

BINKS[®]

Instruction Manual

For

E4-60 Electric Drive Pump

- **Model 107070 – EU Model**
- **Model 107072 – Non Ex Model**
- **Model 107073 - USA Model**

**BINKS**

Product Description

Electric Pump E2, E4

This Product is designed for use with: Solvent and Water based Materials

Suitable for use in hazardous area: Zone 1 & 2

Protection Level: II 2 G X T4 (Pump)
II 2 G Exd/Exde IIB T4 IP55 (Motor) CE0722
II 2 GD ck T4 (Gearbox)

Manufacturer: Binks,
Justus-von-Liebig - Strasse,
63128 Dietzenbach. DE

EU Declaration of Conformity

We: Binks declare that the above product conforms with the Provisions of:

Machinery Directive 2006/42/EC

ATEX Directive 94/9/EC

Pressure Equipment Regulations 1999 (SI 1999/2001)

EMC Directive 2004/108/CE

by complying with the following statutory documents and harmonized standards:

EN ISO 12100: Safety of Machinery - General Principles for Design

EN ISO 4413: Hydraulic Fluid Power - General Rules and safety requirements

EN 12621: Machinery for the supply and circulation of coating materials under pressure - Safety requirements

EN1127-1: Explosive atmospheres - Explosion prevention - Basic concepts

EN 13463-1: Non electrical equipment for use in potentially explosive atmospheres - Basic methods and requirements

EN 13463-5: Non electrical equipment for use in potentially explosive atmospheres - Protection by constructional safety

EN 13463-8: Non-electrical equipment for potentially explosive atmospheres. Protection by liquid immersion 'k'

EN 60079-0: Explosive atmospheres - Equipment. General requirements

EN 60079-1: Explosive atmospheres - Equipment protection by flameproof enclosures "d"

EN 60079-7:2007 - Explosive atmospheres. Equipment protection by increased safety "e"

IEC 60072: Rotating electrical machine FT flange class

IEC 60034-1,5,6,7,8,9,12,14: Rotating electrical machines

Providing all conditions of safe use stated within the product manuals have been complied with and that the final equipment into which this product is installed has been re-assessed as required, in accordance with essential health and safety requirements of the above standards, directives and statutory instruments and also installed in accordance with any applicable local codes of practice.

D Smith (General Manager)

01 November 2012

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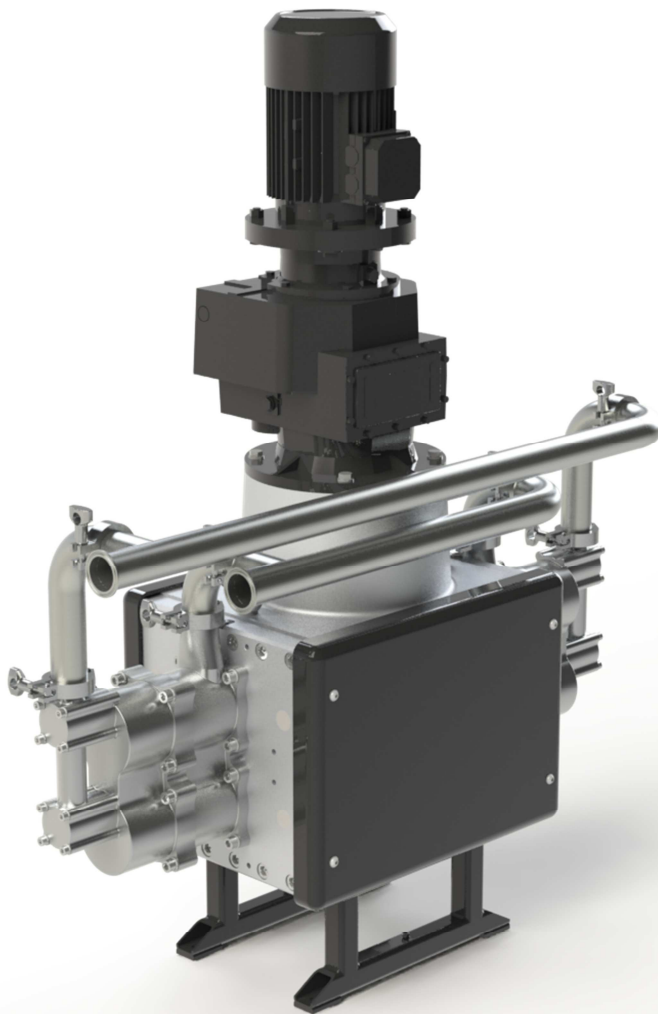
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General Description – Section 1.1



The E4-60 pump uses a standard EExd 4 pole AC electric motor to drive the fluid section, for pumping paints, solvents and other suitable materials.

The unit combines conventional electrical hardware to achieve optimum operating performance at a lower cost. Running costs are much lower than compressed air driven models.

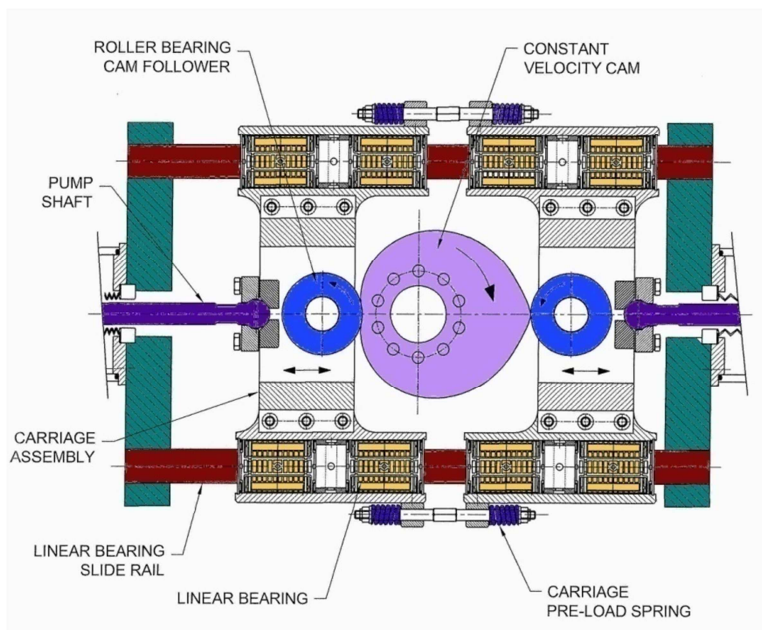
The Model E4-60 Electric Pump achieves a reciprocating drive by using a cam and cam followers combined with a sliding carriage unit.

Equal thrust on each stroke together with the special cam profile reduces fluid pressure fluctuations to an absolute minimum.

The operating speed is adjusted by an AC frequency inverter between 20 and 80 HZ and can be adjusted infinitely within this working range.

Complies with current relevant European and US Legislation

Patent Granted



Operating Principle – Section 1.2

The Assembly comprises of:-

- 1 off Electric Motor
- 1 off In Line Gearbox
- 1 off Drive Shaft / Cam assembly
- 4 off Cam Follower / Carriage assembly
- 4 off Fluid Pistons
- 4 off Fluid Pressure Chambers
- 1 off Fluid Inlet Manifold
- 1 off Fluid Outlet Manifold
- 2 off Support Stand

An AC Induction electric motor drives the fluid section via a mechanical gearbox. The electric motor speed is controlled by an AC Frequency inverter, which can adjust the frequency between 20 and 80 Hz, this being the certified range of the electric motor. The speed adjustment is made by control of the Inverter Frequency Output through manual operation or from a PLC analogue output. The motor frequency is directly proportional to the Fluid Output, (see specifications).

The gearbox is directly coupled to a drive shaft onto which a cam is mounted. As the cam is rotated one of two diametrically opposed fluid displacement pistons is pushed via a connecting rod and cam follower / carriage assembly producing the pressure stroke.

At the same time the other fluid piston is pulled by the opposed cam follower / carriage assembly producing the suction stroke. Each of the two carriage assemblies are held in place by 4 compression springs in order to maintain a constant connection between the cam follower bearings and the cam.

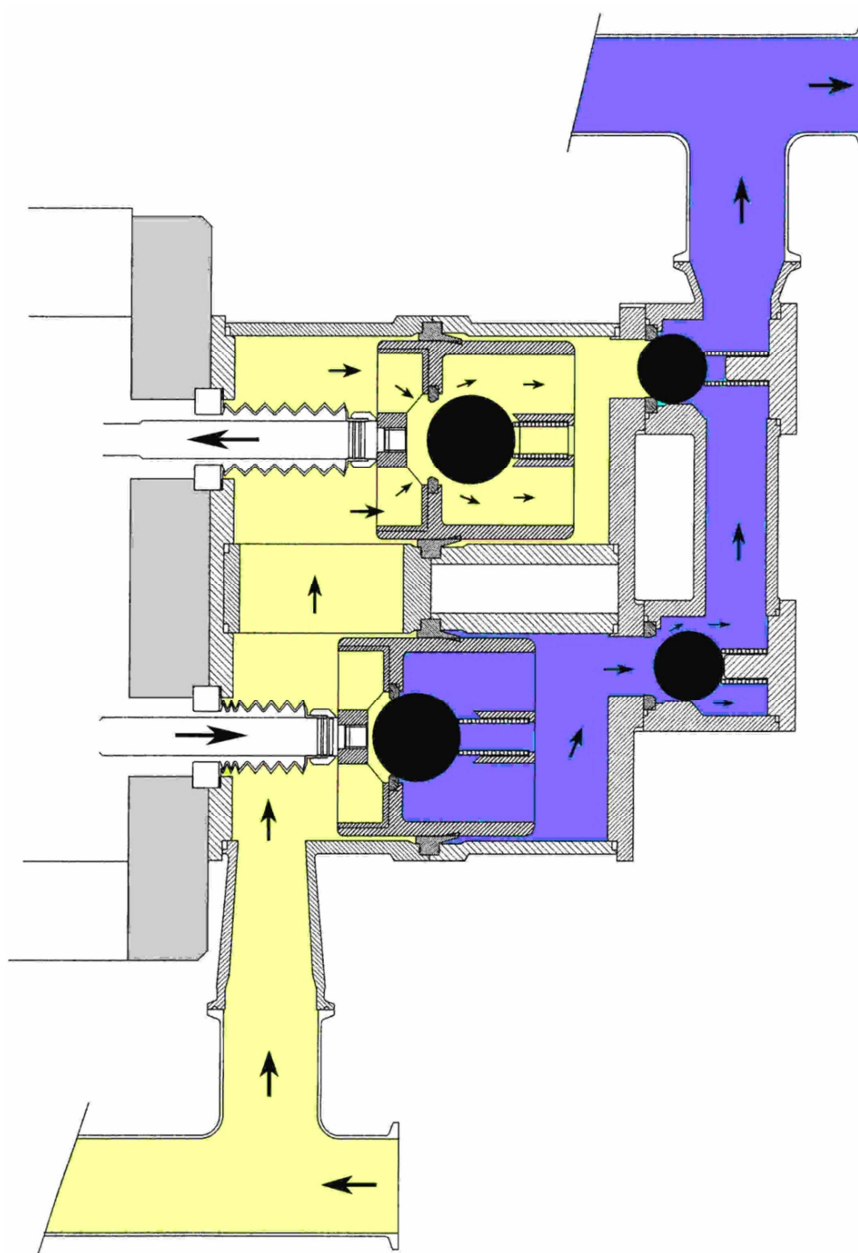
Ball checks control the fluid flow into and out of the pressure chambers during these operations.

Operating Principle – Section 1.2

The Piston Assembly is a unique design as this has the Inlet ball built in to save on space. The outlet ball check is spring assisted to minimise pressure drop at change over.

A bellows provides the fluid seal on the connecting rod within the inlet chamber, whilst a piston lip seal maintains the pump fluid pressure within the pressure chamber.

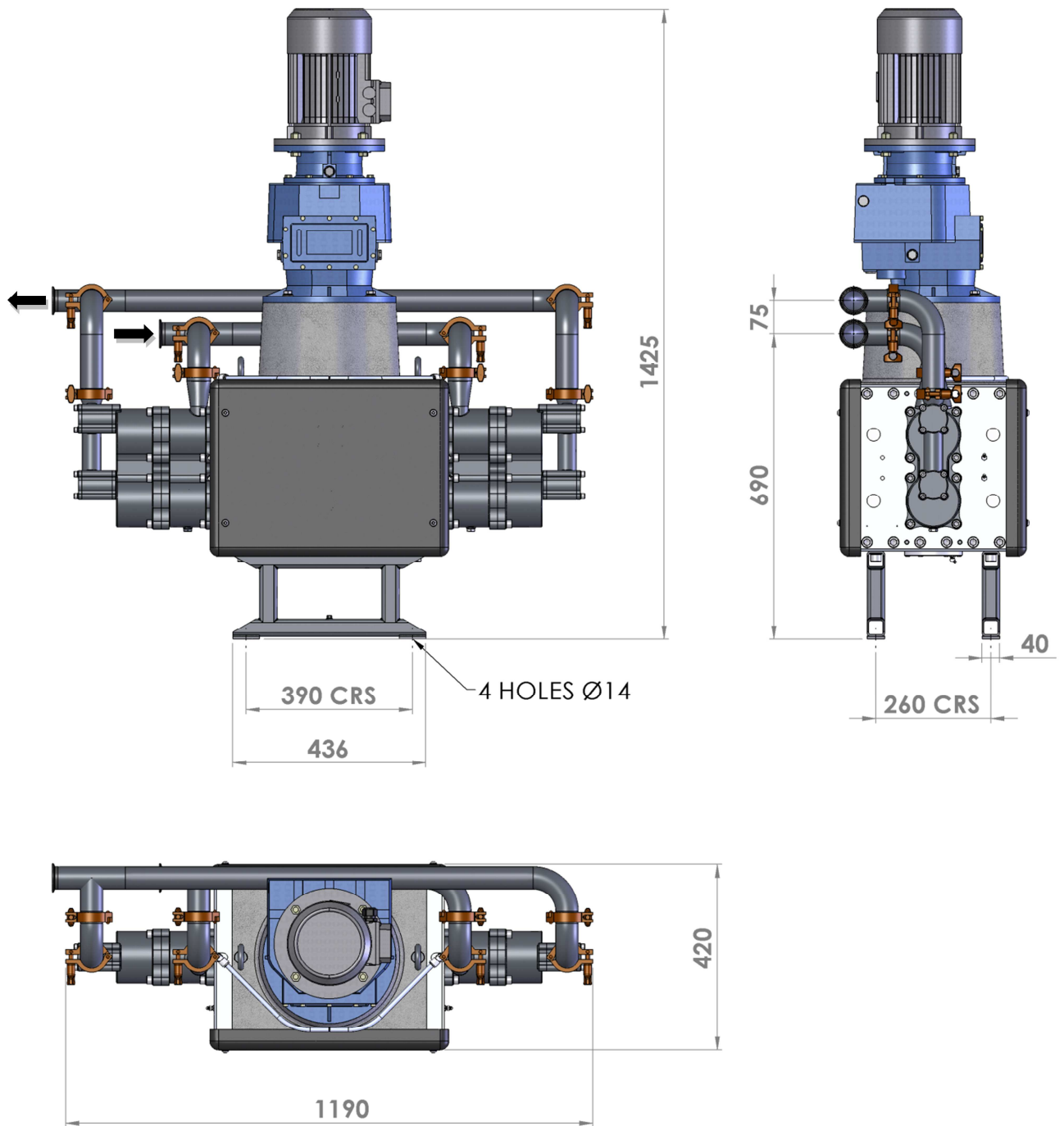
If the main piston seal starts to pass fluid due to wear, any leakage passes into the inlet chamber.



Specification – Section 1.3

Specification	
Pump Nominal Stroke	50 mm 1.97 ins
Max Fluid Pressure (EU & USA)	18 bar (261 psi)
Nominal Flow Volume / Cycle	1.50 Litres 0.40 USGall
Fluid Output @ 20 HZ (10 cycles/min)	15.0 Litres / min 4.0 USGall / min
Fluid Output @ 80 HZ (40 cycles/min)	60.0 Litres / min 16.0 USGall / min
Fluid Inlet / Outlet Connections	2” Sanitary
Gearbox Ratio	56:1
Gearbox Oil Quantity (EP ISO VG 220 Mineral Oil) (EU Model)	7.0 Litres 1.85 USGall
Gearbox Oil Quantity (SHC 630 Synthetic Oil) (USA Model)	7.0 Litres 1.85 USGall
AC Induction Electric Motor - EU Model 3.0 kW 4 Pole 1400 RPM 100L Frame	400V 3PH 3 kW @ 50HZ EEx d 11B T3 Rated 20 to 80 Hz (with thermisters)
AC Induction Electric Motor - USA Model	460V 3PH 5 Hp @ 60HZ Class 1, Group D. Rated 20 to 80 Hz (c/w thermostats)
Total Weight of Pump (inc electric motor)	335 Kg 737 Lb
Total Weight of Pump (exl. motor/gearbox)	250 Kg 550 Lb

Dimensions and Mounting Details – Section 1.4



Important Safety Information - Section 2.1

Directions for Working Safety

This Product has been constructed according to advanced technological standards and is operationally reliable. Damage may, however, result if it is used incorrectly by untrained persons or used for purposes other than those for which it was constructed.

The locally current regulations for safety and prevention of accidents are valid for the operation of this product under all circumstances.

International, national and company safety regulations are to be observed for the installation and operation of this product, as well as the procedures involved in maintenance, repairs and cleaning.

These instructions are intended to be read, understood and observed in all points by those responsible for this product. These operating and maintenance instructions are intended to ensure trouble free operation. Therefore, it is recommended to read these instructions carefully before start-up. Binks cannot be held responsible for damage or malfunctions resulting from the non-observance of the operating instructions. These instructions including regulations and technical drawings may not be copied, distributed, used for commercial purposes or given to others either in full or in part without the consent of Binks.

We reserve the right to alter drawings and specifications necessary for the technical improvement of this product without notice.

High Pressure/Electrostatic Warning

High pressure equipment can be dangerous if used incorrectly, serious bodily injury may occur if the following instructions are ignored. Installation and maintenance should only be carried out by suitably qualified personnel.

1. Before attempting any work on a high-pressure system ensure material pump, hydraulics, compressed air motor are isolated where relevant.
2. Relieve all pressure from the system. Note: It is possible for pressure to get locked into a system, therefore, ensure all sections of the system are checked thoroughly for remaining pressure.
3. Take care when releasing fittings
4. Always replace worn hoses immediately
5. Never plug a leak with your finger, adhesive tape or other stop gap devices

Always ensure equipment is suitably earthed before running, to avoid any chance of electrostatic build up.

Equipment Misuse Hazard

Equipment misuse can cause the equipment to rupture or malfunction and result in serious injury.

- This equipment is for professional use only.
- Read all instruction manuals, tags, and labels before operating the equipment.
- Use the equipment only for its intended purpose.
- Do not alter or modify this equipment. Use only genuine Binks parts and accessories.
- Check equipment daily. Repair or replace worn or damaged parts immediately.
- Do not exceed the maximum working pressure stated on the equipment or in the Technical Data for your equipment. Do not exceed the maximum working pressure of the lowest rated component in your system.
- Use fluids and solvents which are compatible with the equipment wetted parts. Refer to the Technical Data section of all equipment manuals. Read the fluid and solvent manufacturer's warnings.
- Route hoses away from traffic areas, sharp edges, moving parts, and hot surfaces. Do not expose hoses to temperatures above 82°C (180°F) or below -40°C (-40°F).
- Wear hearing protection when operating this equipment.
- Do not lift pressurized equipment.
- Comply with all applicable local, state, and national fire, electrical, and safety regulations.

Important Safety Information - Section 2.1

Fire, Explosion and Electric Shock Hazard

Improper grounding, poor ventilation, open flames or sparks can cause a hazardous condition and result in a fire, explosion, or electric shock.

When installed and operated in accordance with its instructions, the pump is approved for operation in Zone 1 (Europe) & Division 1 (North America), hazardous locations. (ATEX Cat 2)

- Electrical equipment must be installed, operated, and serviced only by trained, qualified personnel who fully understand the requirements stated in this instruction manual.
- Ground the equipment and all other electrically conductive objects in the spray area.
- Keep all covers tight while the motor is energized.
- If there is any static sparking or you feel an electric shock while using this equipment, stop spraying/dispensing immediately. Do not use the equipment until you identify and correct the problem.
- Provide fresh air ventilation to avoid the build up of flammable fumes from solvents or the fluid being pumped.
- Keep the pumping area free of debris, including solvent, rags, and gasoline.
- Electrically disconnect all equipment in the pumping area.
- Extinguish all open flames or pilot lights in the spray/dispense area.
- Do not smoke in the spray/dispense area.
- Do not turn on or off any light switch in the spray/dispense area while operating or if fumes are present.
- Do not operate a gasoline engine in the spray/dispense area.

Hot Surface Hazard

- The electric motor becomes hot during operation, and the heat may be transferred to other connected equipment. To reduce the risk of burning yourself, do not touch the motor surfaces while it is operating. Before servicing, allow the motor to cool.
- Keep flammable materials and debris away from the equipment.

Pressurized Equipment Hazard

Spray from the gun/valve, hose leaks, or ruptured components can splash fluid in the eyes or on the skin and cause serious injury.

- Do not point the gun/valve at anyone or at any part of the body.
- Do not stop or deflect leaks with your hand, body, glove or rag.
- Follow the Pressure Relief Procedure on Section 4.1 whenever you: are instructed to relieve pressure; stop spraying/dispensing; clean, check, or service the equipment.
- Tighten all fluid connections before operating the equipment.
- Check the hoses, tubes, and couplings daily. Replace worn, damaged, or loose parts immediately. Permanently coupled hoses cannot be repaired; replace the entire hose.

Toxic Fluid Hazard

Hazardous fluid or toxic fumes can cause serious injury or death if splashed in the eyes or on the skin, inhaled, or swallowed.

- Know the specific hazards of the fluid you are using.
- Store hazardous fluid in an approved container. Dispose of hazardous fluid according to all local, state and national guidelines.
- Always wear protective eyewear, gloves, clothing and respirator as recommended by the fluid and solvent manufacturer.

Moving Parts Hazard

Moving parts, such as the cam and drive mechanism, can pinch or amputate your fingers.

- Keep clear of all moving parts when starting or operating the pump.
- Never remove the drive section cover while operating the pump.

Installation – Section 3.1 - General

The E4-60 Pump Unit is designed for location in Zone 1 Hazardous areas, ATEX Category 2. Electrical connections must be in accordance with Local regulations for installation in Hazardous areas

A non Ex version is available where the installation is within a non hazardous area.

It is recommended that a Local Control Box is positioned in close proximity to the pump, as a convenient local Start / Stop facility and Junction box. The main Pump Control Panel must be positioned within an Electrically Safe Area.

A Pressure switch (and/or Pressure relief valve) must be connected to the outlet manifold port and set to stop the pump (or relieve the fluid pressure) in the event of the system overpressure e.g. blocked paint filter. This is necessary to protect the Pump mechanics from overload. An adapter to mount a pressure switch and pressure sensor is available, see accessories.

It is recommended that the switch setting is set to 1 bar (14.5 psi) above the maximum required pressure. The maximum Pressure setting the pressure switch should be set to is 19 bar (275 psi)

The pressure switch must be fitted and functioning correctly before the pump is put into use otherwise Pump warranty may be invalidated.

The Pressure Switch is classified as simple apparatus and as such should be electrically connected as part of an intrinsically safe electrical circuit.

The pressure switch should be wired as a Normally Closed contact (fail safe) and be hard wired to stop the motor on operation, to minimise response time.

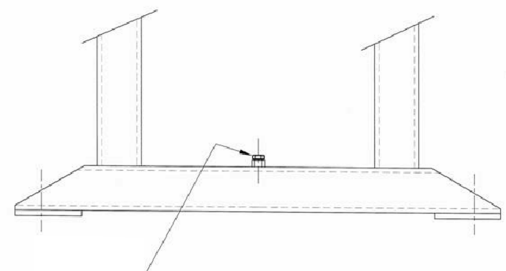
Electric Motor

Motor must be wired to provide a clockwise direction of the cam.

Electric Motors for hazardous areas are specially designed to comply with official regulations concerning the risk of explosion. If improperly used, badly connected, or altered no matter how minor, their reliability could be in doubt.

Standards relating to the connection and use of electrical apparatus in hazardous areas must be taken into consideration. Only trained personnel familiar with these standards should handle this type of apparatus.

The Pump Frame must be wired to a suitable earth ground to ensure that there is no possibility of static build up



M6 HEX. HEAD SCREW FOR PUMP EARTH GROUNDING

Installation – Section 3.2 - Electrical

Inverter

The pump cycle rate and thus the fluid output is controlled by adjusting the motor speed, this is achieved by changing the electrical frequency input to the motor between the range of 20 and 80 Hz.

A suitable AC inverter must be used to control the motor speed.

Where the customer provides a suitable inverter then the following parameters are to be used.

Important! The electric motor is certified for use in a hazardous area between frequencies of 20 Hz an 80 Hz, therefore it is essential that this range cannot be inadvertently exceeded by the operator as this will invalidate the certification and use of the electric motor.

Required European Inverter Settings	Value
Maximum Hz output	80 Hz
Minimum Hz output	20 Hz
Acceleration Ramp	5 Seconds
Deceleration Ramp	0.1 Seconds
Rated Motor Power	3 kW
Rated Motor Current	6.7 A
Rated Motor Voltage	400 V
Rated Motor speed	1440 RPM
Rated Motor Power Factor	0.81
Rated Motor Efficiency	80 %
Rated Motor Frequency	50 Hz

Application Criteria

In a general manner inverters can be connected directly to the power supply line without line reactors. But in this case, ensure the following:

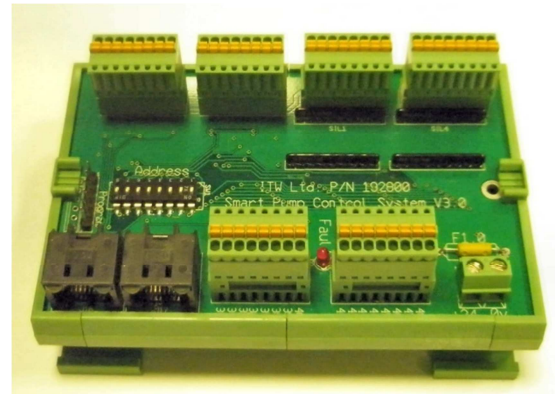
To prevent damage to the inverter and to ensure its expected life, minimum line impedance that introduces a voltage drop of 1%, as a function of the motor load, should be used. If the line impedance (transformers + wirings) is lower than these values, it is recommended to use line reactor.

Installation – Section 3.2 – Electrical

Smart Control - Optional

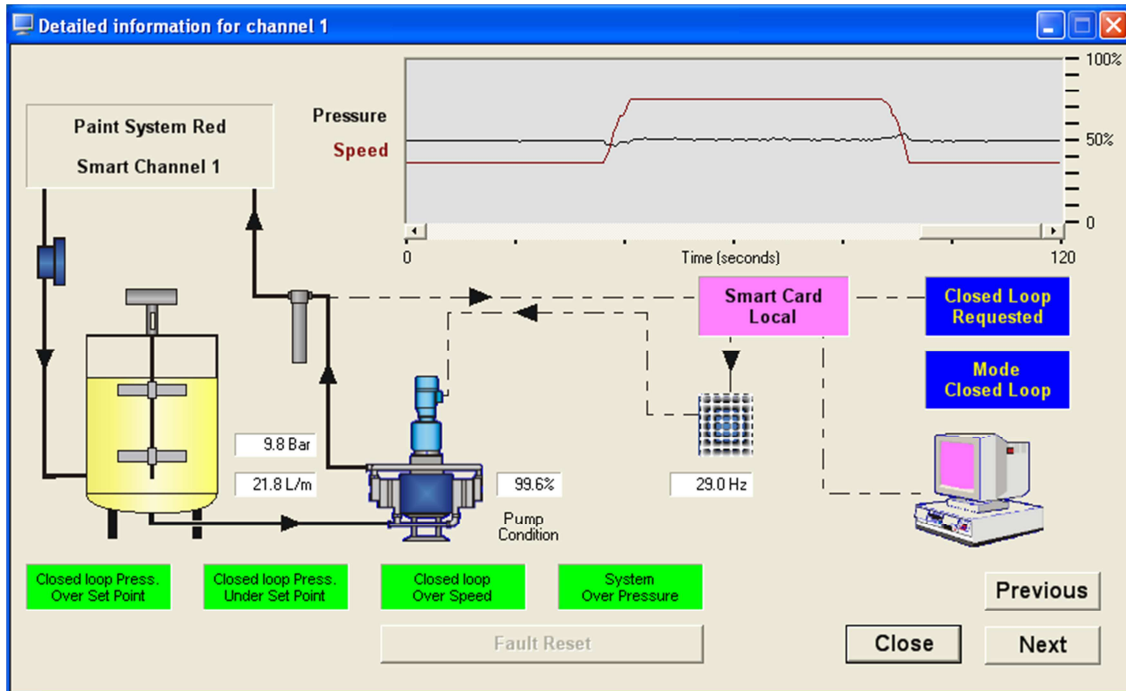
The pump can be used in either flow mode or pressure mode. When Pressure mode is required it is desirable to use a 'Smart card' to control the functionality of the pump.

The control card has in built software to control the paint flow rate and system pressure within given set parameters so that the paint system can be used in the most efficient way at all times, thus saving energy consumption.



Smart Control

The 'Smart' system design provides for two modes of operation, fully automatic closed loop pressure control and open loop flow control.-



Detailed Status for 1 Channel showing 20L/min flow increase in the paint system and the immediate pump speed response increase

Installation – Section 3.3 - Mechanical

- Secure the Pump assembly to the floor (or purpose designed support steelwork) using the 4 off Ø13 mm holes in the base of the pump support frame.
- Attach suitable hoses (20 bar maximum working pressure) to the inlet and outlet connections. E.g. 50 mm NB Inlet and 38 to 50 mm NB Outlet hose.
- In addition to the pressure switch a Pressure relief valve can be connected and piped back to the pump supply tank to relieve pump outlet pressure in the event that the pipework system is closed (by ball valve or other means) causing system overpressure.

This is necessary to protect the Pump mechanics from overload and subsequent damage.

It is recommended that the relief valve setting is set to 1 bar (14.5 psi) above the maximum required pressure. The maximum Pressure setting the relief valve should be set to is 1 bar (14.5 psi) above pump maximum working pressure.

A pressure sensor is utilised when the pump is set up in 'Pressure Mode' (instead of 'Stroke Mode') where the pump cycle rate is adjusted to respond to paint system pressure, a dedicated 'Smart Card' or PLC software should be incorporated in the pump control system to ensure correct operation.

- Ensure adequate air space around the Pump for maintenance and electric motor cooling requirements.
- Check that the oil plug on top of Gearbox has been replaced with the correct venting plug. The vent plug is supplied in a bag attached to the gearbox.
- Ensure the gearbox is filled with oil. (The gearbox is filled with the correct amount of oil at the factory)

Operation - Section 4.1

System Operation

Before starting: -

- Ensure pump is running in a clockwise direction.
- Ensure all electrical and mechanical connections are correctly made.
- All required interlocks are tested and operational.
- Suitable material for pumping is available at the suction hose.
- The outlet connection is not blocked or isolated by any valves.
- Check the gearbox oil level, top up as necessary with the correct grade (see maintenance section) and that the gearbox ventilator is fitted.

Set the pump speed to the minimum frequency 20 HZ and start the pump to remove any air from the circuit. Inspect for any leaks.

Set the pump cycle rate to achieve the required paint volume and then adjust the system back pressure regulator to achieve the desired system fluid pressure. Refer to Fluid Output Table for comparison of fluid output relative to Inverter frequency and Pump cycle rate.

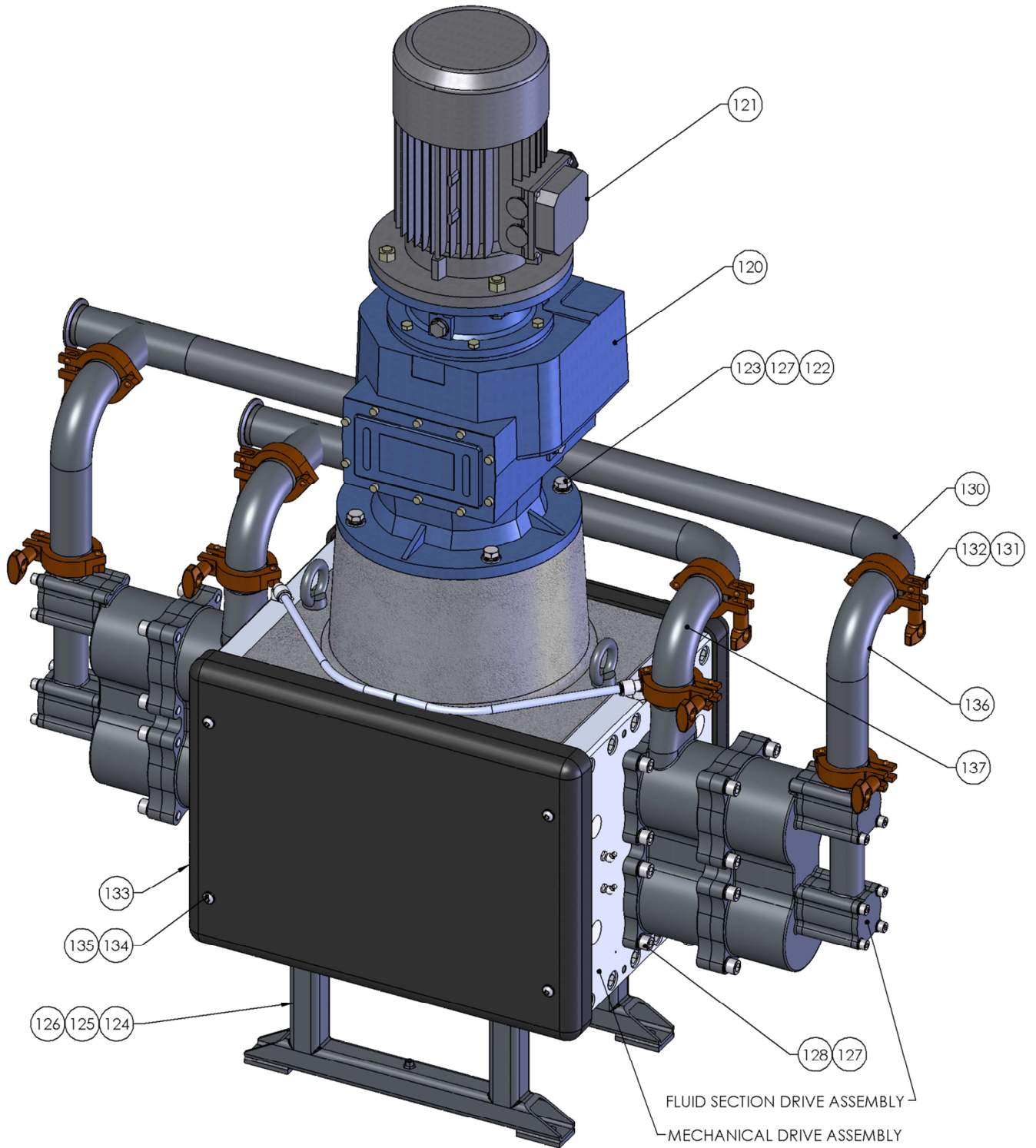
The return line 'back pressure' regulator responds to the changes in system fluid flow demand, (due to variable paint usage) by dynamically adjusting the paint flow rate returning to the system paint tank, thus maintaining the set pressure.

Motor Speed Fluid Output Table			
Motor Speed HZ	Pump Speed Cycles/min	Fluid Flow Rate Litres/min	Fluid Flow Rate US Gall/min
20	10.00	15.00	3.98
25	12.50	18.75	4.97
30	15.00	22.50	5.97
35	17.50	26.25	6.96
40	20.00	30.00	7.96
45	22.50	33.75	8.95
50	25.00	37.50	9.95
55	27.50	41.25	10.94
60	30.00	45.00	11.94
65	32.50	48.75	12.93
70	35.00	52.50	13.93
75	37.50	56.25	14.92
80	40.00	60.00	15.92

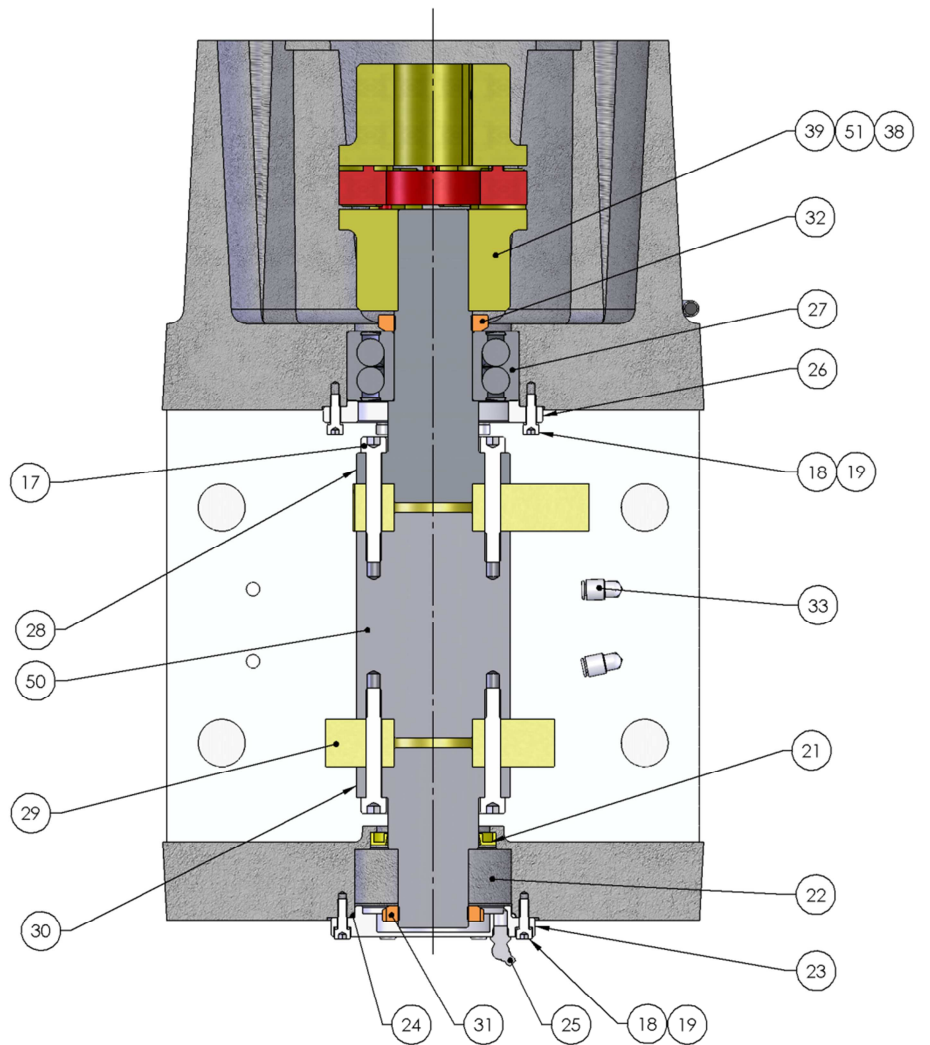
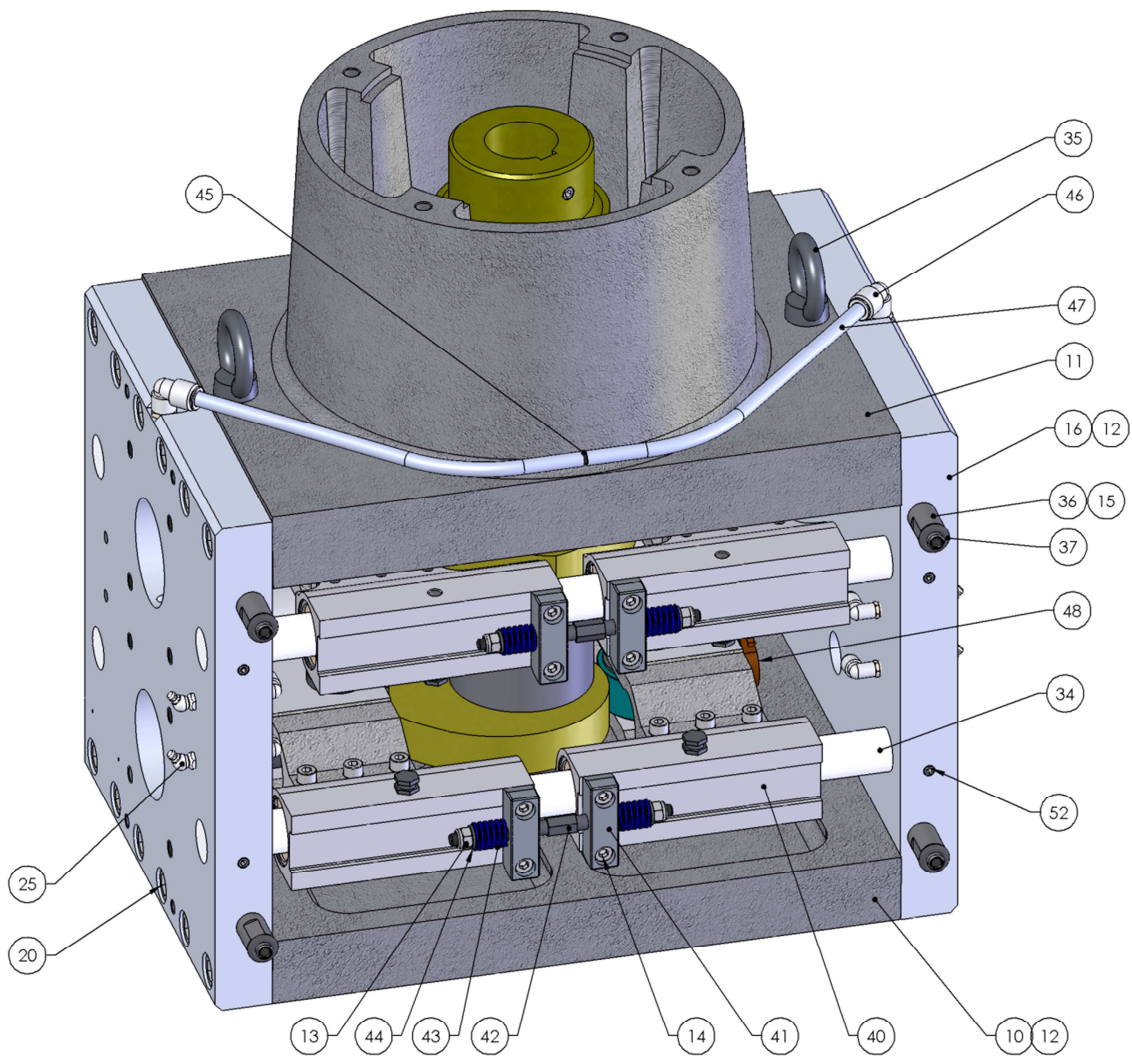
Parts List – Section 5.1

Parts List – E4-60 Main Pump Assembly				
ITEM	PART No	DESCRIPTION	QTY	REMARKS
1	-- -- --	MECHANICAL DRIVE ASSEMBLY	1	
2	192681	FLUID SECTION ASSEMBLY	2	
120	192686	HO83 ATEX GEARBOX (EU)	1	107070 PUMP
<i>120</i>	<i>192687</i>	<i>PHO83 GEARBOX (USA PUMP)</i>	<i>1</i>	<i>107073 PUMP</i>
<i>120</i>	<i>192819</i>	<i>HO83 NON ATEX GEARBOX</i>	<i>1</i>	<i>107072 PUMP</i>
121	192684	3.0 kW ATEX ELECTRIC MOTOR	1	107070 PUMP
<i>121</i>	<i>192685</i>	<i>5 HP ELECTRIC MOTOR (USA PUMP)</i>	<i>1</i>	<i>107073 PUMP</i>
<i>121</i>	<i>192818</i>	<i>3.0 kW NON ATEX ELECTRIC MOTOR</i>	<i>1</i>	<i>107072 PUMP</i>
122	164470	M12 WASHER ST ST	4	
123	164469	M12 x 40 HEX HD SCREW (PLATED)	4	
124	192634	MOUNTING FRAME	2	
125	165100	M16 SPRING WASHER	4	
126	165588	M16 x 30 CAP HD SCREW (PLATED)	4	
127	165044	M12 SPRING WASHER (ST ST)	20	
128	165960	M12 x 40 CAP HD SCREW (ST ST)	16	
129	192635	INLET MANIFOLD	1	
130	192636	OUTLET MANIFOLD	1	
131	192029	2 SANITARY GASKET PTFE	8	①②③④
132	192544	2 SANITARY CLAMP	8	
133	192638	COVER	2	
134	164474	M8 x 16 TORX SCREW (ST ST)	8	
135	192485	M8 WASHER (NYLON)	8	
136	192792	2" OUTLET ELBOW	2	
137	192791	2" STD 90° BEND	2	

Parts List – Section 5.1



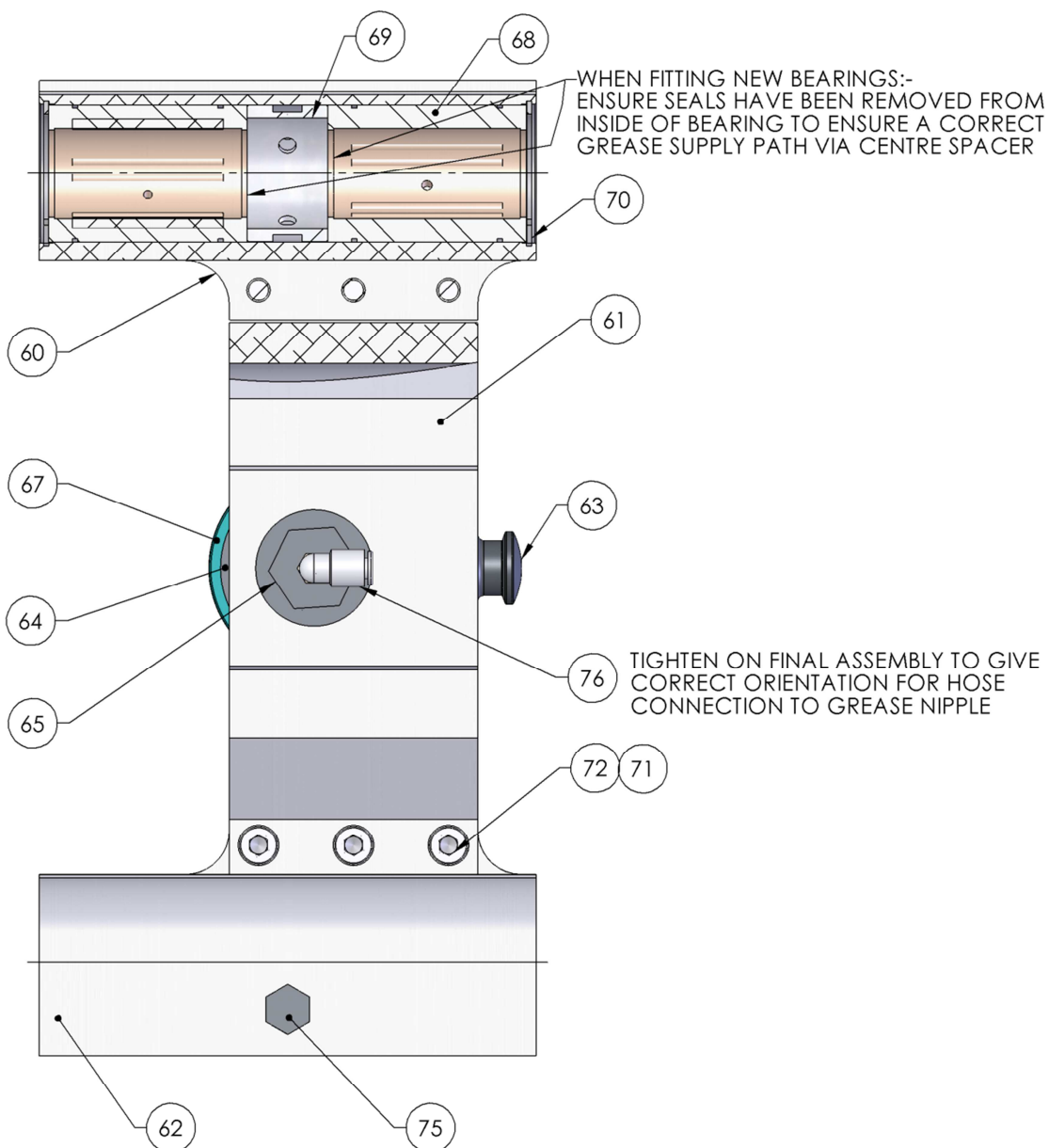
Parts List – Mechanical Assembly				
ITEM	PART No	DESCRIPTION	QTY	REMARKS
10	192602	BASE PLATE	1	
11	192601	TOP PLATE	1	
12	192653	Ø12 x 30 DOWEL PIN	8	
13	163161	M8 NYLOC NUT	8	
14	165552	M8 x 20 CAP HD SCREW (PLATED)	16	
15	165663	M8 x 30 GRUBSCREW	8	
16	192603	SIDE PLATE	2	
17	165571	M10 x 70 CAP HD SCREW (PLATED)	20	
18	163952	M6 x 20 CAP HD SCREW (ST ST)	12	
19	165087	M6 SPRING WASHER (ST ST)	12	
20	165592	M16 x 50 CAP HD SCREW (PLATED)	24	
21	192644	Ø80 SHAFT SEAL	1	⑦
22	192640	Ø100 ROLLER BEARING	1	⑦
23	192616	BEARING CAP	1	
24	192645	O-RING Ø100 x 2.5	1	⑦
25	192650	1/8 x 45 GREASE NIPPLE	5	
26	192617	TOP BEARING CAP	1	
27	192639	Ø110 BALL BEARING	1	⑦
28	192605	TOP SHAFT	1	
29	192600*	CV CAM*	2	
30	192606	BASE SHAFT	1	
31	192655	M45 BEARING LOCKNUT	1	
32	192656	M50 BEARING LOCKNUT	1	
33	192661	1/8R - 6MM PUSH IN ELBOW	4	
34	192643	LINEAR BEARING ROD	4	⑥
35	192441	M16 EYE BOLT	2	
36	192637	SPACER - COVER	8	
37	192440	O-RING Ø10.46 X 5.33	8	
38	192654	14 x 9 x 50 KEY	1	
39	192721	COUPLING ASSEMBLY	1	(192811 SPIDER)
40	192682	CARRIAGE ASSEMBLY	4	
41	193105	SPRING KEEP	8	
42	193102	CARRIAGE SPRING ROD	4	
43	193104	CARRIAGE SPRING	8	⑤
44	192400	SPRING RETAINING WASHER	8	
45	192751	HOSE PLUG	1	
46	192752	1/4 10 PUSH IN ELBOW	2	
47	192817	Ø10 x 6 PU HOSE	2	
48	192668	SHAFT CLAMP ASSY	4	
49	192662	Ø6 GREASE HOSE	2	⑤ Fit to 33 & 76
50	192604	MIDDLE SHAFT	1	
51	165671	M10 GRUBSCREW x 20	2	
52	165660	M8 x 16 GRUBSCREW (ST ST)	8	



Parts List – Section 5.2

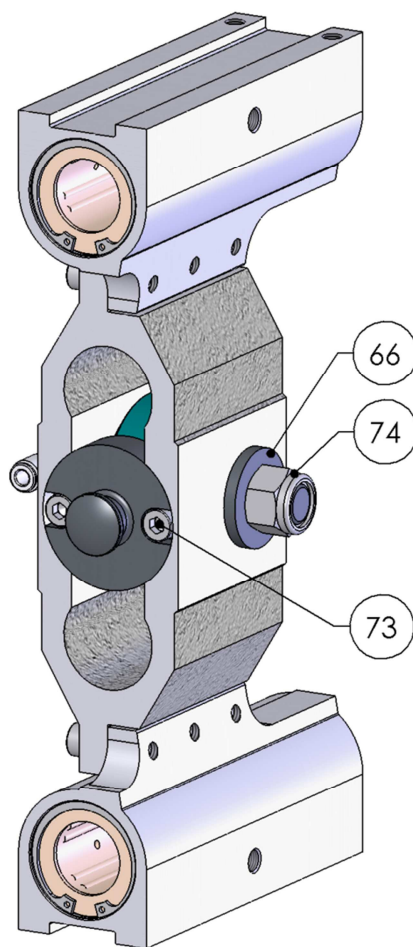
Parts List – Mechanical Assembly - Carriage 192682

ITEM	PART No	DESCRIPTION	QTY	REMARKS
60	192608	LH CARRIAGE END	1	
61	192607	CARRIAGE MIDDLE	1	
62	192609	RH CARRIAGE END	1	
63	192618	CARRIAGE ADAPTOR	1	
64	192611	FOLLOWER GUARD WASHER	2	5
65	192610	CAM FOLLOWER PIN	1	
66	192612	FOLLOWER NUT WASHER	1	
67	192641	Ø72 CAM FOLLOWER	1	5



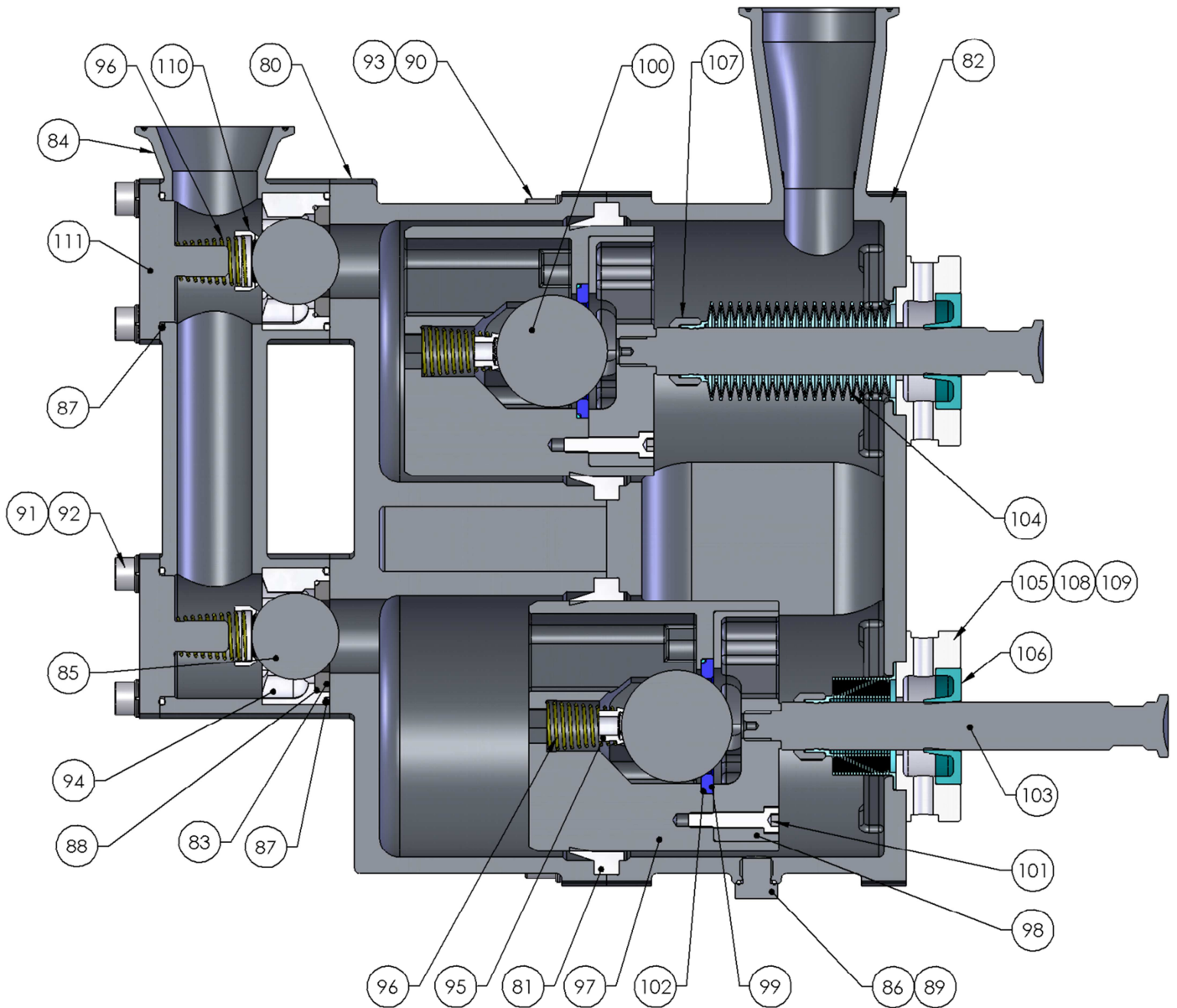
Parts List – Section 5.2

Parts List – Mechanical Assembly - Carriage 192682				
ITEM	PART No	DESCRIPTION	QTY	REMARKS
68	192642	LINEAR BEARING	4	⑥
69	192615	LINEAR BEARING SPACER	2	⑥
70	192652	Ø47 INTERNAL CIRCLIP	4	⑥
71	165086	M8 SPRING WASHER	6	
72	165553	M8 x 25 CAP HD SCREW	6	
73	165552	M8 x 20 CAP HD SCREW	2	
74	163152	M16 NYLOC NUT	1	
75	192649	1/8 GREASE NIPPLE - SLIP ON	2	
76	192661	1/8R - 6MM PUSH IN ELBOW	1	



Parts List – E4-60 Fluid Section				
ITEM	PART No	DESCRIPTION	QTY	REMARKS
80	192621	OUTLET CYLINDER	1	
81	192633	PISTON SEAL	2	② ④
82	192620	INLET CYLINDER	1	
83	192632	OUTLET SEAT	2	④
84	192624	OULET BLOCK	1	
85	171788	1.375 BALL	2	④
86	192551	HEXAGON PLUG - 1/4 BSP	1	
87	192647	O-RING Ø50.5 x 2.62 (PTFE)	4	① ② ④
88	192648	O-RING Ø41.0 x 1.78 (PTFE)	2	① ② ④
89	192505	O-RING Ø12.42 x 1.78 (PTFE)	1	① ② ④
90	165960	M12 x 40 CAP HD SCREW (ST ST)	8	
91	165108	M8 SPRING WASHER (ST ST)	8	
92	165957	M8 x 90 CAP HD SCREW (ST ST)	8	
93	165044	M12 SPRING WASHER (ST ST)	8	
94	192626	OUTLET CAGE	2	
95	192629	INLET SPRING KEEP	2	②
96	160513	CONICAL SPRING	4	②
97	192622	Ø100 PISTON	2	
98	192623	Ø100 PISTON KEEP PLATE	2	
99	192631	PISTON INLET SEAT	2	④
100	171784	1.750 ST ST BALL	2	④
101	163920	M6 x 30 CAP HD SCREW (ST ST)	10	② ④
102	192646	O-RING Ø50.5 x 1.78 (PTFE)	2	① ②
103	192619	PISTON SHAFT	2	
104	192579	KNIFED BELLOWS	2	③ ④
105	192627	BELLOWS SPACER	2	
106	192628	SHAFT SEAL	2	③ ④
107	192374	RETAINING NUT	2	
108	165087	M6 SPRING WASHER (ST ST)	8	
109	163921	M6 x 25 CAP HD SCREW (ST ST)	8	
110	192630	OUTLET SPRING KEEP	2	
111	192625	OUTLET CAP	2	

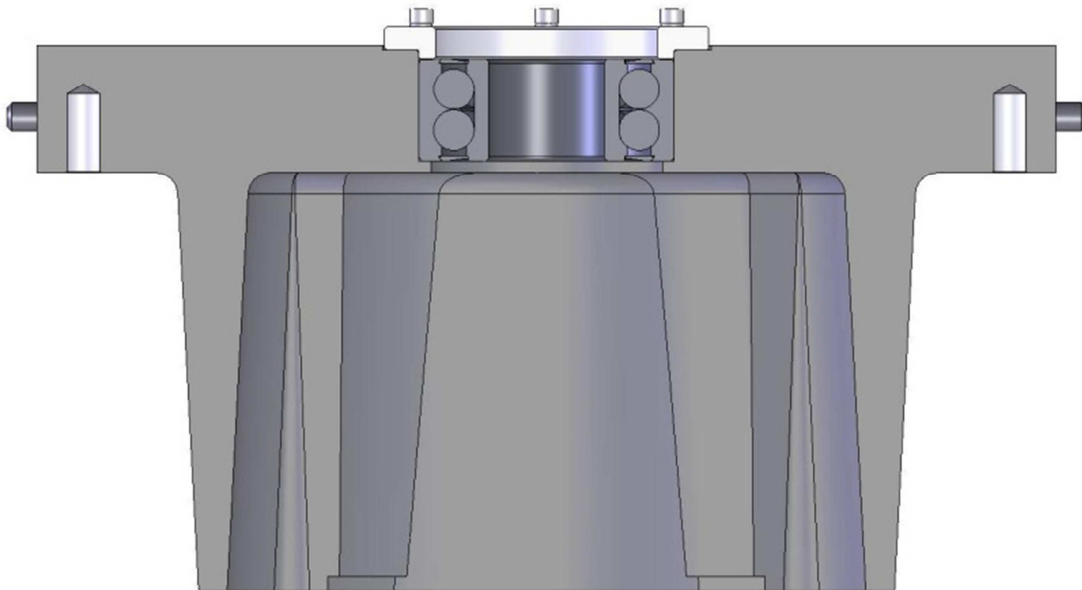
Parts List – Section 5.3



Maintenance – Section 6.1 - Assembly Procedure

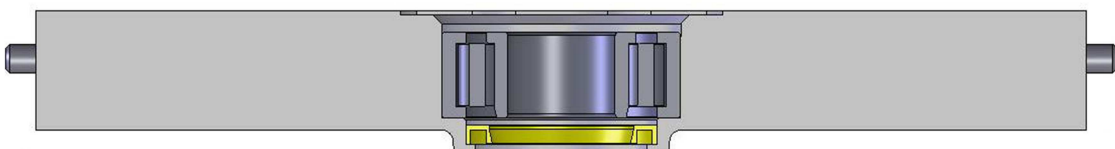
Top Plate Assembly

1. Apply bearing loctite 641 to ball bearing (27) and top plate housing (11) bore. Using tool (502510) press in the bearing until the outer race rests against the shoulder in the casting bore.
2. Fit bearing cap (26) with M6 x 20 cap head screws (18) and spring washers (19) apply threads with loctite 222, tighten to 12 Nm
3. Fit dowels (12) into Ø12 holes of the side of plate, apply Loctite.



Bottom Plate Assembly

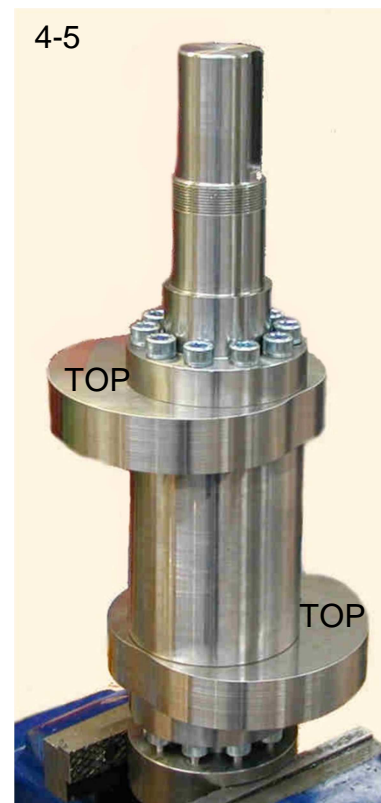
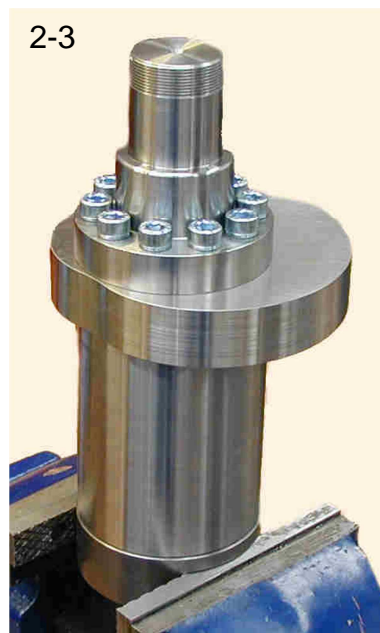
1. Lightly grease seal (21) with 502375 grease and push seal into base plate housing (10) Note orientation of seal, 'U' cup away from bearing. (502375 grease) Remove spring from 'U' cup if fitted
2. Apply bearing loctite 641 to roller bearing (22) and housing bore and press in roller bearing without inner race, using press tool (502511). Retain the bearing inner race for later assembly to the bottom shaft.
3. Fit dowels (12) into Ø12 holes of the side of plate apply 'loctite'.



Maintenance – Section 6.1 - Assembly Procedure

Main Shaft Assembly

1. Hold assy. tool (502512) in a vice and install middle shaft (50).
2. Place cam (29) onto middle shaft (with 'TOP' engraving facing the shaft) and then place base shaft (30) on top of cam.
3. Align holes and screw in M10 x 70 cap head screws (17) using loctite 243, tighten to 65Nm
4. Rotate assembly over in the tool and fit the second cam (with 'TOP' engraving facing up) 3 holes radially out of pitch from the first cam, then fit top shaft (28).
5. Align holes and screw in M10 x 70 cap head screws (17) using loctite 243, tighten to 65Nm



Maintenance – Section 6.1 - Assembly Procedure**Main Drive Assembly.**

1. Place top plate assembly onto a bench, with the bearing facing upwards.
2. Clean the inner surface of bearing, and apply a light coating of bearing lock retainer (Typically Loctite 641)
3. Clean shaft assembly, and apply a light coating of bearing lock retainer to the Ø50 section of the shaft.
4. Place shaft assembly squarely into the bearing. The shaft may require a 'light press' to ensure bearing contact with the Ø58 shoulder.
5. Locate the vent hole end of 2 off side plates (16) and place that end over the top plate dowels. Lightly grease 2 off M16 x 50 cap screws (20) per side and screw in 3 full turns into the outer holes. This will allow you to slide the side plates away from the dowels.
6. Pick up the bottom plate assembly and remove the inner race from the bearing. Fully grease the shaft seal and bearing with (502375)
7. With the side plates extended to their outmost position, place the bottom plate assembly over the shaft end. Working on one side at a time, locate the dowels on both top and bottom plates. When both sides are in position lightly grease and fit the remaining M16 x 50 cap screws (20), tighten to 70Nm.
8. Grease (use 502375) the inner race of the bottom bearing and the rollers of the bearing. Push the inner race over the shaft until it contacts the Ø80 shoulder. There should be at least a 0.1mm gap between the rollers and the inside edge of the inner race.
9. Light grease the M45 locking nut (31) (use 502375). Screw the nut onto the shaft and tighten using special castellated tool (502509).
10. Place the Ø100 rubber 'O' ring (24) over the bearing cap spigot (23) and place over the end plate bearing, making sure that the greasing port is at the back of the pump assy. Fit the 6 off M6 x 20 cap screws (18) and washers (19) using Loctite 222 and tighten in a diagonal pattern until 15Nm is achieved.
11. Fit a 45° push on grease nipple (25) into the grease port, and tighten until the nipple faces the front of the pump assy.
12. Assemble the two mounting legs (124) to the bottom plate, using M16 x 30 cap screws (126) and washers (125)
13. Two people must rotate the mechanical section assembly thus far onto legs (124).

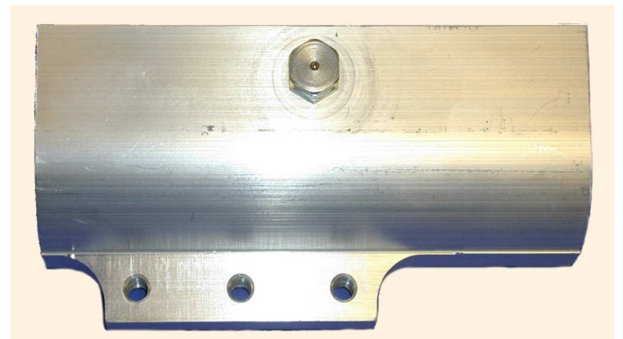
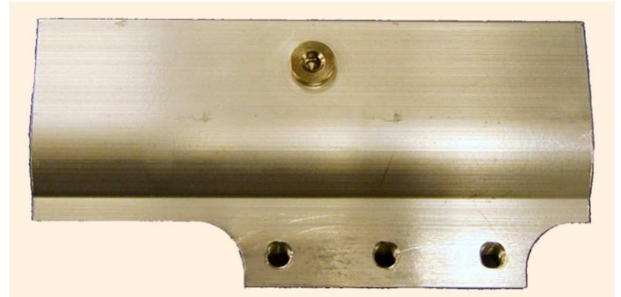
Maintenance – Section 6.1 - Assembly Procedure

192682 Carriage Sub-Assemblies

End block

1. Insert grease nipple (75) into front port, corner of hexagon should point forward.
2. Insert circlip (70) into one end of block.
3. Insert linear bearing (68) into carriage so that the seal side will be on the outside the edge of the block. Orientate bearing so that the wide black section along its body is aligned to the block's side.
4. Insert white bearing spacer (69), with cross holes aligned the ball races.
5. Insert the second linear bearing (68) into carriage so that the seal side will be on the outside; orientate bearing so that the wide black section along its body is aligned to the block's side.
6. Insert the second circlip (70) to other end of the carriage block

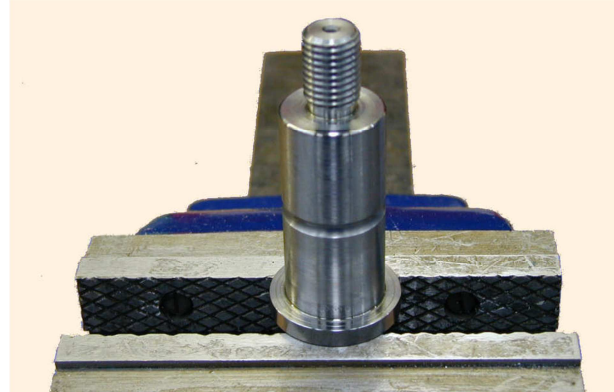
Note: - 1 off LH (60) and 1 off RH (62) carriage blocks are required to build up one sub-assembly.



Maintenance – Section 6.1 - Assembly Procedure

192682 Carriage Sub-Assembly

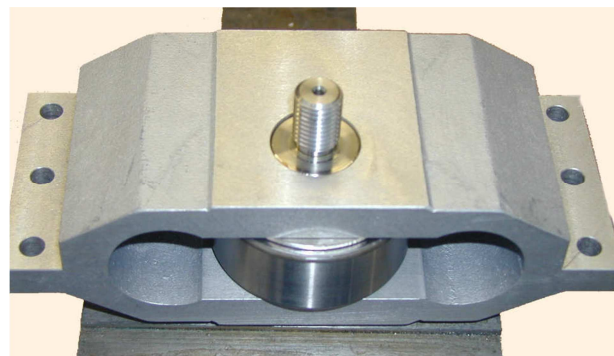
1. Place cam follower pin (65) into a vice gripping the hexagon end so that the pin is vertical and the grease cross hole points towards the back.



2. Place cam follower bearing (67) and one follower washer (64) each side of bearing into middle carriage (61) so that the bearing cross hole faces to the back of the block.



3. Place this loose assembly over the pin, so that the two cross holes line up. Place nut washer (66) and lightly greased nut (74) onto the pin. Hold in position and tighten the nut to 80 Nm.



4. Place the carriage adaptor (63) in the block recess and fit 2 off screws (73) with Loctite 222 on the threads. Tighten screws to 22 Nm

5. Fit the 2 off Ø6 pushin elbows (76) into the cam follower pin grease ports and position to face the rear of the pump.

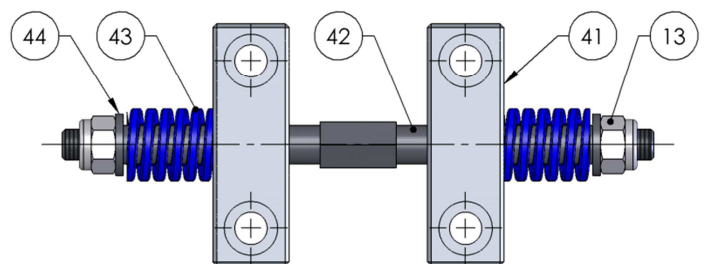
6. Assemble carriages together: - Connect 1 off LH and 1 off RH end blocks to the middle carriage (61) with 3 off per side M8 x 25 cap head screws (72) & spring washers (71) with thread lock Loctite 222. Leave the sub-assembly loose. (4 off assemblies are required.)

Maintenance – Section 6.1 - Assembly Procedure

Main Drive and Carriage Assembly

1. Apply 222 Loctite to the M8 x 16 Grub screws (52) and loosely fit into the bearing support rod clamp holes.
2. From one side 'slide in' 4 off Ø30 linear bearing support rods (34) into the carriage bar holes until they are about 25mm into the main drive.
3. Select a carriage sub-assembly and fit over the top set of support rods (grease nipples to the centre), slide the rods through the carriage assembly until they are level with the main shaft and the fitted carriage is fully back.
4. Select the other carriage sub-assembly and fit over the bearing support rods, pushing the bars into the other support rod hole. When both carriages and bars are in position tighten the M8 x 16 Grub screws (52) to 22Nm
5. Repeat procedure for bottom set of carriages.
6. Selecting one carriage at a time, slide the carriage assembly back to the side plate, pushing via the cam follower bearing (*this will align the carriage parts*). Finally tighten the cap heads M8 x 25 (72) cap head to 22Nm.
7. Check that the carriages are free to move with little or no 'stiction'.
8. Fit the 4 off Ø6 'push in' elbows into the side plate (33) front grease ports and position to face the back of the pump.
9. Push the carriages until the cam follower bearings are touching the cam.

10. Loosely assemble Spring Keeps as shown.
11. Fit 4 off spring keep assemblies to join the carriages using M8 X 20 cap head screws (14) use loctite 222
12. Fully tighten M8 locknuts (13) to 10Nm.

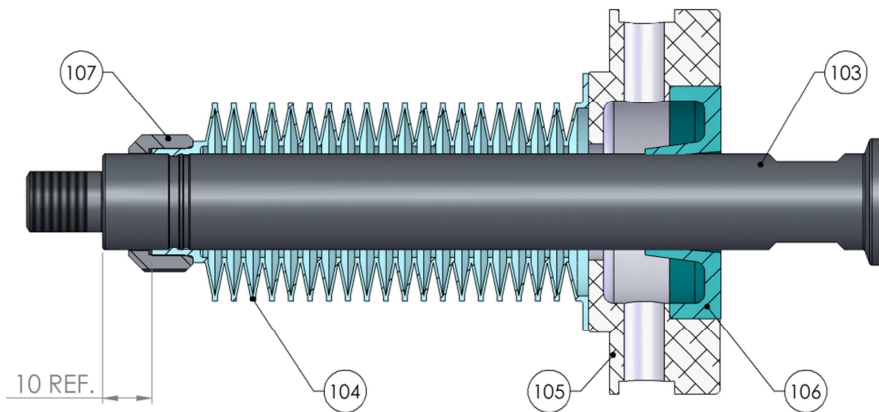


13. Rotate main drive shaft at least one turn making sure that both carriage assemblies move smoothly.
14. Fit Ø6 hoses (49) to the 'push in' elbows (33) and (76)
15. With a grease gun filled with 502375 grease, pump grease into the nipple and hose (approx. 14 strokes of the grease gun), until grease comes out of the hose. Clean off excess grease and connect the hose ends to the opposite cam follower pin 'push in' fittings.

Maintenance – Section 6.1 - Assembly Procedure

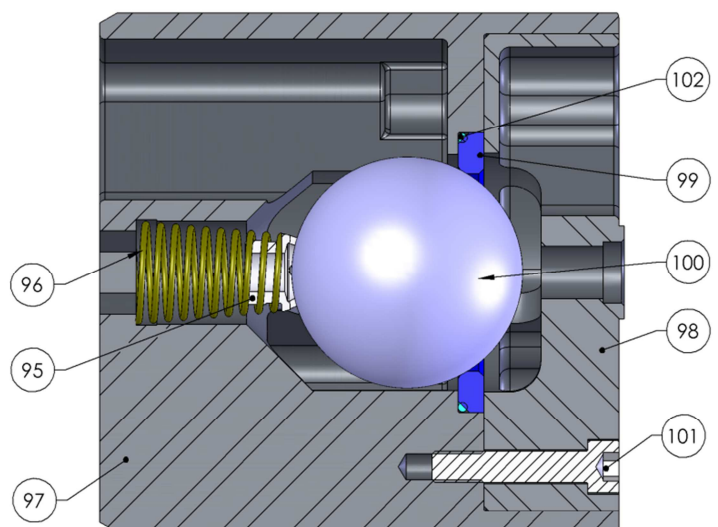
Fluid Section Assembly [2] - Shaft / Bellows Assembly (192679)

1. Screw 502382 assembly spigot onto the piston shaft (103).
2. Push seal (106) and bellows spacer (105) over the piston shaft.
3. Using tool 502377 push the bellows (104) over the assembly spigot until the bellows internal spigot locates into the shaft groove. (Using the tool prevents damage to the convolutions)
4. Smear a film of loctite 572 over the nose of the bellows then thread the nut (107) onto the bellows using tool 502377 to push against the nut ensuring the thread starts squarely. Grip the bellows and tighten the nut with a 1" A/F spanner until the nut contacts the bellows shoulder. Remove 502382 assembly spigot.



Fluid Section Assembly [2] – Piston Assembly (192678)

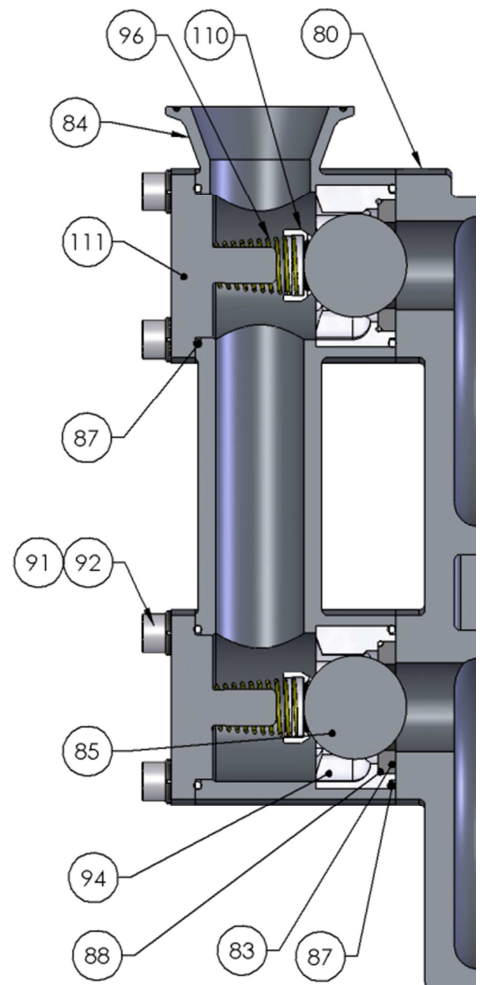
1. Insert spring (96) and spring keep (95) into piston
2. Place the ball (100) against spring keep.
3. Fit the 'O' ring (102) and inlet seat (99) into piston (97).
4. Fit piston keep plate (98) and assemble with 5 off M6x30 caphead screws (101) use Loctite 222 on the threads. Tighten Evenly to 12Nm.



Maintenance – Section 6.1 - Assembly Procedure

Fluid Section Assembly [2]

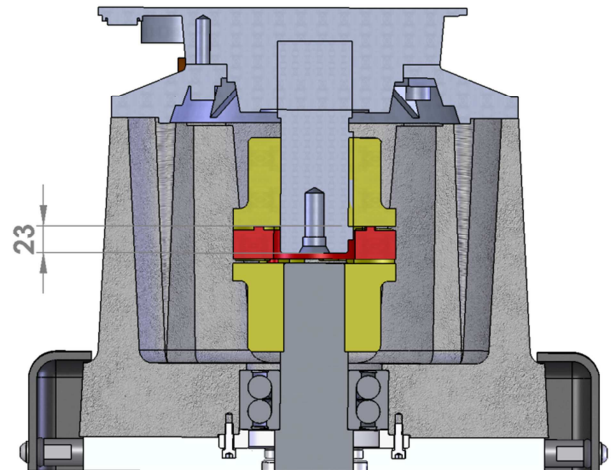
1. Place a shaft / bellows assembly (192679) into the pocket on the back of the inlet cylinder (82). Hold in position and loosely assemble with 4 off M6 x 25 long screws (109) and washers (108) use loctite 222 on the threads.
2. Lightly lubricate with suitable grease a piston seal (81) and push the seal onto the piston assembly (192678) with the seal lip facing away from the shaft end of the piston.
3. Apply Loctite 243 to piston shaft thread and loosely screw the Piston assembly onto the piston shaft. Locate the piston seal (81) into the inlet cylinder (82) (this *will centralize the piston*). Hold the piston and prevent from turning with 14 mm Allen key, tighten the piston onto the shaft with 16mm spanner to 55Nm. Finally tighten 4 off screws (109) to 12Nm.
4. Locate the outlet cylinder (80) over the piston seal until there is a small gap between the cylinders.
5. Lightly grease the thread of 4 off M12x40 caphead screws (90) and assemble with 4 off Ø12 washers (93) to hold the cylinders together. Tighten evenly the caphead screws in a 'criss cross' fashion to 50Nm.
6. Place 2 off outlet ball cages (94) & 'O' rings (87 & 88) and outlet seat (83) into outlet block (84), place this sub-assembly onto outlet cylinder (80) as shown.
7. Place outlet balls (85) into block, followed by outlet spring keep (110), spring (96)
8. Fit 'O' ring (87) onto outlet cap (111) and assemble into outlet block (84)
9. Grease 8 off M8x90 cap head screws (92) fit washers (91) and assemble all parts together. Tighten screws evenly to 22Nm.



Maintenance – Section 6.1 - Assembly Procedure

Final Assembly

1. Use electric pallet lift move the pump assembly from the bench onto packing crate base. (Note: Overall weight at this point of the assembly is 210 Kg)
2. Lightly grease and fit the shaft bearing locknut (32). Hold the main shaft and tighten nut using special castellated tool (502508).
3. Lift pump assembly to a suitable working height using electric pallet lift.
4. Hold a fluid section assembly [2] and feed the piston shaft through the side of the mechanical assembly casting, locate the bellows spacer into the counterbore in the casting. Lightly grease thread of 4 off M12x40 caphead screws (128) and 8 off Ø12 washers (127) to hold the cylinders to the side plate. Tighten all caphead screw to 25Nm in 'criss cross' fashion and then to 50Nm
5. Pull the piston shaft until the shaft and the carriage adaptor are touching. Fit the quick release shaft clamp (51) and tighten to 20Nm
6. Fit inlet manifold and elbows (129 & 137) to the pump with 2" sanitary clamps (132) and seals (131) to the orientation required.
7. Fit outlet manifold and elbows (130 & 136) to the pump with 2" sanitary clamps (132) and seals (131) to the orientation required.
8. Fit the 4 off M8 x 30 grub screws (15) and fit cover spacers (36) over the grub screws with 'O' ring (37)
9. Fit the covers (133) over the cover spacer and secure with M8 Security TORX screws (134) and nylon washers (135)
10. Screw in the 2 off Lifting eye bolts (35)
11. Fit the bellows indication arrangement:- 2 off elbow (46) 2 off hose (47) and 1 off hose plug (45)
12. To assist future disassembly, Brush 'copperlite' or equivalent grease onto main shaft keyway and inside of the coupling half (39). Slide the key (38) onto the shaft and then the coupling half over the shaft and key, pushing until the shaft stop has been reached. Apply Loctite 222 to M10 grub screw (51) and fit to coupling, tighten to 22Nm. Fit the red spider to the coupling half.
13. Brush 'copperlite' grease onto gearbox shaft and keyway. Slide the coupling over the shaft and key, until the distance between the end of the shaft and the inside face of the coupling is 22 to 23mm. Apply Loctite 222 to M10 grub screw (51) and fit to coupling, tighten to 22Nm.
14. Using suitable lifting equipment, lift the motor – gearbox assembly onto the pump assembly, ensure that the spider correctly fits into each coupling hub. Fit the 4 off M12 x 40 hexagon head bolts (123), plain washers (122) and spring washers (127), tighten to 40Nm.



Maintenance – Section 6.2 - General

The working life and thus the expected life prior to replacement of parts within a Paint Pump are greatly affected by three main factors: -

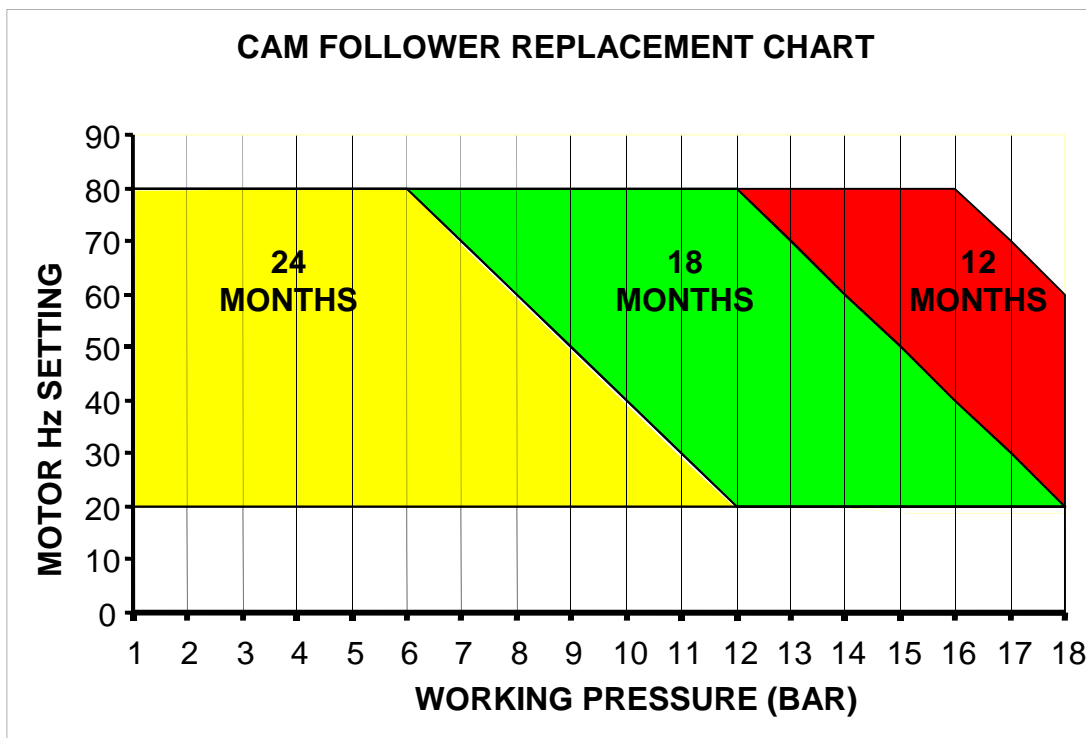
- Abrasiveness of Fluid Pumped
- Pump Duty Cycle
- Fluid Pressure Output requirement

The two components which are more greatly affected by the above criteria than any other components in the pump are: The Main piston Seal and the Cam Follower ; it is therefore recommended that these two items are stocked as spare parts in addition to the recommended spare parts kits.

A useful design feature of the Pump is that only one side of the Cam is under load during operation (Pushing the cam Follower); therefore the life of this component is doubled by reversing the position of the cam on the shaft when excessive wear has taken place.

It is also a requirement of the E.U. ATEX directive (Use of Equipment in Potentially Explosive Atmospheres) that any Bearings should be replaced when they have reached 90% of their calculated operational life. The following chart is included as a helpful guide, as the working life of the Cam Follower bearings used in the Pump is greatly dependant upon the Duty Cycle and Fluid Pressure Output Requirement.

Before any maintenance always switch off the pump and secure against any unintentional start up.



Maintenance – Section 6.2 - General

Maintenance Schedule	
Inspection	Operation
Daily	Check for any fluid leakage.
Weekly	Check for any excessive mechanical noise Check for excessive fluid pressure pulsation
3 Monthly	Grease Cam Follower Bearings (4 off) with 502375 grease. while the pump is running. Inject about 8 full strokes from a standard grease gun fitted with a standard collet connector.
6 Monthly	Grease Linear Bearings (8 off) with 502376 grease. This has to be done with the pump stopped and isolated. Inject about 15 full pumps from a standard grease gun fitted with a Hook connector. Grease Main Shaft Bearing with 502375 grease Check Gearbox Oil Level. Inspect Cam and Cam followers for excessive wear, replace if excessive wear can be seen.
Annually	Inspect Piston and Replace Piston Seals / Bellows / Springs. Inspect Piston & Outlet Ball Checks, replace as necessary. Inspect Linear Guide Bearing and Guide Rails for excessive wear. Replace gearbox oil (per ATEX regulations)
Every 5 Years	Replace main shaft bearings. Linear Guide Bearings, Guide Rails and Cams if excessive wear can be seen.
Use only 502375 (KP2N-20 DIN 51825) Grease for Cam Follower Bearing. Use only 502376 (KP2N-40 DIN 51825) Grease for Linear Guide Bearings.	

Do not mix the Cam Follower and Linear Guide bearings grease as this will reduce the operational life.

Maintenance –Section 6.2 - Initial Run Period

Following approximately 1 month running of the pump remove the cover and grease all bearings. Remove any excess grease and any dust particles present in the cam area, (Any particles present are from the cam follower tyre, this is a normal function of the bearing ‘bedding in’ with the cam surface).

Maintenance – Section 6.3 - Gearbox

Wait until the unit has cooled sufficiently after stopping and isolation.

Gearbox

Oil Plugs / Ventilator

Remove the ventilator plug prior to removing level and/or drain plug.

The gearbox is supplied factory fitted with (see chapter 1.3) oil, only 'top up' with the same type of oil and never overfill as this may cause overheating and leakage. Check the ventilator is clean and fitted correctly.

If changing the oil place a suitable container underneath the plug for draining.

Note: It is recommended that the oil should be warm (40-50° C) to facilitate easier draining.

After filling with fresh oil refit the ventilator, level and/or drain plugs and clean up any oil spillage.

Lubrication

Check the oil level every 3,000 hours or 6 months top up as necessary.

Replace gearbox oil every year as per ATEX regulations.

If Synthetic oil is used (USA Gearbox) the recommendation is to replace the oil every 3 years

Never mix different oil types.

Electric Motors

Maintenance of Ex Motors - are reported by EN 60079-17 standard, in particular:-

- The electric connections must be correctly locked to avoid resistance-increases, with consequent contact overheating.
- The insulation air-distance and the surface-distance between conductors, required by the standards, must be respected.
- All the screws, used to assemble the parts of the motors and of the terminal box, must be completely tightened.
- The replacement of seals and of components for cable entrance would be made using spare parts, supplied from the manufacturer, in order to guarantee the original type of protection.
- The Ex joint surfaces have not to be machined and it is not allowed to insert, between them, any kind of seals, not foreseen or supplied from the manufacturer. The join surfaces have just to be cleaned and, in order to avoid corrosion or water entrance.

Repair procedures of the Ex motors - are reported by IEC 79-19 standard.

When it is not possible to make the repairs of Ex motors at the manufacturer's plant, the outside workshops, deputed to this task, must be endowed by the necessary capability, including:

- Sufficient technical knowledge of these motors.
- Factory equipment with tooling and facilities, suitable to make repairs.
- Quality control department, for the checks and the tests, requested after repairs.
- For the Ex motors the repairs of parts, directly involved on the protection against the explosion risk, must be done without any modification to the original motor design.

Fault Finding – Section 6.4

Symptom	Possible Cause	Remedy
Mechanics		
Gearbox Output shaft does not rotate, even though the motor is running.	Drive between shafts in the gear unit interrupted	Return the unit for repair and replace gearbox
Gearbox Oil leaking <ul style="list-style-type: none"> from the gear unit cover from the motor flange from the gear unit flange from the output oil seal 	a) Defective gasket on gear unit cover. b) Defective gasket. c) Gear unit not ventilated.	a) Retighten screws on gear unit cover. b) Return gearbox c) Check vent is clean/fitted and not the transportation plug
Gearbox Oil leaking from ventilator	a) Unit Overfilled with oil.	Check and correct the oil level
Cam Followers bearing generating heat / noise	Bearing needs lubrication	Grease bearing or replace if damage is too great
Carriage does not maintain contact with cam	a) Spring tension insufficient b) Fluid seal friction or piston movement prevented	Check and replace springs Check fluid section
Fluid Section		
Pump will not 'Prime'	a) Air entering the suction hose/manifold b) Worn piston seals c) Ball checks not seating correctly	a) Check o-rings and hose connections b) Replace piston seals c) Inspect, clean/replace balls/seats
Pump will not run	a) No power b) Inverter Unit or safety interlocks 'tripped'	a) Check supply b) Check inverter and fault conditions
Pump runs but lack of pressure	a) Worn piston seals b) Ball checks not seating correctly	a) Replace piston seals b) Inspect, clean/replace balls/seats
Paint leaking from inside cover	Bellows seal failure	Replace bellows seal Check Piston seal, replace as necessary
Excessive Pressure Pulsation	a) Ball checks not seating correctly b) Main shaft bearings worn c) Cam follower worn	a) Inspect, clean/replace balls/seats b) Replace bearings c) Replace bearings

Testing and Lubricating – Section 6.5

Testing and Lubrication (Qualified personnel only)

1. Connect pump to paint system.
2. Connect electric motor to a suitable electrical supply.
3. Fit the gearbox vent plug.
4. Apply (502376) grease to linear bearings (35 strokes of a grease gun on a new bearing and 15 pumps on a bearing in current use).
5. Turn on paint system and set back pressure regulator to zero.
6. Loosen inlet cylinder vent plugs and allow the inlet air to escape from the pump. When paint starts to come out tighten the plugs back up and clean any paint spillage.
7. Turn the pump on at the local isolation mounted switch. (**IMPORTANT – Never allow the pump to run with a ‘valved off’ inlet or outlet connection**)
8. Allow the pump to run for about 10 minutes between 60 to 80Hz to ensure any trapped air is correctly vented. Check for any leaks and mechanical noises.
9. While running apply (502375) grease to cam follower bearings (8 strokes of a grease gun)
10. While running apply (502375) grease to main shaft bearing (40 strokes of a grease gun on a new bearing and 6 pumps on a bearing in current use)
11. Slow the pump back down to normal running speed and then increase the back pressure to 10 Bar and run for 1 hour. Check for any leaks and mechanical noises.

Fluid Drain Down

Always wear protective eyewear, gloves, clothing and respirator as recommended by the fluid and solvent manufacturer.

1. Stop the pump (turn off the electric motor); isolate the paint supply and place a suitable container underneath the hose to prevent spillage.
2. Disconnect the outlet hose and position securely into a suitable container.
3. Start the pump and run at slow speed (20Hz) for 1 minute. The pump will now have most of the paint removed; however, some material will remain within the fluid cylinders and manifolds.
4. If required to finally remove any paint from the pump, place the supply hose in a compatible solvent and run the pump until sufficiently clean.

Spare Parts List - Section 7.1

Recommended Replacement Spare Parts & Kits for E4-60 Pumps			
Kit No.	Part No.	Description	Remarks
#	192600	Constant Velocity Cam*	
#	192622	Ø100 Piston	
①	250600	Wet Section 'O' Ring kit	
②	250601	Piston Seal / Ball Check Spring Kit	
③	250595	Bellows Replacement Kit	
④	250596	Wet section overhaul Kit	
⑤	250597	Cam Follower Bearing Kit	
⑥	250598	Linear Guide and Rod Kit	
⑦	250599	Main Bearing Overhaul Kit	
#	502673*	Cam Upgrade Kit*	
#	192688	Auto-Lubrication Kit	Cam follower Bearing
Check main Parts List for details of individual Kit Contents			

*Pumps before serial No. 14769 will have a mark 1 constant velocity Cam fitted. If new cams are required, Cam upgrade kit must be ordered as old Cam shape is no longer available. As the Cam is now unidirectional, the direction must be checked to ensure a clockwise motion.

Accessories - Section 8.1

Accessories / Maintenance		
Part No.	Description	Remarks
192800	Smart Card	
107049	Pressure Relief Valve	
502373	Grease Gun for Cam Follower (& Main Bearings)	Collet Connector
502514	Grease Gun for Linear Bearings (300 mm Extension)	Hook Connector
502375	Grease for Cam Follower (& Main Bearings)	
502376	Grease for Linear Bearings	
502144	Pressure Switch	
192569	Sensor Manifold	
192547	Pressure Sensor (4-20 mA / 0-25 Bar)	Pressure feedback
192544	2" Sanitary Clamp	
192029	2" Sanitary Seal	

Special Assembly Tools Required		
Part No.	Description of Use	Remarks
192450	M8 Torx Security Screwdriver for Cover	FOC with a New Pump
502508	Top Bearing Locknut Tool	
502509	Bottom Bearing Locknut Tool	
502510	Top Bearing Press Tool	
502511	Bottom Bearing Press Tool	
502512	Shaft Assembly Tool	
502377	Bellows Assembly Tool	
502382	Bellows Assembly Spigot	

Standard 'Toolbox' Tools Required		
Part	Description of Use	Remarks
4 mm A/F Allen Key	M8 Socket Grub Screw	
5 mm A/F Allen Key	M6 Socket Head Cap Screw	
6 mm A/F Allen Key	M8 Socket Head Cap Screw	
8 mm A/F Allen Key	M10 Socket Head Cap Screw	
14 mm A/F Allen Key	M16 Socket Head Cap Screw	
13 mm A/F Ring Spanner	M8 Hexagon Head Setscrew	
16 mm A/F Spanner	Piston Shaft	
19 mm A/F Ring Spanner	M12 Hexagon Head Setscrew	
Adjustable Spanner	Tie rods, Couplings, Nipples etc..	



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