Very Heavy Duty Hydraulic Cylinders
Series VH

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding
Series “VH” very heavy-duty hydraulic cylinders are premium quality cylinders – with operating capacities of 3,000 PSI. They fully meet NFPA standards. And to make sure every cylinder is premium-quality, Parker Hannifin subjects each and every one – not just batch samples – to tough inspection and performance tests.

**OTHER SERIES “VH” FEATURES AND SPECIFICATIONS**

**Ports**
Series “VH” ports are two sizes or larger than NFPA standards. Standard location is position 1 as shown in dimensional drawings. Where mountings do not interfere, ports may be located at positions 2, 3, or 4. Ports are not available at positions 2 or 4 on mounting style C, 2 1/2” thru 5” bore cylinders. SAE straight thread O-ring ports will be supplied unless otherwise specified.

**Cushions**
Cushions on Series “VH” cylinders are 3” long on all sizes except 3 1/4” and 4” bore sized equipped with 2” and 2 1/2” diameter piston rods which are supplied with cushions 2 3/16” long at head end. Self-centering floating cushion sleeve at head end and cushion spear at cap is tapered for 2/3 its length to give maximum cushioning effect for 1/3 its length.

**Thrust Key**
An extended retainer plate, to serve as a thrust key, can be supplied on mounting styles C and F. The thrust key would be the same as used on Parker Hannifin “2H” hydraulic cylinders.

**Air Bleeds**
When specified, 1/8” NPTF bleed ports are available at either head or cap end.

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- Fluids / Temperature Range / Pressure Ratings
- Ports / Stroke Data
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- Cylinder Safety Guide
- Offer of Sale

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Basic Cylinder Style T
(NFPA Style MX01)

**Rod End Dimensions**

<table>
<thead>
<tr>
<th>BORE NO.</th>
<th>ROG DIA.</th>
<th>THREAD</th>
<th>ROD EXTENSIONS AND PILOT DIMENSIONS</th>
<th>BASIC ENVELOPE AND MOUNTING DIMENSIONS</th>
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</thead>
<tbody>
<tr>
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</tbody>
</table>

- **Bore No.**
- **Rog Dia.**
- **Thread**
- **Rod Extensions and Pilot Dimensions**
- **Basic Envelope and Mounting Dimensions**

**Piston Rod End Threads**

- **Parker Thread Style 4** (NFPA SM)
- **Parker Thread Style 8** (NFPA IM)
- **Parker Thread Style 9** (NFPA SF)

*NOTE: Special piston rod end threads, two times length are available on 2¼" diameter piston rods and smaller. To order, specify thread Style 42 which has KK thread dia. or Style 82 which has CC thread dia. Other piston rod threads are available. To order, specify Style 3 and give desired dimensions for KK, A, and W or WP dimension. For other specials, send dimensions or sketch.*

**Tie Rod Mounted Styles TB, TC, TD** (NFPA Styles MX3, MX2, MX1)

- **Style TB** (MX3)
- **Style TC** (MX2)
- **Style TD** (MX1)

Style TB, Tie Rods Extended, is illustrated at right. Style TC, Cap Tie Rods Extended, and Style TD, Both Ends Tie Rods Extended, can be dimensioned from Style TB drawing.
### Very Heavy Duty Hydraulic Cylinders

**Series VH**

- **Flange Mountings**
  - Styles H, J, HB, JB

- **For Style “H” Mount**
  - Specifications for mounting styles

- **For Style “J” Mount**
  - Specifications for mounting styles

- **Specific Dimensions for Series VH Mounting Styles (in inches)**

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<thead>
<tr>
<th>BORE NO.</th>
<th>ROD DIA. MM</th>
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<th>BB</th>
<th>DD</th>
<th>FB</th>
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- Maximum pressure rating - pull application

### Additional Notes
- Dimension CD is pin diameter.
- Upper surface spotfaced for socket head screws.
- Dimension to be specified by customer.
Very Heavy Duty Hydraulic Cylinders
Series VH

For Style “JB” Mount

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* Maximum pressure rating - push application

For 7” & 8” bores, this style retainer configuration applies to all but J and JB mounts.

For Style HB (NFPA MF6)

For Style JB (NFPA MF5)
Very Heavy Duty Hydraulic Cylinders
Series VH

Side Mountings
Styles C, CP, F, FP

Specific Dimensions for Series VH Mounting Styles (in inches)

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</tbody>
</table>

* Dimension CD is pin diameter. • Upper surface spotfaced for socket head screws. ◆◆ Dimension to be specified by customer.
### Pivot Mountings

**Styles BB, DB, D, DD**

#### STYLE BB (NFPA MP1)

- ZC + STROKE
- P + STROKE
- LB + STROKE

#### STYLE DB (NFPA MT2)

- ZB + STROKE
- P + STROKE
- LB + STROKE

#### STYLE DD (NFPA MT4)

- ZB + STROKE
- P + STROKE
- LB + STROKE

#### STYLE D (NFPA MT1)

- ZB + STROKE
- P + STROKE
- LB + STROKE

---

**Table: Pivot Mountings**

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<th>BORE</th>
<th>ROD NO.</th>
<th>ROD DIA. MM</th>
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- **Style BB (NFPA MP1)**
  - 2 1/2
  - 3

- **Style DB (NFPA MT2)**
  - 2
  - 2 1/2
  - 3

- **Style DD (NFPA MT4)**
  - 2 1/8
  - 2 1/4
  - 2 1/2

- **Style D (NFPA MT1)**
  - 2
  - 2 1/8
  - 2 1/4

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**Very Heavy Duty Hydraulic Cylinders**

**Series VH**

Parker Hannifin Corporation

Cylinder Division

Des Plaines, Illinois USA

www.parker.com/cylinder
**Double Rod Cylinders**

To obtain dimensioning information on a double rod cylinder, first select the desired mounting style and refer to the corresponding single rod cylinder model shown on the preceding pages. After you have determined all necessary dimensions from that drawing, turn back to this page and supplement those dimensions with additional ones from this drawing and the table at right. These added dimensions provide the additional information needed to completely dimension a double rod cylinder model.

On a double rod cylinder where the two rod ends will be different, be sure to state which rod end is to go at which end of the cylinder.

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<td>4(\frac{1}{2})</td>
<td>4(\frac{1}{2})</td>
<td>6(\frac{1}{8})</td>
</tr>
</tbody>
</table>

**HOW TO ORDER SERIES VH CYLINDERS**

Note: Parker Series VH Cylinders can be completely & accurately described by a model number consisting of coded symbols. To develop a model number select only those symbols that represent the cylinder required and place them in the sequence shown in the chart below.

### SERIES VH MODEL NUMBERS — HOW TO DEVELOP THEM — HOW TO DECODE THEM.

<table>
<thead>
<tr>
<th>BORE SIZE</th>
<th>CUSHION HEAD END</th>
<th>DOUBLE ROD MOUNTING STYLE</th>
<th>MOUNTING MOD.</th>
<th>COMBINATION MOUNTING STYLE</th>
<th>SERIES</th>
<th>PISTON SEAL</th>
<th>PORTS</th>
<th>SEALS</th>
<th>SPECIAL MODIFICATIONS</th>
<th>PISTON ROD NO.</th>
<th>ROD END THREAD STYLE NO.</th>
<th>ALTERNATE STANDARD ROD END THREAD LENGTH</th>
<th>THREAD TYPE</th>
<th>CUSHION CAP END</th>
<th>STROKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>C</td>
<td>K</td>
<td>C</td>
<td>X</td>
<td>K</td>
<td>T</td>
<td>V</td>
<td>S</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>A</td>
<td>C</td>
<td>X50</td>
<td></td>
</tr>
</tbody>
</table>

Class 1 SEALS

Class 1 seals are the seals provided as standard in a cylinder assembly unless otherwise specified. For further information on fluid compatibility on operating limitations of all compounds, refer to Operating Fluids and Seals / Temperature.
### Theoretical Push and Pull Forces

#### Push Force and Displacement

<table>
<thead>
<tr>
<th>Cylinder Bore Size (Inches)</th>
<th>Piston Area (Sq. In.)</th>
<th>Push Stroke Force In Pounds At Various Pressures</th>
<th>Displacement Per Inch Of Stroke (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>2 1/2</td>
<td>4.91</td>
<td>123</td>
<td>245</td>
</tr>
<tr>
<td>3 1/4</td>
<td>8.30</td>
<td>208</td>
<td>415</td>
</tr>
<tr>
<td>4</td>
<td>12.57</td>
<td>314</td>
<td>628</td>
</tr>
<tr>
<td>5</td>
<td>19.64</td>
<td>491</td>
<td>982</td>
</tr>
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<td>6</td>
<td>28.27</td>
<td>707</td>
<td>1414</td>
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<td>7</td>
<td>38.49</td>
<td>962</td>
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<td>8</td>
<td>50.27</td>
<td>1257</td>
<td>2513</td>
</tr>
</tbody>
</table>

#### Deductions for Pull Force and Displacement

<table>
<thead>
<tr>
<th>Piston Rod Dia. (Inches)</th>
<th>Piston Area (Sq. In.)</th>
<th>Piston Rod Diameter Force In Pounds At Various Pressures</th>
<th>Displacement Per Inch Of Stroke (Gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>1 1/8</td>
<td>.785</td>
<td>20</td>
<td>39</td>
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<td>1 3/8</td>
<td>1.49</td>
<td>37</td>
<td>75</td>
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<td>1 1/4</td>
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<td>121</td>
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<td>2</td>
<td>3.14</td>
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<td>157</td>
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<td>2 1/2</td>
<td>4.91</td>
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<td>245</td>
</tr>
<tr>
<td>3</td>
<td>7.07</td>
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<td>3 1/2</td>
<td>9.62</td>
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<td>481</td>
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<tr>
<td>4</td>
<td>12.57</td>
<td>314</td>
<td>628</td>
</tr>
<tr>
<td>4 1/2</td>
<td>15.90</td>
<td>398</td>
<td>795</td>
</tr>
<tr>
<td>5</td>
<td>19.64</td>
<td>491</td>
<td>982</td>
</tr>
<tr>
<td>5 1/2</td>
<td>23.76</td>
<td>594</td>
<td>1188</td>
</tr>
</tbody>
</table>

#### General Formula

The cylinder output forces are derived from the formula:

\[ F = P \times A \]

Where:
- \( F \) = Force in pounds.
- \( P \) = Pressure at the cylinder in pounds per square inch, gauge.
- \( A \) = Effective area of cylinder piston in square inches.
Operating Fluids and Temperature Range

Fluidpower cylinders are designed for use with pressurized air, hydraulic oil and fire resistant fluids, in some cases special seals are required.

Standard Seals (class 1)

Class 1 seals are what is normally provided in a cylinder unless otherwise specified. They are intended for use with fluids such as: air, nitrogen, mineral base hydraulic oil or MIL-H-5606 within the temperature range of -10°F (-23°C) to +165°F (+74°C). Generally they are used with cast iron expansion rings. When used with hydraulic fluids, the temperature limitations are necessary to prevent the possible loosening of the threaded connections. Cylinders originally modified for water or high water content service to be free of defects in materials or workmanship, but cannot accept responsibility to premature failure due to excessive pressure applied only to clamp the load.

Warning

The piston rod stud and the piston rod to piston threaded connections are secured with an anaerobic adhesive which is temperature sensitive. Cylinders are assembled with anaerobic adhesive having a maximum temperature rating of +250°F (+121°C). Cylinders specified for high temperature applications, to 400°F (204°C), where longer seal life and improved high temperature sealing performance is required. Minimum operating temperature is -15°F (-26°C). Body and gland o-ring seals will be exposed to ambient temperatures above +165°F (+74°C) the cylinder must be manufactured originally manufactured (before 1997) with class 1 seals (Nitrile) that will be exposed to ambient temperatures above +165°F (+74°C) may be modified for higher temperature service. Contact the factory immediately and arrange for the piston to rod and the stud to piston rod connections to be properly re-assembled to withstand the higher temperature service.

Hi-Load Seals

Hi-load seals consist of one or two filled PTFE dynamic piston seals with a elastostomer expander underneath. Hi-load piston arrangement normally consists of a wear ring on each end of the piston with the seals in the middle. These types of seals are virtually leak free seals under static conditions and can tolerate high pressure. The wear rings on the piston can also tolerate high side loads. The dynamic portion of the seal is bronze filled PTFE and compatible with all conditions and fluids listed on this page. However, carbon filled PTFE will provide better seal life when used with class 6 fluids. A nitrile expander will be provided unless Class 3 or 5 seals are specified. In those cases the expander will be of EPR or fluorocarbon respectively. Note: It may be necessary to cycle the piston seals 40 or 50 times before achieving leakage free performance.

Lipseals

Under most conditions lipseals provide the best all around service for pneumatic applications. Lipseals with a back-up washer are often used for hydraulic applications when virtually zero static leakage is required. Lipseals will function properly in these applications when used in conjunction with moderate hydraulic pressures. A high load piston option is recommended when operating at high pressures and especially with large bore hydraulic cylinders.

Low Friction Hydraulic Seals

Low friction hydraulic seals are available as an option for both piston and rod seals for Series 2H and 3H cylinders. They are sometimes used when a cylinder is controlled by servo or proportional valve. The seal assembly itself is a two piece assembly consisting of a filled PTFE dynamic seal with an elastostomer expander. A piston seal assembly consists of one seal assembly in the middle of the piston with a filled PTFE wear ring on each side of the piston. The rod seal assembly consists of two seal assemblies and an elastostomer wiper seal. The filled PTFE seals are compatible with the fluids listed on this page and provide virtually leak free sealing. The expanders and rod wiper will be fluorocarbon unless EPR or fluorocarbon seals are specified. In those cases the expanders and wiper will be EPR and fluorocarbon respectively. When specifying low friction seals specify if piston, piston rod seals or both are required. Note: It may be necessary to cycle these seals 40 or 50 times before achieving leakage free performance.

Cast Iron Piston Rings

Cast iron rings are the standard piston seals for Series 2H cylinders. They offer the widest operating conditions by tolerating high operating pressures, wide temperature range and are compatible with most fluids. The only drawback of cast iron rings is that the iron oxide that forms on the surface of the rings is a thin protective oxide layer that does not allow the fluid to pass through. Cast iron rings are special nitride compound dynamic seals. Lipseals will have PTFE or polyimide back-up washers when required. O-rings will have nitrile back-up washers when required. Cast iron rings are the standard piston seals for Series 2H cylinders. They offer the widest operating conditions by tolerating high operating pressures, wide temperature range and are compatible with most fluids. The only drawback of cast iron rings is that the iron oxide that forms on the surface of the rings is a thin protective oxide layer that does not allow the fluid to pass through. Cast iron rings are special nitride compound dynamic seals. Lipseals will have PTFE or polyimide back-up washers when required. O-rings will have nitrile back-up washers when required. Cast iron rings are special nitride compound dynamic seals. Lipseals will have PTFE or polyimide back-up washers when required. O-rings will have nitrile back-up washers and straight cushions. HGWC (class 6)

Class 6 seals are used for High Water Content Fluids (HWCF) in which case Class 6 seals should be used. Typical water base fluids are: Water, Water-Glycol, Water-in Emulsion, Houghto-Safe 27, 620, 5040, Mobil Pyrogard D, Shell Irsus 905, Ucon Hydrolube J-4. These seals are nitrile. Lipseal will have polyimide or PTFE back-up washer when required. O-rings will have nitrile back-up washers when required.

Ethereylene Propylene (EPR) Seals (class 3)

Class 3 seals are intended for use with some Phosphate Ester Fluids between the temperatures of -10°F (-23°C) to +130°F (+54°C). Typical fluids compatible with EPR seals are Skydrol 500 and 700. EPR are Ethylene Propylene. Lipseals will have a PTFE back-up washer when required. O-rings will have EPR back-up washers when required. Note: EPR seals are not compatible with mineral base hydraulic oil or grease. Even limited exposure to these fluids will cause severe swelling. PTFE back-up washer may not be suitable when used in a radiation environment.

Low Temperature Nitrile Seals (class 4)

Class 4 seals are intended for low temperature service with the same type of fluids as used with Class 1 seals within the temperature range of -50°F (-46°C) to +150°F (+66°C). Lipseals will have a polyimide or PTFE back-up washers when required. O-rings will have nitrile back-up washers when required. Note: Certain fluids may react adversely with Class 4 seals compared to Class 1 seals.

Fluorocarbon Seals (class 5)

Class 5 seals are intended for elevated temperature service or for some Phosphate Ester Fluids such as Houghto-Safe 1010, 1055, 1120; Fyrquel 150, 220, 300, 350; Mobile Pyrogard 42, 43, 53, and 55. Note: In addition, class 5 seals can be used with fluids listed below under standard service. However, they are not compatible with Phosphate Ester Fluids such as Skydrols. Class 5 seals can operate with a temperature range of -10°F (-23°C) to +250°F (+121°C). Class 5 seals may be operated to +400°F (+204°C) with limited service life. For temperatures above +250°F (+121°C) the cylinder must be manufactured with non-studded piston rod and thread and a pinned piston to rod connection. Class 5 Lips seals will have PTFE back-up washers when required. O-rings will have fluorocarbon back-up when required.

Energized PTFE Seals (class 8)

Class 8 seals consist of PTFE piston lipseals, rod seal and wiperseal. Piston seals have an internal stainless steel spring to energize both the static and dynamic sealing lips. They are intended for high temperature applications, to 400°F (204°C), where longer seal life and improved high temperature sealing performance is required. Minimum operating temperature is -15°F (-26°C). Body and gland o-ring seals will be fluorocarbon. Fluid resistance is comparable to Class 5. Cylinders incorporating Class 8 Seals will not have studded piston rods.

Water Service

Series 2H cylinders can be modified to make them more suitable for use with water as the operating medium. The modifications include chromed-plated cylinder bore; electroadless nickel-plated head, cap and piston; chrome-plated 17-4 stainless steel piston rod; chrome plated cushion sleeve or cushion spear.

Modified cylinders may also be used for higher operating pressures, up to 2000 psi, depending on bore size. See pressure rating for Hydraulic Cylinders on the next page. Series 2H and 3H hydraulic cylinders can also be modified for water operation and supplied with chrome-plated cylinder bore; electroadless nickel-plated head, cap and piston; chrome-plated precipitation hardened stainless steel piston rod; chrome-plated cushion sleeve or cushion spear. When high water base fluids are the operating medium, hydraulic cylinders are usually supplied with high water base rod wiper and seals. Water and high water base fluid operated cylinders are best used on short stroke applications or where high pressure is applied only to clamp the load.

Warranty

Parker Hannifin will warrant cylinders modified for water or high water content fluid service to be free of defects in materials or workmanship, but cannot accept responsibility to premature failure due to excessive pressure applied only to clamp the load.
**Fluids and Temperature Range**

<table>
<thead>
<tr>
<th>Class No.</th>
<th>Typical Fluids</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Standard) (Nitrile Polyurethane)</td>
<td>Air, Nitrogen, Hydraulic Oil, Mil-H-5606 Oil</td>
<td>-10°F (-23°C) to +165°F (+74°C)</td>
</tr>
<tr>
<td>2 Optional Water Base Fluid Seal</td>
<td>Water, Water-Glycol, HWCF — See Class 6 below, Water-in-Oil Emulsion Houghto-Safe, 271, 620, 5040. Mobil Pyrogard D, Shell Irus 905. Ucon Hydrolube J-4</td>
<td>-10°F (-23°C) to +165°F (+74°C)</td>
</tr>
<tr>
<td>3 Special (EPR) (at extra cost)</td>
<td>Some Phosphate Ester Fluids Skydrol 500, 7000</td>
<td>-10°F (-23°C) to +130°F (+54°C)</td>
</tr>
<tr>
<td>4 Special (Nitrile) (at extra cost)</td>
<td>Low Temperature Air or Hydraulic Oil</td>
<td>-50°F (-46°C) to +150°F (+66°C)</td>
</tr>
<tr>
<td>5 Optional (at extra cost) (Fluorocarbon Seals)</td>
<td>High Temperature Houghto-Safe 1010, 1055, 1120 Fyrquel 150, 220, 300, 550 Mobil Pyrogard 42,43,53,55</td>
<td>See paragraph on Fluorocarbon seals for recommended temperature range.</td>
</tr>
<tr>
<td>6 Optional (HWCF) (at extra cost)</td>
<td>Houghton, Hydrolubric 120B Sonsol Lubrizol, for other HWCF — consult factory.</td>
<td>+40°F (+4°C) to +120°F (+49°C)</td>
</tr>
<tr>
<td>8 Optional (at extra cost) Energized PTFE</td>
<td>See Class 5 Seals</td>
<td>-15°F (-26°C) to +400°F (+204°C)</td>
</tr>
</tbody>
</table>

**Application Data**
The proper application of a fluid power cylinder requires consideration of the operating pressure, the fluid medium, the mounting style, the length of stroke, the type of piston rod connection to the load, thrust or tension loading on the rod, mounting attitude, the speed of stroke, and how the load in motion will be stopped. Information given here provides pressure rating data for Series VH hydraulic cylinders.

**Pressures Ratings**
Standard operating fluid — clean, filtered hydraulic oil. Pressure ratings for heavy-duty hydraulic cylinders are shown in the table.

Series VH hydraulic cylinders are recommended for pressures to 3000 p.s.i. for heavy-duty service with hydraulic oil. The 4:1 design factor ratings shown are based on tensile strength of material and are for code 1 rod dia. only. The rating is conservative for continuous severe applications. Design factors at other pressures can be calculated from this rating. In addition, mounting styles, stroke, etc., should be considered because of the limiting effect they may have on these ratings.

**Maximum Pressure Ratings**

<table>
<thead>
<tr>
<th>Bore Size (Inches)</th>
<th>Rod Diameter (Inches)</th>
<th>4:1 Design Factor (Tensile) (PSI)</th>
<th>Heavy-Duty Service (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1/2</td>
<td>1</td>
<td>2340</td>
<td>3000</td>
</tr>
<tr>
<td>3 1/4</td>
<td>1 1/8</td>
<td>2250</td>
<td>3000</td>
</tr>
<tr>
<td>4</td>
<td>1 3/4</td>
<td>2130</td>
<td>3000</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2170</td>
<td>3000</td>
</tr>
<tr>
<td>6</td>
<td>2 3/8</td>
<td>2270</td>
<td>3000</td>
</tr>
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<td>7</td>
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<td>3000</td>
</tr>
<tr>
<td>8</td>
<td>3 1/2</td>
<td>2040</td>
<td>3000</td>
</tr>
</tbody>
</table>

*Applies to all mountings except J and H.
Ports

Parker hydraulic and pneumatic cylinders can be supplied with S.A.E. straight O-ring ports or NPTF pipe thread ports. For the type of port recommended and port size, see respective product catalogs. If specified on your order, extra ports can be provided on the sides of heads or caps that are not occupied by mountings or cushion valve on all cylinders except Series C and S.

Standard port location is position 1 as shown on line drawings in product catalog and Figure 1 below. Cushion adjustment needle and check valves are at positions 2 and 4 (or 3), depending on mounting style. Heads or caps which do not have an integral mounting can be rotated and assembled with ports at 90° or 180° from standard position. Mounting styles on which head or cap can be rotated at no extra charge are shown in Table A below. To order, specify by position number. In such assemblies the cushion adjustment needle and check valve rotate accordingly, since their relationship with port position does not change.

Figure 1

Ports / Stroke Data

Cylinder Port Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;T&quot;</td>
<td>SAE Straight Thread O-Ring Port. Recommended for most hydraulic applications.</td>
</tr>
<tr>
<td>&quot;U&quot;</td>
<td>Conventional NPTF Ports (Dry-Seal Pipe Threads). Recommended for pneumatic applications only.</td>
</tr>
<tr>
<td>&quot;R&quot;</td>
<td>BSPP Port (British Parallel Thread). ISO 228 port commonly used in Europe.</td>
</tr>
<tr>
<td>&quot;P&quot;</td>
<td>SAE Flange Ports Code 61 (3000 psi). Recommended for hydraulic applications requiring larger port sizes.</td>
</tr>
<tr>
<td>&quot;B&quot;</td>
<td>BSPT (British Tapered Thread).</td>
</tr>
<tr>
<td>&quot;G&quot;</td>
<td>Metric Straight Thread Port similar to Option &quot;R&quot; with metric thread. Popular in some European applications.</td>
</tr>
<tr>
<td>&quot;Y&quot;</td>
<td>ISO-6149-1 Metric Straight Thread Port. Recommended for all hydraulic applications designed per ISO standards.</td>
</tr>
</tbody>
</table>

Ports can be supplied at positions other than those shown in Table A at an extra charge. To order, specify port position as shown in Figure 1.

Table C

S.A.E. Straight Thread "O" Ring Ports

<table>
<thead>
<tr>
<th>Size No.</th>
<th>Tube O.D. (In.)</th>
<th>Thread Size</th>
<th>Size No.</th>
<th>Tube O.D. (In.)</th>
<th>Thread Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1/4&quot;</td>
<td>5/32 - 24</td>
<td>12</td>
<td>7/16&quot;</td>
<td>1/16 - 12</td>
</tr>
<tr>
<td>3</td>
<td>3/8&quot;</td>
<td>3/16 - 24</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>1/2&quot;</td>
<td>1/8 - 20</td>
<td>16</td>
<td>1&quot;</td>
<td>1/16 - 12</td>
</tr>
<tr>
<td>5</td>
<td>5/8&quot;</td>
<td>5/32 - 20</td>
<td>20</td>
<td>1 1/4&quot;</td>
<td>1/16 - 12</td>
</tr>
<tr>
<td>6</td>
<td>3/4&quot;</td>
<td>1/4 - 18</td>
<td>24</td>
<td>1 1/2&quot;</td>
<td>1/16 - 12</td>
</tr>
<tr>
<td>8</td>
<td>1&quot;</td>
<td>3/8 - 16</td>
<td>32</td>
<td>2&quot;</td>
<td>2 1/16 - 12</td>
</tr>
<tr>
<td>10</td>
<td>5/8&quot;</td>
<td>1/2 - 14</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Stroke Data

Parker cylinders are available in any practical stroke length. The following information should prove helpful to you in selecting the proper stroke for your cylinder application.

Stroke Tolerances – Stroke length tolerances are required due to build-up of tolerances of piston, head, cap and cylinder body. Standard production stroke tolerances run +1/32” to -1/64” up to 20” stroke, +1/32” to -0.020” for 21” to 60” stroke and +1/32” to -1/32” for greater than 60” stroke. For closer tolerances on stroke length, it is necessary to specify the required tolerance plus the operating pressure and temperature at which the cylinder will operate. Stroke tolerances smaller than .015” are not generally practical due to elasticity of cylinders. If machine design requires such close tolerances, use of a stroke adjuster (below) may achieve the desired result.

Note: For the pressure ratings of individual connectors, contact your connector supplier. Hydraulic cylinders applied with meter out or deceleration circuits are subject to intensified pressure at the cylinder piston rod end. The rod end pressure is approximately equal to:

effective cap end piston area x Operating Pressure

effective rod end piston area
Stop Tubing
Stop tube is recommended to lengthen the distance between the gland and piston to reduce bearing loads when the cylinder is fully extended. This is especially true of horizontally mounted and long stroke cylinders. Long stroke cylinders achieve additional stability through the use of a stop tube.

Thrust Key Mountings
Thrust key mountings eliminate the need of using fitted bolts or external keys on side mounted cylinders. Parker cylinders in mounting styles CP and FP can be provided with the gland retainer plate extended below the mounting side of the cylinder (see illustration below). This extended retainer plate can then be fitted into a keyway milled into the mounting surface of the machine member. This is referred to as the “P” Modification of any side mounting style.

Mounting Classes
Standard mountings for fluid power cylinders fall into three basic groups. The groups can be summarized as follows:
Group 1 – Straight Line Force Transfer with fixed mounts which absorb force on cylinder centerline.
Group 2 – Pivot Force Transfer. Pivot mountings permit a cylinder to change its alignment in one plane.
Group 3 – Straight Line Force Transfer with fixed mounts which do not absorb force on cylinder centerline.

Because a cylinder’s mounting directly affects the maximum pressure at which the cylinder can be used, the chart below should be helpful in selection of the proper mounting combination for your application. Stroke length, piston rod connection to load, extra piston rod length over standard, etc., should be considered for thrust loads. Alloy steel mounting bolts are recommended for all mounting styles, and thrust keys are recommended for Group 3.
Piston Rod — Stroke Selection Chart

How to Use the Chart
The selection of a piston rod for thrust (push) conditions requires the following steps:

1. Determine the type of cylinder mounting style and rod end connection to be used. Then consult the chart below and find the "stroke factor" that corresponds to the conditions used.
2. Using this stroke factor, determine the "basic length" from the equation:
   \[
   \text{Basic Length} = \frac{\text{Actual Stroke}}{\text{Stroke Factor}}
   \]
   The graph is prepared for standard rod extensions beyond the face of the gland retainers. For rod extensions greater than standard, add the increase to the stroke in arriving at the "basic length."
3. Find the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure.
4. Enter the graph along the values of "basic length" and "thrust" as found above and note the point of intersection:
   A) The correct piston rod size is read from the diagonally curved line labeled "Rod Diameter" next above the point of intersection.
   B) The required length of stop tube is read from the right of the graph by following the shaded band in which the point of intersection lies.
   C) If required length of stop tube is in the region labeled "consult factory," submit the following information for an individual analysis:
      1) Cylinder mounting style.
      2) Rod end connection and method of guiding load.
      3) Bore, required stroke, length of rod extension (Dim. “W” or “WF”) if greater than standard, and series of cylinder used.
      4) Mounting position of cylinder. (Note: If at an angle or vertical, specify direction of piston rod.)
      5) Operating pressure of cylinder if limited to less than standard pressure for cylinder selected.

Warning
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 end to fail. If these types of additional loads are expected to be imposed on the piston rods, their magnitude should be made known to our Engineering Department so they may be properly addressed. Additionally, cylinder users should always make sure that the piston rod is securely attached to the machine member.

Recommended Mounting Styles for Maximum Stroke and Thrust Loads

<table>
<thead>
<tr>
<th>Groups 1 or 3</th>
<th>Rod End Connection</th>
<th>Case</th>
<th>Stroke Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long stroke cylinders for thrust loads should be mounted using a heavy-duty mounting style at one end, firmly fixed and aligned to take the principal force. Additional mounting should be specified at the opposite end, which should be used for alignment and support. An intermediate support may also be desirable for long stroke cylinders mounted horizontally. Machine mounting pads can be adjustable for support mountings to achieve proper alignment.</td>
<td>Fixed and Rigidly Guided</td>
<td>I</td>
<td>.50</td>
</tr>
<tr>
<td></td>
<td>Pivoted and Rigidly Guided</td>
<td>II</td>
<td>.70</td>
</tr>
<tr>
<td></td>
<td>Supported but not Rigidly Guided</td>
<td>III</td>
<td>2.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th>Rod End Connection</th>
<th>Case</th>
<th>Stroke Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style D — Trunnion on Head</td>
<td>Pivoted and Rigidly Guided</td>
<td>IV</td>
<td>1.00</td>
</tr>
<tr>
<td>Style DD — Intermediate Trunnion</td>
<td>Pivoted and Rigidly Guided</td>
<td>V</td>
<td>1.50</td>
</tr>
<tr>
<td>Style DB — Trunnion on Cap or Style BB — Clevis on Cap</td>
<td>Pivoted and Rigidly Guided</td>
<td>VI</td>
<td>2.00</td>
</tr>
</tbody>
</table>
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 the 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 guidelines 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 application of cylinders.
• 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:

• 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 members.

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 members connected to the piston rod and/or also used as a stroke adjuster. In both cases the stops will create a pin point and the user should consider appropriate use of guards. If these external stops are not perpendicular to the mating 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 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 reviewed 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:

\[
\text{operating pressure} \times \text{effective cap end area} \div \text{effective rod end piston area}
\]

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 rod 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 glands 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 cylinder 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 clearance. Bearing blocks should be carefully aligned and rigidly mounted so that 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, ensure to check 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 – For tie rod mountings, the tie rod 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 lip seal 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 lip seal 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 (including 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 engineered repair that will prevent recurrence of the problem. 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 terms described in this document and other documents and descriptions provided by Parker Hannifin Corporation, its subsidiaries 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, shall 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 subject to these Terms and Conditions or any newer version of the terms and conditions found on-line at www.parker.com/saleterms/. Seller objects to any contrary or additional terms or conditions of Buyer’s order or any other document issued by Buyer.

2. Price Adjustments; Payments. Prices stated on Seller’s quote or other documentation offered by Seller are valid for 30 days, and do not include any sales, use, or other taxes which may be applicable and stated. Unless otherwise specified by Seller, or upon request, a freight bill can be prepared and is subject to credit approval and is due 30 days from the date of invoice or such other terms as required by Seller’s Credit Department. Buyer shall pay interest on any unpaid invoices at the rate of 1.0% 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 source of shipment, title and risk of loss shall pass to Buyer upon shipment from Seller’s facility. Unless otherwise stated, Seller may exercise its judgment in selecting the carrier and method of transportation. The cost of all shipping charges shall be paid by Buyer due to Buyer’s acts or omissions.

4. Warranty. Seller warrants that the Products sold hereunder shall be free from defects in materials 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 exclusions and limitations of liability and warranties, disclaimers and exclusions of all express and implied warranties of Seller. Seller disclaims all warranties, express and implied, including express, 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 thirty (30) days after delivery. No other claims against Seller will be allowed unless asserted in writing within 30 days after delivery. Buyer shall notify Seller of any alleged breach of warranty within 30 days after the date the defect is or should have been discovered and no further action shall be based upon this agreement or other claim arising out of this sale (other than an action by Seller for an amount due on any invoice) must be commenced within 12 months from the date of the breach without prejudice to Seller’s rights to refuse the claim.

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 DIRECT, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, LOSSES, AS A RESULT OF BUYER'S USE, OR MISUSE, OR AS RESULT OF ANY MISCONDUCT OR USE ARISING OUT OF, OR AS A RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR ANY CHARGES, EXPENSES OR INCURRED WITHOUT SELLER’S WRITTEN CONSENT, EVEN IF SELLER HAS BEEN NEGLIGENCE, WHETHER IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN EVENT THAT SELLER SHALL LOSE THE PRODUCT UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS.

7. 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 system and/or Product designs and 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.

8. 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 (c) files a petition for relief in bankruptcy on its own behalf, or by a third party the goods delivered and this agreement otherwise, Seller shall retain a security interest in the goods delivered and this agreement will be deemed a Security Agreement under the Uniform Commercial Code. Buyer agrees to comply with all applicable laws and regulations, including both the Foreign Corrupt Practices Act, and all anti-corruption laws and regulations, as well as any other applicable laws and regulations, in the United States, the United Kingdom and the United States of America, and of the country or countries to which the Products are delivered. Buyer agrees to ensure that all of Buyer’s employees, agents, and representatives comply with the requirements of this paragraph. Buyer shall not make any payment or give anything of value, directly or indirectly to any governmental official, any foreign political office, or any commercial entity or person, acting for or on behalf of any governmental official, to influence any person to purchase Products or otherwise benefit the business of Seller.
At Parker, we’re guided by a relentless drive to help our customers become more productive and achieve higher levels of profitability by engineering the best systems for their requirements. It means looking at customer applications from many angles to find new ways to create value. Whatever the motion and control technology need, Parker has the experience, breadth of product and global reach to consistently deliver. No company knows more about motion and control technology than Parker. For further info call 1 800 C-Parker (1 800 272 7537)

**Fluid & Gas Handling**

**Key Markets**
- Aerial lift
- Agriculture
- Bulk chemical handling
- Construction machinery
- Food & beverage
- Fuel & gas delivery
- Industrial machinery
- Life sciences
- Marine
- Mining
- Mobile
- Oil & gas
- Renewable energy
- Transportation

**Key Products**
- Check valves
- Connectors for low pressure fluid conveyance
- Deep sea umbilicals
- Diagnostic equipment
- Hose couplings
- Industrial hose
- Monitoring systems & power cables
- PTFE hose & tubing
- Quick couplings
- Rubber & thermoplastic hose
- Tube fittings & adaptors
- Tubing & plastic fittings

**Hydraulics**

**Key Markets**
- Aerial lift
- Agriculture
- Alternative energy
- Construction machinery
- Forestry
- Industrial machinery
- Machine tools
- Marine
- Material handling
- Mining
- Oil & gas
- Power generation
- Refuse vehicles
- Renewable energy
- Trucks
- Hydraulics
- Turf equipment

**Key Products**
- Accumulators
- Cylinders
- Electrohydraulic actuators
- Hydrostatic systems
- Hydraulic motors & pumps
- Hydraulic valves & controls
- High pressure control valves
- High pressure hose & tubing
- Power take-offs
- Power units
- Rotary actuators
- Sensors

**Pneumatics**

**Key Markets**
- Aerospace
- Conveyor & material handling
- Factory automation
- Life sciences & medical
- Machine tools
- Packaging machinery
- Transportation & automotive

**Key Products**
- Air preparation
- Blowers
- Compressors
- Diaphragm valves
- Pneumatic accessories
- Pneumatic actuators & grippers
- Pneumatic valves & controls
- Quick disconnects
- Rotary actuators
- Rubber & thermoplastic hose & couplings
- Structural extrusions
- Thermostatic tubing & fittings

**Aerospace**

**Key Markets**
- Aftermarket services
- Commercial transports
- Engines
- General & business aviation
- Helicopters
- Launch vehicles
- Military aircraft
- Missiles
- Power generation
- Regional transports
- Unmanned aerial vehicles

**Key Products**
- Control systems & actuation products
- Engine systems & components
- Fluid conveyance systems & components
- Fluid metering, delivery & atomization devices
- Fuel systems & components
- Fuel tanking systems & components
- Thermal management
- Wheels & brakes

**Climate Control**

**Key Markets**
- Agriculture
- Air conditioning
- Construction Machinery
- Food & beverage
- Industrial machinery
- Life sciences
- Oil & gas
- Precision cooling
- Process
- Refrigeration
- Transportation

**Key Products**
- Accumulators
- Advanced actuators
- CO2 controls
- Electronic controllers
- Filter devices
- Hand shut-off valves
- Heat exchangers
- Hose & fittings
- Pressure regulating valves
- Refrigerant distributors
- Safety relief valves
- Smart pumps
- Solenoid valves
- Thermostatic expansion valves

**Electromechanical**

**Key Markets**
- Aerospace
- Factory automation
- Life sciences & medical
- Machine tools
- Packaging machinery
- Paper machinery
- Plastics machinery & converting
- Primary metals
- Semiconductor & electronics
- Textile
- Wire & cable

**Key Products**
- A/C, drives & systems
- Electric actuators, pumps, robots & drives
- Electrohydraulic actuation systems
- Electrohydraulic systems
- Electronic valves & controllers
- Human machine interface
- Linear motors
- Linear motion systems
- Servo motors, servo motors, drives & controls
- Structural extrusions

**Filtration**

**Key Markets**
- Aerospace
- Chemical processing
- Consumer
- Fluid power
- General industrial
- Information technology
- Life sciences
- Microelectronics
- Military
- Oil & gas
- Power generation
- Renewable energy
- Telecommunications
- Transportation

**Key Products**
- Analytical gas generators
- Compressed air filters & dryers
- Engine air, coolant, fuel & oil filtration systems
- Fluid control monitoring systems
- Hydraulic & lubrication filters
- Hydrogen, nitrogen & zero air generators
- Instrumentation filters
- Membrane & fiber filters
- Microfilters
- Sterile air filtration
- Water desalination & purification filters & systems

**Sealing & Shielding**

**Key Markets**
- Aerospace
- Chemical processing
- Consumer
- Fluid power
- General industrial
- Information technology
- Life sciences
- Microelectronics
- Military
- Oil & gas
- Power generation
- Renewable energy
- Telecommunications
- Transportation

**Key Products**
- Dynamic seals
- Elastomeric o-rings
- Electro-medical instrument design & assembly
- EMI shielding
- Extruded & precision-cut
- Fabricated elastomeric seals
- High temperature metal seals
- Homogrooves & inserted elastomeric shapes
- Medical device fabrication & assembly
- Metal & plastic retained composite seals
- Shielded optical windows
- Silicone tubing & extrusions
- Thermal management
- Vibration dampening

**Key Markets**
- Alternative fuels
- Biopharmaceuticals
- Chemical & refining
- Food & beverage
- Marine & shipbuilding
- Chemical & refining
- Biopharmaceuticals
- Alternative fuels
- Port & harbor
- Nutrient, oil & gas
- Agricultural & forestry
- Power generation
- Renewable energy
- Telecommunications
- Transportation

**Key Products**
- Advanced actuators
- Accumulators
- A/C, drives & systems
- Analytical gas generators
- Electrohydraulic actuation systems
- Electrohydraulic systems
- Electronic valves & controllers
- Human machine interface
- Linear motors
- Linear motion systems
- Servo motors, servo motors, drives & controls
- Structural extrusions

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- Linear motion systems
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