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Hydraulic Cylinders
HV3 Series
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Operating Instructions and Maintenance Manual

Hydraulic Cylinders

Models 4Z630A thru 4Z659A; 4YRA2 thru 4YRA9; 4YRC1 thru 4YRC9; 4YRD1 thru 4YRD5.

READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THE MILLER HYDRAULIC CYLINDER. FAILURE TO COMPLY WITH INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR PROPERTY DAMAGE!

RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.

Description

The Miller Hydraulic cylinder is constructed of heavy duty materials to give efficient operation in systems using petroleum base fluid only. Optional seal materials are available for operation with other fluids.

General Safety Information

1. Unload any accumulator in the hydraulic system before attempting to remove or repair the cylinders or any components within the system.
2. Keep hands and clothing away from hydraulic cylinders when in operation.
3. Do not exceed the pressure rating of any component in your system.
4. Protect hydraulic hoses from damage or puncture.
5. Check hoses for weak or worn condition on a periodic basis, or before each use. Make sure all connections are secure.



Figure 1

Specifications & Dimensions

FORCE VOLUME CHART FOR 1 1/2 TO 4 BORE CYLINDERS

Bore	Piston Area (Sq. Ins.)	Force In Lbs. @ PSI				Cu. Ft. Displ. Per In. of Stroke
		500	1000	2000	2500	
Push Force						
1 1/2	1.77	885	1770	3540	4425	0.00102
2	3.14	1570	3140	6280	7850	0.00182
2 1/2	4.91	2455	4910	9820	12275	0.00284
3 1/4	8.30	4150	8300	16600	20750	0.00480
4	12.57	6285	12570	25140	31425	0.00727
Pull Force						
1 1/2	1.46	730	1460	2920	3650	0.00084
2	2.36	1180	2360	4720	5900	0.00137
2 1/2	4.12	2060	4120	8240	10300	0.00238
3 1/4	6.81	3405	6810	13620	17025	0.00394
4	10.16	5080	10160	20320	25400	0.00588

Specifications & Dimensions (continued)

Model		Bore Dia.	Stroke	Shipping Wt.	Model		Bore Dia.	Stroke	Shipping Wt.
Standard Piston	Magnetic Piston				Standard Piston	Magnetic Piston			
4Z630A	N/A	1 1/2"	1"	8.0	4Z645A	4YRC2	2 1/2"	6"	23.0
4Z631A	N/A	1 1/2"	2	8.5	4Z646A	4YRC3	2 1/2"	8"	24.0
4Z632A	4YRA2	1 1/2"	3	8.6	4Z647A	4YRC4	2 1/2"	10"	27.0
4Z633A	4YRA3	1 1/2"	4	9.1	4Z648A	N/A	3 1/4"	2	36.0
4Z634A	4YRA4	1 1/2"	6"	11.0	4Z649A	4YRC5	3 1/4"	4	41.0
4Z635A	4YRA5	1 1/2"	8"	11.0	4Z650A	4YRC6	3 1/4"	6"	42.0
4Z636A	N/A	2	1	13.0	4Z651A	4YRC7	3 1/4"	8"	46.0
4Z637A	N/A	2	2	13.0	4Z652A	4YRC8	3 1/4"	10"	51.0
4Z638A	4YRA6	2	4	15.0	4Z653A	4YRC9	3 1/4"	12"	53.0
4Z639A	4YRA7	2	6"	17.0	4Z654A	N/A	4	2	46.0
4Z640A	4YRA8	2	8"	19.0	4Z655A	4YRD1	4	4	54.0
4Z641A	4YRA9	2	10"	20.0	4Z656A	4YRD2	4	6"	61.0
4Z642A	N/A	2 1/2"	1	17.0	4Z657A	4YRD3	4	8"	65.0
4Z643A	N/A	2 1/2"	2	19.0	4Z658A	4YRD4	4	10"	70.0
4Z644A	4YRC1	2 1/2"	4	20.0	4Z659A	4YRD5	4	12"	72.0

*6, 8, 10 and 12" stroke cylinders have cushions on both ends to absorb shocks.

Accessory and Tie Rod Torque Specifications

Always lubricate threads of tie rods or bolts with high pressure lubricant before torquing them to the values listed in this table.

Bore Size	**Ft. Lbs. of Torque	Bore Size	**Ft. Lbs. of Torque
1 1/2"	18	3 1/4"	120
2"	45	4	131
2 1/2"	45	-	-

**Use 1/2 above torque for square retainer assembly.

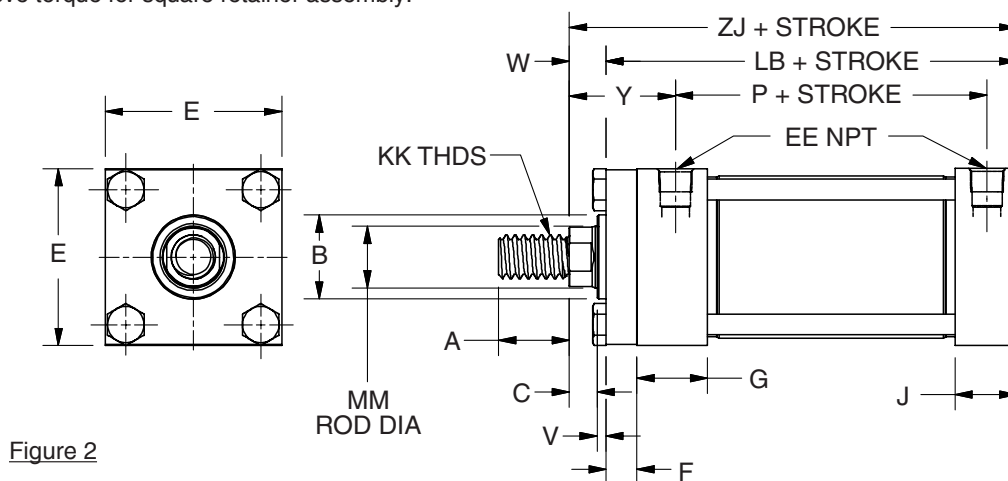


Figure 2

HYDRAULIC CYLINDER DIMENSIONS IN INCHES

Bore	A	B	C	E	EE	F	G	J	KK	LB	MM	P	V	W	Y	ZJ
1 1/2	3/4	1 1/8	3/8	2 1/2	1/2	3/8	1 3/4	1 1/2	7/16-20	5	5/8	2 7/8	1/4	5/8	2	5 5/8
2	1 1/8	1 1/2	1/2	3	1/2	5/8	1 3/4	1 1/2	3/4-16	5 1/4	1	2 7/8	1/4	3/4	2 3/8	6
2 1/2	1 1/8	1 1/2	1/2	3 1/2	1/2	5/8	1 3/4	1 1/2	3/4-16	5 3/8	1	3	1/4	3/4	2 3/8	6 1/8
3 1/4	1 5/8	2	5/8	4 1/2	3/4	3/4	2	1 3/4	1-14	6 1/4	1 3/8	3 1/2	1/4	7/8	2 3/4	7 1/8
4	2	2 3/8	3/4	5	3/4	7/8	2	1 3/4	1 1/4-12	6 5/8	1 3/4	3 3/4	1/4	1	3	7 5/8

Accessories

Dimensions in inches for Mounting Kits

END MOUNTS FOR HYDRAULIC CYLINDERS

(All mounts can be added without removing tie rods. Meet NFPA Mounting Dimensions Standards.)

STEEL FRONT OR REAR FLANGE MOUNT

(Mounts to cylinder rear with 4 bolts provided. Front mounting requires bolt removal of retaining plate. NFPA "MF1" mounting if front flange, NFPA "MF2" mounting if rear flange.)

Model	Bore	F	R	TF	UF	W	FB
1A329B	1 1/2	3/8	1.63	3 7/16	4 1/4	5/8	7/16
1A332B	2	5/8	2.05	4 1/8	5 1/8	3/4	9/16
1A335B	2 1/2	5/8	2.55	4 5/8	5 5/8	3/4	9/16
1A338B	3 1/4	3/4	3.25	5 7/8	7 1/8	7/8	11/16
1A341B	4	7/8	3.82	6 3/8	7 5/8	1	11/16

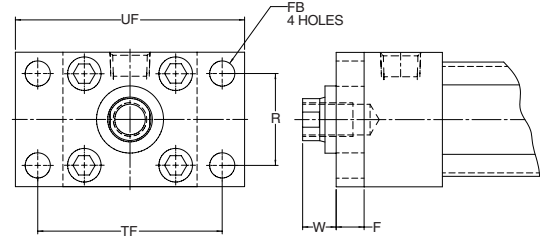
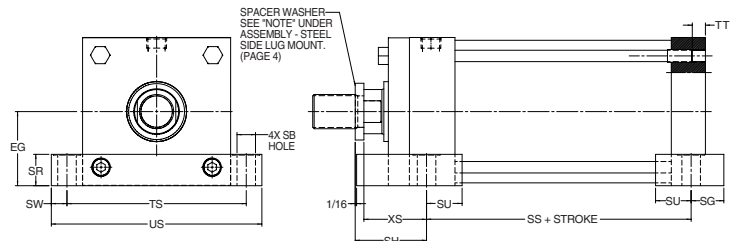


Figure 3

STEEL SIDE LUG MOUNT

(Mounts to cylinder head and cap with four bolts provided. NFPA "MS2" mounting.)

Model	Bore	SH	SG	EG	SB	SR	SU
1A330B	1 1/2	1 9/16	1 1/8	1 1/4	7/16	7/8	15/16
1A333B	2	2 1/8	1 1/2	1 1/2	9/16	1	1 1/4
1A336B	2 1/2	2 5/16	1 11/16	1 3/4	13/16	1	1 9/16
1A339B	3 1/4	2 11/16	1 15/16	2 1/4	13/16	1 1/4	1 9/16
1A342B	4	3	2 1/8	2 1/2	1 1/16	1 1/4	2



Model	Bore	SW	TS	US	XS	SS	TT
1A330B	1 1/2	3/8	3 1/4	4	1 3/8	3 7/8	57/64
1A333B	2	1/2	4	5	1 7/8	3 5/8	7/8
1A336B	2 1/2	11/16	4 7/8	6 1/4	2 1/16	3 3/8	7/8
1A339B	3 1/4	11/16	5 7/8	7 1/4	2 5/16	4 1/8	29/32
1A342B	4	7/8	6 3/4	8 1/2	2 3/4	4	15/16

Figure 4

STEEL REAR CLEVIS MOUNT

(Includes clevis pin and four mounting bolts. NPFA "MP2" mounting.)

Model	Bore	CB	CD	CW	FL	L	M
1A331B	1 1/2	3/4	1/2	7/16	1 1/8	3/4	1/2
1A334B	2	1 1/4	3/4	9/16	1 7/8	1 1/4	3/4
1A337B	2 1/2	1 1/4	3/4	9/16	1 7/8	1 1/4	3/4
1A340B	3 1/4	1 1/2	1	11/16	2 1/4	1 1/2	1
1A343B	4	2	1 3/8	15/16	2 7/8	2	1 5/16

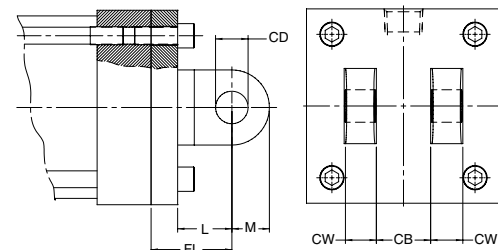


Figure 5

STEEL EYE BRACKET (Model 1A350B is nodular iron.)

(Provides swivel mounting with rod or clevis mount.)

Model	Bore	CB	CD	DD	E	F	FL	LR	M	MR	R
1A344B	1 1/2	3/4	1/2	13/32	2 1/2	3/8	1 1/8	3/4	1/2	9/16	1.63
1A346B	2-2 1/2	1 1/4	3/4	17/32	3 1/2	5/8	1 7/8	1 1/4	3/4	7/8	2.55
1A348B	3 1/4	1 1/2	1	21/32	4 1/2	3/4	2 1/4	1 1/2	1	1 1/4	3.25
1A350B	4	2	1 3/8	21/32	5	7/8	3	2 1/8	1 3/8	1 5/8	3.82

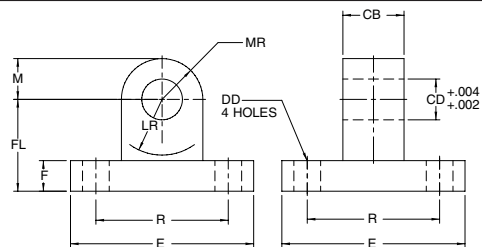


Figure 6

STEEL ROD CLEVIS MOUNT (Model 1A351B is nodular iron.)

(Includes clevis pin.)

Model	Bore	A	CB	CD	CE	CW	ER	KK
1A345B	1 1/2	3/4	3/4	1/2	1 1/2	1/2	1/2	7/16-20
1A347B	2-2 1/2	1 1/8	1 1/4	3/4	2 1/8	5/8	3/4	3/4-16
1A349B	3 1/4	1 5/8	1 1/2	1	2 15/16	3/4	1	1-14
1A351B	4	2	2	1 3/8	3 3/4	1	1 3/8	1 1/4-12

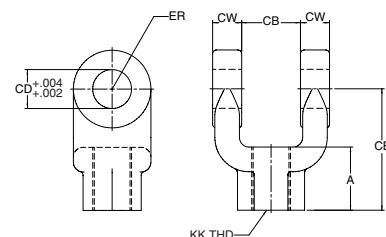


Figure 7

Assembly

FLANGE MOUNT KITS

Front Flange – Remove four bolts which secure the square retainer plate and remove plate. Replace with the flange plate and use the four screws supplied in the kit to secure the flange.

Rear Flange – Secure flange to rear cap with the four screws provided. (See torque specifications on page 2.)

ROD CLEVIS

Thread the rod clevis onto the rod using all the threads and butting the shoulder of the clevis to the shoulder of the rod.

REAR CLEVIS MOUNT KIT

Use four bolts provided with kit to secure clevis bracket to cap of cylinder. (See torque specifications on page 2.)

STEEL SIDE LUG MOUNT

The steel side lug mounts bolt to the front and rear of the cylinder. First, remove the two lower front flange bolts. With cylinder lying on a flat surface, slide the larger U-bracket onto head and secure with two long screws which are supplied in the kit. Slide smaller U-bracket over cap making sure that the bracket is flat on the same surface with the cylinder and secure by using the two short screws provided. (See torque specifications on page 2.)

NOTE: The mating part of the piston rod should always be tight against the piston rod shoulder. If interference with the side lug is a problem, the spacer washer supplied with the side lug mounting should be used. See Figure 4. Lugs should be pinned or blocked on appropriate end to absorb hydraulic or mechanical shock.

STEEL EYE BRACKET

Remove the clevis pin from either the rear clevis or rod clevis. Eye bracket will fit between the clevis and reinsert the clevis pin. Be sure to place the cotter pins in the clevis pin to secure. Eye bracket can be secured to machinery with bolts through the holes provided.

Operation

The maximum life of the hydraulics can be obtained by using the proper filtration in a hydraulic system. The Miller Hydraulic cylinders and accessories are designed to have a maximum rated pressure of 2500 psi.

Prior to connecting the hydraulic hoses to your cylinder, keep the port protectors in place to prevent dirt and other foreign particles from entering the cylinder. Contaminants can cause premature failure to your hydraulic cylinder and other components. Mount the cylinder and carefully check the alignment of the piston rod end and the machine base with the rod in the extended and retracted positions. Attaching the load to a retracted piston rod, of fixed mounted cylinders, will help achieve proper alignment. The cylinders have standard 1/2" NPT or 3/4" NPT ports in the heads and caps. Make sure only standard male NPT fittings are used. Connect the fluid supply line to the head and cap. The use of various sealants on pipe thread fitting will eliminate most minor thread leakages.

Do not grip the piston rod diameter with tools such as pliers, wrenches, etc.; wrench flats are provided for this purpose, as any nicks or scratches on major diameter of the piston rod will damage the rod seals. Always mount cylinders using the largest possible high strength alloy steel socket head screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendation for their size.

Maintenance

1. To replace the rod bushing seals:
 - a. Remove the bolts which hold the square retainer plate or front flange from the cylinder. Slide the retainer or front flange and the rod bushing off of the rod. Remove the rod seals from the bushing, taking care not to damage the seal cavity. Install the new seals as required. Use some lubricant such as lightweight motor oil to aid in inserting the seals into grooves.
 - b. To replace the rod bushing assembly into cylinder, lubricate the inside and outside of the bushing lightly. While supporting the piston rod assembly slide the bushing over the piston rod by turning the bushing clockwise while pushing the bushing gently over the piston rod.
2. To replace the piston seals:
 - a. Before disassembling cylinder, scribe tie rods at the cap to assure proper reassembly. Disassemble the cylinder by loosening the tie rod sleeve nuts at the head end of the cylinder, using a standard socket wrench. Remove the head from the cylinder tube, slide the cylinder tube off of the piston rod assembly. Slide the piston rod assembly out of the head assembly, taking care not to damage the rod seals. Remove the piston seals from the grooves in the piston, taking care not to scratch the piston seal groove. Place the new seal in the piston groove. Remove the tube end seals from the grooves in the head and cap. Lubricate the new tube end seals and install them in the head and cap cylinder tubing grooves.
 - b. Clean the entire inside of the cylinder tube, piston rod assembly and all other parts of the cylinder prior to assembling. Coat the cylinder tube I.D., O.D. of piston, and piston seals with a lightweight petroleum base oil (a 10 weight oil is fine) before assembling the cylinder.
3. Reassemble the cylinder in the following manner:
 - a. Place the cap end on the table with the tube groove facing up.
 - b. Position the cylinder tube in the tube groove.
 - c. Insert the piston rod assembly into the tube, making sure the lip of the piston seal is not damaged as it enters the tube. Insert fully to the bottom of the tube.
 - d. Place head and bushing over end piston rod, pushing gently while turning head and bushing assembly clockwise until the bushing has cleared the wrench flat area of the piston rod.
4. Be sure cylinder tube is seated into the cylinder tube groove in the head.
5. The tie rod to cap thread is critical. Make sure that the tie rods are screwed into the cap to the depth as shown in Figure 4. Scribe mark on the tie rod should be flush with tubing groove face of cap. Grip the tie rods to prevent rotating. Loosely screw the tie rod nuts on the tie rods. Lie the cylinder on a flat surface so that the head and cap will be squarely oriented. Tighten sleeve nuts a little at a time to prevent binding of the cylinder assembly. For correct torque pressure, see "Torque Specifications" on page 2.
6. Replace the square retainer plate over the bushing and torque screws as per table.

Trouble Shooting Chart

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Cylinder will not function.	1. Pressure too low. 2. Piston seal leak. 3. Cylinder is undersized for the load. 4. Contamination in the hydraulic system resulting in scored cylinder bore.	1. Check pressure at cylinder to make sure it is to the circuit requirements. 2. Operate the valve to cycle the cylinder and observe fluid flow at the valve tank drain ports at the end of the cylinder stroke. Replace piston seals if flow is excessive. 3. Replace the cylinder with one of a larger bore size. 4. Disassemble and replace necessary parts of cylinder and filter the hydraulic system.

Safety Guide for Selecting and Using Hydraulic, Pneumatic Cylinders and Their Accessories

WARNING: ⚠ FAILURE OF THE CYLINDER, ITS PARTS, ITS MOUNTING, ITS CONNECTIONS TO OTHER OBJECTS, OR ITS CONTROLS CAN RESULT IN:

- Unanticipated or uncontrolled movement of the cylinder or objects connected to it.
- Falling of the cylinder or objects held up by it.
- Fluid escaping from the cylinder, potentially at high velocity.

THESE EVENTS COULD CAUSE DEATH OR PERSONAL INJURY BY, FOR EXAMPLE, PERSONS FALLING FROM HIGH LOCATIONS, BEING CRUSHED OR STRUCK BY HEAVY OR FAST MOVING OBJECTS, BEING PUSHED INTO DANGEROUS EQUIPMENT OR SITUATIONS, OR SLIPPING ON ESCAPED FLUID.

Before selecting or using Parker Hannifin Corporation (the Company) cylinders or related accessories, it is important that you read, understand and follow the following safety information. Training is advised before selecting and using the Company's products.

1.0 General Instructions

1.1 Scope – This safety guide provides instructions for selecting and using (including assembling, installing, and maintaining) cylinder products. This safety guide is a supplement to and is to be used with the specific Company publications for the specific cylinder products that are being considered for use.

1.2 Fail Safe – Cylinder products can and do fail without warning for many reasons. All systems and equipment should be designed in a fail-safe mode so that if the failure of a cylinder product occurs people and property won't be endangered.

1.3 Distribution – Provide a free copy of this safety guide to each person responsible for selecting or using cylinder products. Do not select or use the Company's cylinders without thoroughly reading and understanding this safety guide as well as the specific Company publications for the products considered or selected.

1.4 User Responsibility – Due to very wide variety of cylinder applications and cylinder operating conditions, the Company does not warrant that any particular cylinder is suitable for any specific application. This safety guide does not analyze all technical parameters that must be considered in selecting a product. The hydraulic and pneumatic cylinders outlined in this catalog are designed to the Company's design guidelines and do not necessarily meet the design guideline of other agencies such as American Bureau of Shipping, ASME Pressure Vessel Code etc. The user, through its own analysis and testing, is solely responsible for:

- Making the final selection of the cylinders and related accessories.
- Determining if the cylinders are required to meet specific design requirements as required by the Agency(s) or industry standards covering the design of the user's equipment.
- Assuring that the user's requirements are met, OSHA requirements are met, and safety guidelines from the applicable agencies such as but not limited to ANSI are followed and that the use presents no health or safety hazards.
- Providing all appropriate health and safety warnings on the equipment on which the cylinders are used.

1.5 Additional Questions – Call the appropriate Company technical service department if you have any questions or require any additional information. See the Company publication for the product being considered or used, or call 1-847-298-2400, or go to www.parker.com, for telephone numbers of the appropriate technical service department.

2.0 Cylinder and Accessories Selection

2.1 Seals – Part of the process of selecting a cylinder is the selection of seal compounds. Before making this selection, consult the "seal information page(s)" of the publication for the series of cylinders of interest.

The application of cylinders may allow fluids such as cutting fluids, wash down fluids etc. to come in contact with the external area of the cylinder. These fluids may attack the piston rod wiper and or the primary seal and must be taken into account when selecting and specifying seal compounds.

Dynamic seals will wear. The rate of wear will depend on many operating factors. Wear can be rapid if a cylinder is mis-aligned or if the cylinder has been improperly serviced. The user must take seal wear into consideration in the application of cylinders.

2.2 Piston Rods – Possible consequences of piston rod failure or separation of the piston rod from the piston include, but are not limited to are:

- Piston rod and or attached load thrown off at high speed.
- High velocity fluid discharge.
- Piston rod extending when pressure is applied in the piston retract mode.

Piston rods or machine members attached to the piston rod may move suddenly and without warning as a consequence of other conditions occurring to the machine such as, but not limited to:

- Unexpected detachment of the machine member from the piston rod.
- Failure of the pressurized fluid delivery system (hoses, fittings, valves, pumps, compressors) which maintain cylinder position.
- Catastrophic cylinder seal failure leading to sudden loss of pressurized fluid.
- Failure of the machine control system.

Follow the recommendations of the "Piston Rod Selection Chart and Data" in the publication for the series of cylinders of interest. The suggested piston rod diameter in these charts must be followed in order to avoid piston rod buckling.

Piston rods are not normally designed to absorb bending moments or loads which are perpendicular to the axis of piston rod motion. These additional loads can cause the piston rod to fail. If these types of additional loads are expected to be imposed on the piston rod, their magnitude should be made known to our engineering department.

The cylinder user should always make sure that the piston rod is securely attached to the machine member.

On occasion cylinders are ordered with double rods (a piston rod extended from both ends of the cylinder). In some cases a stop is threaded on to one of the piston rods and used as an external stroke adjuster. On occasions spacers are attached to the machine member connected to the piston rod and also used as a stroke adjuster. In both cases the stops will create a pinch point and the user should consider appropriate use of guards. If these external stops are not perpendicular to the mating contact surface, or if debris is trapped between the contact surfaces, a bending moment will be placed on the piston rod, which can lead to piston rod failure. An external stop will also negate the effect of cushioning and will subject the piston rod to impact loading. Those two (2) conditions can cause piston rod failure. Internal stroke adjusters are available with and without cushions. The use of external stroke adjusters should be reviewed with our engineering department.

The piston rod to piston and the stud to piston rod threaded connections are secured with an anaerobic adhesive. The strength of the adhesive decreases with increasing temperature. Cylinders which can be exposed to temperatures above +250°F (+121°C) are to be ordered with a non studded piston rod and a pinned piston to rod joint.

2.3 Cushions – Cushions should be considered for cylinder applications when the piston velocity is expected to be over 4 inches/second.

Cylinder cushions are normally designed to absorb the energy of a linear applied load. A rotating mass has considerably more energy than the same mass moving in a linear mode. Cushioning for a rotating mass application should be review by our engineering department.

2.4 Cylinder Mountings – Some cylinder mounting configurations may have certain limitations such as but not limited to minimum stroke for side or foot mounting cylinders or pressure de-ratings for certain mounts. Carefully review the catalog for these types of restrictions.

Always mount cylinders using the largest possible high tensile alloy steel socket head cap screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

2.5 Port Fittings – Hydraulic cylinders applied with meter out or deceleration circuits are subject to intensified pressure at piston rod end.

The rod end pressure is approximately equal to:

$$\frac{\text{operating pressure} \times \text{effective cap end area}}{\text{effective rod end piston area}}$$

Contact your connector supplier for the pressure rating of individual connectors.

3.0 Cylinder and Accessories Installation and Mounting

3.1 Installation

3.1.1 – Cleanliness is an important consideration, and cylinders are shipped with the ports plugged to protect them from contaminants entering the ports. These plugs should not be removed until the piping is to be installed. Before making the connection to the cylinder ports, piping should be thoroughly cleaned to remove all chips or burrs which might have resulted from threading or flaring operations.

3.1.2 – Cylinders operating in an environment where air drying materials are present such as fast-drying chemicals, paint, or weld splatter, or other hazardous conditions such as excessive heat, should have shields installed to prevent damage to the piston rod and piston rod seals.

3.1.3 – Proper alignment of the cylinder piston rod and its mating component on the machine should be checked in both the extended and retracted positions. Improper alignment will result in excessive rod gland and/or cylinder bore wear. On fixed mounting cylinders attaching the piston rod while the rod is retracted will help in achieving proper alignment.

3.1.4 – Sometimes it may be necessary to rotate the piston rod in order to thread the piston rod into the machine member. This operation must always be done with zero pressure being applied to either side of the piston. Failure to follow this procedure may result in loosening the piston to rod-threaded connection. In some rare cases the turning of the piston rod may rotate a threaded piston rod gland and loosen it from the cylinder head. Confirm that this condition is not occurring. If it does, re-tighten the piston rod gland firmly against the cylinder head.

For double rod cylinders it is also important that when attaching or detaching the piston rod from the machine member that the torque be applied to the piston rod end of the cylinder that is directly attaching to the machine member with the opposite end unrestrained. If the design of the machine is such that only the rod end of the cylinder opposite to where the rod attaches to the machine member can be rotated, consult the factory for further instructions.

3.2 Mounting Recommendations

3.2.1 – Always mount cylinders using the largest possible high tensile alloy steel socket head screws that can fit in the cylinder mounting holes and torque them to the manufacturer's recommendations for their size.

3.2.2 – Side-Mounted Cylinders – In addition to the mounting bolts, cylinders of this type should be equipped with thrust keys or dowel pins located so as to resist the major load.

3.2.3 – Tie Rod Mounting – Cylinders with tie rod mountings are recommended for applications where mounting space is limited. The standard tie rod extension is shown as BB in dimension tables. Longer or shorter extensions can be supplied. Nuts used for this mounting style should be torqued to the same value as the tie rods for that bore size.

3.2.4 – Flange Mount Cylinders – The controlled diameter of the rod gland extension on head end flange mount cylinders can be used as a pilot to locate the cylinders in relation to the machine. After alignment has been obtained, the flanges may be drilled for pins or dowels to prevent shifting.

3.2.5 – Trunnion Mountings – Cylinders require lubricated bearing blocks with minimum bearing clearances. Bearing blocks should be carefully aligned and rigidly mounted so the trunnions will not be subjected to bending moments. The rod end should also be pivoted with the pivot pin in line and parallel to axis of the trunnion pins.

3.2.6 – Clevis Mountings – Cylinders should be pivoted at both ends with centerline of pins parallel to each other. After cylinder is mounted, be sure to check to assure that the cylinder is free to swing through its working arc without interference from other machine parts.

4.0 Cylinder and Accessories Maintenance, Troubleshooting and Replacement

4.1 Storage – At times cylinders are delivered before a customer is ready to install them and must be stored for a period of time. When storage is required the following procedures are recommended.

4.1.1 – Store the cylinders in an indoor area which has a dry, clean and noncorrosive atmosphere. Take care to protect the cylinder from both internal corrosion and external damage.

4.1.2 – Whenever possible cylinders should be stored in a vertical position (piston rod up). This will minimize corrosion due to possible condensation which could occur inside the cylinder. This will also minimize seal damage.

4.1.3 – Port protector plugs should be left in the cylinder until the time of installation.

4.1.4 – If a cylinder is stored full of hydraulic fluid, expansion of the fluid due to temperature changes must be considered. Installing a check valve with free flow out of the cylinder is one method.

4.1.5 – When cylinders are mounted on equipment that is stored outside for extended periods, exposed unpainted surfaces, e.g. piston rod, must be coated with a rust-inhibiting compound to prevent corrosion.

4.2 Cylinder Trouble Shooting

4.2.1 – External Leakage

4.2.1.1 – Rod seal leakage can generally be traced to worn or damaged seals. Examine the piston rod for dents, gouges or score marks, and replace piston rod if surface is rough.

Rod seal leakage could also be traced to gland wear. If clearance is excessive, replace rod bushing and seal. Rod seal leakage can also be traced to seal deterioration. If seals are soft or gummy or brittle, check compatibility of seal material with lubricant used if air cylinder, or operating fluid if hydraulic cylinder. Replace with seal material, which is compatible with these fluids. If the seals are hard or have lost elasticity, it is usually due to exposure to temperatures in excess of 165°F. (+74°C). Shield the cylinder from the heat source to limit temperature to 350°F. (+177°C.) and replace with fluorocarbon seals.

4.2.1.2 – Cylinder body seal leak can generally be traced to loose tie rods. Torque the tie rods to manufacturer's recommendation for that bore size.

Excessive pressure can also result in cylinder body seal leak. Determine maximum pressure to rated limits. Replace seals and retorque tie rods as in paragraph above. Excessive pressure can also result in cylinder body seal leak. Determine if the pressure rating of the cylinder has been exceeded. If so, bring the operating pressure down to the rating of the cylinder and have the tie rods replaced.

Pinched or extruded cylinder body seal will also result in a leak. Replace cylinder body seal and retorque as in paragraph above.

Cylinder body seal leakage due to loss of radial squeeze which shows up in the form of flat spots or due to wear on the O.D. or I.D. – Either of these are symptoms of normal wear due to high cycle rate or length of service. Replace seals as per paragraph above.

4.2.2 – Internal Leakage

4.2.2.1 – Piston seal leak (by-pass) 1 to 3 cubic inches per minute leakage is considered normal for piston ring construction. Virtually no static leak with lipseal type seals on piston should be expected. Piston seal wear is a usual cause of piston seal leakage. Replace seals as required.

4.2.2.2 – With lipseal type piston seals excessive back pressure due to over-adjustment of speed control valves could be a direct cause of rapid seal wear. Contamination in a hydraulic system can result in a scored cylinder bore, resulting in rapid seal wear. In either case, replace piston seals as required.

4.2.2.3 – What appears to be piston seal leak, evidenced by the fact that the cylinder drifts, is not always traceable to the piston. To make sure, it is suggested that one side of the cylinder piston be pressurized and the fluid line at the opposite port be disconnected. Observe leakage. If none is evident, seek the cause of cylinder drift in other component parts in the circuit.

4.2.3 – Cylinder Fails to Move the Load

4.2.3.1 – Pneumatic or hydraulic pressure is too low. Check the pressure at the cylinder to make sure it is to circuit requirements.

4.2.3.2 – Piston Seal Leak – Operate the valve to cycle the cylinder and observe fluid flow at valve exhaust ports at end of cylinder stroke. Replace piston seals if flow is excessive.

4.2.3.3 – Cylinder is undersized for the load – Replace cylinder with one of a larger bore size.

4.3 Erratic or Chatter Operation

4.3.1 – Excessive friction at rod gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.

4.3.2 – Cylinder sized too close to load requirements – Reduce load or install larger cylinder.

4.3.3 – Erratic operation could be traced to the difference between static and kinetic friction. Install speed control valves to provide a back pressure to control the stroke.

4.4 Cylinder Modifications, Repairs, or Failed Component – Cylinders as shipped from the factory are not to be disassembled and/or modified. If cylinders require modifications, these modifications must be done at company locations or by the Company's certified facilities. The Cylinder Division Engineering Department must be notified in the event of a mechanical fracture or permanent deformation of any cylinder component (excluding seals). This includes a broken piston rod, tie rod, mounting accessory or any other cylinder component. The notification should include all operation and application details. This information will be used to provide an engineered repair that will prevent recurrence of the failure.

It is allowed to disassemble cylinders for the purpose of replacing seals or seal assemblies. However, this work must be done by strictly following all the instructions provided with the seal kits.

Offer of Sale

The items described in this document and other documents and descriptions provided by Parker Hannifin Corporation, Hydraulics Group, and its authorized distributors ("Seller") are hereby offered for sale at prices to be established by Seller. This offer and its acceptance by any customer ("Buyer") shall be governed by all of the following Terms and Conditions. Buyer's order for any item described in its document, when communicated to Seller verbally, or in writing, shall constitute acceptance of this offer. All goods or work described will be referred to as "Products".

1. Terms and Conditions. Seller's willingness to offer Products, or accept an order for Products, to or from Buyer is expressly conditioned on Buyer's assent to these Terms and Conditions and to the terms and conditions found on-line at www.parker.com/saleterms/. Seller objects to any contrary or additional term or condition of Buyer's order or any other document issued by Buyer.

2. Price Adjustments; Payments. Prices stated on the reverse side or preceding pages of this document are valid for 30 days. After 30 days, Seller may change prices to reflect any increase in its costs resulting from state, federal or local legislation, price increases from its suppliers, or any change in the rate, charge, or classification of any carrier. The prices stated on the reverse or preceding pages of this document do not include any sales, use, or other taxes unless so stated specifically. Unless otherwise specified by Seller, all prices are F.O.B. Seller's facility, and payment is due 30 days from the date of invoice. After 30 days, Buyer shall pay interest on any unpaid invoices at the rate of 1.5% per month or the maximum allowable rate under applicable law.

3. Delivery Dates; Title and Risk; Shipment. All delivery dates are approximate and Seller shall not be responsible for any damages resulting from any delay. Regardless of the manner of shipment, title to any products and risk of loss or damage shall pass to Buyer upon tender to the carrier at Seller's facility (i.e., when it's on the truck, it's yours). Unless otherwise stated, Seller may exercise its judgment in choosing the carrier and means of delivery. No deferment of shipment at Buyers' request beyond the respective dates indicated will be made except on terms that will indemnify, defend and hold Seller harmless against all loss and additional expense. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's changes in shipping, product specifications or in accordance with Section 13, herein.

4. Warranty. Seller warrants that the Products sold hereunder shall be free from defects in material or workmanship for a period of eighteen months from the date of delivery to Buyer. The prices charged for Seller's products are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **DISCLAIMER OF WARRANTY: THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO PRODUCTS PROVIDED HEREUNDER. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS AND IMPLIED, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon delivery. No claims for shortages will be allowed unless reported to the Seller within 10 days of delivery. No other claims against Seller will be allowed unless asserted in writing within 60 days after delivery or, in the case of an alleged breach of warranty, within 30 days after the date within the warranty period on which the defect is or should have been discovered by Buyer. Any action based upon breach of this agreement or upon any other claim arising out of this sale (other than an action by Seller for any amount due to Seller from Buyer) must be commenced within thirteen months from the date of tender of delivery by Seller or, for a cause of action based upon an alleged breach of warranty, within thirteen months from the date within the warranty period on which the defect is or should have been discovered by Buyer.

6. LIMITATION OF LIABILITY. UPON NOTIFICATION, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE A DEFECTIVE PRODUCT, OR REFUND THE PURCHASE PRICE. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR AS THE RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT, EVEN IF SELLER HAS BEEN NEGLIGENT, WHETHER IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS.

7. Contingencies. Seller shall not be liable for any default or delay in performance if caused by circumstances beyond the reasonable control of Seller.

8. User Responsibility. The user, through its own analysis and testing, is solely responsible for making the final selection of the system and Product and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application and follow applicable industry standards and Product information. If Seller provides Product or system options, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products or systems.

9. Loss to Buyer's Property. Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

10. Special Tooling. A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture Products. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the Products, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

11. Buyer's Obligation; Rights of Seller. To secure payment of all sums due or otherwise, Seller shall retain a security interest in the goods delivered and this agreement shall be deemed a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect its security interest. Seller shall have a security interest in, and lien upon, any property of Buyer in Seller's possession as security for the payment of any amounts owed to Seller by Buyer.

12. Improper Use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or other misuse of Products purchased by Buyer from Seller; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as otherwise provided.

13. Cancellations and Changes. Orders shall not be subject to cancellation or change by Buyer for any reason, except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage. Seller may change product features, specifications, designs and availability with notice to Buyer.

14. Limitation on Assignment. Buyer may not assign its rights or obligations under this agreement without the prior written consent of Seller.

15. Entire Agreement. This agreement contains the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of the agreement. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter are herein merged.

16. Waiver and Severability. Failure to enforce any provision of this agreement will not waive that provision nor will any such failure prejudice Seller's right to enforce that provision in the future. Invalidation of any provision of this agreement by legislation or other rule of law shall not invalidate any other provision herein. The remaining provisions of this agreement will remain in full force and effect.

17. Termination. This agreement may be terminated by Seller for any reason and at any time by giving Buyer thirty (30) days written notice of termination. In addition, Seller may by written notice immediately terminate this agreement for the following: (a) Buyer commits a breach of any provision of this agreement (b) the appointment of a trustee, receiver or custodian for all or any part of Buyer's property (c) the filing of a petition for relief in bankruptcy of the other Party on its own behalf, or by a third party (d) an assignment for the benefit of creditors, or (e) the dissolution or liquidation of the Buyer.

18. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to this agreement. Disputes between the parties shall not be settled by arbitration unless, after a dispute has arisen, both parties expressly agree in writing to arbitrate the dispute.

19. Indemnity for Infringement of Intellectual Property Rights. Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Section. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets ("Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that a Product sold pursuant to this Agreement infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If a Product is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Product, replace or modify the Product so as to make it noninfringing, or offer to accept return of the Product and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to Products delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any Product sold hereunder. The foregoing provisions of this Section shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

20. Taxes. Unless otherwise indicated, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of Products.

21. Equal Opportunity Clause. For the performance of government contracts and where dollar value of the Products exceed \$10,000, the equal employment opportunity clauses in Executive Order 11246, VEVRAA, and 41 C.F.R. §§ 60-1.4(a), 60-741.5(a), and 60-250.4, are hereby incorporated.