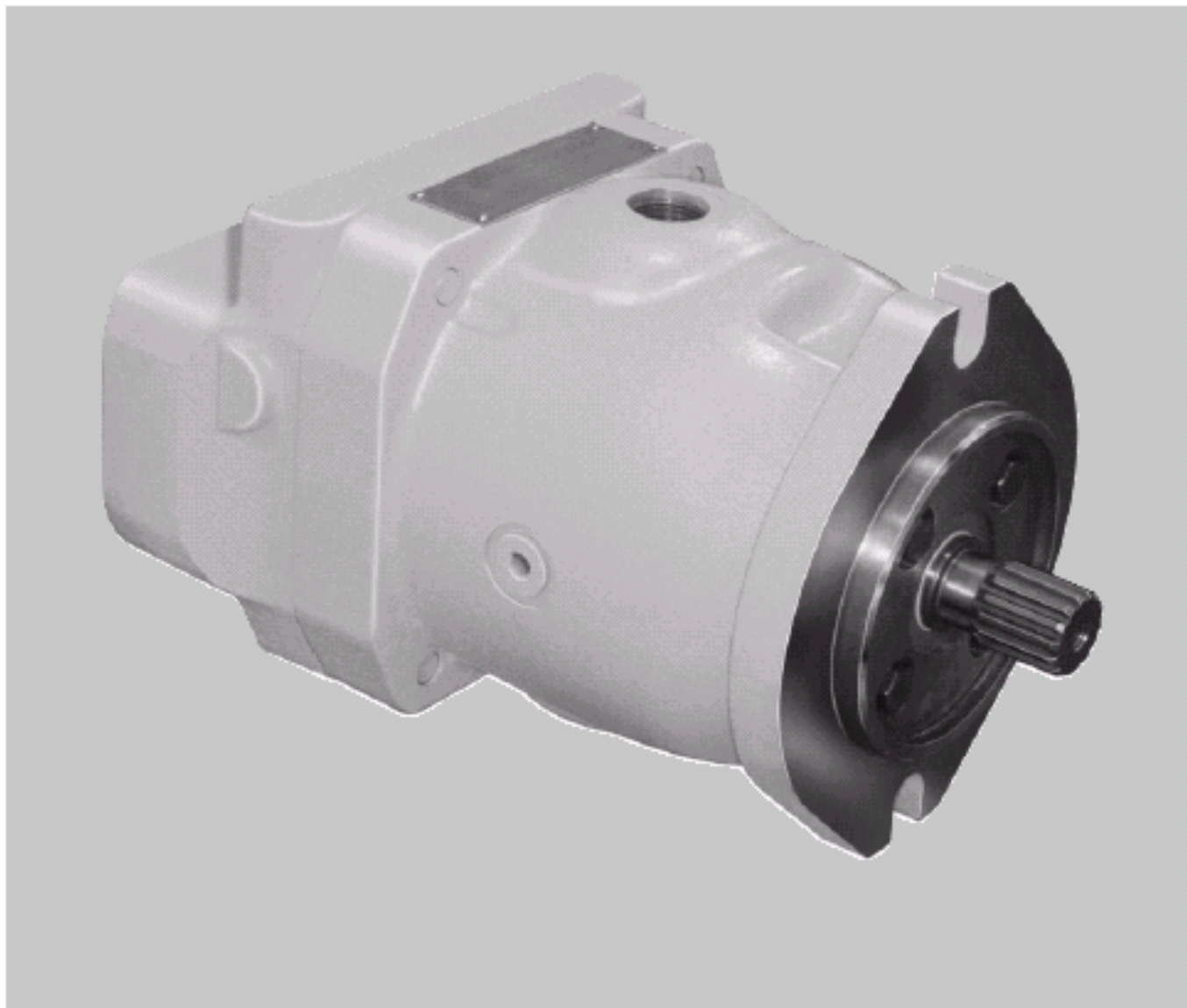


DENISON HYDRAULICS

Fixed Displacement Pumps & Motors

Goldcup Series 6, 7 & 8 D-mod.

Service Information



Publ.S 1 – AM019-C

Replaces S1-AM019-B

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INSTALLATION

TYPICAL CHARACTERISTICS	Specification	Term	Goldcup 6	Goldcup 7	Goldcup 8
	• displacement * see page 18 for disp. options	in ³ /rev. cm ³ /rev.	*6.00 98,3	*7.25 118,8	*8.00 131
	• pressure continuous	psi bar	5000 345	5000 345	3600 248
	• pressure intermittent	psi bar	6000 414	6000 414	4350 300
	• speed, max. continuous	RPM	3000	3000	1800
	• flow, ports A or B ! 1800 RPM (theoretical)	GPM l/min.	46.8 177	56.5 213,8	62.3 235,8
	• mounting-2 bolt flange	SAE	127-2 (C)	127-2 (C)	127-2 (C)
	• shaft-spline or keyed	SAE	32-1 & 4	32-1 & 4	32 – 1 & 4
	• mounting-4 bolt flange	SAE	152-4 (D)	152-4 (D)	152-4 (D)
	• shaft-spline or keyed	SAE	44-1 & 4	44-1 & 4	44-1 & 4
FLUID CONNECTIONS	• weight pkg. mtr.	lbs. kg.	105 47,6	105 47,6	105 47,6
	• port A (system, motor) SAE code 62 split flange	in. mm	1-1/2 38,1	1-1/2 38,1	1-1/2 38,1
	• port A (inlet, pump) SAE code 61 split flange	in mm	2 50,8	2 50,8	2 50,8
	• port B (system) SAE code 62 split flange	in. mm	1-1/2 38,1	1-1/2 38,1	1-1/2 38,1
	• port D1, D2 (case drains) straight thread O-ring seal	SAE	-12	-12	-12
	• port DG (case gage) straight thread O-ring seal	SAE	-6	-6	-6
SEAL KITS	Seal Kit, complete Shaft Seal				S23-03237-0 620-82066

INSTALLATION

INTRODUCTION

The **DENISON HYDRAULICS** Goldcup 6, Goldcup 7 and Goldcup 8 axial piston pumps and motors feature design concepts which are time proven and provide for advance pumping concepts. The instructions contained in this manual cover complete disassembly and re-assembly of the unit. Before proceeding with the disassembly or re-assembly of any unit, this manual should be studied in order to become familiar with proper order and parts nomenclature.

DESCRIPTION

The Goldcup pump and motor are fixed displacement axial piston design which use hydrostatically balanced piston shoes. This feature serves to lubricate as well as absorb much of the force generated by the shoes pressing against the cam, thereby increasing service life of the unit. Rotation of the motor is bidirectional.

MOUNTING

This pump/motor is designed to operate in any position. The mounting hub and mounting flange are in full conformance with SAE standards. The pump/motor shaft must be in alignment with the shaft of the driven load and should be checked with a dial indicator. The mounting pad or adapter into which the fluid pump/motor pilots must be concentric with the pump/motor shaft too prevent bearing failure. This concentricity is particularly important if the is rigidly connected to the driven load with a flexible coupling.

SHAFT INFORMATION

Splined: The shafts will accept a maximum misalignment of .006" TIR, 0,15 mm. Angular misalignment at the male and female spline axes must be less than $\pm .002$ " per inch, 0,002 mm per mm radius. The coupling interface must be lubricated. **DENISON HYDRAULICS** recommends lithium-molybdenum disulfide or similar grease. The female coupling should be hardened to 27-45 Rc and must conform to SAE-J498B (1972) class 1 flat root side fit.

Keyed: High strength heat treated keys must be used. Replacement keys must be hardened to 27-34 Rc. The key corners must be chamfered .03"-.04", 0,75-1 mm at 45° to clear radii that exist in the keyway.

SIDE LOAD

Keyed types of shafts will accept a side load of 300 lbs., 136 kg at the center of the key, with a B10 life of 10,000 hours at 1800 RPM, or 318 lbs., 144 kg with a B10 life of 100000 hours at 1500 RPM.

PIPING

Connect inlet and outlet lines to the port block of the pump/motor.

The maximum case pressure is 75 PSI, 5,7 bar continuous, 125 PSI, 8,6 bar intermittent. Case pressures must never exceed inlet pressure by more than 25 PSI, 1,7 bar. When connecting case drain line, make certain that drain plumbing passes above highest point of the pump/motor before passing to the reservoir. If not, install a 5 PSI, 0,3 bar case pressure check valve to be certain the case is filled with oil at all times.

The case leakage line must be of sufficient size to prevent back pressure in excess of 75 PSI, 5,17 bar and returned to the reservoir below the surface of the oil as far from the supply supply suction as possible. All fluid lines, whether pipe, tubing, or hose must be adequate size and strength to assure free flow through the pump/motor. An undersize inlet line will prevent the pump/motor from operating at full rated speed. An undersize outlet line will create back pressure and cause heat generation. Flexible hose lines are recommended. If rigid piping is used, the workmanship must be accurate to eliminate strain on the pump/motor port block or to the fluid connections. Sharp bends in the lines must be eliminated wherever possible. All system piping must be cleaned with solvent or equivalent before installing pump/motor. Make sure the entire hydraulic system is free of dirt, lint, scale, or other foreign material.

CAUTION: Do not use galvanized pipe. Galvanized coating can flake off with continued use.
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SERVICE INFORMATION

These hydraulic products are designed to give long dependable service when properly applied and their systems properly maintained. These general instructions apply to typical systems. Specific instructions for particular equipment can be developed from them.

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** standard HF-1. Where anti-wear additive fluids are specified, see **DENISON HYDRAULICS** standard HF-0.

INSTALLATION

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, 82°C, at the case drain.

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 HYDRAULICS Standard
Water-in-oil invert emulsions	HF-3
Water glycol solutions	HF-4
Phosphate esters	HF-5

Consult **DENISON HYDRAULICS** bulletin SPO-AM305 for more information.

MAINTENANCE

This pump/motor is self-lubricating and preventative maintenance is limited to keeping system clean by changing filters frequently. Keep all fittings and screws tight. Do not operate at pressures and speeds in excess of the recommended limit. If the pump/motor does not operate properly, check the troubleshooting chart before attempting to overhaul the unit. Overhauling is relatively simple and may be accomplished by referring to the disassembly, rework limits of wear parts, and assembly procedures.

FLUID CLEANLINESS

Fluid must be cleaned before and continuously during operation by filters that maintain a cleanliness level of NAS 1638 class 8 (class 9 for 15 micron and smaller). This approximately corresponds to ISO 17/14. This fluid level cleanliness can usually be accomplished by the effective use of 10 micron filters. Better cleanliness levels will significantly extend the life of the components. As contaminant generation may vary with each application, each must be analyzed to determine proper filtration to maintain the required cleanliness level.

START UP PROCEDURES FOR NEW INSTALLATION

- Read and understand the instruction manual. Identify components and their function.
- Visually inspect components and lines for possible damage.
- Check reservoir for cleanliness and drain and clean as required.
- Check fluid level and fill as required with filtered fluid at least as clean as that recommended. Fill pump/motor case with clean oil prior to starting.
- Check alignment of drive.
- Check oil cooler and activate it if included in circuit.
- Reduce pressure settings of relief valve. Make sure accurate pressure readings can be made at appropriate places.
- If solenoids are included in system, check for actuation.
- Start pump/motor drive. Make sure pump and motor fill properly.
- Bleed system of air. Re-check fluid level.
- Cycle unloaded machine at low pressure and observe actuation (at low speed, if possible).
- Increase pressure settings gradually in steps. Check for leaks in all lines, especially pump and motor inlet lines.
- Make correct pressure adjustments.
- Gradually increase speed. Be alert for trouble as indicated by changes in sounds, system shocks and air in fluid.
- Equipment is operational.

COMPARISON OF SOLID CONTAMINATION CLASSIFICATION SYSTEMS

NATIONAL AERONAUTICS STANDARD (NAS) 1638

		Class													
		00	0	1	2	3	4	5	6	7	8	9	10	11	12
particle size range	5-15µm	125	250	500	1000	2000	4000	8000	16000	32000	64000	128000	256000	512000	1024000
	15-25µm	22	44	89	178	356	712	1425	2850	5700	11400	22800	45600	91200	182400
	25-50µm	4	8	16	32	63	126	253	506	1012	2025	4050	8100	16200	32400
	50-100µm	1	2	3	6	11	22	45	90	180	360	720	1440	2880	5760
	>100µm	0	0	1	1	1	4	8	16	32	64	128	256	512	1024
maximum	5µm	152	304	609	1217	2432	4864	9731	19462	38924	77849	155698	311396	622792	1245584
particles	15µm	27	54	109	217	432	864	1731	3462	6924	13849	27698	55396	110792	221584

ISO: DIS 4402; 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	5µm	32	64	130	2000	4000	8000	16000	32000	64000	130000	250000	500000	1000000	2000000	4000000
particles	15µm	32	64	130	250	500	1000	2000	4000	8000	16000	32000	64000	130000	250000	500000

NOTES: All measurements are for a 100 ml sample size.

TROUBLESHOOTING

Component problems and circuit problems are often interrelated. An improper circuit may operate with apparent success but will cause failure of a particular component within it. The component failure is the effect, not the cause of the problem.

This general guide is offered to help in locating and eliminating the cause of problems by studying their effects.

Effect of Trouble	Possible Cause	Fault which needs remedy
Noisy pump	Air in fluid	Leak at suction line Leak at shaft seal Low fluid level Turbulent fluid Return lines above fluid level Gas leak from accumulator Excessive pressure drop in the inlet line from a pressurized reservoir Suction line strainer acting as air trap
	Cavitation in pump or motor rotating group	Fluid too cold Fluid too viscous Fluid too heavy Shaft speed too high Suction line too small Suction line collapsed Suction strainer too small Suction strainer too dirty Operating altitude too high Boost or replenishment pressure too low Replenishment flow too small for dynamic conditions
	Misaligned shaft	Faulty installation Distortion in mounting Axial interference Faulty coupling Excessive overhung loads
	Mechanical fault in pump/motor	Piston and shoe looseness or failure Bearing failure
Erosion on barrel ports and port plate	Air in fluid	See above
	Cavitation	See above
High wear in pump or motor	Excessive loads	Reduce pressure settings Reduce speeds
	Contaminant particles in fluid	Improper filter maintenance Filters too coarse Introduction of dirty fluid to system reservoir openings Improper reservoir breather Improper line replacement

TROUBLESHOOTING

(continued)

Effect of Trouble	Possible Cause	Fault which needs remedy
High wear in pump and motor (continued)	Improper fluid	Fluid too thin or thick for operating temperature range Breakdown of fluid with time/temperature/ shearing effects Incorrect additives in new fluid Destruction of additive effectiveness with chemical aging
	Improper repair	Incorrect parts Incorrect procedures, dimensions, finishes
	Unwanted water In fluid	Condensation Faulty breather/strainer Heat exchanger leakage Faulty clean-up practice Water in make-up fluid
Pressure shocks	Cogging load	Mechanical considerations
	Worn relief valve	Needed repairs
	Slow response in check valves	Replace or relocate
	Excessive de- Compression energy rates	Improve decompression control
	Excessive line capacitance (line volume, line stretch, accumulator effects)	Reduce line size or lengths Eliminate hose
Barrel blow-off	Re-check pump hold-down, rotating group, drain pressure	
Heating of fluid	Excessive pump or motor leakage	Recheck case drain flow and repair as required Fluid too thin Improper assembly, port timing
	Relief Valve	Set too low (compared to load or to compensator) Instability caused by back pressure, worn parts
	Pump too large for fluid needs	Select smaller pump displacement
	Heat exchanger	Water turned off or too little flow Water too hot Fan clogged or restricted Efficiency reduced by mud or scale deposits Intermittent hydraulic fluid flow
	Reservoir	Too little fluid Entrained air in fluid Improper baffles Insulating air blanket that prevents heat rejection Heat pick-up from adjacent equipment

SHAFT SIZE	A	B	C	D	E
SAE 32-1 in.	1.395	1.255	4.00	2.28	2.20
(keyed C) mm	35,43	31,87	101,6	57,91	55,88
SAE 32-4 in.	1.395	1.240	4.00	2.28	2.20
(splined C) mm	35,43	31,50	101,6	57,91	55,88
SAE 44-1 in.	1.895	1.755	4.50	3.08	3.00
(keyed D) mm	48,13	44,58	114,3	78,23	76,2
SAE 44-4 in.	1.895	1.730	4.50	3.08	3.00
(splined D) mm	48,13	43,94	114,3	78,23	76,2

All dimensions = \pm .005", 0, 13mm

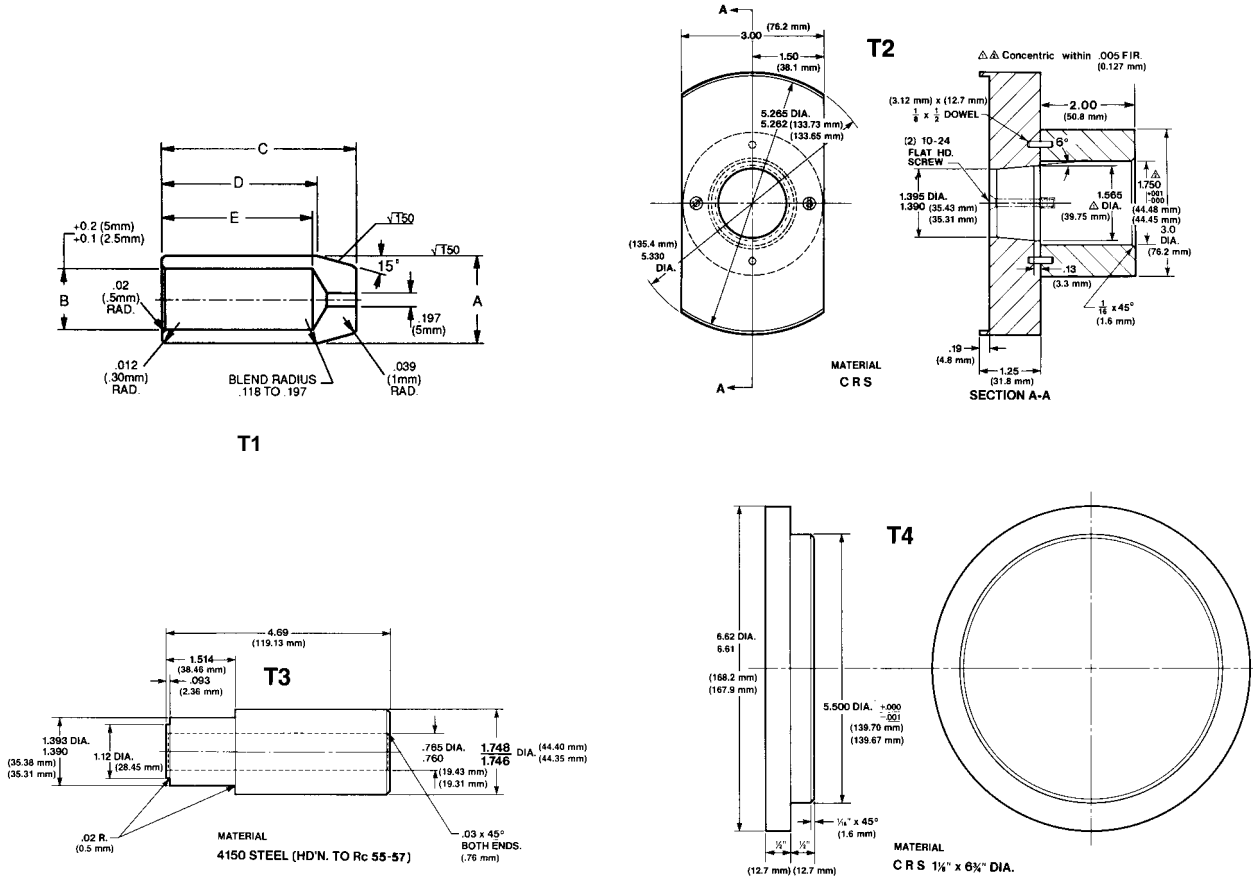


FIGURE 1
ASSEMBLY TOOLS

DISASSEMBLY

The instructions contained in this section cover a complete teardown of the subject pump or motor. Disassemble only as far as necessary to replace or repair any worn parts.

BARREL HOLD-DOWN, PORT BLOCK AND SHUTTLE VALVE

See Fig. 4. Secure the unit in a vise or other suitable holding fixture with the shaft in horizontal position.

If applicable, remove screws (11) that secure the shuttle valve (10) to the port block.

Remove the shuttle valve assembly and seals (9). The shuttle valve is a complete assembly and should not be disassembled.

Remove plug ring (1) and O-ring (2).

Remove four screws (3) that secure the port block (4) to the housing (25).

Remove port block and gasket (5). Remove port plate (6) and port plate pins (8).

Caution: When removing the port plate, it can cling to the face plate because of oil film. Make sure it does not fall and become damaged.

BARREL

Remove the face plate (7) and two face plate pins (8).

Remove barrel assembly (17).

Remove the retaining ring (12), spring retainer (13), barrel stop (14), springs (15), and thrust washers (16) from the barrel.

PISTON AND SHOE ASSEMBLY

Remove the retaining ring (19) and thrust washer from the cam center post.

Remove the piston and shoe assembly (21).

Caution: Use extreme care when removing piston and shoe assembly. Shoe faces must not be scratched or marred.

Remove creep plate (22) from cam (23).

DRIVE SHAFT AND SEAL
(SAE 127-2, "C" mount)

Remove four screws (33), gaskets (32), seal retainer (31) with seal (30), and O-ring (29). Shaft and bearing assembly may be pulled from housing.

Caution: When removing shaft from pump, use extreme care not to damage seal surface of shaft. Any scratches or marks on this surface will cause leaks around shaft seal.

DRIVE SHAFT AND SEAL
(SAE 152-4, "D" mount)

Remove retaining ring (40). Remove seal retainer (31) with seal (30), and O-ring (29). **Note:** Two 1/4-28 screws may be used to assist in pulling seal retainer. Remove four screws (33), outer race retainer (33). Shaft and bearing assembly may be pulled from housing.

Note: Do not remove the bearing (18) from the housing unless damaged or worn and needs replacement.

REWORK LIMITS OF WEAR PARTS

6, 7.25 AND 8.0 IN3	Max. rework from original	Min. dimension after rework
Port plate face	.010", 0,254 mm	.295", 7,49 mm
Shoe retainer face	.005", 0,127 mm	.307", 7,8 mm
Piston shoe face (pocket)	.006", 0,152 mm	.008", 0,2 mm
Creep plate face	.005", 0,127 mm	.286", 7,13 mm
Face plate	none	replace

IMPORTANT:

The port plate finish must be 25 micro-inches, 635 mm both faces, flat within .00006", 0,0015 mm and parallel within .001", 0,0254 mm TIR.

The creep plate wear face finish must be 10 micro-inches, 254 mm, flat within .0002", 0,0581 mm and parallel to the backside within .0005", 0,0127 mm TIR.

The shoe retainer wear face finish must be 32 micro-inches, 813 mm and flat within .0015", 0,0381 mm. (Must not be convex.)

The piston shoes wear face finish must be 5 micro-inches, 127 mm and must be lapped in a set with the retainer plate, all shoe sole thicknesses to be within .001", 0,0254 mm after lapping. The maximum permissible shoe and piston axial looseness is .010", 0,254 mm.

The special retaining ring service kit (S23-12461) may be required to control shoe hold-down clearance.

CLEANING AND INSPECTION

All parts must be inspected and be free of material defects, dirt, scratches or any foreign material.

All parts must be cleaned with a suitable cleaning solvent and all holes and passages blown out with dry, clean, compressed air.

After cleaning and inspection, all parts must be covered with a light film of oil and protected from dirt and moisture. Excessive handling of internal parts should be avoided prior to assembly.

During assembly, lapped and ground surfaces must be lubricated with clean oil and protected from nicks or surface damage.

PISTON AND SHOE ASSEMBLY

See Fig. 4: Place cam (23) flat side down on a clean surface.

Install creep plate (22) over center post on cam with small O.D. of plate turned toward cam.

Position the piston-shoe-retainer assembly (21) over the center post and against the creep plate.

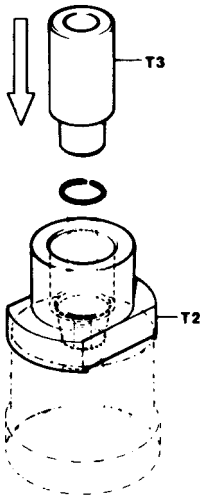
Install thrust washer (20) over center post.

Six different retaining rings (19) are available for the hold-down assembly. Each ring is marked: white dot .087", 2,21 mm thick, blue dot .085", 2,16 mm thick, yellow dot .083", 2,11 mm thick, green dot .081", 2,06 mm thick, and red dot .079", 2,01 mm thick, and black dot .077", 1,96 mm thick. Install the thickest ring (1) with the dot up, that will fit in the groove on the center post and allows a maximum clearance of .002"-.004, 0,051-0,102 mm between the shoe and creep plate while grasping one piston and lifting tightly against the shoe retainer.

The piston and shoe assembly (21) must be free to rotate easily by hand. The assembly must be rotated through 360° to confirm there is no binding and that each shoe is always free in the retainer plate. Oil the assembly thoroughly.

BARREL HOLD-DOWN ASSEMBLY

Assemble the spring retainer (13), twelve springs (15), and thrust washers (16) as shown in enlarged view. Install this assembly in bore or barrel. **Note: Use caution to insure that the spring and**



washer assembly is properly centered and does not shift into the retaining ring groove of the barrel bore when tool T-3 is pressed into T-2.

Position the barrel (17) in a press with the large end down.

Place tool T-2 with the large end of the tapered hold up against the barrel face (**See Fig. 2**).

Place retaining ring (12 Fig. 4) into tool T-2. To ease removal, position the ring such that one end will be over the notch in the barrel. Install tool T-3 with small end against the ring.

Press on T-3 to compress the spring assembly (15) and (16) to allow the retaining ring (12) to seat in groove in barrel.

Remove tools T-2 and T-3 and check to make sure the ring is properly seated.

PORT BLOCK AND CYLINDER BARREL

Install two dowel pins (8) on dowel holes in face of port block (4).

Apply a liberal amount of grease to the port plate.

Place port plate so that the dowel holes line up with the assembled pins in port block, and seat against the port block face. Make sure port plate is firmly seated on port block.

Install three face plate pins (8) in the holes provided in the barrel face. Shoulder of pin must be below barrel face.

Apply grease to the face of the barrel and install the face plate (7) over the pins. Make sure the face plate is properly seated over the pins with steel side against the barrel, bronze side up.

Rest cylinder barrel (17) onto port plate.

ROTATING GROUP

Place assembled port block and cylinder barrel on a clean surface with the barrel facing up.

Apply a thin film of clear oil to the bores in the barrel and to the pistons of the cam assembly.

Hold cam so that the pistons are hanging down. Carefully engage the pistons in the barrel bores and lower.

Install gasket (5) on port block and align holes.

Position the cam (23) on the assembled rotating group so the thick part of cam is at bottom of the port block. (For CCW pump, the thick part is at top).

Place housing (25) on flange end. Place bearing (18) with notch in outer race facing out, and center line of notch in line with hole in housing for bearing retainer plug (35). Place tool T-4 on bearing. With a smooth and steady force, press bearing into housing bore until seated. (Do not hammer or beat into place).

Install bearing retainer plug (35) and o-ring (34) into housing. Check to be sure retainer engages into bearing notch and does not bind against bearing. Torque to 50 ft.-lb., 68 Nm.

Install hex plug (1) and O-ring (2) into housing on bottom side (side furthest from housing/port block dowel holes).

Position housing assembly above and directly over cam and cylinder barrel. Carefully lower housing, align barrel bearing (18) with barrel, dowel pins in housing to holes in port block, and pilot in housing cavity with cam until housing is seated against port block and gasket.

Install screw (26) and tighten. Install screws (3) and torque to 150 ft.-lb., 203 Nm.

DRIVE SHAFT AND BEARING ASSEMBLY

For SAE 127-2 (C) mount, press the cone of bearing (28) over the shaft, wide flange first, and seat against the shoulder. Support only the inner race of the bearing and press on the narrow end of the shaft.

For SAE 152-4 (D) mount, press the cone of bearing (28) over the shaft narrow flange first, till the bearing contacts the shoulder. Install bearing retainer (38) and retaining ring (39). Install bearing cup and press the shaft back till bearing cone seats against the bearing retainer (38). **Caution: Use 1000#, 2200kg maximum force, to avoid damaging bearing.**

SHAFT, SEAL AND RETAINER

Insert barrel stop (14) into the spring assembly (15) through the shaft seal end of motor/pump.

Insert the small end of drive shaft (27) and bearing through the bore of housing, bore of cam, and into the barrel spline until shaft rests against the springs (15) in the barrel. Insert bearing cup into housing and against bearing cone assembly.

For SAE 152-4 (D) mount, install outer race retainer (37) with four screws (3). Torque evenly to 50 ft.-lb., 68 Nm. Install O-ring (29) into counter-bore of housing.

Press shaft seal (30) into seal retainer (31). Lubricate seal with grease. Place seal installation tool T-1 over shaft. Install seal/seal retainer over shaft. Retain with retaining ring (40).

For SAE 127-2 (C) mount, install O-ring (29) into counter-bore of housing. Press shaft seal (30) into seal retainer (31). Lubricate seal with grease. Install screws (33) through retainer (31). Install retainer O-rings (32) over screw end protruding through retainer. Place seal installation tool T-1 over shaft. Install seal/seal retainer over shaft, guiding screws through holes in housing and into cam. Engage each screw by no more than 1/4 inch in sequence so that O-ring (32) is not forced onto the threaded portion of the screw. Torque evenly to 50 ft.-lb., 68 Nm.

Note: Take careful precaution not to scratch seal surface of shaft. Scratches will cause leakage around the seal.

**SHUTTLE VALVE ASSEMBLY
INTERNAL DRAIN**

- Place valve assembly (10 Fig. 4) in a horizontal position with the O-ring groove up.
- Press seat (11) | the 1/2", 12.7mm diameter bore until it is flush with the body surface.
- Install spring centering washer (4) over each end of spool.
- Install springs (3) over ends of spool and into sockets of centering washers.
- Lubricate O-rings (2) and install over plugs (1). Install the plugs over springs and into body.
- Install spool (10) in bore against seat (11).
- Install spring (9) in spool (10).
- Lubricate O-rings (8) and install on groove of plug (7) on internally drained shuttle.
- Install plug (7) over spring (9) and tighten.
- Install seal (9 Fig. 4) in counter-bore in center of shuttle valve assembly. Hold in place with a coating of grease. Install the two seals in remaining counter-bores.
- Install the shuttle valve assembly on port block pad and secure with screws (11 Fig. 4). Torque screws to 20 ft.-lb. , 27 Nm.
- Install orifices (15) if required.

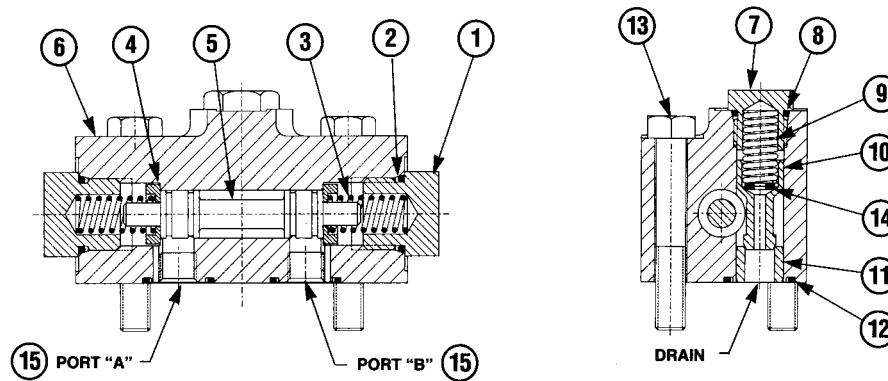


FIGURE 3
S13-48273 assembly, shuttle valve without orifices
S13-48776 assembly, shuttle valve with orifices

PARTS LIST FOR FIGURE 3
Shuttle Valve Assembly

ITEM	DESCRIPTION	PART. NO.	S13-48273 Qty.	S13-48776 Qty.
1	Plug	033-93510	2	2
2	O-ring	691-00908	2	2
3	Spring	033-70515	2	2
4	Washer, spring centering	033-70495	2	2
5	Spool	033-70529	1	1
6	Body	033-53117	1	1
7	Plug	033-72129	1	1
8	O-ring	691-00906	1	1
9	Spring, relief valve	033-71923	1	1
10	Spool, relief valve	033-71925	1	1
11	Seat	033-53154	1	1
12	Tetraseal	671-10016	1	1
13	Screw, HHC, 5/16-18 x 2-3/4	306-40106	3	3
14	Shim washer	345-20004	*	*
15	Orifice	033-53523	-	2

*as required

PARTS LIST

PARTS LIST FOR FIGURE 4

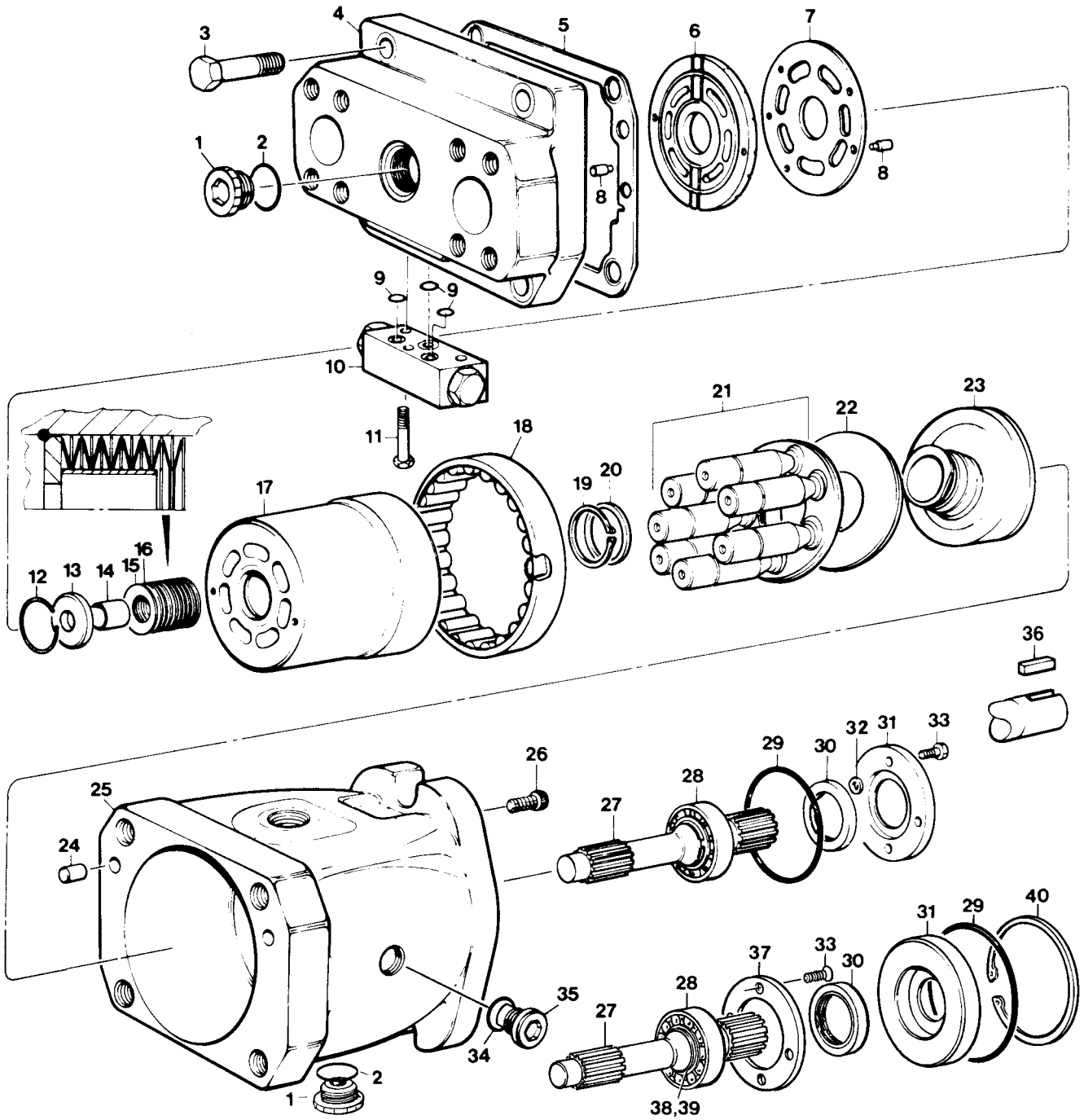
Item	Description	Part No.	Qty.
1	Plug, hex sox. hd.	488-35014	2
2	O-ring	691-00912	2
3	Screw, HHC	306-40181	4
4	Port block w/shuttle (motor) Port block w/o shuttle (pump) Port block w/o shuttle (motor)	033-59992 033-91214 033-59991	1
5	Gasket	033-91171	1
6	Port plate, motor, bi-directional 6.0 CIPR Port plate, motor, bi-directional 7.25 CIPR Port plate, pump, R-H 6.0 CIPR Port plate, pump, L-H 6.0 CIPR Port plate, pump, R-L 7.25 CIPR Port plate, pump, L-H 7.25 CIPR Port plate, pump, R-H 8.0 CIPR Port plate, pump, L-H 8.0 CIPR	033-71531 033-53775 033-59368 033-59333 033-54509 033-54508 031-57379 031-57372	1
7	Face plate, 6.0 CIPR Face plate, 7.25 and 8.0 CIPR	033-71530 033-72532	1
8	Pin, face plate and port plate	035-49825	5
10	Shuttle valve w/two orifices (motor) Shuttle valve w/o orifices (motor)	S13-48776 S13-48273	1
12	Retaining ring	033-70494	1
13	Spring retainer	033-53945	1
14	Barrel stop	033-59973	1
15	Disc spring	031-92600	12
16	Thrust washer	032-59363	12
17	Cylinder barrel, 6.0 CIPR Cylinder barrel, 7.25 CIPR Cylinder barrel, 8.0 CIPR	S13-43657 S13-47511 S23-12718	1
18	Barrel bearing	033-91107	1
19	Retaining ring (orange) .075", 1,90 mm Retaining ring (black) .077", 1,96 mm Retaining ring (red) .079", 2,01 mm Retaining ring (green) .081", 2,06 mm Retaining ring (yellow) .083", 2,11 mm Retaining ring (blue) .085", 2,16 mm Retaining ring (white) .087", 2,21 mm	033-91232 033-54826 033-70490 033-70488 033-70484 033-72176 033-72175	1
20	Thrust washer	033-72249	1
21	Piston, shoes and retainer 6.0 CIPR Piston, shoes and retainer 7.25 CIPR Piston, shoes and retainer 8.0 CIPR	S13-43655 S13-42308 S21-11650	1
22	Creep plate	033-71261	1
23	Cam	See below	1
24	Dowel pin	033-59985	2
25	Housing (C mounting, motor and CW pump) Housing (D mounting, motor and CW pump) Housing (C mounting, CCW pump)	033-91133 033-92288 033-91069	1
26	Screw, Soc. Hd. Cap	358-10120	1
27	Shaft, splined SAE-32-4 (C) Shaft, splined SAE-44-4 (D) Shaft, keyed SAE 32-1 (C) Shaft, keyed SAE-44-1 (D)	033-57233 033-92284 033-59989 033-92285	1
28	Bearing assembly (cone and cup)	S23-03262	1
29	O-ring, C mounting O-ring, D mounting	671-00242 671-00158	1
30	Shaft seal, C mounting Shaft seal, D mounting	620-82066 620-82080	1
31	Seal retainer, C mounting Seal retainer, D mounting	033-59986 032-91269	1
32	O-ring, C mounting	691-00905	4
33	Screw, HHC, 7/16-14 x 1-3/4", C mounting Screw, FH socket, 7/16-14 x 1-3/4", D mounting	306-40225 316-18230	4
34	O-ring	691-00908	1
35	Retainer, barrel bearing	033-91116	1
36	Key, C mounting keyed shaft Key, D mounting keyed shaft	035-71348 031-29899	1
37	Retainer, shaft bearing outer race, D mounting	033-92289	1
38	Retainer, shaft bearing inner race, D mounting	033-91251	1
39	Bearing retaining ring, D mounting	356-65129	1
40	Seal retaining ring, D mounting	356-65130	1

PARTS LIST FOR FIGURE 4

OPTIONAL CAMS

19° cam is standard. All others
are available only in complete
units as "M" mod units

Series		6.0		7.25		8.0	
		Cu. in/rev	Cc/rev.	Cu.in/rev	Cc/rev.	Cu.in/rev.	Cc/rev.
theoretical displacement							
Cam, 19° (std.)	033-59987	6.0	98,3	7.25	118,8	8.0	131,1
Cam, 17°	033-91327	5.33	87,3	6,44	105,5	7.10	116,4
Cam, 15.2°	033-57363	4.73	77,6	5,72	93,7	6.3	103,4
Cam, 13°	033-57902	4.02	65,9	4.86	79,6	5.36	87,8



Seal Kit S23-03237

FIGURE 4
EXPLODED VIEW OF PUMP/MOTOR

TEST PROCEDURE

GENERAL REQUIREMENTS

1. Maximum run-out between pump or motor shaft and electric motor shaft .005 TIR, 0,013 mm.
2. Electric motor speed – 1800 RPM.
3. Inlet temperature - $130^{\circ} \pm 10^{\circ}\text{F.}$, $54^{\circ} \pm 4^{\circ}\text{C}$
4. Inlet pressure 100 to 150 PSI, 6,9 to 10,3 bar.
5. Case pressure 50 PSI \pm 10 PSI, 3,4 \pm .69 bar
6. Fluid -200 SSU, 43cSt at 100°F, 37,8°C

BASIC PUMP TEST

1. Mount pump or motor on test stand. Connect system lines and case drain line to flow-master. Fill case with clean oil. If motor with shuttle, block the shuttle with blanking plate assembly S23-00181, or replace plugs and springs with hex soc. plug to prevent shuttle operation. Restore shuttle operation. Restore shuttle after test.
2. Adjust system pressure for 1000 PSI, 69 bar. Check and record system flow and case drain flow.

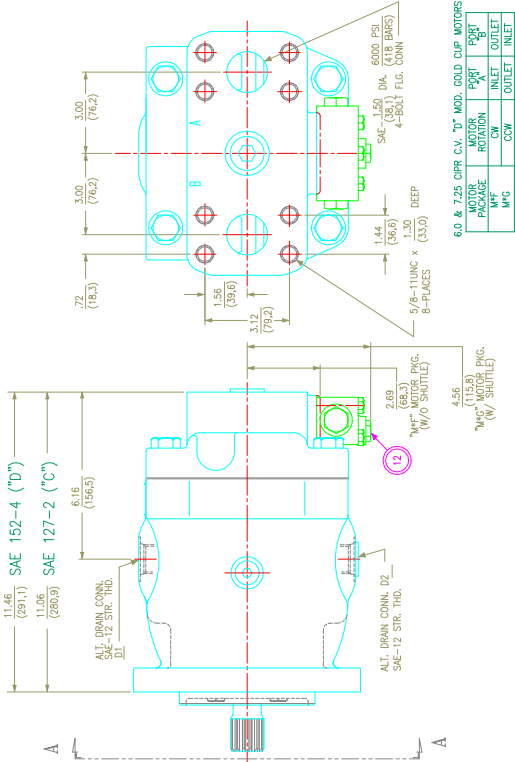
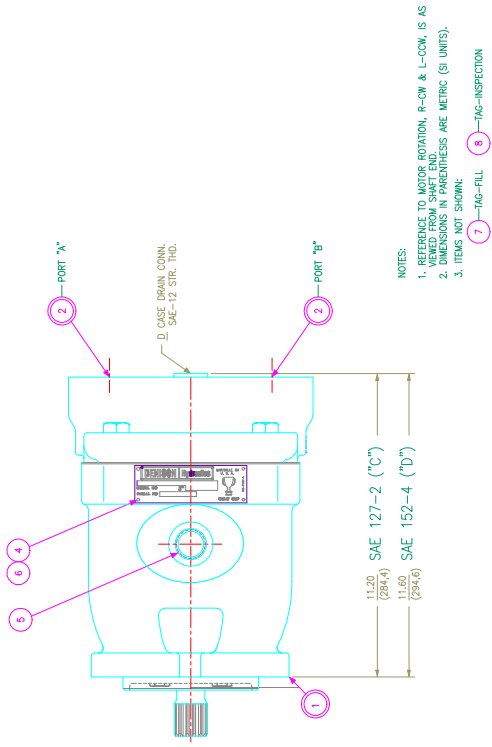
	6.0 in3	7.25 in3	8.0 in3
Maximum	47 GPM	57 GPM	63 GPM
System flow	177,9 l/m	215,7 l/m	238 l/m
Maximum	1 GPM	1.5 GPM	1.5 GPM
Case Drain Flow	3,8 l/m	5,7 l/m	5,7 l/m

3. Adjust system pressure to 5000 PSI, 345 bar for 6.0 and 7.25 in3, or 3500 PSI, 241 bar for 8.0 in3. Check and record system flow and case drain flow.

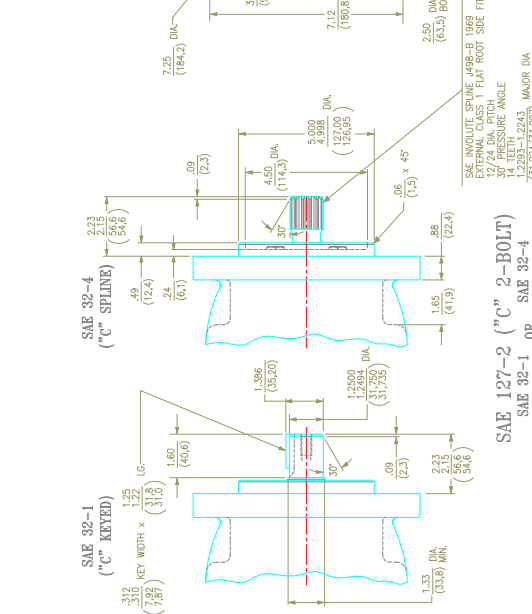
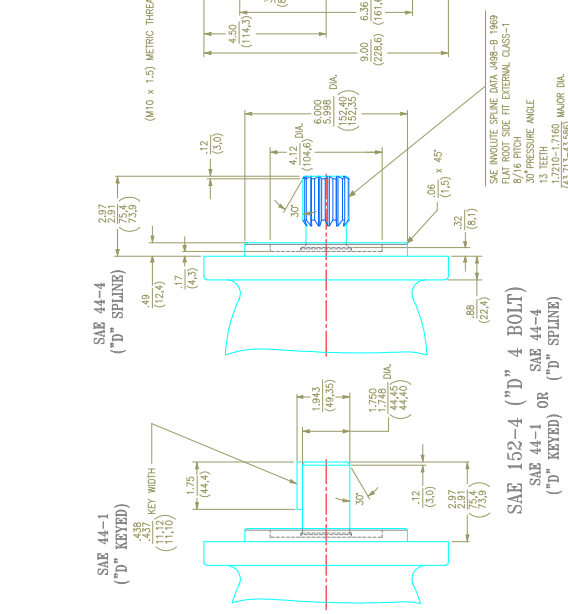
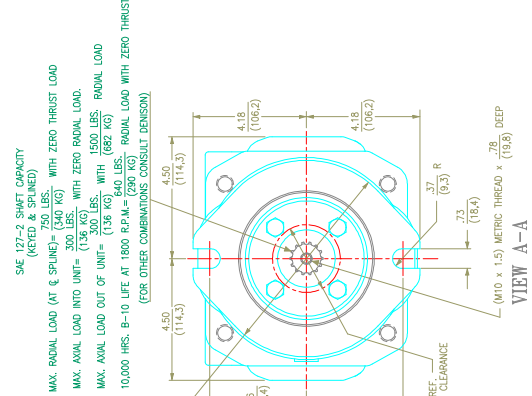
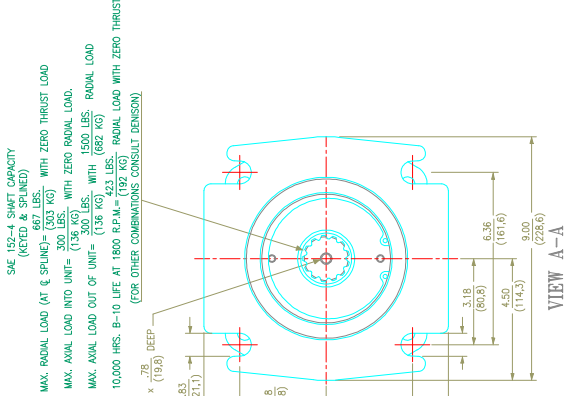
	6.0 in3	7.25 in3	8.0 in3
Maximum	41 GPM	50 GPM	57 GPM
System flow	155,9 l/m	189 l/m	208 l/m
Maximum	1.5 GPM	2 GPM	2 GPM
Case Drain Flow	5,7 l/m	7,6 l/m	7,6 l/m

4. Check for external leaks. No external leaks permitted.

INSTALLATION DRAWING



MOTOR PACKAGE	MOTOR ROTATION	PORT INLET	PORT OUTLET
W/S	R-CW	INLET	OUTLET
W/S	L-CW	OUTLET	INLET



ORDERING CODE

Gold Cup pumps										Model number sheet															
Example model code:										P	11	P		-2	R	1	*	-40	2	-B	00	-0	B	0	
Pump										P															
Displacement																									
6.00 cu.in./rev. (98 cc/rev.)											6														
7.25 cu.in./rev. (119 cc/rev.)											7														
8.00 cu.in./rev. (131 cc/rev.)											8														
11.0 cu.in./rev. (180 cc/rev.)											11														
14.0 cu.in./rev. (229 cc/rev.)											14														
24.6 cu.in./rev. (403 cc/rev.)											24														
30.6 cu.in./rev. (501 cc/rev.)											30														
Type																									
Fixed displacement, closed circuit											F														
Fixed displacement with high torque thru-drive, closed circuit											M														
Variable displacement, closed circuit											P														
Variable displacement with medium torque thru-drive, closed circuit											X														
Variable displacement with medium torque thru-drive & shuttle package, closed circuit											S														
Variable displacement with high torque thru-drive, closed circuit											R														
Variable displacement with high torque thru-drive & shuttle package, closed circuit											L														
Variable displacement, open circuit (for P6, 7, 8, 11, & 14 only)											V														
Variable displacement, open & closed circuit (for P6, 7, & 8 only)											D														
Efficiency																									
High efficiency (for P24 only)											H														
Standard efficiency																									
leave blank																									
Shaft																									
Keyed SAE - mechanical shaft seal (single lip seal on P6/7/8F/M)														-2 or -02											
Splined SAE - mechanical shaft seal (single lip seal on P6/7/8F/M)														-3 or -03											
Keyed SAE-D (mounting & shaft) - mechanical shaft seal (for P6/7/8 only) (single lip seal on P6/7/8F/M)														-4 or -04											
Splined SAE-D (mounting & shaft) - mechanical shaft seal (for P6/7/8 only) (single lip seal on P6/7/8F/M)														-5 or -05											
Keyed SAE - double lip shaft seal														-7 or -07											
Splined SAE - double lip shaft seal														-8 or -08											
Keyed (long) SAE - double lip shaft seal														-9 or -09											
Keyed (long) SAE - mechanical shaft seal														-10											
Rotation																									
Clockwise														R											
Counter-clockwise														L											
Seals																									
Nitrile (Buna N)																1									
EPR (not available when using "5A" or "5C" primary controls) (pump will be unpainted unless otherwise specified)																4									
Fluorocarbon (Viton)																5									
Design letter (assigned by manufacturer)																									
Primary controls																									
None (for fixed displacement units only)																									
Screw adjustment (spring offset to maximum displacement)																									
Cylinder control w/ adjustable maximum volume stops																									
Cylinder control - 3 position (spring centered with zero adjustment)																									
Cylinder control - 2 position electro-hydraulic w/ adjustable maximum volume stop (spring offset to maximum displacement)																									
Cylinder control - 3 position (spring centered) electro-hydraulic																									
Rotary servo - spring centered																									
Rotary servo - spring centered w/ adjustable maximum volume stops																									
Rotary servo - spring centered w/ automatic brake control																									
Rotary servo - spring centered w/ adjustable maximum volume stops & automatic brake control																									
Electro-hydraulic stroker w/ adjustable maximum volume stops																									
Electro-hydraulic stroker w/ adjustable maximum volume stops & automatic brake control																									
High IQ with 10 gpm servovalve & volume indicator																									
High IQ with 10 gpm servovalve & 4A (rotary servo) control																									
High IQ with 4DC01 valve & volume indicator																									
High IQ with 4DC01 valve & 4A (rotary servo) control																									
Hydraulic stroker w/ adjustable maximum volume stops																									
Hydraulic stroker w/ adjustable maximum volume stops & automatic brake control																									
Electro-hydraulic stroker w/ adjustable maximum volume stops																									
Electro-hydraulic stroker w/ adjustable maximum volume stops & automatic brake control																									
Secondary controls																									
None (for fixed displacement units only)																									
Volume indicator																									
Torque limiter & volume indicator																									
Cam position feedback potentiometer																									
Cam position feedback RVDT (DC)																									
Control location																									
None (for fixed displacement units only)																									
Primary control on port A side																									
Primary control on port B side																									

ORDERING CODE

Gold Cup pumps										Model number sheet														
Example model code:										P	11	P		-2	R	1	*	-40	2	-B	00	-0	B	0
Control and displacement features																								
2M* & 2N* controls																								
4D01 valve, 110VAC/60Hz with Hirschmann connector																					00			
4D01 valve, 12VDC with Hirschmann connector																					01			
4D01 valve, 240VAC/50Hz with Hirschmann connector																					02			
4D01 valve, 110VAC/60Hz, wiring box																					03			
4D01 valve, 12VDC, wiring box																					04			
Cetop3 (D03)(NG6) interface, no directional valve																					05			
4D01 valve, 24VDC with Hirschmann connector																					06			
4D01 valve, 110VAC/50Hz with Hirschmann connector																					07			
5** controls																								
with deadband																					00			
without deadband																					01			
7** controls																								
without manual override shutoff																					00			
with manual override shutoff (required for F, G, L & K primary options)																					01			
8** controls																								
75 - 350 psi (5 - 24 bar)																					00			
75 - 435 psi (5 - 30 bar)																					01			
100 - 380 psi (7 - 26 bar)																					02			
150 - 400 psi (10 - 28 bar)																					03			
75 - 250 psi (5 - 17 bar)																					04			
9** controls																								
24VDC																					00			
12VDC																					01			
All other controls																					00			
Reduced displacement options for P*F & P*M																								
Standard cam (19-degree)																					00			
P6 with 17-degree cam (5.3 cu.in./rev. (87 cc/rev.))																					10			
P7 with 17-degree cam (6.4 cu.in./rev. (105 cc/rev.))																					10			
P8 with 17-degree cam (7.1 cu.in./rev. (116 cc/rev.))																					10			
P6 with 15-degree cam (4.6 cu.in./rev. (76 cc/rev.))																					20			
P7 with 15-degree cam (5.6 cu.in./rev. (92 cc/rev.))																					20			
P8 with 15-degree cam (6.2 cu.in./rev. (102 cc/rev.))																					20			
P6 with 13-degree cam (4.0 cu.in./rev. (66 cc/rev.))																					30			
P7 with 13-degree cam (4.8 cu.in./rev. (79 cc/rev.))																					30			
P8 with 13-degree cam (5.3 cu.in./rev. (88 cc/rev.))																					30			
P11 with 17-degree cam (9.7 cu.in./rev. (160 cc/rev.))																					10			
P14 with 17-degree cam (12.5 cu.in./rev. (205 cc/rev.))																					10			
P11 with 15-degree cam (8.5 cu.in./rev. (140 cc/rev.))																					20			
P14 with 15-degree cam (10.9 cu.in./rev. (179 cc/rev.))																					20			
P24 with 17-degree cam (22.0 cu.in./rev. (360 cc/rev.))																					10			
P30 with 17-degree cam (27.2 cu.in./rev. (446 cc/rev.))																					10			
Internal pump																								
1.07 cu.in./rev. (17.5 cc/rev.) (P6/7/8P/S/X/V/D & P11/14V only)																					-0 (omit if no external drive is required)			
2.14 cu.in./rev. (35 cc/rev.) (P11/14P/S/X only)																					-0 (omit if no external drive is required)			
2.81 cu.in./rev. (46 cc/rev.) (P24/30P/S/X only) (standard)																					-0 (omit if no external drive is required)			
1.61 cu.in./rev. (26.4 cc/rev.) (P24/30P/S/X only) (auxiliary external replenishing flow required)																					-1			
1.05 cu.in./rev. (17.2 cc/rev.) (P24/30P/S/X only) (auxiliary external replenishing flow required)																					-2			
3.56 cu.in./rev. (58.3 cc/rev.) (P24/30P/S/X only)																					-3			
4.84 cu.in./rev. (79.3 cc/rev.) (P24/30P/S/X only)																					-4			
5.42 cu.in./rev. (88.8 cc/rev.) (P24/30P/S/X only)																					-5			
6.10 cu.in./rev. (100.0 cc/rev.) (P24/30P/S/X only)																					-6			
No internal pump (standard on P*R/L/F/M)																					-X			
External drive																								
None																							omit	
Blanking plate (for P6/7/8/11/14S/X only)																							M	
SAE-A (SAE 82-2)(P6/7/8/11/14S/X/R/L/M only)																							A	
SAE-B (SAE 101-2 for P6/7/8S/X/R/L/M & P11/14/24/30S/X)(SAE 101-2 & SAE 101-4 for P11/14/24/30R/L/M)																							B	
SAE-C (SAE 127-2 for P6/7/8R/L/M & P24/30S/X)(SAE 127-2 & SAE 127-4 for P11/14/24/30R/L/M)																							C	
SAE-D (SAE 152-4)(P11/14/24/30R/L/M only)																							D	
SAE-E (SAE 165-4)(P11/14/24/30R/L/M only)																							E	
SAE-F (SAE 177-4)(P24/30R/L/M only)																							F	
External mounting																								
No external pump mounted																							0 (omit if no external drive is required)	
External pump mounted (requires special modification "-M2")(must be separately specified)																							1	
Special modification																								
None																							omit	
No paint																							-NP	
Other special modification (example: bronze caged barrel bearing for low viscosity fluids, tandem pumps, etc.)																							-M2	

ORDERING CODE

Gold Cup motors													Model number sheet											
Example model code:																								
	M	11	R			-2	N	1	*	-9A	5	-B	0	0	-B	0								
Motor	M																							
Displacement																								
6.00 cu.in./rev. (98 cc/rev.)		6																						
7.25 cu.in./rev. (119 cc/rev.)		7																						
8.00 cu.in./rev. (131 cc/rev.)		8																						
11.0 cu.in./rev. (180 cc/rev.)		11																						
14.0 cu.in./rev. (229 cc/rev.)		14																						
24.6 cu.in./rev. (403 cc/rev.)		24																						
30.6 cu.in./rev. (501 cc/rev.)		30																						
Type																								
Fixed displacement			F																					
Fixed displacement with shuttle package			G																					
Fixed displacement with thru-drive			M																					
Fixed displacement with thru-drive & shuttle package			N																					
Variable displacement			V																					
Variable displacement with shuttle package			H																					
Variable displacement with thru-drive			R																					
Variable displacement with thru-drive & shuttle package			L																					
Efficiency																								
High efficiency (for M24 only)			H																					
Standard efficiency																					leave blank			
Shaft																								
Keyed SAE - mechanical shaft seal (single lip seal on M6/7/8F/G/M/N)						-2 or -02																		
Splined SAE - mechanical shaft seal (single lip seal on M6/7/8F/G/M/N)						-3 or -03																		
Keyed SAE-D (mounting & shaft) - mechanical shaft seal (for M6/7/8 only)(single lip seal on M6/7/8F/G/M/N)						-4 or -04																		
Splined SAE-D (mounting & shaft) - mechanical shaft seal (for M6/7/8 only)(single lip seal on M6/7/8F/G/M/N)						-5 or -05																		
Keyed SAE - double lip shaft seal						-7 or -07																		
Splined SAE - double lip shaft seal						-8 or -08																		
Keyed (long) SAE - double lip shaft seal						-9 or -09																		
Keyed (long) SAE - mechanical shaft seal						-10																		
Rotation																								
Bi-directional							N																	
Seals																								
Nitrile (Buna N)								1																
EPR (not available when using "5A" primary control)(pump will be unpainted unless otherwise specified)								4																
Fluorocarbon (Viton)								5																
Design letter (assigned by manufacturer)																								
*																								
Primary controls																								
None (for fixed displacement units only)																					omit			
Cylinder control w/ adjustable maximum volume stops																					-2A			
Cylinder control - 2 position electro-hydraulic w/ adjustable maximum volume stop (spring offset to maximum displacement)																					-2M			
Electro-hydraulic stroker w/ adjustable maximum volume stops																					-5A			
Hydraulic stroker w/ adjustable maximum volume stops (required for M 24/30 reverse compensator units)																					-8A			
Electro-hydraulic stroker w/ adjustable maximum volume stops																					-9A			
Secondary controls																								
None (for fixed displacement units only)																					omit			
Volume indicator																					0			
Reverse compensator (spring offset to maximum displacement) + volume indicator																					3			
Reverse compensator (spring offset to minimum displacement) + volume indicator																					5			
Cam position feedback potentiometer																					6			
Cam position feedback RVDVT (AC)																					7			
Cam position feedback RVDVT (DC)																					8			
Reverse compensator (3) + cam position feedback potentiometer (6)																					U			
Reverse compensator (3) + cam position feedback RVDVT (7)																					V			
Reverse compensator (3) + cam position feedback RVDVT (8)																					W			
Reverse compensator (5) + cam position feedback potentiometer (6)																					X			
Reverse compensator (5) + cam position feedback RVDVT (7)																					Y			
Reverse compensator (5) + cam position feedback RVDVT (8)																					Z			

ORDERING CODE

Gold Cup motors										Model number sheet					
Example model code:															
	M	11	R		-2	N	1	*	9A	5	-B	0	0	-B	0
Control location															
None (for fixed displacement units only)													omit		
Primary control on port A side													-A		
Primary control on port B side													-B		
Control and displacement features															
2M control															
4D01 valve, 110VAC/60Hz with Hirschmann connector													0		
4D01 valve, 12VDC with Hirschmann connector													1		
4D01 valve, 240VAC/50Hz with Hirschmann connector													2		
4D01 valve, 110VAC/60Hz wiring box													3		
4D01 valve, 12VDC, wiring box													4		
Cetop3 (D03)(NG6) interface, no directional valve													5		
4D01 valve, 24VDC with Hirschmann connector													6		
4D01 valve, 110VAC/50Hz with Hirschmann connector													7		
5A control															
with deadband													0		
without deadband													1		
8A control															
75-250 psi (5-17 bar)													0		
250-450 psi (17-31 bar)													1		
9A control															
24VDC													0		
12VDC													1		
All other controls													0		
Reduced displacement options for M*F, M*G, M*M, & M*N															
Standard cam (19-degree)													0		
M6 with 17-degree cam {5.3 cu.in./rev. (87 cc/rev.)}													1		
M7 with 17-degree cam {6.4 cu.in./rev. (105 cc/rev.)}													1		
M8 with 17-degree cam {7.1 cu.in./rev. (116 cc/rev.)}													1		
M6 with 15-degree cam {4.6 cu.in./rev. (76 cc/rev.)}													2		
M7 with 15-degree cam {5.6 cu.in./rev. (92 cc/rev.)}													2		
M8 with 15-degree cam {6.2 cu.in./rev. (102 cc/rev.)}													2		
M6 with 13-degree cam {4.0 cu.in./rev. (66 cc/rev.)}													3		
M7 with 13-degree cam {4.8 cu.in./rev. (79 cc/rev.)}													3		
M8 with 13-degree cam {5.3 cu.in./rev. (88 cc/rev.)}													3		
M11 with 17-degree cam {9.7 cu.in./rev. (160 cc/rev.)}													1		
M14 with 17-degree cam {12.5 cu.in./rev. (205 cc/rev.)}													1		
M11 with 15-degree cam {8.5 cu.in./rev. (140 cc/rev.)}													2		
M14 with 15-degree cam {10.9 cu.in./rev. (179 cc/rev.)}													2		
M24 with 17-degree cam {22.0 cu.in./rev. (360 cc/rev.)}													1		
M30 with 17-degree cam {27.2 cu.in./rev. (446 cc/rev.)}													1		
Shuttle valve features															
without orifices													0 (omit for M*F/M*/R units)		
with orifices													2		
External drive															
None (for M*F/G*/H units only)													omit		
SAE-A (SAE 82-2)(for M6/7/8/11/14M/N/R/L units only)													-A		
SAE-B (SAE 101-2 for M6/7/8M/N/R/L)(SAE 101-2 & SAE 101-4 for M11/14/24/30M/N/R/L)													-B		
SAEC (SAE 127-2 for M6/7/8M/N/R/L)(SAE 127-2 & SAE 127-4 for M11/14/24/30M/N/R/L)													-C		
SAE-D (SAE 152-4)(for M11/14/24/30M/N/R/L units only)													-D		
SAE-E (SAE 165-4)(for M11/14/24/30M/N/R/L units only)													-E		
SAE-F (SAE 177-4)(for M24/30M/N/R/L units only)													-F		
External mounting															
No external motor mounted													0		
External motor mounted (requires special modification "-M2")(must be separately specified)													1		
Special modification															
None													omit		
No paint													-NP		
Other special modification (example: bronze caged barrel bearing for low viscosity fluids, tandem motors, etc.)													-M2		

DEFINITION & UNIT

displacement	in ³ /rev x 16.387 = cm ³ /rev	cm ³ /rev x 0.06102 = in ³ /rev
flow	gpm x 3.78 = L/min	L/min x 0.2642 = gpm
power	hp x 0.7457 = kW	kW x 1.341 = hp
torque	lb-ft x 1.3567 = Nm	Nm x 0.7376 = lb-ft
pressure	lbs/in ² (psi) x 0.06895 = bar lbs/in ² (psi) x 6.895 = kPa	bar x 14.50 = lbs/in ² (psi) kPa x 0.1450 = lbs/in ² (psi)
weight	lb x 0.4536 = kg	N x 2.205 = lbs
force	lb x 4.448 = N	N x 0.2248 = lbs
volume	in ³ x 16.387 = cm ³	cm ³ x 0.6102 = in ³
area	in ² x 6.452 = cm ²	cm ² x 0.1550 = in ²
length	in x 25.4 = mm	mm x 0.03937 = in
temperature	<u>degree F-32</u> = °C	1.8 x C+32 = °F
viscosity	cSt x 1.0 = mm ² /sec	mm ² /sec x 1.0 = cSt
	<u>(SSU-14) @ cSt</u> 4.25	cSt x 4.25 + 14 @ SSU

FLUID POWER FORMULAS

Pump input torque	lbs. in.	$\frac{\text{pressure(psi)} \times \text{displacement (in}^3\text{/rev)}}{2\pi \times \text{mech. eff.}}$
Pump input power	hp	$\frac{\text{rpm} \times (\text{in}^3\text{/rev)} \times (\text{psi})}{395934 \times \text{overall eff.}}$
Pump output flow	U.S. gpm	$\frac{\text{rpm} \times (\text{in}^3\text{/rev)} \times \text{volumetric eff.}}{231}$
Fluid motor speed	rpm	$\frac{231 \times \text{flow rate (U.S. gpm)} \times \text{volumetric eff.}}{\text{displacement (in}^3\text{/rev)}}$
Fluid motor torque	lbs. in.	$\frac{\text{pressure(psi)} \times \text{displacement (in}^3\text{/rev)} \times \text{mech. eff.}}{2\pi}$
Fluid motor power	hp	$\frac{\text{rpm} \times (\text{in}^3\text{/rev)} \times (\text{psi}) \times \text{overall eff.}}{395934}$
(metric)		
Pump input torque	Nm	$\frac{\text{pressure(bar)} \times \text{displacement (cm}^3\text{/rev)}}{20\pi \times \text{mech. eff.}}$
Pump input power	kW	$\frac{\text{rpm} \times (\text{cm}^3\text{/rev)} \times (\text{bar})}{600000 \times \text{overall eff.}}$
Pump output flow	Lpm	$\frac{\text{rpm} \times (\text{cm}^3\text{/rev)} \times \text{volumetric eff.}}{1000}$
Fluid motor speed	rpm (min-1) (tr/mn)	$\frac{1000 \times \text{flow rate (Lpm)} \times \text{volumetric eff.}}{\text{displacement (cm}^3\text{/rev)}}$
Fluid motor torque	Nm	$\frac{\text{pressure(bar)} \times \text{displacement (cm}^3\text{/rev)} \times \text{mech. eff.}}{20\pi}$
Fluid motor power	kW	$\frac{\text{rpm} \times (\text{cm}^3\text{/rev)} \times (\text{bar}) \times \text{overall eff.}}{600000}$

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