consistency, temperature etc.)	Product specification (under "Process data")
Main pumping parameters (capacity, head, speed etc.)	Product specification (under "Process data") and nameplate of the pump
Other necessary process data	Product specification (under "Process data")

Table 2 Delivery and design

Delivery and design data:	Sources:
Delivery scopes (pump, coupling, baseplate etc.)	Product specification
Product size	Product specification and nameplate of the pump
Other design alternatives (impeller type and size, materials, lubrication, flange drillings, shaft sealing type etc.)	Product specification
Dimensions (pump, accessories, flanges etc.)	Dimensional drawings
Weights and mass moments of inertia (bare pump, pump + baseplate etc.)	Dimensional drawings
Connections (lubrication, shaft seal, drainage etc.)	Location shown in the parts list under heading "Connections" and in the sectional drawings. Moreover, connections having importance in view of safety have been marked on the product.
Part details (maximum impeller diameter, bearing types, fastener sizes etc.)	Parts list (under heading "Parts")

This instruction set covers the ANSI process pump with the supplementary accessories included in the delivery. All supplied instructions are found in the parts list under the heading "Instructions".

Before commissioning, the operating staff have to be instructed in the guidelines for correct and safe operation of the product as stated in these instructions. This product must be serviced by qualified personnel who are familiar with the design and operation of this product and the system with the essential safety aspects involved. The scope of responsibilities and supervision of the personnel must be exactly defined by the plant operator.

Our guarantee will be valid only if the installation, operation, maintenance and repairs of this pump are carried out in accordance with these instructions. The plant operator is to make sure that the contents of these instructions are fully understood by the operating personnel.

To assure a steady start-up, supervision or service from an authorized manufacturer representative is recommended. During operation, periodic inspections should be made to assure safe operation under the prevailing conditions.

Any modification may be made to the product only after consultation with the manufacturer. Using spare parts and accessories authorized by the manufacturer is a relevant safety aspect. Only genuine spare parts which are in accordance with the original delivery (in the parts list) are to be used. Use of other parts may exempt Sulzer from any liability.

If any assistance regarding the product or its instructions is required, please contact our local representative for a quick supply of the information you need.

The enclosed instructions regarding a possible long-term storage (more than 3 months) must be observed.

All customer instructions regarding this product are also available in an electronic format for viewing and printing (depending on the end user's software & hardware). If electronic format is needed, please contact our local representative for further information.

If the delivery includes customer instructions or other information in an electronic format which can be edited, we are only responsible for the contents of paper versions of these instructions and other information supplied by us.

Keep these instructions at the place of operation for further reference!

2 Document identification

Version 02 > / 20000331 / Replaces 941201 / en / **N10991** / Page 1 (2)

Page number and total number of pages in the document
Indentification number of document
Language code of document
Previous date for document
Date when the document in question was made or updated
Product version number

3 Type designation

C P T 2 3 - 2

Nominal diameter of the discharge (inch) = 2 in
Except the markings:
1C and 1BC showing other hydraulic performance with same basic casing dimensions.

Casing cover (part No. 161) serial number by bearing unit the third casing cover in the bearing unit No. 2

Bearing unit No. = bearing unit No. 2

Dimensioning = in-dimensioned structure

Structure = standard process pump (horizontal)

C = chemical process pump

4 Nameplate information

Every pump has the following plates fastened to the volute casing (102.01) providing necessary identification of the pump and its hydraulic characteristics.

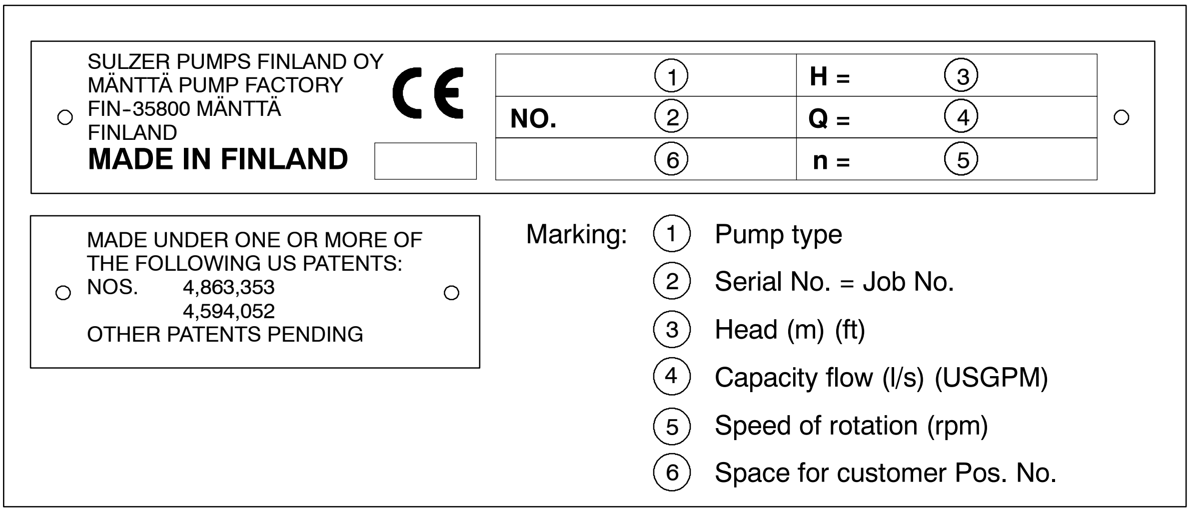


Fig. 1

Every Retrofit exchange unit has the following plates fastened to the adapter (344.01) providing necessary identification.

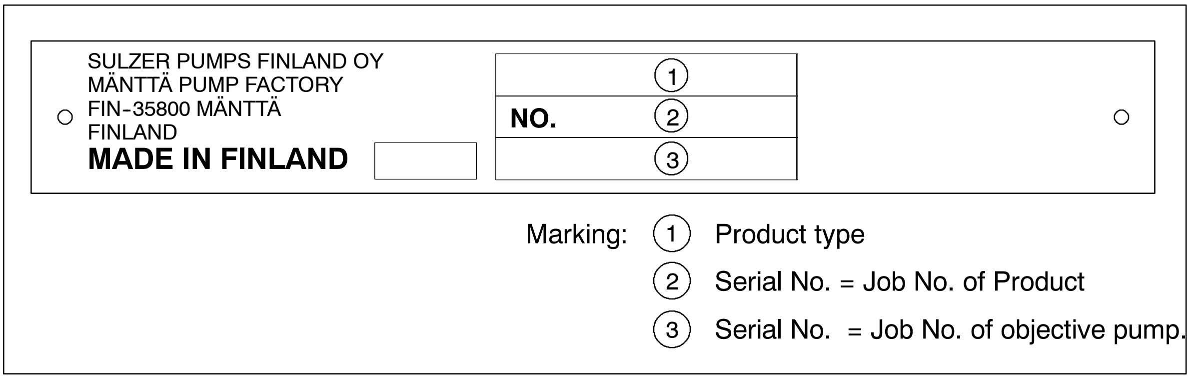


Fig. 2

5 Capacity and head

The pump is always dimensioned according to the pumping values (head, flow) stated in the nameplate (971.01) of the pump. Head and flow values that can be reached with the specific impeller diameter and operating speed are given in the characteristic curve of the pump. The operating point on the curve can be changed by adjusting the pumping system resistance e.g. by throttling the flow with the valve in the pressure piping. If the impeller diameter or the rotational speed of the pump are changed, then the operating point will move totally to another head-flow curve.

The pump must not be used at other operating points without the following verifications:

- When the pump was selected in the original operating point, all factors affecting the mechanical durability (e.g pressure and temperature limits) and pump design (pump, impeller type, shaft sealing and lubrication etc.) were carefully considered. All these factors are to be checked also in the new operating point.
- The pump could temporarily operate even with the pressure valve closed. For continuous operation, a minimum flow is still required. The required suction head (NPSH required) curve presented in the characteristic curve always starts from the point of the minimum continuous flow allowed.
- The suction properties of the system (NPSH available) and drive motor power are always to be checked in a new operating point.
- The efficiency of a pump is a relevant factor when estimating the lifetime costs of the pump. Therefore its influence on the power need must be checked.
- The characteristic curve enclosed is always based on tests with clean water. Other types of pumped liquid can change the head, flow or power need values radically. These factors were recognized when the pump was originally selected and they must be considered also in the new operating point.

SULZER

Safety instructions

Version 02 > / 20051101 / Replaces 20041020 / en / **N15062**

Contest *Page*

1 General

This product is designed and tested for safe and reliable operation in the application for which it is specified and sold. Remember, a pump is a piece of equipment with pressure containing parts and rotating elements which can cause a hazard. Therefore, all the safety measures in the instructions are to be followed strictly. Personal injuries may result if the instructions are not observed and followed.

It is not only the general safety instructions contained under this main heading ”Safety instructions” which are to be observed, but also the specific safety information presented in other instructions relating to this delivery, relevant national safety regulations or any other safety information issued by the plant operator.

The exact and detailed process and application data is relevant for the safe and reliable operation of the product. Special environmental conditions at the place of installation should always be checked between the end user and manufacturer. Such conditions are e.g.

- Abnormal temperature
- High humidity
- Corrosive atmospheres
- Pressure fluctuations
- Falling below the minimum permissible flow, dry running
- Explosive and/or fire risk zones
- Dust, sandstorms
- Earthquakes

Special safety measures are also needed when the type of liquid to be pumped is e.g. the following:

- Flammable
- Corrosive, abrasive
- Poisonous
- Crystallizing
- Solid containing
- Gas containing

Non-compliance with the safety and specific operating instructions may produce a risk to the personnel as well as to the environment, e.g.

- Failure of important functions of the pump and/or plant
- Failure of specific procedures of maintenance and repair
- Exposure of people to electrical, mechanical and chemical hazards
- Endangering the environment owing to hazardous substances being released

2 Definitions

The following words are used in the instructions to indicate issues which require special attention.

WARNING
There is a risk of personal injury if the instruction is not adhered to.

CAUTION
There is a risk of damaging or destroying the product or equipment if the instruction is not adhered to.

NOTE
Is used in the text for highlighting necessary information or requirements which are essential to observe.

3 Essential safety aspects

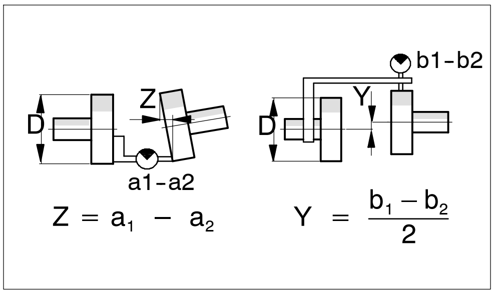
All of the following relevant safety aspects are to be instructed to the operators and maintenance personnel before putting the product into service.

- The product is meant only for the purpose for which it is sold - never operate beyond the intended use described in these instructions.
- Always stop the drive unit before beginning any repair work on the pump. Make sure that the motor cannot be started by any means accidentally during the repairs.
- For delivery, the bearing housing of the pump has been emptied of oil. Remember to refill it before starting.
- Personal injuries may occur if personal protective equipment is not used when servicing the product.
- The product must always be equipped with a shaft sealing system compatible with the pumped liquid.
- Pump units which convey hazardous media must be decontaminated before beginning any maintenance work.
- If there is a possibility that the pump or the pipeline contains explosive gases or vapours, it must be ventilated carefully before working on the pump.
- If there is a possibility that there are explosive gases or vapours in the atmosphere surrounding the pump, the pump's environment be ventilated carefully before working on the pump.
- External heat must not be used when dismantling the pump, as any liquid, gas, vapour or their combination that remains in the pump may explode.
- If there is a possibility of a dangerous return flow after the shutdown of the pump, a nonreturn device shall be assembled in the outlet piping.
- All safety devices (e.g coupling guards) must be correctly installed before starting. For explosive areas, guards with a non-sparking material are to be used.
- The correct rotating direction of the drive unit must be checked before starting and the pump must rotate freely (with coupling spacer removed).
- The coupling must be properly aligned before starting.
- The pump must be sufficiently filled with the pumped liquid before starting.
- The pump must run above the minimum recommended flow and never dry.
- The suction valve must be open during operation.
- If leakage of harmful or dangerous substances can occur - prepare proper means for a safe waste removal.
- There is no protection against contact in the shaft seal area.
- The parts in contact with the pumped liquid can be dangerously hot.

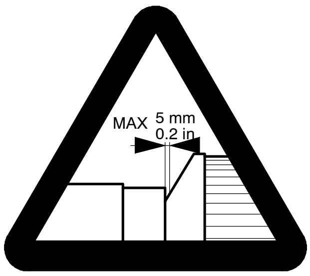
4 Safety signs affixed to the product

The following warnings and informative signs concerning the essential safety aspects are permanently fixed on the product. Safety signs must always be observed and kept clean and legible in any operating condition. The user must always check that the symbols or items presented in those are understood by all user groups before putting the product into service.

4.1 Safety signs on the product

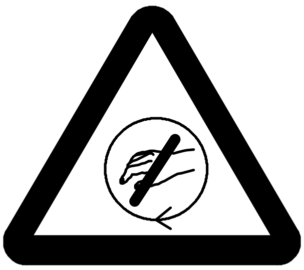


Item no. 976.02 Coupling alignment values.



Item no. 975.04 Coupling guard jacket to be adjusted during assembly.

Item no. 975.03. Dangerous substances.



Item no. 975.02. Rotating shaft, do not touch when in operation.

Item no. 975.01. Hot surface, do not touch (to be fixed when the temperature of the pumped liquid is > 60 °C (140 °F)).

FOR DELIVERY THE BEARING HOUSING OF THE PUMP HAS BEEN EMPTIED OF OIL. REMEMBER TO REFILL IT BEFORE STARTING!

Item no. 976.01. Lubrication oil will have to be added.

020

Item no. 020.01 Sealing liquid inlet (and other signs of connections found in the parts list under heading "Connections").

5 Operating situations affecting product safety

The following inadequate operating situations always have consequences which have an immediate effect on the product safety and therefore they are not allowed in any operating conditions with this product.

Table 1 Typical inadmissible operating situations

Cause:	**Consequence:**
Discharge valve not opened. Inlet pressure or piping system resistance incorrectly estimated when the pump was originally selected. The pump is operated at too high a rotational speed.	Inadmissible pressure increase
Discharge valve not opened. Discharge valve throttled too much. Properties of the pumped liquid incorrectly estimated when the pump was originally selected.	High temperatures (Hydraulic parts)
Gland packing tightened too much . Adequate sealing water service neglected. – Sealing water pump not started – Sealing water valve not opened – Sealing water equipment incorrectly adjusted – Quality of the sealing water does not match our requirements. Inlet pressure incorrectly estimated when the pump was originally selected. Pump is not properly filled with the pumped liquid. – Suction valve not opened – Suction tank not properly filled – Suction piping resistance or air tightness improperly checked.	High temperatures (Shaft sealing)
Pump lubrication carried out inadequately. – Oil/grease filling neglected – Oil/grease quality incorrectly selected – Relubrication carried out inadequately Pump washdown carried out inadequately (sprayed water enters the bearing unit). Properties of the pumped liquid incorrectly estimated when the pump was originally selected.	High temperatures (Bearing unit)

6 Admissible forces and moments on pump flanges

6.1 Allowance nozzle loads

Principles for allowed nozzle loads

Allowable flange loading imposed by the piping is in accordance with HI 9.6.2. In the following the method described in HI 9.6.2 is represented briefly. For additional information and equations to be used in calculations, see the standard.

Loads listed in the following tables 2 – 5 are applicable for pumps constructed of material 41 (ASTM A 890 3A) with either Class 150 or Class 300 flanges, operated between –20 °F and 100 °F (from –29 °C to 38 °C) and mounted on a fully grouted metal baseplate with anchor bolts. For other situations, see adjustment factors below.

Adjustment for temperature and material of construction

For pumps with other than material 41 (ASTM A 890 3A) and/or higher than 100 °F (38 °C) temperature, adjustment factors according to table 6 shall be used. Use adjustment factor to adjust values in table 3. If any of the adjusted values in table 3 becomes lower than the corresponding value in table 2, substitute the lower value into table 2.

Adjustment for ungrouted metal baseplate

Use 100% of the values in the table 3 and 80% of the values in tables 4 and 5. If any of the adjusted values in table 4 and 5 becomes lower than the corresponding value in table 2, substitute the lower value into table 2.

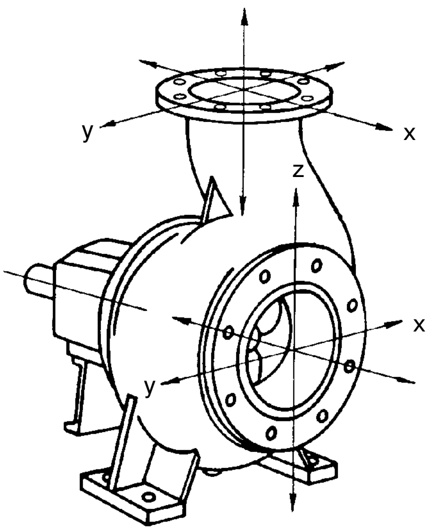


Fig. 3

Table 2 ***Allowable individual nozzle loads. Horizontal end suction pumps in accordance with ASME B73.1.***

Pump size	Size marking	Suction						Dischange					
		Forces (lb)			Moments (ft-lb)			Forces (lb)			Moments (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
11-1	1.5 x 1 x 6	1050	750	750	720	170	170	800	1350	3000	410	410	410
11-1B	3 x 1.5 x 6	1050	1240	1250	900	490	490	800	1350	3000	500	550	510
11-2	3 x 2 x 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
11-3	4 x 3 x 6	1050	1050	1050	900	220	220	800	1350	3000	500	1000	510
12-1	1.5 x 1 x 8	1050	1210	1210	720	190	190	800	1350	3000	360	360	360
12-1B	3 x 1.5 x 8	1050	1240	1250	900	490	490	800	1350	300	440	440	440
21-1B	3 x 1.5 x 8A	2700	1350	1500	1300	370	370	1400	1350	3250	460	460	460
21-2	3 x 2 x 8A	2700	1350	1500	1300	600	600	1400	1350	3250	660	660	660
21-3	4 x 3 x 8A	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
21-4	6 x 4 x 8A	2700	1350	1500	1300	350	350	1400	1350	3250	1200	1460	690
22-1	2 x 1 x 10	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
22-1C	2 x 1 x 10C	2340	960	960	1270	220	220	1400	1350	3250	660	660	660
22-1B	3 x 1.5 x 10	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
22-2	3 x 2 x 10	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
22-4	6 x 4 x 10	2700	1350	1500	1300	1100	1100	1400	1350	3250	1200	1500	690

Pump size	Size marking	Suction						Dischange					
		Forces (lb)			Moments (ft-lb)			Forces (lb)			Moments (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
23-1B	3 x 1.5 x 11	2700	1350	1500	1300	420	420	1400	1350	3250	370	370	370
23-2	3 x 2 x 11	2700	1350	1480	1300	310	310	1400	1350	3250	560	560	560
23-3	4 x 3 x 11	2300	1350	1500	1300	310	310	1400	1350	3250	1200	1480	690
24-1B	3 x 1.5 x 13	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
24-1BC	3 x 1.5 x 13C	2700	1350	1500	1300	670	670	1400	1350	3250	530	530	530
24-2	3 x 2 x 13	1920	1230	1230	1300	350	350	1400	1350	3250	1200	1270	690
24-3	4 x 3 x 13	2700	1350	1500	1300	400	400	1400	1350	3250	1200	1500	690
24-4	6 x 4 x 13	2700	1350	1500	1300	1300	1100	1400	1350	3250	1200	1500	690
31-6	8 x 6 x 13	3500	3180	2000	1500	1170	1170	1500	3000	3500	1250	2840	2840
32-6	8 x 6 x 15	3500	3180	2000	1500	1480	1480	1500	3000	3500	1250	2840	2840
32-8C	10 x 8 x 15C	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840
32-8	10 x 8 x 15	3500	3180	2000	1500	1130	1130	1500	3000	3500	1250	2840	2840

Table 3 ***Allowance combination nozzle loads for nozzle stress, hold-down bolt stress and pump slippage on baseplate. Horizontal end suction pumps in accordance with ASME B73.1.***

Pump size	Size marking	Suction						Dischange					
		Forces (lb)			Moments (ft-lb)			Forces (lb)			Moments (ft-lb)		
		F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
11-1	1.5 x 1 x 6	2020	750	750	1830	170	170	2020	1350	6240	410	410	410
11-1B	3 x 1.5 x 6	2020	1240	2110	2290	490	490	2020	1350	6240	550	550	510
11-2	3 x 2 x 6	2020	1050	1050	2290	220	220	2020	1350	6240	1030	1030	510
11-3	4 x 3 x 6	2020	1050	1050	2290	220	220	2020	1350	6240	1030	1030	510
12-1	1.5 x 1 x 8	2020	1210	1210	1830	190	190	2020	1350	6240	360	360	360
12-1B	3 x 1.5 x 8	2020	1240	1640	2290	490	490	2020	1350	6240	440	440	440
21-1B	3 x 1.5 x 8A	2700	1350	1820	3730	370	370	2020	1350	6240	460	460	460
21-2	3 x 2 x 8A	2700	1350	2490	3730	600	600	1970	1350	6240	660	660	660
21-3	4 x 3 x 8A	2700	1350	1840	3730	350	350	2020	1350	6240	1460	1460	690
21-4	6 x 4 x 8A	2700	1350	1840	3730	350	350	2020	1350	6240	1460	1460	690
22-1	2 x 1 x 10	2340	960	960	3640	220	220	2020	1350	6240	660	660	660
22-1C	2 x 1 x 10C	2340	960	960	3640	220	220	2020	1350	6240	660	660	660
22-1B	3 x 1.5 x 10	2700	1350	1910	3730	420	420	1940	1350	6240	370	370	370
22-2	3 x 2 x 10	2700	1350	1480	3730	310	310	2020	1350	6240	560	560	560
22-4	6 x 4 x 10	2700	1350	6240	3730	1100	1100	2020	1350	6240	3100	3100	690
23-1B	3 x 1.5 x 11	2700	1350	1910	3730	420	420	1940	1350	6240	370	370	370
23-2	3 x 2 x 11	2700	1350	1480	3730	310	310	2020	1350	6240	560	560	560
23-3	4 x 3 x 11	2300	1350	1640	3730	310	310	2020	1350	6240	1460	1460	690
24-1B	3 x 1.5 x 13	2700	1350	3060	3730	670	670	2020	1350	6240	530	530	530
24-1BC	3 x 1.5 x 13C	2700	1350	3060	3730	670	670	2020	1350	6240	530	530	530
24-2	3 x 2 x 13	1920	1230	1230	3730	350	350	2020	1350	6240	1460	1460	690
24-3	4 x 3 x 13	2700	1350	2390	3730	400	400	2020	1350	6240	1730	1730	690
24-4	6 x 4 x 13	2700	1350	6240	3730	4980	1100	2020	1350	6240	2150	2150	690
31-6	8 x 6 x 13	6360	3180	5080	8970	1170	1170	6360	3180	13460	6780	3850	2840
32-6	8 x 6 x 15	6360	3180	6680	8970	1480	1480	6360	3180	13460	6560	3720	2840
32-8C	10 x 8 x 15C	6360	3180	5130	8970	1130	1130	6360	3180	13460	8970	9060	2840
32-8	10 x 8 x 15	6360	3180	5130	8970	1130	1130	6360	3180	13460	8970	9060	2840

Table 4 **Allowance combination nozzle loads for y-axis movement. Horizontal end suction pumps in accordance with ASME B73.1.**

Bearing unit	Suction						Dischange					
	Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
	F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
1		-2000		900	1200	1250		1500		-500	1500	1250
2		-3500		1300	1300	3000		2500		-1200	1500	3000
3		-5000		1500	2000	4000		3000		-1250	5000	4000

Table 5 **Allowance combination nozzle loads for z-axis movement. Horizontal end suction pumps in accordance with ASME B73.1.**

Bearing unit	Suction						Dischange					
	Forces (lb)			**Moments** (ft-lb)			**Forces** (lb)			**Moments** (ft-lb)		
	F_{xs} max	F_{ys} max	F_{zs} max	M_{xs} max	M_{ys} max	M_{zs} max	F_{xd} max	F_{yd} max	F_{zd} max	M_{xd} max	M_{yd} max	M_{zd} max
1	1050		-1250	1500	1200	-2500	800	2000	-3000	-1500	1000	-2500
2	3500		-1500	1500	1300	-3500	1400	2500	-3250	-1500	2150	-3500
3	3500		-2000	1500	4100	-4000	1500	4000	-3500	-1500	5000	-4000

Table 6 **ASME B73.1 metallic pump temperature and material adjustment values to be used on table 3 values. Use for both class 150 and class 300 flanges.**

Temperature °F	Material class (Material code)			
	B1 (41, 4E, 4L, 4T, 4U)	**B2** (4G, 4J)	**B3** (43)	**D1** (5H)
-20 ... 100	1.00	1.00	0.83	0.89
200	1.00	0.86	0.77	0.83
300	1.00	0.78	0.73	0.78
400	0.98	0.72	0.67	0.73
500	0.92	0.67	0.65	0.69

7 Sound level charts

Noise emission values are stated according to ISO 4871 and the essential requirements in the Machinery Directive 89/362/EEC.

The noise values are given in accordance with standard prEN12639.

Sound power levels have been determined according to ISO/DIS 9614 Part II using sound intensity measurements.

It is not possible to measure all different pump applications. Therefore, some values have been determined by calculations based on measurements with similar pumps and Europump's Guide 001/30/E, Forecasting the Airborne Noise Emission of Centrifugal Pumps.

LpA = A-weighted sound pressure level, dB re 20 μPa, at the relevant working station.

LwA = A-weighted sound power level, dB re 1 pW, if A-weighted sound pressure level exceeds 85 dB.

Table 7 ***Sound pressure level LpA / open impellers (dB)***

Pump size	Pump rot. speed (rpm)						
	3600	**3000**	**1800**	**1500**	**1200**	**1000**	**900**
11-1	<70	<70	<70	<70	<70	<70	
11-1B	<70	<70	<70	<70	<70	<70	
11-2, 11-3	72	71	<70	<70	<70	<70	
12-1	<70	<70	<70	<70	<70	<70	
12-1B	<70	<70	<70	<70	<70	<70	
21-2, 21-1B	75	73	<70	<70	<70	<70	
21-3	77	75	<70	<70	<70	<70	
21-4	77	75	<70	<70	<70	<70	
22-1	73	72	<70	<70	<70	<70	
22-1B, 22-1C	74	73	<70	<70	<70	<70	<70
22-2	76	74	<70	<70	<70	<70	<70
22-4	79	76	<70	<70	<70	<70	<70
23-1B	75	74	<70	<70	<70	<70	<70
23-2	80	77	<70	<70	<70	<70	<70
23-3	81	78	<70	<70	<70	<70	<70
24-1B	76	74	<70	<70	<70	<70	<70
24-1BC	79	76	<70	<70	<70	<70	<70
24-2	80	77	<70	<70	<70	<70	<70
24-3			<70	<70	<70	<70	<70
24-4			73	72	<70	<70	<70
31-6			75	73	<70	<70	<70
32-6			74	72	<70	<70	<70
32-8			81	80	74	73	<70
32-8C			79	77	72	71	<70

Table 8 ***Sound pressure level LpA / low flow impellers (dB)***

Pump size	Pump rot. speed (rpm)						
	3600	**3000**	**1800**	**1500**	**1200**	**1000**	**900**
11-1	<70	<70	<70	<70	<70	<70	
12-1	<70	<70	<70	<70	<70	<70	
22-1	73	72	<70	<70	<70	<70	
23-1B	75	74	<70	<70	<70	<70	<70
24-1B	76	74	<70	<70	<70	<70	<70

8 Balance and vibration

The pump is normally balanced in accordance with grade G 6.3 of ISO 1940. Vibration does not exceed the vibration severity limits given in Table 9 when measured at the manufacturer's test facilities. These values are measured radially at the bearing housing at rated speed and flow when operating without cavitation.

A pump equipped with a specially designed impeller may exceed the limits given in Table 9.

Table 9 ***Max. r.m.s values of vibration velocity***

Speed of rotation	Shaft centerline height D			
	≤ 8.86 in	**≤ 225 mm**	**> 8.86 in**	**> 225 mm**
≤ 1800 rpm	0.11 in/s	2.8 mm/s	0.177 in/s	4.5 mm/s
> 1800 rpm	0.177 in/s	4.5 mm/s	0.28 in/s	7.1 mm/s

9 Maximum size of solid particles

The maximum sizes of solid spherical particles which can flow through the pump (casing/impeller) are presented in Table 10.

Table 10 ***Max. size of solid particles***

Pump size	Impeller type			
	Open		**Low flow**	
	⊘ in	⊘ mm	⊘ in	⊘ mm
11-1	0.28	7	0.16	4
11-1B	0.39	10	–	–
11-2	0.43	11	0.16	4
11-3	0.37	9.5		–
12-1	0.31	7.8	–	–
12-1B	0.39	10	–	–
21-1B	0.39	10	–	–
21-2	0.43	11	–	–
21-3	0.59	15	–	–
21-4	0.59	15	–	–
22-1	0.39	10	0.24	6
22-1C	0.47	12	–	–
22-1B	0.47	12	–	–
22-2	0.71	18	–	–
22-4	0.87	22	–	–
23-1B	0.35	9	0.24	6
23-2	0.59	15	–	–
23-3	0.87	22	–	–
24-1B	0.31	8	0.20	5
24-1BC	0.39	10		–
24-2	0.55	14		–
24-3	0.63	16		–
24-4	0.98	25		–
31-6	1.18	30		–
32-6	1.73	44		–
32-8C	1.97	50		–
32-8	1.22	31		–

SULZER

Hoisting and transportation

20010515 / en / **N15063**

Contents *Page*

1 Safety measures

WARNING

Hoisting and transportation instructions are to be strictly followed to avoid dropping of crates or individual assemblies.

The total gross and net weights of the delivery are always found in the packing list affixed to the product or packing.

Special attention is to be paid to the stability of

- pump + baseplate without motor
- exchange unit
- bearing unit
- bare impeller

The center of gravity of these items should always be checked before hoistings and transportation.

Personal protective equipment such as helmet, safety shoes and gloves are to be used.

All lifting accessories and removable components must be capable of withstanding the stresses to which they are subjected during transport, assembly and dismantling.

Lifting ropes used directly for lifting or supporting the pump or pump unit must not include any splicing other than at their ends. Textile ropes and slings must not include any knots, connections or splicing other than at the ends of the sling, except in the case of an endless sling.

Lifting accessories must bear the identification of the manufacturer, material and the maximum working load.

2 Hoisting and transportation

The lifting accessories must always be able to adequately support the hoisted assembly.

If suitable lifting equipment is not available, heavy assemblies must be transferred by using skids etc. on the ground level.

The crates or individual assemblies must never be dropped to the ground during transportation. Refer to Figures 1 – 4 for examples of proper lifting techniques.

The transportation crate is hoisted according to Fig. 1. Permissible lifting points are also marked on the crate.

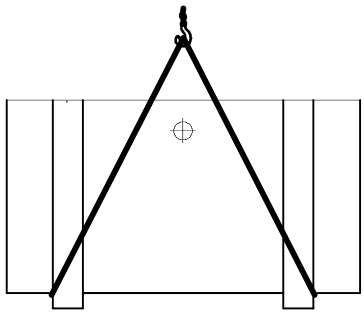


Fig. 1

The pump-motor-baseplate-assembly may be hoisted from under the pump suction flange and motor or under the baseplate. Fig. 2.

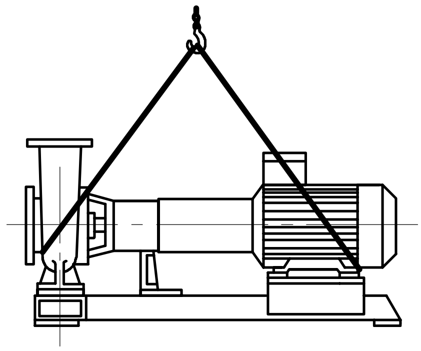


Fig. 2

The pump-baseplate-assembly is hoisted from under the pump suction flange and baseplate. Fig. 3.

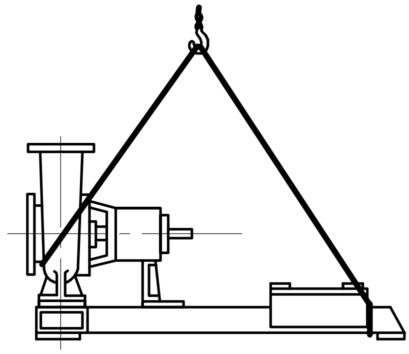


Fig. 3

The bare pump is hoisted from under the pump suction flange and bearing housing. Fig. 4.

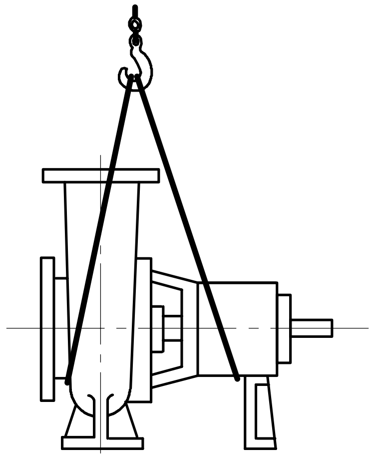


Fig. 4

Commissioning

20010515 / en / **N15064**

Contents *Page*

1 Purchase inspection

Check carefully that the delivery meets your order and is in accordance with the packing list and parts list of the pump. Inform the supplier immediately about any defects or damage observed.

Do not remove the cover plates or plugs protecting the openings before the installation of pipes. Foreign particles inside the pump may damage it at starting.

Examine the crate and wrapping before discarding them since parts and accessories are sometimes wrapped individually or fastened into the crate.

If the pump unit is not installed immediately, it should be stored under conditions that will prevent deterioration due to damage and/or corrosion. The long-term storage requirements should always be specified in the purchase order.

2 Storage

2.1 Short-term (less than 3 months)

When it is necessary to store a pump for a short term before the installation, it must be stored in a dry location where it cannot be affected by dirt or corrosion. Protection plates on the pump openings should not be removed.

The pump bearings and drive elements must be properly protected against any foreign matter.
To prevent rusting or seizing, lubricate the pump unit before storing and turn the pump shaft by hand at least once every two weeks.

2.2 Long-term

NOTE

The grease/oil lubricants must be changed before the pump is taken into use.

WARNING

The rust preventives must be cleaned off carefully before the pump is taken into use. Solvents containing rust preventives can cause irritation to the skin and/or the respiratory system. Prolonged physical contact and breathing of vapor are to be avoided.

If the pump or pump unit is stored for more than 3 months, the following procedures must be observed:

- Store the product in a dry place.
- Drain any liquid from the pump.
- Rotate the pump shaft by hand at least once every month to prevent bearing damage.
- With cast iron pumps equipped with gland packing, remove the gland packings (461) from the stuffing box and apply rust preventives in the stuffing box.
- With oil lubrication, the bearing unit is emptied of oil before the delivery. Fill the bearing unit with oil or coat the interior of the unit with a rust preventing film.
- Apply rust preventing agents to the unprotected parts, such as the shaft end, pump flanges and coupling. If necessary, protect the volute casing and shaft sealing with volatile corrosion inhibitors.
- Observe the storage instructions of any accessory equipment (e.g. electric motors) included in the delivery.
- If the pump unit is covered with a plastic sheet, the bottom should remain open to allow for ventilation.

SULZER

Installation

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1 Safety procedures before installation

NOTE
A pump should have adequate space for proper installation and maintenance actions.

All parts for the installation must be thoroughly cleaned before the installation. All traces of antirust agents should be cleaned off from the pump flanges, shaft assembly and drive elements. Avoid any damage to installed parts when handling them.

Personal protective equipment such as helmet, safety glasses, safety shoes and gloves are to be used.

2 Fastener information

Table 1 shows the rated and maximum moments of torque for fasteners presented in these instructions. These shown values are only valid for fasteners where the moment values are not separately given.

Table 1 Fastener information

Screw size	Moments			
	Rating		**Max. value**	
	(lb ft)	(Nm)	(lb ft)	(Nm)
3/16	2.6	3.5	3.0	4.0
1/4	4.4	6.0	5.0	7.0
5/16	10.3	14	13.0	18
3/8	22.1	30	26.0	35
1/2	36.9	50	44.0	60
5/8	96	130	118.0	160
3/4	184.4	250	221.0	300
1	309.8	420	383.0	520
1 1/8	590.1	800	738.0	1000

3 Installation at the site

N O T E
When welding the foundation screws, connect the earth clamp to the baseplate, never to the pump!

The pump base must be sturdy enough to endure vibration, stress and potential forces caused by the piping.

The pump base is normally reinforced by making a concrete support stand or equivalent. Also note the bottom beams in the foundation or cavities for the different types of foundation screws.

3.1 Installation using welded foundation screws

The bottom beams in the foundation are cast in advance according to the dimensional drawing of the pump. The strength requirements for the bottom beams are given in Table 2. In order to facilitate the alignment of the beams, a so-called concrete frame can be used. The recommended accuracy for the installation of the beams is (± 0.4 in) ±10 mm in all directions. The actual installation becomes much easier, if the upper surfaces are horizontal.

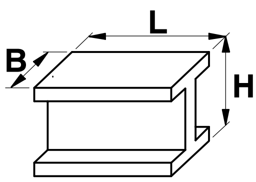
Place foundation screws (918) in the fixing holes of the baseplate. The distance between the foundation and the lower edge of the baseplate must be at least (2 inches) 50 mm. Each foundation screw is fixed to the baseplate by means of hexagonal nuts (2 pcs/foundation screw). Fig.1.

Lower the pre-installed pump-motor-baseplate-assembly onto the floor so that the foundation screws are above the beams, and the pump is in its position in the lateral and longitudinal direction. Now the foundation screws can be welded to the beams.

Adjust the position of the baseplate before grouting by turning the hexagonal nuts of the foundation screws, until the assembly lies horizontally and at the correct height.

Table 2 Welded foundation screw

Foundation screw	The capacity of the bottom beam (min.)				e.g. I-beam H x B x L	
	F_v tension		**F_h shear**		**min. dimensions**	
	(lbf)	(N)	(lbf)	(N)	(in)	(mm)
5/8-11 x 6	1900	8500	1700	7600	4 x 4 x 4	100 x 100 x 100
3/4-10 x 6	3900	17300	3250	14500	4 x 4 x 6	100 x 100 x 150



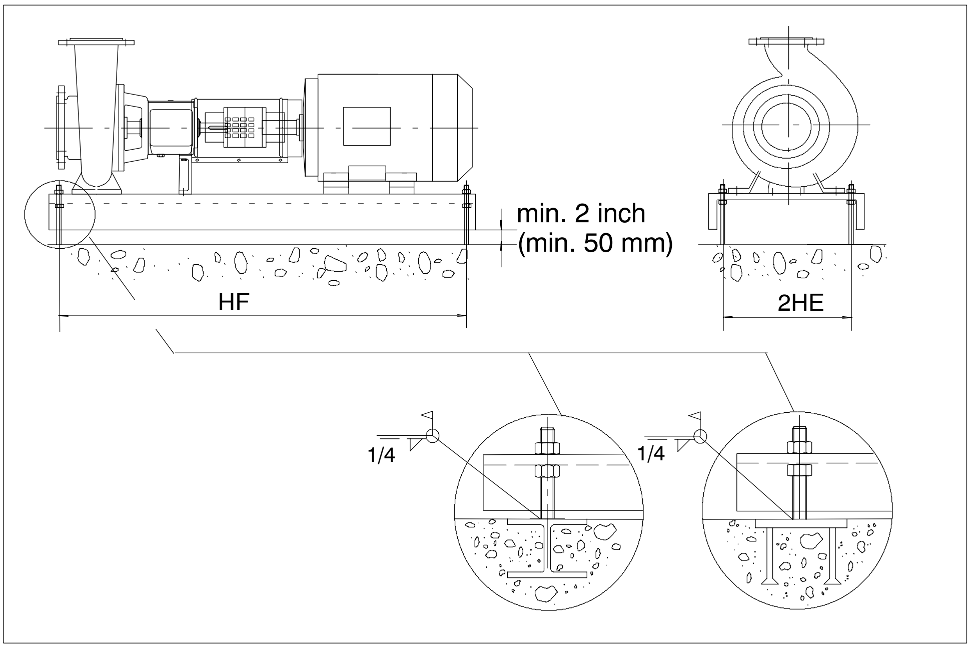


Fig. 1

3.2 Installation using grouted foundation screws

The foundation screw cavities are made in advance (by pouring of concrete, drilling) in the concrete frame according to the dimensional drawing of the pump, Table 3 and Fig. 2. The recommended accuracy for the location of the cavities is (0.4 in) ±10 mm.

Place the foundation screws (918) in the fixing holes of the baseplate, taking into account the distance between the foundation and the lower edge of the baseplate which must be at least (2 in) 50 mm and the minimum dimension U2 according to Table 3. Each foundation screw is fixed to the baseplate by means of hexagonal nuts (2 pcs/foundation screw).

Lift the pre-installed pump and baseplate onto the mounting blocks so that the distance between the foundation and the lower edge of the baseplate is at least (2 in) 50 mm and so that the foundation screws fit into their cavities and the pump is in its position in the lateral and longitudinal directions.

Grout the foundation screws. Use only non-shrinking solder concrete of high quality. Allow the concrete to set for about 1 or 2 days.

Remove the mounting blocks and adjust the position of the baseplate before grouting by turning the hexagonal nuts until the assembly lies horizontally and at the correct height.

Table 3 ***Grouted foundation screws***

	Foundation screw					
Size	**~e**		**U_{min}**		**$U2_{min}$**	
	(in)	(mm)	(in)	(mm)	(in)	(mm)
5/8-11 x 11	4	100	8	200	6.25	160
3/4-10 x 14	5	125	10	250	8	200

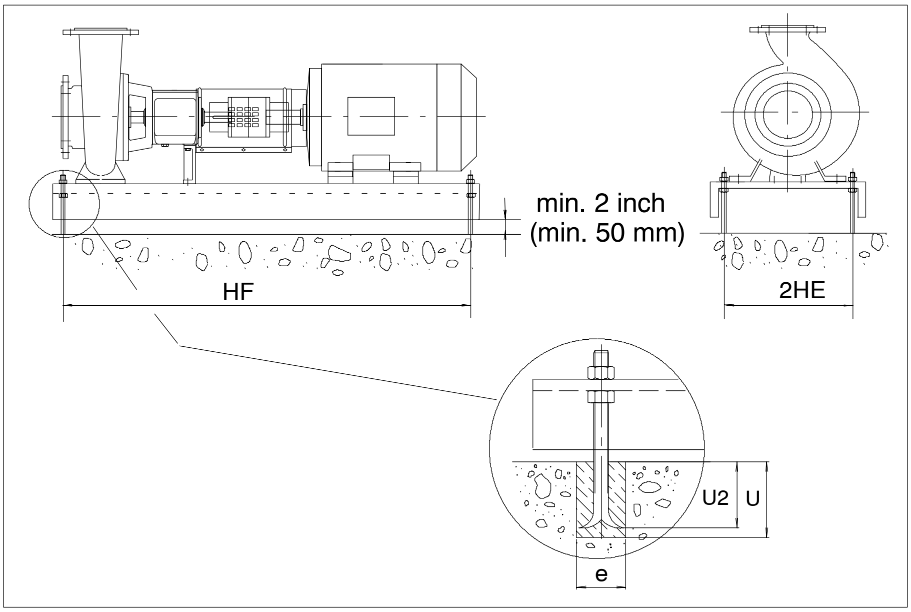


Fig. 2

4 Installation of the motor on the baseplate

WARNING

Personal injuries may occur if personal protective equipment are not used when servicing the product. When pumping hazardous liquids, skin and eye protection are required.

If the motor has not been installed on the baseplate by the pump manufacturer, the installation should be carried out as follows:

The coupling half on the motor side is warmed up to approx. (212 °F) 100 °C and pushed onto the motor shaft in such a way that the space between the ends of the shafts is according to the dimensional drawing (usually the front face of the coupling is even with the end of the shaft).

When installing the coupling, also see instructions supplied by the coupling manufacturer.

The coupling spacer is fastened to the coupling half of the motor without the flexible element.

Check that the pump is aligned as accurately as possible to the middle of the fixing holes of the motor. Lift the motor onto the riser blocks on the baseplate.

The coupling is aligned according to Section ”Installation and alignment of couplings”. The alignment is carried out by moving the motor vertically by means of the riser blocks or shims which are placed under the feet of the motor and laterally by moving the motor and the riser blocks sideways.

When installing the motor, special attention should be paid to the clearance of the coupling spacer, so that the spacer can be removed without detaching the motor.

5 Foundation

The recommended dimensioning for the foundation is given in Fig. 3. The dimensions for baseplate are given in the dimensional drawing, baseplate for pump and motor.

Pour concrete into the mold. The recommended strength grade for the concrete is about (2900 psi) 20 MPa (design strength K 20). The motor stand should be filled with concrete.

The upper surface of the foundation is levelled so that it is slanting in accordance with Fig. 3. Water the grouting during its drying to prevent cracking.

Recheck the alignment of the coupling after the grouting according to section ”Installation and alignment of coupling”.

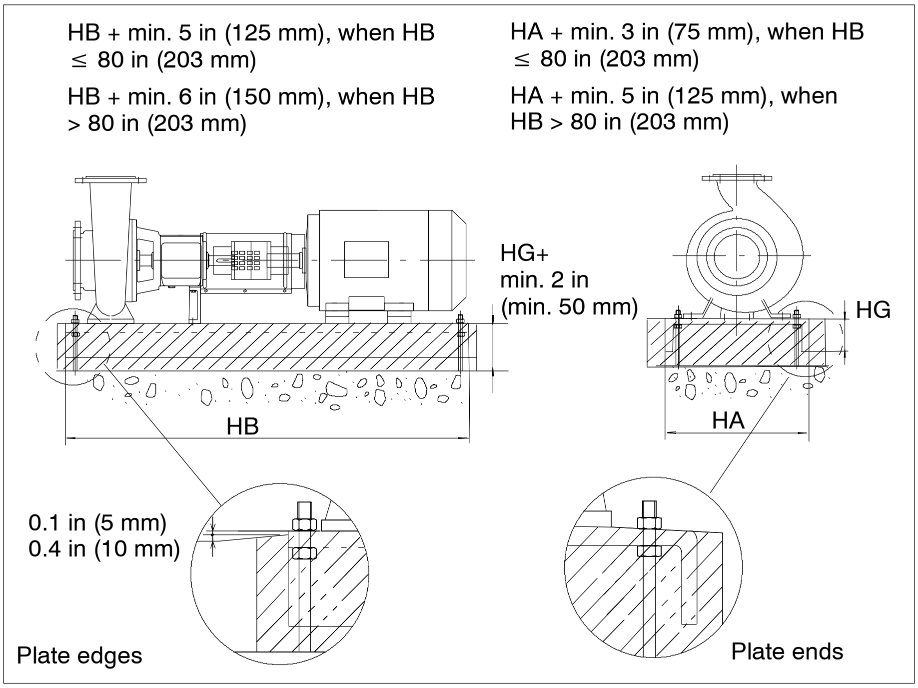


Fig. 3

6 Pipework

6.1 Supporting

The pipes must be installed and supported so that the forces, vibration and weight of the piping are not directed to the pump. When planning the support locations remember the allowance for thermal expansion. Fig. 4.

Fit the pipe flanges accurately to the pump flanges. Flanges which have not been properly aligned must not be forced to position.

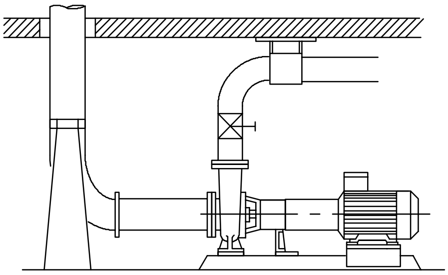


Fig. 4

6.2 Suction pipe below the pump

The suction pipe must be made as short as possible. Avoid points where air pockets or turbulence may be formed.

If the liquid level is below the pump, the suction pipe must gradually rise towards the pump. A sufficient length of the pipe end must be under the liquid level so that air cannot enter the pump. Fig. 5.

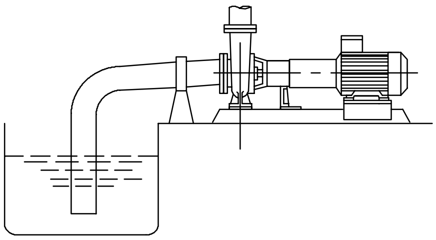


Fig. 5

6.3 Suction pipe above the pump

The suction pipe must descend gradually towards the pump. Fig. 6.

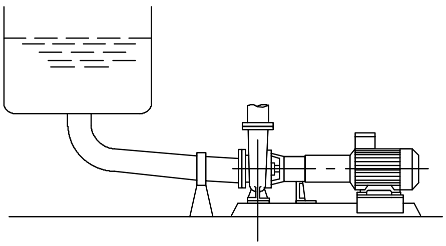


Fig. 6

6.4 Extension piece

The cones must be eccentric and in such a position that the upper level will be horizontal, in Fig. 7. If extension pieces are used, they must be formed so that gathering of gases cannot occur.

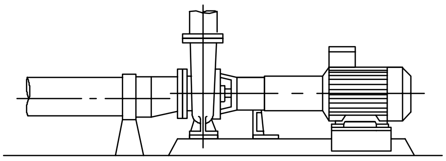


Fig. 7

6.5 Suction pipe design

WARNING

If there is a possibility of a dangerous return flow after the shutdown of the pump, a nonreturn device shall be installed in the outlet piping.

CAUTION

Never use the pump as a support for the piping system.

If the suction pipe has branches, they must be located as far from the pump as possible, and they must be formed advantageously with regard to the flow. The suction pipe must always be made as short as possible. Fig. 8.

A shut-off valve must be placed in the discharge pipe after the potential check valve. Before commissioning, clean the piping and suction pit carefully. Tools or other things left inside the pump will damage the pump already at testing.

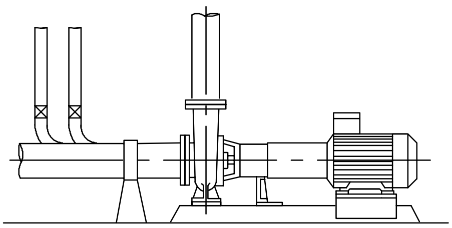


Fig. 8

7 Auxiliary piping

WARNING

During operation – leakage of hazardous substances can occur – prepare proper means for a safe waste removal.

7.1 Sealing liquid pipings

To guarantee faultless shaft seal operation, it may be necessary to lead sealing, flushing or cooling liquid to the seal. Design of the auxiliary piping depends on the construction of the shaft seal and sealing water equipment in question.

For the design and connection details for auxiliary piping, see the sectional drawings of shaft seal and sealing water equipment. Nominal sizes for connections are given in the part list.

The pressure rating of auxiliary piping has to be minimum 87 psi (0,6 MPa) but at least as much as the pressure on the suction side. However, the pressure rating of auxiliary piping for shaft seals using Recirculation from pump discharge or Pressurized external sealing liquid must not be less than that of the casing, see Section ”Product description/Mechanical durability”.

The temperature rating of auxiliary piping has to be minimum the same as temperature limit for the shaft seal, see the seal manufacturer’s instructions.

Install flow regulating valves in the sealing liquid pipes. A rotameter or other flow meter as well as a pressure gauge are also useful in many cases. A non-return valve can be used to prevent the pumped liquid entering the sealing liquid pipes. Often these devices are already included in the delivery of the sealing water equipment; check from the part list and sectional drawing of sealing water equipment.

The piping for Quench seals is installed so that the pipe which leaves the seal (021.01) is continuously falling, the pipe is as short as possible and there are no points throttling the flow, because the throttling bush or the v-ring seal is not meant for pressurized sealing liquid. Fig. 9.

Clean the sealing liquid piping carefully before commissioning.

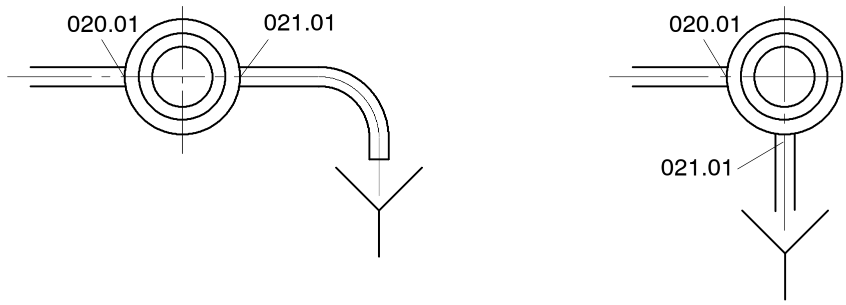


Fig. 9

7.2 Bearing unit pipings

The pipings for pure and purge oil mist lubricated bearing unit have to install according to corresbonding sectional drawing connection numbers 056.01 (oil inlet) and 057.01 (oil outlet).

8 Installation and alignment of coupling

WARNING
Before beginning any installation or alignment procedures, make sure the drive motor cannot be started by any means.

NOTE
Satisfactory performance of the coupling depends on correct installation and alignment.

For procedures and alignment accuracy to be followed when installing and disassembling the coupling, see separate instructions supplied by the coupling manufacturer.

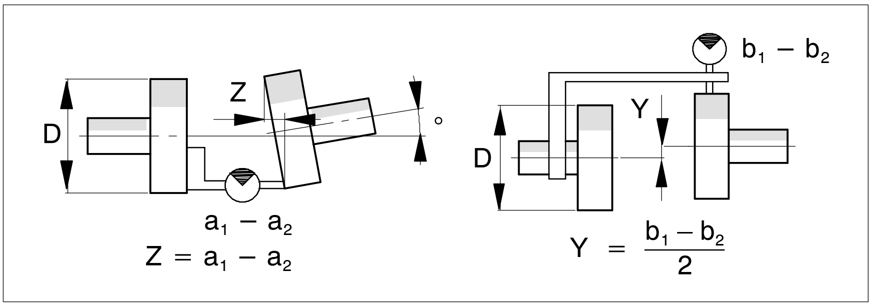
When applicable, the coupling has already been installed and prealigned at the factory. However, the alignment may change due to faulty hoistings, baseplate support, piping support, thermal expansion or the like. Therefore check the shaft alignment of the coupling and re-align during the following stages:

1. After supporting of piping and before starting the pump, tighten the fixing screws of the pump and align the coupling to the required accuracy. Fig. 10.
2. After running the pump with water, look for changes caused by the water run. Correct the changes by altering the supporting of the piping. Tighten the fixing screws of the pump and align the coupling.
3. Carry out hot alignment if the temperature of pumped liquid is higher than (212 °F) 100 °C. The alignment is carried out during production run immediately after the pump is stopped while the pump and the motor are still at the operating temperature. The need for hot alignment depends on the extent of temperature differences and the coupling type chosen.

Aligment is checked by measuring the angular and parallel misaligments in vertical (6 and 12 o’clock) and horizontal (3 and 9 o’clock) directions. During the alignment, the coupling halves have to be locked together so that they do not move against each other. If needed, correct the aligment by adding and removing shims from under the feet of the motor and shifting the motor horizontally, until the shafts are aligned within the given tolerances. Fig. 10.

8.1 Maximum tolerances for coupling alignment

The maximum tolerances for angular and parallel alignments are given in Fig. 10.



D		Z max						Y max			
		≤1800 rpm			>1800 rpm			≤1800 rpm		>1800 rpm	
in	mm	in	mm	°	in	mm	°	in	mm	in	mm
0 - 4	0 - 100	0.003	0.08	0.06	0.002	0.05	0.04	0.004	0.10	0.003	0.07
>4 - 8	>101 - 200	0.004	0.10	0.05	0.003	0.08	0.03	0.006	0.15	0.004	0.10
>8 - 12	>201 - 300	0.006	0.15	0.03	0.004	0.10	0.02	0.008	0.20	0.006	0.15
>12 - 16	>301 - 400	0.008	0.20	0.03	0.004	0.10	0.02	0.010	0.25	0.006	0.15

Fig. 10

SULZER

Operation

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SULZER

1 Safety procedures before start-up

Before starting the pump for the first time and after service repairs, the following precautionary measures are always to be checked carefully to prevent any accidents and to guarantee a trouble-free operation of the pump.

WARNING
Make sure that the motor cannot be started by any means accidentally during the following procedures.

NOTE
Pressure containing pump parts are not pressure vessels within the meaning of the regulations for pressure vessels.

CAUTION
The pump will be damaged if run in the wrong direction.

1.1 Leakage test

The pump parts and the piping shall be able to withstand a leakage test before the start-up. Leakage, particularly in the suction piping, can seriously reduce the performance of the pump and make it impossible to prime the pump before the start-up.

1.2 Direction of rotation

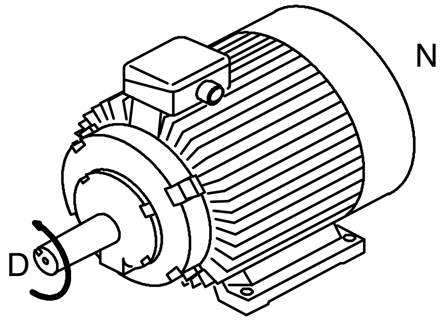

Fig. 1

- Before commissioning, always check the motor for correct rotation.
- It is imperative to detach the coupling spacer before checking the rotation direction of the motor.

The motor rotation must be counter-clockwise when viewed from the coupling end (D-end, Fig. 1) of the motor. (The pump rotation is clockwise when viewed from the coupling end.)

The direction of rotation must correspond to the arrow sign (972.01) on the bearing housing (330.01).

1.3 Free rotation

Rotate the coupling by hand with the coupling spacer detached.

1.4 Coupling alignment

Check that the coupling has been properly aligned according to the instructions in Section ”Installation and alignment of coupling”.

WARNING

Before starting - all safety devices (e.g coupling guards) must always be correctly installed. For explosive areas, guards with non-sparking materials are to be used.

1.5 Lubrication

WARNING

A pump unit operating without proper lubrication will damage the bearings and cause a pump seizure. Use grease lubrication always when the pump is mounted in an inclined position.

Check the oil or grease used for the lubrication of both the pump and motor bearings before start-up. Condensation or ingress of dirt and water may occur if the pump unit is stored for a long time before installation and start-up.

1.6 Shaft seal and sealing water

Depending on the shaft seal fitting, check that the shaft seal's piping arrangement is properly installed and the sealing water system operates with suitable service of the shaft seal.

Table 1 Shaft seal fittings

Fitting				**FR**	**FE**	**Liquid Q**	**BF**	**BN**
PL01								
PL02				X				
PL03					X			
PL04							X	
ME01	MC01	MR01						
ME02	MC02	MR02		X				
ME03	MC03	MR03			X			
ME04	MC04	MR04				X		
ME06	MC06	MR06		X				
	MC20	MR20				X		
	MC21	MR21					X	
	MC22	MR22						X
DS01								
DS02				X				
DS03					X			

FR = Internal circulation

FE = External flushing liquid; (P_T + 7 psi, 0.8 USGPM) P_T + 0.05 MPa, 3 l/min

Q = Unpressurized external sealing liquid; (0.8 USGPM) 3 l/min

BF = Pressurized external flowing sealing liquid; (P_T + 7 psi (minimum), 0.8 USGPM) P_T + 0.05 MPa, 3 l/min

BN = Pressurized external non-flowing sealing liquid; (P_T + 21 psi (minimum)) P_T + 0.15 MPa

Pressure behind the impeller can be calculated according the following formulas.

Impellers with balancing holes

$p_T = p_0 - 0.725$ psi

Where p_T = pressure behind the impeller (psi)

p_0 = inlet pressure (psi)

Atmospheric pressure used as reference pressure = 0 psi

Impellers without balancing holes

$$p_T = p_0 + 151.48 \times 10^{-6} \varrho g H - 240.26 \times 10^{-9} \varrho n^2 \left[\left(d_2/2\right)^2 - \left(d_b/2\right)^2 \right]$$

$$- k \times 216.4 \times 10^{-9} \varrho n^2 \left[\left(d_b/2\right)^2 - \left(d_5/2\right)^2 \right] \text{psi}$$

Where p_T = pressure behind the impeller (psi)

p_0 = inlet pressure (psi)

ϱ = density of the liquid being pumped (lb/ft^3)

g = 32.174 (ft/s^2)

H = pump head at the operating point in question (ft)

n = rotating speed of the pump (rpm)

d_2 = impeller back plate diameter (ft)

d_b = impeller back vane diameter (ft)

d_5 = impeller hub diameter is in bearing unit no. 1 0.12 ft, in bearing unit no. 2 0.18 ft, and in bearing unit no. 3 0.2 ft

k= figure 1

Atmospheric pressure used as reference pressure = 0 psi

s = height of back vane + clearance
t = height of back vane

Fig. 1

The flushing liquid and sealing liquid must fulfill the following quality requirements:

- maximum particle size (0.002 in) 50 µm
- maximum solid material content (0.00027 lb/in^3) 2 mg/l

2 Starting the pump

WARNING

The product is meant only for the purpose for which it is sold - never operate beyond the intended use described in these instructions.

WARNING

Before starting - Make sure that the pump is sufficiently filled with the pumped liquid.

WARNING

Rotating shaft has no safety guard. Do not touch shaft by hand, tool or anything else.

CAUTION

Observe immediately after start-up the instrumentation showing the discharge pressure. If the pressure is not quickly reached, stop the motor and check causes for the low pressure.

CAUTION

If it is necessary to adjust the amount of pumped liquid, do it by adjusting the discharge valve. Never use the suction valve for flow adjustment.

- Open the valves for sealing water if any, and adjust suitable pressure and flow.
- Check that there is abundant leakage at the gland packing. If there is no continuous leakage, slacken the stuffing box gland. If this does not help, remove the packings and re-pack the stuffing box less tight.
- Fill the pump so that at least the suction pipe and pump casing are filled with liquid. The pump must not run dry even momentarily.
- Check that the suction valve is fully open and discharge valve closed.
- Start the motor.
- Open the discharge valve gradually until the desired amount of liquid is reached.
- Check that the gland packing leakage is still abundant. If not, slacken the stuffing box gland immediately. If this does not help and the gland packing becomes hot, stop the pump and find out the reason for the disturbance. When the gland packing has been operating trouble-free for 10 minutes it may be tightened. Tighten it by turning the hexagonal nuts approx. 1/6 turns at a time at 5 - 10 minutes' intervals until the leakage is at least 30 - 80 drops a minute. While tightening, make sure that the stuffing box gland remains perpendicular to the shaft.

SULZER

3 Controls during the first run

WARNING

Personal injuries may occur if personal protective equipment is not used when servicing the product. When pumping hazardous liquids, skin and eye protection are required.

WARNING

Rotating shaft has no safety guard. Do not touch shaft by hand, tool or anything else.

CAUTION

Do not operate the pump below the minimum recommended flow or with the discharge valve closed. Cavitation or recirculation can lead to a quick pump failure.

By controlling the pump operation and output regularly, the possible need for service and repair can be anticipated. In this way, the pump efficiency is kept high, the process is trouble-free and the maintenance costs are low.

Control the temperature of the gland packing and maintain the leakage at 30 - 80 drops/minute by adjusting the stuffing box gland.

The flow and pressure of sealing water must be kept at the enclosed values given by the seal manufacturer.

Check the temperature and vibration of bearings through regular measurings. If one or the other increases, it may be a sign of incorrect lubrication or bearing damage. The measuring studs (SPM, M8 x 24) are in the bearing housing for controlling the bearings.

Also, any noises from the pump and its vibration have to be controlled and the reasons for unusual noises or vibration detected.

The condition of the coupling can be monitored with a stroboscope through the perforation in the coupling guard.

4 Shut-down procedure

- Close the discharge valve to prevent the pumped liquid from flowing back.
- Stop the motor.
- Close the suction valve if there is reason to doubt that the pumped liquid will flow out of the suction piping.
- Close the cooling and flushing liquid valves, if any.
- If the pump has a sealing liquid valve, it cannot be closed until the pump has been drained or until at least the pressure has been relieved from the pump.

During longer shut-downs, the pump must be checked every now and then. Turn the shaft manually a few times. If the pumped liquid congeals easily or the pump is exposed to freezing, drain the pump and suction piping for the shut-down period.

5 Controls after the first run

N O T E
Correct final alignment is essential for the proper functioning of the pump unit.

When the pump unit has run for a sufficient length of time to bring the pump and motor up to the normal operating temperature, check the coupling alignment according to Section ”Installation and alignment of coupling”.

With hot liquid pumps, check the tightness of the casing cover fixing screws. Adjust torque in accordance with the reference values.

With pumps equipped with gland packing, check proper leakage from the stuffing box.

With pumps equipped with mechanical seals, ensure that the flushing or cooling supplies are functioning adequately.

Make sure that the sealing water system is working properly.

Check that there is no overheating in the pump or motor bearings.

6 Trouble-shooting - operation

During the start-up period, problems are mostly caused by pump selection mistakes, poor process design, operational mistakes or foreign objects in the process.

During the long-term operation of a pump unit, problems are mostly caused by random failures, process changes or corrosion and wear.

Problems can normally be traced to either poor maintenance or exceeding the limitations for the intended use of the pump.

The following problem tracing analysis includes the most common malfunctions and their possible causes. If the pump does not function properly, it is important to trace the actual reasons, so that the repairs and required modifications can be done without delay. Tables 2 – 8.

Table 2 Symptom: Pump not delivering liquid

Probable cause:	Remedy:
Wrong direction of rotation	Change the direction of rotation acc. to the arrow sign on the bearing unit
Pump not adequately primed or a vapor lock in the suction pipe	Reprime the pump and suction piping
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping. Readjust the shaft seal
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Suction tank level low	Check the required inlet/suction head

Table 3 Symptom: Insufficient head

Probable cause:	Remedy:
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Wrong direction of rotation	Change the direction of rotation acc.to the arrow sign on the bearing unit
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Suction tank level low	Check the required inlet/suction head

Table 4 Symptom: Insufficient (or irregular) flow

Probable cause:	Remedy:
Vapor lock in the suction pipel	Reprime the pump and suction piping
Suction head too high	Check that the suction valve is fully open and that the suction line is unobstructed
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping and readjust the shaft seal
Unexpected air/gas content in the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions

Probable cause:	Remedy:
Suction piping, suction valve or impeller partially clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary

Table 5 Symptom: High power consumption

Probable cause:	Remedy:
Rotational speed too high	Check the speed requirements/limitations
Wrong direction of rotation	Change the direction of rotation acc.to the arrow sign on the bearing unit
Flow resistance of the piping much higher/lower than the head generated by the pump	Check the piping arrangements
Unexpected specific gravity of the pumped liquid	Consult manufacturer for further instructions
Unexpected viscosity of the pumped liquid	Consult manufacturer for further instructions
Pump and motor incorrectly aligned	Realign the pump and motor assembly, make sure there is no strain on the pump.
Crooked or eccentric shaft	Reassemble the pump and renew the shaft and bearings, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Mechanical tightness of pump components	Reassemble the pump and check the clearances

Table 6 Symptom: Excessive noise and/or vibration

Probable cause:	Remedy:
Difference between inlet pressure and vapor pressure too small (cavitation)	Check the suction piping arrangements
Unexpected air/gas content in the pumped liqud	Consult manufacturer for further instructions
Air leakage in suction opening, suction piping or shaft seal	Check the suction piping/readjust the shaft seal
Suction piping, suction valve or impeller clogged	Check the suction piping and the pump for any obstructions
Rotational speed too low	Check the speed requirements/limitations
Flow resistance of the piping higher than the head generated by the pump	Check resistancies and reduce losses
Pump functioning below the recommended minimum flow (cavitation)	Check the pumping system requirements
Pump foundation not rigid enough	Strengthen the foundation
Inadequate piping support exerting strain on the pump	Check the piping support requirements
Pump and motor incorrectly aligned	Realign the assembly, make sure there is no strain on the pump.
Crooked or eccentric shaft	Reassemble the pump and renew the shaft and bearings, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances

Probable cause:	Remedy:
Pressure containing pump parts worn/damaged/clogged	Check the pump and replace defective parts, if necessary
Mechanical tightness of pump components	Reassemble the pump and check the clearances
Bearings worn or loose	Reassemble the pump and replace the bearings, if necessary
Inadequate or excessive lubrication	Check the pump for proper lubrication
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary

Table 7 Symptom: Bearings wear rapidly

Probable cause:	Remedy:
Pump and motor incorrectly aligned	Realign the pump assembly, make sure there is no strain on the pump. Replace the bearings, if necessary.
Crooked or eccentric shaft	Reassemble the pump and straighten or replace the shaft
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary
Inadequate or excessive lubrication	Check the pump for proper lubrication
Badly installed and/or dirty bearings	Renew bearings, if necessary. Check the quality and amount of lubricant

Table 8 Symptom: Pump overheats/seizes

Probable cause:	Remedy:
Pump not adequately primed	Reprime the pump and suction piping
Difference between inlet pressure and vapor pressure too small	Check the suction piping arrangements. The pump may operate below the recommended minimum flow (cavitation)
Pump functioning below the recommended minimum flow (cavitation)	Check the pumping system requirements
Pump and motor incorrectly aligned	Realign the assembly, make sure there is no strain on the pump
Bearings worn	Reassemble the pump and replace the bearings, if necessary
Crooked or eccentric shaft	Reassemble the pump, straighten or renew the shaft
Impeller damaged or out of balance	Reassemble the pump and replace the impeller, if necessary
Rotating objects or pump parts chafing inside the pump	Reassemble the pump and check the clearances
Discharge valve closed	Open the discharge valve
Discharge valve clogged	Check the pipe and flush it if necessary

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Preventive maintenance

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1 General

NOTE
Preventive maintenance is also a relevant safety factor.

NOTE
If the pump performance does not fulfill the process requirements, the pump is to be disassembled and inspected. All worn parts should be changed to new genuine spare parts.

Regular and systematic preventive and predictive maintenance can extend the product lifetime and requires fewer repairs and spare parts. Monitoring of instrumentation and physical examinations are a vital part of today's quality maintenance. We recommend that the maintenance system includes a historical record kept for each pump, its condition and performance. This will help to prevent sudden failures and aid in case of possible fault tracing analyses. In the process industries, one process downtime caused by a pump normally costs much more than the price of the pump.

Preventive maintenance consists of the following actions:

- Bearing lubrication
- Temperature, noise, vibration monitoring and inspections
- Monitoring the discharge pressure, capacity and power demand
- Inspections regarding corrosion and wear
- Shaft seal monitoring
- Regular pump washdowns
- Monitoring the pump and pipings for leakage
- Quarterly checks of the tightness of critical fasteners, such as foundation screws and pump & motor fasteners onto the baseplate

General measuring instruments for pump operation are presented in Table 1.

Table 1 Measuring instruments

Fixed instruments:	Portable instruments:
Pressure gauges & indicators	Vibration analysers
Flow meters	Tachometers
Ammeters/wattmeters/ voltmeters	Thermometers
Speed indicators	Noise level indicators
Temperature detectors	Ultrasonic indicators (wall thickness)
Vibroswitches	
Any fixed or portable instruments may in themselves create a possible failure and require regular monitoring to ensure their correct functioning.	

2 Grease lubrication

All the grease-lubricated bearings have been lubricated before the shipment. The pump has one cylinder roller bearing unit and two single row angular contact ball bearings (O-system, Table 2).

Table 2 Pump bearings

Bearing unit	Impeller side	Coupling side
1	NUP 207 ECJ	3306AJ (5306AJ)
2	NUP 311 ECJ	2×7309 BECBM
3	NUP 317 ECJ	2×7315 BECBM
SKF designation. If other manufacturers are used, the corresponding bearing types are required.		

Amounts of lubricants and re-lubrication intervals are described in Table 3 and in Table 4 depending on the speed of rotation.

Table 3 Initial and re-lubrication (50 Hz speeds of rotation)

Bearing unit	Initial lubrication				Re-lubrication				Re-lubrication interval 1) (hours, bearing housing temperature ≤ +130 °F / +55 °C)			
	Impeller side		Coupling side		Impeller side		Coupling side		740 rpm	980 rpm	1480 rpm	2950 rpm
	(oz)	(g)	(oz)	(g)	(oz)	(g)	(oz)	(g)				
1	0.7	20	1.5	43	0.22	6	0.40	11	15000	13000	10000	5000
2	3.0	85	3.0	85	0.60	17	0.90	26	13000	11000	8500	3000
3	5.0	142	7.5	213	1.3	37	2.1	60	12000	9500	6500	–

1) Every 59 °F (15 °C) rise in the surface temperature shortens the lubrication interval to a half.

Table 4 Initial and re-lubrication (60 Hz speeds of rotation)

Bearing unit	Initial lubrication				Re-lubrication				Re-lubrication interval [1] (hours, bearing housing temperature ≤ +130 °F / +55 °C)			
	Impeller side		**Coupling side**		**Impeller side**		**Coupling side**		**890 rpm**	**1180 rpm**	**1780 rpm**	**3540 rpm**
	(oz)	(g)	(oz)	(g)	(oz)	(g)	(oz)	(g)				
1	0.7	20	1.5	43	0.22	6	0.40	11	14000	11000	9000	4000
2	3.0	85	3.0	85	0.60	17	0.90	26	12000	9500	7000	2000
3	5.0	142	7.5	213	1.3	37	2.1	60	10000	8000	4500	–

[1] Every 59 °F (15 °C) rise in the surface temperature shortens the lubrication interval to a half.

2.1 *Grease grades*

CAUTION

Never mix different grease grades (consistency, thickeners). The mixed grease becomes softer and does not lubricate the bearings properly.

NOTE

All greasing equipment and fittings used must be clean to prevent any impurities from entering the bearing housing.

NOTE

The surface temperature of the bearing unit can temporarily rise after regreasing due to an excess amount of grease.

For normal conditions when the bearing housing surface temperature is below (+175 °F) +80 °C, we recommend lithium or lithium-calcium-based mineral greases for roller bearings, such as:

- Esso Beacon 2
- Shell Alvania EP2
- SKF LGMT2
- Klüber Centoplex EP2

The first re-lubrication should be done before the initial commissioning of the pump.

If the bearings run hotter and the surface temperatures are above (+175 °F) +80 °C, we recommend the use of the following special greases:

- Esso Unirex N3
- SKF LGHT3
- Shell Limona LX1
- Klüber Staburax NBU 8 EP

These special greases can also be used with surface temperatures below (+175 °F +80 °C).

Always consult the pump manufacturer about the use of any special greases (not mentioned in these instructions).

3 Oil lubrication

CAUTION
For delivery, the bearing housing of the pump has been emptied of oil. Remember to refill it or / and connect oil mist lubrication before starting.

For lubrication, use only high-quality mineral oils, the viscosity of which is ISO VG 46.

- Esso Teresso 46
- Shell Tellus Oil S46
- Mobil DTE Oil Medium
- Neste Paine 46
- Klüber Crucolan 46
- Tebo Larita Oil 46

Viscosity of oil at the operating temperature must not be below 12 cSt (65 SSU). The operating temperature is ca (27 °F) 15 °C higher than the surface temperature of the bearing housing.

3.1 Oil bath lubrication

First oil filling

Without using the constant level oiler

Unscrew the venting device (672.01) and add oil up to the middle of the sight glass (642.01), Fig. 1. When pump is running oil level in the larger sight glass can be little variable. With lower speed oil level can go little bit lower and higher speed go little up (air is mixing into oil). Screw the venting device (672.01) back in place. See the oil volumes in Table 6.

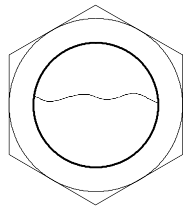


Fig. 1

With using the constant level oiler

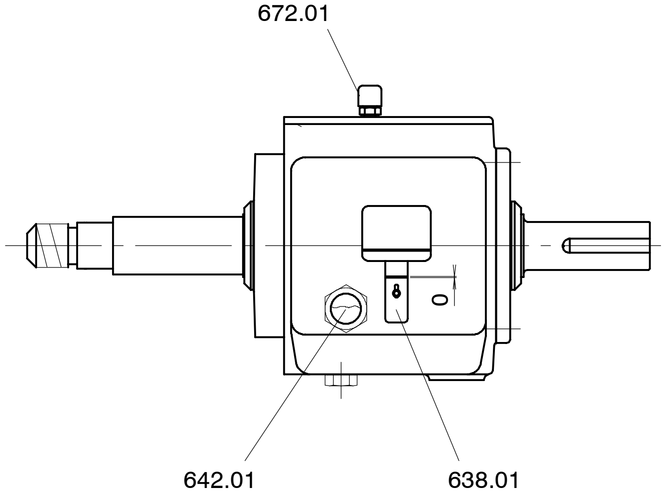


Fig. 2

1. Install the constant level oiler (638.01) in the bearing unit.
2. Adjust the constant level oiler (638.01) to the correct height (0 mm) and tighten the locking screw.
3. Unscrew the venting device (672.01), add oil up to the middle of the sight glass (642.01) and screw the venting device (672.01) back in place.
4. Undo the glass cup of the constant level oiler (638.01) and fill it with oil, and place the glass cup of the constant level oiler (638.01) back in place.

Oil change

After commissioning, oil should be changed for the first time after about 100 hours of operation and thereafter according to Table 5 and more often if the operating conditions cause contamination or change in other properties of the oil used.

Table 5 ***Oil changes***

Bearing housing surface temperature	Oil change interval
65 °C (150 °F)	1 year
75 °C (170 °F)	6 months

Table 6 Oil volumes

Bearing unit	Oil volume	
	(pint)	(l)
1	0.75	0.35
2	2.4	1.1
3	4.7	2.2

3.2 Pure oil mist and purge oil mist lubrication

The oil mist system must be sized to provide, as a minimum, a rate of mist containing 0.018 in^3 (0.01 fl oz or 0.3 ml) of oil per hour per bearing-inch (B.I.). Oil mist system pressure depends on the particular application (number of equipment in the system, type of application fittings used, etc.). Follow the oil mist system manufacturer's instructions for the installation, operation and maintenance of the oil mist system.

B.I. values for each bearing unit are listed in the following table. For pure mist system the values can be used as such. For purge mist system, multiply values by 0.25.

In purge oil mist system, follow also the instructions as given in section "Oil bath lubrication".

Table 7 Bearing-Inch values for CPT bearing units.

Bearing unit	Bearing	Bearing-Inch (B.I.)
1	Radial	1.4
	Thrust	2.4
	Total	3.8
2	Radial	2.2
	Thrust	3.6
	Total	5.8
3	Radial	3.4
	Thrust	6.0
	Total	9.4

4 Temperatures

During operation, the following surface temperatures are to be observed regularly:

- volute casing (102.01)
- bearing housing (330.01)
- shaft seal, measured on the casing cover (161.01)
- motor (800.01)

The reasons for any deviations in temperatures are to be checked immediately to prevent further and more serious damage.

5 Noise and vibration analysis

A regular follow-up of the pump noise and vibration gives a good view regarding the condition and wear of bearings and also other wearing parts of the pump. This enables timely predictive maintenance routines and reduces the potential for unexpected shut-downs. Admissible vibration severity values are presented in Section ”Safety instructions/Balance and vibration”.

6 Discharge pressure

A regular control of the pressure generated by the pump, the rated flow and the power need of the drive unit gives a good view regarding the condition and wear of the hydraulic parts of the pump. The follow-up enables such preventive maintenance actions as clearance adjustments or parts renewals to be scheduled accordingly.

7 Corrosion and wear

When the pumps are operating under corrosive and/or abrasive conditions, a regular follow-up of wall thicknesses in the casing and casing cover is necessary. When the wall thickness has worn more than the permitted corrosion allowance of (0.12 in) 3 mm, the mechanical durability (pressure limits) stated in these instructions is no longer guaranteed.

8 Shaft seal monitoring

CAUTION
The dry running of mechanical seals will damage the sliding surfaces and cause leakage of pumped liquid.

8.1 Gland packing

Gland-packed pumps must be checked regularly to ensure that there is a slight leakage from the gland. An excessively tight gland causes wear to the shaft sleeve and increased power demand. Refer to the instructions in Section ”Operation/Controls during the first run”.

8.2 Mechanical seal

Mechanical seals are normally installed and adjusted at the factory before the delivery. The general principle is that the mechanical seal does not have visible leakage. The lifetime of a mechanical seal depends on the cleanliness and lubricating properties of the pumped liquid and the sealing liquid. If the mechanical seal leaks, stop the pump and replace the mechanical seal.

8.3 Dynamic seal

The expeller (604.01) design of the dynamic seal prevents the leakage of pumped liquid through the stuffing box during operation. During shut-down, the leakage is prevented by the static seal design (435.01).

9 Pump washdown

The pump is designed to prevent external liquids from entering the bearing unit. However, direct spraying of high-pressure water to the labyrinth rings (423.01) must be avoided.

10 Maintenance of shaft seals

WARNING

Always stop the motor before any of the following maintenance actions to the pump. Make sure that the motor cannot be started by any means accidentally during the repairs.

WARNING

Always drain the pump before dissassembling the shaft seal.When pumping hazardous liquids, make sure that there is no trapped liquid remaining in pump parts.

WARNING

Never use gland packing material containing asbestos. It may cause a health hazard.

10.1 Gland packing

- Remove the used gland packing from the stuffing box housing by using a flexible extraction tool (Fig. 3). Clean the stuffing box housing and open any clogged sealing liquid holes.

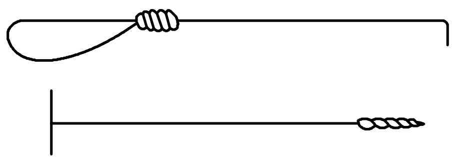


Fig. 3

- If there are scratches or wearing marks on the shaft wearing sleeve (part 524.01 in Table 8) or in the stuffing box housing, replace the damaged parts.
- We recommend the use of precompressed gland packings. However, if you need to cut the packings from a sealing band, proceed as follows: turn four rounds of the sealing band around a wooden pattern having the same thickness as the shaft wearing sleeve (part 524.01 in Table 7) and use a sharp knife to cut the packing rings straight and axially without overdimensioning or underdimensioning, Fig. 4. The dimensions of the stuffing box housing and the total length of the band to be cut without working allowances are given in Table 8.

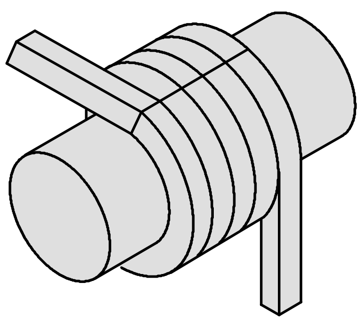
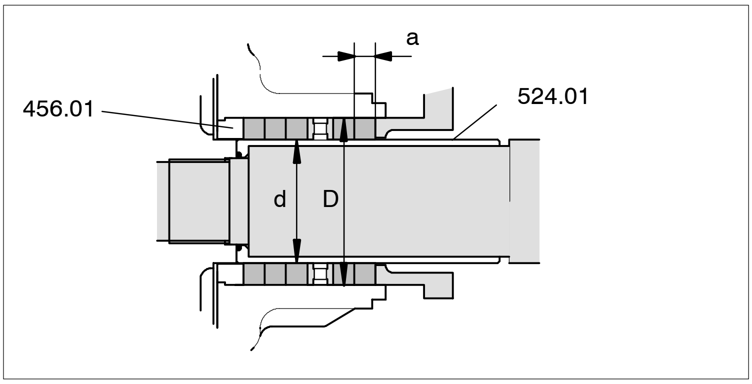


Fig. 4

- When packing new packing rings, be very precise, and keep the parts clean.
- Lubricate the shaft sleeve and packing rings lightly with oil.
- Push the first packing ring tightly against the neck bush (456.01). The ends of the rings must be exactly against each other.
- The second ring is placed against the first one so that the joints are at 180° angle to each other, Fig. 5.

- The third packing ring is placed against the second one so that the joints are at 180° angle to each other. Fig. 5.
- Next put the lantern ring or plate into the seal chamber.
- Fit also the last two rings with the joints at 180° angle to each other.
- After all the packing rings and the lantern ring have been fitted, tighten the nuts of the stuffing box gland by hand.
- The shaft seal is taken into use according to Section ”Operation/Controls during the first run”.

Table 8 Dimensioning of stuffing box



Bearing unit	Stuffing box ∅d x ∅D x a		Total lenght of the packing ring	
	(in)	(mm)	(in)	(mm)
1	1.375 x 2 x 0.31	35 x 51 x 8	2.8	71
2	2.25 x 3 x 0.38	57 x 76 x 10	4.3	109
3	2.5 x 3.38 x 0.44	64 x 86 x 11	4.8	122

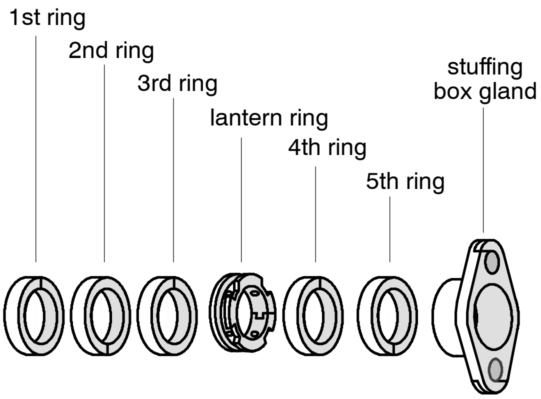


Fig. 5

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10.2 Mechanical seal

Mechanical seals do not normally require any preventive maintenance actions during their operation. If any problems occur, the whole seal package is normally renewed.

10.3 Dynamic seal

Dynamic seals do not normally require any preventive maintenance actions. During the first years of operation, the static seal (435.01) can yet wear so much that some leakage can occur during stoppages. The static seal is again functional when sliding the thrust ring (475.01) towards the volute casing so long that the leakage stops. The thrust ring must always be secured with the grub screws (904.01) during operation. This adjustment can be done several times during the lifetime of the static seal. The wear allowance of the static seal is about half of its thickness. If the seal has worn more or otherwise damaged, it always has to be replaced with a new one according to Section ”Corrective maintenance”.

11 Clearance of open impeller

Exchange unit is preadjusted near to operating clearance. Preadjusting values can be readed from table 8. Fig. 6.

Table 9

Bearing unit	**Distance A**	
	(in)	(mm)
CPT 1	5.142	130.6
CPT 2	6.126 *) 6.750	155.6 *) 171.5
CPT 3	9.094	231.0

*) Retrofit type Durco MkII / III

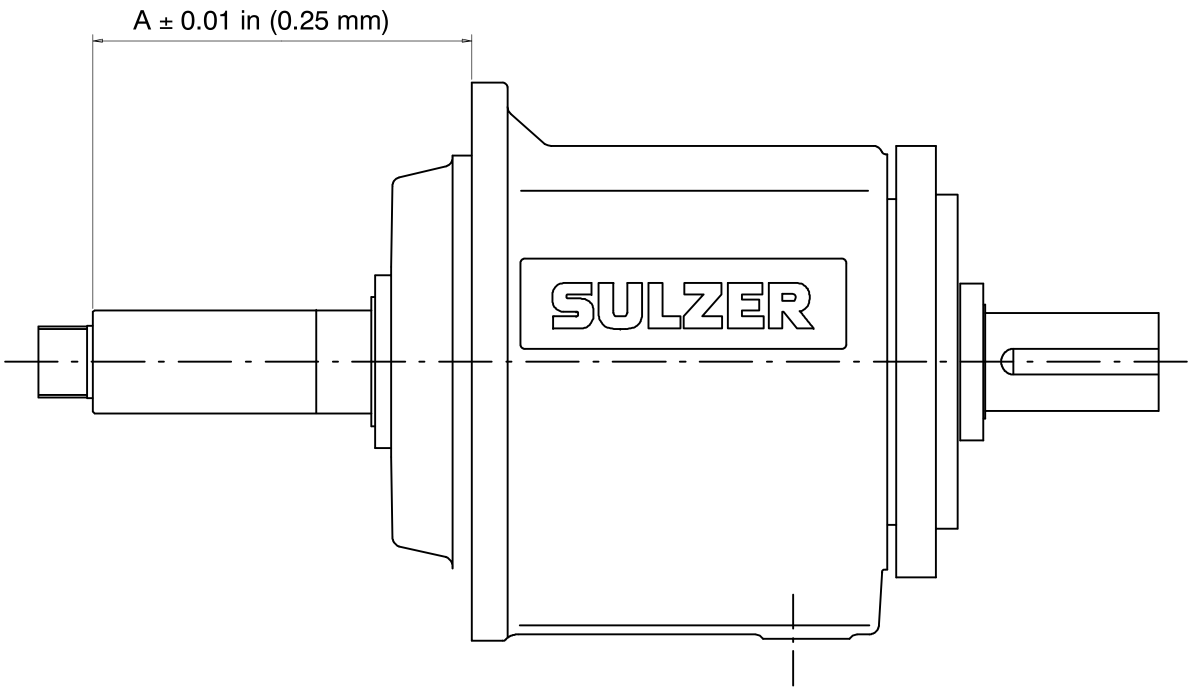

Fig. 6

WARNING

Always stop the motor before any of the following maintenance actions to the pump. Make sure that the motor cannot by any means be started accidentally during the repairs.

- Loosen the hexagonal screws (901.05) of bearing carrier (382.01).
- Turn bearing carrier clockwise until impeller (230.01) touches the casing (102.01). With Retrofit type Durco MkII / III this can be ignored.
- Turn bearing carrier (382 .01) CCW halfway between two notches to get 0.010 inches (0.3 mm)front clearance. When hexagonal screws (901.05) are tightened, the play in bearing carrier thread gives additional 0.005 inches (0.1 mm) front clearnce. If pumped liquid is over 250 °F, thicker casing gasket (400.01) is used and clearance before tightening screws (901.05) is set to 0.020 inches (0.5 mm) to get total 0.025 inches (0.6 mm) front clearance.
- With Retrofit type Durco MkII / III turn bearing carrier (382.01) counter clockwise until impeller (230.01) back vanes touches the casing cover (161.01 / 161.02). Turn bearing carrier clockwise from one notch to next. In bearing unit 2 there are four notches at the outer sphere of the bearing carrier. Turning the bearing carrier between two notches makes impeller back clearance 0.02 inches (0.5 mm) but turn only 70% of that to get 0.014 inches (0.35 mm) back clearance.

- In bearing units 1 and 2 there are four notches and in bearing unit 3 there are six notches at the outer sphere of the bearing carrier. Turning the bearing carrier between two notches makes impeller front clearance increase 0.02 inches (0.5 mm).
- After the adjustment tighten the hexagonal screws (901.05). Bearing carrier must not be turned during tightening. All three hexagonal screws (901.05) must be tightened as much. The tightening must be performed in stages. First all the screws will be tightened to half of the recommended moment and then to a full moment. See Section “Installation” table 1.
- By turning the coupling by hand, check that the pump can rotate freely.

If the shaft is adjusted, the cartridge shaft seal must also be adjusted again, except John Crane seal type SE1, SE2 and SEW have the adjustment allowances shown in table 10. Otherwise see the seal manufacturer’s instructions.

Table 10 John Crane SE1, SE2 and SEW adjustment allowances

Bearing unit	Adjustment allowances	
	(in)	(mm)
1	-0.059 ... +0.098	-1.5 ... +2.5
2	-0.059 ... +0.138	-1.5 ... +3.5
3	-0.059 ... +0.197	-1.5 ... +5.0

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Corrective maintenance

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1 Safety procedures before any repairs

WARNING

When pumping hazardous liquids, secure that there is no trapped liquid remaining in pump parts.

Pumps which convey hazardous media must be carefully decontaminated before any repairs. Skin and eye protection are required during decontamination. Precautions are needed for personal or environmental safety.

Some of the disassembled parts and assemblies are heavy, unstable and due to design requirements they contain sharp edges (e.g. impeller, casing cover). Use proper hoistings and supports to prevent personal injury.

2 Necessary equipment / tools

2.1 Normally available working tools:

- Hoisting accessories. Note the safety requirements!
- Wrenches for hexagonal screws
  sizes (in): 1/2, 9/16, 3/4, 7/8, 15/16, 1 1/8
- Allen wrenches for socket head screws
  sizes (in): 5/32, 3/16
- Torque wrenches for
  moments (lbft): 20, 40, 95, 185, 310, 590
  moments (Nm): 30, 50, 130, 250, 420, 800
    - for hexagonal, sizes (in): 3/4, 15/16, 1 1/8
- Hooked wrenches, sizes (SKF): HN6, HN9, HN15, HN22, HN27, 718911
- Extractors
- Bearing heater
- Dial indicators
- Cleaning agents & equipment
- Lubricating agents & equipment

2.2 Special tools

- Pipe punch series for roller bearings. Fig. 9.

3 Disassembly

NOTE
Ensure that all eventual spare parts are available before the disassembly.

3.1 Preliminaries

1. Close the discharge valve.
2. Stop the motor. Make sure that the motor cannot be started by any means during the repair.
3. Close the suction valve.
4. Drain the pump carefully. For this, use the hexagonal plug (903.01) potentially situated at the bottom of the volute casing (102.01), Fig. 1.

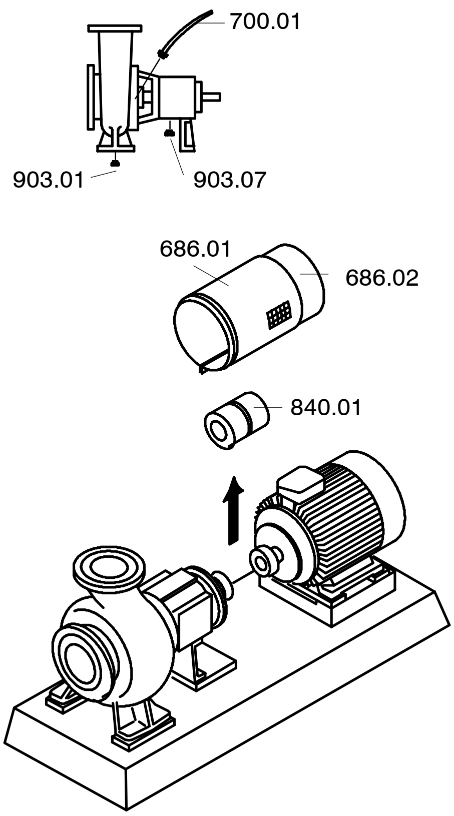


Fig. 1

5 Detach the pipes (700.01) in connection with the shaft seal, if applicable.

6 Remove the guard jacket (686.01) and coupling (840.01) spacer.

7 Drain oil from an oil-lubricated bearing housing by unscrewing the hexagonal plug (903.07).

3.2 Detachment of exchange unit

1 Unscrew the hexagonal screws (901.01) of the adapter (344.01) and the hexagonal screws (901.09) of the support foot from the baseplate (890.01), Fig. 2.

2 Suspend the exchange unit by a hoist at the maintenance opening of the adapter or underneath the adapter.

3 Pull out the exchange unit by using the hexagonal screws (901.01).

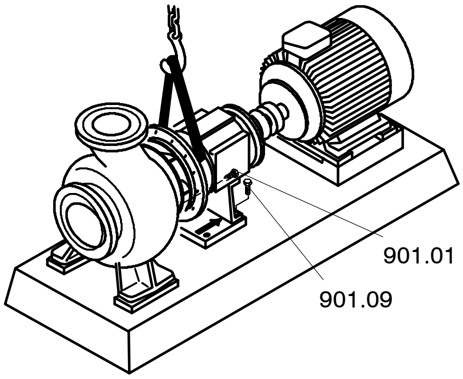
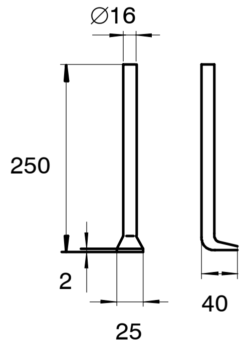


Fig. 2

3.3 Detachment of diffuser (low flow impeller)

Remove the diffuser (171.01) with a proper tool from the volute casing (102.01). Fig. 3.



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3.4 Detachment of impeller

1 Fasten the exchange unit firmly to a vice. Fig. 4.

2 Prevent the shaft (210.01) from rotating at the coupling (840.01) end.

3 Detach the impeller by turning it counter-clockwise. Push e.g. pieces of wood between the impeller vanes to ease the detachment. Never use metal bars or the like, because they might damage the impeller vanes. Fig. 5.

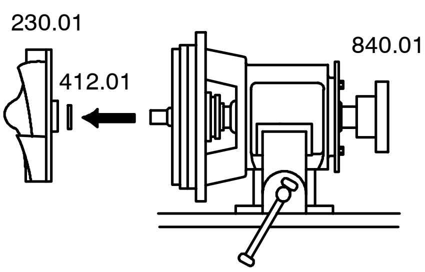


Fig. 4

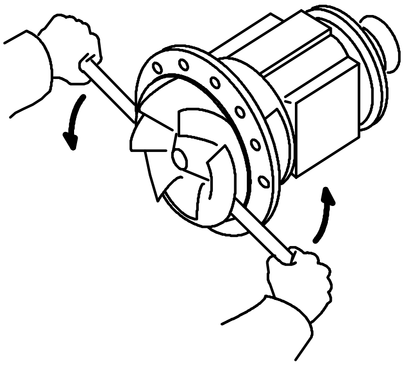


Fig. 5

3.5 Detachment of shaft seal

Refer to the sectional drawing of the shaft seal when reading through these instructions.

Gland packing, fittings PL01, PL02, PL03 and PL04

1. Unscrew the hexagonal screws (901.02) of the casing cover (161.01).
2. By using the said screws as extractors, draw the casing cover out of the adapter (344.01). All parts belonging to the gland packing, except the shaft wearing sleeve (524.01), will stay in the casing cover.
3. Unscrew the hexagonal nuts (920.02) and remove the two-piece stuffing box gland (452.01). The neck bush (456.01), gland packings (461.01) and lantern ring (458.01) can now be drawn out of the casing cover.
4. Detach the shaft wearing sleeve from the shaft with an extractor.
5. Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings ME01, ME02, ME03, ME04 and ME06

1. Unscrew the hexagonal nuts (920.02).
2. Unscrew the hexagonal screws (901.02).
3. By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.
4. The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer's instructions.
5. Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MC01, MC02, MC03, MC04, MC06, MC20, MC21 and MC22

1. Unscrew the hexagonal nuts (920.02).
2. Unscrew the hexagonal screws (901.02).
3. By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.

4 The mechanical seal can now be removed from the shaft and from the casing cover and dismantled according to the seal manufacturer's instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MR01, MR02, MR03, MR04 and MR06

1 Unscrew the hexagonal nuts (920.02).

2 Unscrew the hexagonal screws (901.02).

3 By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). All parts belonging to the mechanical seal (433.01) will remain on the shaft.

4 The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer's instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Mechanical seal, fittings MR20, MR21 and MR22

1 Unscrew the hexagonal nuts (920.02).

2 Unscrew the hexagonal screws (901.02).

3 By using the said screws as extractors, draw the casing cover (161.01) out of the adapter (344.01). Most of the mechanical seal (433.01) together with integrated parts will remain on the shaft. Part of the seal will remain on the casing cover.

4 The mechanical seal can now be removed from the shaft and dismantled according to the seal manufacturer's instructions.

5 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

Dynamic seal, fittings DS01, DS02 and DS03

1 Unscrew the hexagonal screws (901.02).

2 Remove the stuffing box cover (161.02) from the adapter (344.01) by using e.g. hexagonal screws for ejection. The other parts of the dynamic seal, except for the thrust ring (475.01), come off simultaneously in sizes 12 and 32. In other sizes, these parts either come off at the same time or stay on the shaft depending on the friction between the parts.

NOTE
With the size 32 excluded, these parts are not attached to each other in any way so take care not to drop them.

3 Open the hexagonal screws (901.07) in size 32. Remove the stuffing box housing (451.01) and the expeller (604.01) from the stuffing box cover, or pull the expeller and stuffing box housing out of the shaft if they did not come off during stage 2.

4 The cover plate for seal (471.02) and the static seal (435.01) can be detached by unscrewing the hexagonal screws (901.08).

5 Unscrew the grub screws (904.01) and detach the thrust ring (475.01) from the shaft.

6 Unscrew the hexagonal screws (901.03) of the adapter and draw the adapter out by using the same screws as extractors.

3.6 Disassembly of bearing unit

NOTE
Always renew the bearings once they have been removed from the shaft.

WARNING
Personal injuries may occur if personal protective equipment are not used when removing two piece lubrication ring (644.01) from the shaft.

1 Fasten the bearing unit firmly to a vice at the bearing housing (330.01). Fig. 6.

2 Detach the coupling half (840.01) using an extractor.

3 Unscrew the hexagonal screws (901.09) with which the guard end is fixed on the bearing carrier (382.01). Remove the guard end (685.01).

4 Loosen the hexagonal screws (901.05) which tighten the bearing carrier. Fig. 6.

5 Rotate bearing carrier counterclockwise until shaft assembly can be taken away from bearing housing (330.01). Fig. 6.

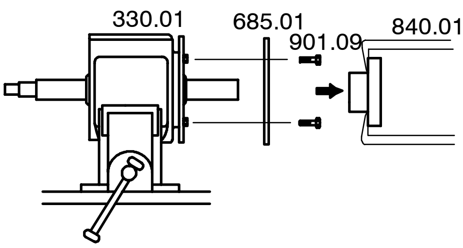


Fig. 6

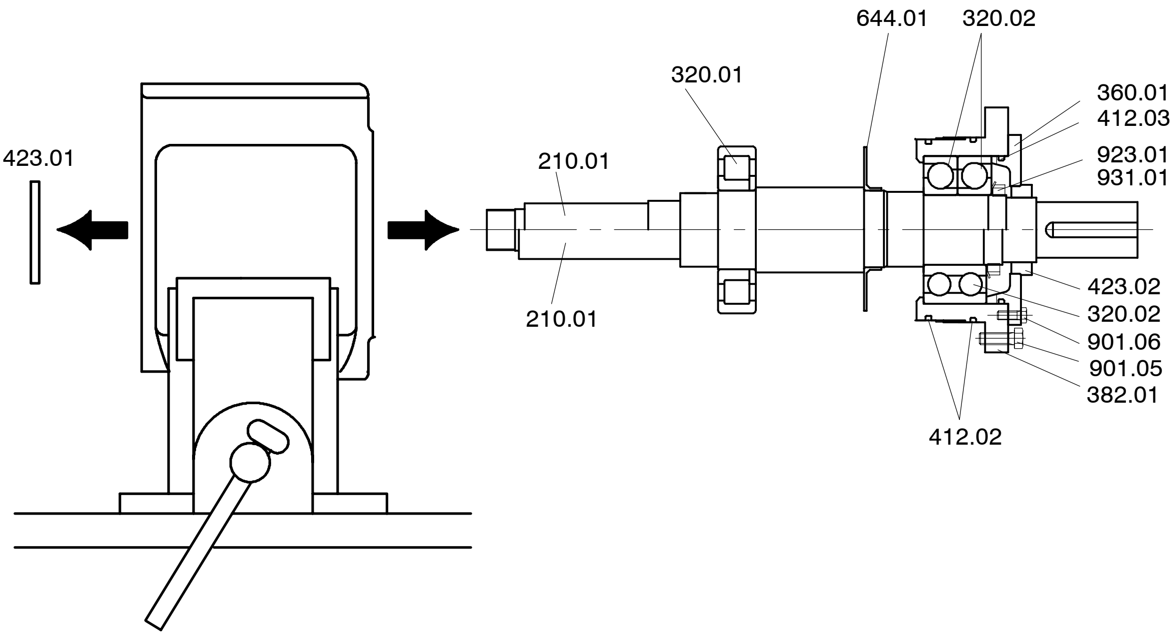


Fig. 7

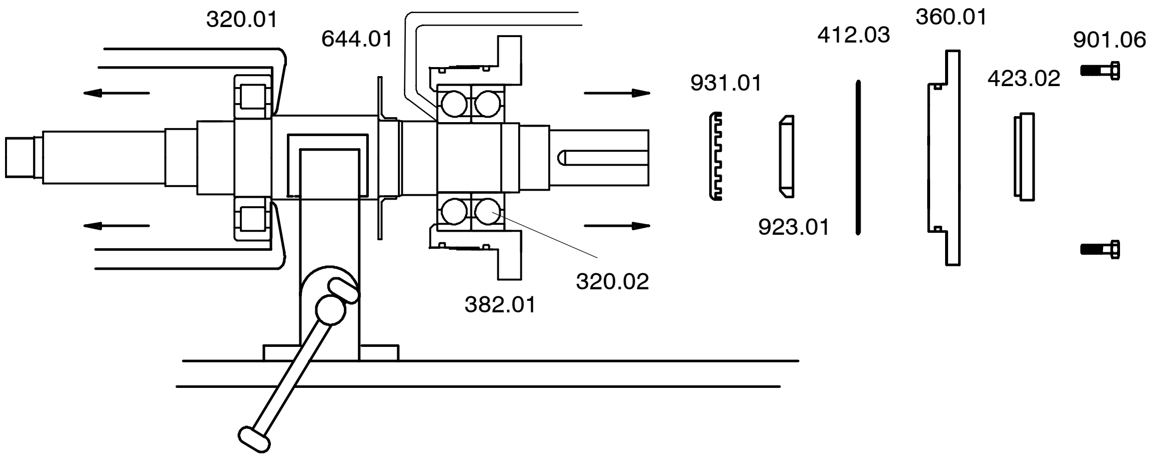


Fig. 8

6 Fasten the shaft with its bearings, bearing carrier and bearing cover to a vice from the center of shaft. Fig. 7. Use soft sheets between the vice clamp jaws to avoid damaging of shaft.

7 Remove radial bearing (320.01) from the shaft with an extractor.

8 Unscrew the hexagonal screws (901.06). Draw the bearing cover (360.01) out by using the hexagonal screws (901.06). As a result the labyrinth ring (423.02) can also be removed. Fig. 7.

9 Remove the bearing nut (923.01) and lockwasher (931.01).

10 Remove thrust bearings (320.02) and bearing carrier (382.01) from the shaft with an extractor. Fig. 7.

11 Slide bearing carrier (382.01) over the thrust bearings.

4 Reassembly

4.1 Preliminaries

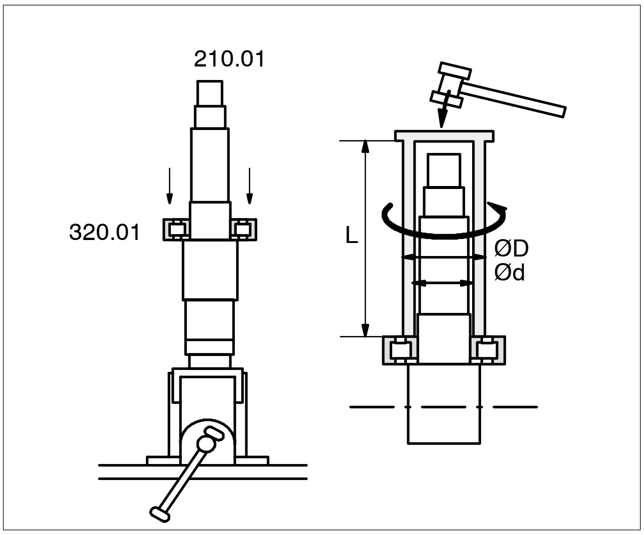
- Clean all gasket surfaces and fittings from rust and layers.
- Inspect for unusual erosion, pitting and wear in parts.
- Inspect keyways and bores for damage.
- Inspect the pump and baseplate for cuts and cracks.

4.2 Reassembly of bearing unit

N O T E
It is absolutely necessary to place the bearings correctly according to the O-system (so called Back-To-Back Design).

W A R N I N G
Personal injuries may occur if personal protective equipment are not used when installing two piece lubrication ring (644.01) on the shaft.

1. Check the shaft (210.01) with its shaft wearing sleeve (524.01) in a span. Their maximum radial difference is (0.002 in) 0.05 mm.
2. Fasten the shaft to a vice with the impeller end of the shaft upwards. Use soft sheets between the vice clamp jaws to avoid shaft damages. Heat the cylinder roller bearing (320.01) to ca (+212 °F) +100 °C and push it onto the shaft. Remember to place the spacer ring of the bearing on the shaft shoulder side. Fig. 9.
3. Let the bearing cool down. Then tap it tightly by the inner ring against the shoulder using a pipe punch. Rotate the pipe punch between the blows.
4. Turn the shaft so that the coupling side is upwards, fasten it to a vice. Install two piece lubrication ring (644.01) to its groove to the shaft (oil lubricated bearing unit) and bearing carrier (382.01) with its o-rings (412.02) in the grooves on the shaft.
5. Heat the two angular contact ball bearings (320.02) to approx. (+212 °F) +100 °C and push them onto the shaft. Let the bearings cool down.



Bearing unit	∅d		∅D		L_{min}	
	(in)	(mm)	(in)	(mm)	(in)	(mm)
1	1.45	37	2.00	50	8.0	203
2	2.25	57	2.80	71	9.0	229
3	3.45	87	4.60	117	12.0	305

Fig. 9

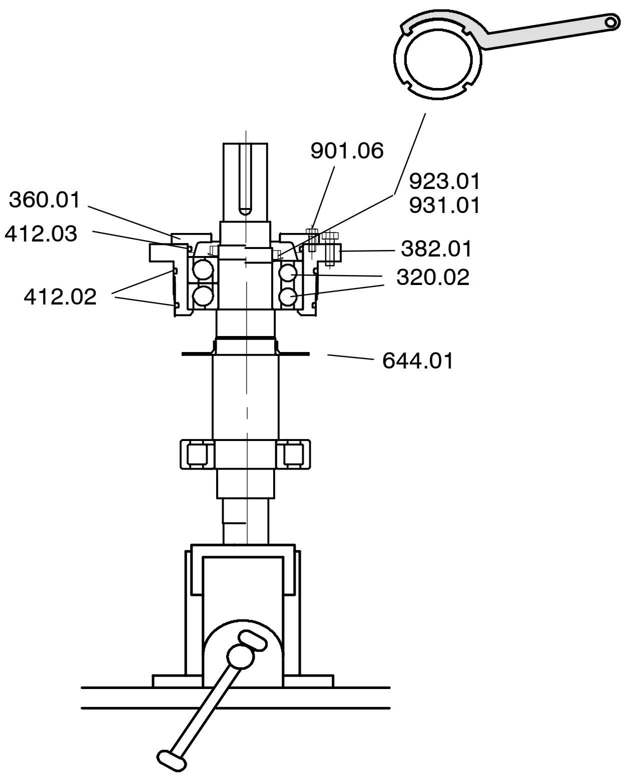


Fig. 10

6 Place the lockwasher (931.01) on the shaft.

7 Tighten the angular contact ball bearings by means of the bearing nut (923.01) tightly against the shaft shoulder, use a suitable hooked wrench.

8 Bend the lockwasher tooth into the bearing nut slots.

9 Set the o-ring (412.03) into the groove in the bearing cover (360.01). Grease the o-ring slightly.

10 Raise bearing carrier (382.01) on the thrust bearings (320.02) and fix bearing cover cautiously into its place by tightening fixing screws (901.06). Fig. 10.

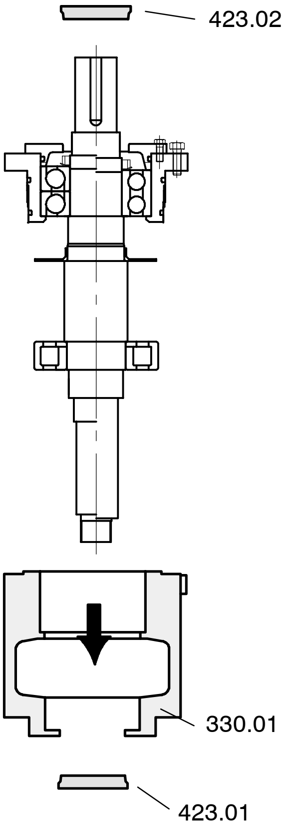


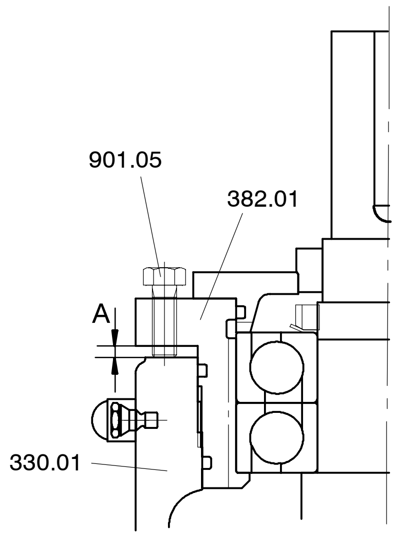
Fig. 11

11 Tighten the bearing housing (330.01) vertically to the vice with the coupling side upwards. Fig. 11.

12 Grease the o-rings (412.02) slightly and lower the shaft assembly carefully into the bearing housing.

13 Rotate from the bearing carrier to clockwise to set the shaft assembly into the bearing housing. Fig. 12. See also Fig. 6 in section Preventive maintenance.

14 Tap the labyrinth rings (423.01 and 423.02) into the bearing housing (330.01) and bearing cover (360.01) with a soft hammer.



A = Pre-setting distance for shaft assembly.

Bearing unit	A $^{0}_{-0.04}$ (in)	A $^{0}_{-1}$ (mm)
1	0.14	3.5
2	0.18	4.5
3	0.24	6

Fig. 12

15 Lock the shaft axially to bearing housing with screws (901.05).

4.3 Assembly of shaft seal

Refer to the sectional drawing of the shaft seal when reading through these instructions.

Gland packing, fittings PL01, PL02, PL03 and PL04

1 Fix the adapter (344.01) to the bearing housing (330.01) with the hexagonal screws (901.03).

2 Place the casing cover (161.01) on a horizontal surface with the sealing cavity upwards.

3 Place the neck bush (456.01) to the bottom of the sealing cavity.

4 Put the shaft wearing sleeve (524.01) in an upright position to the middle of the sealing cavity.

5 Insert the first two gland packings (461.01), the lantern ring (458.01), the other two gland packings and the two-piece stuffing box gland (452.01). Tighten the hexagonal nuts (920.02) by hand.

6 Push the casing cover with gland packing parts onto the shaft. Check that the shaft wearing sleeve is placed towards the shaft shoulder.

7 Attach the casing cover to the adapter with hexagonal screws (901.02).

Mechanical seal, fittings ME01, ME02, ME03 and ME06, v-ring

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) parts into the cover plate for seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 11 and the seal manufacturer's instructions.

Table 11

Assembly distance A in (mm)				
Bearing unit	John Crane T1	John Crane T8-1T	AES P04T	Flowserve RO
1	0.53 (13.4)	1.22 (30.9)	1.08 (27.4)	0.63 (16.3)
2	0.54 (13.6)	1.60 (40.6)	1.20 (30.6)	1.22 (31.0)
3	0.63 (16.0)	2.00 (50.9)	1.18 (29.9)	1.52 (38.7)

3 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

4 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

5 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

Mechanical seal, fitting ME04, v-ring

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) parts into the cover plate for the seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 11 and the seal manufacturer's instructions. Make sure that the cylinder pin (562.02) is in the proper position.

3 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

4 Push the plate (550.01) onto the shaft. Make sure that the rubber lip on the outer edge of the plate comes to the bearing side. Fig. 13.

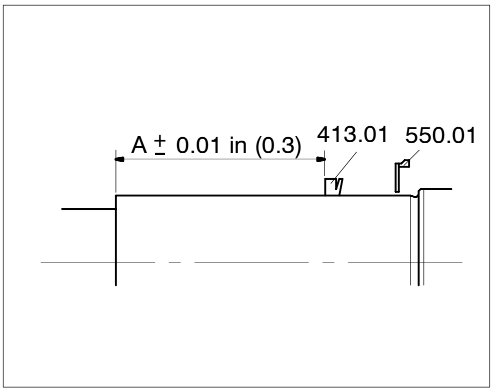


Fig. 13

5 Push the v-ring (413.01) onto the shaft. The distance of the v-ring from the shaft shoulder is shown in Table 12. The use of an installation sleeve helps to get the v-ring perpendicularly with respect to the shaft. Grease the lip of the v-ring slightly.

Table 12 V-ring position, fitting ME04

Bearing unit	Seal size ∅		Distance A	
	mm	in	mm	in
1	35	1.375	90.6	3.57
2	54	2.125	113.2	4.46
3	64	2.500	121.7	4.80

6 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

7 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

8 Continue installation according to item ”Installation of impeller”.

9 After all other parts have been installed, push the plate (550.01) into the groove in the cover plate for seal (471.01) so that the entire rubber lip settles straight in the groove. Fig. 14. To make sure that the lip is correctly situated, use a tool shown in Fig. 15. Place the tip of the tool into the groove and turn around the cover plate for seal.

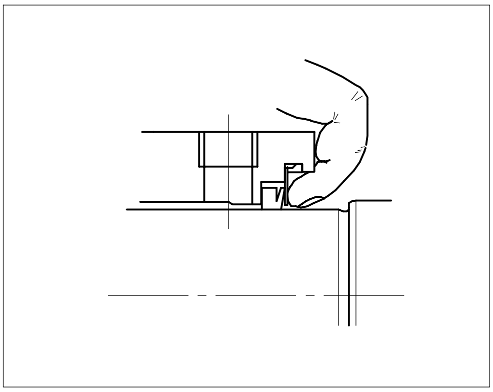


Fig. 14

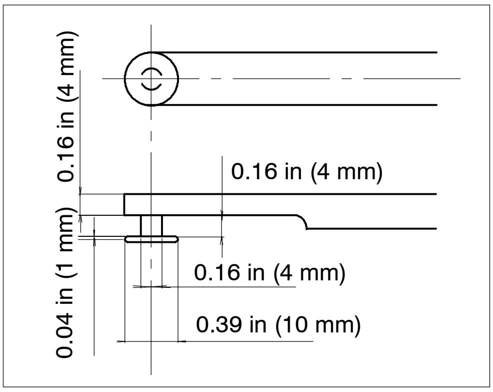


Fig. 15

Mechanical seal, fittings ME01, ME02, ME03, ME04 and ME06, throttling bush

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Heat the cover plate for seal (471.01) to approx. +212 °F (100 °C) and push the throttling bush into the cover plate for seal.

3 Mount the mechanical seal (433.01) parts into the cover plate for seal (471.01) and onto the shaft wearing sleeve (524.01) according to assembly distance A from table 13 and the seal manufacturer's instructions.

Table 13

Assembly distance A in (mm)				
Bearing unit	John Crane T1	John Crane T8-1T	AES P04T	Flowserve RO
1	0.53 (13.4)	1.22 (30.9)	1.08 (27.4)	0.64 (16.3)
2	0.54 (13.6)	1.60 (40.6)	1.20 (30.6)	1.22 (31.0)
3	0.63 (16.0)	2.00 (50.9)	1.18 (29.9)	1.52 (38.7)

4 Place the gasket (400.02) in the cover plate for seal (471.01). Fix the cover plate for seal on the casing cover (161.01). Tighten the hexagonal nuts (920.02).

5 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

6 Push the shaft wearing sleeve (524.01) together with the incorporated parts onto the shaft against the shoulder.

Mechanical seal, fittings MC01, MC02, MC03, MC04, MC06, MC20, MC21 and MC22

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the mechanical seal (433.01) into the casing cover (161.01). Follow the instructions provided by the seal manufacturer. Tighten the hexagonal nuts (920.02).

3 Push the shaft wearing sleeve (524.01) onto the shaft.

4 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Follow the instructions provided by the seal manufacturer. Fix the screws (901.02).

5 Complete all the lockings, fixings and other seal-related jobs as described in the seal manufacturer's instructions.

Mechanical seal, fittings MR01, MR02, MR03 and MR06

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the static part of the mechanical seal (433.01) into the casing cover (161.01) with the flange (723.01) if included in the parts list and the outer rotating part onto the shaft according to the seal manufacturer's instructions. Tighten the nuts (920.02).

3 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

4 Push the rotating part of the mechanical seal onto the shaft against the shoulder.

Mechanical seal, fittings MR04

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the static part of the mechanical seal (433.01) into the casing cover (161.01) with the flange (723.01) if included in the parts list. Follow the instructions provided by the seal manufacturer. Tighten the nuts (920.02).

3 Push the plate (550.01) onto the shaft. Make sure that the rubber lip on the outer edge of the plate comes to the bearing side. Fig. 16.

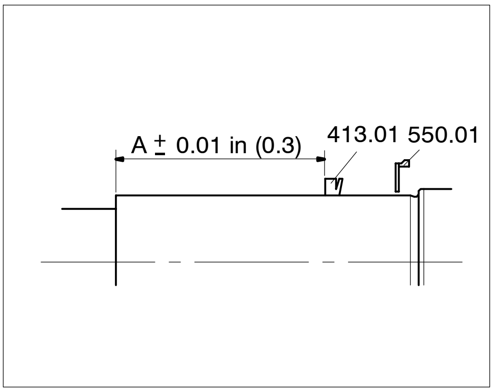


Fig. 16

4 Push the v-ring (413.01) onto the shaft. The distance of the v-ring from the shaft shoulder is shown in Table 14. The use of an installation sleeve helps to get the v-ring perpendicularly with respect to the shaft. Grease the lip of the v-ring slightly.

Table 14 V-ring position, fitting MR04

Bearing unit	Seal size ∅		Distance A	
	in	mm	in	mm
1	1.125	29	3.252	83
2	1.875	48	3.880	99
3	2.250	57	4.425	112

5 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

6 Push the rotating part of the mechanical seal (433.01) onto the shaft against the shoulder.

7 Continue installation according to item ”Installation of impeller”.

8 After all other parts have been installed, push the plate (550.01) into the groove in the cover plate for seal (471.01) so that the entire rubber lip settles straight in the groove. Fig. 17. To make sure that the lip is correctly situated, use a tool shown in Fig. 18. Place the tip of the tool into the groove and turn around the cover plate for seal.

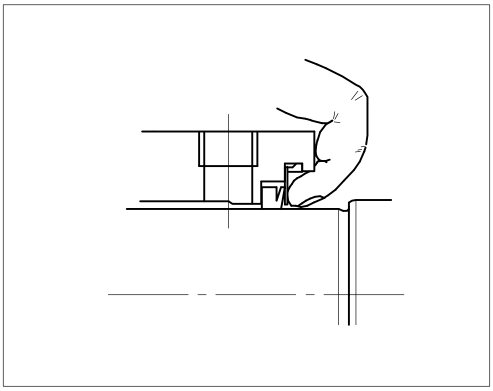


Fig. 17

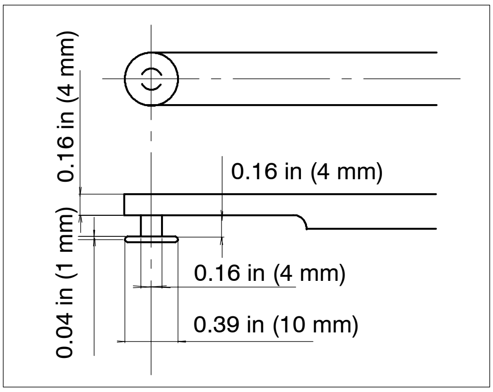


Fig. 18

Mechanical seal, fittings MR20, MR21 and MR22

1 Fix the adapter (344.01) into the bearing housing (330.01) with hexagonal screws (901.03).

2 Mount the static part of the mechanical seal (433.01) into the casing cover (161.01), and the outer rotating part onto the shaft according to the seal manufacturer's instructions. Tighten the nuts (920.02).

3 Push the casing cover (161.01) together with the incorporated parts onto the shaft. Fix the screws (901.02).

4 Push the rotating part of the mechanical seal (433.01) onto the shaft against the shoulder.

Dynamic seal, fittings DS01, DS02 and DS03

1 Fix the adapter (344.01) to the bearing housing (330.01) with the hexagonal screws (901.03).

2 Slide the thrust ring (475.01) with its o-ring (412.05) and grub screws (904.01) along the shaft to a preliminary position up to the hindmost shoulder.

3 Install the o-ring (412.06), static seal (435.01) and cover plate for seal (471.02) into the stuffing box housing (451.01). Tighten the hexagonal screws (901.08). Observe that the static seal must be placed in the right way and centrally in its guiding slot in the stuffing box housing.

4 Put the o-ring (412.04) in its slot in the stuffing box housing.

5 Put the stuffing box cover (161.02) on the table with the expeller side up. Put the expeller (604.01) inside the cover with the vane-side up. Push the stuffing box housing together with its parts on the stuffing box cover in the dedicated runway. In size 32, fix the hexagonal screws (901.07). The position of the stuffing box housing versus the holes of the stuffing box cover screws (901.02) should be such that in a ready assembled pump, the plug (903.09) in the stuffing box housing points horizontally to the left when viewed from the coupling. Check the position of the holes from the adapter.

6 Push the pack of parts (assembled in the stuffing box cover during stage 5) onto the shaft so that the expeller fits in its runway on the shaft and the stuffing box cover in its runaway on the adapter. Fix the hexagonal screws (901.02).

7 Continue the assembly according to the following section "Installation of impeller".

8 When the exchange unit is fully assembled, place the thrust ring (475.01) at the right position on the shaft and fasten the grub screws (904.01). The measure between the face of the cover plate for seal and the shoulder of the thrust ring must be 0.197 in (5 mm). Fig. 19.

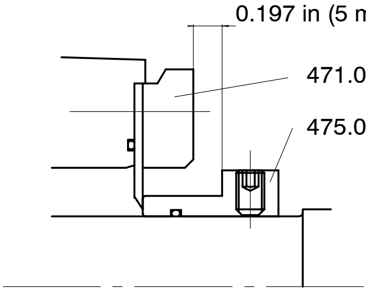


Fig. 19

4.4 Installation of impeller

1 Fit the o-ring (412.01) into its place behind the impeller (230.01). Fig. 20.

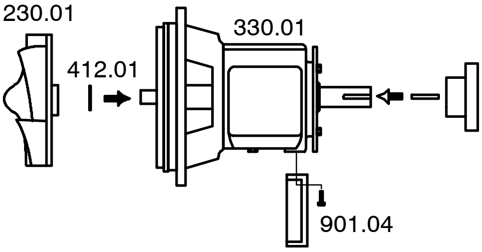


Fig. 20

2 Prevent the shaft from rotating from the coupling end and insert the impeller (230.01) into its place. The clearance between the impeller and casing cover (161.01) is about 0.014 ... 0.015 in (0.35 ... 0.4 mm).

4.5 Installation of diffuser (low flow impeller)

Heat the diffuser (171.01) to approx. (212 °F (+100 °C) and push it into the volutecasing (102.01).

4.6 Installation of exchange unit

1 Fix the support foot of the bearing unit by means of the hexagonal screws (901.04). Fig 21.

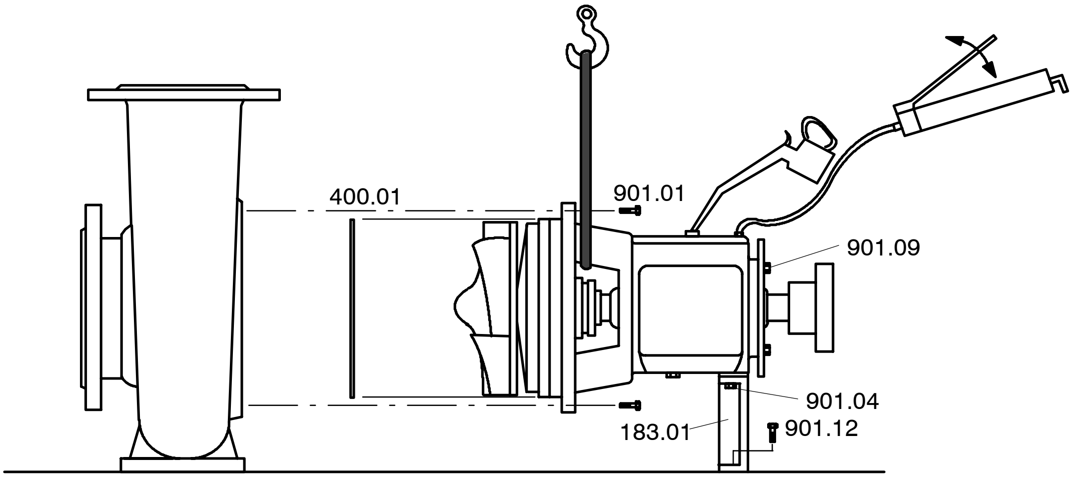


Fig. 21

2 Heat the coupling flange to approx. (+212 °F) +100 °C and push it on the shaft with the front surface at the shaft end level.

3 Suspend the exchange unit with a hoist at the maintenance opening of the adapter or underneath the adapter.

4 Fit the gasket (400.01) into the casing cover (161.01).

5 Install the exchange unit into its place, lubricate the hexagonal screws (901.01) with Molykote Ti 1200 lubricant and tighten them in a cross bolt pattern, to torque values given in Table 15.

Table 15 ***Exchange unit fastening screws (901.01)***

Screw size	Moment			
	Rating		**Max. value**	
	(lb ft)	(Nm)	(lb ft)	(Nm)
1/2 - 13 UNC	35	50	45	60
5/8 - 11 UNC	95	130	120	160
3/4 - 10 UNC	185	250	220	300

6 Check the impeller clearances according to the Section ”Preventive maintenance”.

7 Place adjusting plates under the support foot. The plates must have the same thickness as the gap under the support foot. Do not close the gap by tightening.

8 Fix the support foot (183.01) to the baseplate (890.01) with the hexagonal screws (901.12).

9 Lubricate the bearing unit with oil or grease according to lubricating instructions in Section ”Operation”.

10 Install the coupling spacer according to the coupling manufacturer’s instructions.

11 Fix the coupling guard jackets (686.01) and (686.02). The coupling guard must be adjusted so that the space ”s” between the coupling guard and motor is approx. (0.2 in) 5 mm. Fig. 22.

12 Install the auxiliary pipings (700.01) and accessories according to sectional drawings and the seal manufacturer’s instructions.

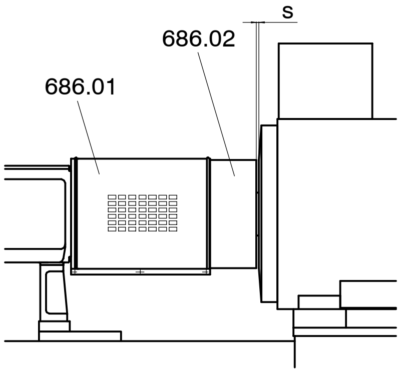


Fig. 22

WARNING

Proper adjustment of the coupling guard jacket is a relevant safety factor.

SULZER

Spare parts recommendation

Version 02 > / 20051101 / Replaces 20010515 / en / **N15069**

Contents *Page*

1 Recommended spare parts

To avoid long and expensive shut-down periods, the following spare parts are recommended to be kept in stock. The number of spare parts is evaluated for two year's use in normal operating conditions, Table 1.

When ordering spare parts, contact your local Sulzer Pumps representative (contact data found in Section "Information for use").

Table 1 Recommended spare parts

Part No.	Description	Number of identical parts in pumps							
		1	2	3	4	5	6 7	8 9	≥10
		Number of recommended spare parts							
102.01	Volute casing							1	10 %
161	Casing cover							1	10 %
171.01	Diffuser	1	1	1	1	2	2	3	10 %
183.01	Support foot							1	10 %
210.01	Shaft	1	1	1	2	2	2	3	30 %
230.01	Impeller	1	1	1	1	2	2	3	30 %
320.01	Antifriction bearing	1	1	1	2	2	3	4	50 %
320.02	Antifriction bearing		2		4		6	8	50 %
330.01	Bearing housing							1	10 %
339.01	Bearing unit							1	10 %
344.01	Adapter							1	10 %
360.01	Bearing cover							1	10 %
382.01	Bearing carrier							1	10 %
400	Gaskets	2	4	6	8	8	9	12	150 %
412	O-rings	2	4	6	8	8	9	10	100 %
413.01	V-ring	2	4	6	8	8	9	10	100 %
423	Labyrinth ring							1	10 %
433.01	Mechanical seal	1	2	3	4	5	6	7	90 %
435.01	Static seal	1	2	3	4	5	6	7	90 %
451.01	Stuffing box housing							1	10 %
452.01	Stuffing box gland							1	10 %
456.01	Neck bush							1	10 %
458.01	Latern ring							1	10 %
461.01	Gland packing				24			32	400 %
471	Cover plate for seal							1	10 %
475.01	Thrust ring	1	2	3	4	5	6	7	90 %
524.01	Shaft wearing sleeve	1	2	2	2	3	3	4	50 %
542	Throttling bush							1	10 %
550.01	Plate	2	4	6	8	8	9	10	100 %
604.01	Expeller	1	1	1	1	2	2	3	30 %
923.01	Bearing nut	1	1	1	2	2	2	3	30 %
931.01	Lockwasher	1	1	1	2	2	2	3	30 %
940.01	Key	1	1	1	2	2	2	3	30 %
Refer to the parts lists of the pumps when estimating the amount of needed spare parts.									

Procedure to Realign Pump after Shipment and Prior to Installation of Piping at Site

1.0 Scope

The scope of this instruction is to explain how to check misalignment in the field after shipment. All Pumps which ship complete with Base and Motor are aligned in the factory. Due to shipment, the alignment will change during transportation.

2.0 Preparation

Before beginning to check this alignment, the base should be on anchor bolts where it will be installed but not yet grouted in or have piping connected to it. The pump should be tightened down to the base with the appropriate amount of shim under the pump support foot. If installed at the customer site, the motor should be on the base with the nominal amount of shim under each foot. If installed at the factory, the motor should have amount of shim that was needed to achieve factory alignment. All the bolts and nuts holding down the motor should be loose to allow movement of the motor. The coupling should be installed as required for the alignment equipment used.

3.0 Rough Alignment

The shafts should first be rough aligned both horizontally and vertically using a scale. The motor should be tapped in the appropriate direction for horizontal alignment and shims should be added or removed for vertical alignment.

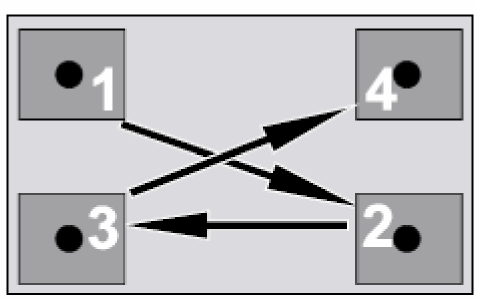
4.0 Correcting Soft Foot

Soft foot can cause the motor to rock during alignment and give false and inconsistent readings. Even though the motor was pre-aligned at the factory the following procedure should be followed.

Note: Alignment on any pump will change due to shipping and should be corrected in the field.

1. Find any obviously loose shim packs and add shim until the packs seem tight.

2. Torque down the bolts. The bolts should be torqued in a sequence that is similar to that shown below:



During the first pass, the bolts should only be torqued down by 50% of the desired torque. After the first pass the bolts can be completely torqued in the same manner.

3. Loosen one bolt at a time. Using a .002" shim or feeler gauge check to see if there is any gap under the foot. If there is more than .002" gap under the foot, then add shim to correct it. Retighten the bolt and move onto the next one, repeating the same process for all four bolts.

4. After this process has been carried out for all four bolts, all of the bolts can be loosened to begin alignment.

5.0 Check for Misalignment

Check for misalignment using alignment equipment. Refer to your user's manual for instructions on how to use the equipment. Correct any horizontal misalignment by moving the motor the amount given to you by the alignment equipment. Correct any vertical misalignment by adding or removing shim. After correcting any misalignment measure both directions again to make sure that it is still within tolerance.

6.0 Solutions to Misalignment Problems

1. Motor becomes bolt bound before horizontal alignment can be achieved.

In this circumstance the easiest solution is to loosen the pump bolts and adjust the pump to allow more room for motor adjustment. The pump should be tapped with a rubber mallet in the appropriate direction until the alignment equipment reads that the shafts are misaligned slightly in the opposite direction. The pump can then be retightened and the procedure for aligning the motor can be repeated.

2. Readings that you receive from alignment equipment do not seem valid.

An easy test can be done to see if the readings coming from the alignment equipment are valid. It is called the rule of validity. The misalignment values at 3:00 and 9:00 o'clock should add up to the amount of misalignment 12:00 and 6:00 o'clock. If this is not the case there are many reasons that can cause this:

- The alignment equipment is bad.
- There is soft foot.
- The shims being used are of poor quality.
- The base is not rigid.
- There is too much play in the coupling.

7.0 Final Steps to Installation

The last step is to tighten down the motor and finish the installation by grouting in the base and installation of the piping.

PUMP DATA SHEET Sulzer Process Pumps

Company:
Name:
Date: 11/29/07

Powered By PUMP-FLO

Pump:

Size: 12-1 1.5x1x8

Type: CPT-O Synch speed: 3600 rpm	Speed: 3525 rpm Dia: 7.75 in
Curve: K17363	Impeller:
Specific Speeds:	Ns: 743 Nss: 3766
Dimensions:	Suction: 1.5 in Discharge: 1 in

Pump Limits:

Temperature: --- °F Pressure: --- psi g Sphere size: 0.31 in	Power: --- hp Eye area: --- in²

Search Criteria:

Flow: 100 US gpm	Head: 240 ft

Fluid:

Water SG: 1 Viscosity: 1.105 cP	Temperature: 60 °F Vapor pressure: 0.2563 psi a Atm pressure: 14.7 psi a
NPSHa: --- ft	

Motor:

Standard: NEMA Enclosure: TEFC	Size: 20 hp Speed: 3600 Frame: 256T

Sizing criteria: Max Power on Design Curve

---- Data Point ----

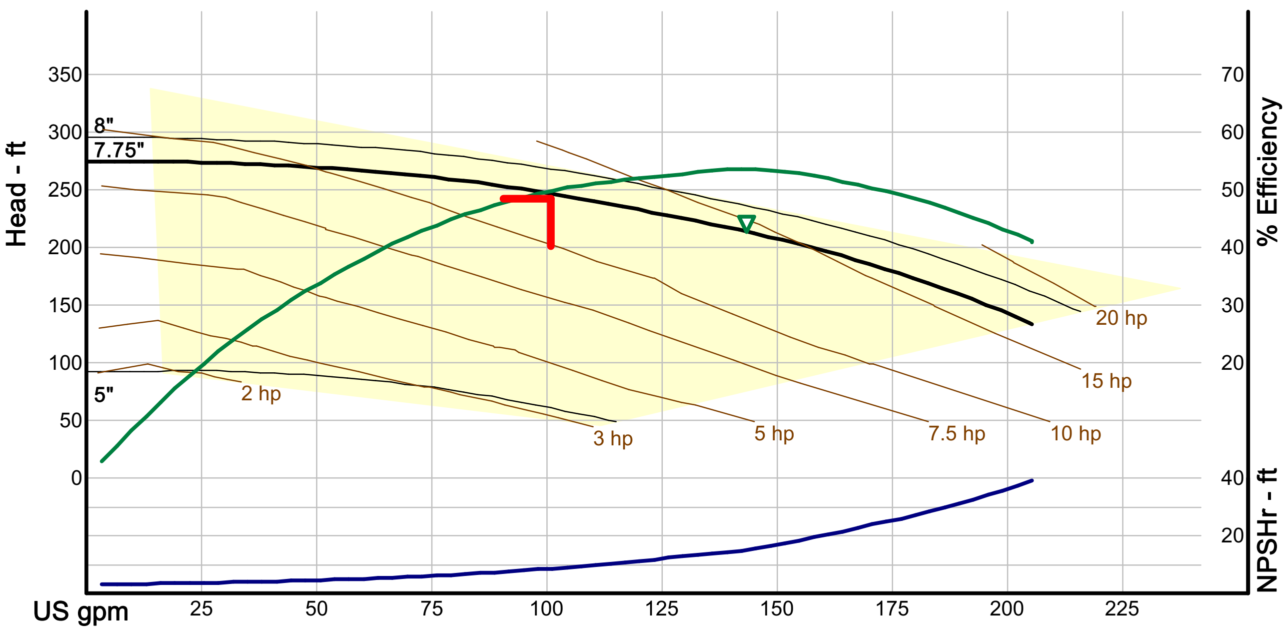
Flow: 100 US gpm
Head: 244 ft
Eff: 49.1%
Power: 12.5 hp
NPSHr: 8.76 ft

-- Design Curve --

Shutoff Head: 272 ft
Shutoff dP: 118 psi
Min Flow: --- US gpm
BEP: 53% eff
@ 142 US gpm
NOL Pwr: 16.7 hp
@ 204 US gpm

-- Max Curve --

Max Pwr: 19.1 hp
@ 214 US gpm



Check the maximum inlet head and power demand of dynamic seal, if applied.

Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Pump %eff	Power hp	NPSHr ft
120	3525	229	51.4	13.5	11.6
100	3525	244	49.1	12.5	8.76
80	3525	255	44.4	11.5	6.79
60	3525	263	37.3	10.6	5.36
40	3525	268	27.8	9.58	4.39

PUMP MOTOR

DATA TRANSMITTAL AND CERTIFICATION

BALDOR
BALDOR • DODGE • RELIANCE

	Customer P.O. Number: NO36-89163-20212A	P.O. Date: 04/16/08	Sales Order Number / Plant Order Number: 98419020-10 / B385172
SOLD TO	WESTECH ENGINEERING 3625 S WEST TEMPLE SALT LAKE CTY UT 84115		REVISED, SUPERSEDES DATA PREVIOUSLY ISSUED.
SHIP TO	Same as "Sold To" unless shown HOLMES MECHANICAL INC. 10890 OLD FRONTIER RD NW ATTN; JOHN HARTMANN SILVERDALE WA 98383		
DATA SOURCE	ISSUED BY TRACEY FOSTER ATHENS PLANT 197 COLLINS INDUSTRIAL DRIVE ATHENS, GA 30601	DATE 4/21/2008	

MOTOR OR GEN. DATA

P.O. Item	Application	Motor or Gen. D/S
	General Industrial	611760-570

Quantitity	Frame	HP	Serv Fact	Elec Type	RPM	C Box D/S
1	254T	15	1		3600	

Ph/Hz/Volts-Winding	Duty	Enclosure	Amb./Insl.	Power Code	Motor or Gen. C/D
3/60/230/460	Cont	TEFC	40/F		416820-2

Bearings	Mounting & Method of Drive	Base/Rails	Model Number	Reducer or Aux. D/S
Ball	F-1 Coupled			

Rotation from Opp. Dr. end	D-C Field Excitation	Electrical Design Number	Brake or Aux. D/S
Bi-directional		W00400-A-C001	

BRAKE DATA

Brake Type	Torque Ft. Lb.	Enclosure	Phase	Hertz	Voltage		Blower Motor:

DATA FOR CONTROL

D-C MOTOR ARMATURE CURRENT: AMPS
FIELD CHARACTERISTICS PER CURVE:

F1--F2,	MAX AMPS	RPM	CODE:	G
F11--F22	MAX AMPS	RPM	LOCKED AMPS:	
F3--F4	MAX AMPS	RPM	F.L. CURRENT AMPS:	33.6/16.8

A-C MOTOR INFORMATION FOR SELECTION OF STARTER HEATERS:

SPCL. FEAT. AND MISC. DATA.

```
Special Features:
   Special Item 1                  Bearing life 125,000 HR - coupled load cent pump
   Product Category                Medium AC Motors

Bearing / Seals / Lubrication
   Typical Bearing Construction O  Open
   Typical Bearing Construction D  Open
   Relief Fitting Type             Gitts Cup
   Opposite Drive End Seal         Inpro
   Lube Type                       Grease
   Grease Type                     Exxon Polyrex EM
   Grease Fittings Rqd             Y
   Grease Fitting Type             Alemite 1610 or Equal
   Drive End Seal                  Inpro
   Bearing Type - ODE              Ball
   Bearing Type                    Ball

Conduit Box / Leads / Connections
   Main Conduit Box Material       Cast Iron
   Main Conduit Box Location       Standard (side)
   Main Conduit Box                Required
   Main Box Size                   Standard Oversize
   Lead Lugs Required              Y
```

**CONTINUED ON PAGE 2 **

Customer P.O. Number	P.O. Date	Sales Order Number / Plant Order Number
NO36-89163-20212A	04/16/08	98419020-10 / B385172

SPCL. FEAT. AND MISC. DATA.

Documentation	
Standard Connection Diagram	Y
Document Unit of Measure	US
Doc Renewal Parts	Y
Doc PDF Format	Y
Doc Instruction Manual	Y
Certified Motor Outline Type	Typical Dimension Sheet to be used with Data Transmittal for Certification.
Certified Motor Outline	Y
Enclosure Enhancements	
XT Features Rqd	Y
Grounding Required	Y
Ground Pad Type	Drilled and Tapped Hole in Frame
Ground Pad Location	On frame on same side as conduit box
Frame Ground Rqd	Y
Auto Drain Type	Stainless Steel T-Drain
Mounting / Flange	
Mounting Position	F-1
Mounting Orientation	Horizontal
Lead Location	Toward Feet - Down
Frame Mounting	Foot
Drive Method	Coupled
Nameplates / Labels	
Special Nameplate Rqd	Y
Product Markings	IEEE 841 Features
Nameplate Language	English
NP Inverter Duty Rqd	Y
Label UR	Y
Label CSA	Y
Grease Markings	Lubricated with Exxon Polyrex EM
EPAct marking	DOE CC Mark Required
Paint / Packaging	
Reliance Paint Spec No	4824-7-BJW
Paint System	Extreme
Paint Color Standard	Reliance
Paint Color	Blue-Green
Performance	
Sound Level dBA	73
Rise at 1.0 SF	53.865
Maximum Altitude (ft)	3300
Balance	Ultra-Standard
Ambient Minimum	-25C
Altitude (ft)	3300
Rating / Enclosure	
Variable Frequency Drive Op	Y
SF on Sine Wave Power	1.15
Product	TEFC-XEX
Poles	2
NRCAN Covered Product	Y
Motor Standard	NEMA - T
Inverter Torque	4:1 Variable Torque
IEEE-841 Features Only Note	Features and/or Rating outside scope of IEEE-841.Nameplate as 841 Features Only.
Enclosure Family	Enclosed

**CONTINUED ON PAGE 3 **

DATA TRANSMITTAL AND CERTIFICATION

Customer P.O. Number	P.O. Date	Sales Order Number / Plant Order Number
NO36-89163-20212A	04/16/08	98419020-10 / B385172

SPCL. FEAT. AND MISC. DATA.

Rating / Enclosure (continued)

Enclosure Enhancement	841-XL
Efficiency	XE
Design Letter	B
Allowed for use in Canada	Y
AC/DC/INV	AC

Shaft / Coupling

Shaft Extension	T

Tests / Services

Routine Test	Non-witnessed

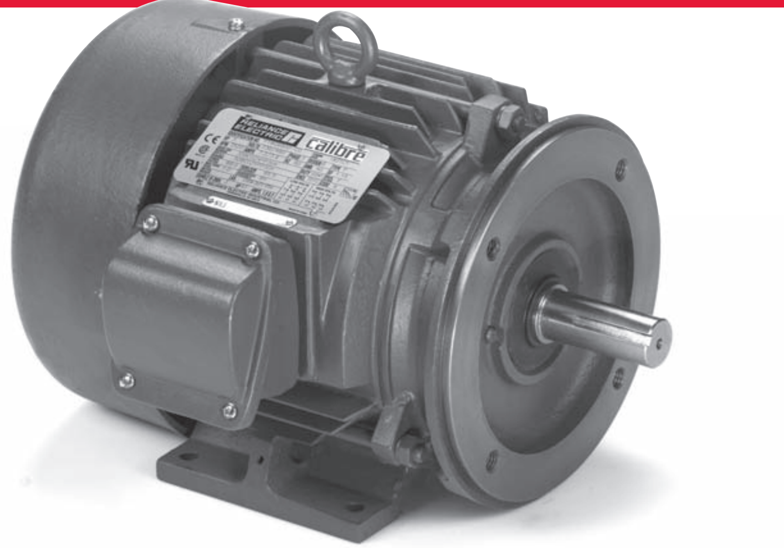
DATA SHEET

HARSH ENVIRONMENT

MOTORS

Extra Tough Calibre XT for Harsh Environments

Reliance Calibre XT is designed to be used in Paper Making, Petrochemical Processing, Mining, Metals Conversion and other tough manufacturing environments. Extra tough features give year after year of low maintenance and are an excellent choice when conditions are severe and dependability is important.



- ✔ Aggregate/Cement
- Food
- ✔ Mining
- ✔ Forest/Paper
- ✔ Petro/Chem
- Unit/Baggage Handling
- ✔ HVAC/Industrial Air Handling
- ✔ Environmental/Fluid Power
- ✔ Automotive
- ✔ Metals
- Nuclear

Features:

- Enclosure IP Code: Totally Enclosed-IP54
- Definitions: Extra-tough motors that meet or exceed EPAct efficiency levels.
- Warranty:24 months from date of Manufacture / 12 months from date of Installation
- Nameplate Certifications: CE, CSA

Electrical Characteristics:

- Phase 3
- Frequency 60hz
- Ambient 40 degree C
- Duty Cycle Continuous
- Insulation Class F
- Service factor 1.15
- Temperature Rise Class B

Application Information:

- Extra Tough motors with complete cast iron construction and additional key features for long life in moist, contaminated environments such as chemical plants, petroleum refineries and paper mills.

Construction Features 180-360T Frames:

- Materials: Cast iron frame, conduit box, fan shroud and end shields.
- Conduit Box: F-1 location, Diagonally split, rotatable in 90 degree increments and NPT threaded hole. Ground connection in Box.
- Bearing Type: Permanently lubricated double shielded ball bearings 180 - 210, relubricable 250 through 360 frames.
- Bearing Protection: Slingers
- Shaft Material: High strength carbon steel
- Nameplate Material: Aluminum
- Drain type & location: Weep holes in both ends

Additional Features:

- The motor's stator and rotor are completely epoxy coated for corrosion protection.
- Special individual lead separator in conduit box

Construction Features 400T-449T Frames:

- Materials: Cast Iron frame, end shields, conduit box, fan cover and inner caps.
- Conduit Box: F1 location, Diagonally split, neoprene gasketed, rotatable in 90 degree increments and NPT threaded lead hole. UL listed clamp type ground lug in box.
- Bearing Type: Regreasable, open ball bearings with PLS.
- Bearing Protection: Non-metallic V-ring shaft slinger on drive end.
- Shaft Material: High strength carbon steel
- Nameplate Material: Stainless steel
- Drain type & location: Stainless Steel T-drains mounted in both end shields.

Additional Features:

- The motor's stator and rotor are completely epoxy coated for corrosion protection.
- Extra Tough motors are provided with alemite grease fittings for easy bearing maintenance.
- Silicone rubber sealed fits provide superior protection against contaminates entering the motor body.
- PLS (Positive Lubrication System) Patented lubrication system that assures lubrication throughout the bearing.

Attn: Ginesh Fax# 908-595-1776
Dimension Sheets Sales order# 98419020

611760-570-SH1

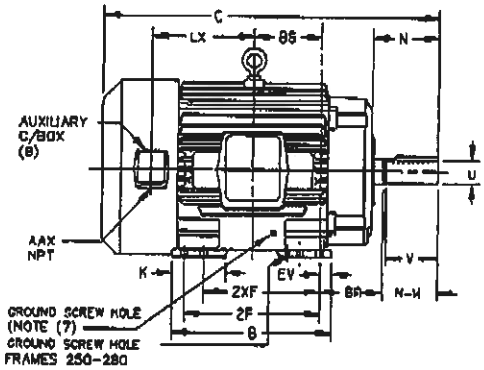
DUTY MASTER ALTERNATING CURRENT MOTORS

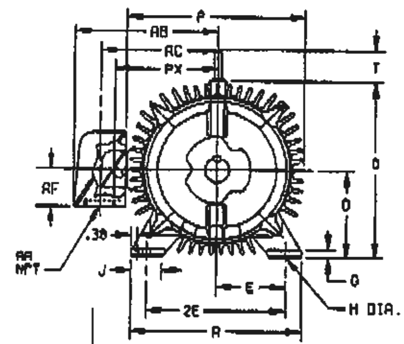
SQUIRREL-CAGE INDUCTION
CAST IRON CONSTRUCTION

ENCLOSURE: TOTALLY ENCLOSED COOLING: FAN COOLED
MOUNTING: FOOT

FRAMES 250T THRU 440TS

841-XL WITH STANDARD OVERSIZED CONDUIT BOX





DIMENSIONS ARE IN INCHES; SEE SHEET 2 FOR DIMENSIONS IN MILLIMETERS

FRAME	A	D(2)	E	G	H	J	K	O	P	T	CAST IRON TERMINAL BOX AA	AB	AC	AF	BA	EV	AUX C/BOX (8) AAX	LX	PX
254T–256T	12.50	6.25	5.00	.75	.56	2.50	--	13.25	13.25	2.44	1-1/4	10.81	8.81	2.50	4.25	1.00	3/4	7.06	9.31
284T–286TS	13.75	7.00	5.50	.75	.56	2.50	--	14.75	14.88	2.44	1-1/2	12.62	10.19	3.00	4.75	1.00	3/4	7.63	10.50
324T–326TS	15.50	8.00	6.25	.88	.69	2.75	4.50	16.69	17.00	2.44	2	15.44	11.69	3.62	5.25	1.38	3/4	8.75	10.50
364T–365TS	17.00	9.00	7.00	.88	.69	2.75	3.88	18.50	19.50	2.94	3	18.00	13.81	4.12	5.88	1.38	3/4	9.12	11.62
404T–405TS	19.00	10.00	8.00	1.12	.81	3.25	4.62	21.31	22.50	2.94	3	19.25	15.08	4.12	6.62	1.13	3/4	9.62	14.44
444T–445TS	21.00	11.00	9.00	1.12	.81	3.25	5.25	23.38	25.25	3.25	3	22.19	17.44	6.00	7.50	1.25	3/4	11.12	15.25
(1)																			

FRAME SIZE	C	BS	B	2F	(4) 2XF	N	SHAFT AND KEY N-W(6)	U(3)	V	SQ.	LGTH.	WEIGHT LBS. (5)
254T	24.58	5.00	12.00	---	8.25	4.12	4.00	1.625	3.75	.375	2.88	335
256T	24.58	5.00	12.00	10.00	---	4.12	4.00	1.625	3.75	.375	2.88	345
284T	27.44	5.50	13.00	---	9.50	5.00	4.62	1.875	4.38	.500	3.25	475
284TS	26.06	5.50	13.00	---	9.50	3.62	3.25	1.625	3.00	.375	1.88	470
286T	27.44	5.50	13.00	11.00	---	5.00	4.62	1.875	4.38	.500	3.25	490
286TS	26.06	5.50	13.00	11.00	---	3.62	3.25	1.625	3.00	.375	1.88	490
324T	30.44	6.00	14.75	---	10.50	5.62	5.25	2.125	5.00	.500	3.88	590
324TS	28.94	6.00	14.75	---	10.50	4.12	3.75	1.875	3.50	.500	2.00	580
326T	30.44	6.00	14.75	12.00	---	5.62	5.25	2.125	5.00	.500	3.88	630
326TS	28.94	6.00	14.75	12.00	---	4.12	3.75	1.875	3.50	.500	2.00	630
364T	33.44	6.12	15.00	---	11.25	6.25	5.88	2.375	5.62	.625	4.25	865
364TS	31.31	6.12	15.00	---	11.25	4.12	3.75	1.875	3.50	.500	2.00	850
365T	33.44	6.12	15.00	12.25	---	6.25	5.88	2.375	5.62	.625	4.25	890
365TS	31.31	6.12	15.00	12.25	---	4.12	3.75	1.875	3.50	.500	2.00	884
404T	38.31	6.88	16.00	---	12.25	7.50	7.25	2.875	7.00	.750	5.62	1220
404TS	35.31	6.88	16.00	---	12.25	4.50	4.25	2.125	4.00	.500	2.75	1211
405T	38.31	6.88	16.00	13.75	---	7.50	7.25	2.875	7.00	.750	5.62	1260
405TS	35.31	6.88	16.00	13.75	---	4.50	4.25	2.125	4.00	.500	2.75	1251
444T	44.62	8.25	19.00	---	14.50	8.94	8.00	3.375	8.25	.875	6.88	1670
444TS	40.88	8.25	19.00	---	14.50	5.19	4.75	2.375	4.50	.625	3.00	1664
445T	44.62	8.25	19.00	16.50	---	8.94	8.50	3.375	8.25	.875	6.88	1880
445TS	40.88	8.25	19.00	16.50	---	5.19	4.75	2.375	4.50	.625	3.00	1844
(1)												

(1) SPECIAL DIMENSIONS APPLYING TO THIS ORDER ON THIS LINE.

(2) "D" VARIES — 250T – 320T +.00, –.03. / 360T – 440T +.00, –.06.

(3) "U" VARIES — UP TO 1.625 DIA. +.0000, –.0005 / 1.625 AND LARGER +.000, –.001.

(4) ALL FRAMES HAVE EIGHT MOUNTING HOLES FOR DUAL MOUNTING.

(5) MOTOR WEIGHTS MAY VARY BY 15% DEPENDING UPON RATING.

(6) "N-W" VARIES +.00, –.25.

(7) GROUND SCREW HOLE 3/8-16 TAP 1 TO 200 HP ABOVE 200 HP 1/2-13

(8) AUXILIARY CONDUIT BOX SUPPLIED ONLY WHEN REQUESTED

CONDUIT BOX LOCATED ON OPPOSITE SIDE WHEN F-2,W-1, W-4,W-5,W-7, OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .001 T.I.R. UP TO AND INCLUDING 1.625 DIA. AND .0015 T.I.R. BALL BEARINGS .002 T.I.R. ROLLER BEARINGS FOR LARGER DIAMETERS.

FRAME-________ TYPE-________ CERTIFIED FOR-________
ORDER-________ ITEM-________ HP-________ RPM-________ PH-________ HZ ________ VOLTS________
SALES ORDER-________ APPROVED BY-________ DATE ________

BALDOR • DODGE • RELIANCE
DIM SHT TEFC 250T-440TS STD BRKT 841-XL C BOX ON TOP
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.
REV. DESC: EDIT HEADER
REV. LTR: B
FILE: \RAG\00005\357
MTC -
VERSION: 02
REVISED: 15:08:01 08/15/2008
TDR: 0600004453739
BY: RAGIRL

611760-570-SH1

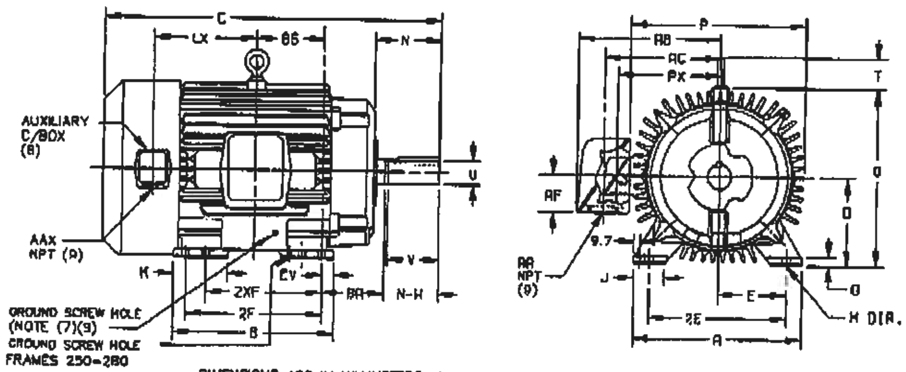
DUTY MASTER ALTERNATING CURRENT MOTORS

SQUIRREL-CAGE INDUCTION
CAST IRON CONSTRUCTION

ENCLOSURE: TOTALLY ENCLOSED — COOLING: FAN COOLED
MOUNTING: FOOT

FRAMES 250T THRU 440TS

841-XL WITH STANDARD OVERSIZED CONDUIT BOX



DIMENSIONS ARE IN MILLIMETERS; SEE SHEET 1 FOR DIMENSIONS IN INCHES

FRAME	A	D(2)	E	G	H	J	K	O	P	T	CAST IRON TERMINAL BOX AA(9)	AB	AC	AF	BA	EV	AUX C/BOX (8) AAX(9)	LX	PX
254T-256T	317.5	158.8	127.0	19.1	14.2	63.5	--	336.6	336.8	82.0	1-1/4	274.8	223.8	63.6	108.0	25.4	3/4	179.3	238.9
284T-286TS	349.3	177.8	139.7	19.1	14.2	63.5	--	374.7	378.0	82.0	1-1/2	320.5	258.8	76.2	120.7	25.4	3/4	193.8	266.7
324T-326TS	393.7	203.2	158.8	22.4	17.5	89.9	114.3	423.9	431.8	62.0	2	392.2	298.9	81.8	133.4	35.1	3/4	222.3	288.7
364T-365TS	431.8	228.6	177.8	22.4	17.5	69.9	98.5	468.9	496.3	74.7	3	437.2	350.8	104.6	149.4	35.1	3/4	231.6	295.1
404T-405TS	482.6	254.0	203.2	28.4	20.6	82.6	117.3	541.3	571.5	74.7	3	489.0	382.5	104.8	188.1	28.7	3/4	244.3	306.8
444T-445TS	533.4	279.4	228.6	28.4	20.6	82.6	133.4	593.9	641.4	82.6	3	563.6	443.0	152.4	190.5	31.8	3/4	262.4	387.4
(1)																			

FRAME SIZE	C	BS	B	2F	(4) 2XF	N	SHAFT AND KEY N-W(6)	U(3)	V	SQ.	LGTH.	WEIGHT KGS. (5)
254T	623.8	127.0	304.8	---	209.0	104.8	101.6	41.28	95.3	9.53	73.2	152
256T	623.8	127.0	304.8	254.0	---	104.8	101.6	41.28	95.3	9.53	73.2	156
284T	697.0	139.7	330.2	---	241.3	127.0	117.3	47.63	111.3	12.70	82.6	215
284TS	661.9	139.7	330.2	---	241.3	91.9	82.6	41.28	76.2	9.53	47.8	215
286T	697.0	139.7	330.2	279.4	---	127.0	117.3	47.63	111.3	12.70	82.6	222
286TS	661.9	139.7	330.2	279.4	---	91.9	82.6	41.28	76.2	9.53	47.8	222
324T	773.2	152.4	374.7	---	266.7	142.7	133.4	53.98	127.0	12.70	98.6	268
324TS	735.1	152.4	374.7	---	266.7	104.6	95.3	47.63	88.9	12.70	50.8	268
326T	773.2	152.4	374.7	304.8	---	142.7	133.4	53.98	127.0	12.70	98.6	286
326TS	735.1	152.4	374.7	304.8	---	104.6	95.3	47.63	88.9	12.70	50.8	286
364T	849.4	155.4	381.0	---	285.8	158.8	149.4	60.33	142.7	15.88	108.0	382
364TS	785.3	155.4	381.0	---	285.8	104.6	95.3	47.63	88.9	12.70	50.8	390
365T	849.4	155.4	381.0	311.2	---	158.8	149.4	60.33	142.7	15.88	108.0	404
365TS	793.3	155.4	381.0	311.2	---	104.6	95.3	47.63	88.9	12.70	50.8	401
404T	873.1	174.8	406.4	---	311.2	190.5	184.2	73.03	177.8	19.05	142.7	553
404TS	898.9	174.8	406.4	---	311.2	114.3	108.0	53.98	101.6	12.70	69.9	549
405T	873.1	174.8	406.4	349.3	---	190.5	184.2	73.03	177.8	19.05	142.7	572
405TS	898.9	174.8	406.4	349.3	---	114.3	108.0	53.98	101.6	12.70	69.9	567
444T	1133.3	209.6	482.6	---	368.3	227.1	215.9	85.73	209.6	22.23	174.8	757
444TS	1038.4	209.6	482.6	---	368.3	131.8	120.7	60.33	114.3	15.88	78.2	750
445T	1133.3	209.6	482.6	419.1	---	227.1	215.9	85.73	209.6	22.23	174.8	844
445TS	1038.4	209.6	482.6	419.1	---	131.8	120.7	60.33	114.3	15.88	78.2	838
(1)												

(1) SPECIAL DIMENSIONS APPLYING TO THIS ORDER ON THIS LINE.

(2) "D" VARIES — 280T - 320T +.0, -.8; 360T - 440T +.0, -1.5

(3) "U" VARIES — UP TO 1.625 DIA. +.000, -.013; 1.625 AND LARGER +.00, -.03

(4) ALL FRAMES HAVE EIGHT MOUNTING HOLES FOR DUAL MOUNTING.

(5) MOTOR WEIGHTS MAY VARY BY 15% DEPENDING UPON RATING.

(6) "N-W" VARIES +.0, -6.4

(7) GROUND SCREW HOLE 3/8-16 TAP 1 TO 200 HP ABOVE 200 HP 1/2-13. SEE NOTE (9)

(8) AUXILIARY CONDUIT BOX SUPPLIED ONLY WHEN REQUESTED

(9) DIMENSIONS ARE IN INCHES

CONDUIT BOX LOCATED ON OPPOSITE SIDE WHEN F-2, W-1, W-4, W-5, W-7, OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .03 T.I.R. UP TO AND INCLUDING 41.28 DIA. AND .038 T.I.R. BALL BEARINGS .05 T.I.R. ROLLER BEARINGS FOR LARGER DIAMETERS.

FRAME-________ TYPE-________ CERTIFIED FOR-________

ORDER-________ ITEM-________ HP-________ RPM-________ PH-________ HZ ________VOLTS________

SALES ORDER-________ APPROVED BY-________ DATE ________

BALDOR • DODGE • RELIANCE

DIM SHT TEFC 250T-440TS STD BRKT 841-XL C BOX ON TOP

CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

REV. DESC: ECN HEADER | TDR: 0000004533739
REV. LTR: B | VERSION: 02
FILE: \RAGC\00005\359 | REVISED: 16:04:46 01/15/2008
MTL: - | BY: RAGNHL

(2)

611760-570-SH2

Volume II

Digester Skim Pump 50P1120

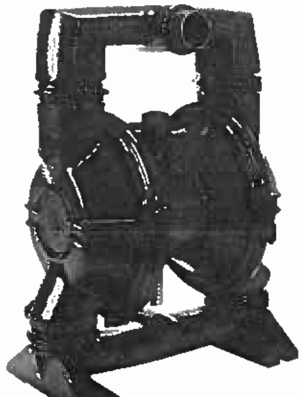
Attachment 2.11

Digester/Skum Pump

Air Operated
Diaphagm Pumps

AOD®

3" Metallic



FEATURES

- **Stall-Free Design**—Our "posi-shift", tandem spool air distribution valve insures reliable operation in all types of low pressure and start/stop applications. Plus, fewer parts and no o-rings result in easier maintenance.
- **Oil-less operation**—No metal to metal wearing surfaces. State-of-the-art materials and precision-manufacturing techniques combine to provide the industry's original completely oil-less design. This design means: no oil misting into the environment no unhealthy working conditions no oil, lubricants or grease to contaminate your products. Our oil-less design results in lower operating and maintenance costs. This design has been field proven, working trouble-free since its introduction over 15 years ago.
- **Externally Serviceable Air Valve**—No need to disassemble the pump for routine maintenance. The air valve can be quickly and easily maintained with minimal downtime.
- **Quiet Operation**—Air valve design minimizes exhaust noise providing a significantly quieter work environment.
- **Variety of Elastomers**—AOD® pumps can be assembled with the elastomer that matches your application; Neoprene, Buna-N, Nordel®, Teflon®, Santoprene® and Viton® are all available.
- **Plastic Air Valve Body**— Models up to 1 1/2" incorporate plastic air valve bodies for greater corrosion resistance in aggressive environments.

PRICE PUMP CO.

Form #AOD3-M 10/03

AOD3 -A,-C

Elastomers

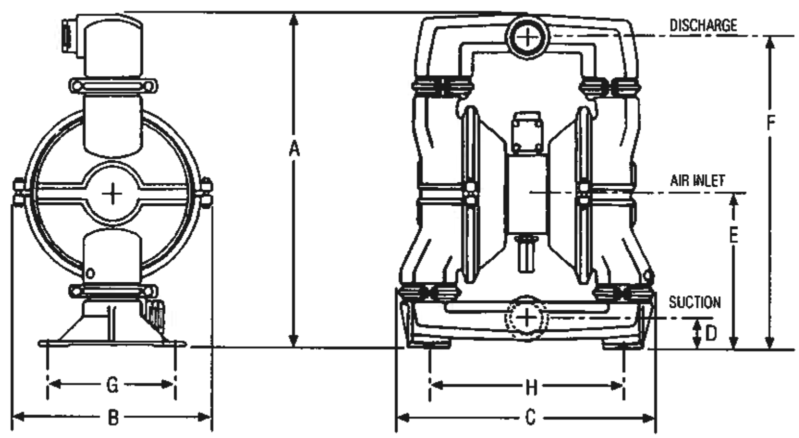
Neoprene
Viton®
Teflon®
Buna-N
Nordel
Santoprene®

Pump Body Materials

A - Aluminum
C - Cast Iron

Applications

- AIRCRAFT INDUSTRY
- AUTOMOTIVE
- BEVERAGE INDUSTRY
- CHEMICAL AND PETROLEUM
- GLASS AND FIBERGLASS
- MARINE
- METAL AND STEEL
- MINE AND CONSTRUCTION
- PAINT
- PAPER AND WOOD

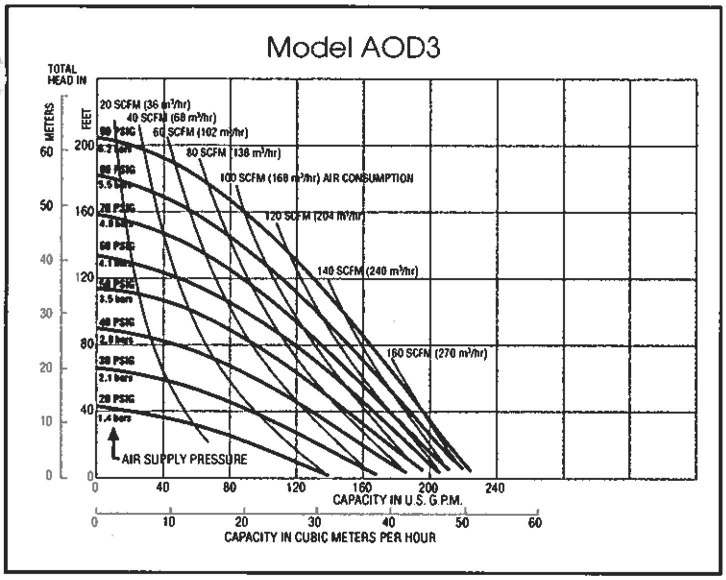


MODEL	Aluminum AOD3-Axxx	Cast Iron AOD3-Cxxx AOD3-Cxxx-B
SUCTION (BOTTOM)	3" MNPT,BSP	3" FNPT,BSP
DISCHARGE (TOP)	3" MNPT,BSP	3" FNPT,BSP
A Inches (mm) Inches (mm)	30 7/16 (773)	28 3/8 (721)
B Inches (mm) Inches (mm)	14 3/8 (365)	14 3/8 (365)
C Inches (mm) Inches (mm)	21 7/16 (545)	19 7/8 (505)
Air inlet size	3/4" NPT	3/4" NPT
Air exhaust size	3/4" NPT	3/4" NPT
D Suction Dimension Inches (mm)	3 1/8 (79)	2 1/2 (64)
E Air Inlet Dimension Inches (mm)	21 (533)	19 11/16 (500)
F Discharge Dimension Inches (mm)	28 5/16 (719)	26 1/8 (664)
G Mounting Dimension Inches (mm)	12 (305)	10 5/16 (270)
H Mounting Dimension Inches (mm)	15 9/16 (395)	14 7/8 (378)

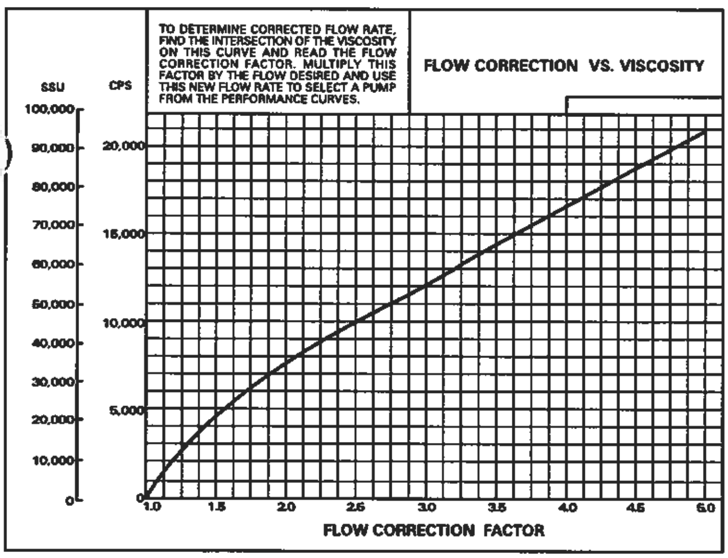
CE Ex

AOD® is a registered trademark of Price®Pump Co.; Teflon® is registered trademark of Dupont; Viton® and Nordel® are registered trademarks of Dupont Dow Elastomers; Santoprene® is a registered trademark of Monsanto Company.

Model AOD3-A, AOD3-C



The performance curves shown and other published literature reflect an average performance for all materials and all elastomers, including Teflon®. No derating of the performance is neccessary for Teflon® fitted pumps.



Technical Data	
Maximum flow GPM (litres per minute)	230 (871)
Displacement/Stroke Gal (litres) **Elastomer Diaphragms** **Teflon® Diaphragms**	 .87 (3.3) .82 (3.1)
Max Air Inlet Pressure PSI (bar)	125 (8.8)
Max Spherical Solids Size IN (mm)	7/16 (11)
High Temperature Limit °F (°C) AL, CI	248 (120)
Low Temperature Limit °F (°C)	32 (0)
Shipping Weight Lbs (kg) Aluminum Cast Iron	 124 (56.2) 223 (101)

Elastomer Kits
Maximum Liquid Temperature

MATERIAL	AL	CI	P/N
Neoprene	180°F (82°C)	180°F (82°C)	45-332-00
Buna-N	180°F (82°C)	180°F (82°C)	45-332-10
Viton®	248°F (120°C)	248°F (120°C)	45-332-20
Nordel	180°F (82°C)	180°F (82°C)	45-332-30
Teflon® Al	212°F (100°C)	212°F (100°C)	46-429-56
Teflon® CI	212°F (100°C)	212°F (100°C)	46-438-00
Santoprene®	212°F (100°C)	212°F (100°C)	45-432-60

Materials of Construction	
Air valve housing	aluminum 356-T6
Air chambers	aluminum 356-T6
Spool Housing	aluminum 356-T6
Pump external finish	enamel blue paint
Valve type	elastomeric ball

Suction Lifts

Elastomer type (Material)	dry prime FT	dry prime metres	wet prime FT	wet prime metres
Standard (CI, Al)	11	3.4	13	4.0
Teflon® (CI, Al)	11	3.4	13	4.0

PRICE® PUMP CO.

21775 Eight St. East, P.O. Box Q
Sonoma, CA 95476-0329
(800) 345-PUMP
(707) 938-8441 FAX: (707) 938-0764
www.pricepump.com
e-mail: sales@pricepump.com

Your Local Price® Pump Distributor:

Price® Pump Co.

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

3" AIR OPERATED DIAPHRAGM PUMPS METALLIC

MODELS: 3 AOD-A
3 AOD-C

ALL ELASTOMERS

Price® Pump Company
P.O.Box Q
Sonoma, CA 95476
Tel: 707-938-8441
Fax 707-938-0764
Email: sales@pricepump.com

PLEASE FILL IN DATA FROM YOUR PUMP NAMEPLATE

Pump Model____________________

Spec. No.____________________

Serial No.____________________

Seal No.____________________

RETAIN MANUAL FOR REFERENCE

IN-AOD-300M rev. -

Congratulations

You are now the owner of a Price® Pump Co. Air Operated Diaphragm Pump. This pump was carefully inspected and subjected to final performance tests before releasing for shipment. In order to achieve maximum performance and reliability, please follow the simple instructions in this manual.

RECOMMENDED PRECAUTIONS

1. **For satisfactory operation and safety, maximum inlet air pressure must not exceed 125 psi (8.79kg/sq cm).**

2. **No modifications, additions or deletions should be made to the pump without prior approval of the factory.**

3. **Drain casing completely and flush with water before servicing pump handling volatile or harmful liquids.**

READ CAREFULLY THE CAUTION BELOW

CAUTION:

The performance of Price® pump is based on clear, cold, fresh water with suction conditions as shown on the performance curves. If used to pump other liquids, pump performance may differ from rated performance based on the different specific gravity, temperature, viscosity, etc. of the liquid being pumped. A standard pump, however, may not be safe for pumping alltypes of liquids, such as toxic, volatile or chemical liquids, or liquids under extreme temperatures or pressures.

Please consult Price® Pump catalogs as well as local codes and general references to determine the appropriate pumps for your particular application. Since it is impossible for us to anticipate every application of a Price® pump, if you plan to use the pump for a non-water application, consult Price® Pump beforehand to determine whether such application may be proper and safe under the circumstances. Failure to do so could result in property damage or personal harm.

Visit Our Web Site

www.pricepump.com

OPERATING INSTRUCTIONS
ALUMINUM, & CAST IRON AIR OPERATED DIAPHRAGM PUMPS
3AOD-A & 3AOD-C (ALL ELASTOMERS)

INSTALLATION

Bolt pump to a mounting pad using appropriately sized diameter bolts. Rubber vibration insulators should be used between the pump mounting feet and mounting pad to reduce pump vibrations and stresses. In permanent installations the pump should not be directly attached to rigid piping, but instead should be connected through flexible hoses or equivalent on both the suction and discharge. This should be done to reduce pipe stresses and vibrations which are characteristic of the reciprocating nature of the pump. A surge suppressor may be required on the discharge line of the pump if further reduction in vibration or a reduction of pulsation in the discharge flow is desired.

If the pump is used in a submerged application a line or hose should be attached to the pump air exhaust to prevent liquid from entering the air valve when the pump is shutdown or operating at low discharge heads. CARE MUST BE EXERCISED WHEN SUBMERGING THE PUMP IN CORROSIVE PUMPING MEDIA.

Suction and discharge pipe size should be at least equal to the inlet pipe diameter or larger. Larger, if highly viscous liquid is to be pumped or long lengths of pipe are used. When using suction hoses use the non-collapsing reinforced type, since this pump is capable of producing high vacuum at the suction inlet.

SOLIDS-HANDLING CAPABILITY

Price® Pump Air Operated Diaphragm Pumps will pass the following spherical solid sizes:

Model	**Size**
3 AOD-Metallic	7/16" Dia. (11mm)

If the possibility exists that larger sized solids may be suspended or carried along by the pumping media. install a strainer on the suction line with smaller sized holes than the allowable solid size. This will prevent the larger solids from entering the pump and interfering with operation of the pump ball valves.

AIR SUPPLY

The inlet to the air valve is a female 1/4" NPT. The air supply line should be sized accordingly so that there is no restriction less than inlet pipe size.

NOTE: Longer air lines require larger diameters to reduce the air system pressure loss and make available required pressure and flow at the pump air inlet. It is safe to use up to 110 psig (7.73 kg/sq cm) for pumping requirements.

WARNING: DO NOT EXCEED 125 PSIG (8.79 KG/SQ CM) AIR SUPPLY PRESSURE AS COMPONENT DAMAGE OR PERSONAL INJURY MAY RESULT.

PUMP CONTROL

The pump operating conditions, flow (GPM) and discharge head (PSIG) can be controlled in the following manner

1. Throttling the pump discharge by means of a valve on the discharge line. When the pump discharge pressure equals the air supply pressure, the pump will stop. This will not harm the pump, however, do not exceed **125 psig (8.6 kg/sq cm)** air supply pressure. The pump may be in this mode indefinitely. By opening the discharge valve the pump will resume pumping.
2. The air pressure supply can be limited to the pump. Price® Pump recommends the installation of a Price® Pump air filter/pressure regulator for all AOD applications. A globe or gate valve can be used before the regulator for on or off control. Failure to use an air pressure regulator will cause the pump air inlet pressure and thus discharge pressure to climb to maximum air system pressure when the pump is stopped.

MINIMUM AIR SUPPLY PRESSURE

This air valve incorporates a stall-free design and will begin operating with air inlet pressures as low as 5 psig.

OPERATING INSTRUCTIONS

The pump air valve is of an oilless design; that is, no lubrication is required or recommended. A clean, dry air supply should be provided for optimum air valve operation and life. In cold weather operation, or under conditions of high pump discharge pressure and relatively high humidity, air valve freezing may occur as a result of moisture in the compressed air being released. If this occurs, anti-freeze. of the ethylene glycol type, may be used in a measuring dispenser, such as an air line lubricator at the pump air inlet. The resulting mist will keep the air valve free of ice build-up.

1. In cases where there are several air-operated diaphragm pumps being used simultaneously and freezing of the air valve occurs frequently due to excessive moisture in the compressed air system, it may be advantageous to install a desiccant type compressed air dryer in the air system to purge the air supply of unwanted moisture.

   For permanent installations, an air filter and water/ oil separator should be used. This is always good practice, since it insures maximum life of the air valve moving parts and seals by keeping them clean of dirt and oil residue.

   Excessive oil and water in the inlet air supply will cause a varnish-like substance to form on the self-lubricated valve spool. This will eventually lead to valve spool "sticking* and result in erratic spool operation. Should this occur, the spool and housing bore may be cleaned with a commercial safety solvent.

2. When starting the pump, make sure all valving on the suction and discharge lines are open. The pump will not prime with the valving closed. Pump cavita-tion will occur if the suction line is restricted with foreign matter • use a suction strainer with hole size less than allowable solid size for model in question.

3. When pumping highly viscous materials, it is advisable to check the pump flow rate vs. the pump stroke rate.

PUMP MODEL	**AVG. GALS. PER STROKE***	
	Stnd. Elast.	Teflon Elast.
3AOD-Metallic	**.87 (3.3L)**	**.82 (3.1L)**

*Actual test data with flooded suction and specific gravity of 1.0.

One pump stroke is equal to one exhaust blast. The pump should not pump faster than the material is capable of being drawn into the pump. If this occurs. cavitation will occur and damage to the pump could result in time.

4. To determine maximum pumping speed, increase air supply while pump discharge increases. When discharge flow no longer increases, throttle back air until pump discharge flow starts to fall off. This point is the optimum pumping speed achievable under those controlled by either one of the two methods previously mentioned under the PUMP CONTROL section of this manual.

5. The pump air exhaust port should be kept free from blockage. The pump should never be operated submerged without installing a line to the exhaust port and directing the same above the liquid surface. An appropriately sized hose with a 1/2" male NPT connector may be piped up to the exhaust port and directed away. The exhaust line, if required, should be kept as short as possible or pump performance could be affected. If long lengths of exhaust line are necessary, increase the internal diameter of the exhaust line to minimize pressure drop and pump performance loss. If the exhaust sound level becomes too objectionable, use the air muffler provided.

   NOTE: Installing an air exhaust muffler on a submerged pump will not prevent the liquid in which the pump is submerged, from entering the air valve.

   CAUTION: If a diaphragm failure occurs, the pumping media may be blown out the exhaust port. This could be hazardous if the pumping media is toxic or aggressive. It is advisable to add a line to the exhaust port and direct it safely away when pumping toxic or aggressive media.

6. Drain pump and flush after use when pumping material which can pack, settle out of liquid suspension, or solidify in time. A packed pump can cause damage to the diaphragm clamping plates and pump shaft when started after a period of interrupted use. The pump may be inverted and drained through the discharge port and flushed through the suction port.

OPERATING TEMPERATURE

3 AOD-Metallic Wetted Parts

The pump should not be used to pump liquids above **180°F (82°C)**. Degradation of the pump elastomers will develop when the temperature of the pumping media rises above **180°F (82°C)**. For operating temperatures above **180°F (82°C)** consult factory.

TROUBLESHOOTING

1. Pump will run but will not pump.

a. check suction line for leaks.

b. tighten bolts or clamps on suction manifold of pumps.

c. material too viscous to pump at high rate of flow - slow down pump by reducing air supply to pump or use larger diameter suction line.

d. suction manifold & pump chambers misaligned - disassemble & realign.

e. suction or discharge balls jammed open with foreign object - disassemble pump & examine.

NOTE: Optimum priming speed for these pumps is obtained when air inlet pressure is maintained between **15-20 psi, (1.0-1.4 kg/cm2)** with open pump discharge.

2. Air bubbles in pump discharge

a. check suction line and manifold bolts or clamps for leaks

b. cracked or ruptured diaphragm

3. Intermittent pump operation and/or ice blowing from exhaust port

a. remove obstruction from suction line

b. valve freeze-up - install de-icer on air inlet line or suitable air dryer in compressed air line.

c. sticky air valve - remove main spool & clean with safety solvent.

4. Pump stops pumping.

a. increase air supply pressure - DO NOT exceed 125 psig (8.79 kg/cm2) under any circumstances and check for obstruction in suction or discharge line.

b. spool sticking - remove main spool & clean with safety solvent - install suitable filter on air inlet if dirt or contaminants persist.

c. air valve ice-up - excess moisture on the muffler is an indication that significant water is present in the air supply. Depending on the degree of severity, an in line water separator or air dryer is recommended.

5. Severe pump vibration with intermittent flow.

a. ruptured diaphragm - disassemble pump, replace diaphragm and clean air valve if necessary.

b. mechanical failure - disassemble pump and inspect for bent shaft, etc.

6. Pumping media leaking from exhaust port.

a. ruptured diaphragm - disassemble pump, replace diaphragm - clean air valve if necessary.

7. Varying pump discharge per stroke.

a. remove suction manifold and check for obstructions.

b. worn or leaky ball valves & seats - disassemble pump and replace worn parts.

c. check to make sure bolts are fastened tightly and retorque them if necessary.

8. Slowing of pumping action

a. clogged air exhaust muffler - replace

b. ice build up in air valve - install de-icer on air inlet line

PUMP DISASSEMBLY INSTRUCTIONS

Prior to disassembly of any AOD pump follow the "caution" below.

CAUTION; Do not attempt to perform any maintenance or repair on the air operated diaphragm pumps until the compressed air line to the pump and pump discharge line has been shut off, bled down, and disconnected. In addition, when pumps are being used to pump toxic or aggressive media the pumps should be flushed clean prior to disassembly.

DISASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, ALUMINUM

STANDARD ELASTOMERS

(refer to Fig. 1, page 12)

1. Pump should be disassembled in the normal upright position. Remove small clamp (27) from the discharge or top manifold (23). Remove manifold, ball valves (29), and ball seats (28). Check for excessively worn seats and replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove clamps (27) from suction or lower manifold (24). Remove remaining pump from manifold & place on table. Perform same inspections on balls and seats as in step #1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 12 1/2" dia. (318 mm) clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1), air chamber flange (10) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   <u>CAUTION:</u> Do **not** use a metal headed hammer on the pump chamber.
4. Place ESNA locknut on end of pump shaft in a table vise and loosen opposing ESNA locknut (2) with wrench. Remove locknut (2), outer diaphragm plate (4), diaphragm (6), "0" ring (5), inner diaphragm plate (7), and rubber bumper (8), from pump shaft (16). Check diaphragm, rubber bumper, and "0" ring for wear and replace if necessary.
5. Remove shaft (16) and remaining diaphragm (attached) from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove locknut and remaining parts.
6. Disassemble air chambers (10) & (11) from air valve housing by removing five 3/8" socket flat head screws (9) from the air chamber.
7. Remove & replace shaft gasket (14) in air chamber.
8. Remove pilot spool gasket (12) from the air chamber and replace if worn excessively.
9. Repeat steps 6 thru 8 for the opposing air chamber.
10. Refer to air valve disassembly instructions in another section of this manual.

REASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, ALUMINUM

STANDARD ELASTOMERS

(refer to Fig. 1, page 12)

1. Place the completed air valve housing assembly on a clean firm surface.

   AIR CHAMBERS ASSEMBLY

   a. Place air chambers (10) and (11) on a clean firm surface with the larger opening facing down.

   b. When installing the POLYPAK seals (12) and (14), the cupped side must face down toward the large opening of the air chamber.
2. Spray one gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
3. Carefully align and place air chamber (10) onto air valve housing assembly.
4. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9) and add a drop of Loctite #242 on the threads. Screw in fasteners (9) until they contact the air chamber. DO NOT TIGHTEN.
5. Turn air valve assembly over and insert the pilot spool assembly (88).
6. Spray the second gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
7. Carefully align and place Air Chamber (11) onto Air Valve Housing assembly.

   NOTE: Gently slide the Air Chamber down the Pilot Spool making sure not to roll the cupped edge.
8. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9). Also, add a drop of Loctite #242 on the threads. Screw in fasteners (9) till they contact the Air Chamber.
9. Spray silicon spray on pump shaft (16) and gently insert it into the air valve assembly.
10. Using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
11. Turn air valve assembly over and using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
12. Be sure the Pilot Spool (88) and pump shaft (16) move freely with some resistance.
13. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws. Assemble new diaphragm (6) (if necessary) with convex side facing upward, diaphragm clamping plates (4) and (7) and new "0" ring (5). Install locknut (2) to shaft. Tighten but do not torque down until later on during reassembly.
14. Insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft must not bind. Bottom out diaphragm in air chamber. Invert assembly and place new rubber bumper, remaining diaphragm, clamping plates, etc. in same procedure as step #13 above. Put ESNA locknut on end of shaft in table vise.
15. Place wrench on opposing lock nut (2) at opposite end of pump shaft. Torque to **80 ft. lb. (108 n-m)**. Be sure both outer diaphragm plates are tightened to **80 ft. lb. (108 n-m)**.

    <u>CAUTION:</u> Be sure inner clamp plates do not rotate while tightening. They could damage pilot spool end caps if allowed to rotate while in contact with pilot spool. Tightened to a torque of **80 ft. lb. (108 n-m)**.
16. To assemble pump chambers (1 to air chambers (11), start with either diaphragm which as the convoy side outward. Secure diaphragm in groove of chamber casting. Place pump chamber previously marked with an index mark (felt pen) to match index mark on air chamber (both suction and discharge ports on pump chamber should be located on a vertical center line through the air valve assembly). If replacing a pump chamber (1), do this roughly by eye. Assemble 12 1/2" (318 mm) dia. clamp quarters (22) and hardware to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first prying up diaphragm plate with large screwdrivers until diaphragm sits securely in groove cast in pump chamber and air chamber castings. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump flange - they should be parallel to the eye.

    <u>NOTE</u>: The pump may leak if these surfaces are not parallel - the pump placed on a flat surface will give a good indication of parallelism.
17. Tighten 12 1/2" (318 mm) clamps (22) by tapping clamps with a wooden or fiber mallet while tightening the 3/8" clamp capscrews. Torque cap screws to approximately **13-20 ft lb. (17-27 n-m)**. Do not over tighten. Check alignment once again. If ok, proceed. If not loosen clamps and realign.
18. Place new valve seat (28) in counterbore holes in suction manifold (24).

    <u>NOTE</u>: Be sure the raised "0" ring on the valve seat must be facing downward toward the counterbore hole. Surfaces for valve seats should be free of nicks, dents, and scratches.
19. Place ball valves (29) in valve seats & assemble pump to manifold and fasten using 3 1/2" dia. clamp halves (27) and attaching hardware (25) & (26). Gently tap clamps while assembling to insure a good seal. Flanges should match evenly before clamps are tightened. Tighten 3 1/2" dia. clamps to 50 inch lbs. (6 n-m).
20. Repeat step #18 for discharge manifold (23) and associated balls, seats, clamps, etc. to complete assembly.

DISASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, ALUMINUM

TEFLON ELASTOMER

(refer to Fig. 2, page 13)

1. Pump should be disassembled in the normal upright position. Remove small clamp (27) from the discharge or top manifold. Remove manifold (23). teflon "0" rings (47), ball valves (29), and ball seats (28). Check for wear on balls and seats and damage to the teflon "0" rings. If ball has deep gouges or cuts replace it.
2. Remove clamps (27) from suction or lower manifold (24). Remove remaining pump from manifold & place on table. Perform same inspections on balls, seats, and "0" rings, as in step #1 above. Heavily worn balls, seats, and "0" rings will affect pump performance.
3. Remove 12 1/2" dia. (318 mm) clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1), air chamber flange (10) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place ESNA locknut (2) on end of pump shaft in a table vise and loosen opposing ESNA locknut (2) with wrench. Remove locknut (2), outer diaphragm plate (4), diaguard (50), diaphragm (6), backing diaphragm (48), inner diaphragm plate (7), and rubber bumper (8), from pump shaft (16). Check diaphragm and rubber bumper for wear. Replace inf necessary. The gortex tape (51) will need to be replaced if damaged. The tape ensures proper diaphragm sealing.
5. Remove shaft (16) and remaining diaphragm (attached) from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove locknut and remaining parts.
6. Disassemble air chambers (10) & (11) from air valve housing by removing five 3/8" socket flat head screws (9) from the air chamber.
7. Remove & replace shaft gasket (14) in air chamber.
8. Remove pilot spool gasket (12) from the air chamber and replace if worn excessively.
9. Repeat steps 6 thru 8 for the opposing air chamber.
10. Refer to air valve disassembly instructions in another section of this manual.

DISASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, ALUMINUM

TEFLON ELASTOMER

(refer to Fig. 2, page 13)

1. Place the completed air valve housing assembly on a clean firm surface.

   AIR CHAMBERS ASSEMBLY

   a. Place air chambers (10) and (11) on a clean firm surface with the larger opening facing down.

   b. When installing the POLYPAK seals (12) and (14), the cupped side must face down toward the large opening of the air chamber.
2. Spray one gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
3. Carefully align and place air chamber (10) onto air valve housing assembly.
4. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9) and add a drop of Loctite #242 on the threads. Screw in fasteners (9) until they contact the air chamber. DO NOT TIGHTEN.
5. Turn air valve assembly over and insert the pilot spool assembly (88).
6. Spray the second gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
7. Carefully align and place Air Chamber (11) onto Air Valve Housing assembly.

   NOTE: Gently slide the Air Chamber down the Pilot Spool making sure not to roll the cupped edge.
8. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9). Also, add a drop of Loctite #242 on the threads. Screw in fasteners (9) till they contact the Air Chamber.
9. Spray silicon spray on pump shaft (16) and gently insert it into the air valve assembly.
10. Using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
11. Turn air valve assembly over and using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
12. Be sure the Pilot Spool (88) and pump shaft (16) move freely with some resistance.
13. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws. Assemble new rubber bumper (8) to shaft. Assemble diaguard (50), diaphragm (6), and backing diaphragm (48), to pump shaft using the diaphragm plates (4) and (7) and rubber bumper (8). Diaphragms should be positioned so that "0" ring groove of diaphragm (6) and rubber backing diaphragm will be facing the air chambers. Lightly tighten outer diaphragm plate (4) to shaft. Diaguard should be next to outer diaphragm plate (4). Radius on edge of inner diaphragm plate (7) should face diaphragm. **Loctite #271** is recommended on threads of outer diaphragm plates (4).
14. Using water (as a lubricant) on free end of shaft, insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft must not bind. Bottom out diaphragm in air chamber. Invert assembly and place new rubber bumper, remaining diaphragms, diaguard, diaphragm plates, etc. in same procedure as step #13 above. Put hex head of outer diaphragm clamping plate on end of shaft in table vise. Use **Loctite #271** on threads of outer clamp plate (4).
15. Place wrench on opposing lock nut (2) at opposite end of pump shaft. Torque to **80 ft. lb. (108 n-m)**. Be sure both outer diaphragm plates are tightened to **80 ft. lb. (108 n-m)**.

    CAUTION: Be sure inner clamp plates do not rotate while tightening. If allowed to rotate, damage to pilot spool end caps could result.
16. To assemble pump chambers (I) to air chambers (10) & (11), secure diaphragm (6) & backing diaphragm (48) in groove of air chamber casting. Carefully align gortex tape (51) on diaphragm (6). This must be clean and undamaged to seal effectively. Replace if necessary. Place pump chamber previously marked with an index mark (felt pen) to match index mark on air chamber (both suction and discharge ports on pump chamber should be located on a vertical center line through the air valve assembly). If replacing a pump chamber (1), do this roughly by eye. Assemble 12 1/2" (318 mm) dia. clamp quarters (22) and hardware to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first prying up diaphragm plate with large screwdrivers until diaphragm sits securely In groove cast in pump chamber and air chamber castings. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump flange - they should be parallel to the eye.

    NOTE: The pump may leak if these surfaces are not parallel - the pump placed on a flat surface will give a good indication of parallelism.
17. Tighten 12 1/2" (318 mm) clamps (22) by tapping clamps with a wooden or fiber mallet while tightening the 3/8" clamp cap screws. Torque cap screws to approximately **13-20 ft lb. (17-27 n-m)**. Do not over tighten. Check alignment once again. If ok, proceed. If not loosen clamps and realign.
18. Place valve seats (28) with flat surface downward into seat ports in suction manifold (24). Then place "0" rings (47) on top of valve seats (28).

    NOTE: If existing "0" ring (47) is cut or badly scratched, it should be replaced. Otherwise, the "0" ring should be reversed from its previous installation (install used "0" ring flat side down).
19. Place ball valves (29) in valve seats & assemble pump to manifold and fasten using 3 1/2" dia. clamp halves (27) and attaching hardware (25) & (26). Gently tap clamps while assembling to insure a good seal. Flanges should match evenly before clamps are tightened. Tighten 3 1/2" dia. clamps to **50 inch lbs. (6 n-m)**.
20. Repeat step #18 for discharge manifold (23) and associated balls, seats, clamps, etc. to complete assembly.

DISASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, CAST IRON

STANDARD ELASTOMERS

(refer to Fig. 3, page 14)

1. Pump should be disassembled in the normal upright position. Remove cap screws (52), flatwashers (53), and hex nuts (54), from the discharge on top manifold (23). Remove manifold, ball valves (29), and ball seats (28). Check for excessively worn seats & replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove cap screws (52), flat washers (53) and hex nuts (54), from the suction or lower manifold (24). Remove remaining pump from suction manifold & place on table. Perform same inspections on balls and seats as in step #1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 12 1/2" (318 mm) dia. clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1) and air chamber flanges (10) & (11) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place hex head of outer diaphragm clamping plate (4) on end of pump shaft (16) in a table vise and loosen opposing outer diaphragm plate with wrench. Remove outer diaphragm plate (4), diaphragm (6), inner diaphragm plate (7), and rubber bumper from pump shaft (16). Check diaphragm and rubber bumper for wear and replace if necessary.

   NOTE: A mild heating of the outer diaphragm clamp plate using a propane torch may be necessary to degrade Loctite on shaft threads, easing outer diaphragm plate removal.
5. Remove shaft (16) and remaining diaphragm (attached) from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove diaphragm clamp plate and remaining parts.
6. Disassemble air chambers (10) & (11) from air valve housing by removing five 3/8" socket flat head screws (9) from the air chamber.
7. Remove & replace shaft gasket (14) in air chamber.
8. Remove gasket (12) from the air chamber and replace if worn excessively.
9. Repeat steps 6 thru 8 for the opposing air chamber.
10. Refer to air valve disassembly instructions in another section of this manual.

REASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, CAST IRON

STANDARD ELASTOMERS

(refer to Fig. 3, page 14)

1. Place the completed air valve housing assembly on a clean firm surface.

   AIR CHAMBERS ASSEMBLY

   a. Place air chambers (10) and (11) on a clean firm surface with the larger opening facing down.

   b. When installing the POLYPAK seals (12) and (14), the cupped side must face down toward the large opening of the air chamber.
2. Spray one gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
3. Carefully align and place air chamber (10) onto air valve housing assembly.
4. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9) and add a drop of Loctite #242 on the threads. Screw in fasteners (9) until they contact the air chamber. DO NOT TIGHTEN.
5. Turn air valve assembly over and insert the pilot spool assembly (88).
6. Spray the second gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
7. Carefully align and place Air Chamber (11) onto Air Valve Housing assembly.

   NOTE: Gently slide the Air Chamber down the Pilot Spool making sure not to roll the cupped edge.
8. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9). Also, add a drop of Loctite #242 on the threads. Screw in fasteners (9) till they contact the Air Chamber.
9. Spray silicon spray on pump shaft (16) and gently insert it into the air valve assembly.
10. Using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
11. Turn air valve assembly over and using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
12. Be sure the Pilot Spool (88) and pump shaft (16) move freely with some resistance.
13. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws. Assemble new rubber bumper (8) to shaft. Assemble new diaphragm (6) (if necessary) with convex side facing upward and diaphragm plates (4) and (7). Tighten (but do not torque down until later on during reassembly.) **Loctite #271** is recommended on internal threads of outer diaphragm plates (4).
14. Using water (as a lubricant) on end of shaft, insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft must not bind. Bottom out diaphragm in air chamber. Invert assembly and place new rubber bumper, remaining diaphragm, diaphragm plate, etc. in same procedure as step #13 above. Put hex head of outer diaphragm clamping plate on end of shaft in table vise.
15. Place wrench on hex head of opposing outer diaphragm plate at opposite end of pump shaft. Torque to **80 ft.lb. (108 n-m)**. Be sure both outer diaphragm plates are tightened to **80 ft. lb. (108 n-m)**.

    CAUTION: Be sure inner diaphragm plates do not rotate while tightening as they could damage pilot valve end caps if allowed to rotate while in contact with pilot spool.
16. To assemble pump chambers (1) to air chambers (10) & (11) start with either diaphragm which has the convex side outward. Secure diaphragm in groove in air chamber casting. Place pump chamber previously marked with an index mark (felt pen) to match index mark on air chamber (both suction and discharge ports on pump chamber should be located on a vertical center line through the air valve assembly).If replacing a pumpchamber(1), do this roughly by eye. Assemble 12 1/2" (318 mm) dia. clamp quarters (22) and hardware to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first prying up diaphragm plate with large screwdrivers until diaphragm sits securely in groove cast in pump chamber and air chamber castings. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump flange -they should be parallel to the eye.

    NOTE: The pump may leak if these surfaces are not parallel - the pump placed on a flat surface will give a good indication of parallelism.
17. Tighten 12 1/2" (318 mm) clamps (22) by tapping clamps with a wooden or fiber mallet while tightening the 3/8" clamp cap screws. Torque capscrews to approximately 13-20 ft lb. (17.27 n-m). Do not over tighten. Check alignment once again. If OK, proceed. If not, loosen clamps and realign.
18. Place a ball valve (29) and a valve seat (28) in each pump chamber (1). Be sure the raised "0" ring counter on the valve seat is facing downward toward the suction manifold. Align the suction manifold (24) and secure with cap screws (52), washers (53) and hex nuts (54).
19. The discharge manifold (23) should have two ball valves (29) and two valve seats (28) placed into it. The raised "0" ring contour should be visible when the seat (28) is placed in the manifold (23). Using cap screw (52), washer (53) and hex nut (54), secure the discharge manifold (23) with ball valve and valve seats to the pump.

DISASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, CAST IRON

TEFLON ELASTOMERS

(refer to Fig. 4, page 15)

1. Pump should be disassembled in the normal upright position. Remove cap screws (52), flatwashers (53), and hex nuts (54), from the discharge on top manifold (23). Remove manifold, ball valves (29). and ball seats (28A). Check for excessively worn seats & replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove cap screws (52), flat washers (53) and hex nuts (54), from the suction or lower manifold (24). Remove remaining pump from suction manifold & place on table. Perform same inspections on balls and seats as in step #1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 12 1/2" (318 mm) dia. clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1) and air chamber flanges (10) & (11) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place hex head of outer diaphragm clamping plate (4) in a table vise. Remove opposing outer diaphragm plate (4) with wrench. **Loctite #271** is used to secure outer diaphragm plates (4) to shaft (16). Heating hex area of outer diaphragm plate with propane torch will assist removal if difficult. The light heating will degrade strength of **Loctite #271**. Then remove diaguard (50), diaphragm (6), backing diaphragm (48), inner diaphragm plate (7), and rubber bumper (8) from pump shaft (16). Check diaphragm and rubber bumper for wear. Replace if necessary. The gortex tape (51) will need to be replaced if damaged. The tape ensures proper diaphragm sealing.
5. Remove shaft (16) and remaining diaphragm (attached) from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove diaphragm clamp plate and remaining parts.
6. Disassemble air chambers (10) & (11) from air valve housing by removing five 3/8" socket flat head screws (9) from the air chamber.
7. Remove& replace shaft gasket (14) in air chamber.
8. Remove gasket (12) from the air chamber and replace if worn excessively.
9. Repeat steps 6 thru 8 for the opposing air chamber.
10. Refer to air valve disassembly instructions in another section of this manual.

REASSEMBLY INSTRUCTIONS FOR

MODEL 3 AOD, CAST IRON

TEFLON ELASTOMERS

(refer to Fig. 4, page 15)

1. Place the completed air valve housing assembly on a clean firm surface.

   AIR CHAMBERS ASSEMBLY

   a. Place air chambers (10) and (11) on a clean firm surface with the larger opening facing down.

   b. When installing the POLYPAK seals (12) and (14), the cupped side must face down toward the large opening of the air chamber.
2. Spray one gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
3. Carefully align and place air chamber (10) onto air valve housing assembly.
4. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9) and add a drop of Loctite #242 on the threads. Screw in fasteners (9) until they contact the air chamber. DO NOT TIGHTEN.
5. Turn air valve assembly over and insert the pilot spool assembly (88).
6. Spray the second gasket (15) on both sides with 3M SUPER 77 adhesive and carefully align and place sprayed gasket (15) onto air valve housing assembly.
7. Carefully align and place Air Chamber (11) onto Air Valve Housing assembly.

   NOTE: Gently slide the Air Chamber down the Pilot Spool making sure not to roll the cupped edge.
8. Apply Permatex gasket maker to the countersink shoulder on five of the 3/8 fasteners (9). Also, add a drop of Loctite #242 on the threads. Screw in fasteners (9) till they contact the Air Chamber.
9. Spray silicon spray on pump shaft (16) and gently insert it into the air valve assembly.
10. Using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
11. Turn air valve assembly over and using a torque wrench, torque the 3/8 fasteners (9) in a cross pattern to 13 -15 ft. lbs.
12. Be sure the Pilot Spool (88) and pump shaft (16) move freely with some resistance.
13. Place Dump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws. Assemble new rubber bumper (8) to shaft. Assemble inner diaphragm plate (7), backing diaphragm (48), diaphragm (6), diaguard (50), and remaining diaphragm plate (4), to shaft (1 6). Diaphragms should be positioned so that "0" ring groove of diaphragm (6) and rubber backing diaphragm will be facing the air chambers (with convex side facing upward). Tighten, but do not torque down until later on during reassembly. **Loctite #271** is recommended on internal threads of outer diaphragm plates (4).
14. Using water (as a lubricant) on end of shaft, insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft must not bind. Bottom out diaphragm in air chamber. Invert assembly and place new rubber bumper, remaining diaphragms, diaguard, diaphragm plate, etc. in same procedure as step #13 above. Put hex head of outer diaphragm clamping plate on end of shaft in table vise. Use **Loctite #271** on threads of 7. outer clamp plate (4).
15. Place wrench on hex head of opposing outer diaphragm plate at opposite end of pump shaft. Torque to **80 ft. lb. (108 n-m)**. Be sure both outer diaphragm plates are tightened to **80 ft. lb. (108 n-m)**.

    CAUTION: Be sure inner diaphragm plates do **not** rotate while tightening. If allowed to rotate, damage to pilot spool end could result.
16. To assemble pump chambers (l) to air chambers (10) & (11), secure diaphragm (6) & backing diaphragm (48) in groove of air chamber casting. Carefully align gortex tape (51) on diaphragm (6). This must be clean and undamaged to seal effectively. Replace if necessary. Position pump chamber previously marked with an index mark (felt pen) to match index mark on air chamber (both suction and discharge ports on pump chamber should be located on a vertical center line through the air valve assembly). If replacing a pump chamber (1), do this roughly by eye. Assembly 12 1/2" (318 mm) dia. clamp quarters (22) and hardware to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first prying up diaphragm plate with large screwdrivers until diaphragm sits securely in groove cast in pump chamber and air chamber castings. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump flange - they should be parallel to the eye.

    NOTE: The pump may leak if these surfaces are not parallel - the pump placed on a flat surface will give a good indication of parallelism.
17. Tighten 12 1/2" (318 mm) clamps (22) by tapping clamps with a wooden or fiber mallet while tightening the 3/8" clamp cap screws. Torque capscrews to approximately **13-20 ft lb. (17-27 n-m)**. Do not over tighten. Check alignment once again. If OK, proceed. If not, loosen clamps and realign.
18. Place a ball valve (29) and a valve seat (28) in each pump chamber (1). Align the pump with suction manifold (24) and secure with cap screws (52), washers (53) and hex nuts (54).
19. Place a ball valve (29) and a valve seat (28) with two "0" rings (47) into each side of the discharge manifold (23). Using capscrew (52), washer (53) and hex nut (54) secure the discharge manifold (23) with ball valve and valve seats to the pump.

AIR VALVE DISASSEMBLY INSTRUCTIONS FOR MODEL 3 AOD, ALUMINUM & CAST IRON ALL ELASTOMERS

(refer to Fig. 5, page 16)

1. Remove pilot spool assembly (88) and check O.D. of phenolic (82) for wear. Replace phenolic if deeply scratched, chipped or worn.

   The pilot spool assembly can be disassembled by unscrewing the end caps (80) from the tie rod (81). Use heat from a propane torch to break down the loctite on the screw threads.

   Apply **#242 blue loctite** on reassembly.

   If bore for pilot spool has become corroded, excessively pitted, or deeply scratched, replace air valve housing (34).
2. Remove main spool end caps (36), gaskets (37), and capscrews (35), from valve housing (34).
3. Remove main spool (39) and examine spool and piston ring sets (38) for wear. Replace piston ring sets & spool if deeply scratched, chipped or worn. New spools will be interchangeable with old. If main spool bore in spool housing has become corroded, excessively pitted, or deeply scratched, replace spool housing.
4. Replace oilite bronze sleeve bushings (43) in valve housing shaft bore if worn excessively. Bushings can be removed by pressing out using a hydraulic press - care must be taken to avoid cracking the valve housing. Each bushing should protrude **0.135/ 0.125 inches (3.429/3.175 mm)** from the shaft bore. Maintain these dimensions to prevent internal air leaks.

AIR VALVE REASSEMBLY INSTRUCTIONS FOR MODEL 3 AOD, ALUMINUM & CAST IRON ALL ELASTOMERS

(refer to Fig. 7, page 20)

1. Press Oilite bronze sleeve bushings (#43) into housing shaft bore. Make sure both bushings press in squarely while leaving between .125" and .135" protruding from the shaft bore flange.

   MAIN SPOOL ASSEMBLY

   a. Inspect main spool (#39) for chips and scratches and replace if necessary. Clean main spool (#39) and spool bores in spool housing (#34) with a clean dry rag. Remove any obstructions from the signal ports in the spool housing using a pipe cleaner.

   b. Assemble the piston ring set (#38) to the main spool (#39). Place each metal expander into one of the groves on the main spool. Place a piston ring over each of the metal expanders. Note that the split in the piston ring should be placed 180° from the split in the metal expander. These parts should move freely on the main spool.
2. Insert the main spool and piston ring assembly into the air valve housing (#34). Note that the split in each piston ring should enter into the air valve housing at either the 3 or 9 o'clock position.

   NOTE: This will prevent the splits from hanging up on the housing ports during assembly. Carefully compress each piston ring set as it enters the spool bore. Be certain to push the main spool completely into the bore so that one end of the main spool is flush with one end of the spool bore. Do **NOT** assemble the main spool in a centered position or the pump will not start.
3. Install spool cap gaskets (#37) and end caps (#36) to both ends of the air valve housing (#34) and fasten with cap screws (#35). Align the slots in gaskets and caps with the 3/16 hole at the 9 o'clock position on the flange.

   NOTE: Tighten cap screws only until the gasket starts to protrude.

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MODEL 3AOD - ALUMINUM

(ALL ELASTOMERS EXCEPT TEFLON)

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	LOCK NUT
4	PLATE, DIAPHRAGM (OUTER)
5	O-RING
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW
10	CHAMBER, AIR
12	SEAL
14	SEAL
15	GASKET, AIR VALVE
16	SHAFT, PUMP
19	CAP SCREW
21	HEX NUT
22	CLAMP
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CAP SCREW
26	HEX NUT
27	CLAMP
28	SEAT, BALL VALVE
29	BALL, VALVE

KEY	TORQUE
9	100 in-lb (11 n-m)
4	80 ft-lb (108 n-m)
19,21	13-20 ft-lb (17-27 n-m)

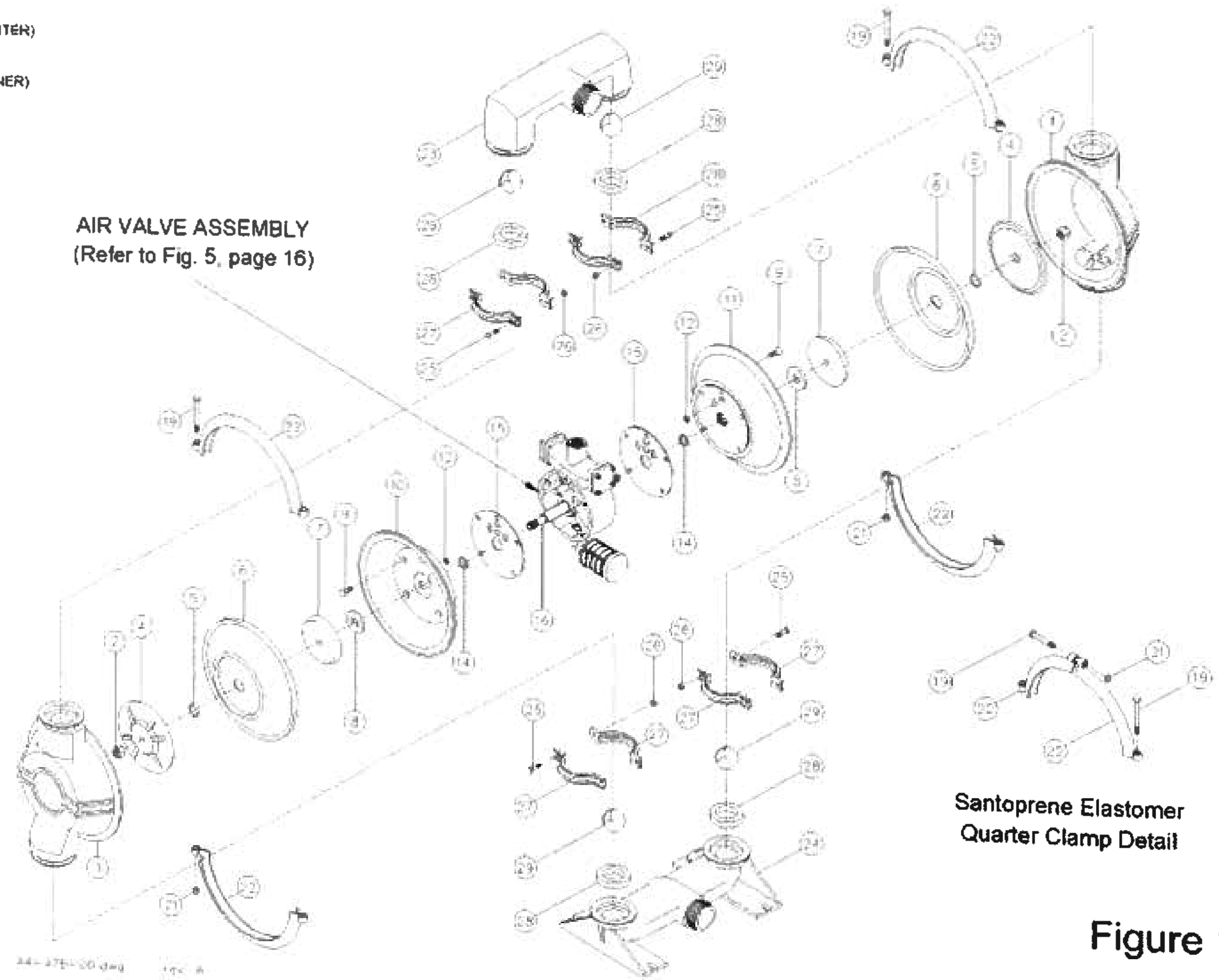


Figure 1

MODEL 3AOD - ALUMINUM
(TEFLON ELASTOMERS)

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	LOCK NUT
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW
10	CHAMBER, AIR
12	SEAL
14	SEAL
15	GASKET, AIR VALVE
16	SHAFT, PUMP
19	CAP SCREW
21	HEX NUT
22	CLAMP
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CAP SCREW
26	HEX NUT
27	CLAMP
28	SEAT, BALL VALVE
29	BALL, VALVE
47	O-RING
48	DIAPHRAGM BACK-UP
50	DIAGUARD
51	GORTEX TAPE

KEY	TORQUE
9	100 in-lb (11 n-m)
4	80 ft-lb (108 n-m)
19,21	13-20 ft-lb (17-27 n-m)

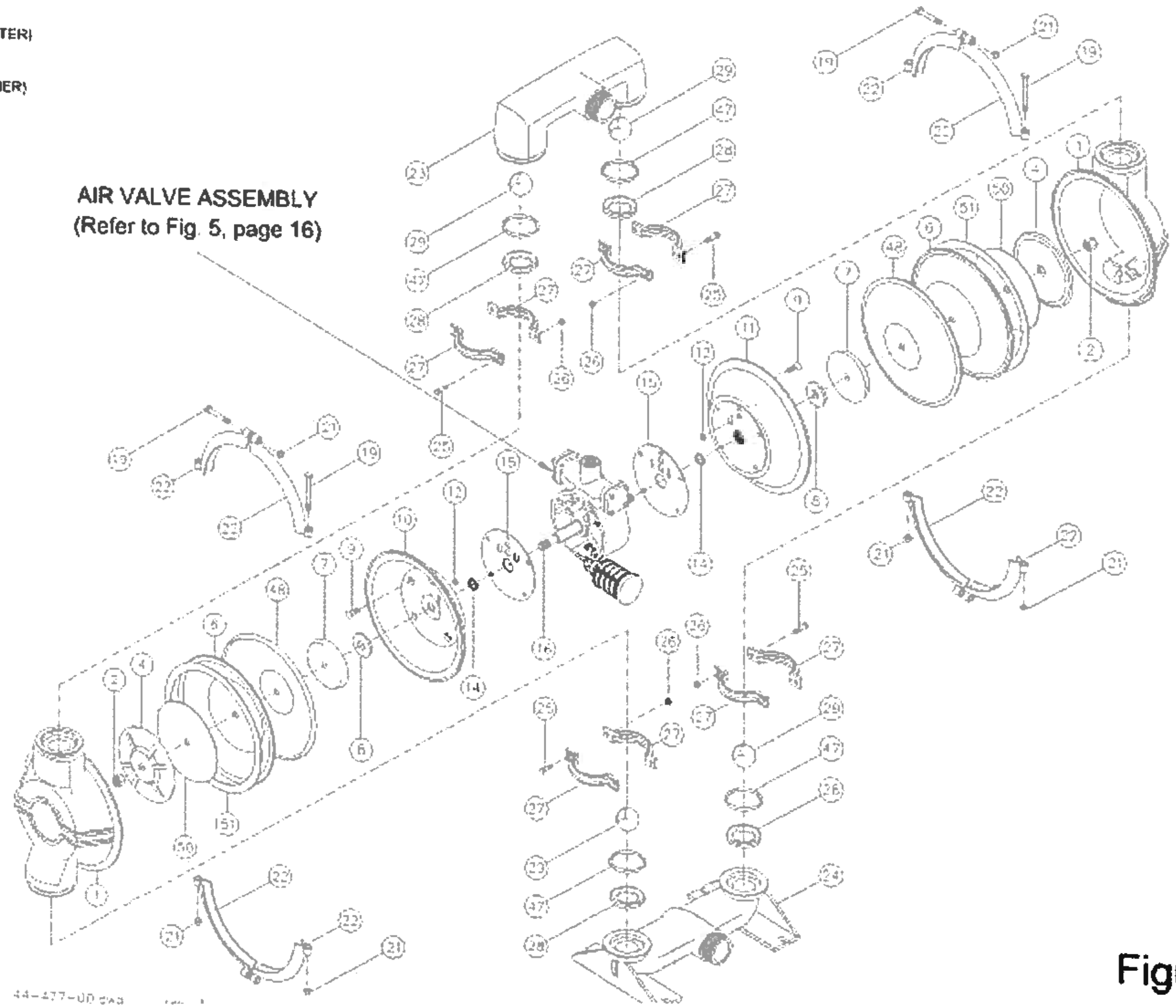


Figure 2

MODEL 3AOD - CAST IRON
(ALL ELASTOMERS EXCEPT TEFLON)

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	LOCK NUT
4	PLATE, DIAPHRAGM (OUTER)
5	O-RING
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW
10	CHAMBER, AIR
12	SEAL
14	SEAL
15	GASKET, AIR VALVE
16	SHAFT, PUMP
19	CAP SCREW
21	HEX NUT
22	CLAMP
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CAP SCREW
26	HEX NUT
27	CLAMP
28	SEAT, BALL VALVE
29	BALL, VALVE

KEY	TORQUE
9	100 in-lb (11 n-m)
4	80 ft-lb (108 n-m)
19,21	13-20 ft-lb (17-27 n-m)

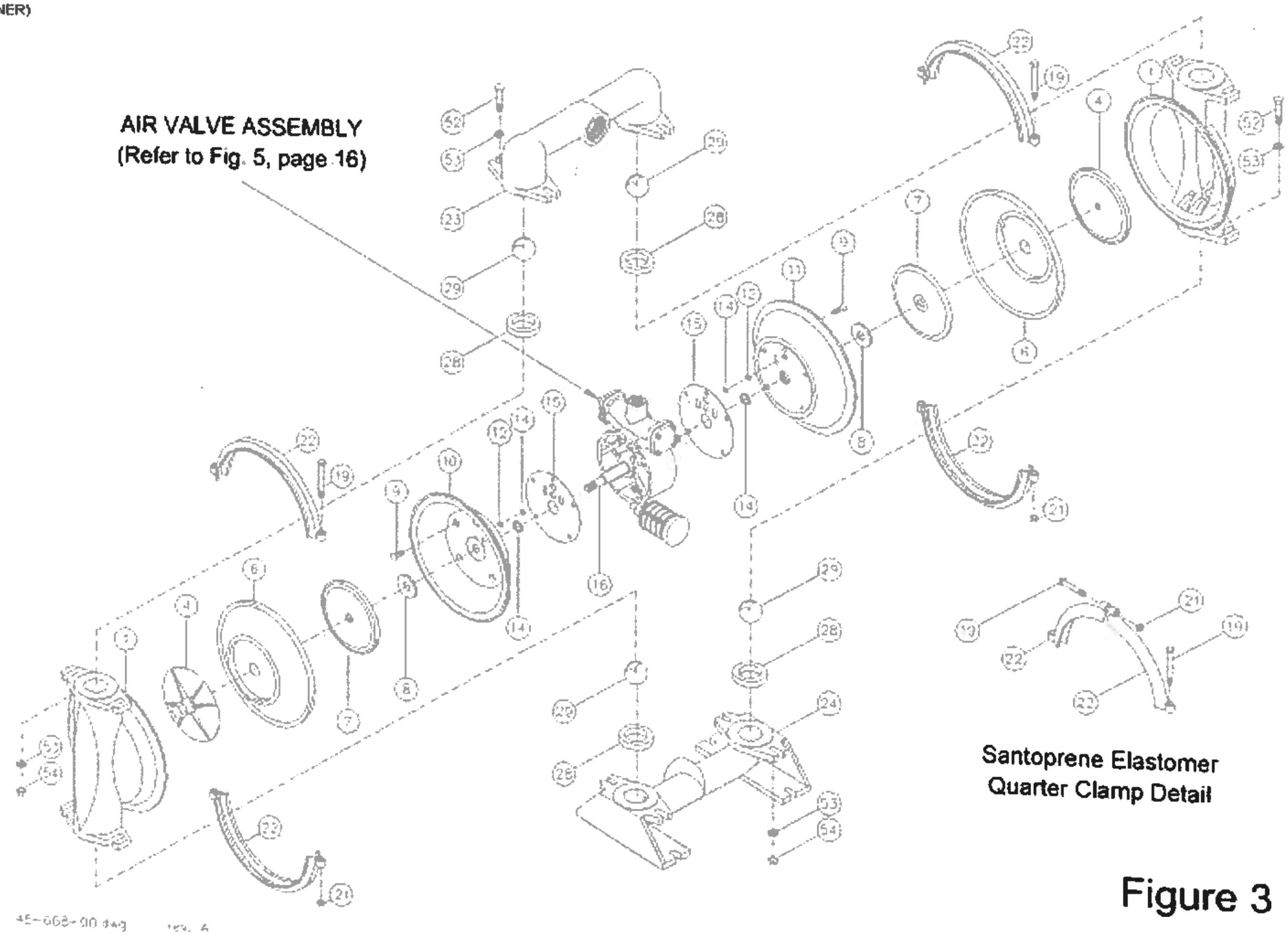


Figure 3

MODEL 3AOD - CAST IRON

(TEFLON ELASTOMERS)

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	LOCK NUT
4	PLATE DIAPHRAGM (OUTER)
5	O-RING
6	DIAPHRAGM
7	PLATE DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW
10	CHAMBER, AIR
12	SEAL
14	SEAL
15	GASKET, AIR VALVE
16	SHAFT, PUMP
19	CAP SCREW
21	HEX NUT
22	CLAMP
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CAP SCREW
26	HEX NUT
27	CLAMP
28	SEAT, BALL VALVE
29	BALL, VALVE
47	O-RING
48	DIAPHRAGM, BACKUP
50	DIAGAURD
51	GORTEX TAPE

KEY	TORQUE
9	100 in-lb (11 n-m)
4	80 ft-lb (108 n-m)
19.21	13-20 ft-lb (17-27 n-m)

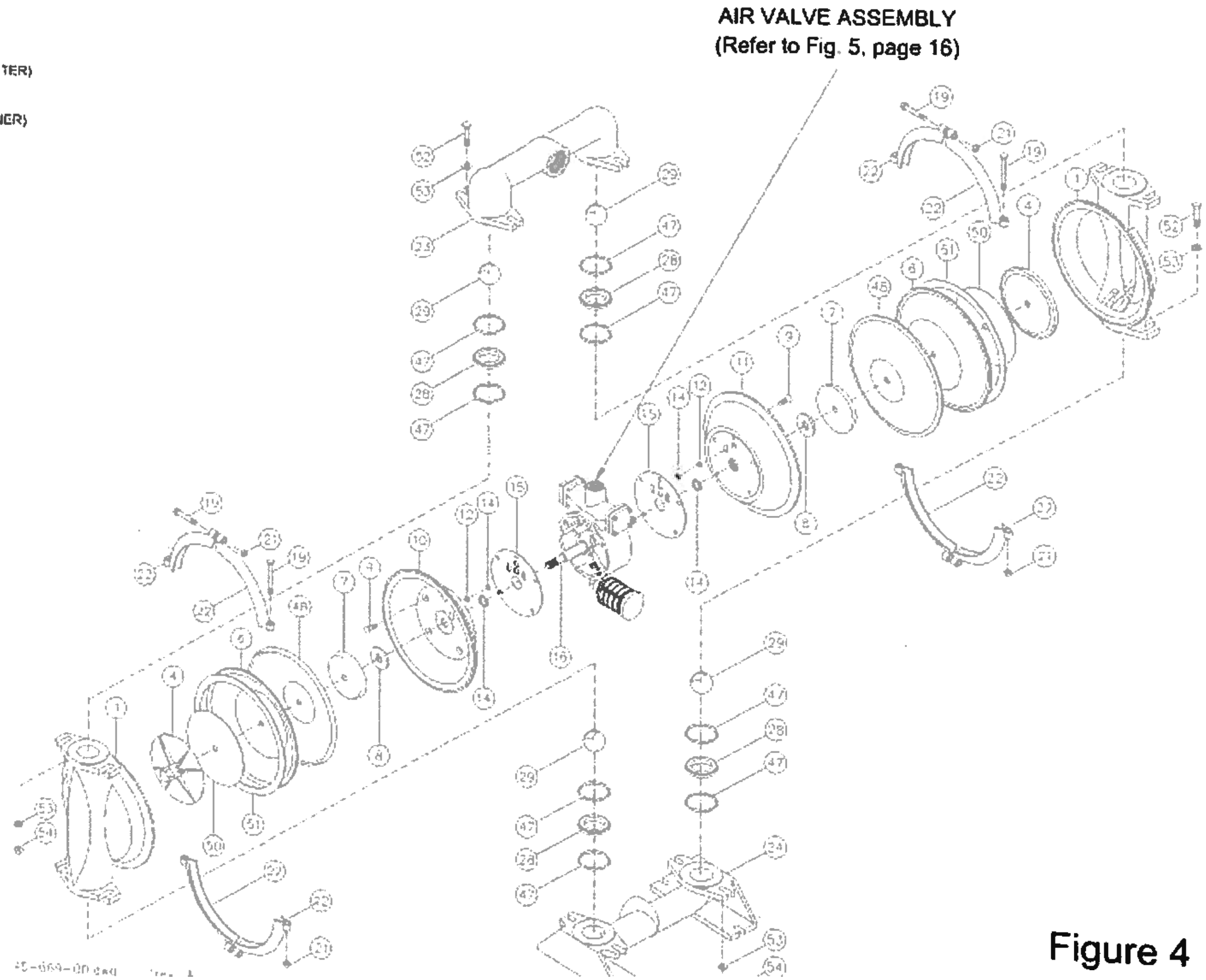


Figure 4

MODELS 2 & 3 AOD - AIR VALVE
(ALL ELASTOMERS)

KEY	DESCRIPTION
34	HOUSING, AIR VALVE
35	CAP SCREW, SOCKET HEAD
36	CAP, SPOOL HOUSING
37	GASKET, CAP
38	PISTON RING W/ EXPANDER
39	SPOOL, AIR VALVE
43	SLEEVE, BUSHING
44	MUFFLER
88	PILOT SPOOL ASSEMBLY
89	ELBOW

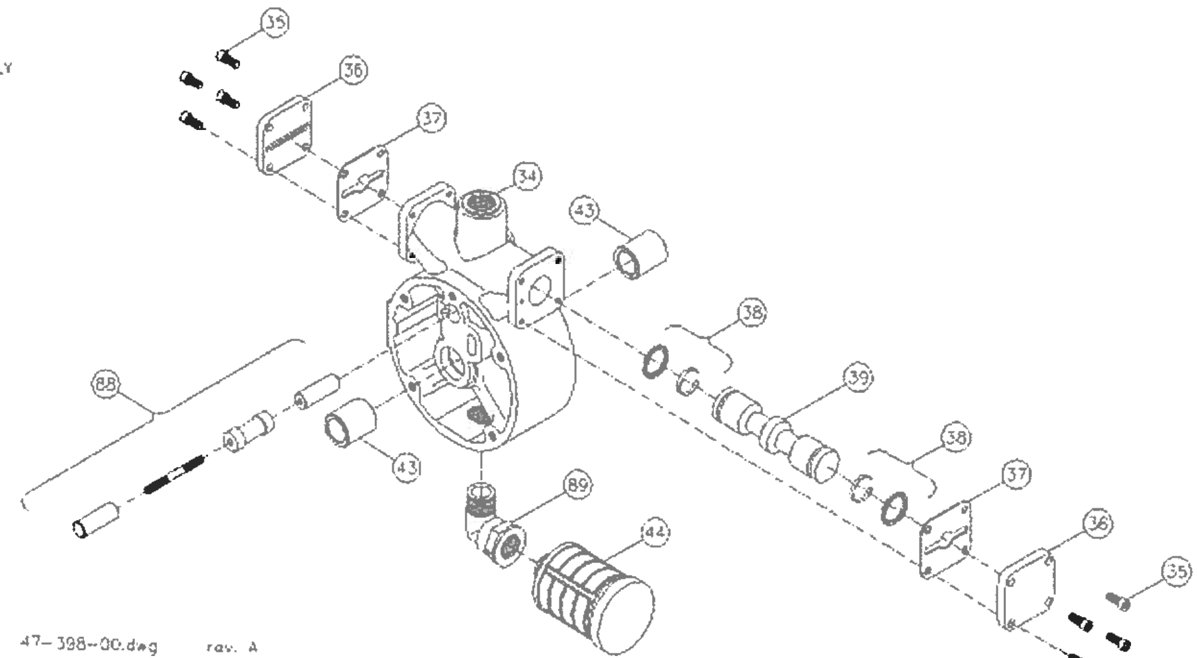


Figure 5

AOD® PUMP WARNINGS

- A Static charge buildup could occur in a plastic pump or an electrically insulated metal pump.
- Any contaminants in the air supply will be exhausted out the muffler to the atmosphere.
- All piping connections to the pump should be flexible.
- The chemical compatibility of the pump materials of construction with the fluids being pumped must be checked before use.
- AOD® pumps are not to be used for sanitary food applications.
- Submerged AOD® pumps should have their exhaust pipes away from the liquid level. A submerged pump may leak some air from gasketed joints. Do not submerge pumps in corrosive media.
- A pump which has stopped due to air valve icing will restart by itself when ice melts.
- Use only original factory replacement parts.
- Before start-up re-torque all external fasteners to the torque values listed in the I&O manual supplied with the pump.
- Pump temperature limits must be observed: Polypro pump - 150 deg F max. (65 deg. C)
Metal pump - 180 deg F max. (82 deg. C)
- Do not exceed 125 psi (8.79 bar) air inlet pressure as component damage or personal injury may result.
- AOD® pumps must only be operated by oil free, clean, dry compressed air
- Shut off, bleed down and disconnect the compressed air supply before doing any maintenance or repair to the pump.
- The pump should be flushed before disassembly. The pump should be inverted (outlet at bottom) to drain properly.
- A diaphragm failure could:
  a. cause the system to which the pump is connected to be pressurized up the the compressed air supply pressure and mix air with the fluid being pumped.
  b. Cause the fluid being pumped to be sprayed out through the exhaust muffler.
- AOD® pumps are not suitable for use with 1,1,1-trichloroethane, methylene chloride or other materials containing halogenated hydrocarbons. Aluminum wetted parts can react with these solvents and explode. Consult solvent suppliers for compatibility with aluminum before installation.
- For 1-1/2",2" and 3" AOD® pumps- CAUTION- unit weight may exceed 65lbs. (30 kg).

AOD® sound level at a distance of 1 meter with an air inet pressure of 35 psig.

Pump Size in Inches	Pump Material	Sound Pressure Level (RMS db)
1/2"	Non-Metallic	82 db
1"	Non-Metallic	82 db
1"	Metallic	82 db
1-1/2"	Metallic	82 db
2"	Non-Metallic	79 db
2"	Metallic	80 db
3"	Metallic	80 db

GENERAL TERMS OF SALE FOR PRODUCTS

1. GENERAL
   A. Seller's price is based on these sales terms and conditions. This contract shall represent the final, complete and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained or waived by parole evidence, any Terms and Conditions contained in Buyer's purchase order or request for quotation, any course of dealings between the parties, Seller's performance or delivery, or in any other way. The Terms and Conditions of this contract may only be modified or waived in a written document signed by an Officer of Seller. These terms are intended to cover all activity of Seller and Buyer hereunder, including sales and use of products, parts and work and all related matters (references to products include parts and references to work include construction, installation and start-up). Any reference by Seller to Buyer's specifications and similar requirements are only to describe the products and work covered hereby and no warranties or other terms therein shall have any force of effect. Any information provided by Seller including, but not limited to, suggestions as to specific equipment does not imply any guarantee of specific suitability and/or material compatibility in a particular application, since many factors outside the control of Seller may affect the suitability of products in a particular application. Catalogs, circulars, similar pamphlets and information contained on websites of the Seller are issued for general information purposes only and shall not be deemed to modify the provisions hereof.
   B. The agreement formed hereby and the language herein shall be construed and enforced under the Uniform Commercial Code as in effect in the State of California on the date hereof.
2. TAXES
   Any sales, use or other similar type taxes imposed on this sale or on this transaction are not included in the price. Such taxes shall be billed separately to the Buyer. Seller will accept a valid exemption certificate from the Buyer if applicable; however, if an exemption certificate previously accepted is not recognized by the governmental taxing authority involved and the Seller is required to pay the tax covered by such exemption certificate. Buyer agrees to promptly reimburse Seller for the taxes paid.
3. PERFORMANCE, INSPECTION AND ACCEPTANCE
   A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after arrival at point of delivery. Where seller has responsibility for installation, construction or start-up all work shall be finally inspected and accepted with thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer, (including claims for shortages) except only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clauses, hereof, must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty- (30) day period for each partial performance. There shall be no revocation of acceptance. Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.
   B. Seller shall not be responsible for non-performance or for delays in performance occasioned by any causes beyond Seller's reasonable control, including, by way of example and not limitation, to labor difficulties, delays of vendors or carriers, fires, governmental actions, or shortages of material, components, labor, or manufacturing facilities. Any delays so occasioned shall affect a corresponding extension of Seller's performance dates, which are, in any event, understood to be approximate. IN NO EVENT SHALL BUYER BE ENTITLED TO INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR LATE PERFORMANCE OR FOR A FAILURE TO PERFORM. Seller reserves the right to make partial shipments and to ship products, parts or work which may be completed prior to the scheduled performance date.
   C. In the event that Seller has agreed to mount motors, turbines, gears, or other products which are not manufactured by Seller and which are not an integral part of Seller's manufactured product, and a delay in the delivery of such products to Seller occurs that will cause a delay in Seller's performance date, Seller reserves the right to ship its product upon completion of manufacture and to refund an equitable portion of the amount originally included in the purchase price for mounting without incurring liability for non-performance.
   D. Seller reserves to itself the right to change its specifications, drawings and standards if such changes will not impair the performance of its products, and parts, and further that such products, and parts, will meet any of Buyer's specifications and other specific product requirements which are a part of this agreement.
   E. The manufacture and inspection of products and parts shall be to Seller's Engineering and Quality Assurance standards, plus such other inspections or tests of documentation as are specifically agreed to by Seller. Requirements for any additional inspection, tests, documentation, or Buyer witness of manufacture, test, and/or inspection shall be subject to additional charges.
4. TITLE AND RISK OF LOSS
   Title and risk of loss shall pass to buyer upon delivery of products at the designated "Ex Works" as defined by Incoterms, unless other wise agreed by the parties.
5. EROSION AND CORROSION
   It is specifically understood that products and parts sold hereunder are not warranted for operation with erosive or corrosive fluids. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore.
6. BUYERS RESPONSIBILITY
   The design specifications of the equipment require the operation of the equipment within certain parameters and may call for the use of speed controls, safety devices, set points or other control devices to insure that the operation remains within design parameters. Buyer agrees and understands that the equipment must be operated and maintained within design specifications.
7. WARRANTY AND LIMITATION OF LIABILITY.
   A. Seller warrants only that its product and parts, when shipped, will be free from defects in materials and workmanship. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and, in any event, within two (2) years of shipment by seller and all claims for defective work must be made in writing immediately upon discovery. Defective items must be held for Seller's inspection and returned to the sellers' point of original shipment upon request. UNAUTHORIZED DISASSEMBLY OR TAMPERING WITH ANY PRODUCT OR COMPONENT MAY VOID ITS WARRANTY. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY, INCLUDING WITHOUT LIMITATION, THE IMPLIED, WARRANTIES OF MERCHANTABILITY AND FITNESS.
   B. ANY PRODUCT (S) SOLD HEREUNDER WHICH ARE NOT MANUFACTURED BY SELLER ARE NOT WARRANTED BY SELLER and shall be covered only by the express warranty, if any, of the manufacturer thereof. With respect to products and parts not manufactured by Seller, Seller's only obligation shall be to assign to Buyer, to the extent possible, whatever warranty Seller obtains from the manufacturer.
   C. Upon Buyer's submission of a claim as provided above and its substantiation, Seller shall at its option either (i) repair or replace its product, part or work at the original place of shipment, or (ii) refund an equitable portion of the purchase price.
   D. THE FOREGOING IS SELLER'S ONLY OBLIGATION AND BUYER'S EXCLUSIVE REMEDY FOR BREACH OF WARRANTY AND, EXCEPT FOR THE REMEDIES PERMITTED UNDER THE PERFORMANCE, INSPECTION AND ACCEPTANCE AND THE PATENTS CLAUSES HEREOF, THE FOREGOING IS BUYER EXCLUSIVE REMEDY AGAINST SELLER FOR ALL CLAIMS ARISING HEREUNDER OR RELATING HERETO WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE OR STRICT LIABILITY) OR OTHER THEORIES. BUYER'S FAILURE TO SUBMIT A CLAIM AS PROVIDED ABOVE SHALL SPECIFICALLY WAIVE ALL CLAIMS FOR DAMAGES OR OTHER RELIEF, INCLUDING BUT NOT LIMITED TO CLAIMS BASED ON LATENT DEFECTS. IN NO EVENT SHALL BUYER BE ENTITLED TO INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, NOR FOR DAMAGES FOR LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL, WORK OR PRODUCTION STOPPAGE, IMPAIRMENT OF OTHER GOODS, INCREASED EXPENSES OF OPERATION, OR THE COST OF PURCHASING REPLACEMENT POWER OR OTHER SERVICES BECAUSE OF SERVICE INTERRUPTIONS. FURTHERMORE, IN NO EVENT SHALL SELLER'S TOTAL LIABILITY FOR DAMAGES OF BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS OR PARTS MANUFACTURED BY SELLER AND UPON WHICH SUCH LIABILITY IS BASED. ANY ACTION ARISING HEREUNDER RELATED HERETO, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES, MUST BE COMMENCED WITHIN ONE (1) YEAR AFTER THE CAUSE OF ACTION ACCRUES OR IT SHALL BE BARRED.
8. PURCHASER'S REPRESENTATIONS & WARRANTIES
   Purchaser represents and warranties that the products(s) covered by this contract shall not be used in or in connection with a nuclear facility or application. The parties agree that this representation and warranty is material and is being relied on by seller. This provision may be modified in a separate writing signed by an officer of Price Pump Co.
9. PATENTS
   Seller agrees to assume the defense of any suit for infringement of any patents brought against Buyer to the extent of such suit charges infringement of an apparatus or product claim by Seller's product in and of itself, provided (i) said product is built entirely to Seller's design, (ii) Buyer notifies Seller in writing of the filing of such suit within ten (10) days after the service of process thereof, and (iii) Seller is given complete control of the defense of such suit, including the right to defend, settle and make changes in the product for the purpose of avoiding infringement of any process or method claims. Provided however, Seller will not defend any suit for infringement of a claimed patent where such alleged infringement is the result of following specific instruction furnished by Seller.
10. EXTENT OF SUPPLY
    Only products as listed in Seller's proposal are included in this agreement. It must not be assumed that Seller has included anything beyond same.
11. MANUFACTURING SOURCES
    To maintain delivery schedules, Seller reserves the right to have all or any part of the Buyer's order manufactured at any of Sellers', sellers' licensees or sub contractors' plants, globally.
12. TERMS OF PAYMENT
    Net 30 days from date of invoice.
13. ARBITRATION
    In the event a dispute arises between the parties relating to or arising out of this agreement, the parties agree to attempt to have their senior management amicably settle the matter. In the event that the matter cannot be settled, the parties shall submit all disputes relating to this Agreement (whether contract, tort, products liability or otherwise) to binding Arbitration before a panel of arbitrators under the Commercial Dispute Resolution Procedures of the American Arbitration Association. Each party shall appoint an arbitrator and the third shall be selected in accordance with the rules of the American Arbitration Association. Judgment upon the award may be entered in any court having jurisdiction. The parties shall cooperate in providing reasonable disclosure of relevant documents. Each party shall bear its own expenses, and the costs and fees of the arbitration shall be borne as allocated by the Arbitrator.

Volume II

Filter Press/Digester Feed Pump 50P1460

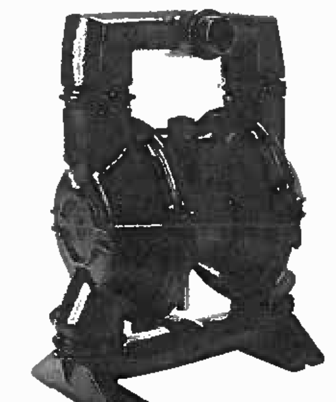
Attachment 2.12

Filter Press / Digester Feed Pump

Air Operated
Diaphagm Pumps

AOD®

1.5" Metallic



MODEL AOD1.5

FEATURES

- **Stall-Free Design**—Our "posi-shift", tandem spool air distribution valve insures reliable operation in all types of low pressure and start/stop applications. Plus, fewer parts and no o-rings result in easier maintenance.
- **Oil-less operation**—No metal to metal wearing surfaces. State-of-the-art materials and precision-manufacturing techniques combine to provide the industry's original completely oil-less design. This design means: no oil misting into the environment no unhealthy working conditions no oil, lubricants or grease to contaminate your products. Our oil-less design results in lower operating and maintenance costs. This design has been field proven, working trouble-free since its introduction over 15 years ago.
- **Externally Serviceable Air Valve**—No need to disassemble the pump for routine maintenance. The air valve can be quickly and easily maintained with minimal downtime.
- **Quiet Operation**—Air valve design minimizes exhaust noise providing a significantly quieter work environment.
- **Variety of Elastomers**—AOD® pumps can be assembled with the elastomer that matches your application; Neoprene, Buna-N, Nordel®, Teflon®, Santoprene® and Viton® are all available.
- **Plastic Air Valve Body**— Models up to 1 1/2" incorporate plastic air valve bodies for greater corrosion resistance in aggressive environments.

Note: Stainless Steel models are not sanitary rated, but may be used in certain sanitary applications.

AOD1.5-A,-S,-C

Elastomers

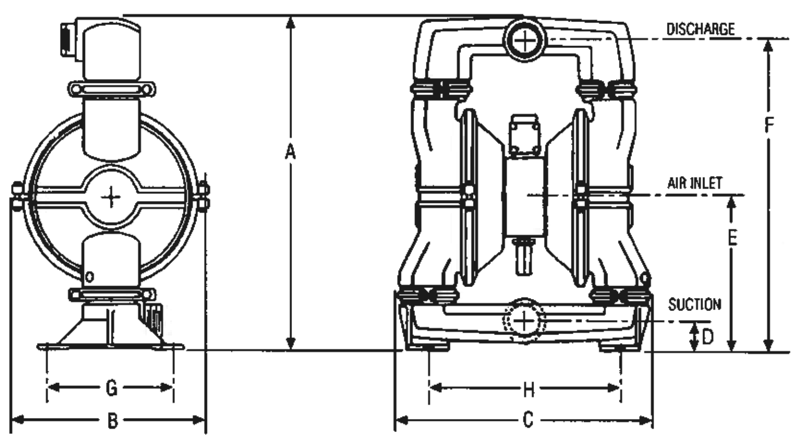
Neoprene	Buna-N
Viton®	Nordel
Teflon®	Santoprene®

Pump Body Materials

A - Aluminum
S - Stainless Steel
C - Cast Iron

Applications

- AIRCRAFT INDUSTRY
- AUTOMOTIVE
- BEVERAGE INDUSTRY
- CHEMICAL AND PETROLEUM
- GLASS AND FIBERGLASS
- MARINE
- METAL AND STEEL
- MINE AND CONSTRUCTION
- PAINT
- PAPER AND WOOD



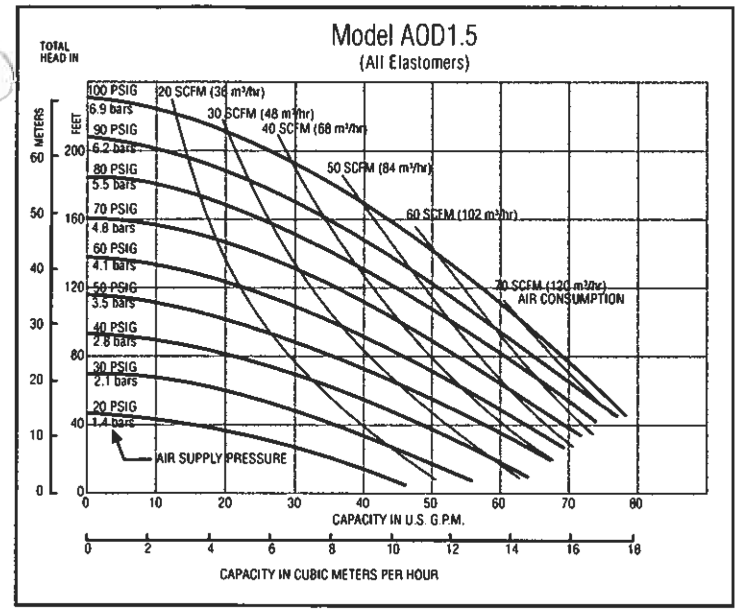
MODEL	Aluminum AOD1.5-Axxx AOD1.5-Axxx-B	Stainless Steel AOD1.5-Sxxx AOD1.5-Sxxx-B	Cast Iron AOD1.5-Cxxx AOD1.5-Cxxx-B
SUCTION (BOTTOM)	1½"MNPT,BSP	1½"FNPT,BSP	1½"FNPT,BSP
DISCHARGE (TOP)	1½"MNPT,BSP	1½"FNPT,BSP	1½"FNPT,BSP
A Inches (mm) Inches (mm)	17 1/16 (433)	17 1/16 (433)	17 ⅜ (441)
B Inches (mm) Inches (mm)	12 (305)	12 (305)	12 (305)
C Inches (mm) Inches (mm)	16 ⅞ (429)	16 ⅞ (429)	16 5/16 (414)
Air inlet size	⅜" NPT	⅜" NPT	⅜" NPT
Air Exhaust size	⅜" NPT	⅜" NPT	⅜" NPT
D Suction Dimension Inches (mm)	2 (51)	2 (51)	1 ⅝ (41)
E Air Inlet Dimension Inches (mm)	8 5/16 (211)	8 5/16 (211)	8 ⅞ (225)
F Discharge Dimension Inches (mm)	15 ¾ (400)	15 ⅝ (397)	16 ⅛ (410)
G Mounting Dimension Inches (mm)	5 ⅞ (149)	7 ⅞ (200)	6 ⅞ (175)
H Mounting Dimension Inches (mm)	13 3/16 (335)	13 ⅛ (333)	13 3/16 (335)

PRICE PUMP CO.

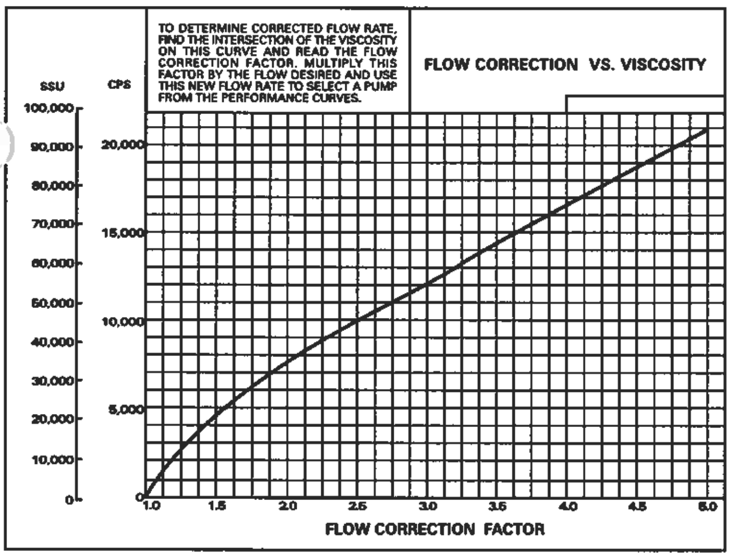
Form #AOD1.5-M 10/03

CE Ex

Model AOD1.5-A, AOD1.5-S, AOD1.5-C



The performance curves shown and other published literature reflect an average performance for all materials and all elastomers, including Teflon®. No derating of the performance is neccessary for Teflon® fitted pumps.



Technical Data	MODEL AOD1.5
Maximum flow GPM (litres per minute)	75 (284)
Displacement/Stroke Gal (litres) **Elastomer Diaphragms** **Teflon® Diaphragms**	 .35 (1.3) .20 (.75)
Max Air Inlet Pressure PSI (bar)	125 (8.8)
Max Spherical Solids Size IN (mm)	3⁄16 (4.7)
High Temperature Limit °F (°C)	180 (82)
Low Temperature Limit °F (°C)	32 (0)
Shipping Weight Lbs (kg) Aluminum Stainless Steel Cast Iron	 48 (21.8) 85 (38.6) 88 (39.9)

Elastomer Kits
Maximum Liquid Temperature

MATERIAL	AL	SS	CI	P/N
Neoprene	180°F (82°C)	180°F (82°C)	180°F (82°C)	45-808-00
Buna-N	180°F (82°C)	180°F (82°C)	180°F (82°C)	45-808-10
Viton®	248°F (120°C)	248°F (120°C)	248°F (120°C)	45-808-20
Nordel	180°F (82°C)	180°F (82°C)	180°F (82°C)	45-808-30
Teflon® Al,SS	212°F (100°C)	212°F (100°C)	212°F (100°C)	46-200-55
Teflon® CI	212°F (100°C)	212°F (100°C)	212°F (100°C)	46-107-00
Santoprene®	212°F (100°C)	212°F (100°C)	212°F (100°C)	45-808-60

Materials of Construction

Air valve housing	aluminum 356-T6
Air chambers	aluminum 356-T6
Spool Housing	aluminum 356-T6
Pump external finish	enamel blue paint
Valve type	elastomeric ball

Suction Lifts

Elastomer type (Material)	dry prime FT	dry prime metres	wet prime FT	wet prime metres
Standard (Alum, SS, CI)	20	6.1	20	6.1
Teflon® (Alum, SS, CI)	14	4.3	22	6.7

PRICE® PUMP CO.

21775 Eight St. East, P.O. Box Q
Sonoma, CA 95476-0329
(800) 345-PUMP
(707) 938-8441 FAX: (707) 938-0764
www.pricepump.com
e-mail: sales@pricepump.com

Your Local Price® Pump Distributor:

Price® Pump Co.

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

1" AND 1-1/2" AIR OPERATED DIAPHRAGM PUMPS

STANDARD ELASTOMERS

PLEASE FILL IN DATA
FROM YOUR PUMP
NAMEPLATE

Pump Model______________________

Spec. No.________________________

Serial No.________________________

Seal No.________________________

RETAIN MANUAL
FOR REFERENCE

Price® Pump Company
P.O.Box Q
Sonoma, CA 95476
Tel: 707-938-8441
Fax 707-938-0764
Email: sales@pricepump.com

47396-4/95
IN-AOD-5

Congratulations

You are now the owner of a Price® Pump Co. Air Operated Diaphragm Pump. This pump was carefully inspected and subjected to final performance tests before releasing for shipment. In order to achieve maximum performance and reliability, please follow the simple instructions in this manual.

RECOMMENDED PRECAUTIONS

1. **For satisfactory operation and safety, maximum inlet air pressure must not exceed 125 psi (8.79 kg/sq cm).**
2. **No modifications, additions or deletions should be made to the pump without prior approval of the factory.**
3. **Drain casing completely and Bush with water before servicing pump handling volatile or harmful liquids.**

READ CAREFULLY THE CAUTION BELOW

CAUTION:

The performance of Price® pump is based on clear, cold, fresh water with suction conditions as shown on the performance curves. If used to pump other liquids, pump performance may differ from rated performance based on the different specific gravity, temperature, viscosity, etc. of the liquid being pumped. A standard pump, however, may not be safe for pumping alltypes of liquids, such as toxic, volatile or chemical liquids, or liquids under extreme temperatures or pressures.

Please consult Price® Pump catalogs as well as local codes and general references to determine the appropriate pumps for your particular application. Since it is impossible for us to anticipate every application of a Price® pump, if you plan to use the pump for a non-water application, consult Price® Pump beforehand to determine whether such application may be proper and safe undeer the circumstances. Failure to do so could result in property damage or personal harm.

Visit Our Web Site

www.pricepump.com

or

www.pumpnet.com

CENTRIF U

School of Pumpology

OPERATING INSTRUCTIONS

1"&1-1/2" AIR OPERATED DIAPHRAGM PUMPS

STANDARD ELASTOMERS

INSTALLATION

Bolt pump to a mounting pad using appropriately sized diameter bolts. Rubber vibration insulators should be used between the pump mounting feet and mounting pad to reduce pump vibrations and stresses. In permanent installations the pump should not be directly attached to rigid piping, but instead should be connected through flexible hoses or equivalent on both the suction and discharge. This should be done to reduce pipe stresses and vibrations which are characteristic of the reciprocating nature of the pump. A surge suppressor may be required on the discharge line of the pump if further reduction in vibration or a reduction of pulsation in the discharge flow is desired.

If the pump is used in a submerged application a line or hose should be attached to the pump air exhaust to prevent liquid from entering the air valve when the pump is shutdown or operating at low discharge heads. CARE MUST BE EXERCISED WHEN SUBMERGING THE PUMP IN CORROSIVE PUMPING MEDIA.

Suction and discharge pipe size should be at least equal to the inlet pipe diameter or larger. Larger, if highly viscous liquid is to be pumped or long lengths of pipe are used. When using suction hoses use the non-collapsing reinforced type, since this pump is capable of producing high vacuum at the suction inlet.

SOLIDS-HANDLING CAPABILITY

Price® Pump Air Operated Diaphragm Pumps will pass the following spherical solid sizes:

Model	Size
1AOD-P	1/8" Dia. (3.1 mm)
1-1/2 AOD	3/16" Dia. (4.7mm)
1 AOD-P	3/16" Dia. (4.7mm)

If the possibility exists that larger sized solids may be suspended or carried along by the pumping media. install a strainer on the suction line with smaller sized holes than the allowable solid size. This will prevent the larger solids from entering the pump and interfering with operation of the pump ball valves.

AIR SUPPLY

The inlet to the air valve is a female 1/4" NPT. The air supply line should be sized accordingly so that there is no restriction less than inlet pipe size.

NOTE: Longer air lines require larger diameters to reduce the air system pressure loss and make available required pressure and flow at the pump air inlet. It is safe to use up to 110 psig (7.73 kg/sq cm) for pumping requirements.

WARNING: DO NOT EXCEED 125 PSIG (8.79 KG/SQ CM) AIR SUPPLY PRESSURE AS COMPONENT DAMAGE OR PERSONAL INJURY MAY RESULT.

PUMP CONTROL

The pump operating conditions, flow (GPM) and discharge head (PSIG) can be controlled in the following manner

1. Throttling the pump discharge by means of a valve on the discharge line. When the pump discharge pressure equals the air supply pressure, the pump will stop. This will not harm the pump, however, do not exceed **125 psig (8.6 kg/sq cm)** air supply pressure. The pump may be in this mode indefinitely. By opening the discharge valve the pump will resume pumping.
2. The air pressure supply can be limited to the pump. Price® Pump recommends the installation of a Price® Pump air filter/pressure regulator for all AOD applications. A globe or gate valve can be used before the regulator for on or off control. Failure to use an air pressure regulator will cause the pump air inlet pressure and thus discharge pressure to climb to maximum air system pressure when the pump is stopped.

MINIMUM AIR SUPPLY PRESSURE

This air valve incorporates a stall-free design and will begin operating with air inlet pressures as low as 5 psig.

OPERATING INSTRUCTIONS

The pump air valve is of an oilless design; that is, no lubrication is required or recommended. A clean, dry air supply should be provided for optimum air valve operation and life. In cold weather operation, or under conditions of high pump discharge pressure and relatively high humidity, air valve freezing may occur as a result of moisture in the compressed air being released. If this occurs, anti-freeze. of the ethylene glycol type, may be used in a measuring dispenser, such as an air line lubricator at the pump air inlet. The resulting mist will keep the air valve free of ice build-up.

1. In cases where there are several air-operated diaphragm pumps being used simultaneously and freezing of the air valve occurs frequently due to excessive moisture in the compressed air system, it may be advantageous to install a desiccant type compressed air dryer in the air system to purge the air supply of unwanted moisture.

   For permanent installations, an air filter and water/oil separator should be used. This is always good practice, since it insures maximum life of the air valve moving parts and seals by keeping them clean of dirt and oil residue.

   Excessive oil and water in the inlet air supply will cause a varnish-like substance to form on the self-lubricated valve spool. This will eventually lead to valve spool "sticking* and result in erratic spool operation. Should this occur, the spool and housing bore may be cleaned with a commercial safety solvent.
2. When starting the pump, make sure all valving on the suction and discharge lines are open. The pump will not prime with the valving closed. Pump cavita-tion will occur if the suction line is restricted with foreign matter • use a suction strainer with hole size less than allowable solid size for model in question.
3. When pumping highly viscous materials, it is advisable to check the pump flow rate vs. the pump stroke rate.

PUMP MODEL	AVG. GALLONS PER STROKE*
	Standard Elastomers
1 AOD	**.18(.68L)**
1 1/2 AOD	**.35 (1.3L)**
	Standard Elastomers
1 AOD-P	**.12 (.45L)**

*Actual test data with flooded suction and specific gravity of 1.0.

One pump stroke is equal to one exhaust blast. The pump should not pump faster than the material is capable of being drawn into the pump. If this occurs. cavitation will occur and damage to the pump could result in time.

4. To determine maximum pumping speed, increase air supply while pump discharge increases. When discharge flow no longer increases, throttle back air until pump discharge flow starts to fall off. This point is the optimum pumping speed achievable under those controlled by either one of the two methods previously mentioned under the PUMP CONTROL section of this manual.
5. The pump air exhaust port should be kept free from blockage. The pump should never be operated submerged without installing a line to the exhaust port and directing the same above the liquid surface. An appropriately sized hose with a 1/2" male NPT connector may be piped up to the exhaust port and directed away. The exhaust line, if required, should be kept as short as possible or pump performance could be affected. If long lengths of exhaust line are necessary, increase the internal diameter of the exhaust line to minimize pressure drop and pump performance loss. If the exhaust sound level becomes too objectionable, use the air muffler provided.

   NOTE: Installing an air exhaust muffler on a submerged pump will not prevent the liquid in which the pump is submerged, from entering the air valve.

   CAUTION: If a diaphragm failure occurs, the pumping media may be blown out the exhaust port. This could be hazardous if the pumping media is toxic or aggressive. It is advisable to add a line to the exhaust port and direct it safely away when pumping toxic or aggressive media.
6. Drain pump and flush after use when pumping material which can pack, settle out of liquid suspension, or solidify in time. A packed pump can cause damage to the diaphragm clamping plates and pump shaft when started after a period of interrupted use. The pump may be inverted and drained through the discharge port and flushed through the suction port.

OPERATING TEMPERATURE

1 AOD & 1 1/2 AOD-Metal Wetted Parts

The pump should not be used to pump liquids above **180°F (82 °C)**. Degradation of the pump elastomers will develop when the temperature of the pumping media rises above **180°F (82°C)**. For operating temperatures above **180°F (82°C)** consult factory.

OPERATING TEMPERATURE 1 AOD-P

The pump should not be used to pump liquids above **150°F (65 °C)**. For operating temperatures above **150°F (65°C)** consult factory.

TROUBLESHOOTING

1. Pump will run but will not pump.

a. check suction line for leaks.

b. tighten bolts or clamps on suction manifold of pumps.

c. material too viscous to pump at high rate of flow - slow down pump by reducing air supply to pump or use larger diameter suction line.

d. suction manifold & pump chambers misaligned - disassemble & realign.

e. suction or discharge balls jammed open with foreign object - disassemble pump & examine.

NOTE: Optimum priming speed for these pumps is obtained when air inlet pressure is maintained between **15-20 psi, (1.0-1.4 kg/cm2)** with open pump discharge.

2. Air bubbles in pump discharge

a. check suction line and manifold bolts or clamps for leaks

b. cracked or ruptured diaphragm

3. Intermittent pump operation and/or ice blowing from exhaust port

a. remove obstruction from suction line

b. valve freeze-up - install de-icer on air inlet line or suitable air dryer in compressed air line.

c. sticky air valve - remove main spool & clean with safety solvent.

4. Pump stops pumping.

a. increase air supply pressure - DO NOT exceed 125 psig (8.79 kg/cm2) under any circumstances and check for obstruction in suction or discharge line.

b. spool sticking - remove main spool & clean with safety solvent - install suitable filter on air inlet if dirt or contaminants persist.

c. air valve ice-up - excess moisture on the muffler is an indication that significant water is present in the air supply. Depending on the degree of severity, an in line water separator or air dryer is recommended.

5. Severe pump vibration with intermittent flow.

a. ruptured diaphragm - disassemble pump, replace diaphragm and clean air valve if necessary.

b. mechanical failure - disassemble pump and inspect for bent shaft, etc.

6. Pumping media leaking from exhaust port.

a. ruptured diaphragm - disassemble pump, replace diaphragm - clean air valve if necessary.

7. Varying pump discharge per stroke.

a. remove suction manifold and check for obstructions.

b. worn or leaky ball valves & seats - disassemble pump and replace worn parts.

8. Slowing of pumping action

a. clogged air exhaust muffler - replace

b. ice build up in air valve - install de-icer on air inlet line

PUMP DISASSEMBLY INSTRUCTIONS

Prior to disassembly of any AOD pump follow the "caution" below.

CAUTION: Do not attempt to perform any maintenance or repair on the air operated diaphragm pumps until the compressed air line to the pump and pump discharge line has been shut off. bled down. and disconnected. In addition, when pumps are being used to pump toxic or aggressive media the pumps should be flushed clean prior to disassembly.

DISASSEMBLY INSTRUCTIONS FOR MODEL 1AOD, CAST IRON, ALUMINUM, STAINLESS STEEL

(refer to Fig. 1, page 13)

1. Pump should be disassembled in the normal upright position. Remove cap screws (52). flatwashers (53). and hex nuts (54). from the discharge (top) manifold (23). Remove manifold, ball valves (29), and ball seats (28). Check for excessively worn seats & replace if necessary. Check ball valves tor gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove cap screws (52) and hardware from suction manifold (24). Remove remaining pump chamber assem-bty from suction manifold & place on table. Perform same inspectors on balls and seats as in ste p#1 above. Heavily worn balls and seats will affect pump performance.

   NOTE: Mark pump chambers (1) and air chambers (86) with an index line 90° across the diaphragm as well as an L and R (left and right) to distinguish the pump chambers. These marks will aid in alignment during reassembly.
3. Remove cap screws (52), flat washers (53) and hex nuts (54). from pump chamber (1) which connect pump chamber to clamp ring (87). Remove pump chambers.
4. Remove 3/8"-16 x 1 1/4" 316 SS cap screw (2) and stainless washers (3) from pump shaft (16). Disassemble outer diaphragm clamping plate (4), diaphragm (6), inner diaphragm clamping plate (7). and bumper (8). Slide shaft (16) from the air valve housing (78). with opposing diaphragm and plates attached. Check diaphragms & rubber bumpers tor wear and replace, if necessary.
5. Remove remaining diaphragm and plates from shaft by putting shaft in vise between two blocks of wood or soft metal jaws and removing the 3/8" capscrew from other end of shaft.
6. Refer to Air Valve Disassembly Instructions on page 11 of this manual.

REASSEMBLY INSTRUCTIONS FOR MODEL 1AOD, CAST IRON, ALUMINUM, STAINLESS STEEL

(refer to Fig. 1. page 13)

1. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws and shaft. Assemble new rubber bumper (8), inner diaphragm clamping plate (7), new diaphragm (6) and outer diaphragm clamping plate (4) with the diaphragm concave side facing upward. Apply Loctite #242 to 3/8"-16 x 1 1/4" 316 SS capscrew (2) and assemble to shaft with 3/8" stainless steel flat washer (3). **Torque capscrew to 400 inch lbs. (45 n-m).**
2. Push shaft through bore in air chamber/air valve assembly. Check for free movement of shaft, then bottom out diaphragm in air chamber. Invert assembly and assemble remaining new bumper, diaphragm (6), clamping plates & capscrew per step #1 above. **Torque capscrew to 400 inch lbs. (45 n-m).**
3. Place pump chamber (1) marked either L or R on table and align proper index mark on respective air chamber (86).

   NOTE: Diaphragm should be depressed into air chamber being assembled at this time. Place diaphragm outer bead into groove in pump chamber. Check to make sure diaphragm bead fits evenly into groove.
4. Install and tighten the capscrews (52), washers (53), and nuts (54). After tightening, check alignment between pump chamber and air chamber.
5. Push opposing diaphragm into its respective air chamber, the diaphragm bead should sit flush in air chamber groove.
6. Place the other pump chamber (1) onto the exposed diaphragm. Using either the previously made alignment marks, or by visual inspection, align the two pump chambers (1) so their respective manifold flanges are parallel. If surfaces are not reasonably parallel, leakage at the ball seats could occur.
7. Repeat step 4 for second pump chamber.
8. Place a suction ball valve (29) and a valve seat (28) into the bottom of each pump chamber (1). Be sure the raised "0" ring contour on the valve seat is facing downward toward the suction manifold. Align the pump with the suction manifold (24) and attach with cap screws (52). washer (53) and hex nuts (54).

   The discharge manifold (23) should have two ball valves (29) and two valve seats (28) placed into it. The raised "0" ring contour should be visible when the seat (28) is placed in the manifold (23). Using cap screw (52), washer (53) and hex nut (54). secure the discharge manifold (23) with ball valve and valve seats to the pump.

CAUTION: DO NOT TORQUE MANIFOLD BOLTS BEYOND 130 IN-LB (15 N-M).

DISASSEMBLY INSTRUCTIONS FOR MODEL 1AOD-P

(refer to Fig. 2. page 14)

1. Start disassembly by standing pump upright. Remove discharge manifold (23) by removing cap screws (52). hex nuts (32). and flat washers (31).
2. Remove "0" rings (47). ball cages (57). balls (29). ball seats (28), and gaskets (58) from discharge end of pump chambers (1). Check "0" ring, ball cages, balls, and ball seats. Replace any part that appears to be worn or damaged.

   NOTE: It is recommended that discharge seat gasket (58) automatically be replaced.
3. Remove suction manifold (24) and mounting feet (55) by removing cap screws (56), hex nuts (32). and flat washers (31).
4. Remove "0" rings (47). ball seats (28). balls (29). and ball cages (57) from suction end of pump chambers (1). Check "0" rings, ball seats, balls, and ball cages. Replace any part that appear to be worn or damaged.
5. **NOTE:** Mark pump chambers (1) and air chambers (86) with an index line 90° across the diaphragm (6) as well as an L and R (Left and Right). These marks will aid in proper alignment during reassembly. Remove both pump chambers by removing cap screws (30), hex nuts (32), and flat washers (31).
6. While holding the hex head portion of one of the plastic outer diaphragm clamping plates (4), unscrew the other clamp plate. Either plate may come loose first. Completely remove outer clamp plate (4), diaphragm (6). inner clamp plate (7) and bumper (8). Slide shaft (16), with opposing diaphragm and plates attached, out of air valve housing (78).

   Check clamping plates, diaphragms and bumpers for wear or damage. Replace if necessary.
7. Remove remaining diaphragm and plates from shaft by putting shaft in vise between two blocks of wood or soft metal jaws and unscrewing the outer clamp plate.
8. Refer to Air Valve Disassembly Instructions on page 11 of this manual.

REASSEMBLY INSTRUCTIONS FOR MODEL 1AOD-P

(Refer to Fig. 2, page 14)

1. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws and shaft. Place new rubber bumper (8) on end of shaft. Assemble new diaphragm (6) and inner diaphragm clamping plate (7) onto 3/8" stud protruding from outer diaphragm clamping plate (4), concave side facing away from shaft. Apply **Loctite #242** to thread and screw assembly into end of shaft. **Tighten hex head portion of outer clamp to 150-200 In lbs. (17-22 nm).**
2. Push shaft through bore in air chamber/air valve assembly. Check for free movement of shaft, then bottom out diaphragm in air chamber. Invert assembly and assemble new bumper to shaft, new diaphragm, inner clamp plate to outer clamp plate and screw into end of shaft. **Tighten outer clamp plate to 150-200 in lbs (17-22 nm).**
3. Place pump chamber (1) marked either L or R on table and align proper index mark on respective air chamber (86). Diaphragm should be depressed into air chamber being assembled at this time. Place diaphragm outer bead into groove in pump chamber. If no index marks are present, visually align the air valve housing. The word "Top" appears on the outside portion of one of the large "cube-like" pump chamber sections.
4. Install and tighten the capscrews (30), washers (31), and nuts (32) securing the pump chamber to the air chamber in several steps. **Tighten cap screws and nuts in several steps to 7040 inch lbs (8-9 nm) so as not to distort the non-metallic parts.**
5. Push opposing diaphragm into its respective air chamber groove.
6. Align and secure the other pump chamber to the air chamber following the procedure in step ^5.
7. Place pump assembly on a table with the "top" of the pump chamber facing down.
8. Into each of the pump chamber openings facing-up, insert ball cage (57), ball (29), ball seat (28) and "0" ring gasket (47). Place suction manifold (24) on top of the pump assembly so that the flat surfaces of the square pads are against the "0" ring gasket (47). Align the holes in the mounting feet (55) with the holes in the suction manifold (24) and pump chambers (1). Insert the eight 3/8" x 4 3/4" cap screws with flatwashers through the mounting feet, manifold and pump chambers and secure with flatwasher (31) and hex nuts (32). **Torque capscrews and nuts to 115-125 in lbs (13-14 nm).**
9. Invert the pump so it is now resting on its feet.
10. Into the top of each pump chamber, insert new gasket (58), ball seat (28), ball (29), ball cage (57) and "0" ring gasket (47).
11. Place discharge manifold (23) on top of the pump assembly so that the flat surfaces of the square pads are against the "0" ring gaskets. Insert the eight 3/8" x 4 1/2" capscrews with flat washers through the manifold and pump chambers. Secure with flatwashers & hex nuts. **Torque capscrews and hex nuts to 115-125 In lbs (13-14 nm).**
12. Your pump is now ready to be placed back in service.

DISASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, CAST IRON

(refer to Fig. 3. page 15)

1. Pump should be disassembled in the normal upright position. Remove cap screws (52), flatwashers (53), and hex nuts (54), from the discharge (top) manifold (23). Remove manifold, ball valves (29). and ball seats (28). Check for excessively worn seats & replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove cap screws from suction (lower) manifold (24). Remove remaining pump chamber assembly from suction manifold & place on table. Perform same inspections on balls and seats as in step #1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 91/2" dia. (241 mm) clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1). air chamber flange (86) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place hex head of outer diaphragm plate (4) on end of pump shaft (16) in a table vise and loosen opposing diaphragm plate with wrench. Remove outer diaphragm plate (4), diaphragm (6), inner diaphragm plate (7), and rubber bumper (8) from pump shaft (16). Check diaphragm, rubber bumper, and "O" ring for wear and replace if necessary.
5. Remove shaft (16) and remaining diaphragm (assembly) from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove diaphragm plate and remaining parts.
6. Refer to air valve disassembly instructions on page 11 of this manual.

REASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, CAST IRON

(refer to Fig. 3, page 15)

1. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws and shaft. Assemble new diaphragm (6) to the pump shaft using the inner diaphragm clamping plate (7), outer diaphragm clamping plate (4), and new rubber bumper (8). The diaphragm concave side must face upward. Apply **Loctite #242** to the internal threads of the outer clamp plate (4) and assemble to shaft.
2. Insert shaft assembly through bore in air chamber/ air valve assembly. Check for free movement of shaft. Shaft should not bind. Bottom out diaphragm in air chamber. Invert assembly and place remaining diaphragm, clamping plates, and new rubber bumper, as in step #1 above.
3. Place hex head of diaphragm clamping plate (4) in table vise. Place wrench on hex head of opposing diaphragm plate (4) at opposite end of pump shaft. **Torque to 35 ft. lbs., (47 n-m). Be sure both outer clamp plates are torqued to 35 ft. lbs. (47 n-m).**
4. To assemble pump chambers (1) to air chambers (86) start with either diaphragm which is fully recessed in air chamber. Place pump chamber previously marked with an index mark (felt pen) to match index marks on air chamber. If replacing a pump chamber, align roughly by eye. Assemble QVz" (241 mm) dia. clamp halves (22) and hardware bolt (19). & Nut (21) to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first depressing diaphragm until it sits securely in groove cast in air chamber casing. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump chamber flange - they should be parallel. Place pump upright on that flat surface - the suction flange of pump chamber should lie flat.

   NOTE: The pump may leak at the manifolds if these surfaces are not parallel.
5. Tighten 9 1/2" (241 mm) clamps (22) by tapping clamps with a soft metal or wooden mallet while tightening the 3/8" clamp capscrews. **Torque capscrews to approximately 150-200 Inch lbs. (17-23 n-m).** Do not over tighten. Check alignment once again. If OK. proceed. If not, loosen clamps and realign.
6. Place a suction ball valve (29) and valve seat (28) into the bottom of each pump chamber (1). Be sure the raised "0" ring contour on the valve seat is facing downward toward the suction manifold. Align the pump with the suction manifold (24) and secure with cap screws (52), washers (53), and hex nuts (54).

   The discharge manifold (23) should have two ball valves (29) and two valve seats (28) placed into it. The raised "0" ring contour should be visible when the seat (28) is placed in the manifold (23). Using cap screw (52), washer (53) and hex nut (54), secure the discharge manifold (23) with ball valve and valve seats to the pump. Reassembly is complete.

DISASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, ALUMINUM

(refer to Fig. 4, page 16)

1. Pump should be disassembled in the normal upright position. Remove small clamps (27) from the discharge (top) manifold (23) by removing carriage bolts (25) and hexnuts (26). Remove manifold, ball valves (29). and ball seats (28). Check for excessively worn seats & replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove small clamp halves (27) from suction (lower) manifold (24). Remove remaining pump assembly from suction manifold & place on table. Perform same inspections on balls and seats as in step ^1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 91/2" dia. (241 mm) clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1), air chamber flange (86) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place ESNA locknut (2) on end of pump shaft in a table vise and loosen opposing ESNA locknut with wrench. Remove ESNA locknut (2). outer diaphragm plate (4). diaphragm (6), inner diaphragm plate (7), and rubber bumper (8) from pump shaft (16). Check diaphragm & rubber bumper for wear and replace if necessary.
5. Remove shaft and remaining diaphragm from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove ESNA locknut and remaining parts.
6. Refer to air valve disassembly instructions on page 11 of this manual.

REASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, ALUMINUM

(Refer to Fig. 4, page 16)

1. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws and shaft. Assemble new rubber bumper (8), inner diaphragm clamping plate (7). new diaphragm (6), outer diaphragm clamping plate (4), and ESNA locknut (2) to shaft. Tighten locknut but do not torque down until step #3 during reassembly.
2. Insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft should not bind. Bottom out diaphragm in air chamber. Invert assembly and place remaining diaphragm, clamping plates, and new rubber bumper, as in step #1 above.
3. **Torque ESNA nuts to 35 ft. lbs., (47 n-m). Be sure both ESNA nuts are torqued to 35 ft. lbs. (47 n-m).**
4. To assemble pump chambers (1) to air chambers (86) start with either diaphragm which is fully recessed in air chamber. Place pump chamber previously marked with an index mark (felt pen) to match index marks on air chamber. If replacing a pump chamber, do this roughly by eye. Assemble 9 1/2" (241 mm) dia. clamp halves (22) and hardware bolt (19), & Nut (21) to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first depressing diaphragm until it sits securely in groove cast in air chamber casing. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump chamber flange - they should be parallel. Place pump upright on flat surface - the suction flanges of pump chambers should lie flat.

   NOTE: The pump may leak at the manifolds if these surfaces are not parallel.
5. Tighten 9 1/2" (241 mm) clamps (22) by tapping clamps with a soft metal or wooden mallet while tightening the 3/8" clamp capscrews. Torque capscrews to approximately 150-200 inch lbs. (17-23 n-m). Do not over tighten. Check alignment once again. If OK, proceed. If not, loosen clamps and realign.
6. Place valve seats (28) in counterbored holes in suction manifold (24).

   NOTE: Raised "0" ring lip on valve seat must be facing downward in counterbored hole. Surfaces for valve seats should be free of nicks, dents and scratches. The rubber valve seat should protrude an even height above suction flange.
7. Place a ball valve (29) in valve seats & place assembled pump onto suction manifold. Use clamp halves (27) and hardware. To assemble pump body to manifold, gently tap clamps while assembling to insure a good seal. Make sure manifold flanges & pump chamber flanges are centered. **Tighten 3 ½" (89 mm) dia. clamps to 20 inch lbs., (2 n-m).**
8. Repeat similar procedure for discharge manifold (23) and associated balls, seats, clamps, etc. to complete assembly.

DISASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, STAINLESS

(refer to Fig. 5, page 17)

1. Pump should be disassembled in the normal upright position. Remove small clamps (27) from the discharge (top) manifold (23) by removing carriage bolts (25) and hexnuts (26). Remove manifold, ball valves (29), and ball seats (28). Check for excessively worn seats & replace if necessary. Check ball valves for gouges and deep scratches or heavily worn or abraded areas and replace. Heavily worn balls and seats will affect pump performance.
2. Remove small clamp halves (27) from suction (lower) manifold (24). Remove remaining pump assembly from suction manifold & place on table. Perform same inspections on balls and seats as in step ^1 above. Heavily worn balls and seats will affect pump performance.
3. Remove 9 1/2" dia. (241 mm) clamps (22) from the pump chamber/air chamber connection. As you remove clamps, place an index mark across the pump chamber flange (1). air chamber flange (86) with a felt pen marker. This will aid in finding the right alignment during reassembly. Remove pump chamber (1) by lightly tapping pump chamber with a fiber or wooden mallet until it is free of the diaphragm.

   CAUTION: Do not use a metal headed hammer on the pump chamber.
4. Place hex head of outer diaphragm plate (4) on end of pump shaft (16) in a table vise, loosen opposing diaphragm plate with wrench. Remove outer diaphragm plate (4). diaphragm (6). inner diaphragm 5-plate (7), and rubber bumper (8) from pump shaft (16). Check diaphragm & rubber bumper for wear and replace if necessary.
5. Remove shaft and remaining diaphragm from pump by sliding through pump shaft bore. Put free end of shaft in vise between two blocks of wood or soft metal jaws and remove diaphragm plate and remaining parts.
6. Refer to air valve disassembly instructions on page 11 of this manual.

REASSEMBLY INSTRUCTIONS FOR MODEL 1 1/2 AOD, STAINLESS

(refer to Fig. 5, page 17)

1. Place pump shaft (16) in vise with soft metal jaws or wooden blocks between the vise jaws and shaft. Assemble new diaphragm (6), inner diaphragm clamping plate (7), outer diaphragm clamping plate (4), and new rubber bumper (8) with the diaphragm concave side facing upward. Tighten clamp plate but do not torque down until step ^3 during reassembly. Apply **Loctite #242** to the internal threads of the outer clamp plate (4) and assemble to shaft.
2. Insert and push shaft assembly through bore in air chamber/air valve assembly. Check for free movement of shaft. Shaft should not bind. Bottom out diaphragm in air chamber. Invert assembly and place remaining diaphragm, clamping plates, and new rubber bumper, as in step #1 above.
3. Place hex head of diaphragm clamping plate (4) in table vise. Place wrench on hex head of opposing diaphragm plate (4) at opposite end of pump shaft. Torque to 35 ft lbs., (47 n-m). Be sure both outer clamp plates are torqued to 35 ft lbs. (47 n-m).
4. To assemble pump chambers (1) to air chambers (86) start with either diaphragm which is fully recessed in air chambers. Place pump chamber previously marked with an index marking (felt pen) to match index marks on air chamber. If replacing a pump chamber, do this roughly by eye. Assemble 91/2" (241 mm) dia. clamp halves (22) and hardware bolt (19), & Nut (21) to pump chamber flange and tighten slightly. Assemble second pump chamber to opposing air chamber by first depressing diaphragm until it sits securely in groove cast in air chamber casing. Rotate pump chamber until index marks align. Add clamp halves & hardware and tighten slightly. At this point an alignment check should be made. Place a straight edge on each pump chamberf lange -they should be parallel. Place pump upright on flat surface - the suction flange of pump chamber should lie flat.

   NOTE: The pump may leak at the manifolds if these surfaces are not parallel.
5. Tighten 9 1/2" (241 mm) clamps (22) by tapping clamps with a soft metal or wooden mallet while tightening the 3/8" clamp capscrews. **Torque capscrews to approximately 150-200 inch lbs. (17-23 n-m).** Do not over tighten. Check alignment once again. If OK, proceed. If not. loosen clamps and realign.
6. Place valve seats (28) in counterbored holes in suction manifold (24).

   NOTE: Raised "0" ring lip on valve seat must be facing downward in counterbored hole. Surfaces for valve seats should be free of nicks, dents and scratches. The rubber valve seat should protrude an even height above suction flange.
7. Place a ball valve (29) in valve seats & place assembled pump onto suction manifold. Use clamp halves (27) and hardware. To assemble pump body to manifold, gently tap clamps while assembling to insure a good seal. Make sure manifold flanges & pump chamber flanges are centered. **Tighten 3 ½" (89 mm) dia. clamps to 20 inch lbs., (2 n-m).**
8. Repeat similar procedure for discharge manifold (23) and associated balls, seats, clamps, etc. to complete assembly.

AIR VALVE DISASSEMBLY INSTRUCTIONS

Removal of Air Chambers

(Refer to appropriate pump exploded view)

1. Remove the five hex nuts (62), lockwashers (61). special flat washers (17) and flat head socket screws (9) which retain one of the air chambers (86) to the air valve housing (key no. 78 of Fig. 6, page 18). Repeat this step for the opposite air chamber.
2. Loosen the connection between the long flathead screw (66) and short flat head screw (91) at coupling nut (85) by turning both (66) and (91) counter clockwise using two Alien wrenches. Loosen locknut (84) from coupling nut (85), and remove both from long flat head screw (66).
3. Set aside gaskets (15) and, if used, air chamber clamping rings (87). Plastic pumps are bolted while metallic pumps use clamping rings. Remove seals (12) and (14) from both air chambers (86). Replace these items during reassembly.

AIR VALVE DISASSEMBLY INSTRUCTIONS

Air Valve Body Disassembly

(Refer to Fig. 6 page 18)

1. Remove spool housing end caps (36). gaskets (37) and cap screws (35) from spool housing (68).
2. Remove main spool (39) and examine spool, piston rings (45) and ring expanders (46) for wear. Replace piston ring set & spool if deeply scratched, chipped or worn. New spools will be interchangeable with old. If main spool bore in spool housing has become corroded, excessively pitted, or deeply scratched replace spool housing (68).
3. Remove muffler (44) from air valve housing (78) and check inside for dirt and debris. If muffler is clogged it will affect pump performance. Replace if necessary.
4. Remove spool housing (68) and gasket (65) by removing the four socket head cap screws (95) and lockwashers (90). Check gasket for any degradation and replace if required.
5. Check Oilrte bronze sleeve bushings (43) in valve housing (78). If worn they can be removed by carefully pressing out. Replace as necessary.
6. Remove the pilot spool (82) from the air valve by pulling out at one end. Remove the piston ring assemblies (83) from each end of the pilot spool. Examine for wear and replace as necessary.
7. Your air valve assembly is now completely disassembled and ready for reassembly.

AIR VALVE BODY REASSEMBLY INSTRUCTIONS

(Refer to Fig. 6, page 18 and appropriate pump exploded view.)

CAUTION: Care must be taken at this stage of reassembly to ensure cleanliness. A dirty valve will stick and work improperly. Keep area free of dirt, oil, and metal chips.

1. Clean all metal parts with good grade safety solvent prior to reassembly.
2. Press shaft bushings (43) into air valve housing (78), making sure they are properly aligned with the bore in the valve housing. Press bushings in to 0.165" above the flush position.
3. Install new piston ring assemblies (83) on pilot spool (82). Push pilot spool with piston rings into bore of air valve. Take care to position splits in piston rings to 3 o'clock or 9 o'clock position in bore.
4. Inspect spool (39) for scratches, scoring, chips, and wear. If severe grooving or marking is evident, replace spool. To ensure maximum performance the spool should not be excessively worn, although the pump will still run satisfactorily.
5. Insert piston ring seals (45) and expander rings (46) prior to reassembly. Replace with new if required.

   NOTE: Upon reassembly of piston ring seals (45) and expander rings (46) the opening in the expander ring and the split in the piston ring should be assembled 180° apart. Also, upon reassembling the spool to the spool housing bore, rotate piston ring seals in their grooves until the split in the seal is at the valve housing 3 or 9 o'clock position. This prevents the split from covering valve housing ports during reassembly. This also eliminates the tendency to hang up on a port. Do not install main spool in a centered position or pump may not start.
6. Install spool housing cap gaskets (37) with existing end caps (36) and 1/4" - 20 Alien head screws (35) at both ends of spool housing.
7. Position new gasket (65). and spool housing assembly onto valve housing and secure with four Alien head screws (95), and lockwashers (91). **Torque screws (95) to 7 ft-lbs. (9.5 n-m).**
8. Check muffler (44) to make sure that it is clean and free of debris. If it cannot be cleaned, replace with new. Install muffler in air valve housing. Do not overtighten. One quarter turn past hand tight should be sufficient.

AIR CHAMBER REASSEMBLY TO AIR VALVE BODY

(Refer to Fig. 6, page 18 and appropriate pump exploded view)

1. Install new seals (12) and (14) in both air chambers. Important! The lips of seal (12) must face away from the air valve housing and the lips of seal (14) must face inwards towards the center of the air valve housing.
2. Align gasket (15) with air valve housing (78) and attach air chamber (86) using five flathead screws (9), special flatwashers (17), lockwashers (61) and hex nuts (62).

   NOTE: For any model which uses air chamber clamp rings (87) make certain to place the clamp rings (87) in position before attaching air chambers to the air valve body. The beveled edge of the clamp ring should face towards the air chamber.
3. Thread long flat head screw (66) through the appropriate hole in the opposite air chamber (86) and gasket (15), which lines up with the hole left blank in step 2 when this air chamber was installed. Thread locknut (84) and coupling nut (85) onto long flathead screw (66). Lock coupling nut in place with locknut.
4. Install second air chamber (86) with gasket (15) and long flathead screw with locknut and coupling nut onto air valve (78). Attach air chamber to air valve using five flathead screws (9), special flat washers (17). lockwashers (61) and hex nuts (62).
5. Install short flat head screw (35) in blanfchole4izfirst air chamber, then engage coupling nut. Tighten flat head screws (66) and (35) using two Allen wrenches. **Torque all air chamber to air valve hardware to 7 ft-lbs. (9.5 n-m).**
6. Your air valve assembly is now completely refurbished and ready for further pump assembly.

MODEL 1AOD – ALUMINUM, CAST IRON & STAINLESS STEEL

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	CAP SCREW
3	FLAT WASHER
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW, FLAT SOCKET HEAD
12	SEAL
14	SEAL
15	GASKET, AIR VALVE/AIR CHAMBER
16	SHAFT, PUMP
17	FLAT WASHER, SPECIAL
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
28	SEAT, BALL VALVE
29	VALVE, BALL
52	CAP SCREW
53	FLAT WASHER
54	HEX NUT
61	LOCK WASHER
62	HEX NUT
63	CAP SCREW, FLAT SOCKET HEAD
64	LOCK NUT
65	COUPLING NUT
66	CHAMBER, AIR
67	RING, CLAMP
91	CAP SCREW, FLAT SOCKET HEAD

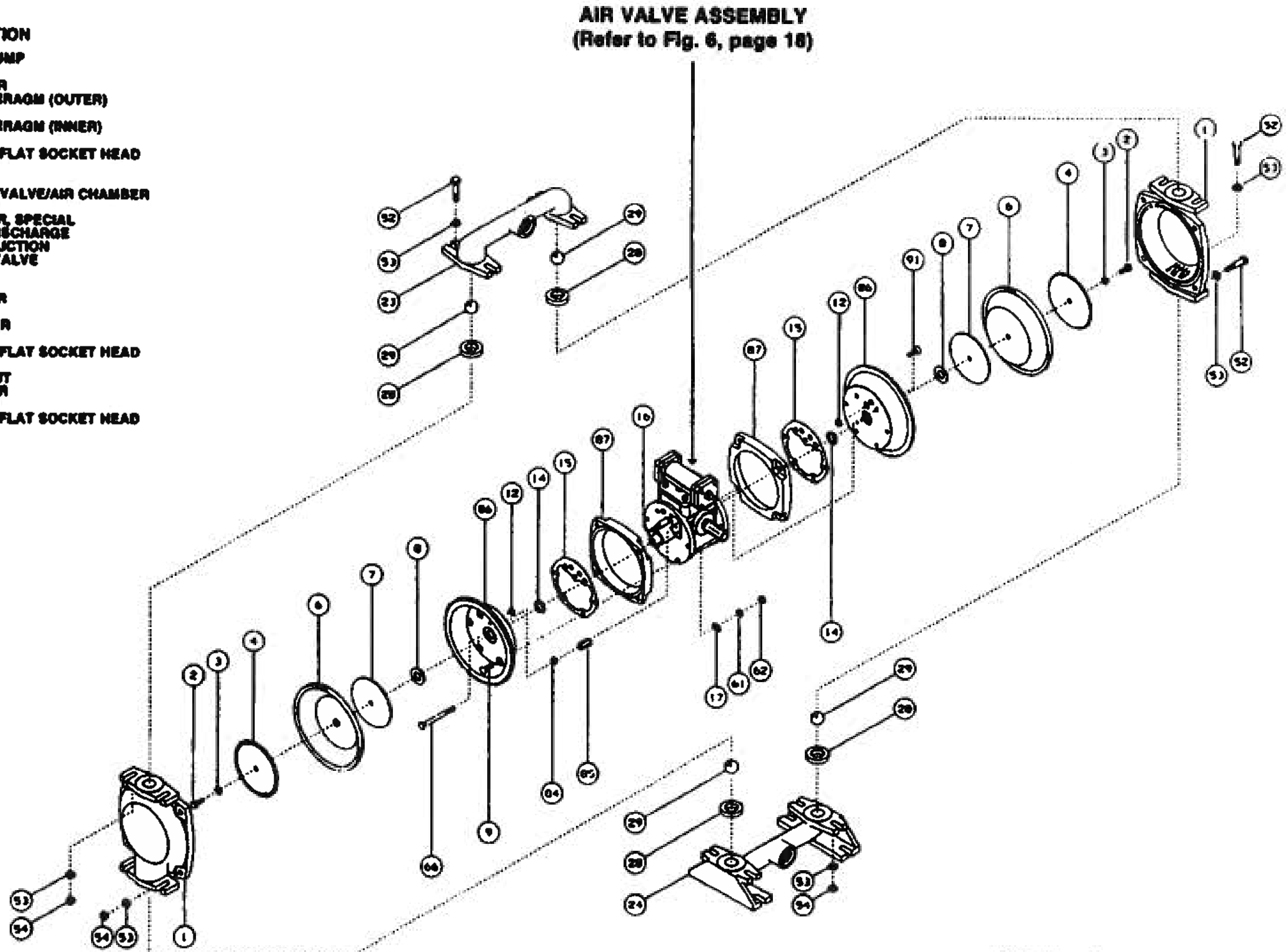


Figure 1

MODEL 1AOD – P

KEY	DESCRIPTION
1	CHAMBER, PUMP
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW, FLAT SOCKET HEAD
12	SEAL
14	SEAL
15	GASKET, AIR VALVE/AIR CHAMBER
16	SHAFT, PUMP
17	FLAT WASHER, SPECIAL
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
28	SEAT, BALL VALVE
29	VALVE, BALL
30	CAP SCREW
31	FLAT WASHER
32	HEX NUT
47	"O" RING
48	"O" RING, DIAPHRAGM
51	TAPE, TEFLON
52	CAP SCREW
55	FOOT, MOUNTING
56	CAP SCREW
57	CAGE, BALL VALVE
58	GASKET
61	LOCKWASHER
62	HEX NUT
66	CAP SCREW, FLAT SOCKET HEAD
79	GASKET
84	LOCK NUT
85	COUPLING NUT
88	CHAMBER, AIR
91	CAP SCREW, FLAT SOCKET HEAD

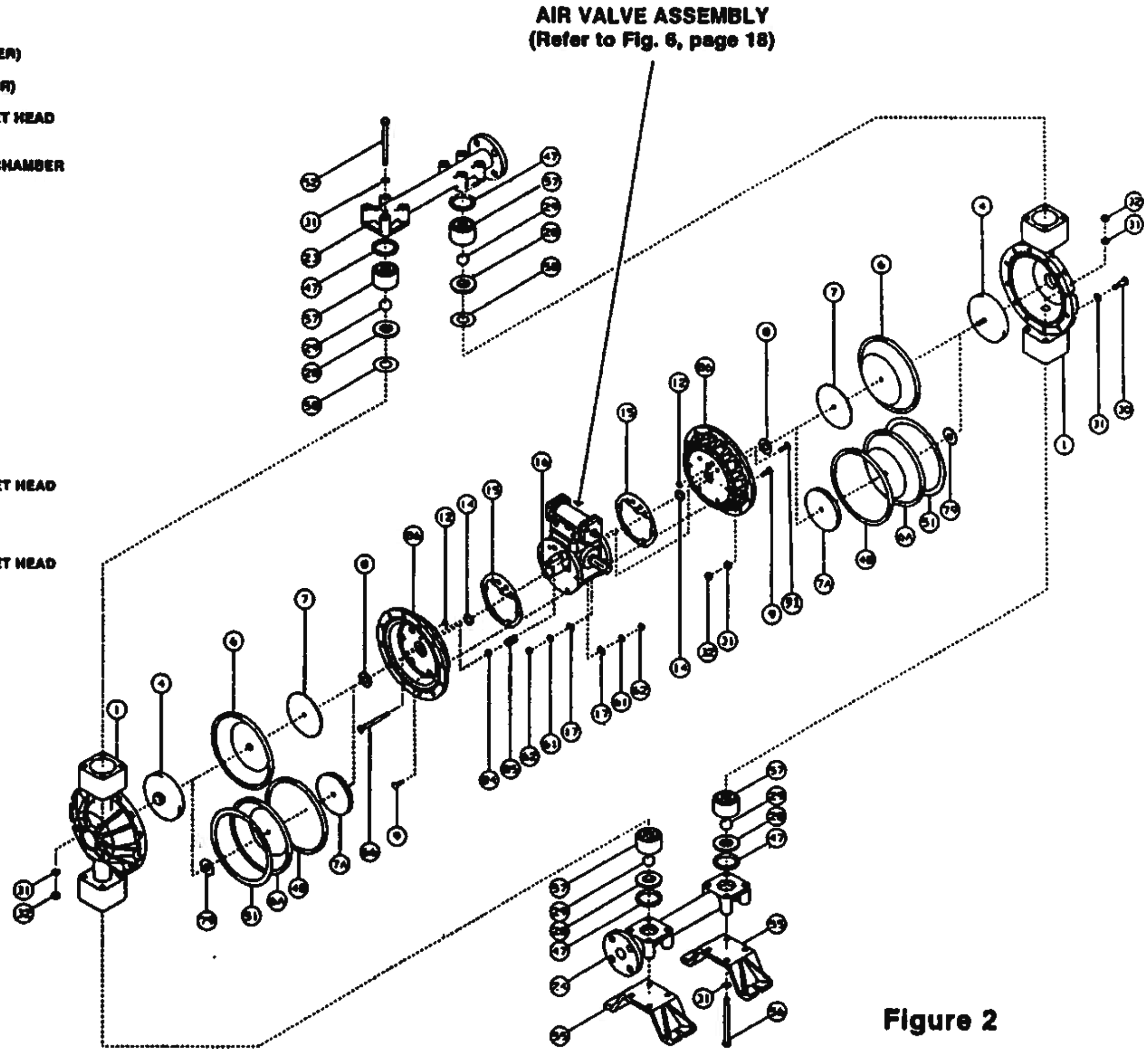


Figure 2

47396-14-4/95

MODEL 1 1/2 AOD – CAST IRON

KEY	DESCRIPTION
1	CHAMBER, PUMP
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW, FLAT SOCKET HEAD
12	SEAL
14	SEAL
15	GASKET, AIR VALVE/ AIR CHAMBER
16	SHAFT, PUMP
17	FLAT WASHER, SPECIAL
19	CAP SCREW
21	HEX NUT
22	CLAMP, HALF
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CARRIAGE BOLT
28	SEAT, BALL VALVE
29	VALVE, BALL
52	CAP SCREW
53	FLAT WASHER
54	HEX NUT
61	LOCKWASHER
62	HEX NUT
83	CAP SCREW, FLAT SOCKET HEAD
84	LOCK NUT
85	COUPLING NUT
88	CHAMBER, AIR
91	CAP SCREW, FLAT SOCKET HEAD

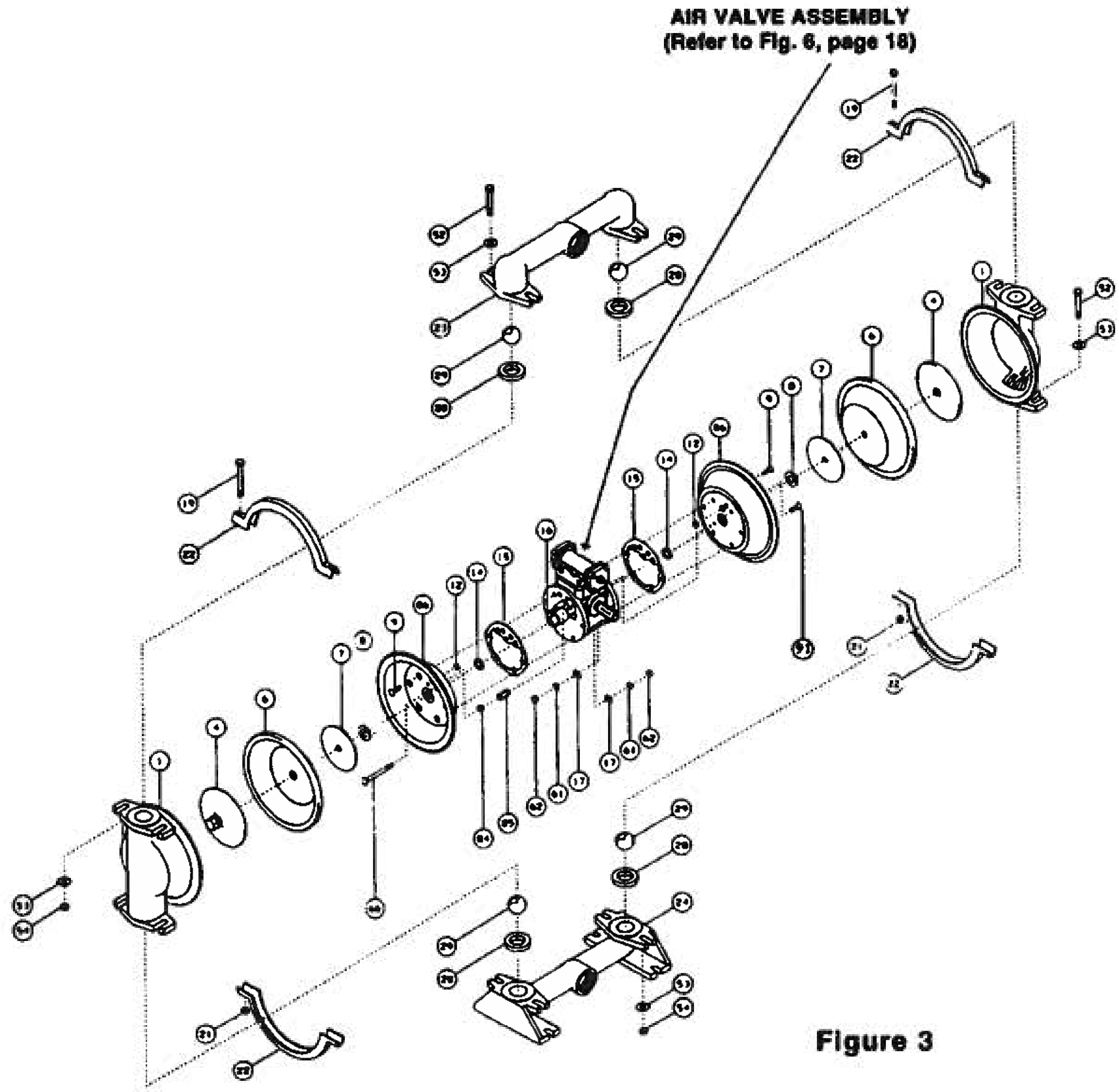


Figure 3

MODEL 1 1/2AOD – ALUMINUM

KEY	DESCRIPTION
1	CHAMBER, PUMP
2	NUT, LOCK
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW, FLAT SOCKET HEAD
12	SEAL
14	SEAL
15	GASKET, AIR VALVE/ AIR CHAMBER
16	SHAFT, PUMP
17	FLAT WASHER, SPECIAL
19	CAP SCREW
21	HEX NUT
22	CLAMP, HALF 9 ½"
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CARRIAGE BOLT
26	HEX NUT
27	CLAMP, HALF 3 ½"
28	SEAT, BALL VALVE
29	VALVE, BALL
61	LOCKWASHER
62	HEX NUT
63	CAP SCREW, FLAT SOCKET HEAD
64	LOCK NUT
65	COUPLING NUT
66	CHAMBER, AIR
91	CAP SCREW, FLAT SOCKET HEAD

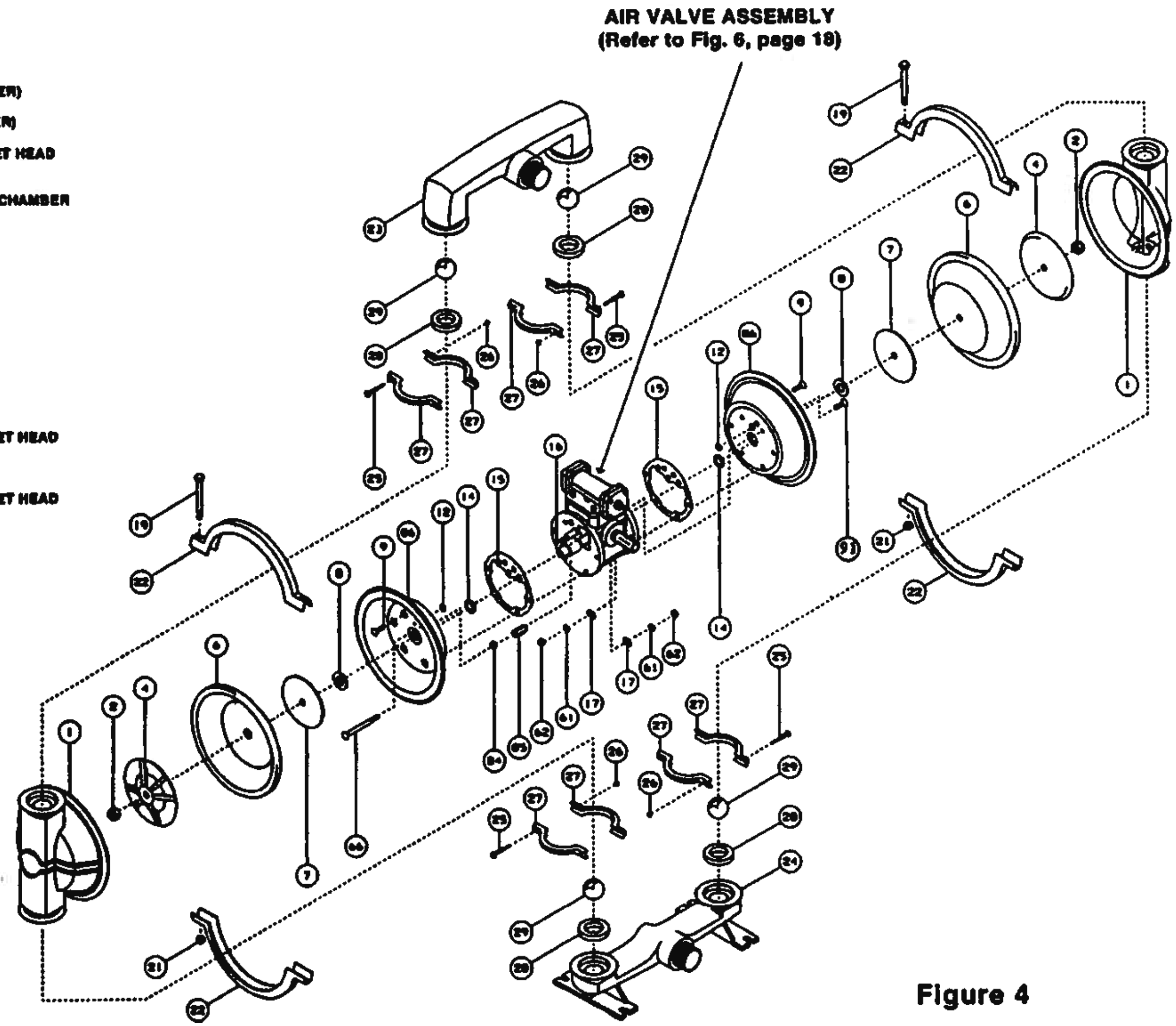


Figure 4

MODEL 1 1/2AOD – STAINLESS

KEY	DESCRIPTION
1	CHAMBER, PUMP
4	PLATE, DIAPHRAGM (OUTER)
6	DIAPHRAGM
7	PLATE, DIAPHRAGM (INNER)
8	BUMPER
9	CAP SCREW, FLAT SOCKET HEAD
12	SEAL
14	SEAL
15	GASKET, AIR VALVE/AIR CHAMBER
16	SHAFT, PUMP
17	FLAT WASHER, SPECIAL
19	CAP SCREW
21	HEX NUT
22	CLAMP, HALF 9 ¼"
23	MANIFOLD, DISCHARGE
24	MANIFOLD, SUCTION
25	CARRIAGE BOLT
26	HEX NUT
27	CLAMP, HALF 3 ¼"
28	SEAT, BALL VALVE
29	VALVE, BALL
61	LOCK WASHER
62	HEX NUT
63	CAP SCREW, FLAT SOCKET HEAD
64	LOCK NUT
65	COUPLING NUT
66	CHAMBER, AIR
91	CAP SCREW, FLAT SOCKET HEAD

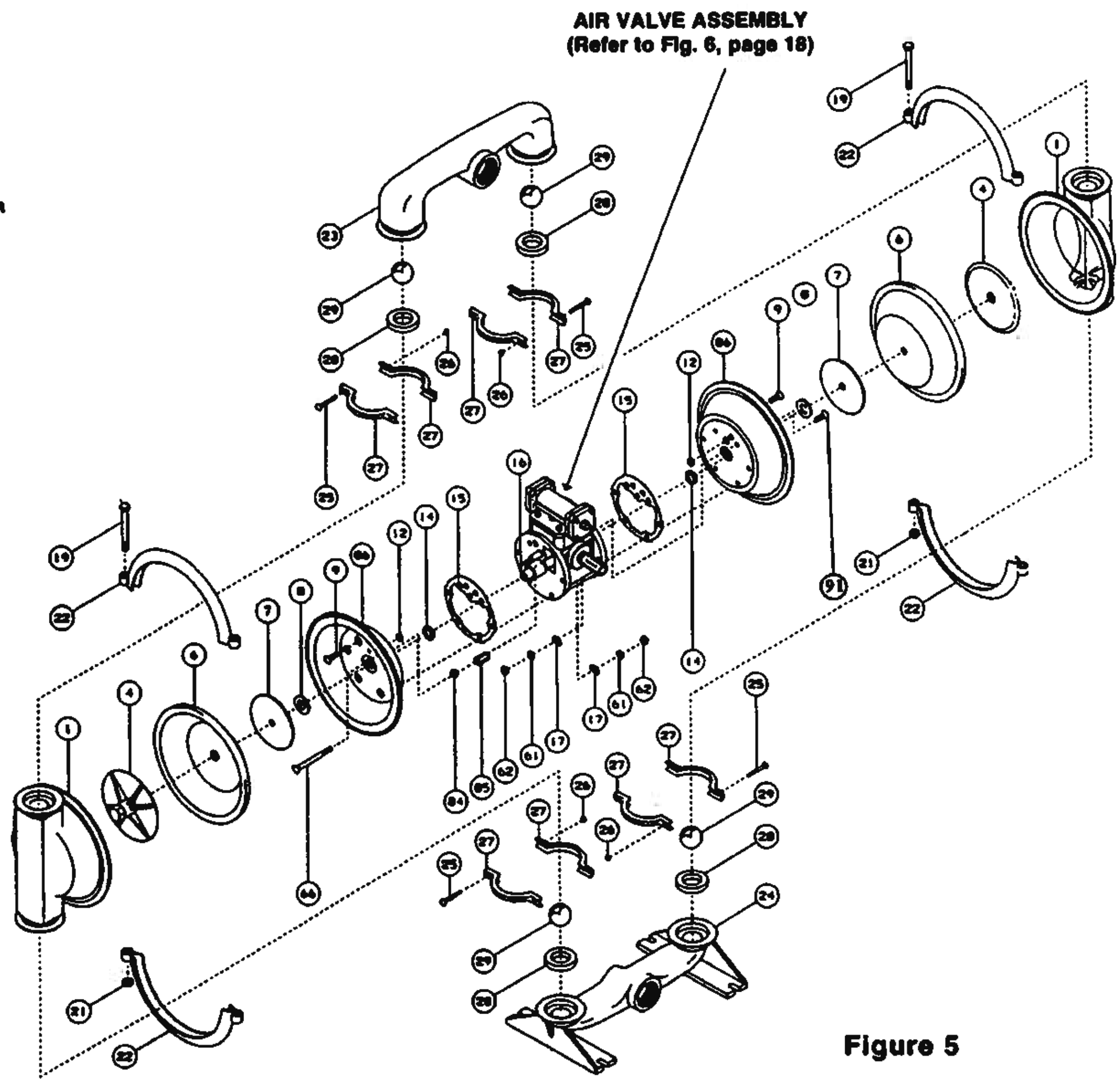


Figure 5

MODELS 1 & 1 1/2 AOD – AIR VALVE

KEY	DESCRIPTION
16	SHAFT
35	CAP SCREW, SOCKET HEAD
36	CAP, SPOOL HOUSING
37	GASKET, SPOOL HOUSING CAP
39	SPOOL
43	BUSHING, SLEEVE
44	MUFFLER
45	RING, PISTON
46	RING, EXPANDER
65	GASKET, AIR VALVE/SPOOL HOUSING
68	HOUSING, SPOOL
78	HOUSING, AIR VALVE
82	SPOOL, PILOT
83	PISTON RING ASSEMBLY
89	CAP SCREW, SOCKET HEAD
90	LOCKWASHER
95	CAP SCREW, SOCKET HEAD

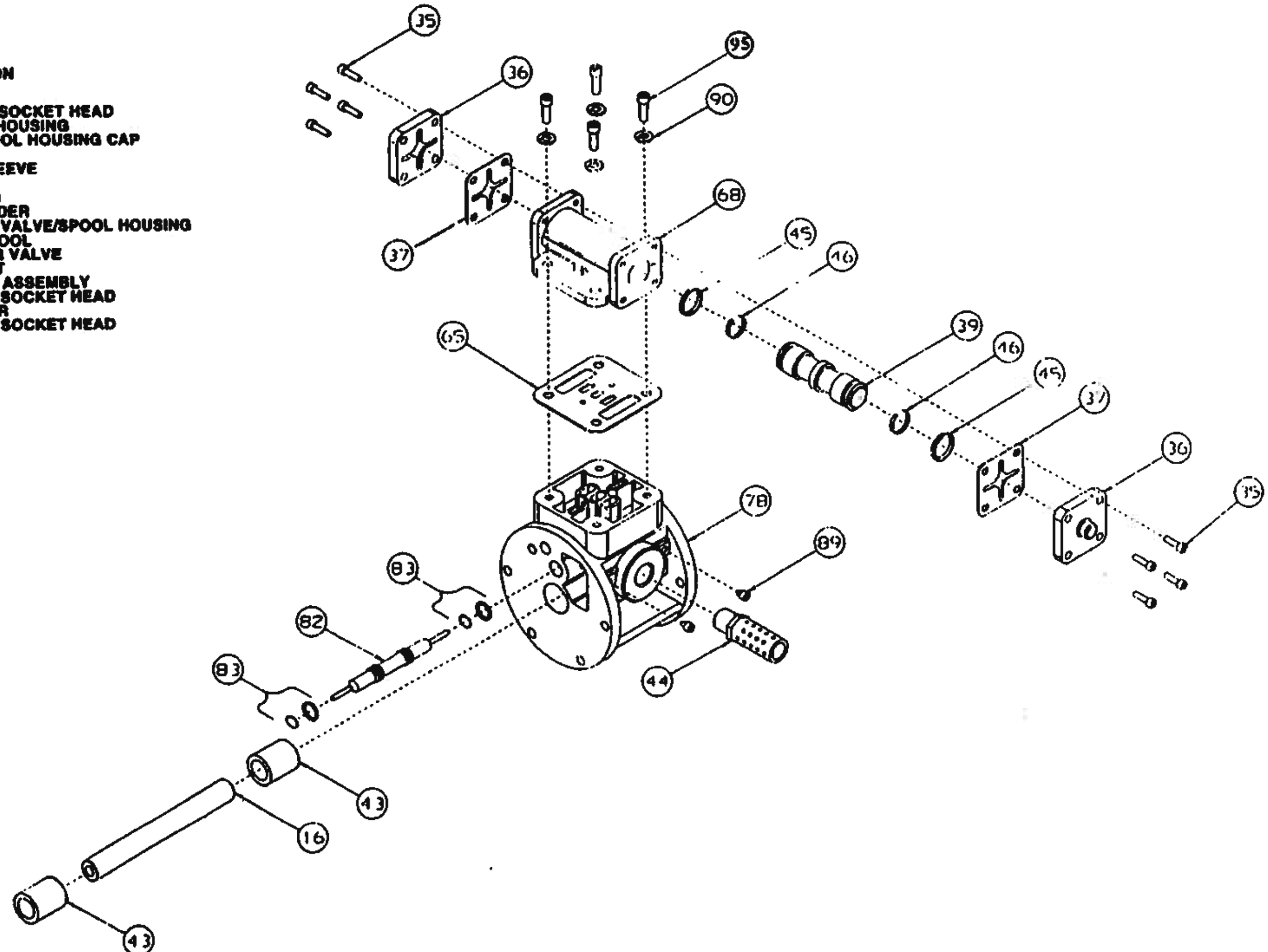


Figure 6

AOD® PUMP WARNINGS

- A Static charge buildup could occur in a plastic pump or an electrically insulated metal pump.
- Any contaminants in the air supply will be exhausted out the muffler to the atmosphere.
- All piping connections to the pump should be flexible.
- The chemical compatibility of the pump materials of construction with the fluids being pumped must be checked before use.
- AOD® pumps are not to be used for sanitary food applications.
- Submerged AOD® pumps should have their exhaust pipes away from the liquid level. A submerged pump may leak some air from gasketed joints. Do not submerge pumps in corrosive media.
- A pump which has stopped due to air valve icing will restart by itself when ice melts.
- Use only original factory replacement parts.
- Before start-up re-torque all external fasteners to the torque values listed in the I&O manual supplied with the pump.
- Pump temperature limits must be observed: Polypro pump - 150 deg F max. (65 deg. C)
Metal pump - 180 deg F max. (82 deg. C)
- Do not exceed 125 psi (8.79 bar) air inlet pressure as component damage or personal injury may result.
- AOD® pumps must only be operated by oil free, clean, dry compressed air
- Shut off, bleed down and disconnect the compressed air supply before doing any maintenance or repair to the pump.
- The pump should be flushed before disassembly. The pump should be inverted (outlet at bottom) to drain properly.
- A diaphragm failure could:
  - a. cause the system to which the pump is connected to be pressurized up the the compressed air supply pressure and mix air with the fluid being pumped.
  - b. Cause the fluid being pumped to be sprayed out through the exhaust muffler.
- AOD® pumps are not suitable for use with 1,1,1-trichloroethane, methylene chloride or other materials containing halogenated hydrocarbons. Aluminum wetted parts can react with these solvents and explode. Consult solvent suppliers for compatibility with aluminum before installation.
- For 1-1/2",2" and 3" AOD® pumps- CAUTION- unit weight may exceed 65lbs. (30 kg).

AOD® sound level at a distance of 1 meter with an air inet pressure of 35 psig.

Pump size Inches	Pump Material	Sound Pressure Level RMS db (A)	Peak db (C)	Sound Power Level db (A)
½	Polypro	87	104	97
1	Polypro	89	105	99
1	Metal	95	110	105
1-1/2	Metal	90	109	100
2	Metal	98	108	108
3	Metal	97	108	103

GENERAL TERMS OF SALE FOR PRODUCTS
Effective: January 1, 1999

1. GENERAL

A. Seller's price is based on these sales terms and conditions. This contract shall represent the final, complete and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained or waived by parol evidence, any Terms and Conditions contained in Buyer's purchase order or request for quotation, any course of dealings between the parties, Seller's performance or delivery, or in any other way. The Terms and Conditions of this contract may only be modified or waived in a written document signed by an Officer of Seller. These terms are intended to cover all activity of Seller and Buyer hereunder, including sales and use of products, parts and work and all related matters (references to products include parts and references to work include construction, installation and start-up). Any reference by Seller to Buyer's specifications and similar requirements are only to describe the products and work covered hereby and no warranties or other terms therein shall have any force of effect. Any information provided by Seller, including but not limited to suggestions as to specific equipment does not imply any guarantee of specific suitability and/or material compatibility in a particular application since many factors outside the control of Seller may affect the suitability of products in a particular application. Catalogs, circulars and similar pamphlets of the Seller are issued for general information purposes only and shall not be deemed to modify the provisions hereof.

B. The agreement formed hereby and the language herein shall be construed and enforced under the Uniform Commercial Code as in effect in the State of California on the date hereof.

2. TAXES

Any sales, use or other similar type taxes imposed on this sale or on this transaction are not included in the price. Such taxes shall be billed separately to the Buyer. Seller will accept a valid exemption certificate from the Buyer if applicable; however, if an exemption certificate previously accepted is not recognized by the governmental taxing authority involved and the Seller is required to pay the tax covered by such exemption certificate Buyer agrees to promptly reimburse Seller for the taxes paid.

3. PERFORMANCE, INSPECTION AND ACCEPTANCE

A. Unless Seller specifically assumes installation, construction or start-up responsibility, all products shall be finally inspected and accepted within thirty (30) days after arrival at point of delivery. Products not covered by the foregoing and all work shall be finally inspected and accepted with thirty (30) days after completion of the applicable work by Seller. All claims whatsoever by Buyer (including claims for shortages) excepting only those provided for under the WARRANTY AND LIMITATION OF LIABILITY and PATENTS Clauses hereof must be asserted in writing by Buyer within said thirty (30) day period or they are waived. If this contract involves partial performance, all such claims must be asserted within said thirty- (30) day period for each partial performance. There shall be no revocation of acceptance. Rejection may be only for defects substantially impairing the value of products or work and Buyer's remedy for lesser defects shall be those provided for under the WARRANTY AND LIMITATION OF LIABILITY Clause.

B. Seller shall not be responsible for non-performance or for delays in performance occasioned by any causes beyond Seller's reasonable control, including, but not limited to, labor difficulties, delays of vendors or carriers, fires, governmental actions, or short ages of material, components, labor, or manufacturing facilities. Any delays so occasioned shall affect a corresponding extension of Seller's performance dates, which are, in any event, understood to be approximate. In no event shall Buyer be entitled to incidenal or consequential damages for late performance or for a failure to perform. Seller reserves the right to make partial shipments and to ship products, parts or work which may be completed prior to the scheduled performance date.

C. In the event that Seller has agreed to mount motors, turbines, gears, or other products which are not manufactured by Seller and which are not an integral part of Seller's manufactured product, and a delay in the delivery of such products to Seller occurs that will cause a delay in Seller's performance date, Seller reserves the right to ship its product upon completion of manufacture and to refund an equitable portion of the amount originally included in the purchase price for mounting without incurring liability for non-performance.

D. Seller reserves to itself the right to change its specifications, drawings and standards if such changes will not impair the performance of its products, and parts, and further that such products, and parts, will meet any of Buyer's specifications and other specific product requirments which are a part of this agreement.

E. The manufacture and inspection of products and parts shall be to Seller's Engineering and Quality Assurance standards plus such other inspections, tests of documentation as are specifically agreed to by Seller. Requirements for any additional inspection, tests, documentation, or Buyer witness of manufacture, test, and/or inspection shall be subject to additional charges.

4. TITLE AND RISK OF LOSS

Title and risk of loss shall pass to buyer upon delivery of products at the designated Ex Works place (Incoterns 1990) unless other wise agreed by the parties.

5. EROSION AND CORROSION

It is specifically understood that products and parts sold hereunder are not warranted for operation with erosive or corrosive fluids. No product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action of any fluid and Buyer shall have no claim whatsoever against Seller therefore.

6. WARRANTY AND LIMITATION OF LIABILITY.

A. Seller warrants only that its product and parts when shipped. will be free from defects in materials and workmanship. With respect to products and parts not manufactured by Seller,. Seller's only obligation shall be to assign to Buyer. to the extent possible. whatever warranty Seller requires from the manufacturer. All claims for defective products or parts under this warranty must be made in writing immediately upon discovery and. in any event, within one (1) year after initial start-up or eighteen (18) months after shipment, whichever first occurs, and all claims for defective work must be made in writing imme diately upon discovery and in any event, within one (1) year of completion thereof by Seller.

Defective items must be held for Seller's inspection and returned to the originai f.o.b. point upon request.

THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESS, IMPLIED AND STATUTORY. INCLUDING WITHOUT LIMITATION,. THE IMPLIED, WARRANTIES OF MERCHANTABILITY AND FITNESS.

B. ANY PRODUCT (S) SOLD HEREUNDER WHICH IS NOT MANUFACTURED BY SELLER IS NOT WARRANTED BY SELLER and shall be covered only by the express warranty. if any of the manufacturer thereof.

C. Upon Buyer's submission of a claim as provided above and its substantiation,. Seller shall at its option either (i) repair or replace its product, part or work at the original place of delivery, or (ii) refund an equitable portion of the purchase price.

D. THE FOREGOING IS SELLER'S ONLY OBLIGATION AND BUYER'S EXCLUSIVE REMEDY FOR BREACH OF WARRANTY AND. EXCEPT FOR GROSS NEGLIGENCE, WILLFUL MISCONDUCT, AND REMEDIES PERMITTED UNDER THE PERFORMANCE, INSPECTION AND ACCEPTANCE AND THE PATENTS CLAUSES HEREOF. THE FOREGOING IS BUYER EXCLUSIVE REMEDY AGAINST SELLER FOR ALL CLAIMS ARISING HEREUNDER OR RELATNG HERETO WHETHER SUCH CLAIMS ARE BASED ON BREACH OF CONTRACT. TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES. BUYER'S FAILURE TO SUBMIT A CLAIM AS PROVIDED ABOVE SHALL SPECIFICALLY WAIVE ALL CLAIMS FOR DAMAGES OR OTHER RELIEF, INCLUDING BUT NOT LIMITED TO CLAIMS BASED ON LATENT DEFECTS. IN NO EVENT SHALL BUYER BE ENTITLED TO INDIRECT, SPECIAL,INCREMENTAL OR CONSEQUENTIAL DAMAGES, NOR FOR DAMAGES FOR LOSS OF USE, LOST PROFITS OR REVENUE, INTEREST, LOST GOODWILL. WORK OR PRODUCTION STOPPAGE, IMPAIR MENT OF OTHER GOODS, INCREASED EXPENSES OF OPERATION, OR THE COST OF PURCHASING REPLACEMENT POWER OR OTHER SERVICES BECAUSE OF SERVICE INTERRUPTIONS. FURTHERMORE. IN NO EVENT SHALL SELLER'S TOTAL LIABILITY FOR DAMAGES OF BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS OR PARTS MANUFACTURED BY SELL ER AND UPON WHICH SUCH LIABILITY IS BASED. ANY ACTION ARISING HEREUNDER RELATED HERETO, WHETHER BASED ON BREACH OF CON TRACT, TORT (INCLUDING NEGLIGENCE) OR OTHER THEORIES. MUST BE COMMENCED WITHIN ONE (I) YEAR AFTER THE CAUSE OF ACTION ACCRUES OR IT SHALL BE BARRED.

7. PURCHASER'S REPRESENTATIONS & WARRANTIES

Purchaser represents and warranties that the products(s) covered by this contract shall not be used inor in connection with a nuclear facility orapplication. The parties agree that this representation and warranty is material and is being relied on by seller. This provision may be modified in a separate writing signed by an officer of PPC.

8. PATENTS

Seller agrees to assume the defense of any suit for infringement of any patents brought against Buyer to the extent of such suit chuges infringement of an apparatus or product claim by Seller's product in and of itself, provided (i) said product is built entirely to Seller's design. (ii) Buyer notifies Seller in writing of the filing of such suit within ten (10) days after the service of process thereof, and (iii) Seller is given complete control of the defense of such suit, including the right to defend. settle and make changes in the product for the purpose of avoiding infringement of any process or method claims; unless infringement of such claims is the result of following specific instruction furnished by Seller.

9. EXTENT OF SUPPLY

Only products as listed in Seller's proposal are included in this agreement. It must not be assumed that Seller has included anything beyond same.

10. MANUFACTURING SOURCES

To maintain delivery schedules, Seller reserves the right to have all or any part of the Buyer's order manufactured at any of Sellers' or its licensees' plants on a world-wide basis.

11. TERMS OF PAYMENT

Net 30 days from date of invoice.