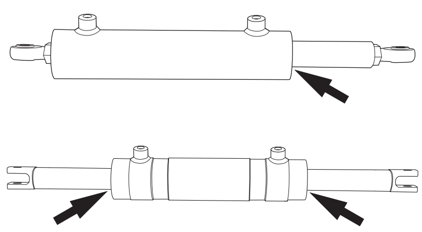
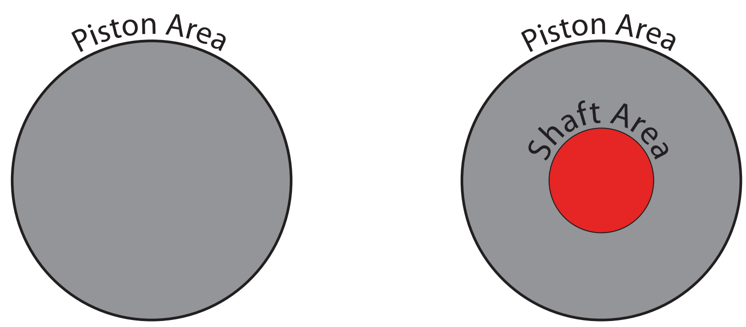
Cylinder Tips:
Calculating Volume and Force

Cylinder volume and force are important to know when setting up a power steering system. The larger the piston, the greater the displacement volume of the cylinder. Increasing stroke will also increase the volume. In addition, a larger piston will result in a greater output of force.

Piston area times length of stroke yields the cylinder volume. When a shaft exists on one or both sides of the cylinder, the shaft size must be taken into account to properly determine the volume of the cylinder. On single ended cylinders, there will be a difference in the force applied left to right because there is a shaft on only one side of the piston. On double ended cylinders the shaft area must be subtracted from both sides to accurately determine the amount of force or volume.



Arrow indicates shaft side



The fluid does not fill the area where the shaft is, decreasing volume. As a result, the fluid can not push on the piston in this area, decreasing force.

Cylinder Volume = Stroke x (Piston area - Shaft area, if any)
Area is calculated as:
Pi x r squared. Pi x radius x radius (where radius = cylinder bore or shaft diameter divided by 2 and Pi = 3.14)
A cylinder with a 2.5" bore and 8" stroke with a shaft diameter of 1.5" will result in:

NON-SHAFT SIDE	SHAFT SIDE
radius = bore/2 2.5/2=1.25	radius = bore/2 2.5/2=1.25
Area = 3.14 x 1.25 x 1.25 = 4.91	Piston Area = 3.14 x 1.25 x 1.25 = 4.91
Volume = 8 x 4.91 = 39.28 cu. in.	Shaft Area = 3.14 x .75 x .75 = 1.77
	Volume = 8 x (4.91 - 1.77) = 25.12 cu. in.

If the displacement of the orbital valve is known, cylinder volume can be used to determine the number of turns from lock to lock for a given system. Using an orbital with a displacement of 9.8 cu. in. and the above example will result in:

DOUBLE ENDED CYLINDER
Cylinder/Orbital = Turns lock to lock
25.12/9.8 = 2.6 Turns lock to lock

Force = Pump Pressure x (Piston area - Shaft area, if any)
Using the cylinder in the example above, and assuming a pump pressure of 1500 psi the following is achieved:

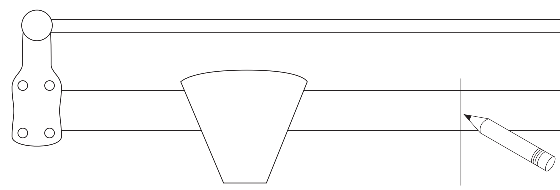
NON-SHAFT SIDE	SHAFT SIDE
Area = 3.14 x 1.25 x 1.25 = 4.91	Piston Area = 3.14 x 1.25 x 1.25 = 4.91
Force = 1500 x 4.91 = 7365 PSI	Shaft Area = 3.14 x .75 x .75 = 1.77
	Force = 1500 x (4.91 - 1.77) = 4710 psi

Determining the Required Stroke Length for a Hydraulic Cylinder

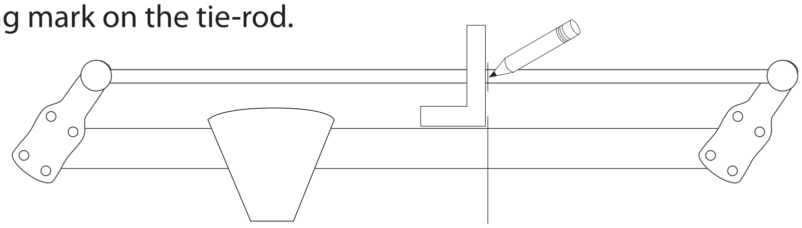
NOTE*** It is imperative that the steering arms to be used are installed for this procedure. Use of arms with different dimensions will result in dramatically different numbers.

The cylinder's required stroke length can be determined using the following steps:

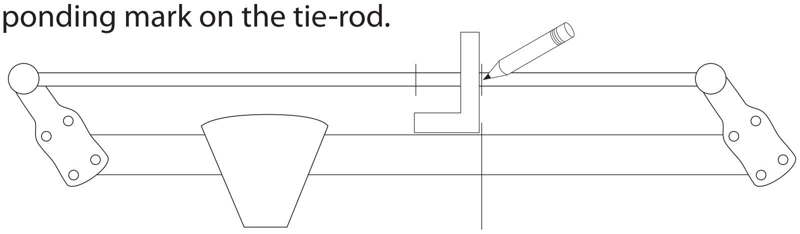
1. Make a reference mark on the axle tube.



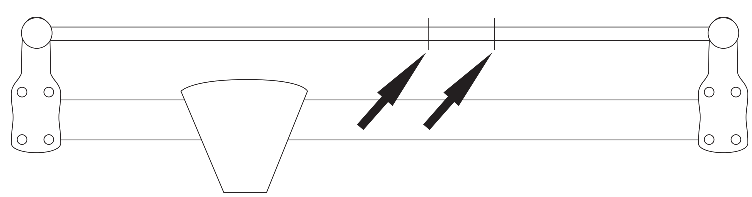
2. Turn the wheels full right to the desired position. This does not have to be against the axle stop, allow clearance for shocks, springs, etc. The cylinder should be used as the stop, otherwise the power of the cylinder may damage other components. Using the reference mark as a guide, make a corresponding mark on the tie-rod.

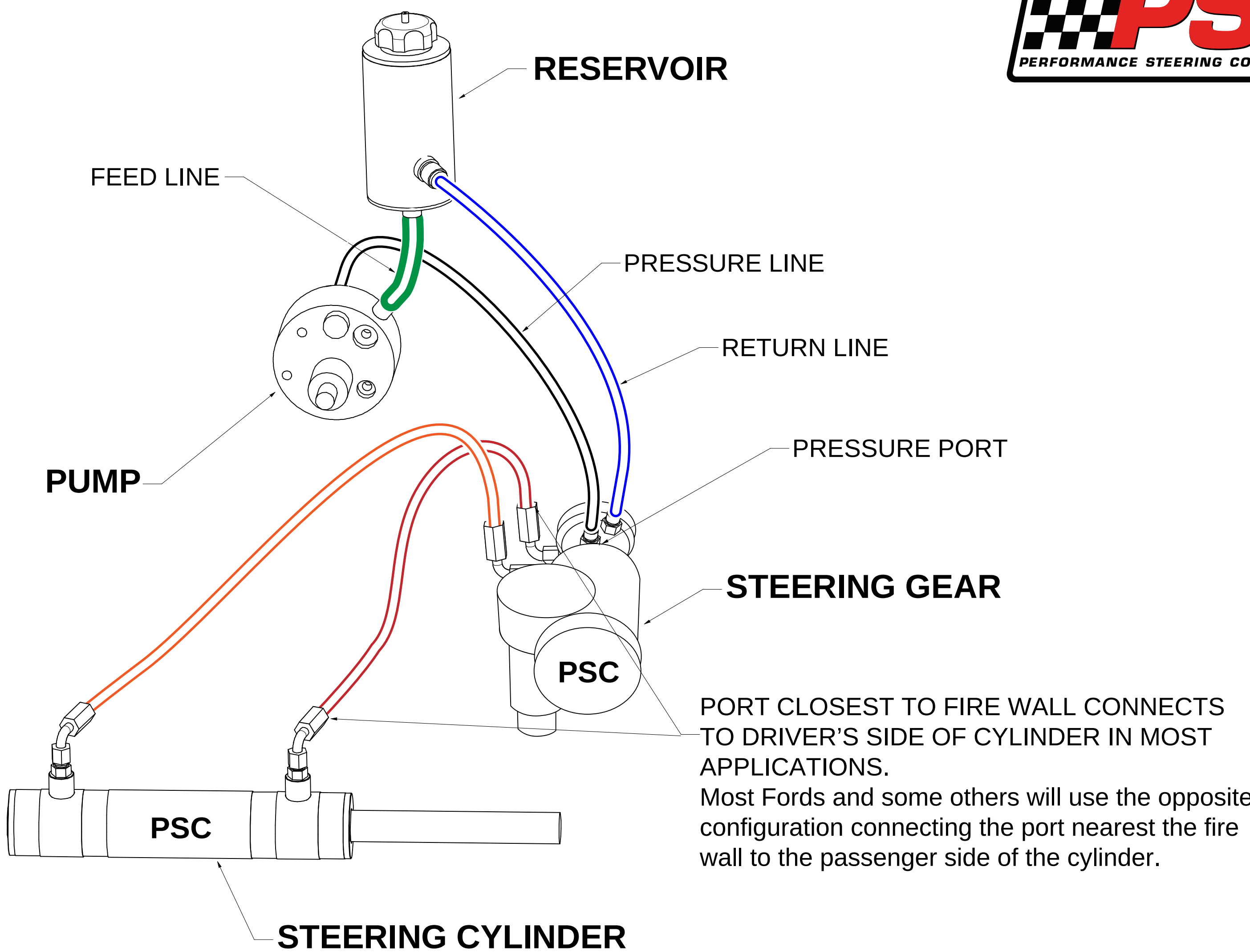


3. Turn the wheels full left to the desired position. Again, this does not have to be against the axle stop, allow clearance for shocks, springs, etc. The cylinder should be used as the stop, otherwise the power of the cylinder may damage other components. Using the reference mark as a guide, make a corresponding mark on the tie-rod.



4. The distance between the two marks on the tie-rod is the stroke required for this application.





HOSE ROUTING FOR STEERING GEAR BOX / CYLINDER APPLICATION