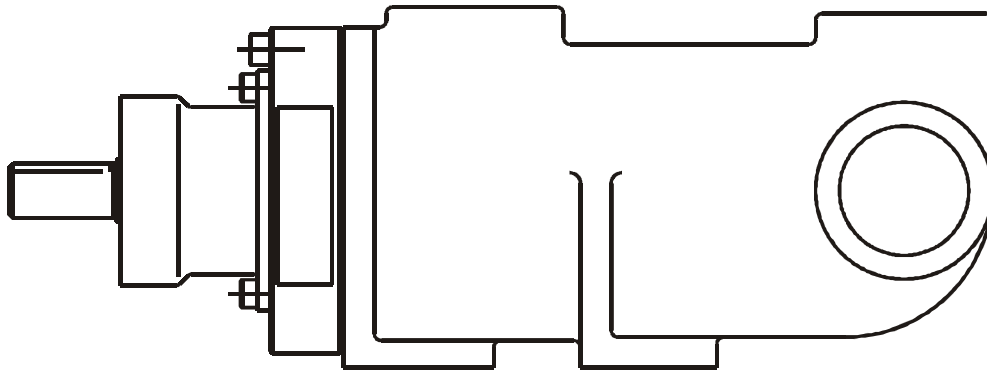


# **PLENTY MIRRLEES PUMPS**

An SPX Process Equipment Operation

## **Operation and Maintenance Manual TRIRO C6000 Series**



**Read and understand this manual  
prior to installing, operating or servicing this equipment.**

# PLENTY MIRRLEES PUMPS

An SPX Process Equipment Operation

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# **1. INTRODUCTION**

## **1.1 Safety**

**READ THE FOLLOWING GENERAL SAFETY TIPS BEFORE STARTING PUMP!**

**Failure to comply with them may result in an accident causing physical damage,  
Serious personal injury or death.**

1. Always use caution near rotating parts including the drive system for the pump.
2. Install proper guard(s). Never operate pump without guard(s) in place.
3. Do not operate this equipment in excess of its rated capacity, pressure, speed, temperature or other in accordance with the instructions contained within this manual.
4. Install and properly set an external relief valve. Never use relief valve for the flow control. It is intended for pump and system protection only.
5. Certain system conditions such as sudden opening or closing of inlet or outlet valves etc. can result in high transient (short time) pressure pulses that exceed the external relief valve setting. The user is responsible for determining the system characteristics and providing hose, pipe, fittings etc. adequate for these conditions.
6. These pumps are general-purpose pumps for a wide range of applications and therefore it is not practical to include performance or maximum ratings in these instructions. Standard ratings are contained in Plenty Mirrlees Pumps sales brochures for the type of pump involved. If you do not have ratings or performance characteristics for your pump, they can be obtained by contacting your Plenty Pump distributor, representative or Plenty Mirrlees Pumps factory direct.
7. In applications where Plenty furnished equipment is to be integrated with a process or other equipment, these instructions should be thoroughly reviewed to determine the proper integration of the equipment into the overall plant or system operational procedures.
8. Plenty Mirrlees Pumps does not supply, recommend or approve the various systems in which its pumps are or may be used. Unless designed, manufacture and used properly, various systems may be inherently unsafe or dangerous. The user should check and comply with all local and other regulations such as NFPA, UL, API, OSHA etc.
9. These instructions cannot possibly cover every situation concerning the operation, inspection, and adjustment and testing of the equipment furnished. Plenty Mirrlees Pumps, in furnishing this equipment and these instructions, must presume that the operating and maintenance personnel using this equipment have sufficient technical knowledge and experience to apply sound safety and operational practices that may not be otherwise mentioned.
10. When liquid being pumped is hazardous or volatile, precautions should be taken at all times including the run in period, dismantling and assembling off the pump.

**Every Plenty Mirrlees Pump is performance tested before being shipped from our factory. Correctly installed, operated and maintained, it will give long, dependable service. It is a well-known fact that faulty selection and installation form the basis for more pump troubles than all other causes combined. Read these instructions carefully before installing and operating this pump.**

**Finally, if there are any questions concerning the ratings or instructions, please contact your local Plenty Pump distributor or Plenty Mirrlees factory for assistance.**

## 2. INSTALLATION AND OPERATION

### 2.1 Preparation and Installation of Foundation - Baseplate Mounted Pumps

An adequate foundation is essential. Concrete is best as it is heavy enough to support the baseplate rigidly and absorb strain and shock throughout the operating life of the equipment.

**NOTE:** In the case of small size baseplates, provided that it has been checked to ensure that no distortion has occurred during transit or handling, it is acceptable practice to grout the baseplate with pump and motor mounted thereon together with the foundation bolts in one operation.

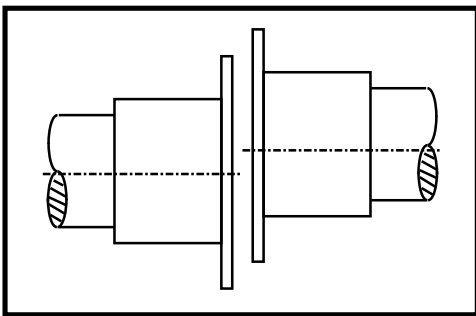
Set baseplates on foundation with the foundation bolts hanging freely in their pockets. Insert steel shims under the rim of the bedplate until the pump is in line with its associated piping, also ensuring that pump and motor alignment has been maintained. The foundation bolts can now be grouted at this stage. When grout has set, tighten foundation bolts and check alignment. Rectify if necessary. (Refer to Section 2.2, Pump and Driver Alignment.)

Suction and discharge piping can now be bolted ensuring that no stresses or flexing due to pipe strains are imposed upon the pump.

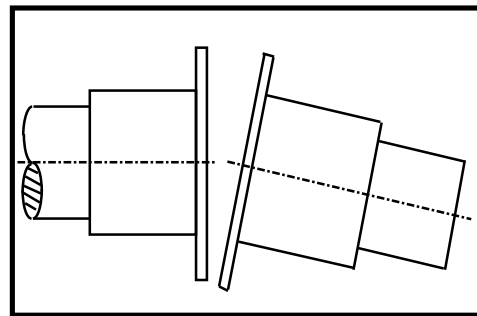
### 2.2 Pump and Driver Alignment

Driver and pump units are factory aligned before shipping, but they must be accurately re-aligned during and after installation. Insertion of shims under the feet of the driver allows the motor to be corrected for parallel and angular misalignment.

To align coupling, use a straight edge and feeler gauges to check for parallel and angular misalignment.

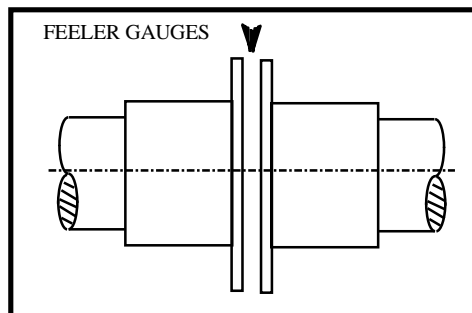
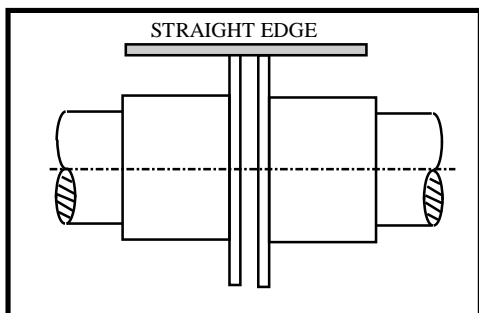


**Parallel Misalignment** - Axes of both shafts are parallel but laterally displaced.



**Angular Misalignment** - Axes are at an angle to one another.

Lay a straight edge across the coupling hub tops and check for parallelism at 90° intervals. Next, rotate the coupling, checking with feeler gauges, again at 90° intervals, that an equal gap between the coupling halves is measured. The coupling gap, see diagram below, should be checked against the manufacturer's recommendations.



If the pump is handling hot oil or is driven by a turbine, final alignment can only be carried out when operating temperatures have stabilised.

**DO NOT DEPEND ON FLEXIBLE COUPLINGS TO COMPENSATE FOR MISALIGNMENT.**

## **2.3 Piping Installation**

### **General**

When erecting the piping, the pump flanges should be the final connections. Check coupling alignment before and after the pump flanges have been tightened. Any alteration is indicative of piping loading on the pump flanges. It is essential that no load is imposed on the pump flanges as this is liable to disturb rotor and bearing alignment resulting in excessive wear and possible seizure. Pump piping supports and expansion gaskets should be used to avoid weight and stresses on the pump.

### **Filtration**

Only clean, viscous liquids should be handled and the suction system must be flushed clean prior to installing and operating pumps. Ingestion of a single piece of weld slag or a similar solid particle could cause immediate seizure and irreparable damage to the pump's internals. A filter of ample size and regularly cleaned should be used in the inlet piping to prevent foreign material from entering the pump. The filter should be sized so that pump net inlet pressure required (NIPR) is always met. Although for general applications, it is recommended that at least a 40-60 mesh filter is provided in the pump suction piping.

## **Suction / Discharge Piping.**

1. Where possible, arrange for the pump to operate on a positive flooded suction.
2. Pipe diameters, suction side in particular, should be at least as large as the pump inlet.
3. A short, straight length of pipe adjacent to the pump suction inlet is recommended. Where a bend is unavoidable, it should be of the largest possible radius.
4. Eliminate all possibility of air pockets being trapped in the suction piping, e.g. ensure piping rises continuously towards the pump. Where pipe diameter is reduced in direction of flow, use eccentric reducers with flat side up.
5. A primary connection should be provided near the pump inlet and an air vent connection on the discharge side. If there is a risk of reverse flow on shut down, a check valve should be installed.
6. On long, negative suction runs a foot valve is recommended to ensure rapid priming. When choosing foot valves, filters, bends etc., select those that will provide minimal restriction to flow.
7. On re-circulating systems, the sump tank should be of adequate size to dispel the heat generated. The return pipe should enter the tank at a point furthest from the suction piping and should be submerged to reduce foaming, or entrained air.

## **2.4 Start-up / Operation**

The following procedure outlines the most important steps involved in pump operation. Any deviations from this procedure should be based on good engineering practice and site operating experience or practices.

### **Priming**

The simplest method of attaining satisfactory priming is to position the pump so that it will always operate under a positive flooded suction condition. Where suction lift is required, provision must be made for the pump to be adequately primed with the fluid being handled. Once the pump is primed, ensure that the main rotor is free to rotate by turning the coupling in the direction the pump is designed to rotate. By carrying out all of the afore mentioned, the pump should now evacuate any air present from the air bleed plugs.

### **Valves**

It is important that all suction and discharge valves are fully open before the pump is started.

### **Driver**

The electric motor or driver should be momentarily started and the direction of rotation checked against the pump nameplate rotation arrow (usually CW viewed from coupling end of pump). Reverse rotation for extended periods may result in damage to the pump.

**CAUTION:- If the pump fails to deliver the required output against the designated discharge pressure, stop the pump immediately and carry out the previous start up procedure.**

Further priming of the pump should not be required during service although it is good practice to check that the pump retains its prime if operated in a start / stop system.

## **General**

Where the pump is required to start against an already pressurised main, i.e. where another pump is already running, at least full-load starting torque is required. This means that reduced voltage starters, such as Star Delta, are not suitable for this condition. Usually a direct-on-line starter is found to be satisfactory. The pump should never be allowed to run dry.

## **2.5 Recommended Instrumentation**

Pressure gauge connections should be provided close to the suction and discharge flanges. These should be provided with suitable isolating valves. Siphon pipes are not necessary but the pressure connections may be piped to a convenient gauge position.

The suction gauge should be reasonably close to the pump to ensure a reliable reading. Snubber gauges are preferred but not essential.

Gauges should be specified to suit the working conditions. The suction side gauge preferably a combined pressure and vacuum gauge.

Where the oil being pumped is hot, a thermometer pocket is recommended in the piping system.

### 3. OPERATING TROUBLES AND FAULT FINDING CHART

The best aids to fault finding in screw pumps are vacuum and pressure gauges. To ensure that the pump continues to meet the original specifications, vacuum and discharge pressure gauges should be fitted as close as possible to the pump inlet and outlet.

If pump suction piping does not supply a natural reservoir at pump inlet on close down, a suitable foot valve at the end of the suction line is an advantage.

<b>GUIDE TO USING CHART.</b>												
1. Identify the particular <b>TROUBLE SYMPTOMS</b> from the list on the right hand side of the chart. 2. Scan the relevant column and use list of <b>POSSIBLE CAUSES</b> as a guide to identifying the problem. 3. If several <b>TROUBLE SYMPTOMS</b> exist, contact Plenty Mirrlees direct for assistance.	<b>TROUBLE SYMPTOMS</b>	Pump does not deliver	Insufficient capacity delivered	Insufficient discharge pressure	Pump loses prime after starting	Pump requires excessive power	Hammering in long pipe lines	Pump vibrates or is noisy	Pump overheats or seizes	Bearings have short life	Coupling failure	Mechanical seal has short life
	<b>POSSIBLE CAUSES</b>											
Pump not primed		•						•	•			
Suction lift too high		•	•		•			•				
Foot-valve too small			•					•				
Foot-valve partially clogged			•					•				
Suction inlet pipe is insufficiently submerged		•	•		•			•				
Excessive pipe thrust on pump									•			
Operation at very low flows								•	•			
Pump or suction pipe not completely filled		•	•		•							
Liquid too close to vapour pressure		•	•					•				
Air or gas in liquid			•	•	•			•				
Air pocket in suction line		•	•		•			•				
Air leakage into suction line		•	•		•			•				
Speed too low		•	•	•								
Speed too high						•						
Wrong direction of rotation		•	•	•		•						
Viscosity of liquid differed from pump design duty			•	•		•						
Leaking foot-valve or suction pipe		•	•		•							
Change in electrical supply to motor						•						
Sudden change in liquid velocity							•					
Pressure gauges wrongly situated / not properly vented				•								
Sudden closure of air release valves in delivery pipe							•					
Non-return valve slam on shutdown							•					
Operation temperature differs from design temperature								•	•			

**(Fault Finding Chart Continued)**

<p align="center"><b>GUIDE TO USING CHART.</b></p> <p>4. Identify the particular <b>TROUBLE SYMPTOMS</b> from the list on the right hand side of the chart.</p> <p>5. Scan the relevant column and use list of <b>POSSIBLE CAUSES</b> as a guide to identifying the problem.</p> <p>6. If several <b>TROUBLE SYMPTOMS</b> exist, contact Plenty Mirrlees direct for assistance.</p>	TROUBLE SYMPTOMS	Pump does not deliver	Insufficient capacity delivered	Insufficient discharge pressure	Pump loses prime after starting	Pump requires excessive power	Hammering in long pipe lines	Pump vibrates or is noisy	Pump overheats or seizes	Bearings have short life	Coupling failure	Mechanical seal has short life
<b>POSSIBLE CAUSES</b>												
Location of suction / discharge pipes within supply tank			•	•					•			
Blockage in suction pipe and / or partially closed valve	•	•	•	•				•				
Excessive misalignment between pump / driving unit						•		•	•	•	•	•
Excessive hydraulic or mechanical thrust								•	•	•		
Bearings worn								•	•	•		
Dirt in bearings								•		•		
Excessive grease or oil in bearing								•	•	•		
Lack of bearing lubrication								•	•	•		
Bearing improperly installed								•	•	•		
Incorrect type of mechanical seal						•						•
Improperly fitted mechanical seal						•						•
Mechanical seal setting size incorrect												•
Mechanical seal components damaged												•
Wrong rotation spring fitted												•
Mechanical seal spring locked												•
Seal abutment ring retaining screw loose												•
Seal faces not properly run in												•
Foundation / baseplate not rigid								•				
Incorrect suction conditions	•	•	•	•				•	•			
Damaged screwset	•	•	•			•		•	•			
Incorrect relief valve setting / partially jammed open	•	•	•					•				
Relief valve operating for prolonged period of time		•	•					•	•			
Discharge pressure higher than anticipated						•						

## **4. MAINTENANCE**

### **4.1 Safety**

1. Before attempting to dismantle the pump unit, ensure that the drive is properly turned off and locked out. Also check that suction and discharge valves are closed and, if possible, locked. Any proposed electrical connections should be properly protected.
2. All lifting operations should be conducted using properly certified tackle and by approved methods.
3. It is recommended that pump overhauls take place in a workshop.

### **4.2 Dismantling**

#### **4.2.1 Removal of Insert / Pump from its Mounting**

REFER TO APPENDIX C FOR MOUNTING ARRANGEMENTS.

1. Shut down the prime mover and lock out.
2. Shut and tag out pump suction and discharge valves.
3. Remove coupling guard and disconnect motor / pump flexible coupling.
4. Open vent cock or remove plug on top of pump body. Remove any drain plugs, drain thoroughly by manually rotating drive shaft in correct pumping rotation.
5. Remove bolts from suction and discharge flanges and disconnect.
6. On tank mounted units remove the tank top unit from the tank, remove suction fitting and discharge bend by removing setscrews. Examine O-rings for signs of damage.
7. Note and mark location of cover plate to body for proper reinstallation.
8. Remove insert from body or its mounting by removing setscrews. Jacking holes are provided in the insert flange to facilitate this operation. Examine gaskets for signs of damage.

#### **4.2.2 Dismantling the Insert**

REFER TO APPENDIX B FOR SECTIONAL ARRANGEMENT.

**NOTE:** The bearing, mechanical seal and related gaskets are the only replaceable components in the insert. Dismantling beyond step 6 should only be attempted if pump output has been affected. Damage to any one of the major components (screwset, sleeve or idler bushes) is likely to have affected all of them, resulting in the complete insert needing replacement.

1. Remove shaft key.
2. Remove cap screws (A24) from bearing housing (A2). Reinstall two of these screws into jacking holes provided and use a two-jaw puller attached to the jacking screws to remove the bearing housing (A2). Do not use jack screws to press the housing (A2) away from sandwich plate assembly (A3) as this could result in the pump being damaged. Discard gasket (16a).
3. The stationary half of the mechanical seal (B1) can be removed from the bearing housing (A2), taking care not to mark the seal face.
4. The rotating half of the mechanical seal can now be removed from the rotor shaft (A4).
5. Remove internal (A10) and external (A11) snap rings.
6. Ensuring that the seal/bearing housing (A2) is properly supported, press bearing (A9) and bearing collar (A8) out of bearing housing (A2) by applying pressure to inner bearing race.

**STEPS 7 THROUGH 10 ONLY REQUIRED IF PUMP OUTPUT HAVE BEEN AFFECTED.**

7. Remove cap screws (A12) from sandwich plate assembly (A3).
8. Support sleeve (A1) and rotor (A4) properly and tap sandwich plate assembly (A3) away from sleeve (A1) using a soft mallet. Remove sandwich plate assembly by hand once hold is broken. Discard gasket (A16b).
9. Carefully remove screwset, comprising of rotor (A4) and idlers (A28), and idler bearing bushings (A7) from sleeve (A1).
10. Separate bushings (A7) and rotors (A4 and A28). Insert now ready for inspection and / or reassembly.

**NOTE:** Mark idlers(A28), bushings (A7) and rotor (A4) so that they can be replaced in same relative positions.

## **4.3 Inspection and Cleaning**

### **4.3.1 Pump Body and Bearing Housing**

1. Clean inside of pump body with grease solvent, examine for signs of scoring, corrosion and wear.
2. Clean gasket surfaces (A16a & b) thoroughly.
3. Clean seal / bearing housing (A2) with grease solvent, examine for burrs and damage to gasket faces.
4. Examine sandwich plate (A3) for burrs and damage to gasket faces.

### 4.3.2 Pump Rotor (A4) and Idlers (A28)

1. Clean pump rotor (A4) and idlers (A28) with grease solvent.
2. Examine surfaces of screws, balance piston and sleeve for burrs, chipping, high spots and uneven wear. Do not attempt to polish, dress or rework any of these components. If damage is noted, the insert should be replaced.
3. Check key and keyway for burrs and damage.
4. O-rings (A15) should be replaced with each overhaul.

### 4.3.3 Bearings (A9)

It is recommended that a new bearing (A9) is fitted at each complete overhaul.

### 4.3.4 Mechanical Seals (B1)

1. Check that rubber components of seal are in good condition.
2. Check seat and face surfaces for marks, signs of wear etc. If surfaces are damaged, replace whole seal.
3. It is generally good engineering practise to replace the mechanical seal (B1) at each overhaul.

## **4.4 Assembly**

### 4.4.1 Assembly of Insert

1. Assemble idler bearing bushes (A7), roll pins (A13) and O-rings (A15).
2. Place idlers (A28) on either side of rotor (A4). Ensure that flattened edges of idler bushing (A7) are flush against rotor. This helps to ensure that screws engage correctly.
3. Adding lubrication oil, carefully insert screwset into sleeve (A1). Take care not to bend roll pins (A13). Check that screws turn by hand. Add more oil via suction inlet if required.
4. Replace gasket (A16b) onto sandwich plate assembly (A3) and fasten to sleeve using cap screws (A12). When assembling these components, ensure that the oil passageway that connects each part is correctly aligned to allow free passage of liquid from the seal / bearing housing (A2).
5. Apply a light film of oil to bearing diameter of rotor to enable installation of rotating half of mechanical seal (B1). Insert stationary seat mechanical seal into seal / bearing housing (A2).
6. Fasten seal / bearing housing (A2) and new gasket (A16a) onto sandwich plate assembly (A3) using socket cap screws (A24). Again, ensure that the corresponding hole in this component correctly aligns to passageway highlighted in point 4 above.

7. Insert bearing collar (A8) and bearing (A9) into seal/bearing housing (A2). Using a suitable press and tool on the inner bearing race, press bearing simultaneously onto shaft and into seal / bearing housing (A2).
8. Insert new internal (A10) and external (A11) snap rings into seal / bearing housing (A2).
9. Refer to Section 2.4, Start-up / Operation before restarting pump.

#### 4.4.2 Re-Assembly of Insert / Pump to its Mounting

The insert should be reassembled to its mounting generally in reverse sequence to dismantling instructions (see Section 4.2.1, Removal of Insert / Pump from its Mountings). Care should be taken to ensure that the insert is correctly refitted back in the body as previously marked in Section 4.2.1, point 1.

The unit can now be reinstalled / recommissioned as outlined in Section 2, Installation and Operation.

### 4.5 Routine Maintenance and Repair Parts

Routine maintenance and servicing are essential to ensure that the pump and all associated equipment give many years of trouble free operation.

The main factors in determining if overhaul is required are (but not limited to) a falling off in pump discharge pressure to an unsatisfactory level or a significant increase in current.

Use only Plenty repair parts. Plenty Pump takes no responsibility for the use of parts other than those manufactured and supplied by us. The use of substitutes may result in poor pump performance or an accident causing physical damage or injury to personnel.

#### RECOMMENDED ESSENTIAL SPARES KIT\*

<b>REF. NO.</b>	<b>DESCRIPTION</b>	<b>QTY</b>	<b>TOTAL</b>
<b>A9</b>	<b>Bearing</b>	<b>1</b>	<b>5</b>
<b>A15</b>	<b>O-Ring</b>	<b>2</b>	<b>10</b>
<b>A16a</b>	<b>Gasket – Seal / Bearing Housing</b>	<b>1</b>	<b>5</b>
<b>A16b</b>	<b>Gasket – Sleeve</b>	<b>1</b>	<b>5</b>
<b>A22</b>	<b>Gasket – Body</b>	<b>1</b>	<b>5</b>
<b>A23</b>	<b>O-Ring</b>	<b>1</b>	<b>5</b>
<b>B1</b>	<b>Mechanical Seal</b>	<b>1</b>	<b>5</b>

\*Always supply serial number when ordering spare parts.

### **4.6 Service and Maintenance Record**

DATE OF SERVICE	PUMP SERIAL NO	COMMENTS

## **APPENDIX A.**

(Product Identification / Sizing)

**C6000 PRODUCT IDENTIFICATION / SIZING**

**C 6 0 0 0**

		<b><u>Displacement (theoretical capacity)</u></b>		
	12	=	12 gals /1000 RPM	(insert size : 38-4 / SL)
	15	=	15 gals /1000 RPM	(insert size : 38-4 / NL)
	17	=	17 gals /1000 RPM	(insert size : 45-4 / SL)
	21	=	21 gals /1000 RPM	(insert size : 45-4 / NL)
	30	=	30 gals /1000 RPM	(insert size : 52-4 / SL)
	38	=	38 gals /1000 RPM	(insert size : 52-4 / NL)
	40	=	40 gals /1000 RPM	(insert size : 60-4 / SL)
	50	=	50 gals /1000 RPM	(insert size : 60-4 / NL)
	65	=	65 gals /1000 RPM	(insert size : 70-4 / SL)
	80	=	80 gals /1000 RPM	(insert size : 70-4 / NL)
	95	=	95 gals /1000 RPM	(insert size : 80-4 / SL)
	120	=	120 gals /1000 RPM	(insert size : 80-4 / NL)
	<b><u>Case construction</u></b>	-	1	= Ductile iron / one piece NPT ported case
			3	= Ductile iron / two piece flange ported case
			5	= Fabricated steel
			8	= Insert only (no additional case)
			9	= Flange mounted pump (insert with suction chamber)
	<b><u>Series</u></b>	-	C 6	= C6000 series TRIRO triple screw pump

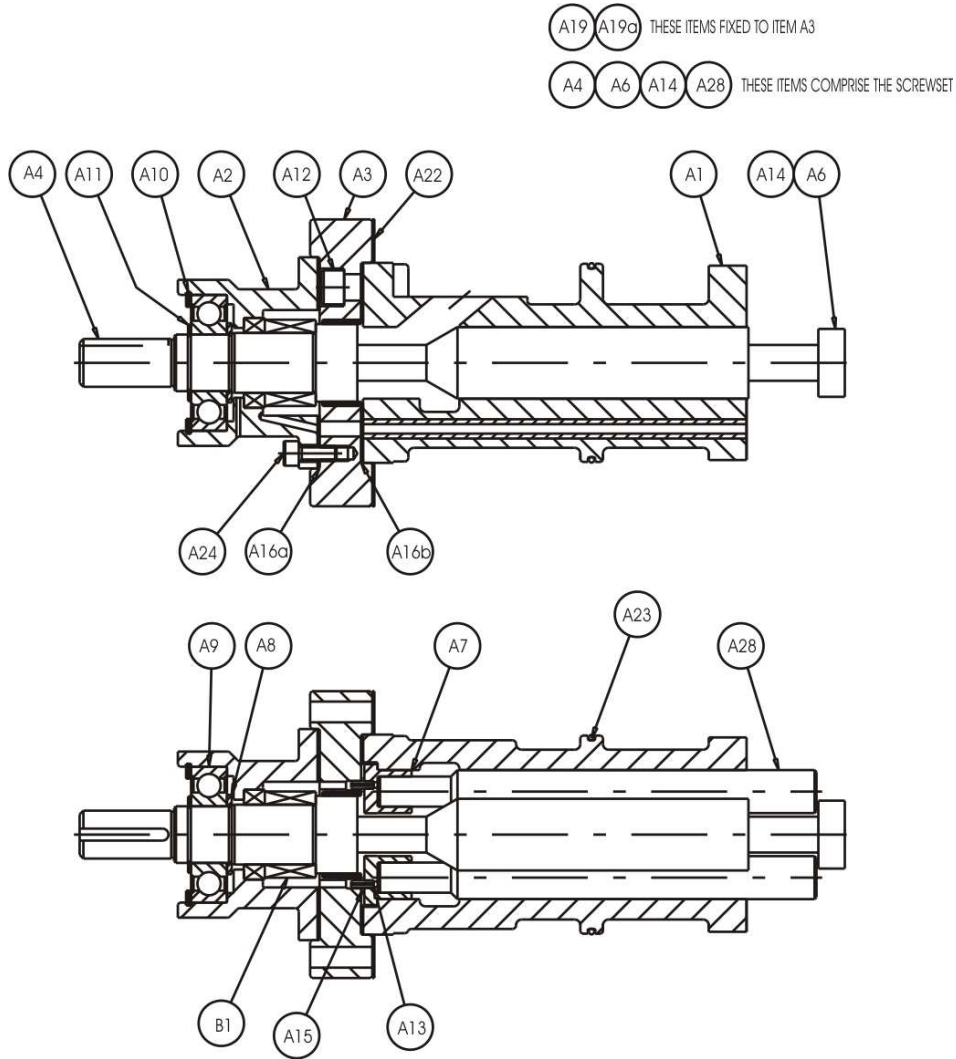
**EXAMPLE:** C6 5 21 – C6Series TRIRO Triple Screw Pump, with fabricated steel casing, with theoretical capacity of 21 GALS / 1000 RPM, with insert 45-4 / NL.

## **APPENDIX B.**

(Sectional Arrangement of C6000 Insert.)

# PLENTY MIRRLEES PUMPS

## Sectional Arrangement of C6000 Insert



Items A19 & A19a are fixed to item A3

Items A4, A6, A14 & A28 comprise the screwset

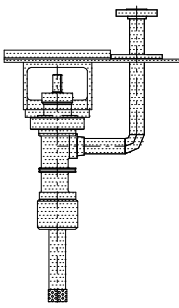
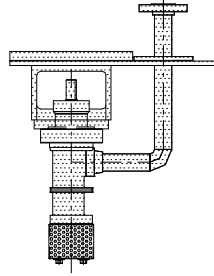
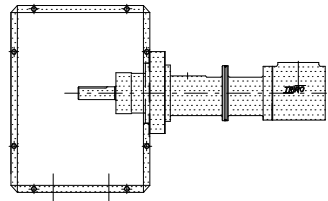
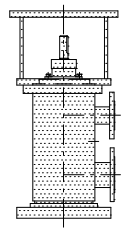
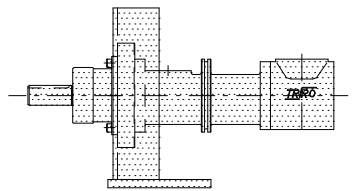
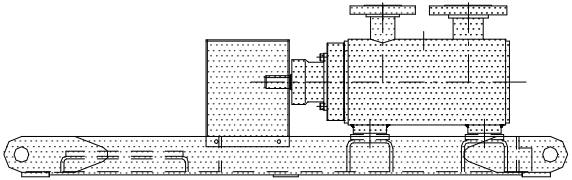
A9	Bearing – Deep ball groove ball	1	B1	Mechanical Seal	1
A8	Bearing Collar	1	A28	Idler (Screwset)	2
A7	Idler Bearing Bushing	2	A24	Socket Cap Screw	6
A6	Thrust Collar (Screwset)	1	A22	Gasket – Body	1
A4	Rotor (Screwset)	1	A19	Direction Arrow	1
A3	Sandwich Plate Assembly	1	A15 / A23	O-rings	2 / 1
A2	Seal / Bearing Housing	1	A14	Roll Pin (Screwset)	1
A19a	Drive Screw	2	A13	Roll Pin	2
A16b	Gasket – Sleeve	1	A12	Socket Cap Screw	4
A16a	Gasket – Seal / Bearing Housing	1	A11	Snap rings – External	1
A1	Sleeve	1	A10	Snap rings - Internal	1

## **APPENDIX C.**

(Mounting Arrangements of C6000 Insert.)

# PLENTY MIRRLEES PUMPS

## Optional Mounting Arrangements of the C6000 Insert

 <p>TANK TOP MOUNTED (AXIAL SUCTION)</p>	 <p>TANK TOP MOUNTED (RADIAL SUCTION)</p>
 <p>PEDESTAL MOUNTED INSERT</p>	 <p>VERTICAL MOUNTED PUMP</p>
 <p>BRACKET MOUNTED</p>	 <p>STANDARD &amp; API BASEPLATE MOUNTED</p>

# **PLENTY MIRRLEES PUMPS**

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