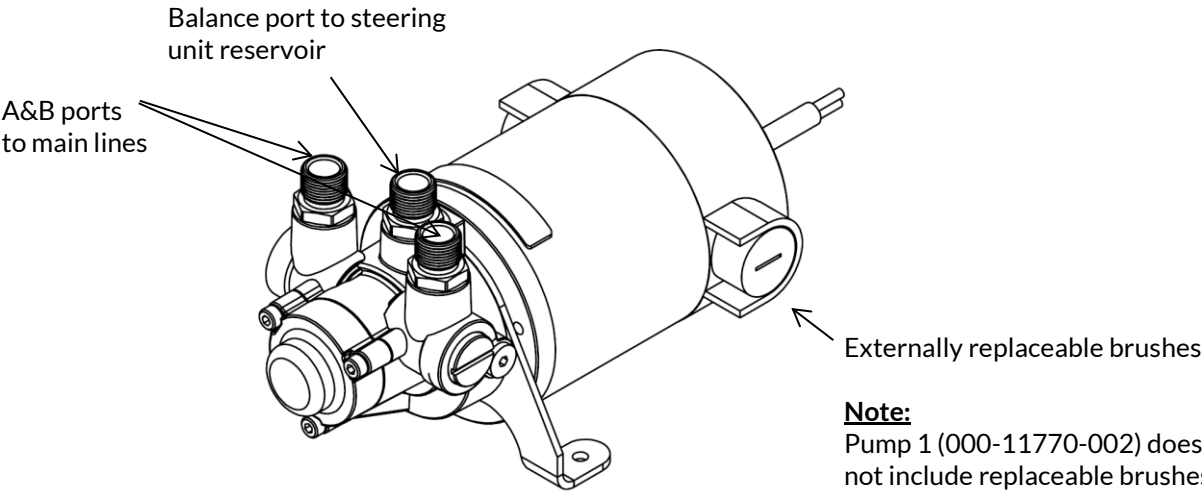


SELECTION & INSTALLATION GUIDE - REVERSING GEAR PUMPS

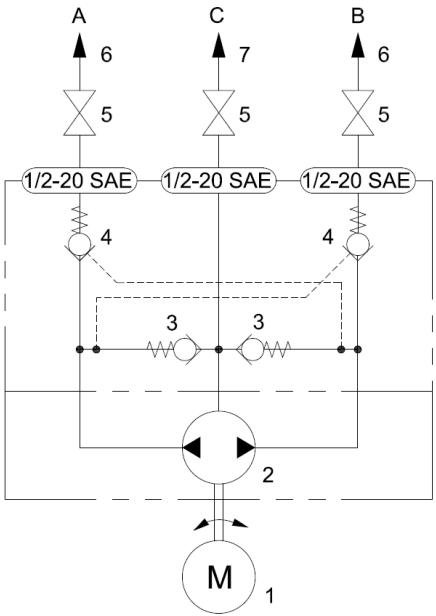
Pump family overview

This family of high efficiency pilot drive gear pumps is available in five models covering nominal flow sizes of: 0.8, 1.6 and 3.0 lpm. The 0.8 and 1.6 lpm sizes come with 12V motors, while the 3.0 lpm size is available in both 12Vdc and 24Vdc. Other than Pump 1, all motors in this family feature externally replaceable motor brushes.



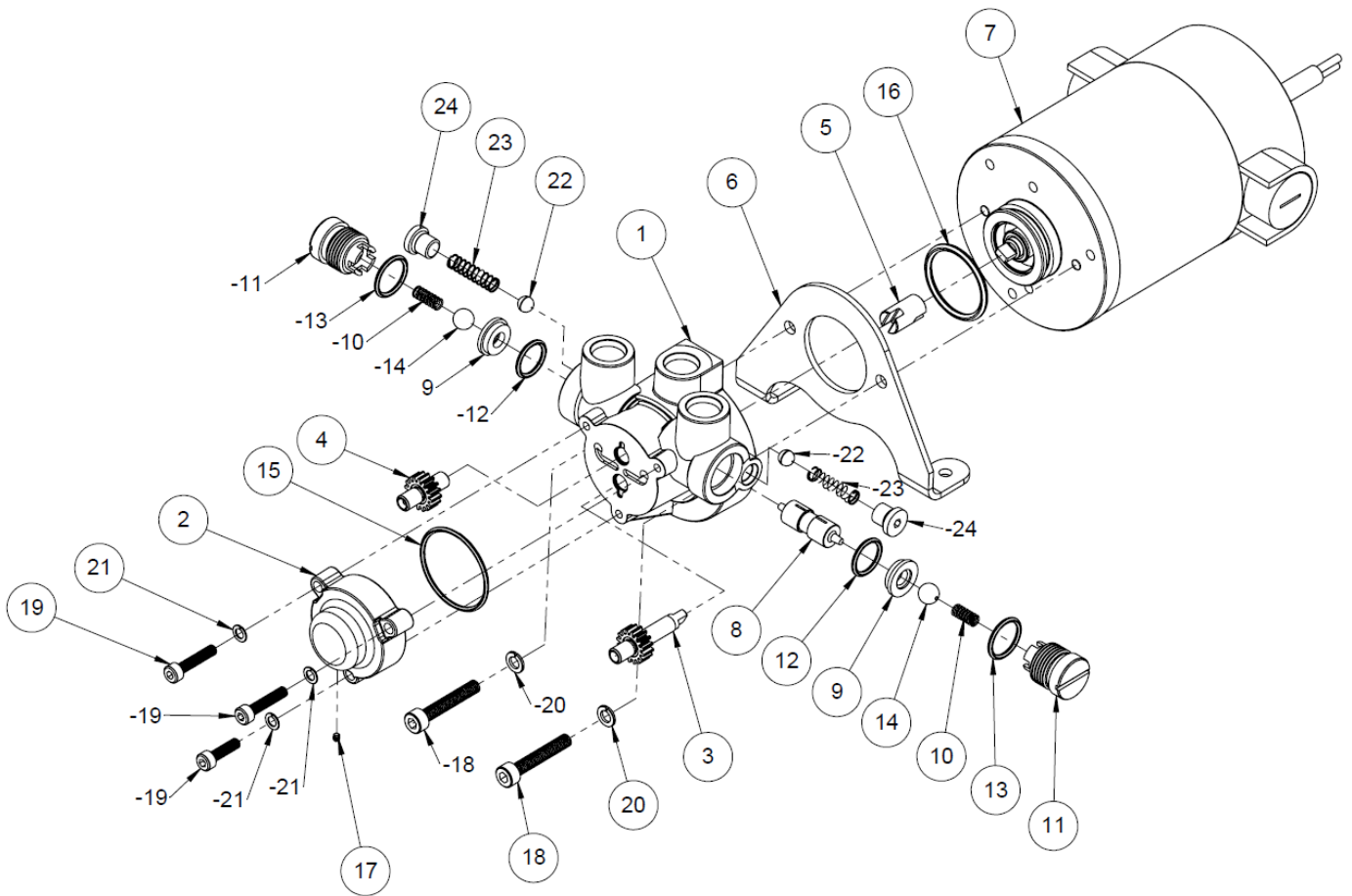
The pumps are reversible and therefore don't need an external direction control valve to change flow direction. All models include integral lock valves to ensure positive load holding. The pumps can only be used with balanced cylinders.

Pump schematic



- 1. DC motor (permanent magnet type)
- 2. Reversible gear pump
- 3. Inlet check valves
- 4. Dual lock valves (non-return valves)
- 5. Stop cocks (not supplied with pump)
- 6. A + B main lines
- 7. Balance line C-to steering unit/expansion tank

Gear pump components



<i>Item</i>	<i>Qty.</i>	<i>Description</i>	<i>Item</i>	<i>Qty.</i>	<i>Description</i>
1	1	Gear Pump Body	13	2	O-ring 2-015 Nitrile, 70 Durometer
2	1	Gear Cap	14	2	Check Ball
3	1	Drive Gear	15	1	O-ring 2-026 Nitrile, 70 Durometer
4	1	Idler Gear	16	1	O-ring 2-121 Nitrile, 70 Durometer
5	1	Drive Coupling	17	1	Expander Plug
6	1	Motor Mount	18	2	Cap Screw M5-0.8 x 30 (SS)
7	1	DC Motor	19	3	Cap Screw M4-0.7 x 16 (SS)
8	1	Pilot Piston	20	2	Lock Washer #10 (SS)
9	2	Lock Valve Seat	21	3	Lock Washer #8 (SS)
10	2	Lock Valve Spring	22	2	Inlet Check Ball
11	2	Lock Valve Body	23	2	Inlet Spring
12	2	O-ring 2-014 Nitrile, 70 Durometer	24	2	Plug

Pump models covered

PUMP-1, 12V, Nominal Flow 0.8 lpm – Model: 000-11770-002
 PUMP-2, 12V, Nominal Flow 0.8 lpm – Model: 000-15444-002
 PUMP-3, 12V, Nominal Flow 1.6 lpm – Model: 000-15445-002
 PUMP-4, 12V, Nominal Flow 3.0 lpm – Model: 000-15446-002
 PUMP-5, 24V, Nominal Flow 3.0 lpm – Model: 000-15447-002

Pump selection - sizing

When sizing a pump for an autopilot application consider the following:

- This pump family works only with balanced cylinders.
- Match the motor voltage to the supply voltage from the autopilot course computer.
- Size pump considering both the steering cylinder size and vessel/autopilot manufacturer's recommended rudder Hard Over to Hard Over (HO to HO) time. See chart below.
- Rudder HO to HO speed usually falls within 9-15 seconds.

Pump selection chart for optimum performance*

* Pumps will work with cylinders outside these ranges, but HO-to-HO time will fall outside optimum ranges.

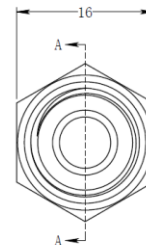
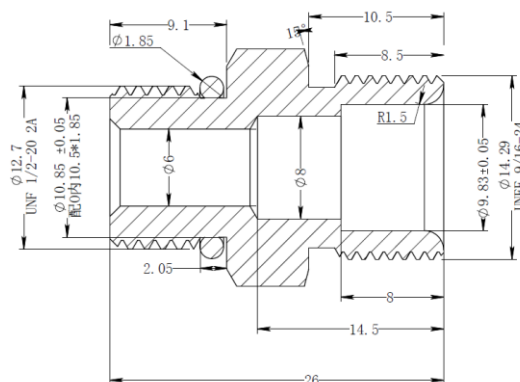
Flow (lpm)	Voltage	Name	Model	STEERING RAM DISPLACEMENT cm ³ (cu.in)																
				98 (6)	131 (8)	164 (10)	197 (12)	230 (14)	262 (16)	295 (18)	328 (20)	361 (22)	394 (24)	426 (26)	459 (28)	492 (30)	525 (32)	558 (34)	590 (36)	623 (38)
0.8	12	PUMP-1	000-11770-002	9-15 Seconds HO to HO																
0.8	12	PUMP-2	000-15444-002	9-15 Seconds HO to HO																
1.6	12	PUMP-3	000-15445-002					9-15 Seconds HO to HO												
3.0	12	PUMP-4	000-15446-002											10-15 Seconds HO to HO						
3.0	24	PUMP-5	000-15447-002											9-14 Seconds HO to HO						

Pump preparation and mounting

Preparation

Port connections

The three female ports on the pump body are ½-20 SAE (-05 ORB). Each pump kit also includes 3 x adapter straight: ½-20 male SAE (-05 ORB) x 9/16-24 male (3/8" tube style).



Replacement
O-ring Parker 3-905

The two outer ports on the pump body connect to the main steering lines through an appropriate Tee connection. The middle port connects to the of the expansion tank associated with the primary helm.

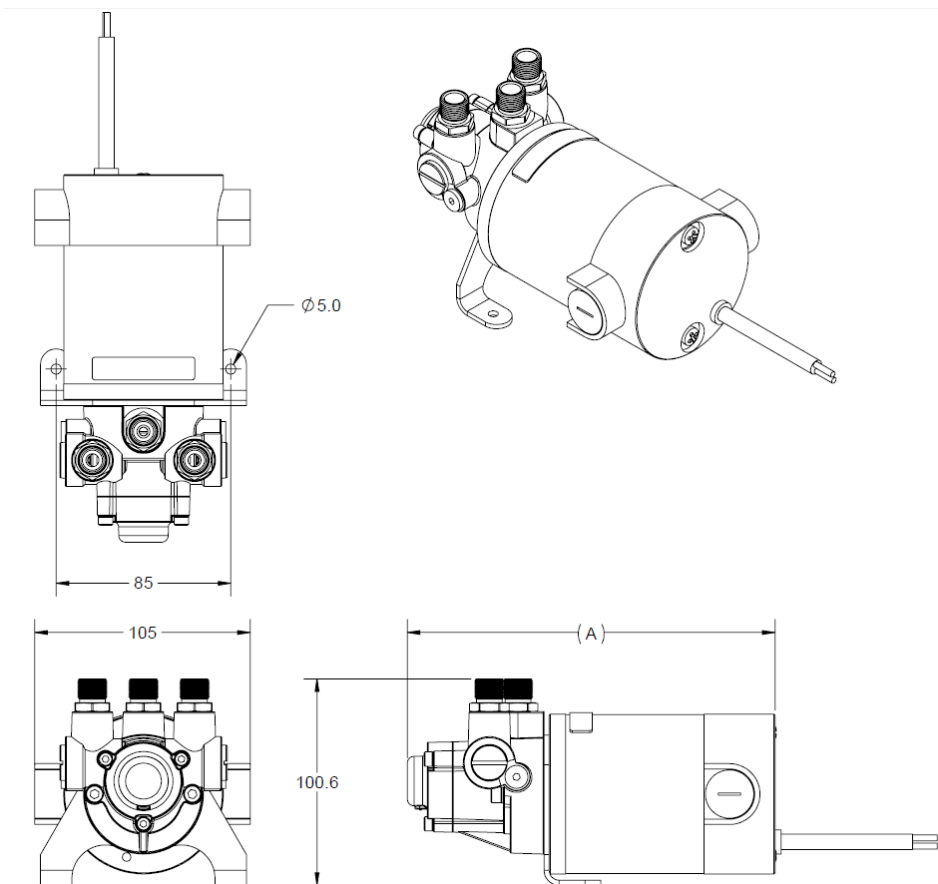
Assembling SAE ORB fittings into pump ports:

1. Inspect port and connector threads to ensure they are free of dirt, burrs etc.
2. Lube fitting O-ring with oil and install the fitting into pump and torque to 17Nm (150 in-lb).

Mounting

The pump must be located at a level lower than the helm pump; it can be mounted in any orientation. Care should be taken to ensure the reservoir hose runs in an upwards path towards the Helm pump reservoir connection with no loops or dips. The main steering lines should run as directly and neatly as possible.

Pump dimensions



Pump model	OAL (A) mm
000-11770-002 (12V, 0.8 LPM)	168
000-15444-002 (12V, 0.8 LPM)	179
000-15445-002 (12V, 1.6 LPM)	194
000-15446-002 (12V, 3.0 LPM)	214
000-15447-002 (24V, 3.0 LPM)	214

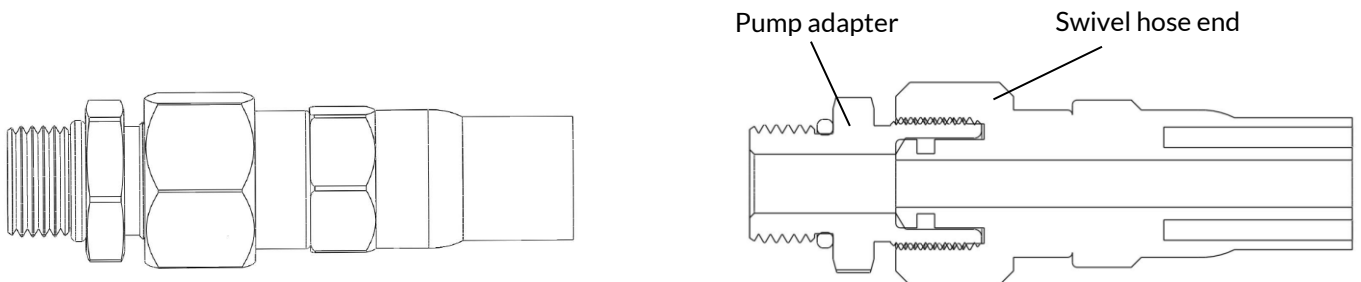
Hydraulic connections

1. The two outer ports on the pump unit must be connected, using tee fittings, to the main steering lines that run from the steering unit to the steering cylinder. Use flexible hoses from the rigid tubing to the steering cylinder to accommodate cylinder motion.
2. The middle port on the pump is the balance line which must be connected to the reservoir associated with the steering unit. This is either a separate pressurized reservoir or the steering unit itself. There is usually a port on the bottom of the steering unit. If there are two steering units, use the most convenient.
3. **To reduce noise transfer from the pump to the vessel structure and tubing fatigue, it is recommended to use hose connections from the pump to the rigid piping.**

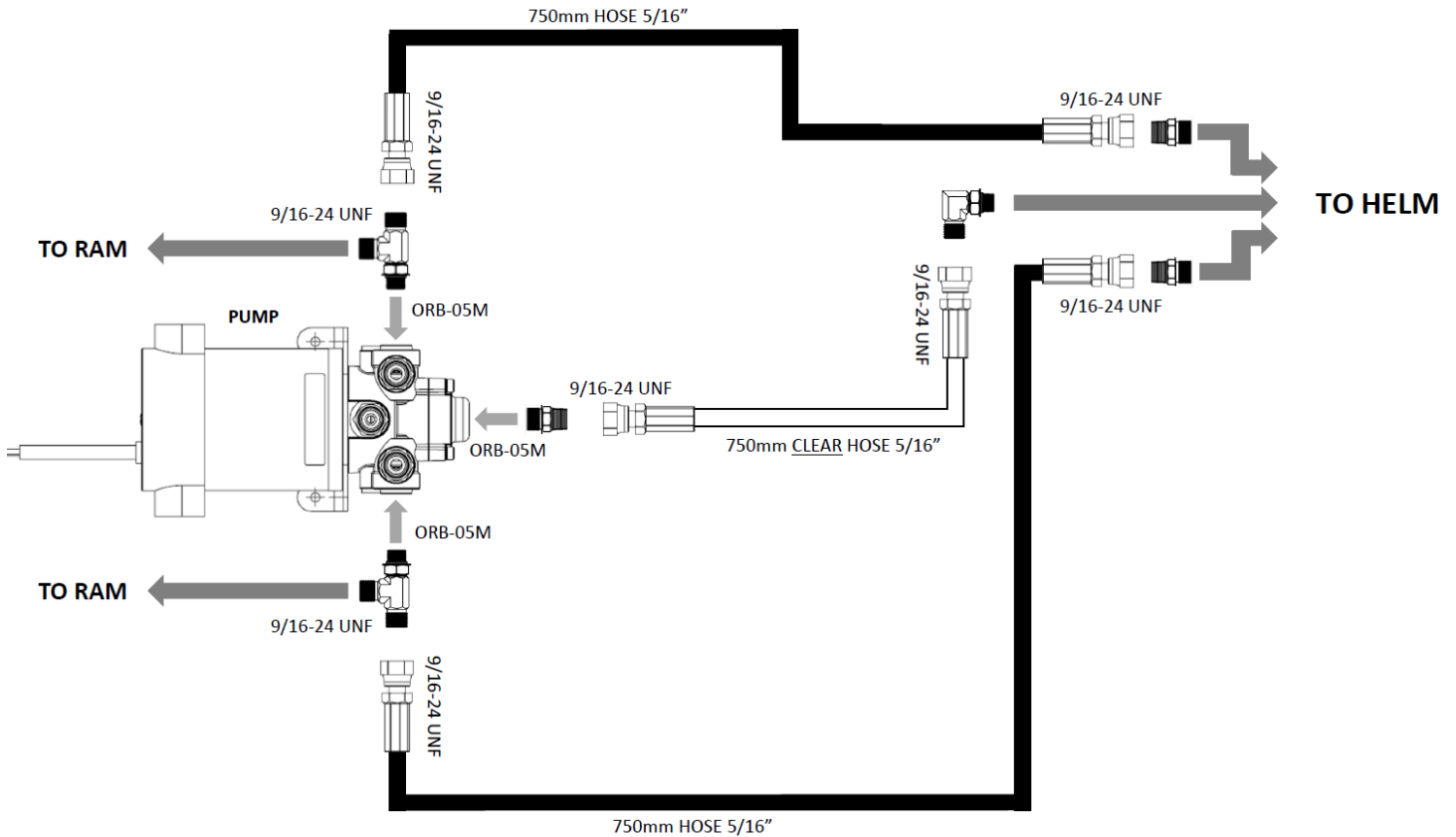
Recommended tube material:

- North American: $\text{Ø}3/8$ " OD Annealed Copper – Type L ASTM B88, 0.030" min wall
 - European: $\text{Ø}10\text{mm}$ OD Annealed Copper – BS EN 12735-1:2001, 0.8mm min wall
4. If making tubes, it is important to prepare the tube ends correctly to ensure a leak free installation. Consider the following recommendations:
 - Cut tube squarely within $\pm 1^\circ$
 - Do not use an abrasive cutting wheel as this can introduce contamination into the tube
 - Deburr both the ID and OD of the tube end
 - Clean each tube with compressed air.
 5. A swivel hose end is needed to connect to supplied fittings. Common name is "3/8 female tube connection". The female hose swivel thread callout is 9/16"-24 UNEF-2B.

Pump fitting to hose connection



Typical hydraulic installation



Caution!

Ensure that the existing hydraulic system has non-return/lock valves (check with the steering system manufacturer); if it does not, then suitable valves must be fitted. Most modern steering systems do include non-return valves.

Electrical connections

Correct sizing of cable is important for optimal pump performance. See the chart below for suggested wire sizing. Do not compromise pump performance by using undersize cables. Ensure all electrical connections are properly made.

Flow (lpm)	Voltage	Model	Typical current (A)	Peak current @ 50 bar	Suggested min. wire size
0.8	12	000-11770-002	4-7	11	AWG 12 (4.0mm ²)
0.8	12	000-15444-002	4-7	11	AWG 12 (4.0mm ²)
1.6	12	000-15445-002	8-14	22	AWG 10 (6.0 mm ²)
3.0	12	000-15446-002	10-20	30	AWG 8 (10 mm ²)
3.0	24	000-15447-002	6-10	15	AWG 12 (4.0mm ²)

Bleeding the system

It is important to bleed the hydraulic lines system once the pump is installed and plumbing connections are complete. If there is any air left in the system; the steering will feel unresponsive. Excessive air will also reduce pump performance and increase pump noise.

The electrical components (course computer/control head) must be installed and the pump connected in order to utilize the pump during the bleeding procedure.

The system reservoir must be full of hydraulic fluid before starting this procedure and this level must be maintained during the procedure. See the steering system manufacturer's guide for the exact procedure for your steering system. (Note: this can vary depending upon the type of steering cylinder that is fitted).

Stage 1 –Purge the lines using the pilot pump

1. Using the autopilot control head, run the pump in one direction to fully extend the steering cylinder
2. Using the autopilot control head, run the pump in the opposite direction to fully retract the steering cylinder.
3. Repeat above steps 2-3 times. If pump does not pick up, re check fluid level in steering unit and confirm that balance line has no dips that could trap air. It may also help to turn the wheel on the steering unit CW and CCW to help fill the lines.

Stage 2 – Purge the steering unit through to the steering cylinder

The type of steering cylinder will dictate the specific procedure for this operation. See the steering system manufacturer's purging guide. What follows is a generic guide to the steering cylinder bleeding process:

1. With steering unit full of oil, turn the steering wheel clockwise until cylinder rod is fully extended. Open the air bleeder on the side of the cylinder that is extended.
2. Holding the cylinder rod to prevent it from retracting while simultaneously turning the steering wheel slowly in the counter-clockwise direction. Observe the stream of oil exiting the bleeder fitting. Note: It is easier to do the procedure with an appropriately sized clear vinyl bleeder tube attached to the bleeder fitting. Continue turning the steering wheel until the steam of oil is steady and free of air. It is important to keep the reservoir topped up with oil while doing this step.
3. Close the bleeder and turn the steering wheel counter-clockwise until the cylinder rod is fully retracted Open the air bleeder on the side of the cylinder that is now fully retracted.
4. Holding the cylinder rod to prevent it from extending while simultaneously turning the steering wheel slowly in the clockwise direction. Observe the stream of oil exiting the bleeder fitting. Note: It is easier to do this procedure with an appropriately sided clear vinyl bleeder tube attached to the bleeder fitting. Continue turning the steering wheel until the stream of oil

Note: In steps 1-4, the CW rotation of wheel rotation may result in the cylinder retracting rather than extending. In this case, use opposite bleed screw on the cylinder. The goal of the procedure is to bleed from side of the cylinder that has its oil volume at minimum thus ensuring there is no trapped air left in the cylinder.

Stage 3 – Oil level and system check

At this time, the steering system must be checked for proper connections of all hoses and fittings and for air removal. To do so, turn the steering wheel and pressurize very hard to port. Apply enough force to the wheel to exceed the pressure relief valve setting. You will not harm the system. While pressure is maintained on the steering wheel; check all port fittings and line connections for leaks. If no leaks are obvious your steering system is ready for use. If leaks are found they must be corrected. Repeat this procedure for the starboard lines. Watch the oil level in the helm pump when the steering reached both hard over positions. If there is no obvious drop in the oil level; the air has been removed. If there is an obvious drop in oil level; you are compressing air and further purging is required. Repeat **Stage 2 – Purge the steering unit through to the steering cylinder**.

Troubleshooting

If the unit fails to operate after installation is complete, check for the following common causes:

Motor does not run

- No voltage applied to motor - Action: Check voltage with voltmeter.
- Autopilot not switched on correct setting - Action: Check autopilot manual.

Motor runs but pump does not move the rudder

- System not filled with oil - Action: Top up with oil and purge system.
- Hydraulic connections incorrect - Action: Check that both steering ports and balance line are connected as per diagram on page 5.
- Balance line to helm has air pocket – Action: Ensure there are no dips in line that can trap air.
- Steering Unit is non-vented – Action: Ensure that upper most steering unit on vessel has vented cap.

Hard over to hard over time is excessive

- Low voltage to motor – Action: Confirm wire size to motor is correct.
- Pump undersized for steering cylinder – Action: Select larger pump.