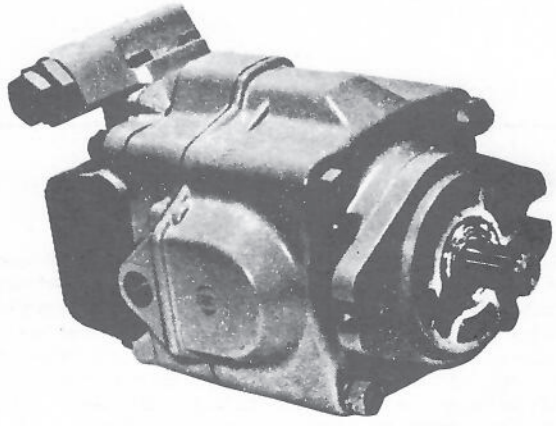
AP Series Piston Pump Features



Single Piston Pump Series

Piston Pump Features

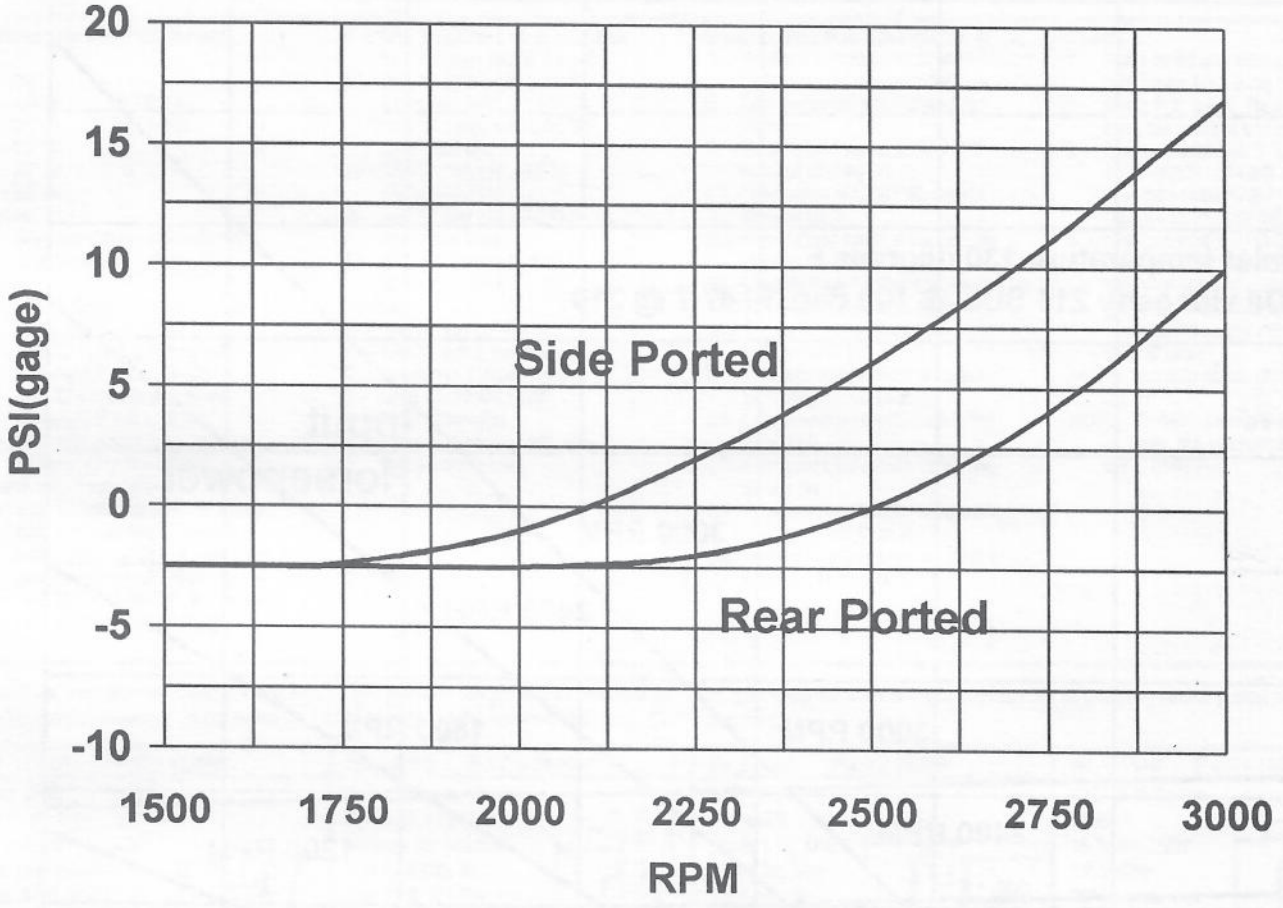
- Axial piston design
- Optional auxiliary pump mount and drive
- Field-proven, rotating groups
- Fast response times
- Viton seals
- Split-flange or straight-thread ports
- Splined or keyed shafts
- Aluminum housings
- Ductile iron porting covers

Specifications

- Maximum rated speed ..... 3000 RPM
  See inlet pressure vs speed chart
- Maximum continuous operating pressure ..... 3500 PSI (241 BAR)
- Maximum displacement ..... 4.0 CIR (65.5 CCR)
- Approximate weight ..... 50 lbs. (22.7 Kg)
- Maximum operating temperature continuous (see viscosity requirements) ..... 180°F (82°C)
- Maximum case pressure ..... 25 PSI (1.7 BAR)
- Mounting flange ..... SAE 'C' 2 & 4 Bolt
  Optional ..... SAE 'B' 2 Bolt
- Auxiliary mounting adapter and spline
  SAE 'A' & 'B'
- Maximum input horsepower
  Continuous ..... 80 H.P. (60 KW)
  Intermittent ..... 120 H.P. (90 KW)
- Optimum filtration recommendation:
  Beta 12 ≥ 200
  Fluid cleanliness ISO Code (16/14/12)
- Operating viscosity limits
  Maximum at start up ..... 5000 SUS (1100 CST)
  Maximum Continuous ..... 1000 SUS (220 CST)
  Minimum Continuous ..... 60 SUS (10.3 CST)
  Minimum Intermittent ..... 50 SUS (7.4 CST)
- Inlet pressure requirement ..... 5 in Hg to 20 PSI
  See inlet pressure vs speed chart
- Average response times for full stroke:
  on stroke ..... 200 msec
  off stroke ..... 125 msec
- Approved hydraulic fluids ..... Bulletin 10-430.0

AP Series Piston Pump Performance Data

Minimum inlet pressure requirements VS pump speed, 4.0 CIR



Inlet Pressure vs Altitude

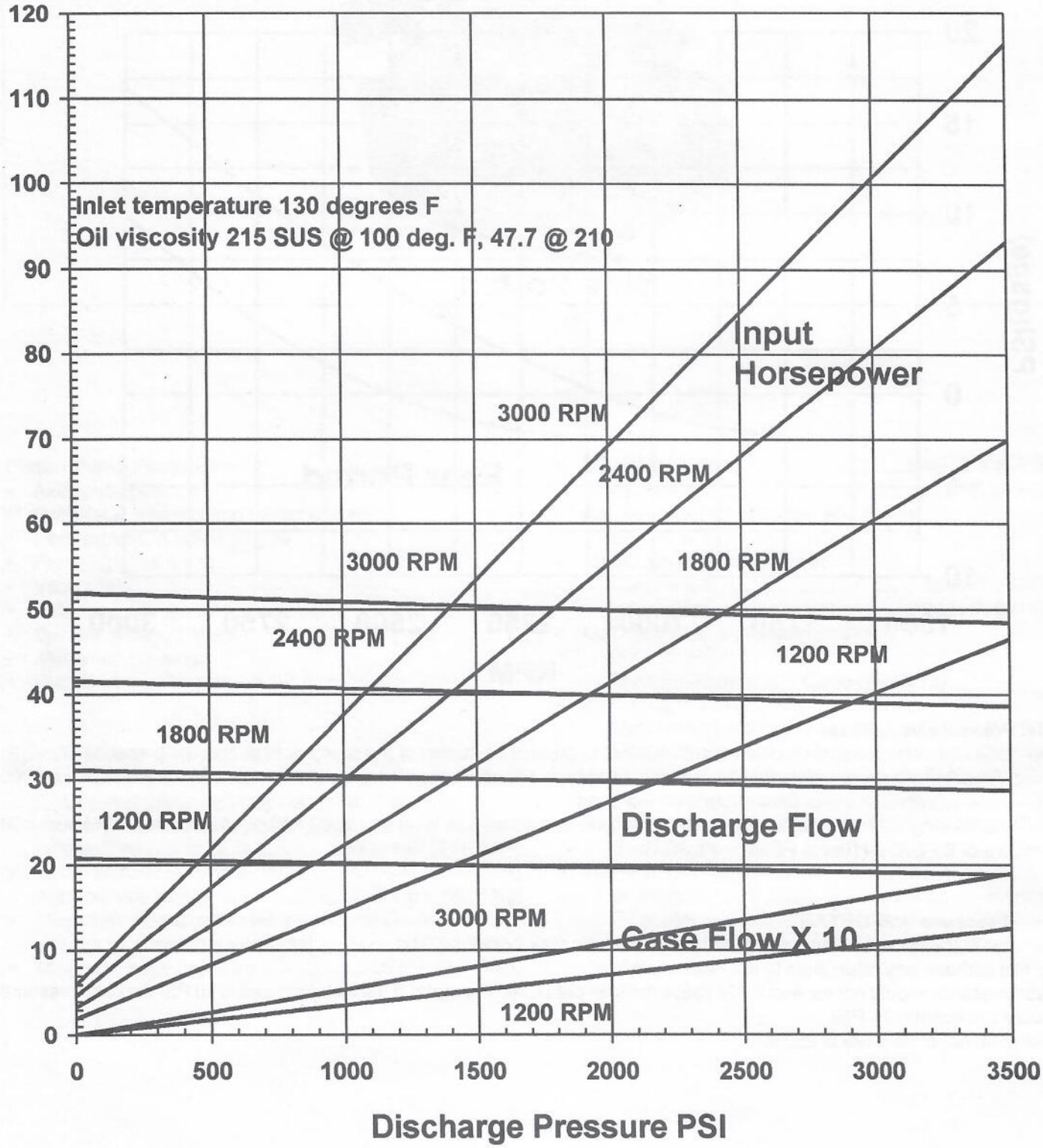
The minimum inlet pressures indicated are required to prevent cavitation of the pump at high-operating speeds.
The curves represent operation elevations below 1000 feet. For application in higher elevations, add 0.5 PSI for each 1000 feet above sea level to the pressure found on the chart.
Example: A single AP40 side port operating at 10,000 feet above sea level and 2500 RPM's will require a minimum inlet pressure of 6 PSIG x (10x0.5 PSIG) = 11 PSIG

Case Pressure "IMPORTANT"

Use one 1/2" case drain line connected to the hydraulic tank below the fluid level.
Do Not connect any other lines to the case drain line.
Case pressure should not exceed 5 PSI above the inlet pressure. Example: If the inlet pressure is 10 PSI the case pressure should not exceed 15 PSI.
Maximum case pressure is 25 PSI.

AP Series Piston Pump Performance Data

Pump Performance Characteristics 4.0 CIR



AP Series Piston Pump Model Numbering System

Model Number System

AP	40	B	1	B	1	A	2	R
Atmospheric Inlet Piston Pump	Models	Series	Shafts	Adapter	Construction	Controls	Covers	Rotation

Atmospheric Inlet Piston Pump
AP

Models
40 - 4.0 cir
35 - 3.5 cir
30 - 3.0 cir
27 - 2.7 cir
25 - 2.5 cir
23 - 2.3 cir
20 - 2.0 cir

Series
B - Standard design with reduced sound level

Shafts
1 - SAE 'B' Spline (use only with 'B' flange) P x D = 11,000
2 - SAE 'C' Spline (use only with 'C' flange) P x D = 29,400
3 - SAE 'C' Keyed (use only with 'C' flange) P x D = 29,400
4 - SAE 'B-B' Spline (use only with 'B' flange) P x D = 15,000

Shafts with Rear Drives
5 - SAE 'C' Spline-SAE 'A' rear drive (use #3 cover and 'C' flange)
6 - SAE 'C' Keyed-SAE 'A' rear drive (use #3 cover and 'C' flange)
7 - SAE 'B-B' Spline-SAE 'A' rear drive (use #3 cover and 'B' flange)
8 - SAE 'B' Spline-SAE 'A' rear drive (use #3 cover and 'B' flange)
17 - SAE 'C' Spline with SAE 'B' spline rear drive
18 - SAE 'C' Spline with SAE 'BB' spline rear drive
19 - SAE 'C' Key with SAE 'B' spline rear drive
20 - SAE 'C' Key with SAE 'B-B' spline rear drive
21 - SAE 'B' Spline with SAE 'B' spline rear drive

Adapter
B - SAE 'B' two bolt flange
C - SAE 'C' two & four bolt flange

Construction - Single Pump
1 - Long differential cutoff
4 - Short differential
5 - Torque limiter (use with torque limiter control only)

Controls (Required Construction #)
A - Pressure compensator (1 or 4)
B - Dual pressure compensator (1 or 4)
C - Load sense w / 170 PSI nominal standby (4)
D - Remote load sense w / 170 PSI nominal standby (4)
CA - Load sense w / 350 PSI nominal standby (4)
DA - Remote load sense w / adjustable standby (4)
M - Load sense w / adjustable standby (4)
T - Torque limiter w / load sense (5)
W - Torque limiter w / pressure compensator (5)
P - Pressure compensator w / electric unloading 12 vdc (1 or 4)
CB - Load sense w / electric unloading 12 vdc (4)
CC - Load sense w / electric unloading 24 vdc (4)
PA - Pressure compensator w / electric loading 12 vdc (1 or 4)
PB - Pressure compensator w / electric loading 24 vdc (1 or 4)

Covers
1 - Same as #3 with max. cam stop adj. (adj. range 4.0-1.0 cir) Note - Use shafts 1, 2, 3 & 4. Rear 'A' pad not available with this cover.
2 - Rear port-inlet SAE 1 1/2" O.D. tub port 1-7/8 - 12UN - 2B(-24)
Rear port-outlet SAE 1" O.D. tub port 1-5/16 - 12UN - 2B(-16)
3 - Side port-inlet 1 1/2" O.D. split flange per SAE J518C code 61
Side port-outlet 1" split flange per SAE J518C code 61
7 - Same as #3 except with rear SAE 'B' drive

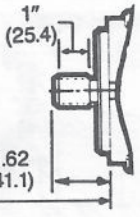
NOTE: Use with shafts 17, 18, 19, 20, 21

NOTE: When no setting is specified on order, the compensator will be set at 2500 PSI

The drive shaft can withstand the required torque provided the product of pressure (in psi.) times displacement (in cu. inches/re.) does not exceed the constant indicated. On tandem units the **sum** of these products for all pumping sections must not exceed this constant.

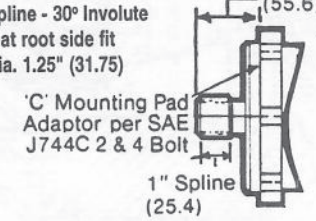
No. 1 Shaft P x D = 11,000

SAE 'B' Spline Shaft
13 Tooth 16/32 DP
Spline - 30° Involute
Flat root side fit
Dia. .875" (22.2)



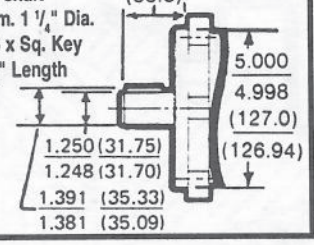
No. 2 Shaft P x D = 29,400

SAE 'C' Spline Shaft
14 Tooth 12/24 DP
Spline - 30° Involute
Flat root side fit
Dia. 1.25" (31.75)



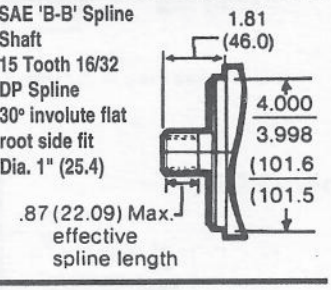
No. 3 Shaft P x D = 29,400

SAE 'C' St.
Key shaft
(Nom. 1 1/4" Dia.
5/16 x Sq. Key
1 1/2" Length



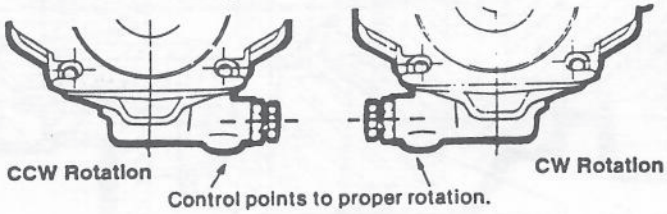
No. 4 Shaft P x D = 15,000

SAE 'B-B' Spline
Shaft
15 Tooth 16/32
DP Spline
30° involute flat
root side fit
Dia. 1" (25.4)

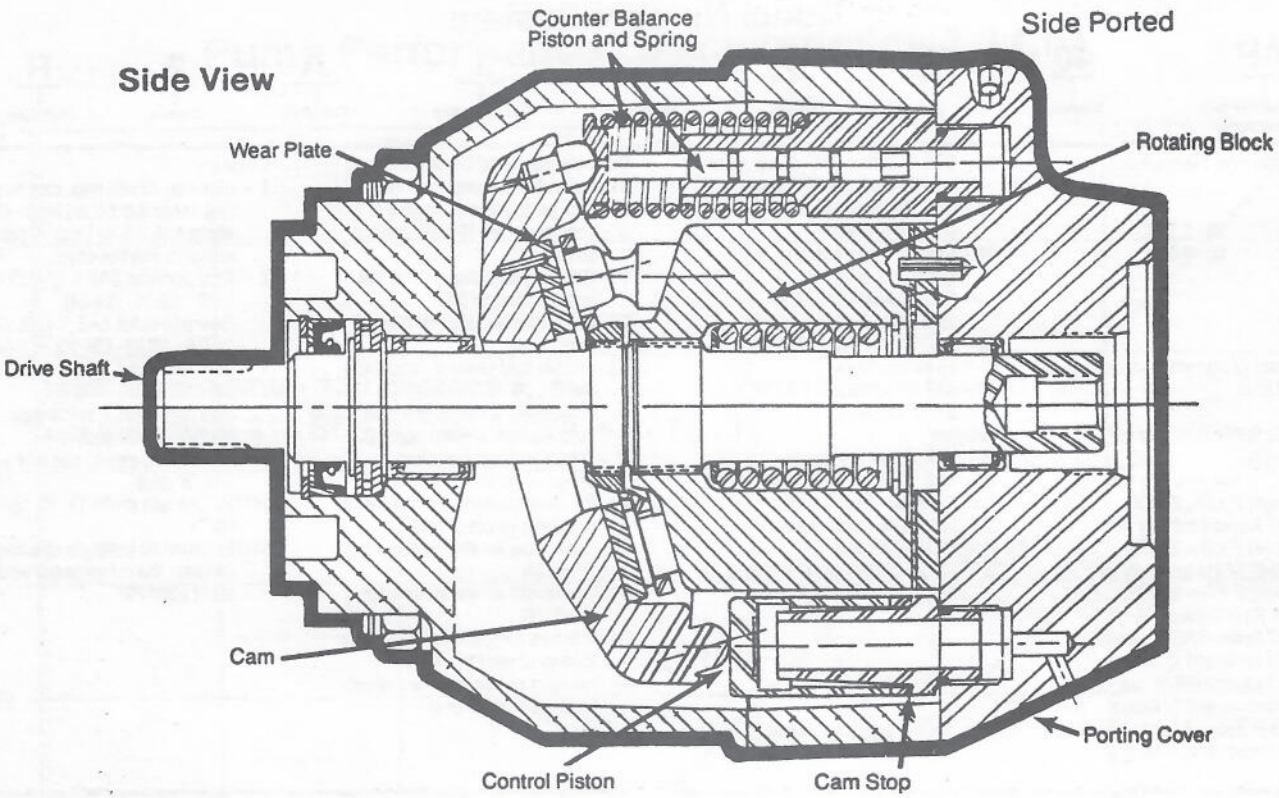


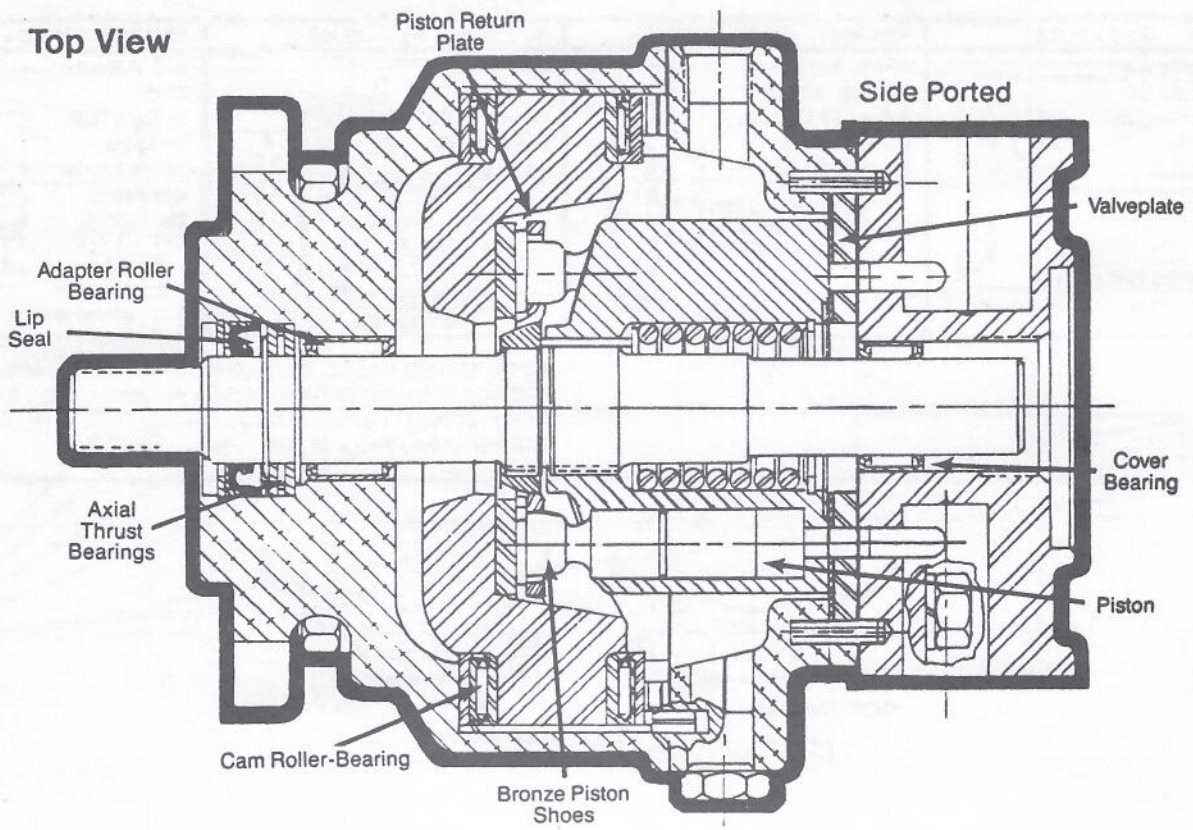
NOTE: All shafts from No. 5 through No. 8 must be used with no. 3 cover only SAE 'A' 5/8" internal spline for tandem mounting - PxD - 5,000. Shafts 17 through 21 must be used with No. 7 cover only - SAE 'B' spline - PxD = 11,000 SAE 'BB' spline - PxD = 15,000

Rotation: When viewing from the front or shaft end.



AP Series Piston Pump
Cross-Sectional View

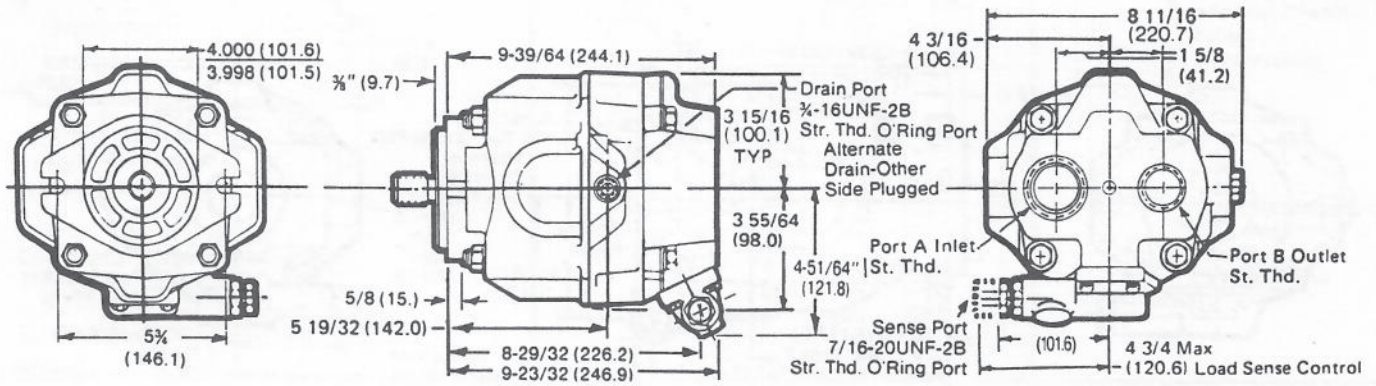




AP Series Piston Pump Installation Dimensions

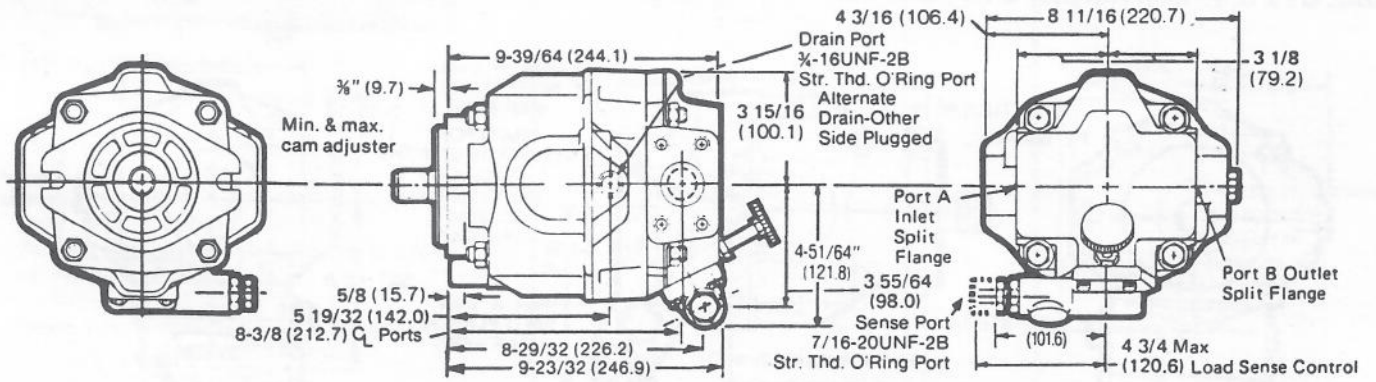
SAE B-2-Bolt Adapter-Rear Ports

No. 2 Cover



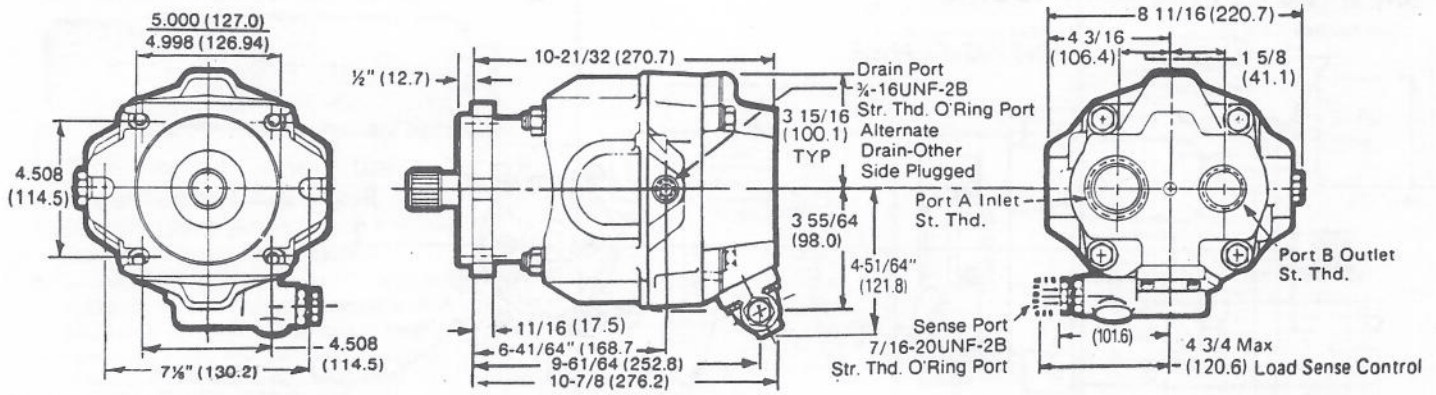
SAE B - 2-Bolt Adapter-Side Ports with min. and max. cam adjustments

No. 1 Cover



SAE C-2 & 4 Bolt Adapter-Rear Ports

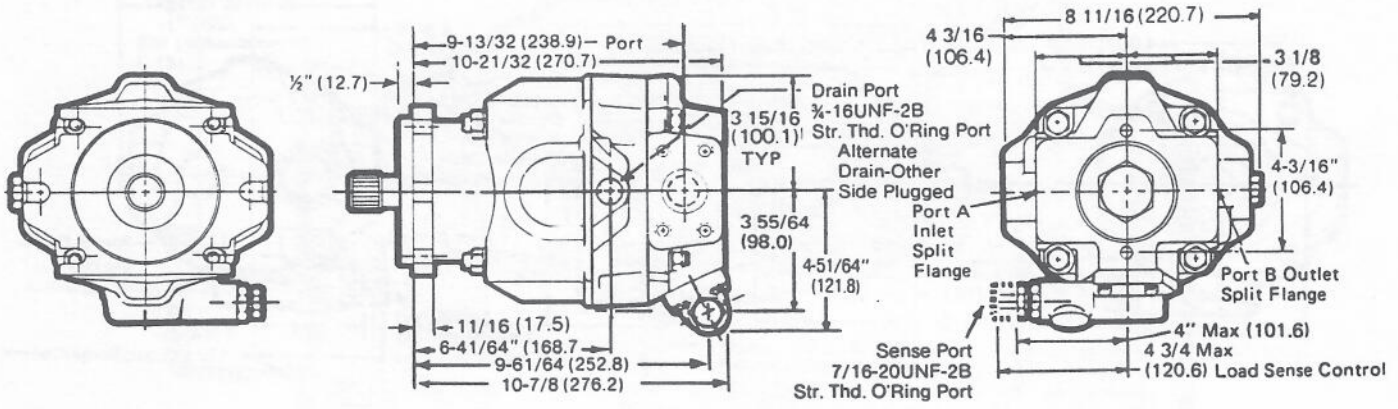
No. 2 Cover



AP Series Piston Pump Installation Dimensions

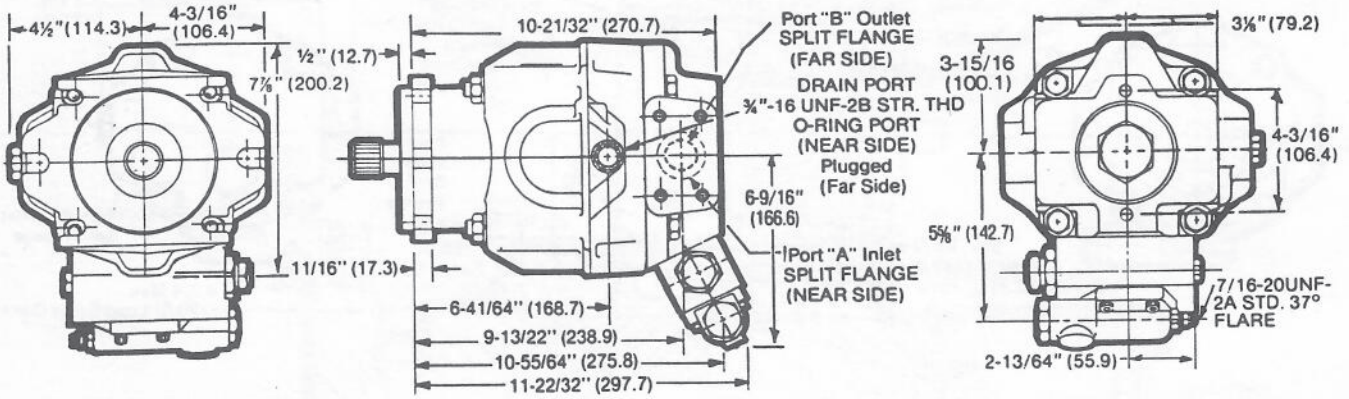
SAE C-2 & 4 Bolt Adapter-Side Ports

No. 3 Cover SAE 'A' Pad

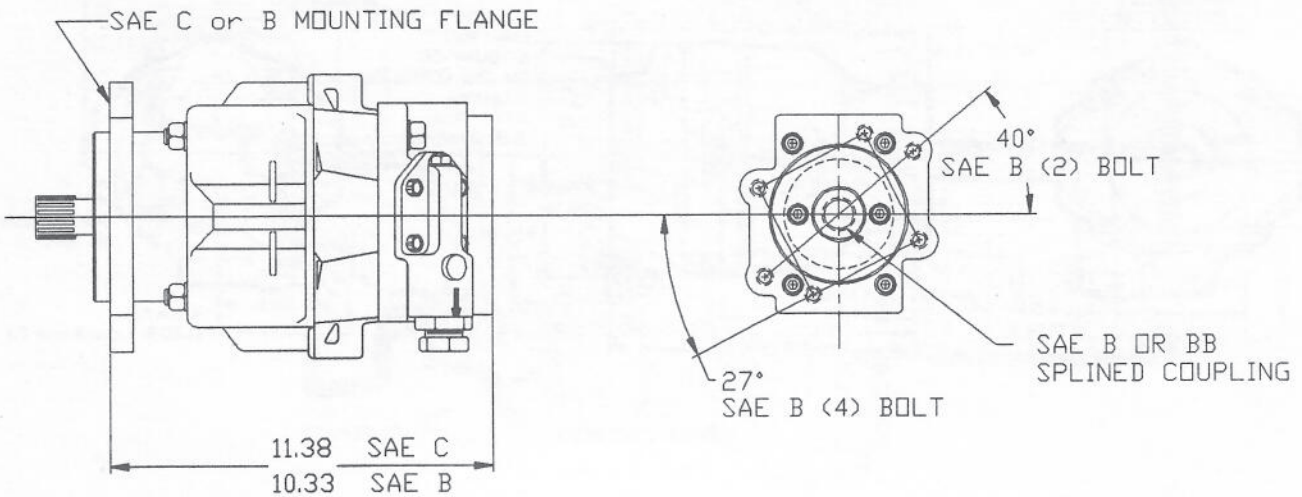


SAE C - 2 & 4 - Bolt Adapter-Side Ports with Torque Limiter Controls

No. 3 Cover SAE 'A' Pad

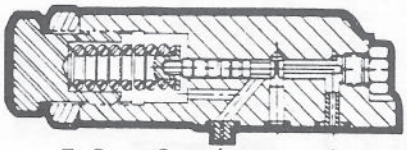


SAE B - 2 & 4 Bolt Adapter Thru Drive

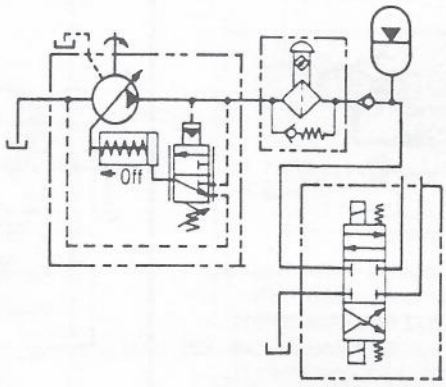


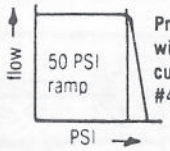
AP Series Piston Pump Controls and Applications

Description	Schematic	Characteristics
Pressure Compensator - 'A' Control - (P/N VR54X4)		

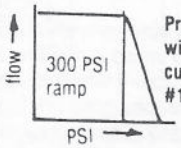


- Pressure Compensated
- Destrokes pump at preset pressure
- Adjustable to 3500 PSI
- Open or closed center applications
- Externally adjust high pressure cut-off by blocking system flow



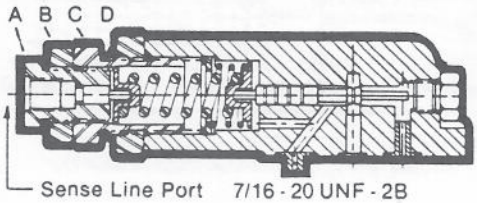


Pressure compensator with short differential cut-off #4 construction



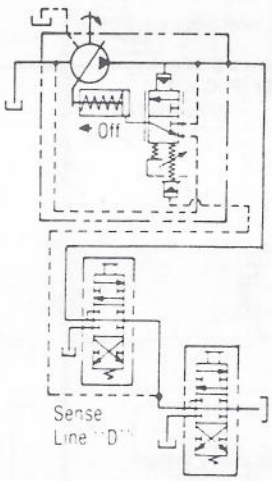
Pressure compensator with long differential cut-off #1 construction

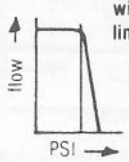
Dual Pressure Compensator - 'B' Control (P/N VR54X5)



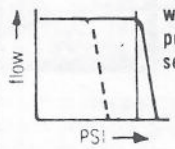
- Compensates system pressure at two different settings
- Pump destrokes at lower preset setting with 0 PSI at sense line port
- Pump destrokes at higher pressure setting with system pressure at sense line port
- Set lower pressure with adjustment "C" and no pressure at sense port
- Lock low pressure with "D"
- Set higher pressure by applying full system pressure to sense line and adjust "A"
- Lock high pressure with "B"
- Not available with load sense
- Min. low 750 PSI
- Max. high 3500 PSI
- Lower pressure settings available

Typical Circuit for Dual Stage Pressure Compensator



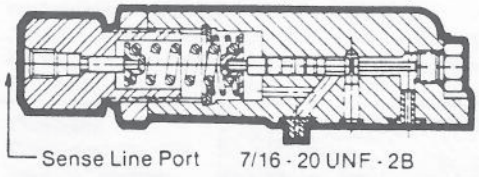


Pressure compensator without sense line pressure

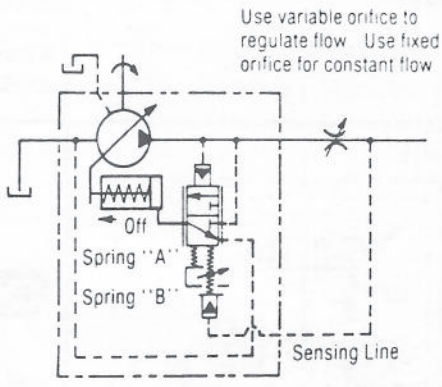


Pressure compensator with system pressure at sense line port

Load Sense - 'C' Control - (P/N VR54X3)

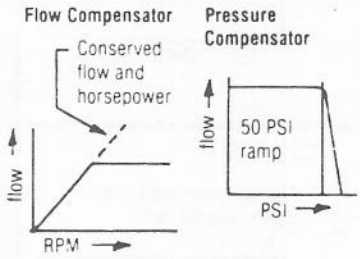


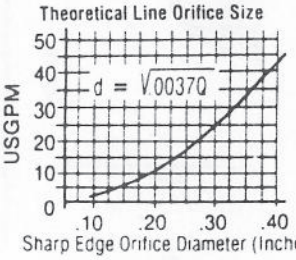
- Flow and pressure compensated
- Destrokes pump to match exact flow and pressure requirements of system
- Low pressure (170 PSI) standby with no flow in idle hydraulic system occurs when pump flow is blocked & sense line is vented to tank
- Increases pump flow as control valve is opened or variable orifice is opened
- Flow is controlled by line orifice size
- Pump maintains 170 PSI drop across line orifice
- Destrokes pump at preset pressure
- Externally adjustable high pressure cut-off to 3500 PSI (adjust by blocking pump flow, sense line must be connected to pressure.



Spring 'A'—Light spring to maintain 170 PSI across the orifice

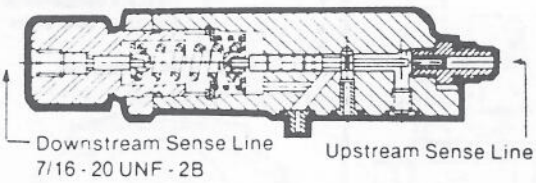
Spring 'B'—Heavy spring to limit max. pressure at compensating setting.

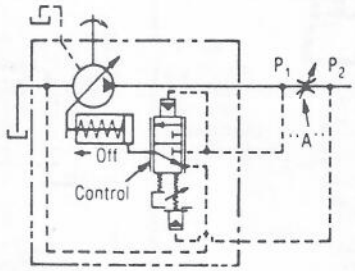


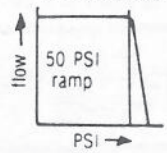


AP Series Piston Pump Controls and Applications

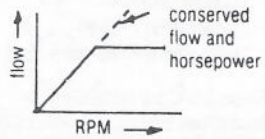
Description	Schematic	Characteristics
Remote Load Sense - 'D' Control (P/N VR54X6)		**Pressure Compensator**



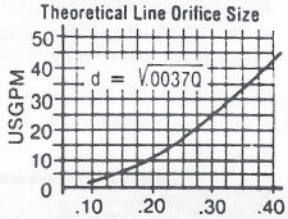




Flow Compensator

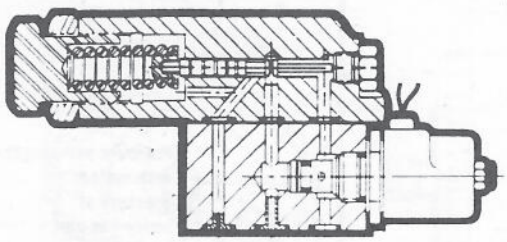


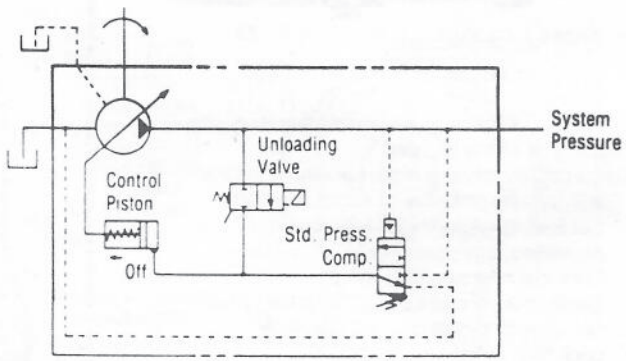
Theoretical Line Orifice Size



- Pressure and flow compensated
- Same as load sense control except uses two sense lines to accurately measure flow through a distance control orifice
- Eliminates line loss pressure drop effect when maintaining 170 PSI across control orifice (not available w/350 PSI standby)
- Measures system pressure at a remote location instead of internally at pump outlet port
- Use remote load sense if line pressure drop exceeds 70 PSI between pump and control valve
- If line pressure drop exceeds 70 PSI pump may flow compensate prior to reaching full flow
- Adjustable delta P control may replace remote load sense in some system (contact Delta^Q)

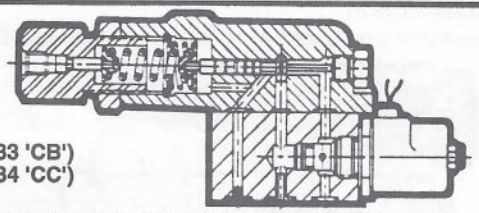
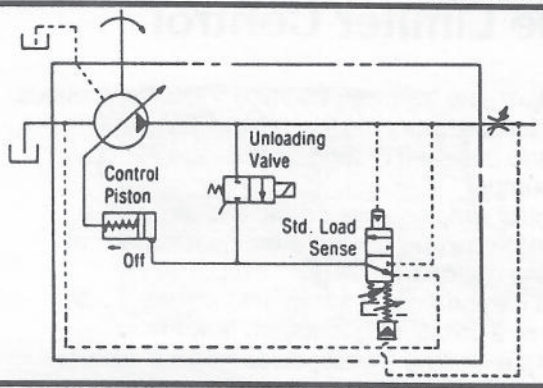
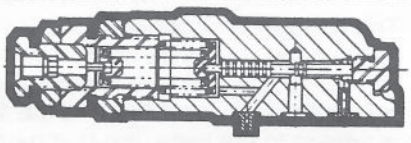
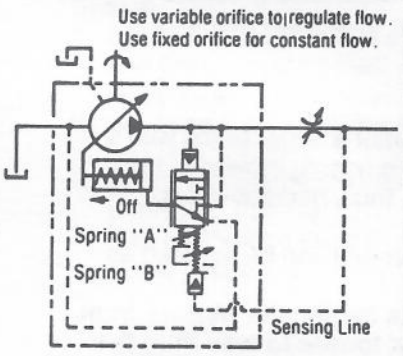
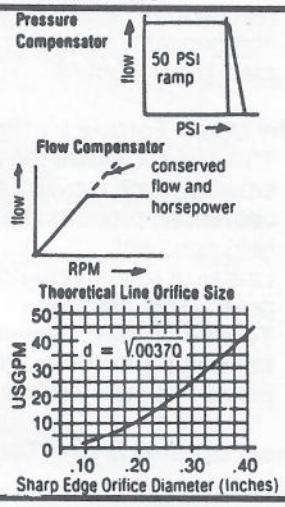
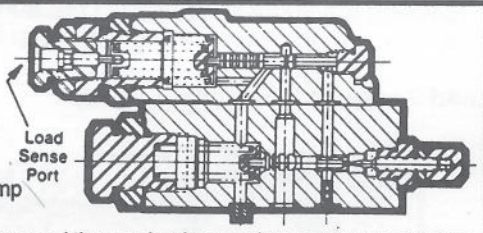
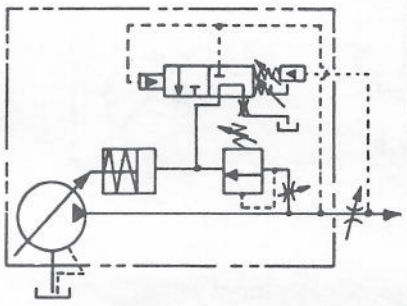
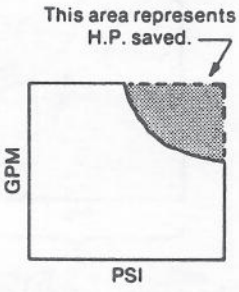
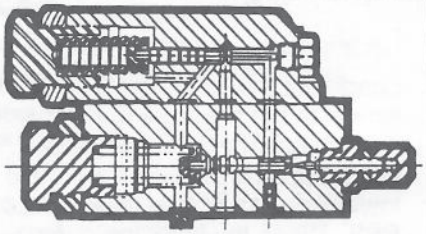
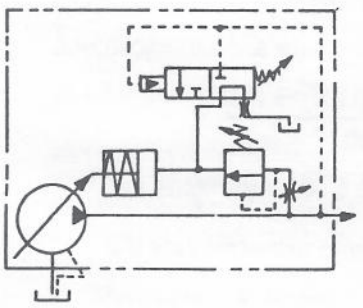
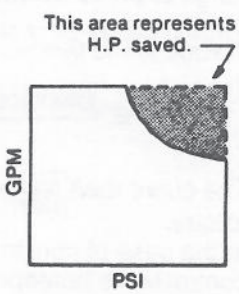
Unloading Control with Pressure Compensator 'P' Control (P/N VR54X27)





- Destrokes and unloads pump when activated
- For applications requiring low starting torque (i.e. diesel engines) or pump start-up under no load
- Solenoid - operated on/off directional valve (normally closed energize to unload pump)
- Requires 12 vdc - option 24 vdc
- Uses standard pressure compensator control (VR54X4 'A')

AP Series Piston Pump Controls and Applications

Description	Schematic	Characteristics
Unloading Control with Load Sense CB & CC Controls (P/N - VR54 x 33 'CB') (P/N - VR54 x 34 'CC')  • Destrokes and unloads the pump when activated • For applications where low pressure standby cannot be obtained at start-up • Solenoid operated on/off directional valve (normally closed energize to unload pump) • Requires 12 vdc (VR54X33 'CB') or 24 vdc (VR54X34 'CC') input • Uses standard load sense control (VR54X3 'C')		
Load Sense with Adjustable Standby 'M' Control (P/N VR54X13)  • Flow and pressure compensated • Destrokes pump to match exact flow and pressure requirements of system • Pump "stands by" at present low pressure and zero flow in idle hydraulic system when pump flow is blocked and sense line is vented to tank • Flow is controlled by line orifice size • Flow increases as variable orifice is opened • Destrokes pump at preset pressure • Externally adjustable high pressure cut-off to 3500 PSI (adjust by blocking pump flow; sense line must be connected to pressure) • Pump maintains preset standby pressure across line orifice	 Spring 'A'—Light spring to maintain ΔP across the orifice. Spring 'B'—Heavy spring to limit max. pressure at compensating setting.	
Load Sense with Torque Limiting 'T Control (P/N VR54X35)  • Reduces pump flow as system pressure increases and thus maintains nearly constant input torque • In the case of constant speed prime movers the control limits horsepower • Allows the use of a larger pump with a smaller prime mover • Linear or rotary actuator speed can be reduced as pressure increases • Used where standard load sensing is needed plus giving the benefit of torque limiting		
Pressure Compensator with Torque Limiting 'W' Control (P/N VR54X29)  • Reduces pump flow as system pressure increases and thus maintains a nearly constant input torque • In the case of constant speed prime movers the control limits horsepower • Allows the use of a large pump with a smaller prime mover • Linear or rotary actuator speed can be reduced as pressure increases • Used where standard pressure compensation is needed plus giving the benefit or torque limiting		

AP Series Piston Pump Torque Limiter Controls

Torque Limiter Control

Features

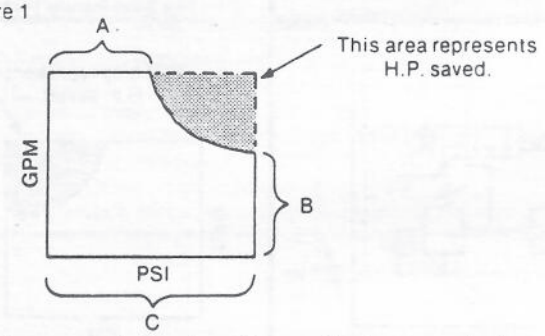
- Fully adjustable between 700 and 1700 inch/pounds of input torque; at a constant 1800 RPM this equates to between 20 and 50 horsepower on single pumps.
- The control simply works on the basis of orifice pressure drops and spring rates; no mechanical feedbacks needed.
- The unit can be factory set or field adjusted with the use of a pressure gauge and flow meter.
- This torque-limiting (horsepower-limiting) control can be interfaced with an adjustable pressure compensator control or an adjustable stand-by *load-sense* control.

Why Use a Torque Limiter

- This control allows the use of a larger pump with a smaller prime mover. As pressure increases flow decreases proportionally, thus, horsepower is held constant.
- Linear or rotary actuator speed can be reduced as pressure increases.
- **Torque limiting prevents engines or motors from stalling by holding input torque to less than the prime mover's output torque.**

Basic Operation of a Torque Limiter Control

Figure 1



- The control simply reduces displacement when pressure increases. Points A, B and C are adjustable which allows much flexibility for applying to a wide range of prime movers. (Figure 1)

- Torque is the product of pressure and displacement.

$$T = \frac{\text{Displacement (IN)}^3 \times \text{PSI}}{6.28}$$

The curve then represents a constant figure for torque.

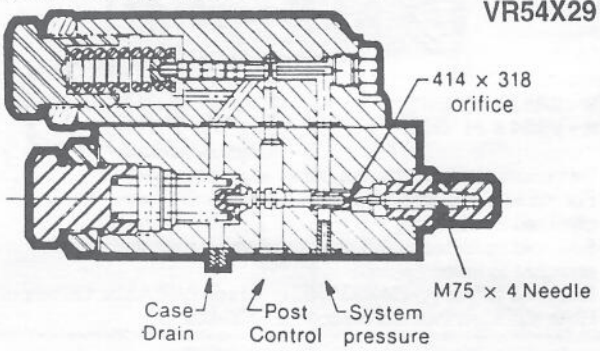
- In the case of constant speed prime movers the control limits horsepower.

$$HP = \frac{GPM \times PSI}{1714}$$

Construction

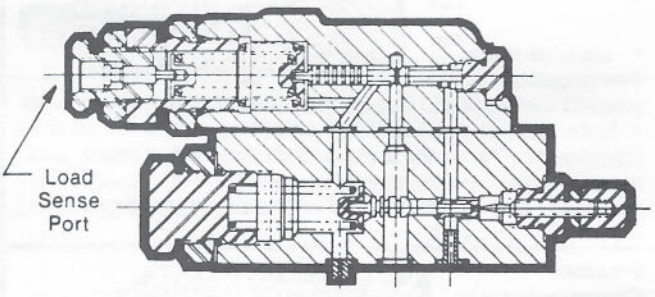
Pressure compensator with Torque Limiter

VR54X29 'W'



- The control block consists of a three-way valve with a relief sandwich block connected in parallel. When system pressure is diverted to the control post the pump destrokes. As the system pressure is vented to the case, the pump goes on stroke. (See curve - Figure 2)
- The knee of the curve (point C) starts when system pressure exceeds the spring force on the bottom control causing the poppet to move left communicating pressure to the post which starts the pump to destroke.
- As the poppet moves left, the control post is under the influence of flow through the orifice in part 414 x 318 as modified by needle.
- The final cut-off (point A) happens when system pressure exceeds the spring force on the top control causing the spool to move left communicating pressure to the post making the pump fully destroke.

Load Sense with Torque Limiting



- Load-sense control with torque limiting works very similar to the pressure compensator version. The main difference is the sense port. When this is vented to tank the pump will go to an adjustable low pressure standby (zero stroke at 170 to 500 PSI). When the load, the pump will maintain almost the standby setting above the load pressure. This control can be used where standard load sensing is needed plus giving the benefit of torque limiting.

AP Series Piston Pump Torque Limiter Controls

Determining the Proper Torque Limiter Setting

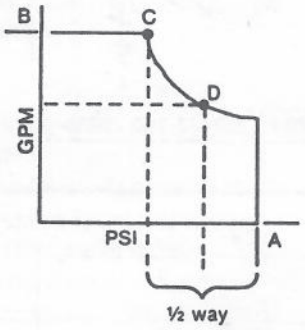
- It is best to study the torque curve as supplied by the manufacturer of the engine or motor you will be using. Simply specify the maximum torque allowed in inch/pounds to Delta^Q and the pump will be factory set. If curves are not available use the following formula: (Note that horsepower and operating speed of prime mover must be known.)

$$\text{Tin\#} = \frac{(\text{Hp})\ (63025)\ (\text{EFF})}{\text{RPM}}$$

Electric motor EFF = .95
Gas engine EFF = .8
Diesel engine EFF = .9

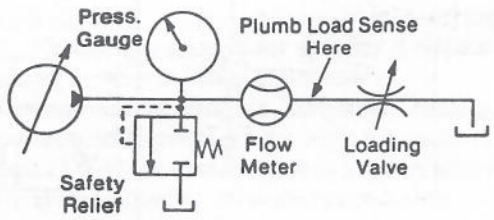
Step 1
Draw a flow vs. pressure curve reflecting the constant horsepower needed.

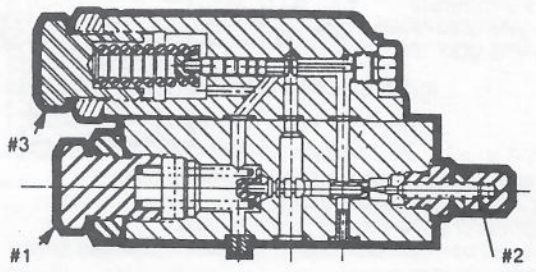
Figure 2



A) Draw in final compensator setting line.
B) Draw in max flow output line.
C) draw in point where PSI = $\frac{\text{HP}\ (1525)^*}{\text{GPM}}$
D) 1/2 way between point C and line A on the PSI axis, draw in point where GPM = $\frac{\text{Hp}\ (1525)}{\text{PSI}}$
E) Draw in constant Hp curve between C, D, and A. Other points can be checked by the formulas.

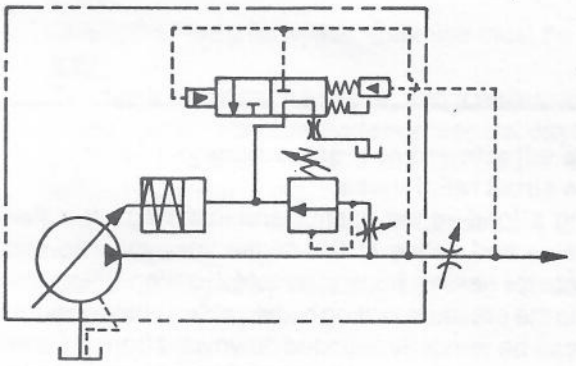
*This number takes efficiency into account.





Step 2
1. Point B on the Curve is a function of pump speed and flow control by load sense (if used) to establish pump flow.
2. Set point C by adjusting spring compression with cap (#1).
3. Adjust needle (#2) to desired flow for a given pressure. Point D
4. Cap (#3) will be used to set desired final compensator cutoff. Point A

"T" Control

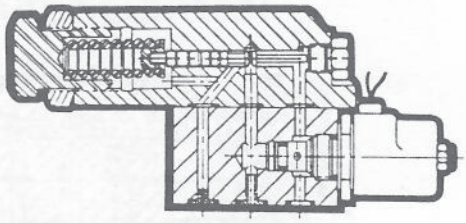
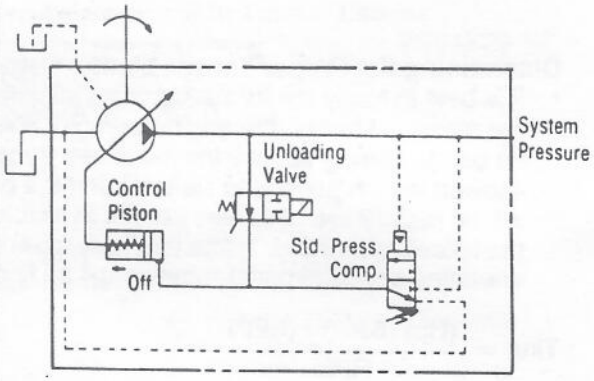
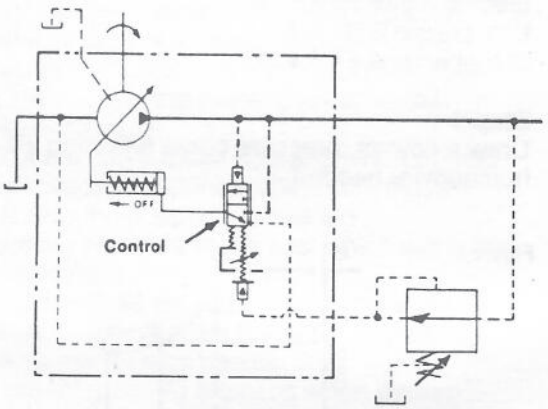
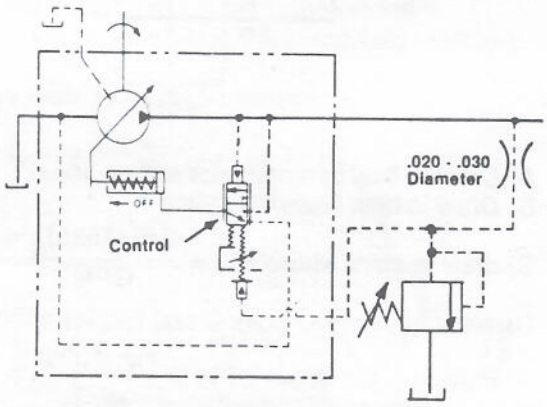
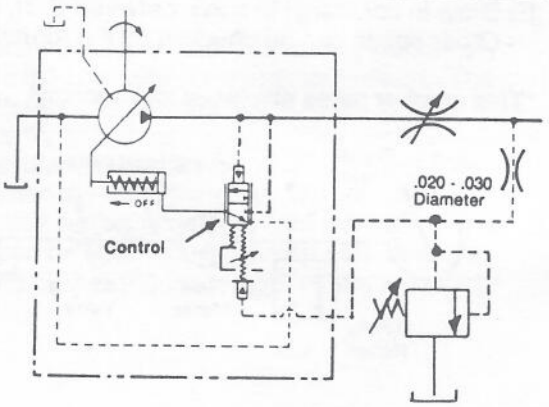


"W" Control
Same as "T" Control above only the adjustable orifice, load-sense line, and upper pin with bias spring are omitted.

Control
T - Torque control with adjustable load-sense control (M style)
W - Torque control with press comp control (A style)

Information Needed
- Final pressure compensator setting
- Bias setting (if load sense is used)
- Torque in inch/pounds
- Pump size
- Shaft speed in RPM

AP Series Piston Pump Control and Remote Adjustments

Description	Schematic
Loading Control with Pressure Compensator PA & PB Controls (P/N - VR54X32 "PA") (P/N - VR54X37 "PB")  • Brings a pump on stroke and load when activated • For applications requiring low starting torque (i.e. diesel engines) or pump start-up under no load • solenoid operated on/off directional valve (normally open energize to load pump) • Requires 12 vdc (VR54X32 'PA') or 24 vdc (VR54X37 'PB') • Uses standard pressure compensator control (VR54X4 'A')	
Remote adjustment of pressure compensator Using pressure reducing valve By using a load-sense control and installing an adjustable pressure-reducing valve in the sense line, you can simply dial in the compensator setting from a remote location. remote adjustment is limited to the pressure setting of the control compensator. The pressure setting can be remotely adjusted downward from the control setting (i.e. control compensator is set for 2500 PSI; remote adjustment can range from a minimum value up to 2500 PSI)	
Remote adjustment of pressure compensator Using a small relief valve By using a load-sense control and installing an adjustable pressure relief valve and orifice in the sense line, you can simply dial in the compensator setting from a remote location. Remote adjustment is limited to the pressure setting of the control compensator. The pressure setting can be remotely adjusted downward from the control setting (i.e. control compensator is set for 2500 PSI; remote adjustment can range from a minimum value up to 2500 PSI).	
Remote adjustment of flow compensator By using a load-sense control and installing an adjustable pressure-relief valve and orifice in the sense line, you can simply dial in the flow setting from a remote location. The main line orifice can be fixed or variable and limits the maximum pump flow. By adjusting the pressure relief valve to allow more flow to pass through the .020-.030 inch diameter orifice the pump flow can be varied downward from the maximum value determined by the mainline orifice. Maximum pressure is limited to the control compensator setting. Flow setting is good for one load only. As pressure (load changes, flow setting must be readjusted.	

AP Series Piston Pump Application Notes

Filtration

Inlet

- Use 100 mesh screen.
- Inlet filters are not recommended except for supercharged systems.

Discharge

- Filters, either pressure-line or return, should be capable of keeping fluid cleanliness as follows:

Operating Pressure	ISO Cleanliness
<2000 PSI	18/16/14
2000 to 3000 PSI	17/15/13
>3000 PSI	16/14/12

Inlet Conditions

- Check pumps drive speed against required inlet pressure.
- Make adjustments for altitude if necessary.
- Install pump below reservoir to assure flooded inlet when possible.
- If necessary install charge pump on auxiliary pad (SAE 'A' or 'B').
- Conditions must be met at lowest operating temperatures.

Case Pressure "IMPORTANT"

- Use one case drain per pump, ½ inch dia. Minimum.
- Do not use filters or coolers in case drain lines.
- Case pressure must not exceed 5 PSI above inlet pressure (Example: If inlet pressure is 10 PSI, case pressure must not exceed 15 PSI).
- 25 PSI maximum case pressure.
- Use upper most case drain port.
- Connect case drain below fluid level in side of reservoir.
- Run case lines in such a manner to prevent draining, siphoning or air locking of fluid.

Compensator setting

- Compensator settings are factory set but may be field adjusted.
- If adjustments are necessary CW rotation will increase setting; CCW rotation will decrease setting.

Load Sense Lines

- Use of ¼" O.D. steel or steel-braid load-sense lines may be required for stability if distance from pump to control valve is excessive.
- On load-sense controls, sense line must be connected to pressure for high-pressure cut-off to occur. For low-pressure standby the sense line must be vented to tank unless dynamic load-sense pin is used then line may be blocked.

Start-Up

- Install required gages prior to filling pump with fluid to observe case pressure, system pressure and inlet pressure to make sure it is within DELTA^Q ratings.
- Check all fittings to be sure they are tight.
- Fill reservoir with *filtered* approved oil.
- Fill pump case with filtered system oil. Make sure case is at least half full before start-up. Internal leakage will not provide enough lubrication if case is dry. *Pump must not run dry.*
- Open any shut off valves between reservoir and pump.
- If the pump is used in a closed outlet system, disconnect the outlet line until pump is primed and pumping fluid. *Pump must not be allowed to pump into a closed system application until the pump has primed or damage to the pump will occur.*
- Start prime mover and operate at minimum speed and minimum pressure until all air is purged from the pump. Stop the prime mover and reconnect pump outlet hose then purge air from the system by starting the prime mover and operating control valve.
- Check fluid lines for leaks. Inlet line must be *"air tight".*
- Re-check reservoir fluid level, add if necessary.
- Cycle pump – observe system pressure, case pressure and inlet pressure to ensure that they fall within the pump rating.

Pump Rotation

- Can be changed by installing opposite rotation cover and valve plate.

Application Assistance

- Professional application and controls engineering assistance is available.
- Complete the pump application form and contact DELTA^Q.