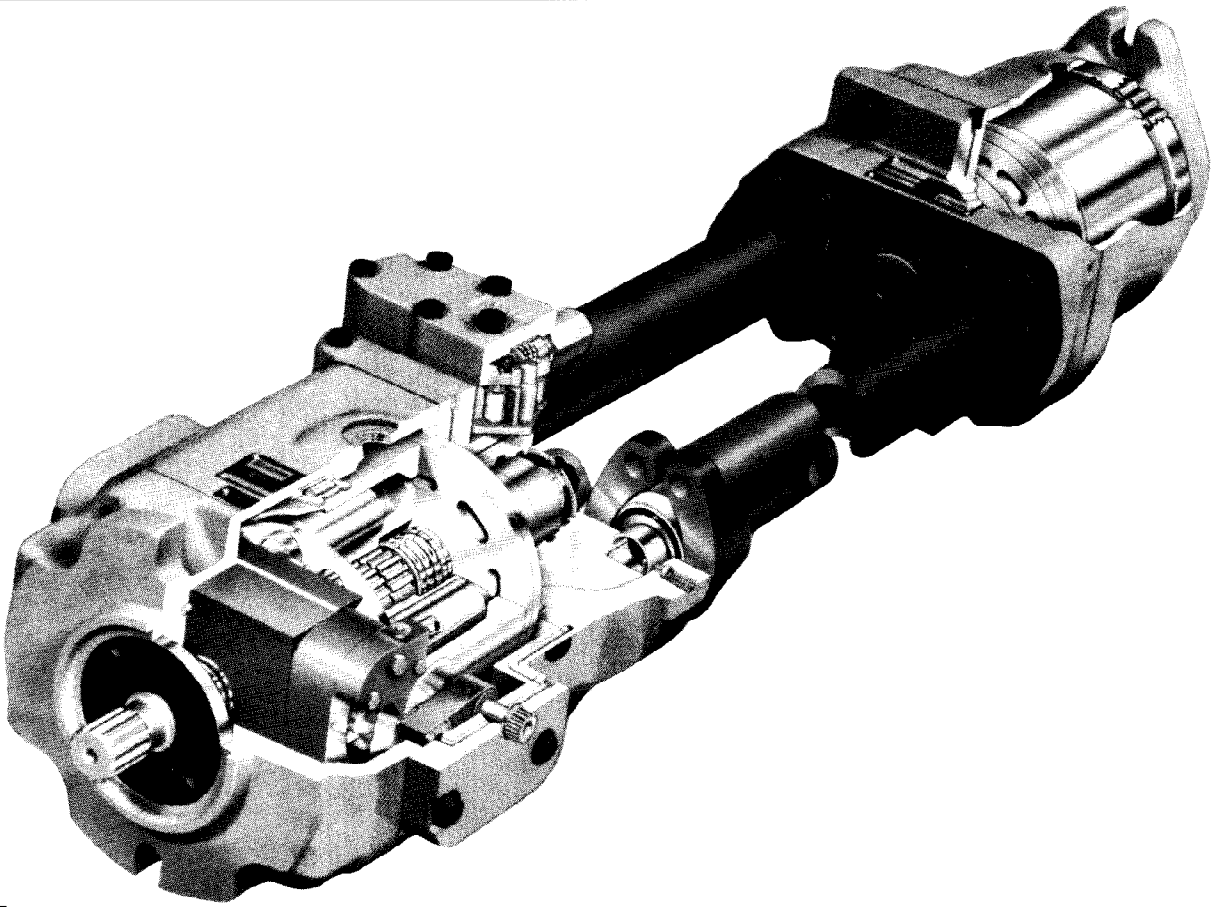
DENISON | **Hydraulics**

Hydrostatic Transmission

Pumps/Motors & Open Loop Pumps

Series P6...30, M6...30



Features

- **High power** – 227 hp(169 kW) to 696 hp(519 kW) continuously.
- **Pump displacement control** – is rotary servo with pressure compensator overrides. Optional additional controls available as standard include spring-positioning, automatic brake control, electro-hydraulic, torque limiter override, servovalve with feedback and others.
- **Compensator over-ride** – for the pump is effective in both flow directions, may be vented or remotely pressure controlled together or individually. It typically eliminates the need completely for system reliefs because it has full-flow relieving capability. Compensator is fast, (.050 seconds on the series 6, 7 & 8), (.070 seconds on the series 11&14) and (.100 seconds on the series 24&30) and extremely stable.
- **SAE conformance** – The mounting pads and shafts are all within full conformance of SAE standards. Two shafts options: SAE keyed and SAE splined.
- **Shaft-through-rocker design** – allows convenient mounting and porting.
- **Rocker displacement control** – shrinks package size, eliminates high force linkages and reduces noises.
- **Barrel bearing** – reduces barrel face loads, reduces wear and extends temperature and speed range.
- **Low speed operation** – of pump without cavitation—because drain oil makes up replenishment flow when needed. NOTE: Optional case pressure check valve must be used for low speed operation.
- **Military Specifications** – These products are qualified to meet Military specifications MIL-P-17869A and MIL-S-901C Grade A (P8, P30 pending).
- **Fixed displacement pumps and motors** – Also available from 4.05 in^3/rev. (66.38 cm^3/rev.) to 7.25 in^3/rev. (118.8 cm^3/rev.).

Publ. 1-AM021-B 3-95

▌ Denotes change

Specifications	Term	Series 6	Series 7	Series 8	Series 11	Series 14	Series 24	Series 30
PUMP & MOTORS* **								
Displacement at Max. angle	in³/rev	6.00	7.25	8.00	11.00	14.00	24.6	30.6
	cm³/rev	98.3	118.8	131	180.3	229.4	403.1	501.4
Pressure Ports A or B max continuous	psi	5000	5000	3600	5000	5000	5000***	5000***
	bar	345	345	250	345	345	345***	345***
intermittent	psi	6000	6000	4350	6000	6000	5000***	5000
(not to exceed 6 sec./min.)	bar	414	414	300	414	414	345***	345
Mounting Standard		SAE-C	SAE-C	SAE-C	SAE-E	SAE-E	SAE-F	SAE-F
Fluid connections ports A & B								
4-bolt pad for 6000 psi split flange		SAE-1.5	SAE-1.5	SAE-1.5	SAE-1.5	SAE-1.5	SAE-2.0	SAE-2.0
port A open loop 3000 psi split flange		SAE-2.0	SAE-2.0	SAE-2.0	SAE-2.5	SAE-2.5		
PUMP								
Speed max. continuous (consult Denison Hydraulics about service at higher speeds)	rpm	3000	3000	1800	2400	2400	2100*	1800
Flow theor. at max. displ. at 1500 rpm	gpm	38.9	47.1	51.9	71.4	90.9	159.7	198.7
	l/mi	147.5	178.2	196.4	270.4	344.1	604.6	752.1
at 1800 rpm	gpm	46.8	56.5	62.3	85.7	109.1	191.7	238.4
	l/min	177	213.8	235.8	324.4	412.9	725.5	902.5
Aux. Pump theor. displacement per rev	in³/rev	1.07	1.07	1.07	2.14	2.14	2.81	2.81
	cm³/rev	17.53	17.53	17.53	35.07	35.07	46.1	46.1
flow at 1500 rpm	gpm	6.9	6.9	6.9	13.9	13.9	18.2	18.2
	l/min	26.3	26.3	26.3	52.6	52.6	69.1	69.1
1800 rpm	gpm	8.33	8.33	8.33	16.7	16.7	21.9	21.9
	l/min	31.6	31.6	31.6	63.1	63.1	82.9	82.9
Aux. Pump servo pressure range	psi	335-535	335-535	335-535	335-535	335-535	335-535	458-570
(varies upward with pressure in port A or B) (minus case pressure)	bar	23-37	23-37	23-37	23-37	23-37	23-37	31.6-38.8
Replenishment package	psi	200	200	200	200	200	200	350
pump relief valve (minus case pressure)	bar	14	14	14	14	14	14	24.1
Weight, package pump	lbs	175	175	175	325	325	560	620
	kg	79	79	79	147	147	254	281
MOTOR								
Speed, max. continuous at full displacement	rpm	3000	3000		2400	2400	2100	1800
at 50% displacement	rpm	3600	3600		2800	2800	2100	1800
Torque theo. max. per 100 psi	in#	95.5	115.4		175	222	392	487
per 6.9 bar	Nm	10.79	13.04		19.8	25	43	55
max. at 5000 psi	in#	4774	5769		8750	11100	19576	24,351
at 345 bar	Nm	539.5	651.9		990	1250	2158	2752
Power theo. max. at 5000 psi per 100 rpm	hp	7.57	9.15		13.8	17.6	31.1	38.64
at 345 bar	kW	5.65	6.82		10.3	13.1	23.1	28.8
at 5000 psi at 2000 rpm	hp	151.5	183.1		277.8	353.5	621.3	695**
at 345 bar	kW	113.0	136.6		207.0	263.7	463.5	518.2
Efficiency Torque—approx. Stalled	% theor.	81	81		81	81	81	81
Running	% theor.	93	93		93	93	93	93
Weight package motor fixed displacement	lbs	105	105		250	250	510	600
	kg	47.7	47.7		113	113	230	272
package motor variable displacement	lbs	155	155		300	300	510	
2A0 control	kg	70.4	70.4		136	136	230	
Rotary Inertia	lb in²	92	92		290	290	821	977
	kg m²	0.027	0.027		0.085	0.085	0.240	0.286

*On R & O Oils (Rust and Oxidation Inhibitor)
**@ 1800 rpm
***M24 and 30 series variable motors, max. pressure 4000 psi (276 bar) (consult factory for 5000 psi (345 bar) applications.)

Operation of Pump and Motor

These pumps and motors have the familiar principles originated for Denison Hydraulics Inc. axial piston units.

The shaft is splined to the barrel which contains axial pistons. Each piston terminates with a ball onto which is swaged a shoe. The shoe bears against the cam surface whose angle determines displacement and direction of flow relative to rotation; full-through zero to full in the opposite direction. The opposite end of the barrel bears against the port plate whose two ports communicate to the system inlet and outlet ports, A & B.

The piston shoes are held at the cam surface by the hold-down plate which rotates at shaft speed and is free to follow the changing cam angles. The barrel and piston shoes are free to adjust axial clearances to compensate for fluid film thickness, wear and dimensional changes caused by temperature and pressure. The variable displacement pump or motor has its cam surface supported on the movable rocker cam. It rides on a semi-cylindrical bearing which has two hydrostatic pads directly in line with the piston thrust. Each pad is subject to the system pressure present on its A or B side.

The P30P features new designs in the rotating group using inertia welded pistons for increased performance and a spherical shaft bearing design to increase bearing life and withstand heavier side loads.

The rocker cam is positioned by two integral vane actuators, one on either side. They are more fully described in Displacement Controls. A displacement indicator projects from the case to show cam angle.

The rocker cam axis, the shaft, the plane of the piston ball centers all coincide with the center of moments of the unit to give a fully balanced design. This reduces control forces and wear to a minimum.

A large roller bearing on the barrel is most important to the superiority of these units. Its location, also at the center of moments, eliminates any tendency of the radial vectors of the piston shoe forces to tip the barrel off the port plate and allows the barrel to optimize its loading against it. This unique design feature relieves the shaft of any bending forces caused by hydraulic loads and easily accommodates changes in housing and shaft lengths caused by temperature and pressure.

This bearing system permits these units to be more tolerant of viscosity extremes in either short or long term It also reduces the shaft and piston circle diameter, allowing higher shaft speeds for any given displacement.

The displacement of the main system pump is varied by the rocker cam which rotates in the rocker cradle. Both cam and cradle are loaded in compression and are very rigid. They do not deflect as do bearing supported trunnions. This reduction in deflection reduces transmitted noise and increases efficiency. The rocker cam is partially floated by system pressure exposed to a small area between the cam and cradle surface, this reduces friction and lowers servo pressure requirements.

The Auxiliary Replenishing Port (port k) is provided in the plug opposite the shaft between system ports A and B. This port allows additional replenishing flow from an accumulator or other source to the gallery between the ring checks. Additional replenishment is frequently required by systems with high fluid capacitance.

Closed Hydraulic Loop Circuit

A pump, whose discharge port connects to a motor which returns the fluid directly to the pump inlet, is operating in a closed hydraulic loop. The package pump and package motor include all the major components required for a superior closed loop circuit. Connected together the pair is a hydrostatic transmission.

Power Characteristics of Hydrostatic Transmissions

Variable Pump/Fixed Motor. This combination provides for a constant torque output at a fixed maximum pressure over the full speed range. Speed and direction are controlled with a variable displacement crossover center pump. Regenerative loads are decelerated by transferring them to the pump prime mover. Motor speed is limited to the maximum speed permitted by full pump displacement. System is capable of full power only at maximum pump displacement.

Variable Pump/Variable Motor. This combination provides for an extended range of motor speeds. The motor, at full displacement, delivers maximum torque, while its speed and direction respond to displacement changes of the crossover center pump. Power varies directly with speed over this lower part of the operating range.

For increased speed from the motor, its displacement is reduced while the pump is kept at full volume. Speed varies inversely with motor displacement and torque over this upper operating range, while power capability remains constant. The displacement of the motor may be reduced to 30% of maximum, if shaft speed limits permit.

This transmission system has the capability of constant torque and rising power until the pump reaches full displacement and full power at elevated speeds as motor displacement and torque are reduced.

Package Pump

The package pump contains the circuit elements shown in the hydraulic schematic Figs. 2, 3 and 4 (pgs. 30, 31, and 32). These include the axial piston crossover-center variable pump which controls the speed and direction of the motor, the auxiliary pump which supplies servo pressure (for controlling the displacement of the variable pump) and replenishment pressure, the servo pressure relief valve, the replenishment pressure relief valve and the replenishment check valves for leg A and B. The pump package also includes the displacement control valves as well as an external arm which shows actual displacement. The various control features are described below.

Package Motor

The package motor, shown in schematic Figs. 2, 3 and 4 (pgs. 30, 31, and 32), contains the axial piston fluid motor, the shuttle valve that continuously strips hot oil from the low pressure leg of the loop and a relief valve to establish minimum hydraulic loop pressure at the motor. The fluid motor is available with fixed displacement or with the variable displacement option described below. The standard variable motors include an external arm which shows displacement.

Open Loop Pump

The open loop pump contains the circuit elements shown in Figure 5 and 6 (pgs. 33 and 34). These include a cross-center variable volume pump which is normally limited to one side of center. The auxiliary pump supplies only servo pressure to control the main pump displacement. The replenishing check valve on the inlet side is omitted and inlet porting is enlarged to improve the pump's inlet characteristics. As the open loop pump operates on one side of center only, not all controls are available.

Displacement Control Operation

Two Double-acting Vane Actuators accept the fluid signal to adjust and hold angular displacement settings of the rocker cam. Each actuator, one on each side of the rocker, displaces fluid in a curved chamber. Each consists of a moving vane with an elastomer seal. The actuator force is applied tangent to the friction forces opposing the rocker cam's movement. The single piece rocker is extended on each side to provide the slots for the close fitting vanes. There are no links or pins to wear and cause unstable control. Fig. 1.(pg 5)

Hydrostatic Balanced Shoes are positioned by the rotary servo input and act as a precision slide valve to direct flow to and from the rotary actuators in a position feed back system. Servo response is purposely restricted by orifices to a minimum of approximately one second between zero and full. The system will store full error signals without difficulty. Additional shoes balance out the transverse forces of this valve system.

Modulated Servo Pressure is established on the outflow from the auxiliary pump. Servo pressure is approximately 335 psi (23 bar) at low system pressures to reduce power and heat. It is modulated upward to approximately 535 psi (37 bar), automatically to give positive control as system pressure increases to 5000 psi (345 bar).

Pressure Compensator Override both sides of center is a standard feature of the pump. The pressure in the system legs A and B is limited to a maximum value as is controlled by the full-flow sequence and dual area relief valve in series in each leg. This full-flow relieving path eliminates damaging pressures even if a mechanical failure prevents the pump from reducing displacement. Additional reliefs are unnecessary. Flow from the sequence valves enters the vane actuator and overrides the rotary servo signal. During override, the off-side actuator volume is subject to 2 times servo pressure as the on-side actuator volume is maintained at servo pressure. This changes pump displacement to prevent exceeding the adjusted maximum pressure, crossing center if necessary. Typical pressure compensator override response is .050 seconds, series 6, 7 and 8; .070 seconds, series 11 & 14; and .100, series 24 & 30.

The compensators are effective for both directions of flow and for pumping and motoring (overhauling) loads. There is minimum pressure overtravel and heating of the fluid during overloads. The control will maintain steady pressures during compensation, the flow matching the instantaneous requirement of the system. When the load is reduced the displacement returns to the rotary command in approximately one second.

Remote Control of the Compensators is accomplished by drawing fluid from one or more of the vent ports on the pump. The integral screw adjustment limits maximum compensator pressure for legs A and B. Draw fluid from vent port V to remotely control compensation pressure in legs A and B to lower values. Draw fluid from port VA to control only in leg A or from port VB in leg B. Use these vent ports for (1) reduced-load-starting, (2) load-sensing systems, and (3) to maintain constant pump flow even though discharge pressure and pump shaft speed varies.

> **CAUTION:** Do not vent quickly from high pressure. Contact Denison Hydraulics Inc. if you need this feature.

A Displacement Indicator projects from the pump on the opposite side of the rotary servo control and gives a visual read-out of rocker cam displacement angle, even during compensation. This facilitates start-up and improves safety. The indicator may be used to operate limit switches or other low-force signal devices in an approved manner.

Pump Displacement Control Options

The rotary servo control and pressure compensator override described are supplied on all of the standard pumps. Additional optional controls are added by substituting alternate control plates on the command and feedback side. The displacement indicator is standard on all of the controls.

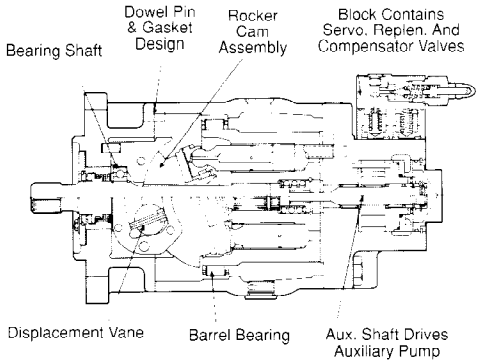
Primary Controls

Code 1 — Screw Adjustment

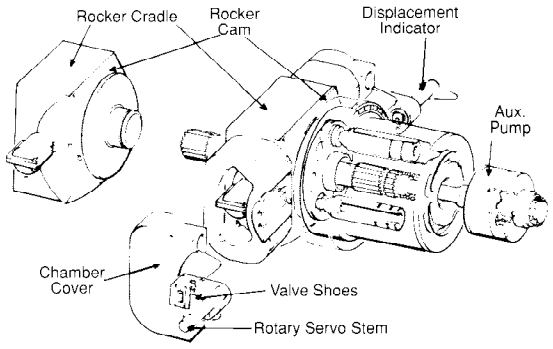
The screw adjustment spring offsets the rotary servo to the maximum displacement as adjusted by the screw control. The operator needs only to override the spring offset torque of approximately 20 in. lb. (2.26Nm) with the rotary servo stem to manually reduce displacement. The minimum displacement is set by the adjustable screw which determines the minimum rotary servo command. The pressure compensator override is independent of this control. A pump with this control acts as with a traditional pressure compensator. In the absence of an overriding rotary servo command the pump is held at the adjustable maximum displacement. The maximum screw is adjustable from approximately 100% to 0%. The minimum screw is nominally set at zero stroke but is adjustable from -50% to +100% displacement.

Code 2 — Cylinder Control

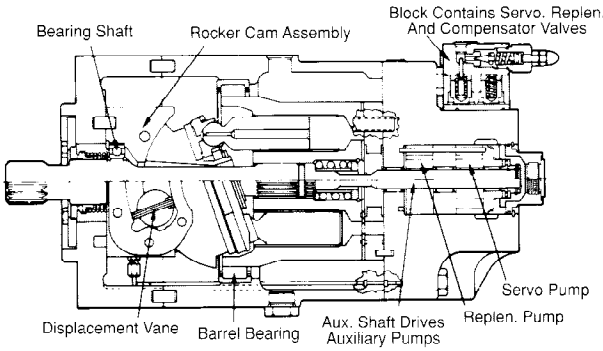
This control provides the capability of hydraulically selecting either of two present displacements, on one side of center only. The control is spring offset to minimum displacement and it can be piloted to either maximum or minimum displacement by introducing a pilot pressure into the Y or X ports respectively. Maximum and minimum displacements are adjustable from zero to 100%.



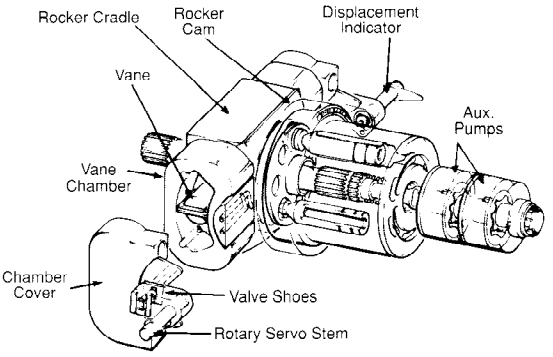
Pump, Series 6, 7 & 8



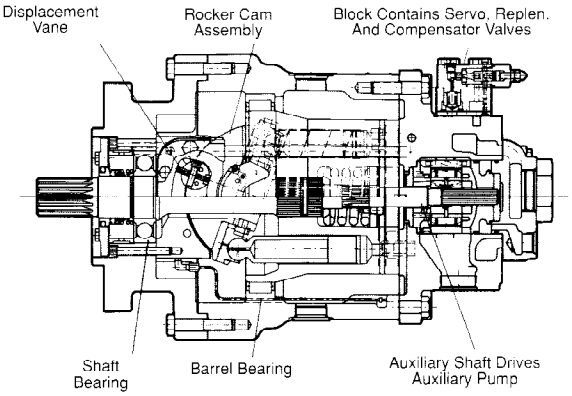
Pump, Series 6, 7 & 8



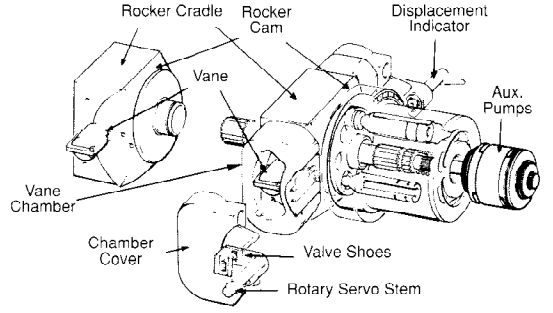
Pump, Series 11 & 14



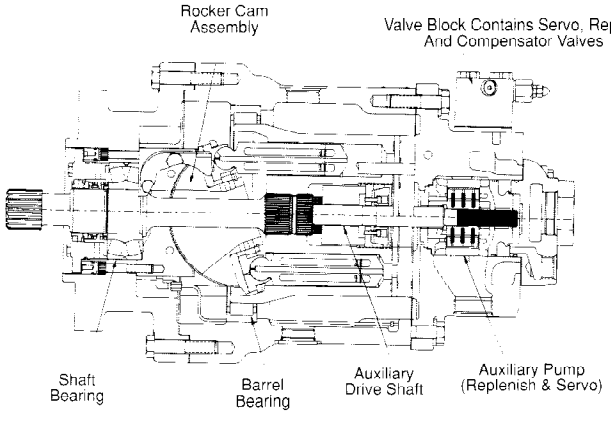
Pump, Series 11 & 14



Pump, Series 24

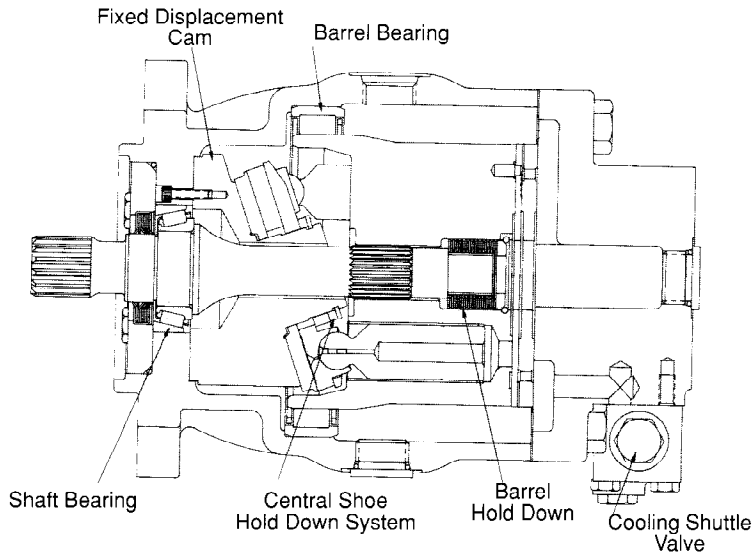


Pump, Series 24, 30 (Series 24 shown)

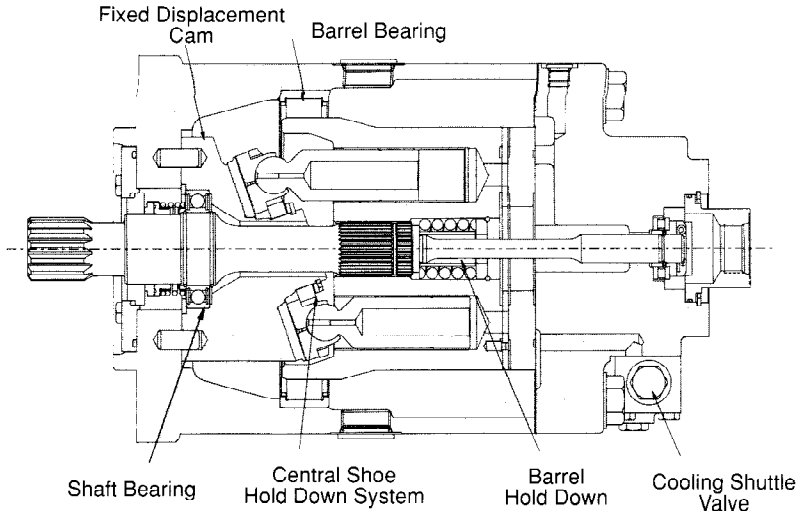


Pump, Series 30

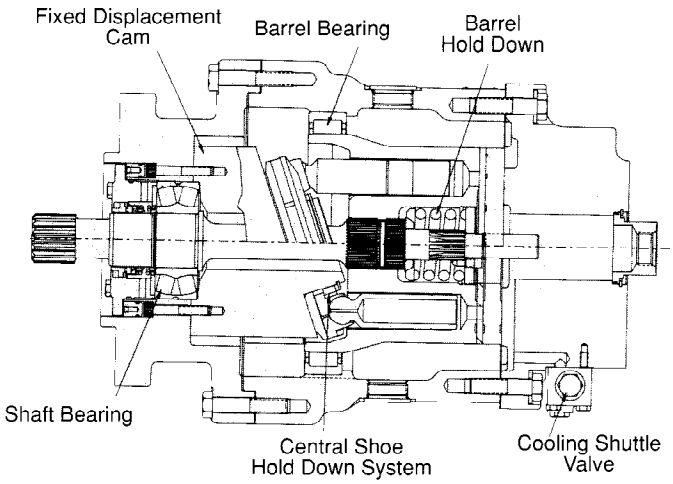
FIG. 1



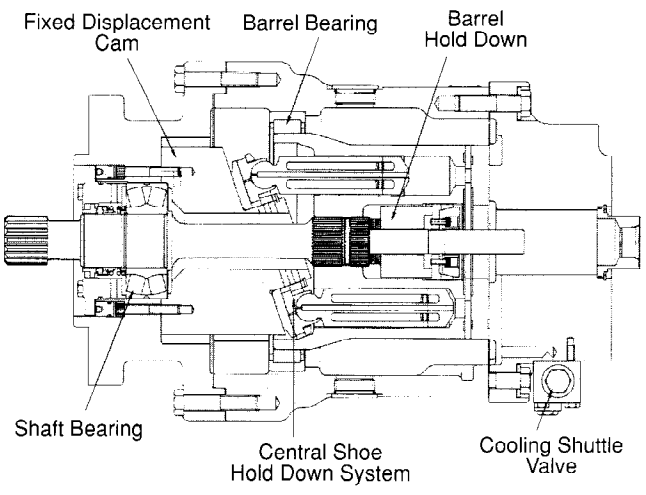
Motor, Series 6, 7 & 8



Motor, Series 11 & 14



Motor, Series 24



Motor, Series 30

Code 2H — Cylinder Control

This control is basically the same as the code 2 except the 2H is a 3-position control and is spring bias to the '0' or neutral position, whereas the code 2 above is off-set to the maximum displacement for motor applications and off-set to minimum displacement for pump applications. The control may be operated hydraulically on both sides of center with normal servo pressure. It may also be operated manually by rotating the input shaft. It also has maximum volume stops as standard.

CAUTION: Do not exceed 100 in. lbs. (11.3 Nm) torque against the stops.

Code 4 — Spring Centered Rotary Servo

The spring centered rotary servo centering torque may be manually over-ridden with approximately 20 in. lb. (2.26Nm) torque. The spring centered position is factory set at neutral. It may be readjusted externally to approximately 5% displacement. Pressure compensator override is independent of these displacement limits.

Onstroke Response Times:

P6 — .9 seconds
P7 — .9 seconds
P11 — 1.5 seconds
P14 — 1.5 seconds
P24 — 1.8 seconds
P30 — 1.8 seconds
with standard .062 orifice (1.57mm)

CAUTION: Do not exceed 100 in. lbs. (11.3 Nm) torque against the stops.

Code 5 — Electrohydraulic Stroker

This electrohydraulic control actuates the rotary input shaft by means of a hydraulic piston. In the zero current condition the jet pipe is centered over the two receiver orifices and generates equal pressure in each receiver. The jet pipe is held in this position by the feedback spring from the piston and the null adjust spring which counter each other and result in a net force of zero on the jet pipe. Assume the current is increased in a polarity that causes the jet pipe to move to the right. This will cause the pressure to increase on the right receiver and fall in the left receiver. Since these pressures are communicated to opposite ends of the piston it will move and in turn move the rotary servo shaft. The feedback spring is also connected to the arm which continues to move until the force balance recenters the jet pipe. Thus, a new steady state condition is achieved. The control shaft can be manually operated without servo pressure applied to the jet pipe. Spring centering is also available to center the pump when servo pressure is removed from the servo control. See page 22 and 23 for additional information.

Code 6 — Hydraulic Stroker

This control actuates the rotary input shaft by means of a hydraulic piston, which is pressurized by an external pressure source. The piston is trapped between two caged springs, which are set to provide zero displacement. When the external pressure is introduced into one of the two control ports, the piston exerts a force on one of the springs. When this force exceeds the precompression force of the spring, the piston begins to move, rotating the rotary servo shaft in proportion to pressure.

Removing or reducing the input pressure allows the spring to move the servo shaft back toward the zero displacement position. Pressurizing the opposite control port causes the pump to increase displacement on the opposite side of center. See page 24 for additional information.

Code 7 — Servovalve and Feedback Control

This control uses a high response servovalve to direct flow to or from the pump vane chambers. This provides very rapid, very precise changes in the pump displacement. A rocker cam position feedback device, either a potentiometer or RVDT, measures the cam angle, and the position loop is closed electrically.

The pump compensator override remains fully functional with this control, and its speed and ability to accurately control and limit pressure is unchanged. See page 25 for additional information.

Code 8A* — Proportional Hydraulic Stroker

For both pump and motor controls. It consists of one spring centered spool in the control cover that is operated by modulation ports P1 or P2. The control may also be manually operated whenever the external control pressure is removed and ports P1 and P2 are connected to each other or to tank. The control, consisting of the stroking piston and the centering spring, positions the rotary servo proportion to pilot or control pressure, which controls the rocker cam position. With no external control pressure and the centering spring properly adjusted, the stroking piston will position the rotary servo exactly at the zero stroke position. There is no free play in the control.

When the control pressure is removed from the control port, the rotary servo angle returns to the zero position on the pump control and to the full stroke position on the motor controls. Applying control pressure in the opposite control port results in motion of the rotary servo in proportion to control pressure, but in the opposite direction.

Manual operation requires an external torque of 10 in lbs. (1.3 Nm) to overcome spring preload and 40-50 in lbs. (4.5-5.7 Nm) at full stroke for the pump and motor controls respectively. The 8A2 Hydraulic Stroker maximum volume stops are standard. The Brake and Bypass valve is not available at the present time for this control. For those applications requiring a Brake and Bypass valve they are still available with the 6B2 and 6C2 Controls.

Code 9A* –Electrohydraulic Stroker

The 9A* is basically an 8A* package with the addition of two electric proportional pressure control valves mounted in a manifold block. It is a low-cost electrohydraulic control with comparable performance to the 5A* in most applications. It may be ordered with S-4 seals for fire resistant fluids.

A new Jupiter Driver card, called the Jupiter 900 Driver Card, has been developed to accompany the 9A2 since there are now two coils to control, instead of just one as with the 5A2. The card is a 24VDC card which eliminates the need for the Jupiter Power Supply Accessory card. All you need is a Eurocard holder and a 24VDC, 1A regulated power supply to operate open-loop. Secondly, you can still obtain that superior Jupiter closed-loop performance with this card since it is completely compatible with the existing Jupiter Options card.

Consult Denison Hydraulics Inc. factory on all water-glycol applications before applying this control.

Primary Control Options

Code A — Adjustable Displacement Stops

This option provides external screw stops for the rotary servo command, one for either side of center. Each is adjustable from full to zero displacement.

*Code B — Automatic Brake Control

This control signals a spring set brake to actuate and bypasses pump ports A & B when both the rotary servo command and the rocker cam's displacement are simultaneously neutral. It does not actuate during normal reversals of a drive nor during dynamic braking when the pressure compensator override holds the pump displacement off neutral.

It is useful for traction drives or winches that have a spring-set brake. It permits smooth operation with them at very low displacements as is required to slowly move or accurately position an hydraulically driven machine.

The automatic brake control dead band at neutral can be internally readjusted from the standard ±5% setting made at the factory.

*Code C — Adjustable Displacement Stops with Automatic Brake Control

This option combines the functions of codes A and B control options above.

Code D — 10 GPM Servovalve with Feedback Potentiometer.

Code E — 10 GPM Servovalve with Feedback RVDT.

Code F — 10 GPM Servovalve with Feedback Potentiometer and Manual Override.

Code G — 10 GPM Servovalve with Feedback RVDT and Manual Override.

Secondary Controls and Accessories

These control features are not located on the command side of the pump as the primary controls are. They are used in addition to primary controls and primary control options.

Code 4 —Torque Limiter Override

This control hydraulically limits the maximum shaft torque imposed by the pump load at all speeds. At constant speed it serves as a power limiter.

This operation is in addition to the pressure compensator override and rotary servo functions described above. It limits pressure in proportion to displacement so that the product of pressure and displacement, P x D, (which represents torque) does not exceed the adjusted value over the full range from minimum to maximum displacement. If, for instance, the operator commands the pump to full displacement, the pump will faithfully respond while pressure remains low but will go to a reduced displacement if the pressure imposed by the load rises. Pressure may continue to rise as pump displacement decreases following the P x D curve until pressure reaches the maximum value permitted by the pressure compensator override adjustment.

** Not available on open loop pumps*

There are two separate adjustments, one for each side of center operation of the pump. These are on the cover plate, feedback side. It purposely does not limit on motoring loads as occur during dynamic braking. These are torque limited by the pressure compensator override.
When system pressure falls below the P x D value, the displacement returns to that commanded by the operator. Return response is purposely restricted by standard orifices to a typical minimum of 1.0 seconds from zero to full. Minimum torque setting is limited to one fourth max. rated torque.

Control Location, Pumps and Motors

The location of the displacement indicator and the location of the rotary servo control plate and the options are specified in the model number.

A-side Assembly

Units whose model numbers have the letter "A" in the appropriate location have the input displacement command on the same side as port A; that is, the left side facing the shaft with the compensator block on top. Their displacements indicators are on the right side with port B.

B-side Assembly

Units with the letter "B" in the appropriate location in the model number have the input displacement command on the right side with port B and the displacement indicator on the left side with port A.

Motor Displacement Control Options

The motor is a package unit containing the circuit elements shown in the hydraulic schematic, Fig. 2, 3, and 4 (pgs. 30, 31, and 32). These include the shuttle valve and the low pressure replenishment relief valve. Motors are either fixed or variable displacement.

Control

Code 2AO — Cylinder Control with Adjustable Stops

The displacement of the package motor is spring offset toward full displacement, the cam below center. Pilot pressure applied to signal port Y on the "A" side assists the spring force. Pressure at port X over-rides the spring, changing the motor displacement toward minimum displacement. Reverse the ports for a "B" side application. The pilot source can be taken from a tee at pump port H through a small 2-position 4-way valve. An external screw gives adjustment of maximum displacement between 100% and 50%. Another external screw gives adjustment of the minimum displacement between 30% and 75%. Response between 100% and 30% is purposely restricted by orifices to a typical minimum of 0.6 seconds. The rotary servo over-ride and the displacement indicator described above are included.

> **NOTE:** Servo pressure must be furnished from Port H of pump to Port H of motor.

2A5 — Cylinder Control with Reverse Compensator is used on the M6H thru the M14H, variable motors only. Its function is to stroke the motor to full displacement,(low speed, high torque, at pressures above a preset pressure and will remain in the high torque) condition until the load decreases and the motor displacement returns to high speed. The reverse compensator is only used in high inertia and slow

responding load. Consult with Denison Hydraulics Inc. before applying this control.

Code 5AO — Electrohydraulic Stroker

This control functions the same as the Code 5 Electrohydraulic Stroker for pumps, except that it is offset to maximum displacement and reduces the motor displacement in response to increasing current. A minimum displacement stop is included to prevent the displacement from going too low, to the point of destructive speeds.

See pages 22 & 23 for detailed performance characteristics.

Code 6AO — Hydraulic Stroker

This control actuates the rotary input shaft by means of a hydraulic piston, which is pressurized by an external pressure source. A spring holds the piston in the full displacement position. When the external control pressure is introduced into the control port, the piston begins to move toward the minimum displacement stop, after it overcomes the spring precompression, in proportion to control pressure. The minimum stop prevents the motor displacement from reaching very low displacements where destructive speeds occur.

See page 24 for detailed performance characteristics.

7*2 Hi-IQ Control

The High IQ Control uses a high response servovalve to direct flow to and from the Goldcup pump or motor vane chambers. This provides very rapid, very precise changes in displacement. A rocker cam position feedback device, a feedback potentiometer or RVDT measures the cam angle and the position loop is closed electronically.

The Goldcup compensator override is fully functional with the High IQ control and its speed and ability to accurately control and limit pressure is unchanged.

A manual override feature using any of the standard Goldcup rotary servo based controls is an available option. This allows the pump or motor displacement to be manually controlled in the event of shutdown or malfunction in the electronics.

See page 25 for detailed performance characteristics.

Code 8A* — Proportional Hydraulic Stroker

For both pump and motor controls. It consists of one spring centered spool in the control cover that is operated by modulation ports P1 or P2. The control may also be manually operated whenever the external control pressure is removed and ports P1 and P2 are connected to each other or to tank. The control, consisting of the stroking piston and the centering spring, positions the rotary servo proportion to pilot or control pressure, which controls the rocker cam position. With no external control pressure and the centering spring properly adjusted, the stroking piston will position the rotary servo exactly at the zero strike position. There is no free play in the control.

When the control pressure is removed from the control port, the rotary servo angle returns to the zero position on the pump control and to the full stroke position on the motor controls. Applying control pressure in the opposite control port results in motion of the rotary servo in proportion to control pressure, but in the opposite direction.

Manual operation requires an external torque of 10 in lbs. (1.3 Nm) to overcome spring preload and 40-50 in lbs. (4.5-5.7 Nm) at full strike for the pump and motor controls respectively. The 8A2 Hydraulic Stroker maximum volume stops are standard. The Brake and Bypass valve is not available at the present time for this control. For those applications requiring a Brake and Bypass valve they are still available with the 6B2 and 6C2 Controls.

Code 9A* –Electrohydraulic Stroker

The 9A* is basically an 8A* package with the addition of two electric proportional pressure control valves mounted in a manifold block. It is a low-cost electrohydraulic control with comparable performance to the 5A* in most applications. It may be ordered with S-4 seals for fire resistant fluids.

A new Jupiter Driver card, called the Jupiter 900 Driver Card, has been developed to accompany the 9A2 since there are now two coils to control, instead of just one as with the 5A2. The card is a 24VDC card which eliminates the need for the Jupiter Power Supply Accessory card. All you need is a Eurocard holder and a 24VDC, 1A regulated power supply to operate open-loop. Secondly, you can still obtain that superior Jupiter closed-loop performance with this card since it is completely compatible with the existing Jupiter Options card. Consult Denison Hydraulics Inc. factory on all water-glycol applications before applying this control.

Auxiliary Rear Drive

Additional auxiliary flow is available with the rear drive pump option. The rear drive may also be utilized for servo and other purposes.

P * P	SAE Mount A	B	C	Max Aux Drive Torque
6, 7 & 8	x	x	-	1751 in lbs. (198. Nm)
11 & 14	x	x	-	2400 in lbs. (271. Nm)
24 & 30	-	x	x	2700 in lbs. (305. Nm)

See model number key sheet for additional detail—

Shaft Options

Code 2—Keyed			
TYPE	6, 7 & 8 SAE-C	11 & 14 SAE-E	24 & 30 SAE-F
Diameter	1.25" (31.7mm)	1.75" (44.5mm)	2.00 (50.8 mm)
Key size	.31 (7.9 mm)	.44 (11.2 mm)	.50 (12.7 mm)

Code 3—Splined, per SAE-J498 B-1969 Flat Root Side Fit Class 1			
TYPE	6, 7 & 8 SAE-C	11 & 14 SAE-E	24 & 30 SAE-F
Teeth and Diametral Pitch	14T-12/24 DP	13T-8/16 DP	15T-8/16 DP

P6, 7 & 8, P6(C), P7(A) & P8(A) Mod 1800 RPM		
Shaft Load lbs.	Case Pressure	B10-Life Hours*
170 (77.1 kg)	75 (5.2 bar)	10,000
P6, 7 & 8, P6 (C), P7(A) & P8(A) 1500 RPM		
170 (77.1 kg)	75 (5.2 bar)	10,600
P11 & 14 'A' MOD 1800 RPM		
300 (136.1 kg)	75 (5.2 bar)	10,000
P11 & 14 'A' MOD 1500 RPM		
300 (136.1 kg)	75 (5.2 bar)	10,600
P24 'D' MOD 1800 RPM		
Shaft Load lbs.	Case Pressure	B10-Life Hours*
0	35 (2.4 bar)	95,600 to 197,100
0	125 (8.6 bar)	41,200 to 71,300
1000 (454 kg)	35 (2.4 bar)	35,000 to 58,800
1000 (454 kg)	125 (8.6 bar)	35,000 to 58,800
P30 1800 RPM		
0	35 (2.4 bar)	24,100 to 40,600
0	125 (8.6 bar)	13,800 to 21,400
1000 (454 kg)	35 (2.4 bar)	12,300 to 18,800
1000 (454 kg)	125 (8.6 bar)	7,800 to 11,200

*Note: Variation in life is due to variations in tolerance within the pump.

NOTE: The splined shaft is designed for use with coaxial drives, without side or thrust loads. Contact Applications Engineering dept. for B-10 with other operating conditions and with other care pressure values.

Mounting

The pump or motor is designed to operate in any position. The mounting hub and mounting flange are in full conformance with SAE standard. The shaft must be in alignment with the shaft of the driven load and should be checked with a dial indicator. The mounting pad or adaptor into which the fluid pump pilots must be concentric with the pump shaft within 0.006 TIR (.152 mm) to prevent bearing failure. This concentricity is particularly important if the shaft is rigidly connected to the driven load without a flexible coupling.

Inlet Characteristics—Auxiliary Pump Port C

Speed		Displacement	Inlet Pressure Minimum			
			Gage			
Series-	RPM	in^3/rev(cm^3/rev)	in Hg	mm Hg	psia	bar(abs)
6,7,8,11,14	1200	1.07 (17.6)	(-) 10	(-) 245	9.5	0.66
6,7,8,11,14	1800	1.07 (17.6)	(-) 10	(-) 245	9.5	0.66
6,7,8,11,14	2400	1.07 (17.6)	(-) 8	(-) 203	10.5	0.73
24, 30	1200	4.84 (79.4)	(-) 10	(-) 245	9.5	0.66
24, 30	1800	4.84 (79.4)	(-) 8	(-) 203	10.5	0.73

NOTE: Maximum Pressure on Inlet Port C is 200 psi (13.8 bar)

Inlet Pressures, Ports A & B

In a closed hydraulic loop the pump inlet or the fluid motor inlet (during dynamic braking) are supercharged by the integral replenishment system. Consult Denison Hydraulics Inc. in cases where fluid viscosity or dynamics or line size is apt to cause inlet pressure at either A or B to be less than the 150 psi maintained by the integral replenishment system. For operation in open loop or combination open-closed loops consult Denison Hydraulics Inc.

Drain Port

Pressure, maximum: 75 psi (5.2 bar) continuous, 125 psi (8.6 bar) intermittent — pump or motor. Not to exceed 25 psi(1.7 bar) above inlet in open loop pump.

Drain the package pump from the uppermost drain port. If drain port is above the fluid level in the tank install a 5 psi (0.3 bar) relief of suitable size in the drain line to tank.

For pump speeds intermittently below 1000 rpm, install a back pressure relief 40 psi (2.8 bar) of suitable size in the drain line from the uppermost of port to tank. Motor case drain must be connected to pump case.

Motor. Drain the motor from the uppermost of its drain ports into the lowermost of pump port or tank. Make provision that the motor drain port pressure will not exceed the maximum limits specified above.

Fluid Connections. Comply with SAE-J518B. Ports A and B have pads for SAE 4-bolt, 1.5" (38 mm) 6000 psi (414 bar) split flange connectors except 24 & 30 series which have 2" (51 mm). The open loop 6 - 14 series has a SAE-2" (51 mm) 3000 psi (200 bar) pad on the "A" port.

All other ports are tapped for SAE straight threads or NPTF. Refer to installation drawing for sizes and identification.

Auxiliary Pump, integral to the package pump's envelope is of the gerotor type (P24P & 30 have vane integral pump). It provides servo and replenishment pressure. A floating sideplate extends its life and efficiency. Servo pressure is factory set to automatically modulate from approximately 335 psi (23 bar) at minimum system pressure to 535 psi (37 bar) at 5000 psi (345 bar). Replenishment pressure is factory set for 200 psi (13.8 bar), approximately. In the open loop pumps the auxiliary pump supplies control pressure at 160-525 psi. (11-36 bar).

NOTE: Servo and replenishing integral pump. Customer must supply external line from integral pump back into main pump (see installation drawing.)

Hydraulic Fluids

Recommended Fluids
The fluid recommended for use in these pumps and motors has a petroleum base and contains agents which provide oxidation inhibition and anti-rust, anti-foam and de-aerating properties as described in Denison Hydraulics Inc. standard HF-1. These preferred fluids do not contain anti-wear additives. Fluids containing anti-wear additives that meet Denison Hydraulics Inc. standard HF-O are acceptable.

Viscosity
Max. at cold start—7500 SUS (1600 Cst)
(at low pressure, low flow and, if possible, low speed)
Max. at full power—750 SUS (160 Cst)
Optimum for max. life—140 SUS (30 Cst)
Minimum at full power—60 SUS (10 Cst)

Viscosity Index
90 V.I. minimum. Higher values extend the range of operating temperature but may reduce the service life of the fluid.

Temperature
Determined by the viscosity characteristics of the fluid used. Because high temperatures degrade seals, reduce the service life of the fluid and create hazards, fluid temperatures should not exceed 180° F at the case drain.

Acceptable Fluids
Fluids meeting Denison Hydraulics Inc. standard HF-2 do contain anti-wear additives but are otherwise similar to the HF-1 fluids above. Consult Denison Hydraulics Inc. for warranty and limitations for service with this class of fluids.

Alternate Fluids
Some applications require fire-resistant fluids. They will give good service if the system is originally designed for their use. Permissible fire resistant fluids include:

Type	Denison
Standard	
Water-in-oil invert emulsions	HF-3
Water glycol solutions	HF-4
Phosphate Esters	HF-5

Consult Denison Hydraulics Inc. for design requirements and warranty limitations for service with this class of fluids.

See Denison Hydraulics Inc. bulletin 2002 for more details.

Return Line Filter
Relatively inexpensive low pressure filters are recommended for installation in the return lines and drain lines from circuits using these pumps or motors. Consider the possibility of decompression surges and intensified flow in cylinder circuits as well as the factors above in selecting return line filters.

Auxiliary Flow Filter
It is recommended the auxiliary pump fluid be fully filtered to aid in maintaining acceptable cleanliness levels. For good filtration and reasonable maintenance intervals the filter capacity must be at least twice the auxiliary pump flow. To use this feature, install the isolation plug and connect the filter between ports G&H(P6,P7&P8), J&K(11,14) or G&H (P24, P30). See detailed schematics and drawings for location of these ports.

NOTE: Auxiliary and return filters MUST use bypass valves.

Fluid Cleanliness
Fluid must be cleaned before and continuously during operation by filters that maintain a cleanliness level of NAS 1638 Class 8. This approximately corresponds to ISO 17/14. Better cleanliness levels will significantly extend the life of the components. As contaminant entrainment and contaminant generation may vary with each application, each must be analyzed to determine proper filtration to maintain the required cleanliness level.

COMPARISON OF SOLID CONTAMINATION CLASSIFICATION SYSTEMS

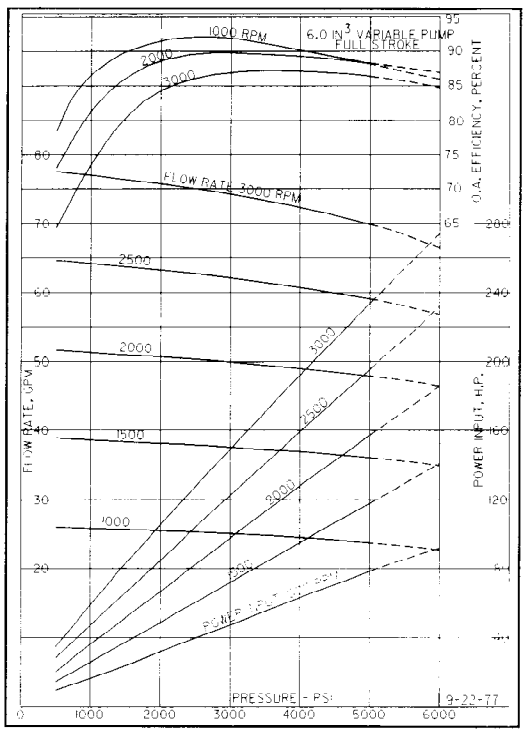
NATIONAL AEROSPACE STANDARD (NAS) 1638

		CLASS													
		00	0	1	2	3	4	5	6	7	8	9	10	11	12
PARTICLE SIZE RANGE	5-15 µm	125	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	128,000	256,000	512,000	1,024,000
	15-25 µm	22	44	89	178	356	712	1,425	2,850	5,700	11,400	22,800	45,600	91,200	182,400
	25-50 µm	4	8	16	32	63	126	253	506	1,012	2,025	4,050	8,100	16,200	32,400
	50-100 µm	1	2	3	6	11	22	45	90	180	360	720	1,440	2,880	5,760
	>100µm	0	0	1	1	2	4	8	16	32	64	128	256	512	1,024
MAXIMUM PARTICLES	>5 µm	152	304	609	1,217	2,432	4,864	9,731	19,462	38,924	77,849	155,698	311,396	622,792	1,245,584
	>15 µm	27	54	109	217	432	864	1,731	3,462	6,924	13,849	27,698	55,396	110,792	221,584

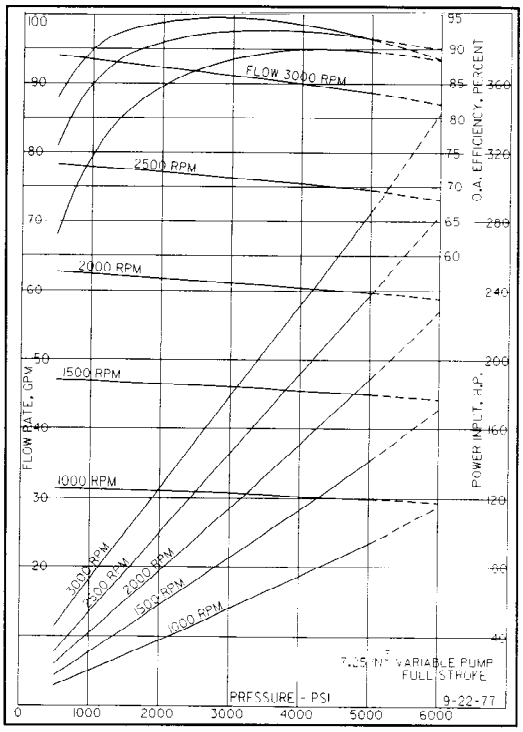
ISO:DIS 4406; SAE J1165

		ISO SOLID CONTAMINANT CODE														
		8/5	9/6	10/7	11/8	12/9	13/10	14/11	15/12	16/13	17/14	18/15	19/16	20/17	21/18	22/19
MAXIMUM PARTICLES	>5 µm	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	130,000	250,000	500,000	1,000,000	2,000,000	4,000,000
	>15 µm	32	64	130	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	130,000	250,000	500,000

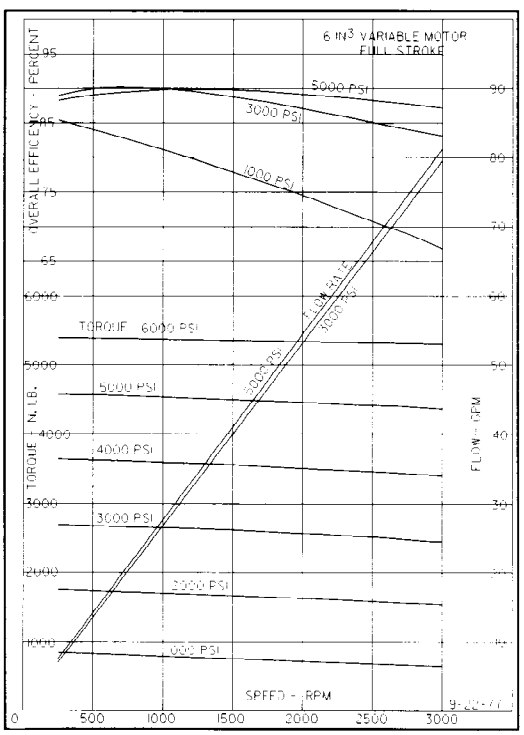
NOTES: ALL MEASUREMENTS ARE FOR A 100 ML SAMPLE SIZE.



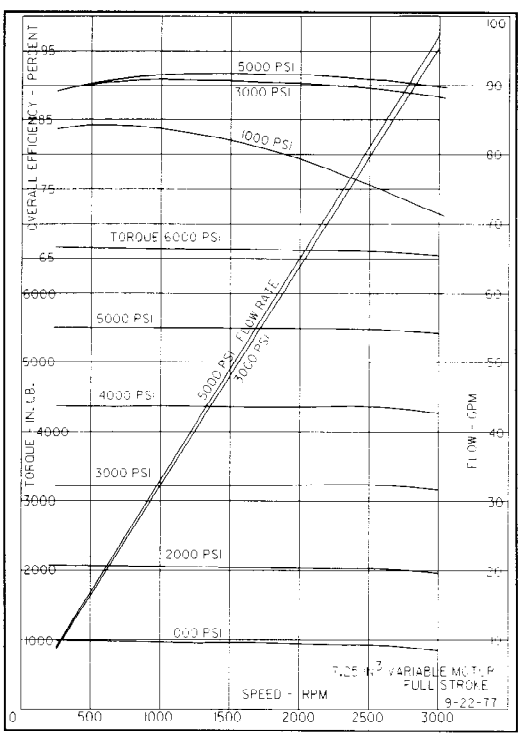
Performance curves Series 6
Pump at full displacement



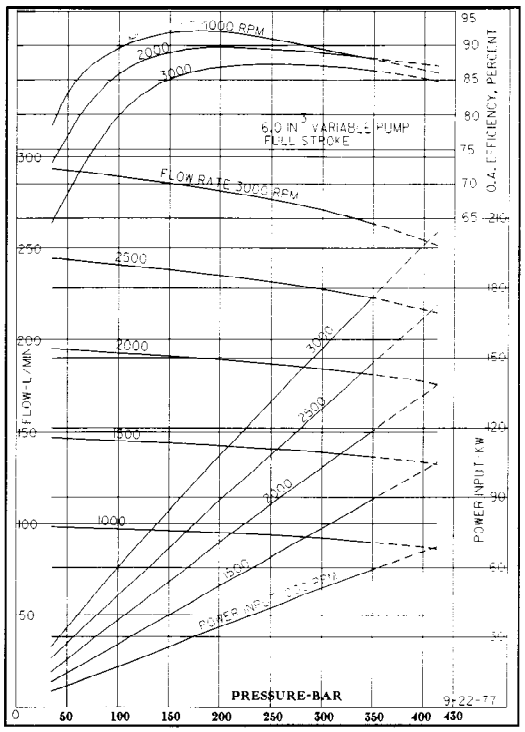
Performance curves Series 7
Pump at full displacement



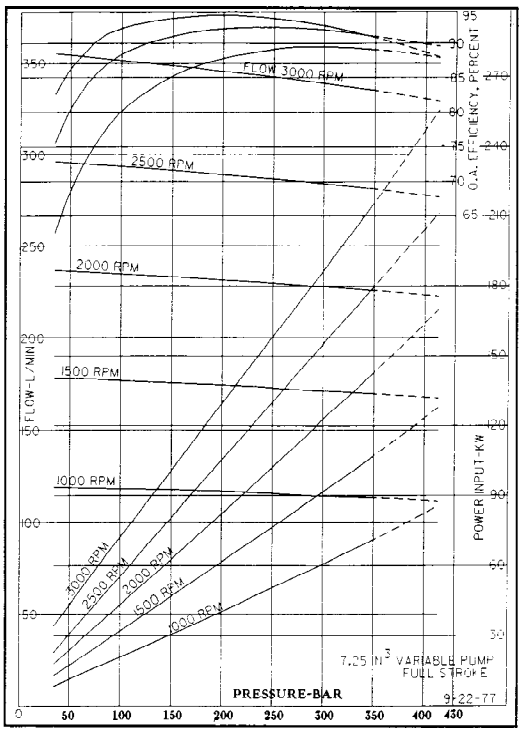
Performance curves Series 6
Motor at full displacement



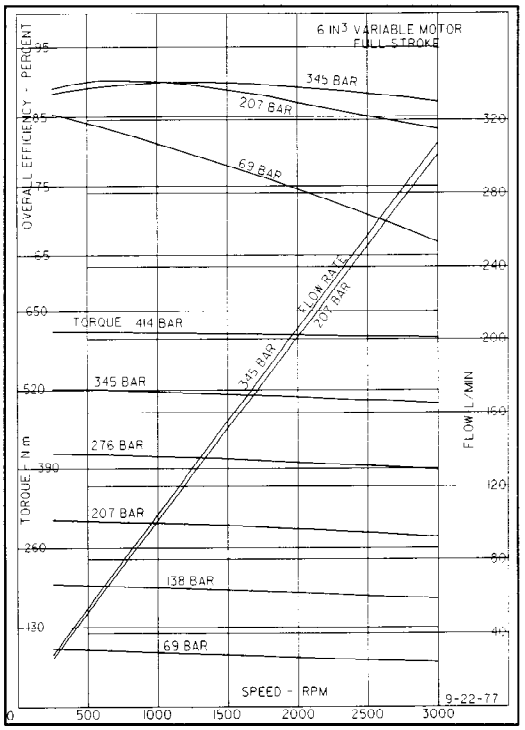
Performance curves Series 7
Motor at full displacement



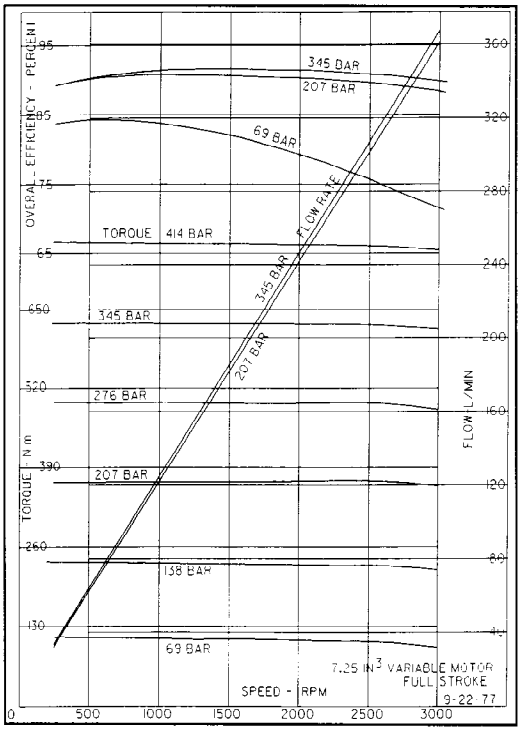
Performance curves Series 6
Pump at full displacement



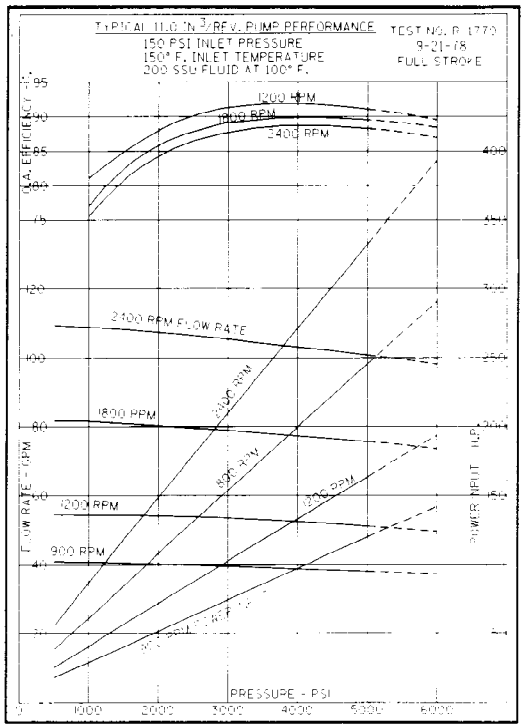
Performance curves Series 7
Pump at full displacement



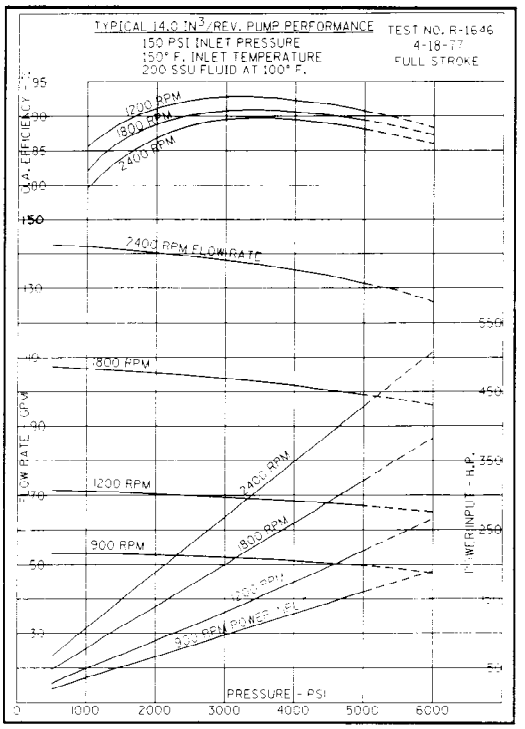
Performance curves Series 6
Motor at full displacement



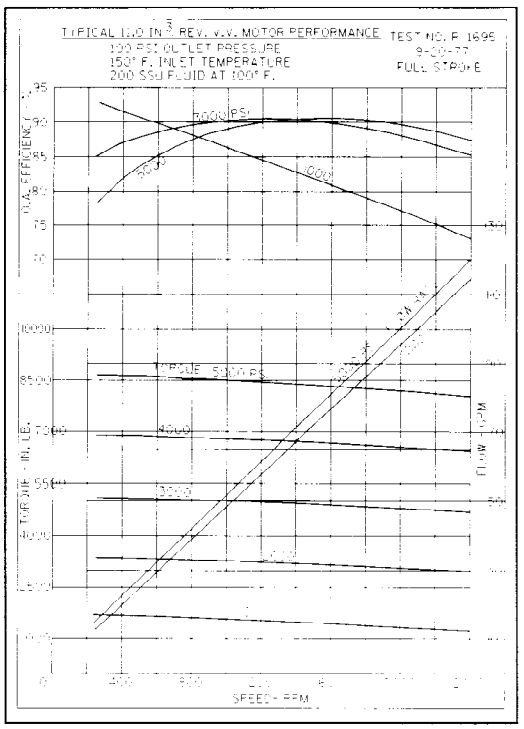
Performance curves Series 7
Motor at full displacement



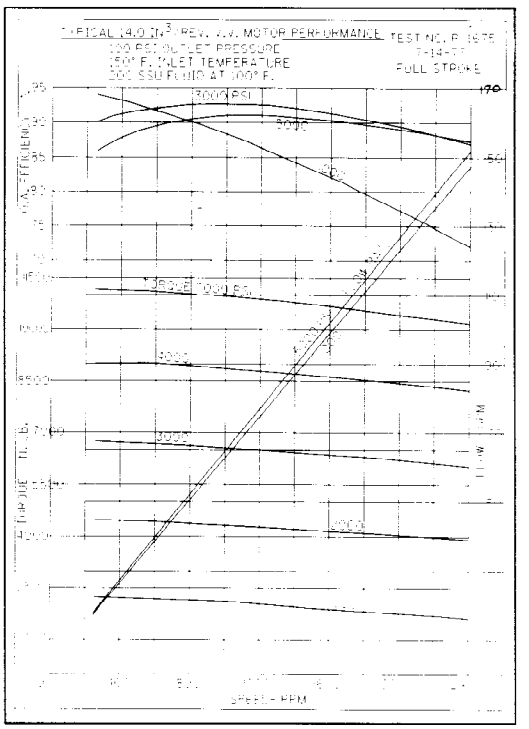
Performance curves Series 11
Pump at full displacement



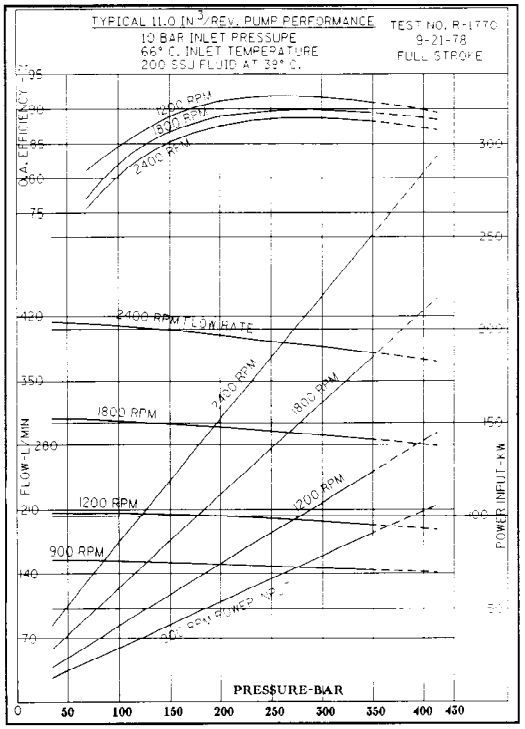
Performance curves Series 14
Pump at full displacement



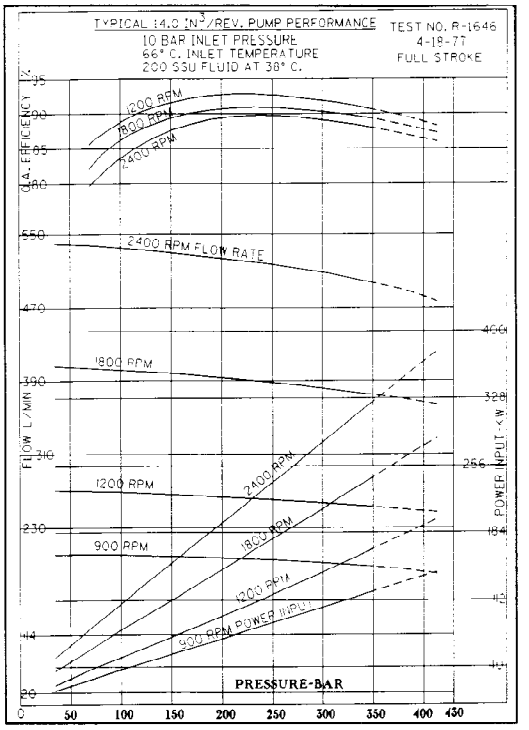
Performance curves Series 11
Motor at full displacement



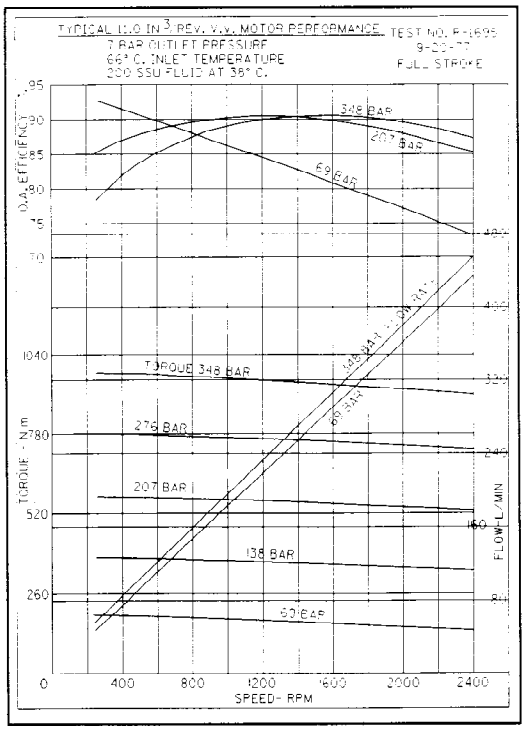
Performance curves Series 14
Motor at full displacement



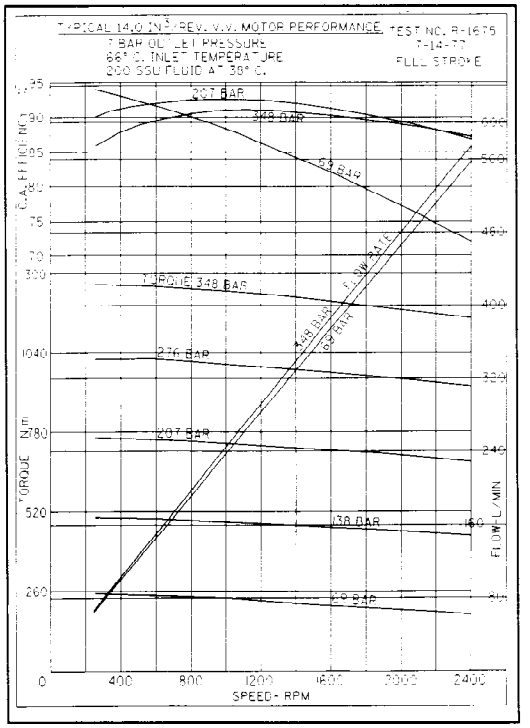
Performance curves Series 11
Pump at full displacement



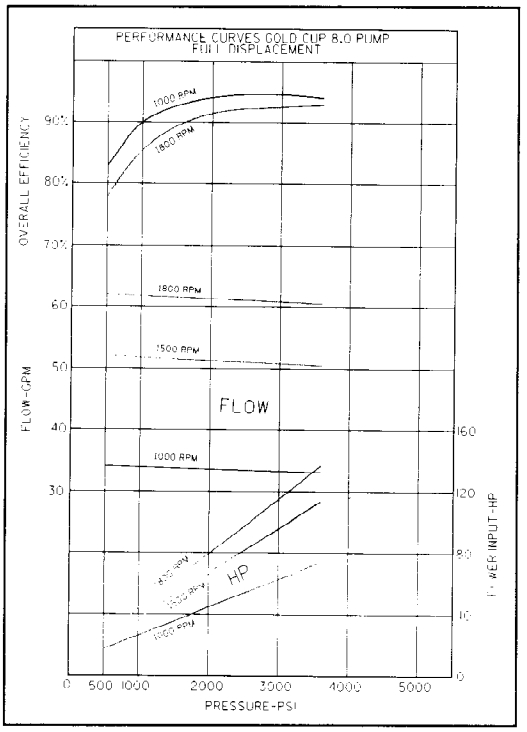
Performance curves Series 14
Pump at full displacement



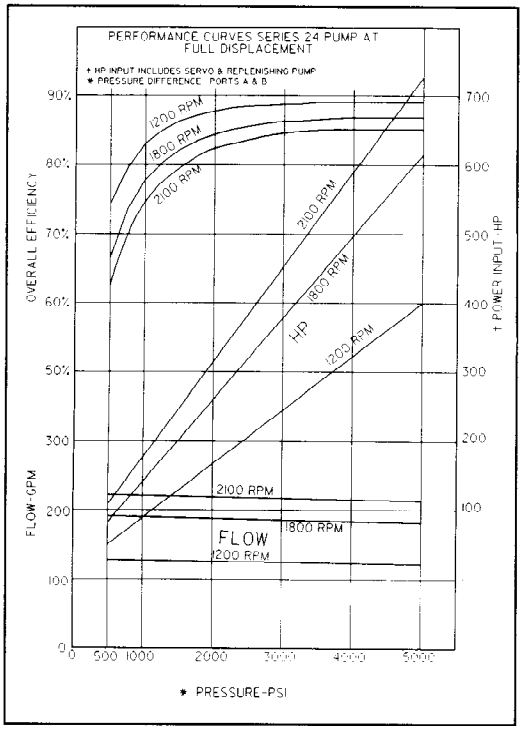
Performance curves Series 11
Motor at full displacement



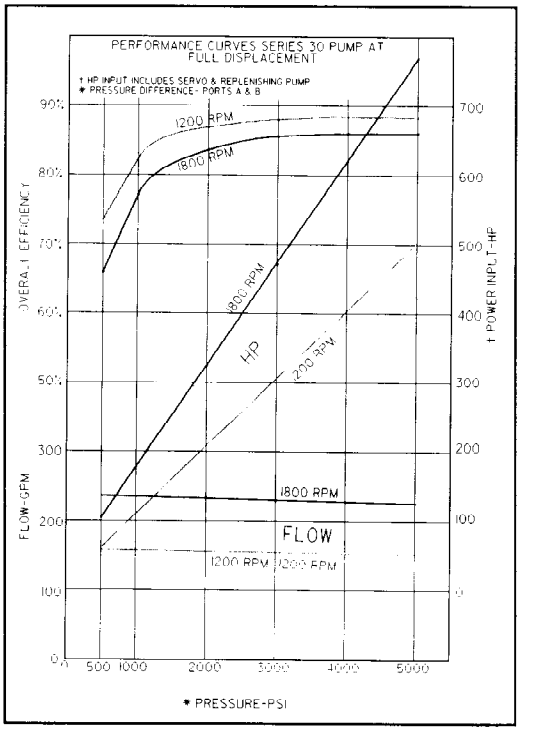
Performance curves Series 14
Motor at full displacement



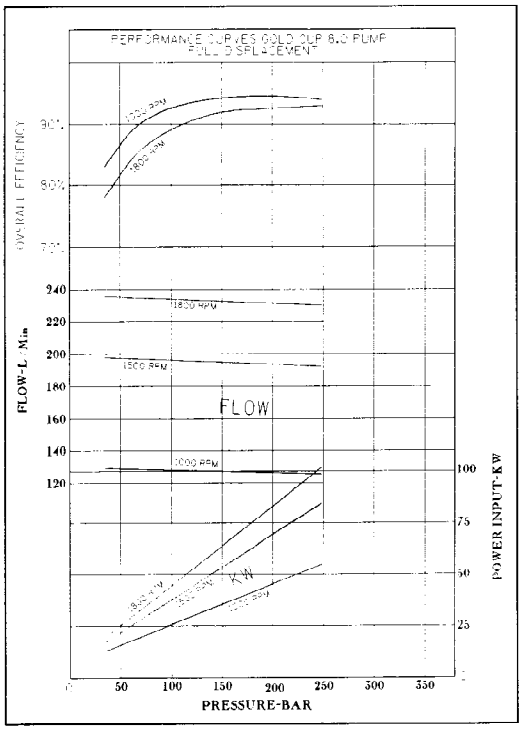
Performance curves Series 8
Pump at full displacement (Std.)



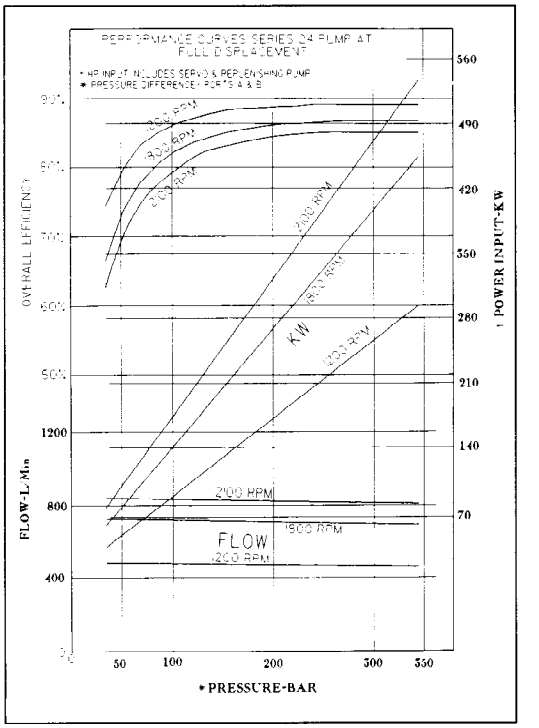
Performance curves Series 24
Pump at full displacement



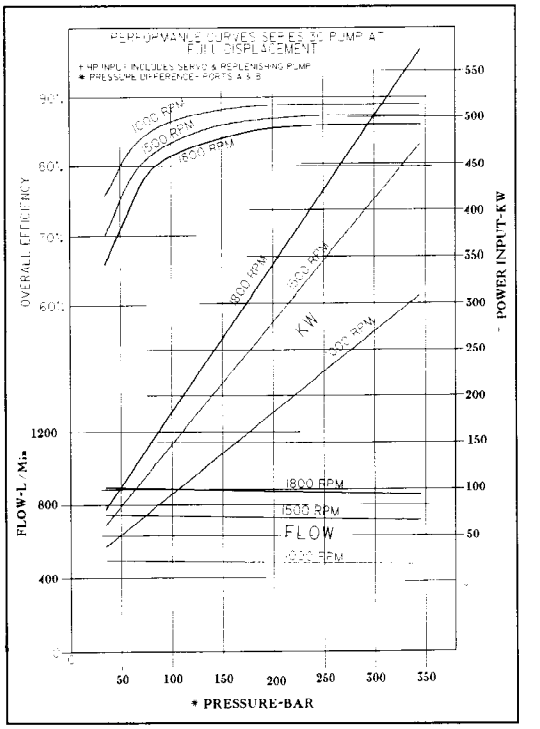
Performance curves Series 30
Pump at full displacement



Performance curves Series 8
Pump at full displacement (Std.)

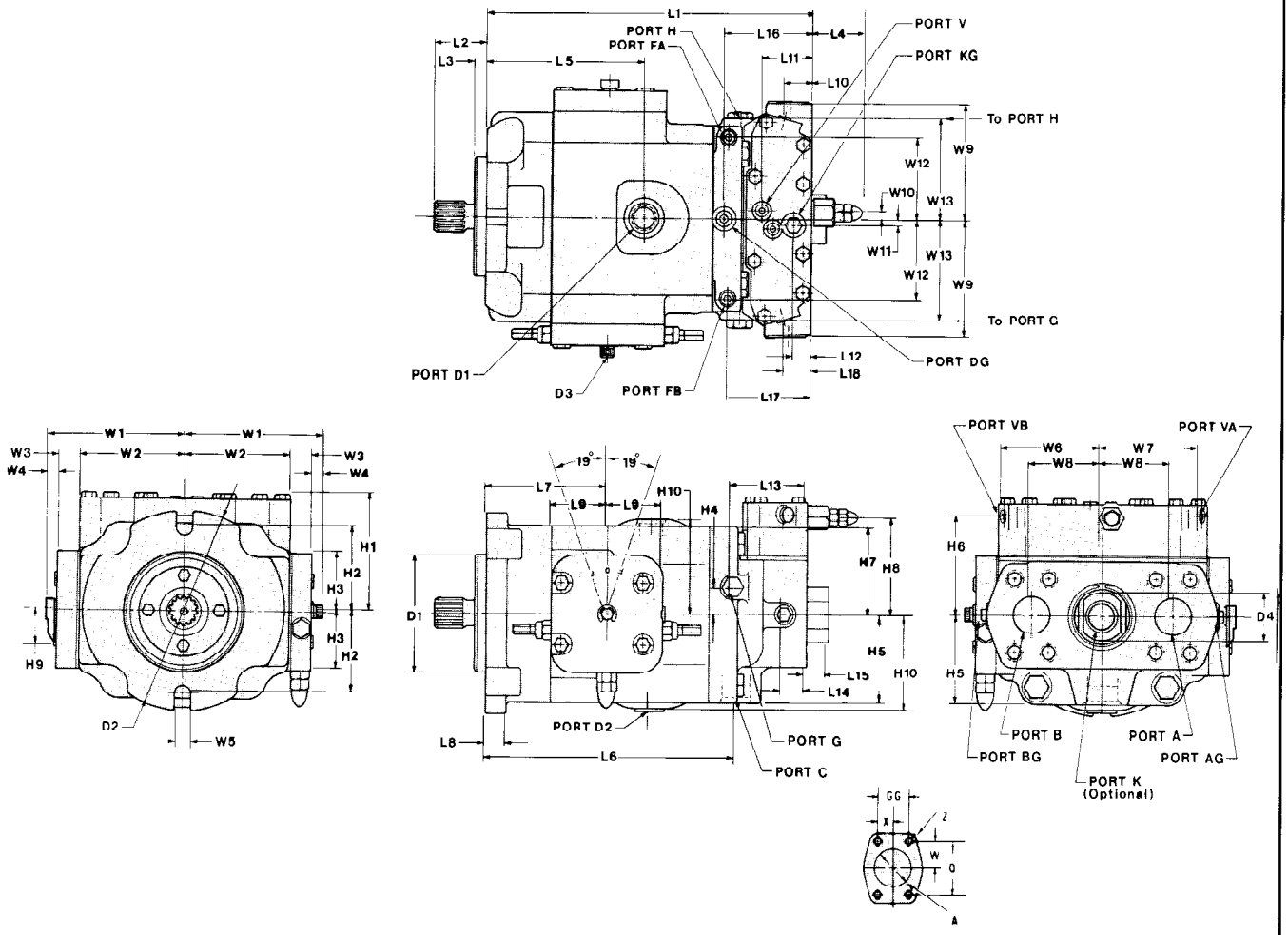


Performance curves Series 24
Pump at full displacement



Performance curves Series 30
Pump at full displacement

Series 6, 7, & 8 w/Manual Rotary Servo (4**)



CONTROL MOUNTING POSITION Input Control "A" Port Side Output Control "B" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
*R	CCW	Outlet	Inlet
*L	CW	Outlet	Inlet
L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION Input Control "B" Port Side Output Control "A" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
*R	CW	Outlet	Inlet
R	CCW	Inlet	Outlet
L	CW	Inlet	Outlet
*L	CCW	Outlet	Inlet

Not available for open loop pumps.

Series 6, 7 & 8 w/Manual Rotary Servo (4**)

Port Dimensions—Closed Loop - A&B

Dim.	A	W	Q	X	GG	Z
inch	1.50	1.56	3.12	72	1.44	5/8 11 UNCx 1.31 Deep
mm	38.1	39.6	79.3	18.3	36.6	5/8 11 UNCx 33.3 Deep

Open Loop—Port "A" Only

inch	2.00	1.53	3.06	84	1.68	1/2-13 UNC x 1.06 Deep
mm	50.8	38.8	77.7	21.3	42.7	1/2-13 UNC x 26.9 Deep

See page 35 for installation drawing numbers.

Ports

Code	Connection function	Port size or thread
A,B	System power	4-bolt pad for SAE-1.5" 6000 PSI
A	Open loop inlet	4-bolt pad for SAE-2" 3000 PSI
AG,BG	System pressure gage, each side	SAE-6 staight thread
C	Auxiliary pump inlet	SAE-16 straight thread
DG	Case pressure gage	SAE-6 straight thread
D1,D2	Case drains	SAE-12 straight thread
G	Auxiliary pump outlet	SAE-8 straight thread
H	Auxiliary flow return, servo pressure	SAE-8 straight thread
K	Replenishment inlet	SAE-16 straight thread
FA	Control area, A-side	1/4" NPTF Dryseal
FB	Control area, B-side	1/4" NPTF Dryseal
V	Compensator vent, both side	SAE-4 straight thread
VA	Compensator vent, A side	SAE-4 straight thread
VB	Compensator vent, B side	SAE-4 straight thread

Length Dimensions—L

	L1	L2	L3	L4	L5	L6	L7	L8	L9
inch	13.66	2.23	0.49	1.77	7.00	10.63	5.15	1.00	2.37
mm	347.0	56.6	12.4	45.0	177.8	270.0	130.8	25.4	60.2

	L10	L11	L12	L13	L14	L15	L16	L17	L18
inch	0.94	2.09	0.75	3.08	0.94	1.31	3.6	3.50	1.15
mm	23.9	53.1	19.0	78.2	23.9	33.3	91.4	88.9	29.2

Height Dimensions—H

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
inch	5.32	3.56	2.50	1.16	3.70	4.51	3.73	4.38	1.50	3.87
mm	135.1	90.4	63.5	29.5	94.0	114.6	94.7	111.3	38.1	98.3

Width Dimensions—W

	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13
inch	5.84	4.50	0.88	0.46	0.69	4.23	4.17	3.00	4.91	0.31	0.25	3.41	4.22
mm	148.3	114.3	22.4	11.7	17.5	107.4	105.9	76.2	124.7	7.9	6.3	86.8	107.2

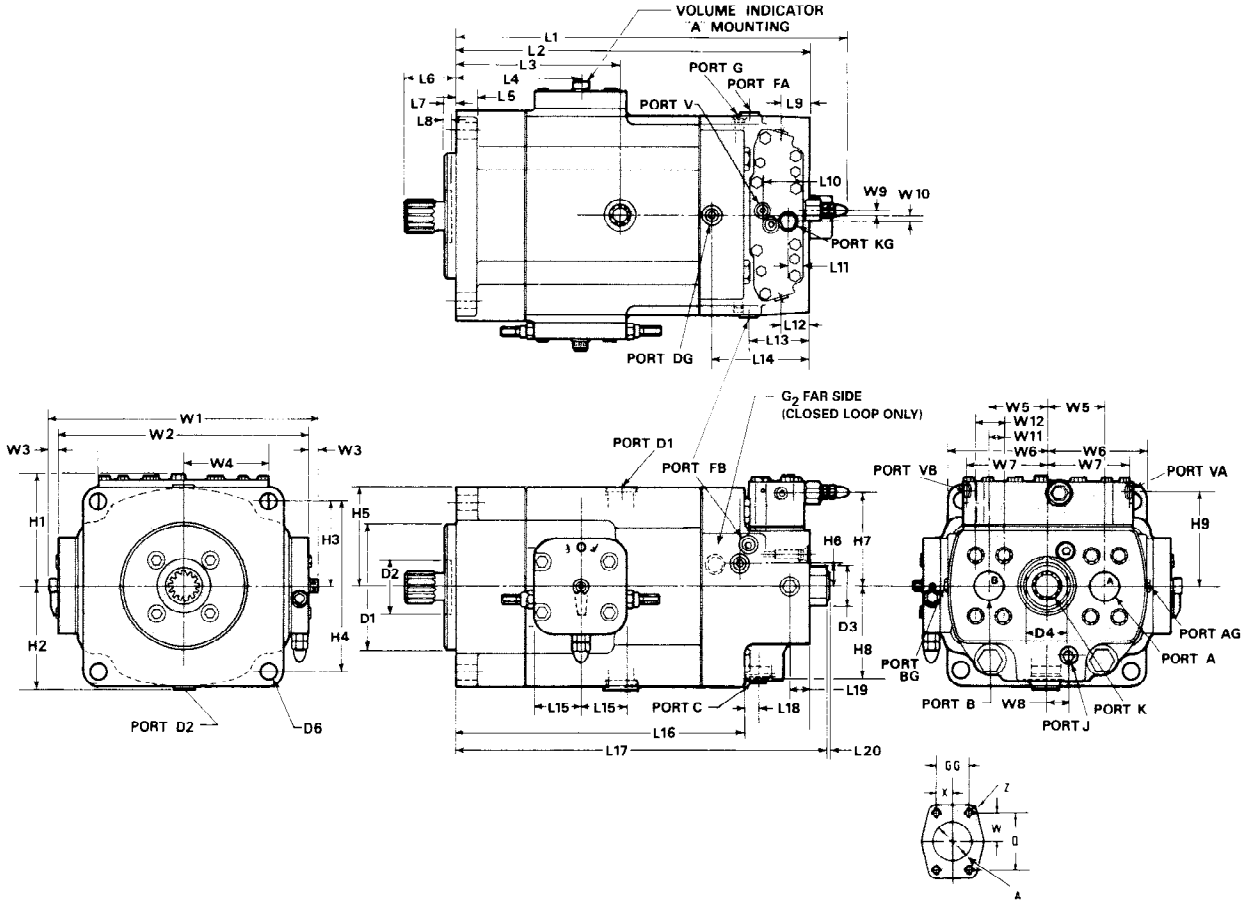
Diameter Dimensions—D

	D1	D2	D3	D4
inch	5.000/4.998	8.50	.513/.508 Knurl	1.75 D with 1.37 between flats
mm	127.00/126.95	215.9	13.03/12.90	44.4 D with 24.8 between flats

Shaft Dimensions

					Key Shaft Dimensions				Spline Shaft Dimensions				
Shaft Code	Shaft Type	Shaft Standard	Dimension	Length L-2	Diameter	Square Key Section	Dimension Overkey	Key Length	Major Diameter	Number Teeth	Pitch	Pressure Angle	Spline Length
3	Splined	SAE-C	inch	2.23	x	x	x	x	1.2293 1.2294	14	12/24	30°	1.19
			mm	56.6					31.22 31.10				30.2
2	Keyed	SAE-C	inch	2.23	1.250 1.248	3.12 3.10	1.386	1.25 1.22	x	x	x	x	x
			mm	56.6	31.75 31.70	7.92 7.87	35.2	31.75 31.0					

Series 11 & 14 w/Manual Rotary Servo (4**)



CONTROL MOUNTING POSITION Input Control "A" Port Side Output Control "B" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
*R	CCW	Outlet	Inlet
*L	CW	Outlet	Inlet
L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION Input Control "B" Port Side Output Control "A" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
*R	CW	Outlet	Inlet
R	CCW	Inlet	Outlet
L	CW	Inlet	Outlet
*L	CCW	Outlet	Inlet

Not available for open loop pumps.

Series 11 & 14 w/Manual Rotary Servo (4**)

Port Dimensions—Closed Loop - A&B

Dim.	A	W	Q	X	GG	Z
inch	1.50	1.56	3.12	.72	1.44	5/8 11 UNCx 1.31 Deep
mm	38.1	39.6	79.3	18.3	36.6	5/8 11 UNCx 33.3 Deep

Open Loop—Port "A" Only

inch	2.50	1.75	3.50	1.00	2.00	1/2-13 UNC x 1.19 Deep
mm	63.5	44.5	88.9	25.4	50.8	1/2-13 UNC x 30.2 Deep

See page 35 for installation drawing numbers.

Ports

Code	Connection function	Port size or thread
A,B	System power	4-bolt pad for SAE-1-1/2" 6000 PSI
A	Open loop pump	4-bolt pad for SAE-2-1/2" 2500 PSI
AG,BG	System pressure gage, each side	SAE-6 straight thread (AG, closed loop only)
C	Auxiliary pump inlet	SAE-20 straight thread
DG	Case pressure gage	SAE-6 straight thread
D1,D2	Case drains	SAE-16 straight thread
G	Servo press. gage conn each side	SAE-4 straight thread
G2	Alternate (closed loop only)	SAE-8 straight thread
K	Auxiliary Replen. pressure port & pump filter return port	SAE-16 straight thread
J	Aux. pump outlet (closed loop only)	SAE-10 straight thread
KG	Replenishing pressure gage	SAE-6 straight thread
FA	Control pressure gage, A side	SAE-6 straight thread
FB	Control pressure gage, B side	SAE-6 straight thread
V	Compensator vent, both sides	SAE-4 straight thread
VA	Compensator vent, A side	SAE-4 straight thread
VB	Compensator vent, B side	SAE-4 straight thread

Length Dimensions—L

	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
inch	19.8	18.31	8.48	6.38	1.12	2.97 2.90	0.36	2.61 2.54	1.25	2.09
mm	502.9	465.1	215.4	162.1	28.4	75.4 73.7	9.14	66.29 64.51	31.8	53.1

	L11	L12	L13	L14	L15	L16	L17	L18	L19	L20
inch	0.75	1.49	2.81	5.06	2.37	14.94	19.38	0.72	1.00	0.12
mm	19.1	37.1	71.4	128.5	60.2	379.5	492.3	18.3	25.4	3.0

Height Dimensions—H

	H1	H2	H3	H4	H5	H6	H7	H8	H9
inch	5.91	5.33	4.42	8.84	5.17	1.38	4.95	4.81	5.08
mm	150.1	135.4	112.3	224.5	131.3	35.1	125.7	122.2	129.0

Width Dimensions—W

	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
inch	13.80	12.88	0.46	4.42	3.00	5.00	4.23	1.25	0.31	0.25	0.72	1.44
mm	350.5	327.2	11.7	112.3	76.2	127.0	107.4	31.8	7.9	6.4	18.3	36.6

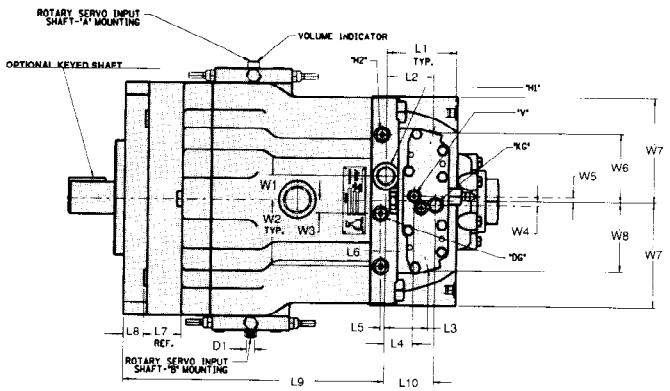
Diameter Dimensions—D

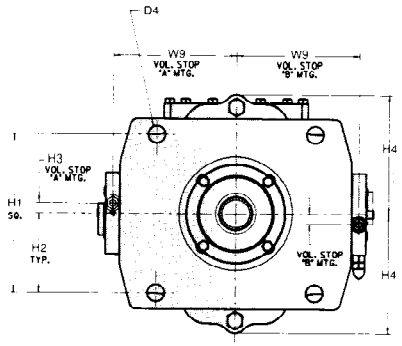
	D1	D2	D3	D4	D5	D6
inch	6.500 6.498	2.75	2.38	2.12	.513/.508 Knurl	.81
mm	165.10 165.05	69.9	60.5	53.8	13.03/12.90	20.6

Shaft Dimensions

					Key Shaft Dimensions				Spline Shaft Dimensions				
Shaft Code	Shaft Type	Shaft Standard	Dimension	Length L-2	Diameter	Square Key Section	Dimension Overkey	Key Length	Major Diameter	Number Teeth	Pitch	Pressure Angle	Spline Length
3	Splined	SAE-E	inch	2.97	x	x	x	x	1.7210 1.7160	13	8/16	30°	1.50
			mm	74.5					43.71 43.59				38.1
2	Keyed	SAE-E	inch	2.97	1.750 1.748	.437 .435	1.941	1.50	x	x	x	x	x
			mm	75.4	44.50 44.40	11.10 11.05	49.30	38.1					

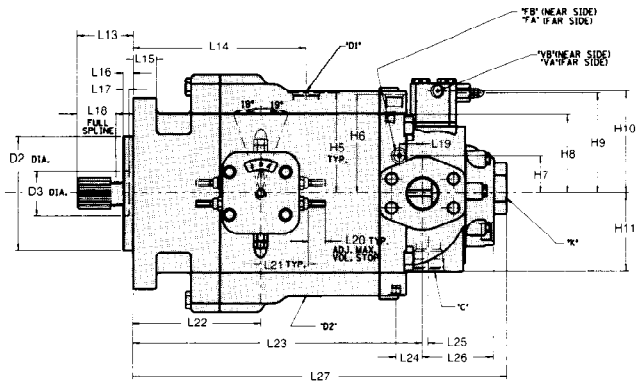
Series 24 & 30 w/Manual Rotary Servo (4**)

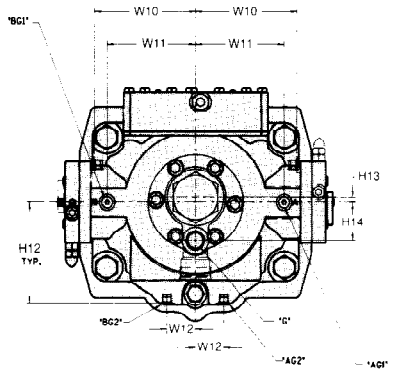


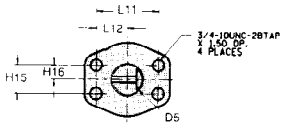


NOTES:
1. "B" CONTROL MOUNTING - AS SHOWN
"A" CONTROL MOUNTING - IN PHANTOM

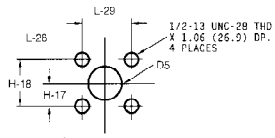
THIS VIEW SHOWN OUT OF POSITION







DETAIL "A"
TYP. 2-PLACES
SAE-6000 PSI 4-BOLT FLG. CONN.



DETAIL PORT "C"
SAE-3000 PSI 4 BOLT FLG. CONN.

CONTROL MOUNTING POSITION Input Control "A" Port Side Output Control "B" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
*R	CCW	Outlet	Inlet
L	CW	Outlet	Inlet
L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION Input Control "B" Port Side Output Control "A" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Outlet	Inlet
R	CCW	Inlet	Outlet
L	CW	Inlet	Outlet
L	CCW	Outlet	Inlet

NOTE: Open Loop not available in 24 Series, except with Full Boost in Open Loop applications.
'D' MOD is .030 inch (.762 mm) longer than 'C' MOD unit.

Series 24 & 30 w/Manual Rotary Servo (4**)

Ports Code	Connection function	Port size or thread
"AG1," "AG2" (A-side)	System gage	AG1 SAE-6 straight thread AG2 SAE-8 straight thread
"BG1," "BG2" (B-side)	System gage	BG1 SAE-6 straight thread BG2 SAE-8 straight thread
"C"	Aux. Pump supply inlet (Servi & Replen.)	4-Bolt Flg. Conn. (See detail)
"DG"	Case Gage	SAE-6 straight thread
"DG1," "DG2"	Case Drain	SAE-20 straight thread
"G"	Aux. Pump (Servo & Replen.) Outlet to ext. filter	SAE-12 straight thread
"H1"	Servo and Replenish Inlet from Servo Filter	SAE-12 straight thread
"H2"	Servo gage	SAE-6 straight thread
"K"	Optional-Replenishing Pump Supply Inlet	SAE-32 straight thread
"KG"	Replenishing gage	SAE-6 straight thread

Length Dimensions—L

	L1	L2	L3	L4	L5	L6	L7	L8	L9 (24)	L9 (30)	L10	L11	L12	L13	L14	L15
inch	4.26	2.88	2.67	1.76	0.26	0.31	2.61	1.25	16.33	17.33	3.07	3.82	1.91	3.47	10.92	1.44
mm	108.2	73.0	67.7	44.6	6.5	7.8	66.3	31.7	414.8	440.2	77.8	97	48.5	88.1	277.5	36.6

	L16	L17	L18	L19	L20	L21	L22	L23 (24)	L23 (30)	L24	L25	L26	L27 (24)	L27 (30)	L28	L29
inch	.61	0.36	1.75	1.42	1.06	2.94	8.14	18.08	19.08	1.62	0.38	4.38	23.27	24.27	.84	1.68
mm	15.5	9.1	44.4	36.2	26.9	74.7	206.7	459.3	484.7	41.3	9.5	111.1	591	616.4	21.3	42.7

Height Dimensions—H

	H1	H2	H3	H4	H5	H6	H7	H8
inch	9.75	4.87	0.63	7.31	6.18	4.85	2.31	4.85
mm	247.6	123.7	16	185	156.9	123.2	58.7	123

	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18
inch	6.18	6.31	4.78	6.18	0.31	2.35	1.75	0.88	1.53	3.06
mm	157.0	160.3	123.7	157.0	0.79	59.7	44.5	22.4	38.9	77.7

Width Dimensions—W

	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
inch	1.66	4.04	0.82	0.25	0.31	4.17	6.44	7.57	7.57	3.07	3.81	1.91
mm	42.2	102.6	20.8	6.35	7.87	105.9	163.5	192.28	192.3	78.0	96.77	48.51

Diameter Dimensions—D

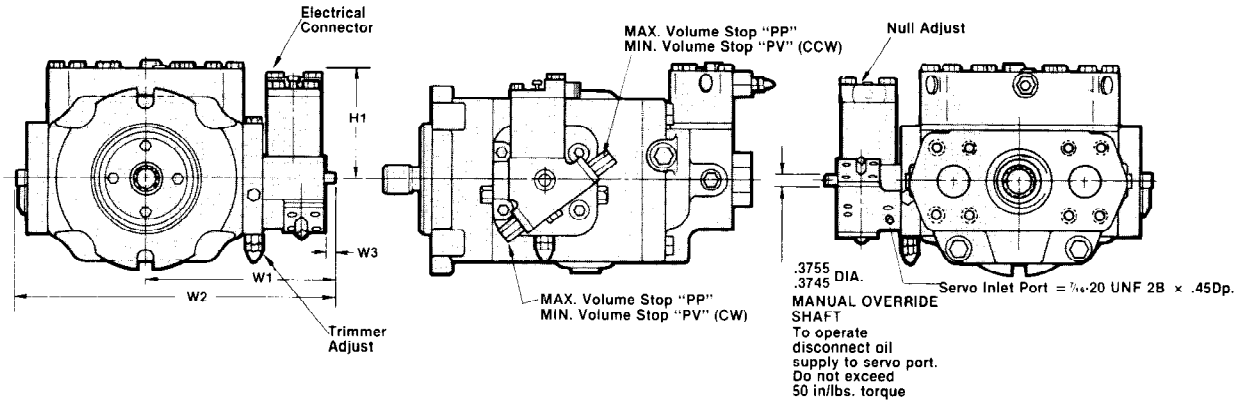
	D1	D2	D3	D4	D5
inch	0.513-0.508	7.000-6.998	2.75	1.06 THRU	2
mm	13.0-12.9	177.8-177.7	69.8	26.9	50.8

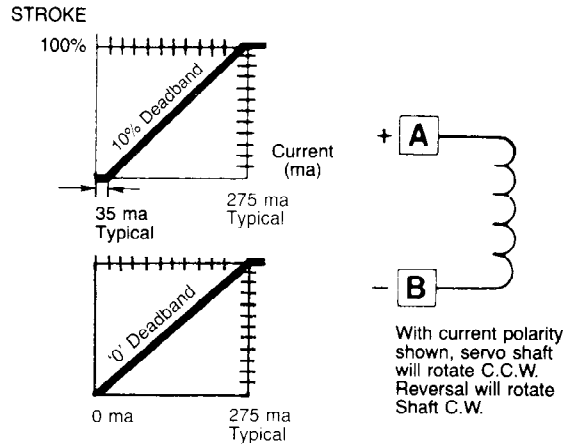
Shaft Dimensions

					Key Shaft Dimensions				Spline Shaft Dimensions				
Shaft Code	Shaft Type	Shaft Standard	Dimension	Length. L13	Diameter	Square Key Section	Dimension Overkey	Key Length	Major Diameter	Number Teeth	Pitch	Pressure Angle	Spline Length
3	Splined	SAE-F	inch	3.47					1.9710				1.75
					x	x	x	x	1.9660	15	8/16	30°	
			mm	88.1					50.1				44.4
									49.9				
2	Keyed	SAE-F	inch	3.47	1.999	.500	2.218	2.25					
					1.998	.498	2.212						
			mm	88.1	50.8	12.7	56.3	57.15	x	x	x	x	x
					50.7	12.65	56.2						

Electrohydraulic Control (5A*)

Available with Automatic Brake Control





Input command on port B side (A side Opposite)

CONTROL MOUNTING POSITION Input Control "A" Port Side Output Control "B" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
R	CCW	Outlet	Inlet
*L	CW	Outlet	Inlet
*L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION Input Control "B" Port Side Output Control "A" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Outlet	Inlet
*R	CCW	Inlet	Outlet
*L	CW	Inlet	Outlet
L	CCW	Outlet	Inlet

Dimensions Series		H1	W1	W2	W3
6, 7 & 8	inch	5.12	8.56	14.40	.56
	mm	130.1	216.4	365.7	14.2
11&14	inch	5.12	9.64	16.54	.56
	mm	130.1	277.7	420.1	14.2
24 & 30	inch	5.12	11.22	19.71	.56
	mm	130.1	285	500.6	14.2

Electrohydralic Control (5A*)

Hysteresis:	Typ. 5%, Max. 8%
Linearity:	Within 5%
Repeatability:	Within 2%
Temperature Null Shift:	Less than 2% per 100°F (56°C)
Neutral Deadband:	0% or 10% of full current
Pressure Input:	Externally supplied by customer to servo inlet port from any source with 400 PSI (28 bar) nominal pressure. Pressure range acceptable is 200 to 1000 PSI above pump case pressure. (14-70 bar)
Coil Resistance:	24 to 30 OHMS
Electrical Input:	275 ma. typical to stroke pump over full 19° cam angle, 400 ma. maximum. Current source should have at least 1 12 VDC capability. Absolute maximum current should be limited to 500 ma. to avoid damage to coil. Adjustable displacement stops are provided to mechanically limit the stroke to less than maximum.
Stroke rate:	0 - Full .5 Sec.(Standard servo) P6/P7 - 0.9 seconds max. P11/P14 - 1.5 seconds max. P24/P30 - 1.8 seconds max. Consult factory for faster response.
Fluid Type:	Any fluid compatible with the seats and pump may be used expcept water glycol, Phosphate Ester, and Invert emulsions including Skydrol. SeeDenison Hydraulics Inc. Bulletin 2002 for fluid recommendations.
Fluid Cleanliness:	This control is capable of passing particles up to 200 Micron in size. It contains a 75 Micron "last chance" filter screen built into the body. See page 11 for cleanliness specifications.
Jupiter Controls:	Driver card—S20-11712 Options card—S20-11716 Power supply—S20-11715 Euro card holder—701-00007-8
Comments:	The control may be manually overridden only if the external pressure source is disconnected or shut off. A torque of approximately 20 in. lb. (2.25 Nm) is required to rotate the shaft with external pressure disconnected. Do not exceed 50 in. lb. (11 Nm). Adjustable max vol. stops are included and may be adjusted from 0-19° degrees.

Note: If the driver uses Pulse Width Modulation (PWM) the frequency must be 2000 HZ or higher. 60 to 600 HZ will cause erratic operation.

Hydraulic Stroker Control (6**)

Available with Automatic Brake Control

Specifications

Linearity: Within 2%

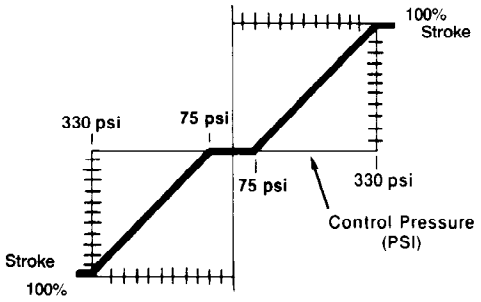
Pressure Input: Control pressure may be from any external source.

Comments: The control may be manually overriden if the external pressure source is disconnected. Do not exceed 100 in. lbs. torque on servo shaft in manualmode. Adjustable maximum volume stops areavailable upon request.

Fluid Type: Any fluid compatible with seals and pump may be used. See Denison Hydraulics Inc. Bulletin 2002 for fluid recommendations.

Fluid Cleanliness: See page 11.

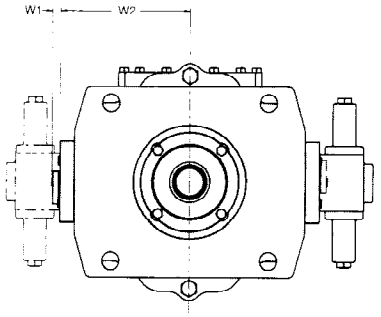
Stroke Vs. Control Pressure-Pump



(Other pressure ranges available)

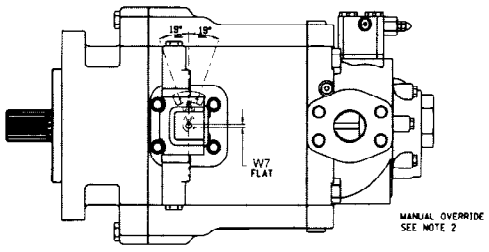
Dimensions

Series		W1	W2	W3	W4	W5	W6	H1
6, 7 & 8	inch	0.49	5.15	8.57	6.9	0.19	0.37	3.02
	mm	12.4	130.8	216.5	175.3	4.8	9.4	76.7
11 & 14	inch	0.49	8.01	9.56	7.78	0.19	0.37	3.02
	mm	12.4	162.3	242.8	197.6	4.8	9.4	76.7
24 & 30	inch	0.49	8.01	11.32	9.54	0.19	0.37	3.02
	mm	12.4	203.5	287.5	245.1	4.8	9.4	76.7

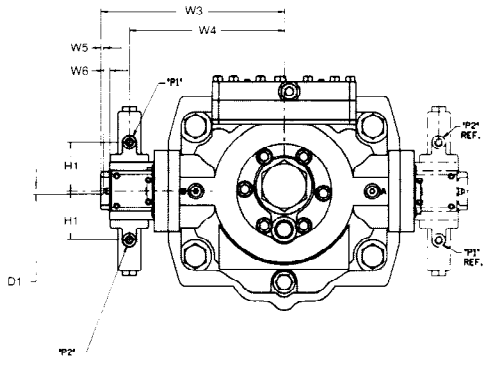


Dimensions and configurations shown in reduced installation drawings are for reference only.

CONTROL MOUNTING POSITION Input Control "A" Port Side Output Control "B" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
*R	CCW	Outlet	Inlet
*L	CW	Outlet	Inlet
L	CCW	Inlet	Outlet



CONTROL MOUNTING POSITION Input Control "B" Port Side Output Control "A" Port Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
*R	CW	Outlet	Inlet
R	CCW	Inlet	Outlet
L	CW	Inlet	Outlet
*L	CCW	Outlet	Inlet



Not available for open loop pumps

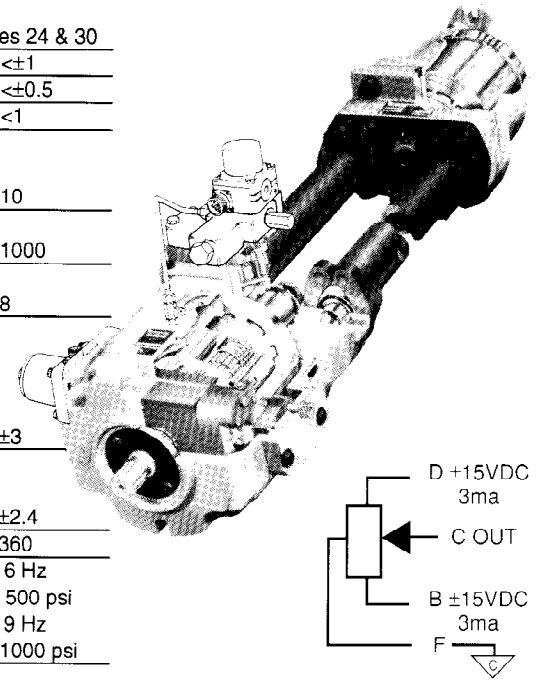
Notes:

1. "B" Control Mounting—As Shown
   "A" Control Mounting—In Phantom
2. To Operate Disconnect Oil Supply
   To Control Input Ports—Do Not Exceed 100 in. lbs. (11.3 Nm) Torque
3. P24P Shown for Reference

High IQ Gold Cup Control (7**)

Specifications Unit Displacement	Term	Series 6 or 7.25	Series 11 & 14	Series 24 & 30
Hysteresis	%	<±1	<±1	<±1
Linearity	%	<±0.5	<±0.5	<±0.5
Threshold	%	<1	<1	<1
Servovalve flow at 1000 psi Pressure Drop	GPM	10	10	10
Servovalve coil resistance	ohm	1000	1000	1000
Servovalve current	Milliamps	8	8	8
Feedback potentiometer voltage at 19° cam angle w/ 15VDC excitation	VDC	±3	±3	±3
Feedback RVDT voltage at 19° cam angle	VDC	±2.4	±2.4	±2.4
*Step response	millisec	180	300	360
*Small signal (10%) frequency response at 90° phase shift	Hz Servo Pressure	10 Hz @ 400 psi 17 Hz @ 1000 psi	8.2 Hz @ 440 psi 13 Hz @ 1000 psi	6 Hz @ 500 psi 9 Hz @ 1000 psi

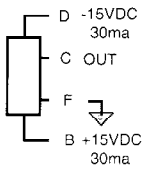
*Response is improved if servo pressure is set to 1000 PSI (70 bar) and if a 20-40 in³ (330-660 cm³) accumulator is connected to the servo pressure port.



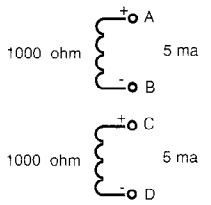
FEEDBACK POTENTIOMETER
3.1 VDC OUT AT 19° CAM ANGLE

Dimensions

Series		L1	H1	W1	W2	W3
6, 7 & 8	inch	5.15	9.54	7.69	13.76	6.07
	mm	130.8	242.3	193.3	349.5	154.2
11 & 14	inch	6.38	10.41	8.75	15.61	8.75
	mm	162.1	264.4	222.3	396.5	222.3
24 & 30	inch	8.14	11.25	11.02	19.53	8.51
	mm	206.7	285.8	279.9	496.0	216.2



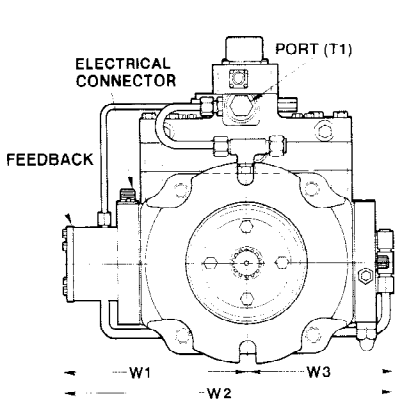
RVDT DIAGRAM
2.4VDC OUT AT 19° CAM ANGLE

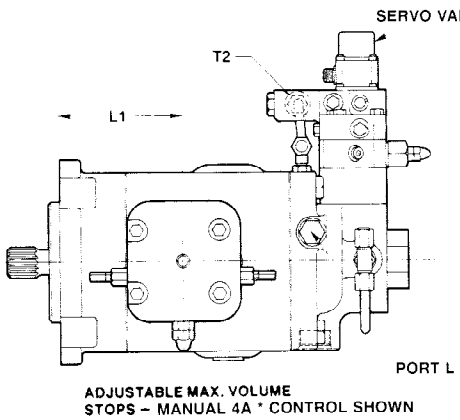


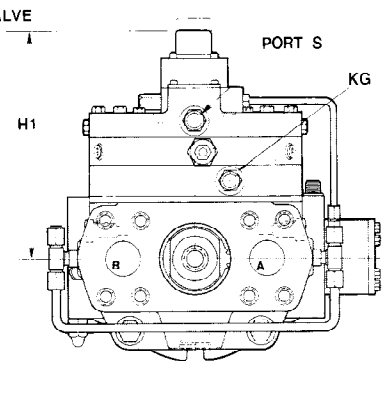
SERVOVALVE COIL
10 ma DIFFERENTIAL CURRENT
FOR MAX. STOKE RATE

Control Ports Added

Code	Connection Function	Series 6, 7 & 8 Port Size	11 & 14	24 & 30
S	Servo Inlet	SAE-8, STR, THD	SAE-8, STR, RHD	SAE-8, STR, THD
T1	Servovalve Drain	SAE-8, STR, THD	SAE-8, STR, THD	SAE-8, STR, THD
T2	Alternate Servo Drain	SAE-6, STR, THD	SAE-6, STR, THD	SAE-6, STR, THD

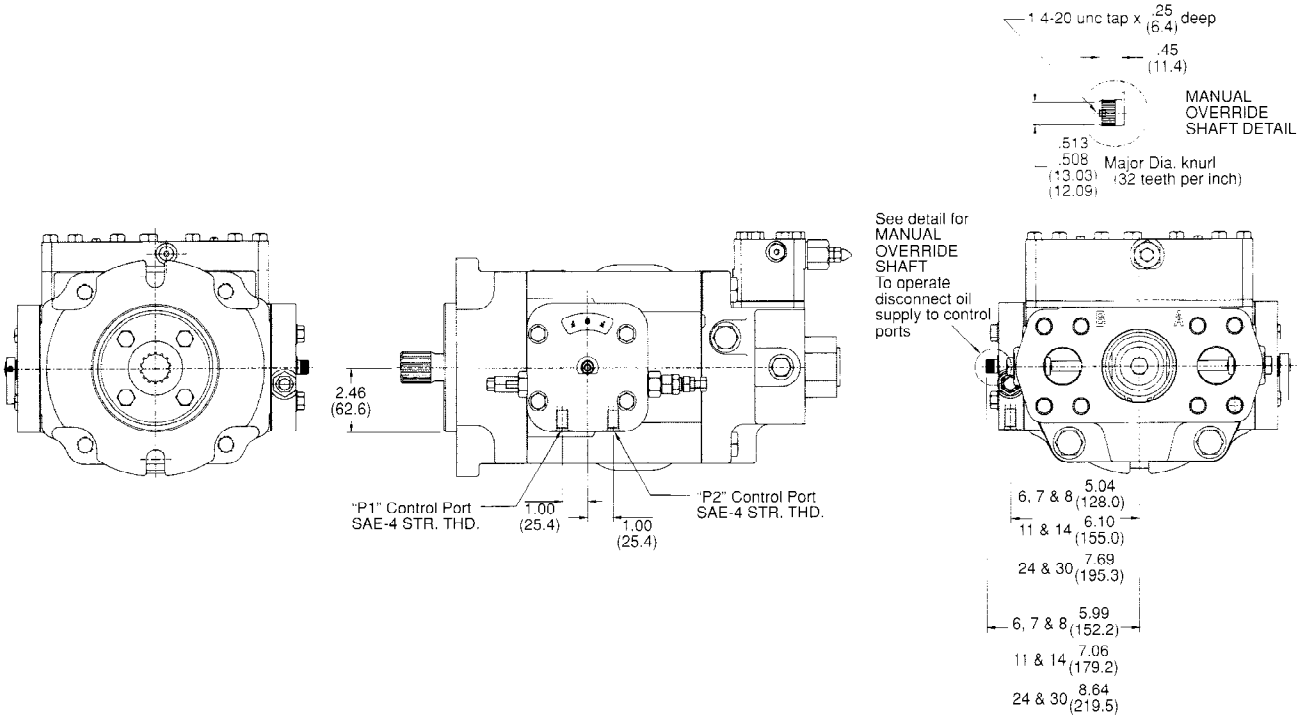


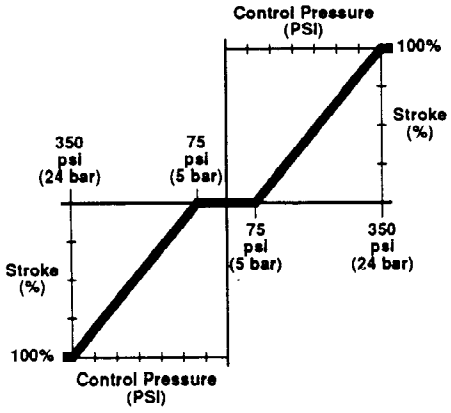




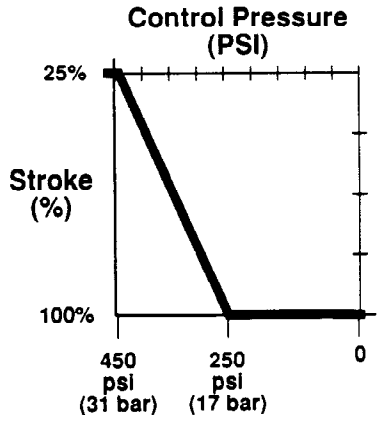
ADJUSTABLE MAX. VOLUME STOPS – MANUAL 4A * CONTROL SHOWN

Proportional Hydraulic Stroker (8A*)





Pump Stroke Vs. Control Pressure
– Figure 1 –



Motor Stroke Vs. Control Pressure
– Figure 2 –

CONTROL MOUNTING POSITION "B" PORT SIDE				
Pump Rot.	Control Pressure To Control Port:	Manual Override Shaft Rotation	Port "A"	Port "B"
CW	P1	CCW	Inlet	Outlet
CCW	P2	CW	Inlet	Outlet
CW	P2	CW	Outlet	Inlet
CCW	P1	CCW	Outlet	Inlet

CONTROL MOUNTING POSITION "A" PORT SIDE				
Pump Rot.	Control Pressure To Control Port:	Manual Override Shaft Rotation	Port "A"	Port "B"
CW	P1	CCW	Outlet	Inlet
CCW	P2	CW	Outlet	Inlet
CW	P2	CW	Inlet	Outlet
CCW	P1	CCW	Inlet	Outlet

Electrohydraulic Stroker Control (9**)

Current to reach maximum Displacement (±19°) rotation (See Note 1)	Min.	270mA
	Typ.	325mA
	Max.	380mA
Threshold Current (Deadband) (See Note 1 and Note 2)	Min.	150mA
	Typ.	180mA
	Max.	210mA
Coil Resistance, per coil at 20° C.	41 Ohms	
Hysteresis (See Note 1)	Typ.	5%
	Max.	8%
Linearity	within 8%	

Response Zero to Full (19°)

P6/7	P11/14	P24/30
0.9 Sec. Max.	1.5 Sec. Max	1.8 Sec. Max.

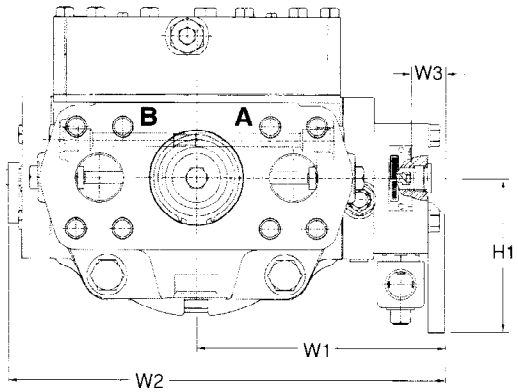
(Consult Factory for Faster Response)

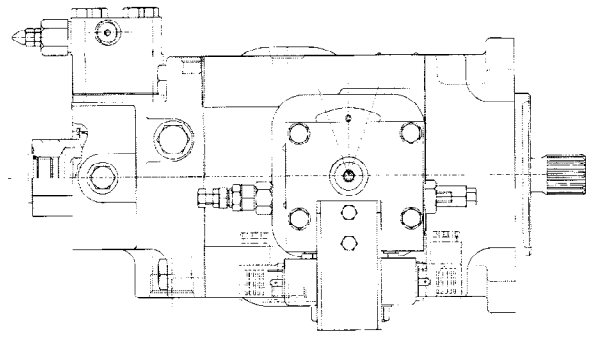
Repeatability	within 2%
Temperature Null Shift	< 2% per 100°F (56°C)
Pressure Supply	325 PSI (22 bar) min., internally connected in pump.
Fluid Type	Fluid Compatible with Viton (S-5) seals. EPR (S-4) seals available on request.
Mating Connector	Din 43650 type AF, Denison part No. 167-010008-8 (provided with control)
Max. volume stops	Preset at ± Full Displacement, Adjustable to zero (each side)
Manual Override	3/16" Allen wrench on input shaft. 30 in-lb. (3.4 Nm) torque required to adjust with Zero current.Do not exceed 40 in-lb. (11 Nm)

Note 1. All specifications are defined using a Jupiter 900 Driver with a 24 VDC supply and set at 120 Hz pulse width modulation (PWM). Performance will vary if different types of controls are used. It is always recommended to use 100-200 Hz PWM for control.

Vote 2. Deadband is Electrically adjustable from 30% to 3% each direction with the Jupiter 900 Driver (Input of card vs. control output position).

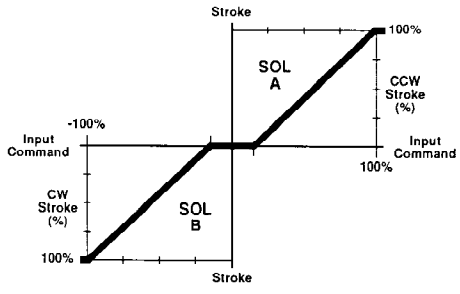
Recommended controls:		
	Jupiter 900 Control, Eurocard with Manual Control Panel	S20-14078-0
	Jupiter 900 Control, Panel mount	S20-14087-0
	24 VDC Power Supply	762-30026-0
	Eurocard Holder	701-00007-8





Installation Dimensions

Pump Series	H1		W1		W2		W3	
	inch	mm	inch	mm	inch	mm	inch	mm
6, 7 & 8	4.75	120,6	7.74	196,6	13.64	346,4	1.12	28,5
11 & 14	4.75	120,6	8.80	223,5	15.76	400,3	1.12	28,5
24 & 30	4.75	120,6	10.39	263,9	18.94	481,1	1.12	28,5

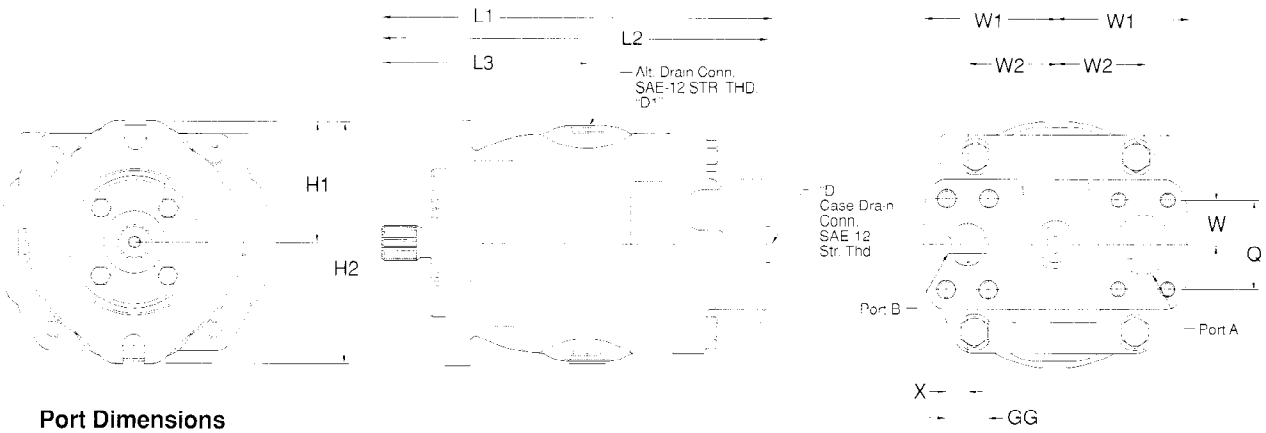


Output vs Input Command w / Jupiter 900 Driver Card

NOTE:

1. With "A" coil energized, servo shaft will rotate CCW.
2. With "B" coil energized, servo shaft will rotate CW.

Series 6 & 7 Fixed displacement pump



Port Dimensions

	Port A	W	Q	X	GG	Z
inch	2.00	1.53	3.06	.84	1.68	1/2-13 UNC × 1.05 Deep
mm	50.8	38.9	77.7	21.3	42.7	1/2-13 UNC × 26.7 Deep
	Port B					
inch	1.50	1.56	3.12	.72	1.44	5/8-11 UNC × 1.30 Deep
mm	38.1	39.6	79.2	18.3	36.6	5.8-11 UNC × 33.0 Deep

Length Dimensions—L

	L1	L2	L3
inch	11.20	11.06	4.90
mm	284.4	280.9	124.5

Height Dimensions—H

	H1	H2
inch	4.18	8.36
mm	106.2	212.4

Width Dimensions—W

	W1	W2
inch	4.50	3.00
mm	114.3	76.2

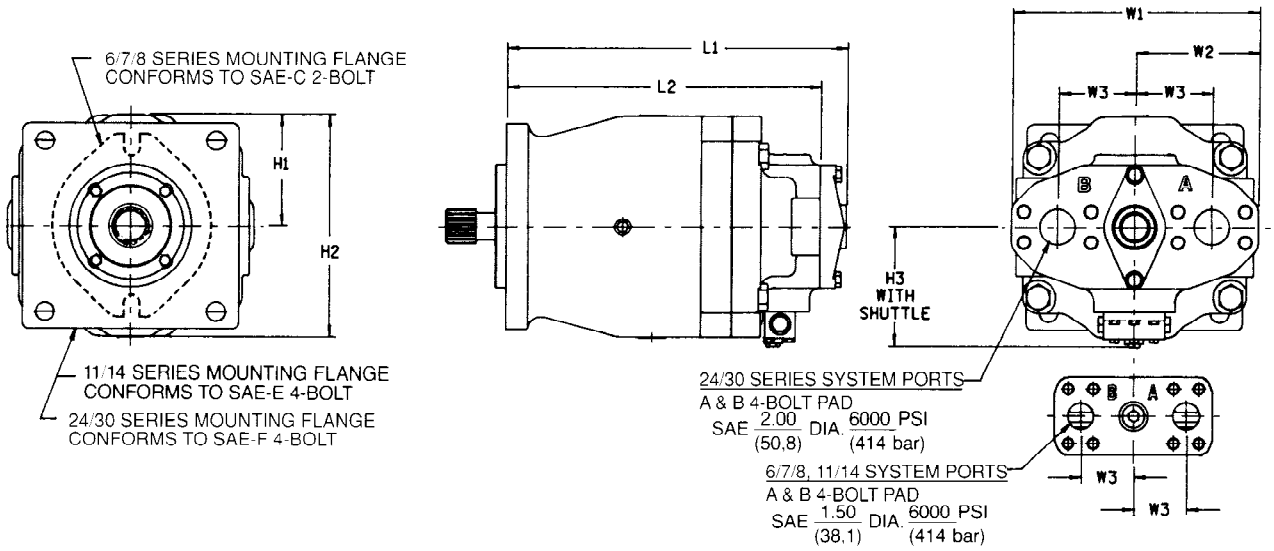
P6F/P7F Inlet Conditions at Sea Level

Unit Displacement	Speed RPM	Gage Pressure PSIG	Bar	In Hg	mm Hg	Absolute Pressure PSI	Bar
4.05	1200	-3	-0.2	-6	-152	11.70	0.80
[66.38]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2200	-1.67	-0.12	3.14	-87	13.03	0.90
	2337	0	0	0	0	14.70	1.01
	2400	0.80	0.06	1.63	42	15.50	1.07
4.71	1200	-3	-0.2	-6	-152	11.70	0.80
[77.2]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2200	-0.1	-0.06	-1.86	-47	13.79	0.95
	2271	0	0	0	0	14.70	1.01
	2400	1.71	0.12	3.48	89	16.40	1.13
4.9	1200	-3	-0.2	-6	-152	11.70	0.80
[80.31]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2200	-1.88	-0.13	-3.83	-97	12.82	0.98
	2355	0	0	0	0	14.70	1.01
	2400	0.56	0.04	1.13	29	15.26	1.05
5.3	1200	-3	-0.2	6	152	11.70	0.80
[86.9]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2215	0	0	0	0	14.70	1.01
	2400	2.54	0.18	5.18	132	17.24	1.19

Unit Displacement	Speed RPM	Gage Pressure PSIG	Bar	in Hg	mm Hg	Absolute Pressure PSI	Bar
5.7	1200	3	0.2	-6	-152	11.70	0.80
[93.4]	1500	-3	0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2276	0	0	0	0	14.70	1.01
	2400	1.63	0.11	3.33	85	16.33	1.13
6	1200	-3	-0.2	-6	-152	11.70	0.80
[98.0]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2152	0	0	0	0	14.70	1.01
	2400	3.57	0.25	7.29	185	18.27	1.06
6.4	1200	-3	-0.2	-6	-152	11.70	0.80
[105]	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2211	0	0	0	0	14.70	1.01
	2400	2.61	0.18	5.33	135	17.31	1.19
7.25	1200	-3	-0.2	6	-152	11.70	0.80
	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2136	0	0	0	0	14.70	1.01
	2400	3.84	0.26	7.84	199	18.54	1.07

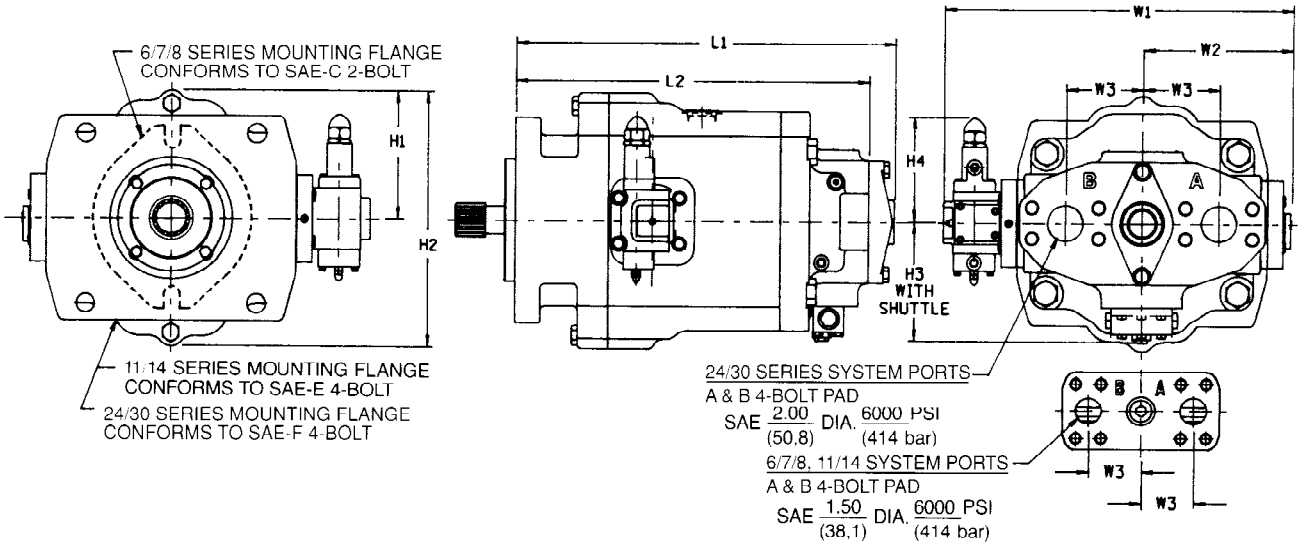
ABSOLUTE INLET PRESSURE is the pressure required to fill the pump. The difference between the inlet pressure at the pump flange and atmospheric pressure must never exceed(–) 3 psi.

Fixed and Variable Motor (All)



Fixed Displacement Motor

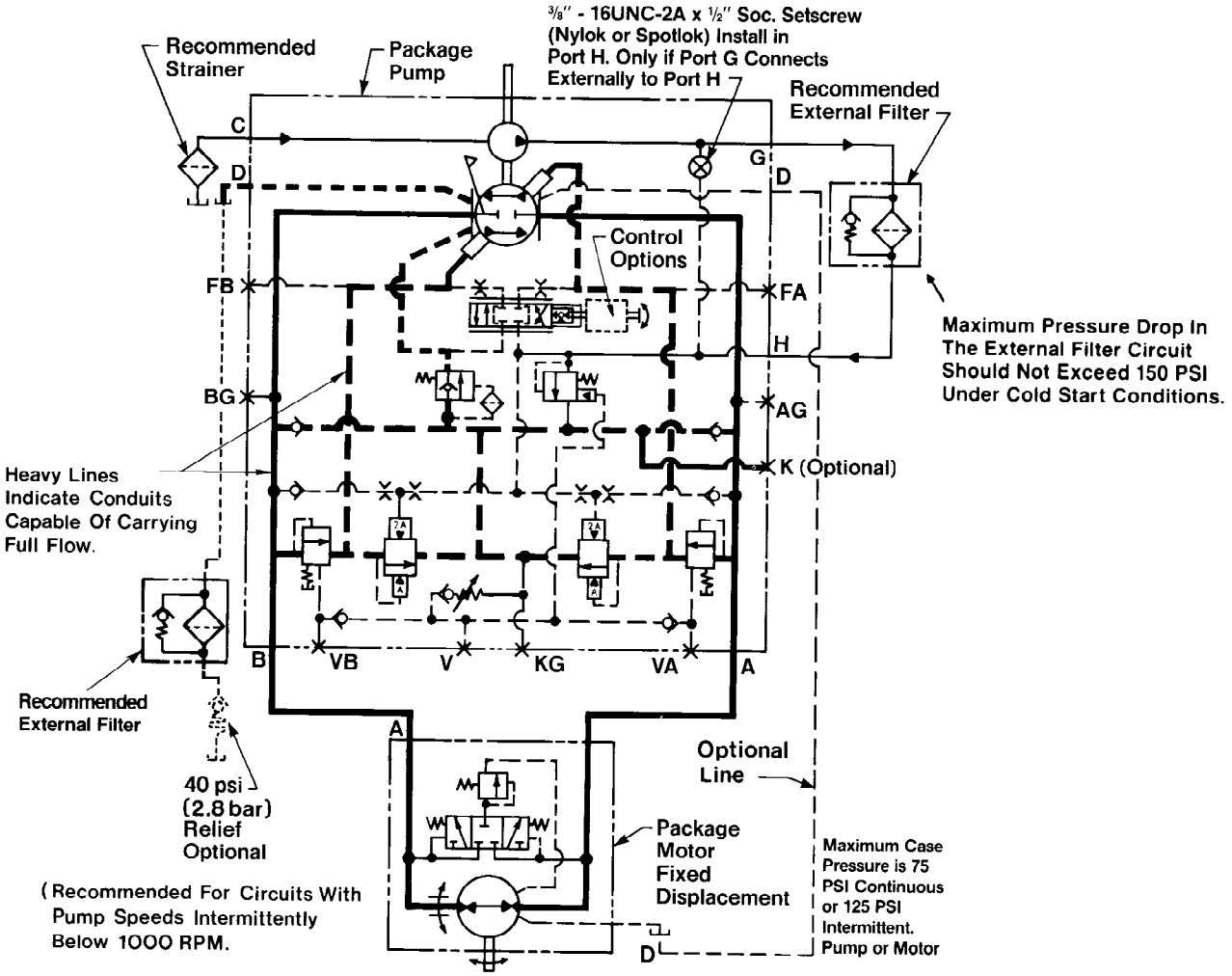
	H1	H2	H3	L1	L2	W1	W2	W3
6, 7 & 8 Series	4.19	8.38	4.56	11.20	11.06	9.00	4.50	3.00
	(106.5)	(212.9)	(115.8)	(284.4)	(280.9)	(228.6)	(144.3)	(179.2)
11 & 14 Series	5.17	10.34	4.86	15.75	15.28	10.34	5.17	3.00
	(131.3)	(262.6)	(123.4)	(400.1)	(388.1)	(262.6)	(131.3)	(76.2)
24 Series	7.31	14.62	6.81	21.61	20.46	14.04	7.02	4.38
	(185.7)	(371.4)	(173.0)	(548.8)	(519.6)	(356.6)	(178.3)	(111.2)
30 Series	7.31	14.62	6.81	22.61	21.46	14.04	7.02	4.38
	(185.7)	(371.4)	(173.0)	(574.2)	(545.01)	(356.6)	(178.3)	(111.2)



Variable Displacement Motor

	H1	H2	H3	H4	L1	L2	W1	W2	W3
6, 7 & 8 Series	4.22	8.44	4.56	5.97	13.16	12.80	14.54	5.87	3.00
	(107.2)	214.4	115.8	(151.6)	(334.4)	(325.2)	(369.5)	(149.2)	(76.2)
11 & 14 Series	5.33	10.60	4.86	5.97	17.79	17.32	16.69	6.92	3.00
	(135.4)	269.2	123.4	(151.6)	(451.9)	(439.9)	(424.0)	(176.2)	(76.2)
24 Series	7.31	14.62	6.81	5.97	21.61	20.46	19.85	8.51	4.38
	(185.7)	371.4	173.0	(151.6)	(548.8)	(519.6)	(504.1)	(216.1)	(111.2)
30 Series	7.31	14.62	6.81	5.97	22.61	21.46	19.85	8.51	4.38
	(185.7)	371.4	173.0	(151.6)	(574.2)	(545.01)	(504.1)	(216.1)	(111.2)

Series 6, 7 & 8 Information



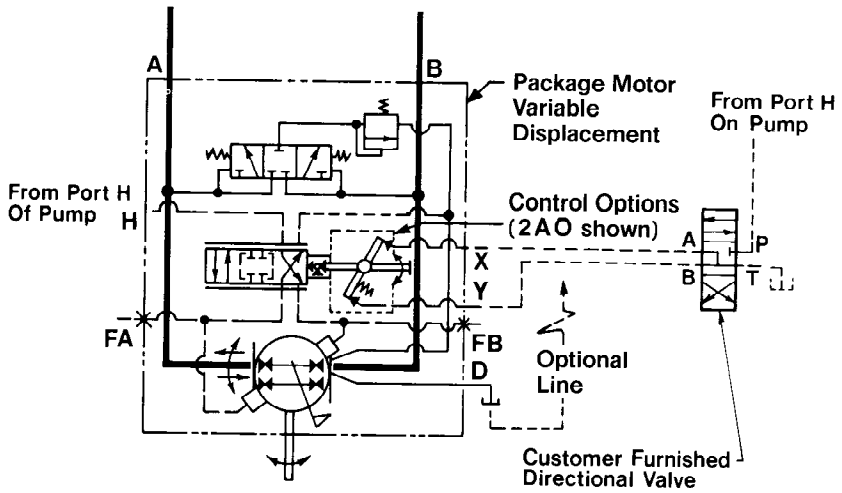
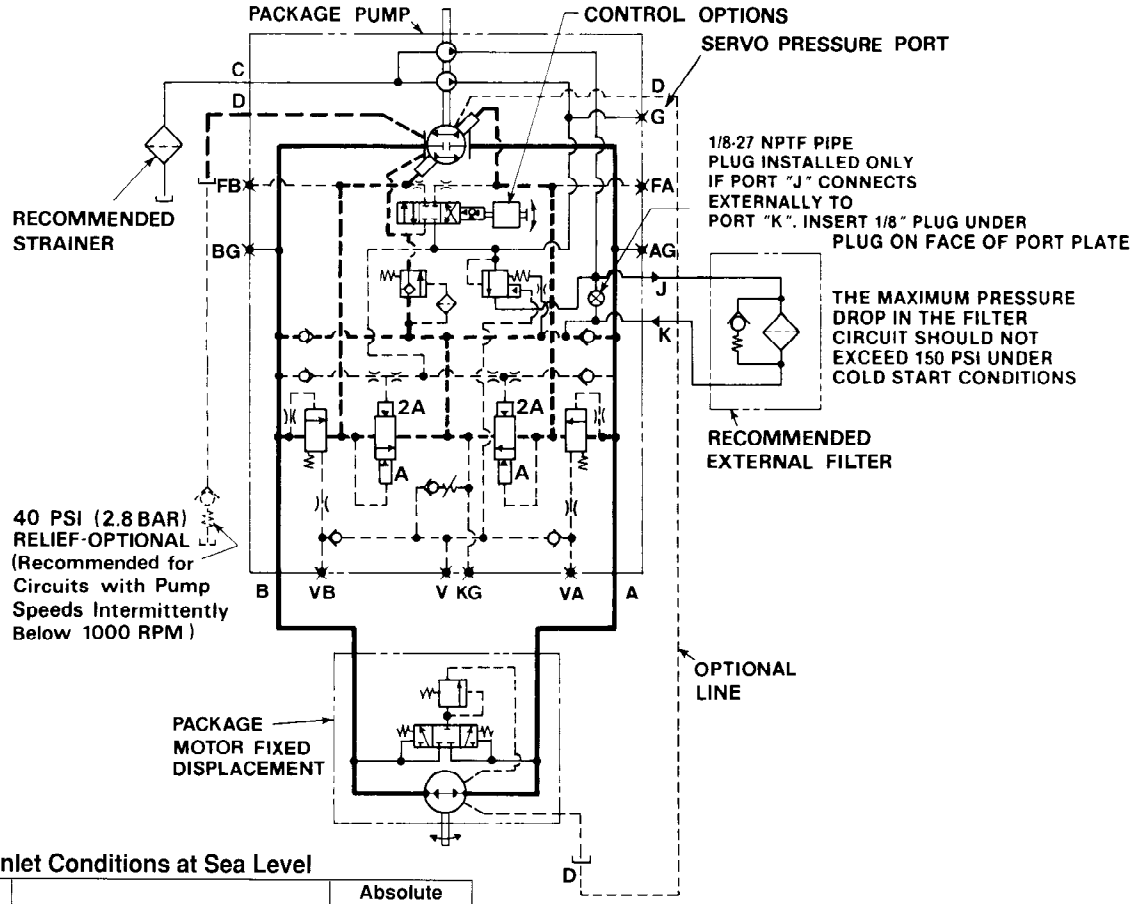


FIG. 2

Series 11 & 14 Information



P11V Inlet Conditions at Sea Level

Speed	Gage Pressure				Absolute Pressure	
rpm	psig	barg	inHg	mmHg	psia	bara
1200	-3	-0.20	-6	-152	8.0	.55
1500	-3	-0.20	-6	-152	9.0	.62
1800	0	0	0	0	14.7	1.01
2100	5.3	0.37	10.8	274.3	20.0	1.38

P14V Inlet Conditions at Sea Level

Speed	Gage Pressure				Absolute Pressure	
rpm	psig	barg	inHg	mmHg	psia	bara
1200	-3	-0.20	-6	-152	2.0	.48
1500	-3	-0.20	-6	-152	10.9	.75
1740	0	0	0	0	14.7	1.01
1800	1	.07	2.0	52	15.7	1.48
2100	5.3	0.37	10.8	346	21.4	1.48

NOTE:
Servo pressure must be furnished from Port G of pump to Port H1 or H2 of motor.

NOTE:
INLET PRESSURE MINIMUM —
The above measurements are at the pump inlet flange with petroleum base fluids — Increase inlet pressures 35% for fire resistance fluids.
ABSOLUTE PRESSURES — Are the minimum pressure to fill the pump at these speeds.
MAXIMUM INLET PRESSURES — Must not exceed 200 psig (13.8 barg) on port "A" and Port "C".

1. The suction line between the reservoir and the pump should be 3 inch (76.2 mm) minimum and reduced at the pump inlet only.
2. Do not use a strainer in the suction line. A course screen is recommended.
3. Aeration is not allowed.

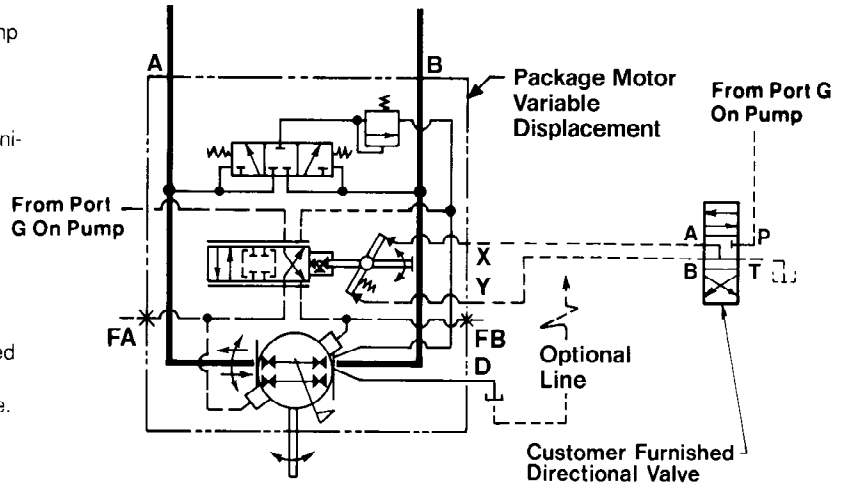
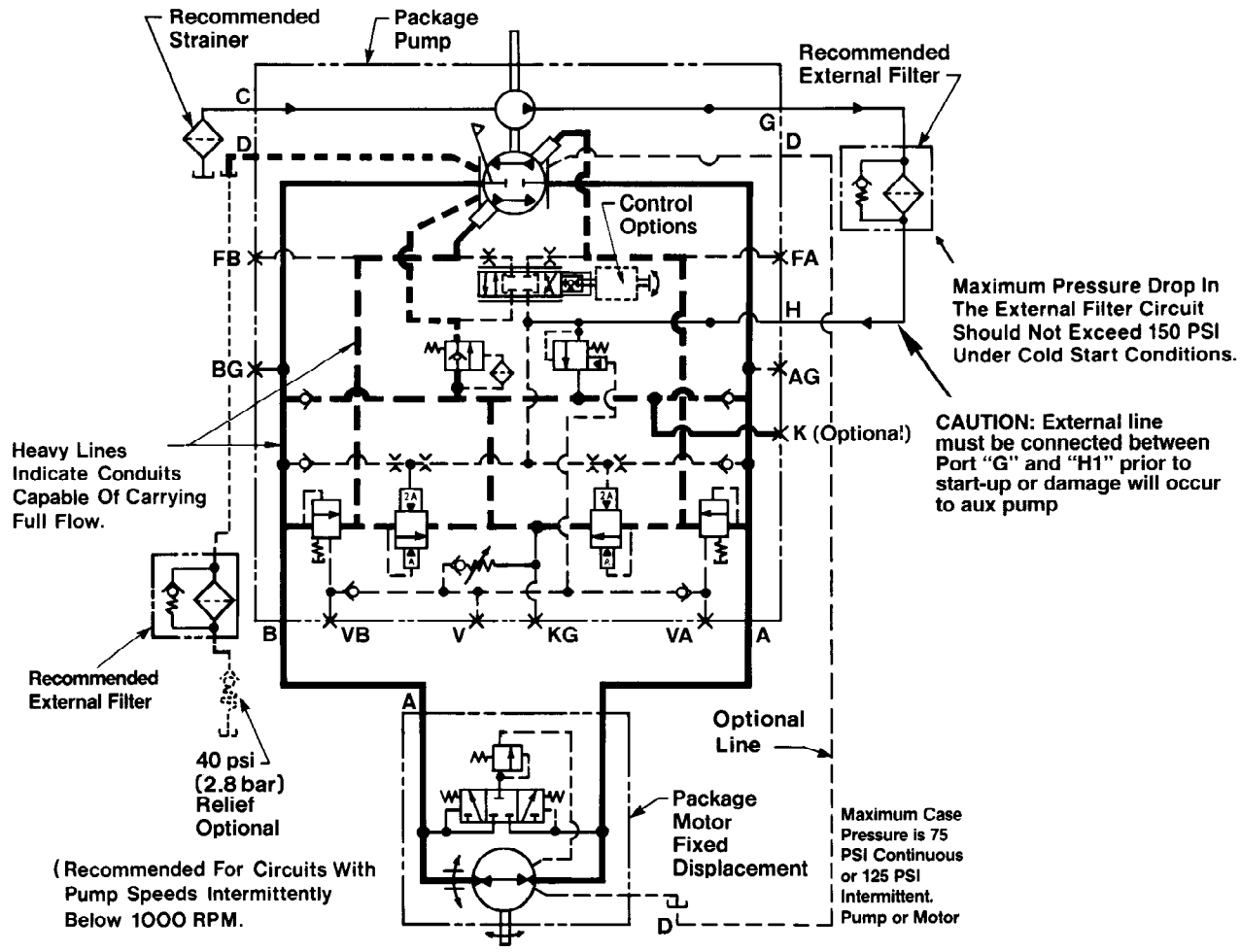
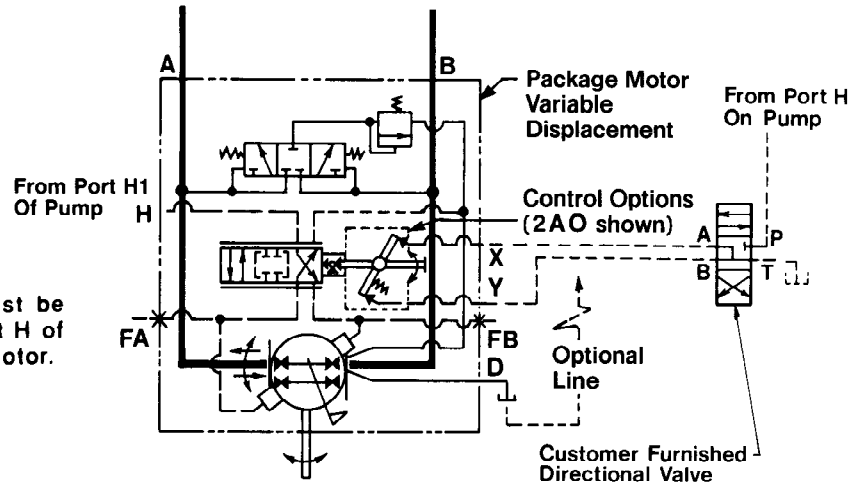


FIG. 3

Series 24 & 30 Information





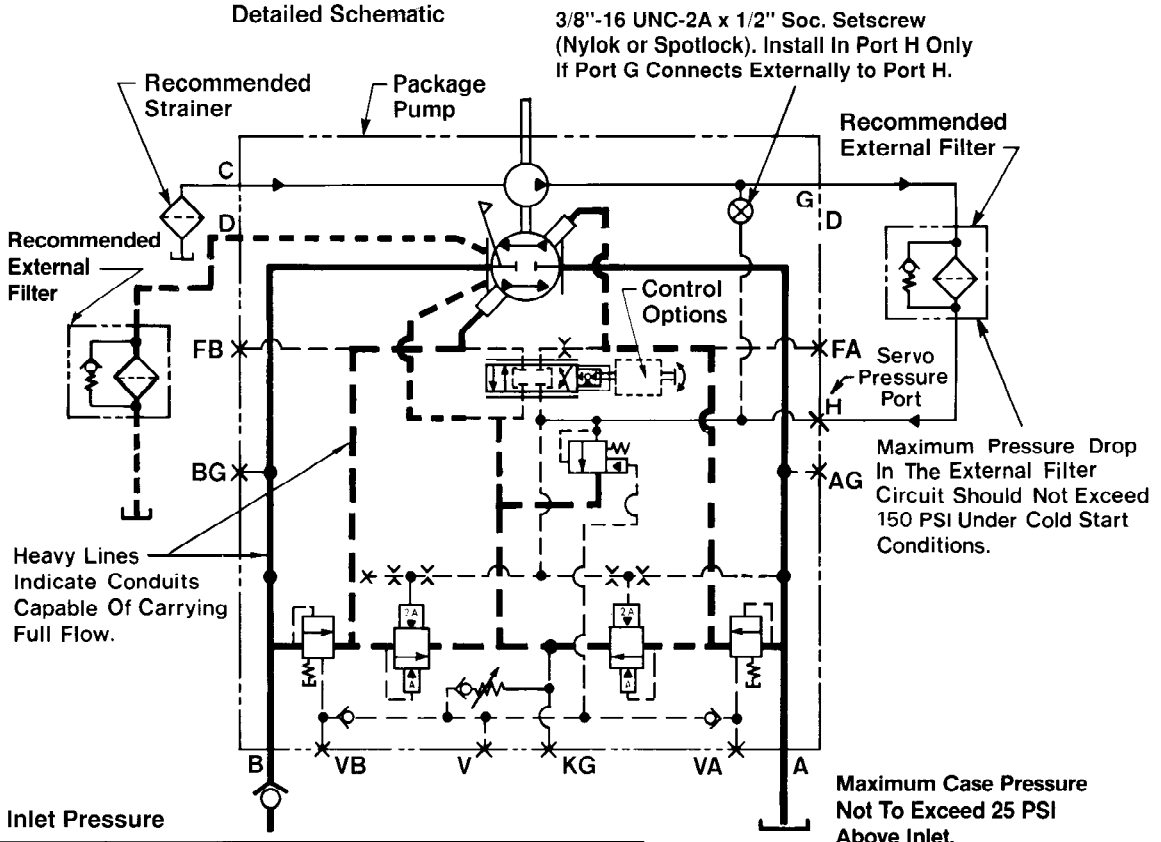
NOTE: Servo pressure must be furnished from Port H of pump to Port H of motor.

Filters must use bypass valves.

FIG. 4

Series 6 & 7 Information

Open Loop Pump
Detailed Schematic



Minimum Inlet Pressure

Series	Speed	Gage Pressure psig	(bar)	in•Hg	mm•Hg	Absolute Pressure psi	(bar)
6 (98.3)	1200	-3	-0.2	-6	-152	11.70	0.80
	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2152	0	0	0	0	14.70	1.01
	2400	3.57	0.25	7.29	185	18.27	1.26
7.25 (118.8)	1200	-3	-0.2	-6	-152	11.70	0.80
	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2136	0	0	0	0	14.70	1.01
	2400	3.84	0.26	7.84	199	18.54	1.27
8.0 (131)	1200	-3	-0.2	-6	-152	11.70	0.80
	1500	-3	-0.2	-6	-152	11.70	0.80
	1800	-3	-0.2	-6	-152	11.70	0.80
	2100	0	0	0	0	14.70	1.01
	2400	4.50	0.30	9.00	233	19.20	1.32

A CHECK VALVE IN THE OUTLET LINE BETWEEN THE PUMP AND LOAD IS HIGHLY RECOMMENDED WHERE HOSES, ACCUMULATORS OR OTHER COMPONENTS MAY DECOMPRESS WHEN PUMP IS VENTED BY THE COMPENSATOR

ABSOLUTE INLET PRESSURE is the pressure required to fill the pump. The difference between the inlet pressure at the pump flange and atmospheric presure must never exceed (–) 3 psi.

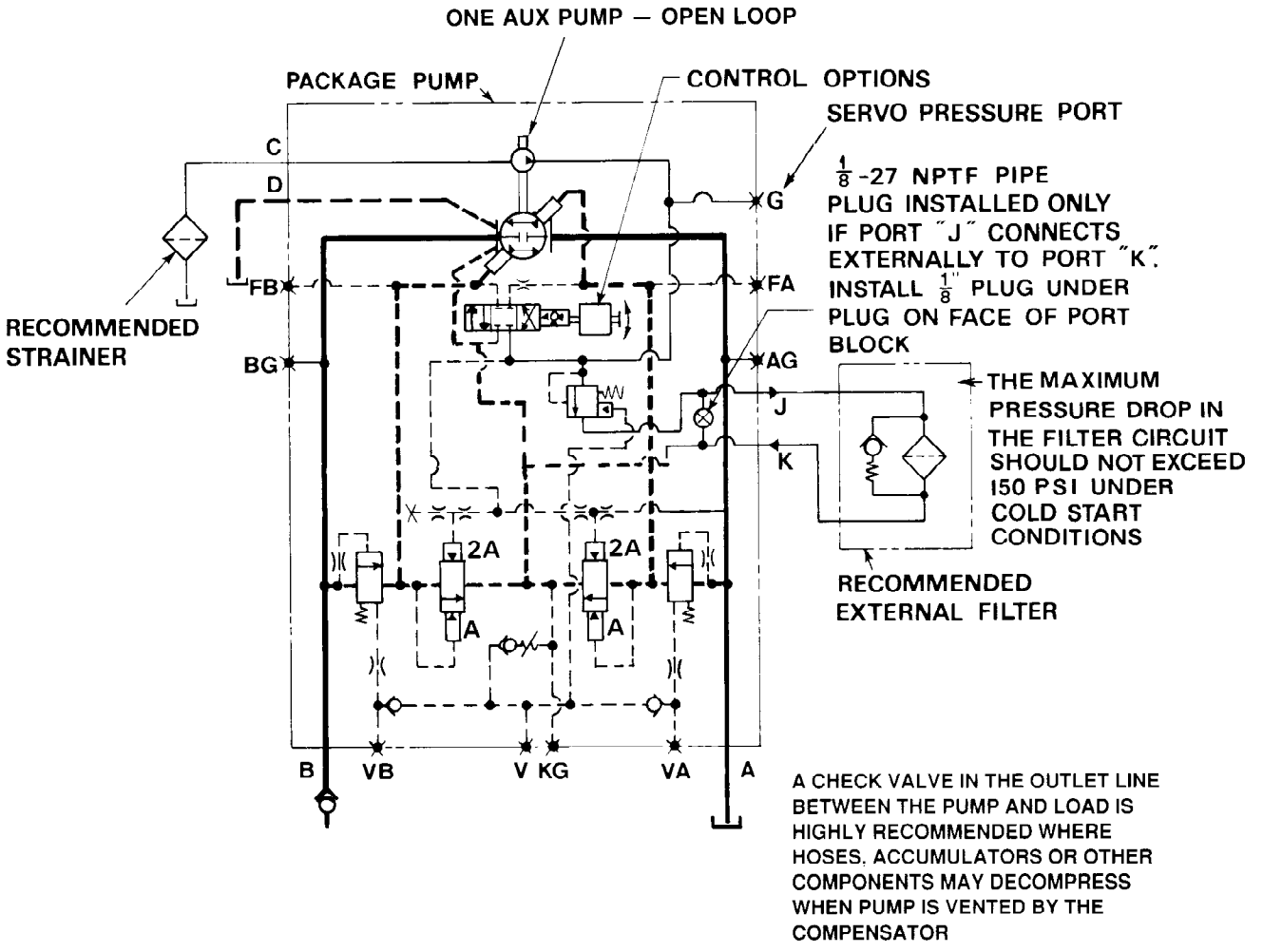
CONTROL MOUNTING POSITION — Input Command "A" Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION — Input Command "B" Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CCW	Inlet	Outlet
L	CW	Inlet	Outlet

Notes:

1. The auxiliary pump inlet must be connected directly to the reservoir. See page 8 for Auxiliary Pump Inlet requirements.
2. Case pressure must not exceed inlet pressure by more than 25 psi. (1.7 bar)
3. Maximum allowable inlet (Port C) pressure: 200 psi (13.8 bar)
4. Filters must use bypass valves.
5. Absolute Inlet Pressure must be increased for the following fluids.
   a. 35% for water glycols
   b. 35% for phosphate esters

Series 11 & 14 Information



P11V Inlet conditions at sea level

Speed	Gage Pressure				Absolute Pressure	
rpm	psi	bar	inHg	mmHg	psi	bar
*1200	–3	–0.20	–6	–152	6.5	4.5
*1500	–3	–0.20	–6	–152	10.2	.70
1800	0	0	0	0	14.7	1.01
2100	5.3	0.37	10.8	274.3	20.0	1.38

P14V Inlet conditions at sea level

Speed	Gage Pressure				Absolute Pressure	
rpm	psi	bar	inHg	mmHg	psi	bar
*1200	–3	–0.20	–6	–152	9.0	.48
*1500	–3	–0.20	–6	–152	10.9	.75
1740	0	0	0	0	14.7	1.01
1800	1	.07	2.0	52	15.7	1.08
2100	5.3	0.37	10.8	346	21.4	1.48

CONTROL MOUNTING POSITION			
Input Command "A" Side			
Pump Rot.	Rotary Servo Input Shaft Rotation	Port "A"	Port "B"
R	CW	Inlet	Outlet
L	CCW	Inlet	Outlet

CONTROL MOUNTING POSITION			
Input Command "B" Side			
Pump Rot.	Control Pressure to Control Port	Port "A"	Port "B"
R	CCW	Inlet	Oulet
L	CW	Inlet	Outlet

Notes:

1. The auxiliary pump inlet must be connected directly to the reservoir. See page 8 for Auxiliary Pump Inlet requirements.
2. Case pressure must not exceed inlet pressure by more than 25 psi. (1.7 bar)
3. Maximum allowable inlet (Port C) pressure: 200 PSI (13.8 bar)
4. Filters must use bypass valves.
5. Absolute Inlet Pressure must be increased for the following fluids.
   a. 35% for water glycols
   b. 35% for phosphate esters

Pump Installation Drawings

Control	P6P	P6V	P7P	P7V	P11P	P11V	P14P	P14V	P24P	P30P
102	23-7981	23-7981	23-7982	23-7982	23-7965	23-7965	23-7965	23-7965	23-7981, 23,9599	
104	23-9321	23-9321	23-9312	23-9321						
2A2	23-9312								23-7950, 23-9311	
2A4										
2H2										
2H4										
402	23-7951	—	23-7880	—	23-7961	-	23-9761	-	23-9600	
404	—	23-9288	—	—						
4A2	23-7951	23-7951	23-7880	23-7880	23-7962	23-7961	23-7961	23-7961	23-7951	
4A4	23-9326	23-9288	23-9326	—					23-9351	
4B2	23-7952	—	23-7877	—					23-7952, 23-9603	
4B4	23-9315	—	—	—						
4C2	23-7952	23-7952	23-7877	23-7952	23-7962	-	23-7962	-	23-9603	
4C4	23-9315	—	—	—						
5A2	23-9055	23-9055	23-9055	23-9049	23-9069	23-9069	23-9069	23-9069	23-9055	
5A4	23-9605	23-9605	23-9605	23-9323					23-9351	
5C2	23-9056	23-9056	23-9050	23-9056	23-9082	23-9288	23-9082	-		
5C4	23-9313	—	23-9313	—					23-9350	
6A4	—	—	—	23-7880						
602-6A2	23-9097	23-9260	23-9179	23-9260	23-9127	-	23-9127	-	23-9601	
604									23-9676	
6B2	23-9193	—	23-9180							
6B4	23-9605	—	—							
6C2	—	—	23-9180							
6C4	—	—	—							
7D2	23-9316	—	23-9308							
7G2	—	—	23-9298							
7F2	23-9316	—	—							
8A2	23-9786	—	23-9786		23-9816		23-9816		23-9811	23-9810

Motor Installation Drawings

Control	M6H	M7H	M6G	M7G	M11H	M11G	M14H	M14G	M24G	M24H
2AO	23-7954	23-7878	23-7955	23-7878	23-7958	23-7957	23-7958	23-7957	—	—
5AO	23-9665	—	—	—	—	—	—	—	—	—
6AO	23-9262	23-9262	—	—	—	—	—	—	—	—
2A5									23-9579	23-9580
5A5										
6A5										
8A2										
8A5										

P 6 P -2 R 1 C -4 A 2 -A -00 -0 B 1 -M-XXXXX

Pump series

Displacements, max
6-6.0 in³/rev., 98 cc/rev.
7-7.25 in³/rev., 119 cc/rev.
8-8.0 in³/rev., 131 cc/rev.
11-11.0 in³/rev., 180 cc/rev.
14-14.0 in³/rev., 229 cc/rev.
24-24.6 in³/rev., 403 cc/rev.
30-30.6 in³/rev., 501 cc/rev.

F-Fixed
P-Closed Loop Transmission
R-Tandem (6, 7 & 8 only)
V-Open Loop Unit

Shaft
SAE-C (6, 7 & 8)
SAE-E (11 & 14)
SAE-F (24 & 30)
2-Keyed
3-Splined

Shaft Rotation
(viewed from shaft end)
R-CW; **L**-CCW

Fluid Class
1-compatible w/ Buna N
4-compatible w/ EPR
5-compatible w/ Viton

Design Letter
(assigned by manufacturer)

Primary Controls
(Omit Fixed Displacement)
1-Screw Adjustment
2-Cylinder Control
4-Rotary Servo (spring centered w/trimmer)
5-Electrohydraulic Stroker
6-Hydraulic Stroker
7-Servovalve & Feedback Device
(All include rotary servo, pressure compensator override & displ. indicator)
8-Proportional Hydraulic Stroker
9-Electrohydraulic Stroker

Primary Control Options
0-None
A-Adjustable maximum volume stops
B-Automatic brake control
C-A & B above, together
D-10 GPM Servovalve w/feedback potentiometer
E-10 GPM Servovalve w/feedback RVDT
F-10 GPM Servovalve w/potentiometer & manual override - w/ 4A2 Control
G-10 GPM Servovalve w/2/RVDT & manual override - w/ 4A2 Control
H-3 Pos. (Spring centered w/trimmer)

Secondary Controls
2-Auxiliary Replenishment Port on Centerline
4-Torque Limiter and Auxiliary Replenishing Port

CONTROL LOCATION
A-Command on Port A side
B-Command on Port B side (Displacement indicator on opposite side)

Designates special

External Mounting
0-Pump not mounted
1-Pump mounted (must be separately specified)

External Drive
0-None
A-SAE-A (Not on 24, 30 & Tandem)
B-SAE-B
C-SAE-C (24, 30 & Tandem ONLY)

Internal Pump
P6, P7 & P8
0-1.07 in³/rev. (17.5 cc/rev.)
X-no internal pump (std. on tandem pumps)
P11 & 14
0-1.07 in³/rev. (17.5 cc/rev.) Servo
1.07 in³/rev. (17.5 cc/rev.) Repl.
X-no internal pump
P24
0-2.81 in³/rev. (46.0 cc/rev.)
1-1.61 in³/rev. (26.4 cc/rev.)
2-1.05 in³/rev. (17.2 cc/rev.)
3-3.56 in³/rev. (58.3 cc/rev.)
4-4.84 in³/rev. (79.3 cc/rev.)
X-no internal pump
P30
4-4.84 in³/rev. (79 cc/rev.) Std.
consult factory for other sizes

Control Features
500 Control
00-with deadband
01-without deadband
02-N/A

600 Control
00-75-350 PSI (5-24 bar)
01-75-435 PSI (530 bar)
02-100-380 PSI (7-26 bar)
03-150-400 PSI (10.3-27.6 bar)

700 Control
00-w/o manual override shut-off
01-w/manual override shut-off
02-N/A

8A2 Control
00-75-350 PSI (5-24 bar)
01-75-435 PSI (5-30 bar)
02-100-380 PSI (7-26 bar)
03-150-400 PSI (10.3-27.6 bar)
04-75-250 PSI (5-17 bar)

9A2-Control
00-24 VDC
01-12 VDC
FOR ALL OTHER CONTROLS USE 00

Allowable Controls: P_P: 102,104,2A2,2A4,2H2,2H4,402, 404,4A2,4A4,4B2,4B4,4C2,4C4, 5A2,5A4,5C2,5C4,602,604,6B2, 6B4,7D2,7E2,7F2,7G2,8A2,8A4,9A2,9A4

P_V: 102,104,2A2,2A4,4A2,4A4, 4C2,4C4,5A2,5A4,5C2,5C4, 6A2,6A4,6C2,6C4,7D2,7E2, 7F2,7G2,8A2,8A4,9A2,9A4

Note: 24 & 30 in³ not available in Open Loop-Consult Factory

M 6 H -2 N 1 C -2A0 -A -00 -M-XXXXX

Motor series

Displacements, max
6-6.0 in³/rev., 98 cc/rev.
7-7.25 in³/rev., 119 cc/rev.
11-11.0 in³/rev., 180 cc/rev.
14-14.0 in³/rev., 229 cc/rev.
24-24.6 in³/rev., 403 cc/rev.
30-30.6 in³/rev., 501 cc/rev.

F-Fixed w/o shuttle
G-Fixed Displacement w/shuttle
H-Variable Displ. w/ shuttle
V-Variable Displ. w/o shuttle

Shaft
2-Keyed SAE-C (6 & 7)
3-Splined SAE-E (11 & 14)
SAE-F (24 & 30)

Shaft Rotation
(viewed from shaft end)
N-Bi-directional

Fluid Class
1-compatible w/ Buna N
4-compatible w/ EPR
5-compatible w/ Viton

Design Letter
(assigned by manufacturer)

Primary Controls
(Omit Fixed Displacement)
2-Cylinder with adjustable maximum & minimum stops
5-Electrohydraulic Stroker
6-Hydraulic Stroker
(All include Rotary servo stem and displace ment indicator
8-Hydraulic Stroker
9-Electrohydraulic (w/o deadband)

Primary Control Options
0-None
A-Adjustable maximum volume stops

Secondary Control Options
0-None
5-Reverse compensator

Designates special

Shuttle Features
M*H & M*G
0-without Orifices
2-with Orifices

Control Features
5A* Control
1-without deadband

6A* Control
0-170-350 PSI (11.7-24.1 bar)
1-200-450 PSI (17.2-31.0 bar)
2-150-380 PSI (10.3-26.2 bar)
3-75-250 PSI

8A2 Control
0-75-250 PSI (5-17 bar)
1-250-450 PSI (17-31 bar)

9A*-Control
0-24 VDC
1-12 VDC

CONTROL LOCATION
(omit)-Fixed Displacement
A-Command on Port A side
B-Command on Port B side

Allowable Controls: M * V, M* H: 2AO, 2A5, 5A0, 5A5, 6A0, 6A5, 8A2, 8A5, 9A2

NOTE: Maximum Stops: Full Displacement
Minimum Stops: Motor, Approximately 30% Displacement

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OPI 82763