Series MH Hydraulic Cylinders

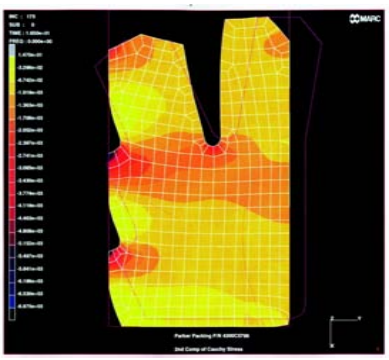
ATLAS CYLINDERS

Atlas Cylinders "Tri-Lip" Seal Designed To Eliminate Rod Seal Leakage

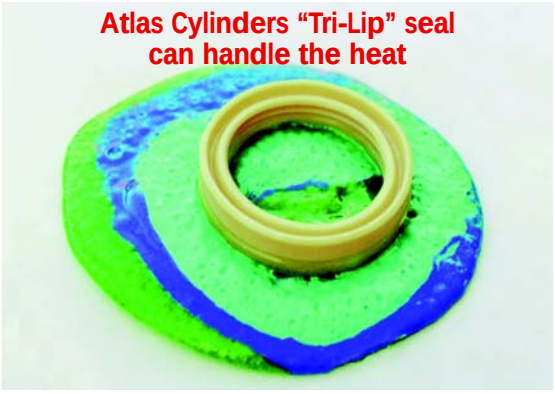
Atlas Cylinders Series MH Heavy Duty Mill Hydraulic Cylinders with the "Tri-Lip" seal offers positive protection against cylinder rod leakage under the most demanding applications.

The "Tri-Lip" seal is the product of countless hours of research, development and extensive field-testing and is only available on Atlas Cylinders.

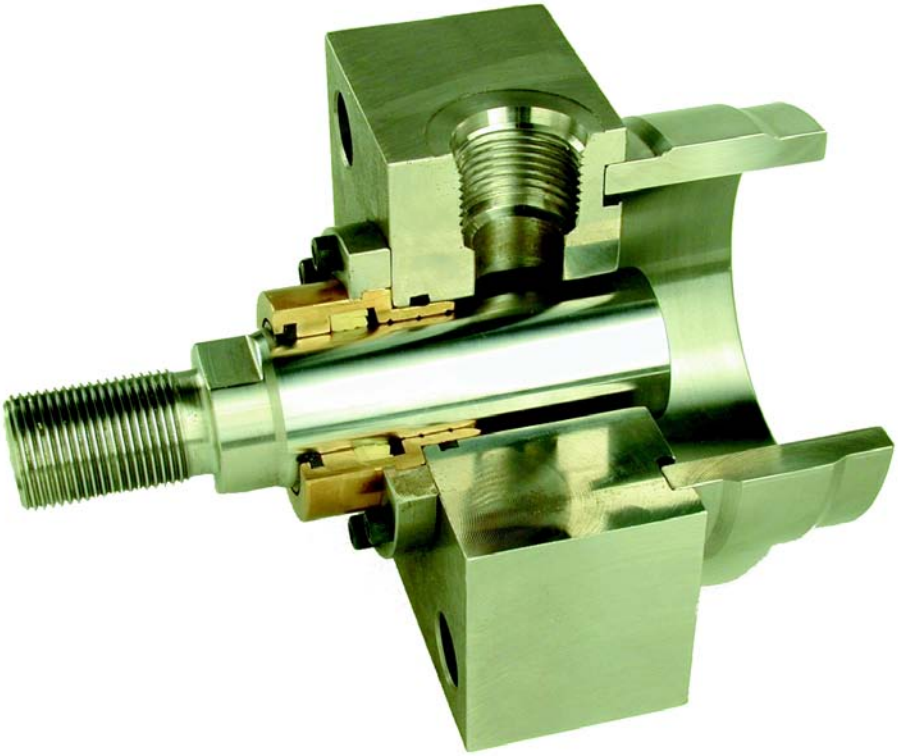
Based on a proven BS seal profile, the Atlas Cylinders "Tri-Lip" seal incorporates the pressure-compensated, uni-directional characteristics of a U-cup with the multiple edge sealing effectiveness of compression-type stacked-packing.



The goal for Atlas Cylinders was to design a rod seal suitable for all types of applications, regardless of pressure profile. It had to be composed of a material that would not react chemically with hydraulic fluids, and it had to produce better and more reliable "dry rod" performance than the standard lip-seal designs in a broad range of applications.



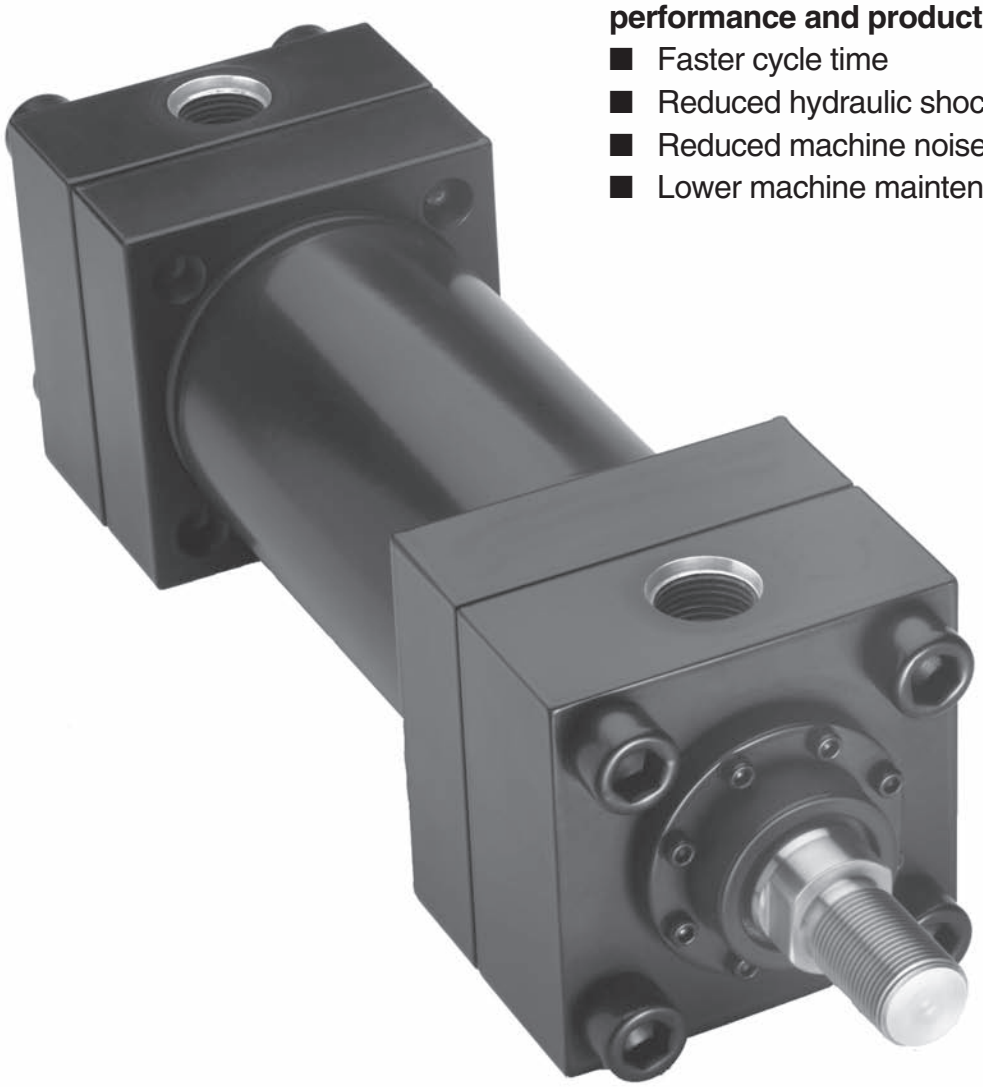
The result is the Atlas Cylinders "Tri-Lip" rod seal, designed specifically to eliminate rod seal leakage in the most demanding applications. It features a special polyurethane material that will not react chemically with petroleum based hydraulic fluid, is extremely resistant to abrasion and extrusion, and provides exceptional service life. It has more sealing edges than other seals on the market, which in turn produces "dry rod" performance. The seal geometry was refined for maximum stability in the groove and has excellent performance characteristics throughout a broad range of pressures and piston rod velocities.



Atlas Cylinders Heavy Duty Mill Hydraulic Cylinders

Series MH

- **Stepped Cushion for increased performance and productivity**
  - Faster cycle time
  - Reduced hydraulic shock
  - Reduced machine noise
  - Lower machine maintenance



- **Meets All NFPA Mounting Dimensions**
- **Heavy Duty Service – Mill Type Construction**
- **Nominal Pressure – 2000 PSI**
- **Standard Bore Sizes – 1-1/2" through 14"**
- **Piston Rod Diameters – 5/8" through 10"**

ATLAS CYLINDERS

The heavy-duty mill hydraulic cylinder with features only Atlas can promise – and deliver!

Series MH cylinders keep on performing like you expect from Atlas — producing more power per pound, more power per dollar — millions of trouble-free cycles. Everything you need for reliable 2,000 psi performance:

- Chrome-plated, induction hardened piston rods.
- Heads retained with ASTM A-574 socket head cap screws.
- Floating cushions with float-check action and positive metal-to-metal seal.
- And every Atlas cylinder is *individually* tested before it leaves our plant.

ATLAS CYLINDERS

Atlas Series "MH" Index

Page

How to Order Series "MH" Cylinders

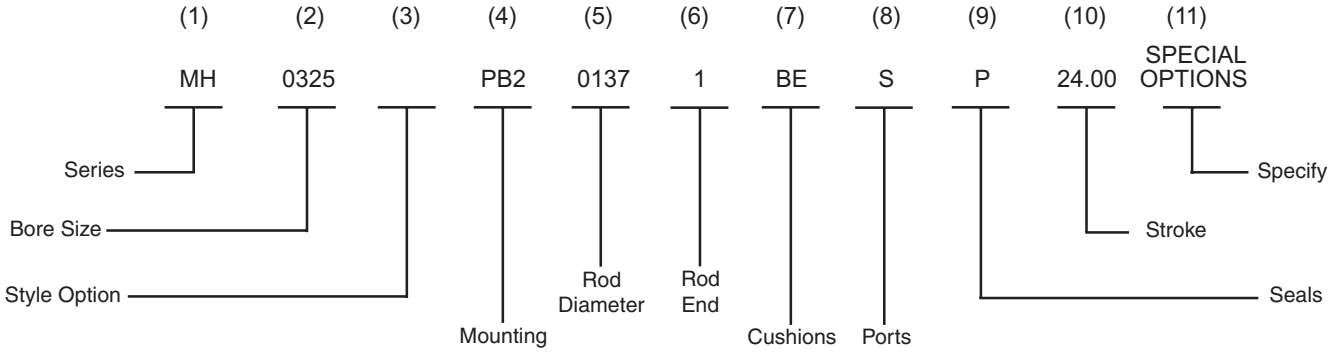
Data Required on All Cylinder Orders

When ordering Series "MH" cylinders, be sure to specify each of the following requirements:

1. **Series Designation ("MH")**
2. **Bore**
3. **Style Option (X for double rod, blank otherwise)**
4. **Mounting Style**
   Specify your choice of mounting as shown and dimensioned in this catalog.
5. **Piston Rod Diameter**
   Call out rod diameter. Standard (smallest) rod diameter will be furnished if not specified, unless stroke length makes the application questionable.
6. **Piston Rod End Style**
   Call out the rod end style or specify dimensions if non-standard. Rod end style 1 will be furnished if not specified.
7. **Cushions**
   Specify cushions if required and at which end, using the codes provided. If double rod end with only one end cushioned, be sure to clearly indicate which end.
8. **Ports**
   Atlas recommends SAE straight thread ports for leak-proof connections on series "MH" hydraulic cylinders.
9. **Seals**
   Polyurethane piston seals, the Atlas "Tri-Lip" Enhanced Polyurethane rod seal, Buna-N static seals and a Polyurethane wiper are all standard, for use with mineral oil based hydraulic fluids. Fluorocarbon, EPR, Nitroxile and other compounds can be specified, but depend on application temperature range and fluid used. Cast iron piston rings or low friction PTFE piston seals can be specified in the special options section.
10. **Stroke**
    Specify length required.
11. **Special Options**
    Specify. Consult factory for questions.

Note: Duplicate cylinders can be ordered by giving the serial number from the rod end head of the original cylinder. Factory records will supply a quick and positive identification.
Additional data is required on orders for cylinders with special modifications. For further information, consult factory.

SAMPLE MODEL CODE



NOTE: On double rod end cylinders, repeat rod size and specify rod end threads for each side.

"MH" SERIES ORDERING GUIDE

(1) SERIES	(2) BORE	(3) STYLE	(4) MOUNT	(5) ROD	(6) ROD END	(7) CUSHIONS	(8) PORTS	(9) SEALS	(10) STROKE	(11) OPTIONS
MH	**015** (1.50")	**(Leave**	**CL**	**0062** (.63")	***1 (KK MALE)***	***NC (NONE)***	***S (SAE)***	***P (POLY)***	**XXX.XX**	**S**
	020 (2.00")	**blank**	**FS**	**0100** (1.00")	**2** (CC MALE)	**HE** (HEAD END)	**N** (NPTF)	**V** (FLUOROCARBON)	(SPECIFY	(SEE
	025 (2.50")	**if**	**IH3**	**0137** (1.38")	**3** (KK FEMALE)	**CE** (CAP END)	**I** (ISO 6149)	**E** (EPR)	GROSS	BELOW)
	032 (3.25")	**standard)**	**IH4**	**0175** (1.75")	**4** (SPECIAL**+**)	**BE** (BOTH ENDS)	**F** (FLANGE)	**B** (NITROXILE)	STROKE	
	040 (4.00")		**ME5**	**0200** (2.00")	**5** (SAFETY COUPLER)		**X** (OTHER)	**M** (STD. POLY	IF STOP	
	050 (5.00")	**X**	**ME6**	**0250** (2.50")	**6** (STUB END)		(SPECIFY)	W/ BRASS	TUBE IS	
	060 (6.00")	(Double	**PB1**	**0300** (3.00")				SCRAPER)	REQUIRED)	
	070 (7.00")	rod end)	**PB2**	**0350** (3.50")				**X** SPECIAL		
	080 (8.00")		**SA**	**0400** (4.00")				SPECIFY		
	100 (10.0")		**SL**	**0450** (4.50")						
	120 (12.0")		**TM1**	**0500** (5.00")	**+** MUST SPECIFY:					
	140 (14.0")		**TM2**	**0550** (5.50")	**WF** (ROD EXTENSION)					
			TM3*	**0700** (7.70")	**A** (THREAD LENGTH)					
				0800 (8.00")	**KK** OR **CC** (THREAD SIZE AND PITCH)					
				1000 (10.0")						

***specify dimension XI**

NOTE: Items in italics are standard and will be supplied unless otherwise specified

OPTIONS

Switches	Specify Magnaswitch or Proxswitch and desired location(s)—1 1/2" through 8" bore
Rod gland drain	Specify if desired
Stop tube	Specify stop tube length and net stroke
Stainless piston rod	Specify if desired
Low friction rod seals	Specify if desired
Low friction piston seals	Specify if desired
Cast iron piston rings	Specify if desired
Water service	Specify if desired
Other option	Specify (consult factory for questions)

Certified Dimensions

Atlas Cylinders guarantees that all cylinders ordered from this catalog will be built to dimensions shown. All dimensions are certified to be correct, and thus it is not necessary to request certified drawings.

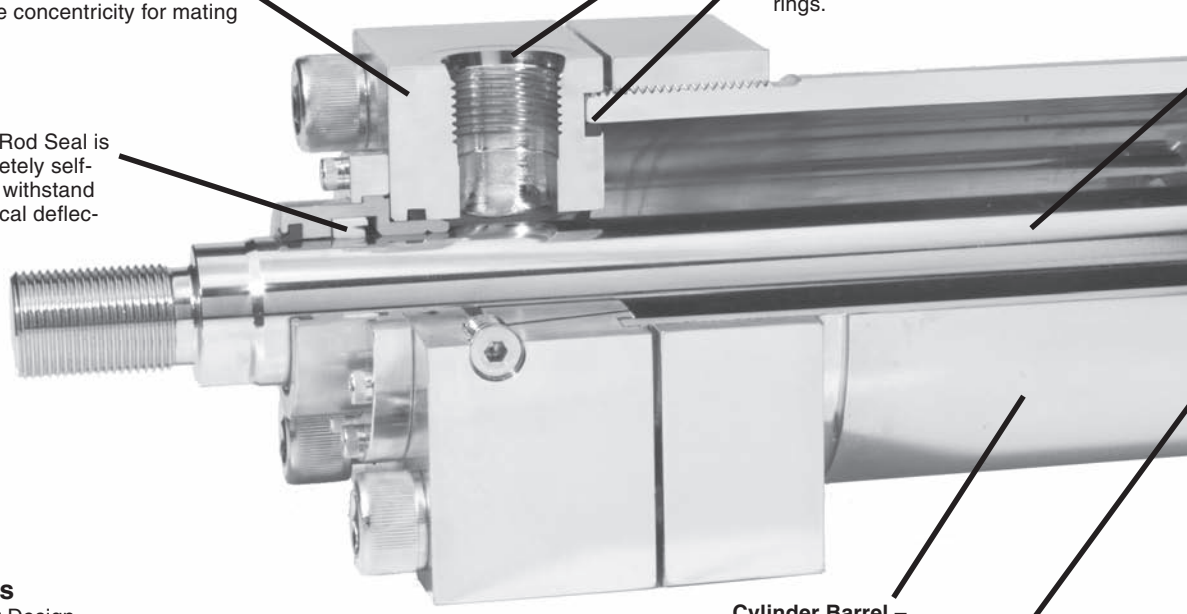
The inside story on why Series MH is your best choice in heavy duty mill hydraulic cylinders

Ports – S.A.E. "O" ring ports are standard.

End Seals – Pressure-actuated cylinder body-to-head and cap "O" rings.

Steel Head – Bored and grooved to provide concentricity for mating parts.

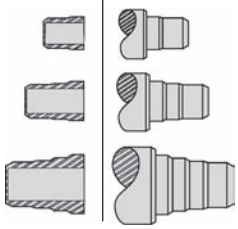
Primary Seal – Exclusive "Tri Lip" Rod Seal is a proven leakproof design – completely self-compensating and self-relieving to withstand variations and conform to mechanical deflection that may occur.



Cylinder Barrel – Heavy-wall steel tubing, honed to a micro finish bore.

Stepped Cushions

Sleeve Design | Spear Design



Adjustable Floating Stepped Cushions – For maximum performance – economical and flexible for even the most demanding applications – provides superior performance in reducing shock. Cushions are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions.

Stepped floating cushions combine the best features of known cushion technology.

Deceleration devices or built-in "cushions" are optional and can be supplied at head end, cap end, or both ends without change in envelope or mounting dimensions. Cushions are a stepped design and combine the best features of known cushion technology.

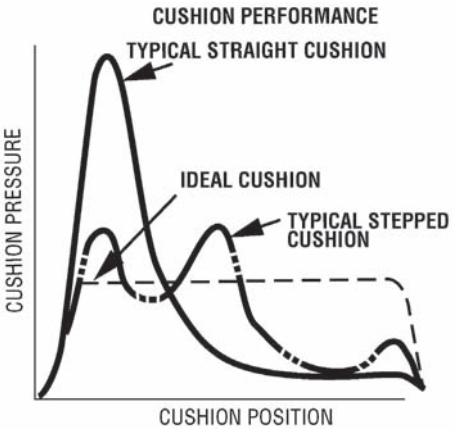
Standard straight or tapered cushions have been used in industrial cylinders over a very broad range of applications. Extensive research has found that both designs have their limitations.

As a result, we have taken a new approach in cushioning of industrial mill hydraulic cylinders and for specific load and velocity conditions have been able to obtain deceleration curves that come very close to the ideal. The success lies in a stepped sleeve or spear concept where the steps are calculated to approximate theoretical orifice areas curves.

In the cushion performance chart, pressure traces show the results of typical orifice flow conditions. Tests of a three-step sleeve or spear show three pressure pulses coinciding with the steps. The deceleration cushion plunger curves shape comes very close to being theoretical, with the exception of the last $^1/_2$ inch of travel. This is a constant shape in order to have some flexibility in application. The stepped cushion design shows reduced pressure peaks for most load and speed conditions, with comparable reduction of objectionable stopping forces being transmitted to the load and the support structure.

All cushions are adjustable.

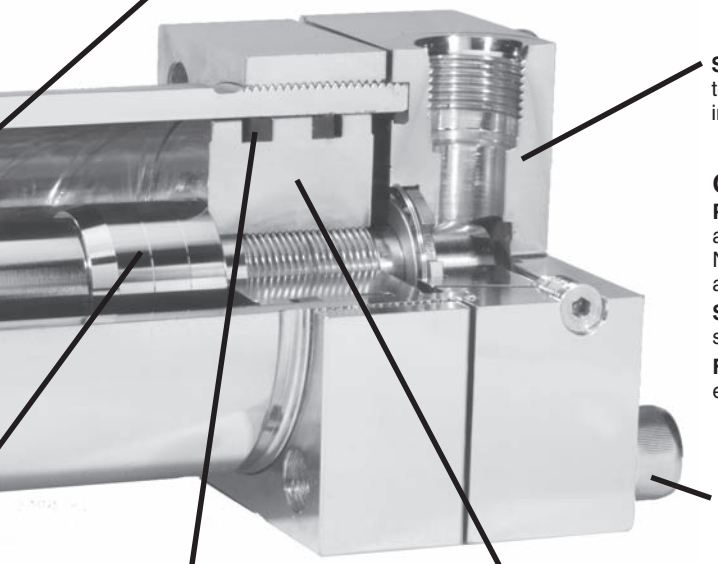
The Series MH cylinder design incorporates the longest cushion sleeve and cushion spear that can be provided in the standard envelope without decreasing the rod bearing and piston bearing strengths.



(1) When a cushion is specified at the head end:

a. A self-centering stepped sleeve is furnished on the piston rod assembly.

Piston Rod – Carbon steel, induction case-hardened to 54 R_c, hard chrome-plated and polished to 10 RMS finish. Piston rods are made from 90,000 to 100,000 psi minimum yield material in $^5/_8$" through 4" diameters. Larger diameters vary between 57,000 and 90,000 psi minimum material, depending on rod diameter. The piston thread equals the catalog style #1 rod end thread for each rod diameter to assure proper piston-to-rod thread strength. Two wrench flats are provided for rod end attachment.



Steel Cap – Bored and grooved to provide concentricity for mating parts.

Optional Ports

Ports – N.P.T.F. ports are optional at no extra charge. Oversize N.P.T.F. and S.A.E. ports are available at extra charge.

Seals – Buna-N (Nitrile) static seals are standard.

Fluorocarbon Seals – Optional at extra charge.

Socket Head Cap Screws Made from high alloy steel for added strength.

Poly Flex Seals are furnished as standard.

One-Piece Fine Grained Cast Iron Piston – The wide piston surface contacting cylinder bore reduces bearing loads, and a long thread engagement with rod provides greater shock absorption. Anaerobic adhesive is used to permanently lock and seal the piston to the rod.

Atlas Cylinders Standard Rod Cartridge – The standard Atlas Cylinders rod cartridge is a unitized design that is piloted into the rod head and carries the exclusive Atlas Tri-Lip rod seal. An extra-long inboard bearing surface insures lubrication from within the cylinder. A spiral groove on the bearing area helps eliminate drag pressure that can cause damage to the rod seal and provides positive lubrication for less wear.

Atlas Cylinders Low Friction Rod Cartridge – The Atlas Cylinders low friction rod cartridge provides the same unitized design as the standard rod cartridge with low friction seals. The bronze-filled PTFE seals in tandem with the wiperseal offer a virtual zero leak seal system with very low slip-stick and smooth operation up to 2000 psi. The spiral groove is also utilized from the standard rod cartridge.

Cast Iron Piston Ring – Optional at no extra charge.

Low Friction Piston – Optional at extra charge. Includes wear rings and bronze-filled PTFE seals. Two wear rings serve as bearings which deform radially under side-loading, enabling the load to be spread over a larger area and reduce unit loading. A bronze-filled PTFE seal designed for extrusion-free, low friction service and longer cylinder life than the standard piston.

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b. A needle valve is provided that is flush with the side of the head even when wide open. It may be identified by the fact that it is socket-keyed. It is located on side number 2, in all mounting styles, except TM-1, ME-5, and CL.

c. On 5" bore and larger cylinders a springless check valve is provided that is also flush with the side of the head and is mounted opposite to the needle valve except on mounting style CL, TM-1, and ME-5, where it is mounted adjacent to the needle valve. It may be identified by the fact that it is slotted.

d. On 1½" - 4" bore cylinders, a slotted sleeve design is used in place of the check valve.

e. 1½" - 2" bore cylinders use a cartridge style needle valve. (See Figure A)

(2) When a cushion is specified at the cap end:

a. A cushion stepped spear is provided on the piston rod.

b. A "float check" self-centering bushing is provided on 1½" - 6" bore which incorporates a large flow check valve for fast "out-stroke" action. A springless ball check valve is provided from 7" - 14" bore cylinders.

c. A socket-keyed needle valve is provided that is flush with the side of the cap when wide open. It is located on side number 2 in all mounting styles except CL, TM-2, ME-6. In these styles it is located on side number 3.

Cushion Length

Cyl. Bore In.	Rod Dia. In.	Cushion Length – Inch	
		Head*	Cap
1½	⅝	1⅛	13/16
	1	1⅛	13/16
2	1	1⅛	1⅛
	1⅜	1⅛	1⅛
2½	1	1⅛	1⅛
	1¾	1⅛	1⅛
3¼	1⅜	1⅜	15/16
	2	1 1/16	15/16
4	1¾	1⅜	1¼
	2½	1 1/16	1¼
5	2	1 1/16	1⅛
	3½	1 1/16	1⅛
6	2½	15/16	1½
	4	15/16	1½
7	3	1 13/16	1 15/16
	5	1 11/16	1 15/16
8	3½	2 1/16	2
	5½	1 15/16	2

*Head end cushions for rod diameters not listed have cushion lengths with the limits shown.

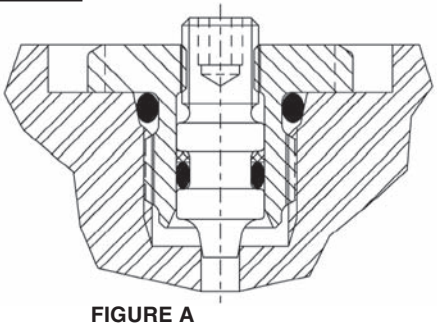


FIGURE A

Standard Specifications

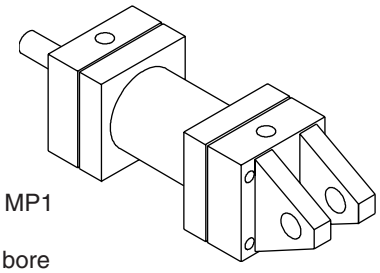
- Heavy Duty Service – NFPA specifications and ANSI B93.15-1981 mounting dimension standards
- Standard Construction – Square Head – Mill Design
- Nominal Pressure – 2000 P.S.I.*
- Bore Sizes – $1\frac{1}{2}$" through 14" (Larger sizes available)
- Mounting Styles – 14 standard styles at various application ratings
- Piston Rod Diameter – $\frac{5}{8}$" through 10"
- Rod Ends – Five Standard Choices – Specials to Order
- Strokes – Available in any practical stroke length
- Cushions – Optional at either end or both ends of stroke. "Float Check" at cap end.
- Standard Fluid – Hydraulic Oil
- Standard Temperature – -10˚ F to +165˚ F

*If hydraulic operating pressure exceeds 2000 P.S.I., send application data for engineering evaluation and recommendation.

In line with our policy of continuing product improvement, specifications in this catalog are subject to change.

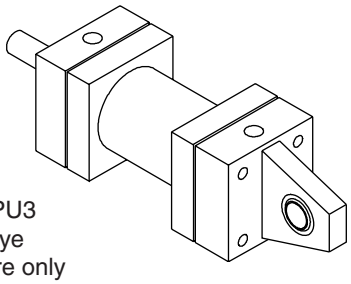
Note: Series MH Mill Hydraulic Cylinders fully meet N.F.P.A. Standards and ANSI Standard B93.15-1981 for Mounting Dimensions for Square Head Industrial Fluid Power Cylinders.

MOUNTING STYLES



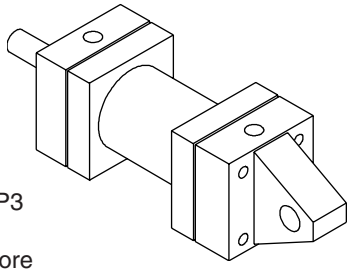
MH-PB-2
NFPA Styple MP1
Fixed Clevis
1.5" thru 14" bore

Page 14, 15, 24, 25



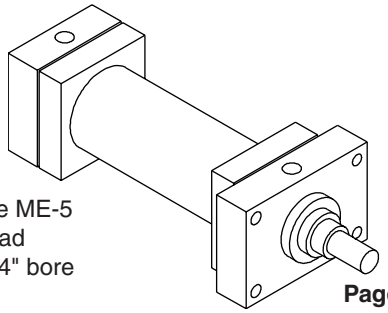
MH-SA
NFPA Style MPU3
Self-Sligning Eye
1.5" thru 6" bore only

Page 14, 15



MH-PB-1
NFPA Style MP3
Pivot Eye
1.5" thru 14" bore

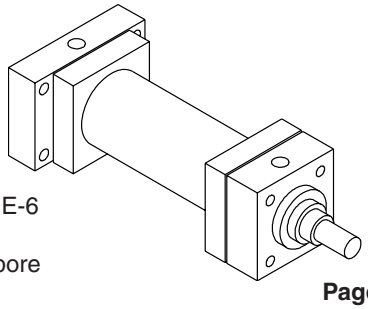
Page 14, 15, 24, 25



MH-ME-5
NFPA Style ME-5
Flange Head
1.5" thru 14" bore

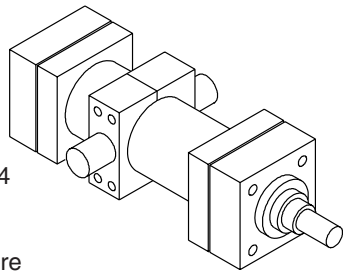
Page 10, 11, 20, 21

MOUNTING STYLES



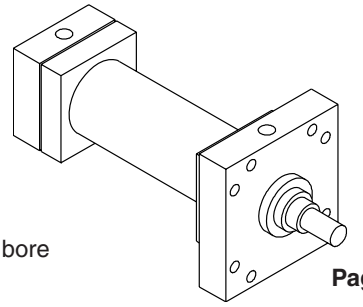
MH-ME-6
NFPA Style ME-6
Flange Head
1.5" thru 14" bore

Page 10, 11, 20, 21



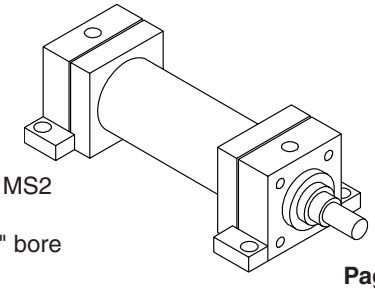
MH-TM-3
NFPA Style MT4
Intermediate
Trunnion
1.5" thru 14" bore

Page 16, 17, 26, 27



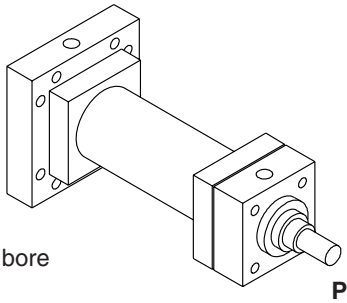
MH-IH-3
Flange Head
1.5" thru 14" bore

Page 10, 11, 20, 21



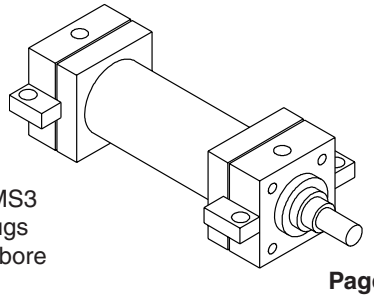
MH-SL
NFPA Style MS2
Side Lug
1.5" thru 14" bore

Page 12, 13, 22, 23



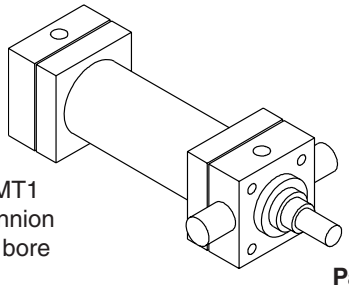
MH-IH-4
Flange Head
1.5" thru 14" bore

Page 10, 11, 20, 21



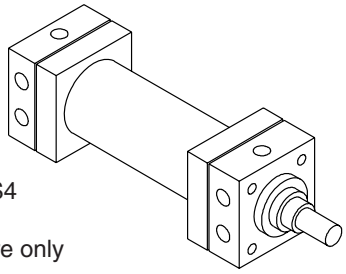
MH-CL
NFPA Style MS3
Centerline Lugs
1.5" thru 14" bore

Page 12, 13, 22, 23



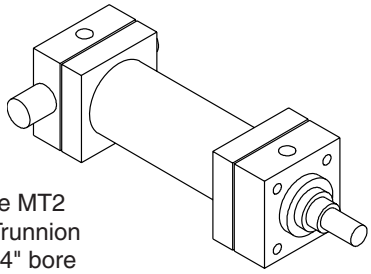
MH-TM-1
NFPA Style MT1
Rod End Trunnion
1.5" thru 14" bore

Page 16, 17, 26, 27



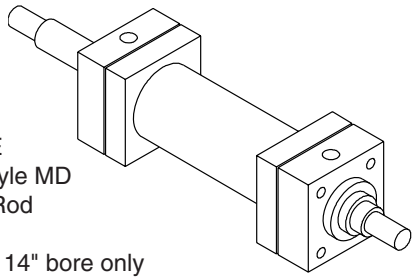
MH-FS
NFPA Style MS4
Side Tapped
1.5" thru 8" bore only

Page 12, 13



MH-TM-2
NFPA Style MT2
Cap End Trunnion
1.5" thru 14" bore

Page 16, 17, 26, 27



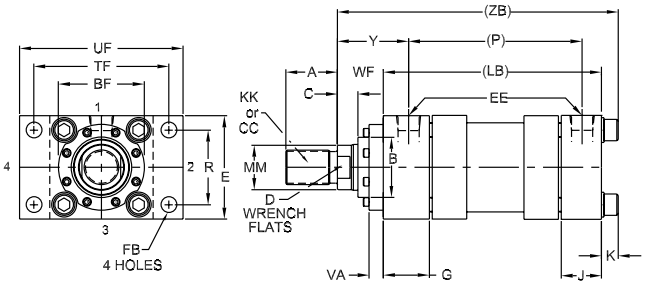
MH-DRE
NFPA Style MD
Double Rod
Cylinder
1.5" thru 14" bore only

Page 18, 19

1 1/2" THRU 8" "MH" RECTANGULAR ROD HEAD, RECTANGULAR CAP HEAD, SQUARE ROD HEAD AND SQUARE CAP HEAD

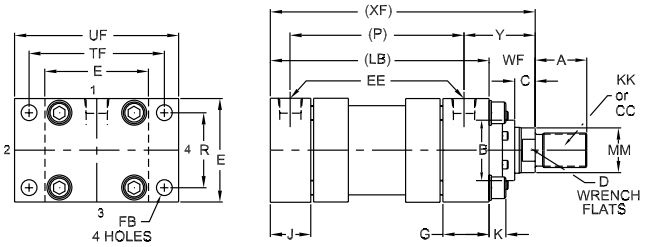
MH-ME-5
1.5" thru 8" Bore

NFPA STYLE ME5
ROD HEAD FLANGE



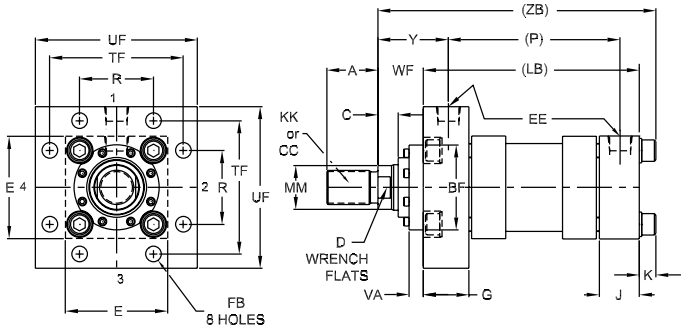
MH-ME-6
1.5" thru 8" Bore

NFPA STYLE ME6
CAP HEAD FLANGE



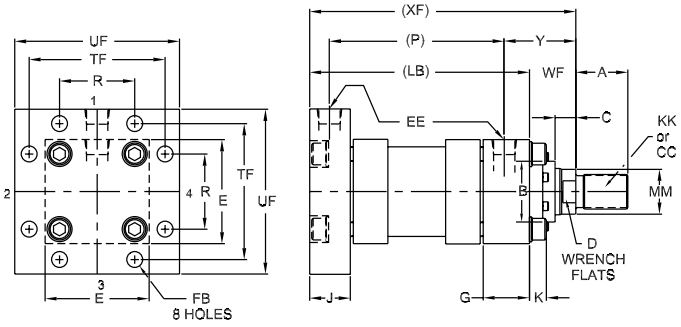
MH-IH-3
1.5" thru 8" Bore

ROD HEAD FLANGE



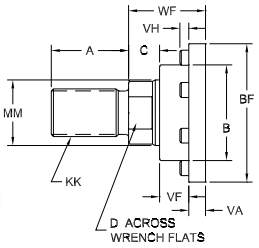
MH-IH-4
1.5" thru 8" Bore

CAP HEAD FLANGE



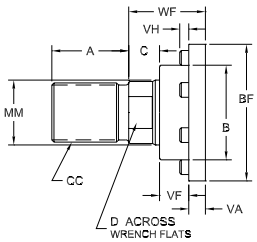
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

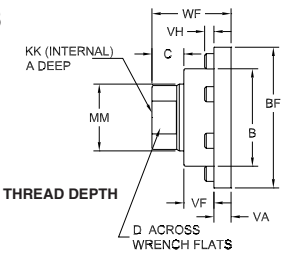


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread



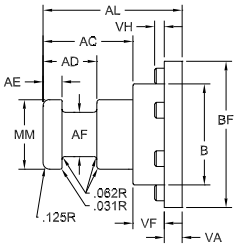
STYLE 4

"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

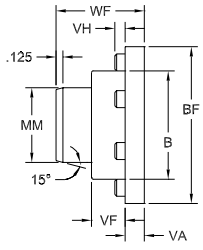
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	E	EE		FB	G	J	K	R	TF	UF	Add Stroke		Minimum Stroke
		SAE	NPTF								LB	P	
1 1/2	2 1/2	#8	1/2	7/16	1 3/4	1 1/2	.38	1.63	3 7/16	4 1/4	4 5/8	2 7/8	1.63
2	3	#8	1/2	9/16	1 3/4	1 1/2	.50	2.05	4 1/8	5 1/8	4 5/8	2 7/8	1.63
2 1/2	3 1/2	#8	1/2	9/16	1 3/4	1 1/2	.50	2.55	4 5/8	5 5/8	4 3/4	3	1.50
3 1/4	4 1/2	#12	3/4	11/16	2	1 3/4	.63	3.25	5 7/8	7 1/8	5 1/2	3 1/2	1.75
4	5	#12	3/4	11/16	2	1 3/4	.63	3.82	6 3/8	7 5/8	5 3/4	3 3/4	1.50
5	6 1/2	#12	3/4	15/16	2	1 3/4	.88	4.95	8 3/16	9 3/4	6 1/4	4 1/4	1.50
6	7 1/2	#16	1	1 1/16	2 1/4	2 1/4	1.00	5.73	9 7/16	11 1/4	7 3/8	4 7/8	2.38
7	8 1/2	#20	1 1/4	1 3/16	2 3/4	2 3/4	1.13	6.58	10 5/8	12 5/8	8 1/2	5 1/2	3.25
8	9 1/2	#24	1 1/2	1 5/16	3	3	1.25	7.50	11 13/16	14	9 1/2	6 1/4	4.75

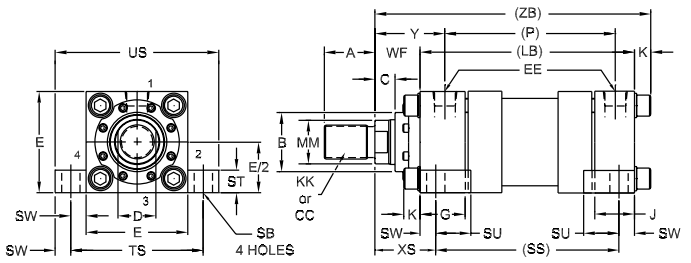
Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Y	Add Stroke	
		Style 1 & 3	Style 2											XF	ZB
		KK	CC												
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	2	5 5/8	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6	6 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	6 1/4	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6 1/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	6 3/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	6 5/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 3/4	7 1/8	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	7 3/8	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	7 1/2	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	7 5/8	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	7 3/4	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	8 1/4	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	8 1/2	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 3/8	8 1/2	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/8	8 1/2	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/2	9 5/8	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/8	1	2 5/8	15/16	5/16	—	2 1/4	3 1/2	9 5/8	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 1/2	9 5/8	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 1/2	9 5/8	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 3/4	10 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/4	10 3/4	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 3/4	10 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 3/4	10 3/4	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 3/4	10 3/4	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 7/8	11 3/4	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 7/8	11 3/4	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 7/8	11 3/4	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 7/8	11 3/4	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	—	15/16	5/16	—	2 1/4	3 7/8	11 3/4	13 1/4

1½" THRU 8" "MH" SIDE LUG, CENTER LUG, FLUSH MOUNT

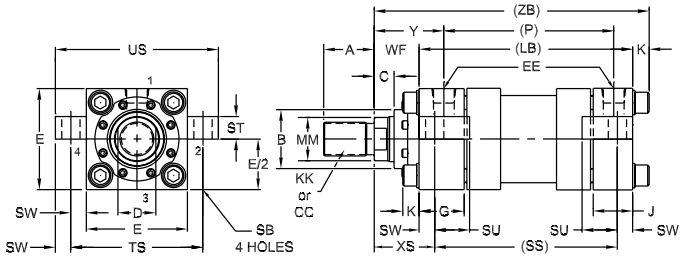
MH-SL
1.5" thru 8" Bore

NFPA STYLE MS2
SIDE LUG



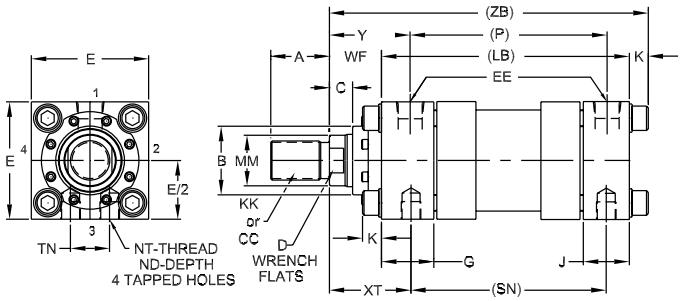
MH-CL
1.5" thru 8" Bore

NFPA STYLE MS3
CENTER LUG



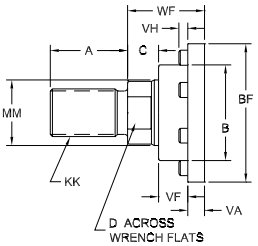
MH-FS
1.5" thru 8" Bore

NFPA STYLE MS4
SIDE TAPPED



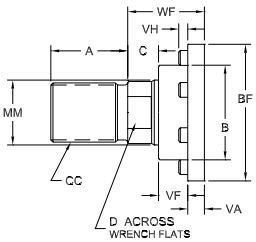
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

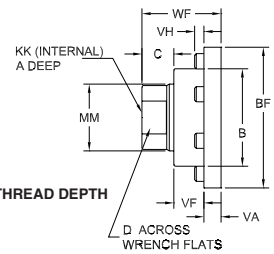


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread



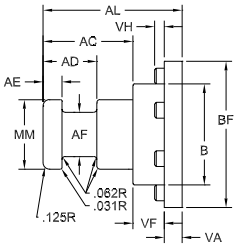
STYLE 4

"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

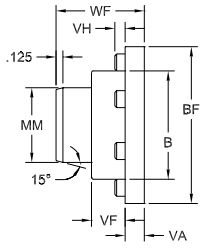
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	E	EE		G	J	K	ND	NT	SB	ST	SU	SW
		SAE	NPTF									
1 1/2	2 1/2	#8	1/2	1 3/4	1 1/2	.38	3/8	3/8 - 16	7/16	1/2	15/16	3/8
2	3	#8	1/2	1 3/4	1 1/2	.50	7/16	1/2 - 13	9/16	3/4	1 1/4	1/2
2 1/2	3 1/2	#8	1/2	1 3/4	1 1/2	.50	1/2	5/8 - 11	13/16	1	1 9/16	11/16
3 1/4	4 1/2	#12	3/4	2	1 3/4	.63	11/16	3/4 - 10	13/16	1	1 9/16	11/16
4	5	#12	3/4	2	1 3/4	.63	11/16	1 - 8	1 1/16	1 1/4	2	7/8
5	6 1/2	#12	3/4	2	1 3/4	.88	1	1 - 8	1 1/16	1 1/4	2	7/8
6	7 1/2	#16	1	2 1/4	2 1/4	1.00	1 1/4	1 1/4 - 7	1 5/16	1 1/2	2 1/2	1 1/8
7	8 1/2	#20	1 1/4	2 3/4	2 3/4	1.13	1 1/8	1 1/2 - 6	1 9/16	1 3/4	2 7/8	1 3/8
8	9 1/2	#24	1 1/2	3	3	1.25	1 1/2	1 1/2 - 6	1 9/16	1 3/4	2 7/8	1 3/8

Envelope and Mounting Dimensions—Continued

BORE	TN	TS	US	Add Stroke				MIN STROKE
				LB	P	SN	SS	
1 1/2	3/4	3 1/4	4	4 5/8	2 7/8	2 7/8	3 7/8	1.63
2	15/16	4	5	4 5/8	2 7/8	2 7/8	3 5/8	1.63
2 1/2	1 5/16	4 7/8	6 1/4	4 3/4	3	3	3 3/8	1.50
3 1/4	1 1/2	5 7/8	7 1/4	5 1/2	3 1/2	3 1/2	4 1/8	1.75
4	2 1/16	6 3/4	8 1/2	5 3/4	3 3/4	3 3/4	4	1.50
5	2 15/16	8 1/4	10	6 1/4	4 1/4	4 1/4	4 1/2	1.50
6	3 5/16	9 3/4	12	7 3/8	4 7/8	5 1/8	5 1/8	2.38
7	3 3/4	11 1/4	14	8 1/2	5 1/2	5 7/8	5 3/4	3.25
8	4 1/4	12 1/4	15	9 1/2	6 1/4	6 5/8	6 3/4	4.75

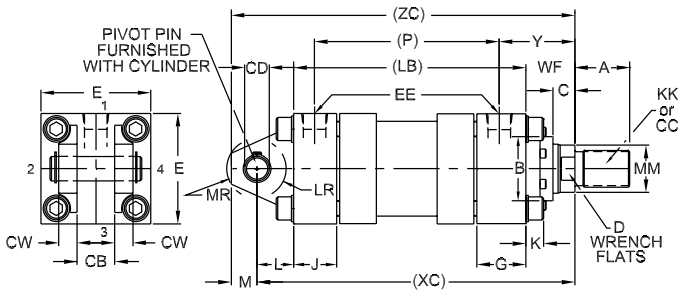
Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	XS	XT	Y	Add Stroke
		Style 1 & 3	Style 2													
		KK	CC													ZB
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	1 3/8	1 5/16	2	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 3/4	2 5/16	2 3/8	6 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	1 7/8	2 5/16	2 3/8	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/8	2 9/16	2 5/8	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/16	2 5/16	2 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/16	2 9/16	2 5/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 9/16	2 13/16	2 7/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/16	2 9/16	2 3/4	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 9/16	2 13/16	3	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2 11/16	2 15/16	3 1/8	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 3/4	2 15/16	3	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2 7/8	3 1/16	3 1/8	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/8	3 5/16	3 3/8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	2 7/8	3	3 1/8	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/8	3 1/4	3 3/8	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 1/8	3 1/4	3 3/8	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 1/8	3 1/4	3 3/8	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	3 5/16	3 1/2	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/8	1	2 5/8	15/16	5/16	—	2 1/4	3 3/8	3 5/16	3 1/2	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/8	3 5/16	3 1/2	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 3/8	3 5/16	3 1/2	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 5/8	3 13/16	3 3/4	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 5/8	3 13/16	3 3/4	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 5/8	3 13/16	3 3/4	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 5/8	3 13/16	3 3/4	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 5/8	3 13/16	3 3/4	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	—	15/16	5/16	—	2 1/4	3 5/8	3 15/16	3 7/8	13 1/4

1½" THRU 8" "MH" FIXED CLEVIS, PIVOT EYE, AND DETACHABLE CLEVIS
1½" THRU 6" SELF-ALIGNING EYE

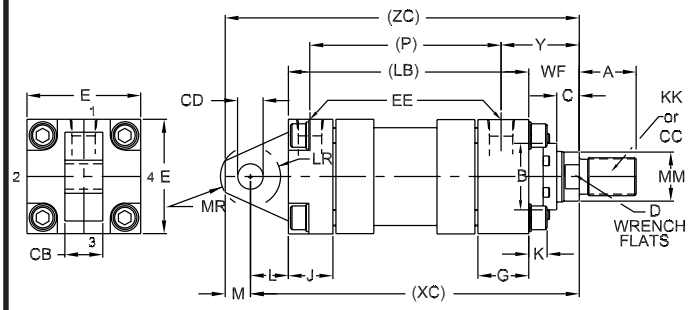
MH-PB-2
1.5" thru 8" Bore

NFPA STYLE MP1
FIXED CLEVIS



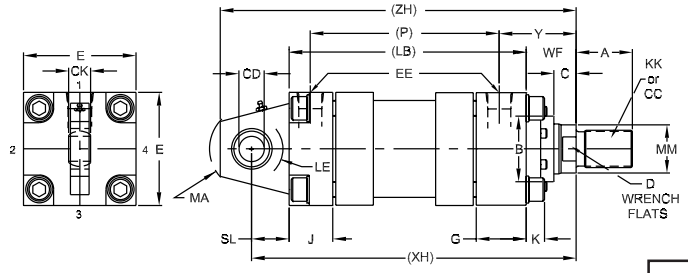
MH-PB-1
1.5" thru 8" Bore

NFPA STYLE MP3
PIVOT EYE



MH-SA*
1.5" thru 6" Bore

NFPA STYLE MPU3
SELF ALIGNING EYE



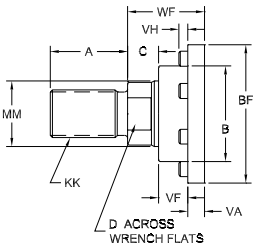
MH-SA

Bore	Max. Op. PSI†
1½	1250
2	2000
2½	1450
3¼	1500
4	1850
5	2000
6	1800

*See Table 1 on page 31 for recommended maximum swivel angles.

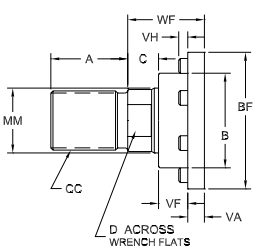
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

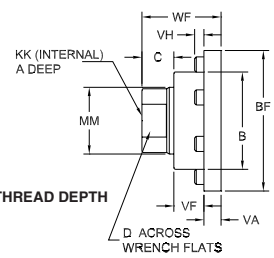


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread

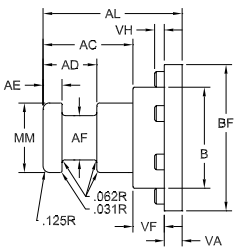


STYLE 4
"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

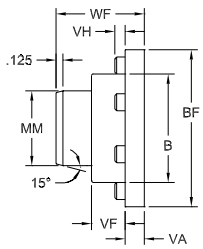
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	CB	CD	CK	CW	E	EE		G	J	K	L	LE	LR
						SAE	NPTF						
1 1/2	3/4	0.501	7/16	1/2	2 1/2	#8	1/2	1 3/4	1 1/2	.38	3/4	7/8	9/16
2	1 1/4	0.751	21/32	5/8	3	#8	1/2	1 3/4	1 1/2	.50	1 1/4	7/8	1
2 1/2	1 1/4	0.751	21/32	5/8	3 1/2	#8	1/2	1 3/4	1 1/2	.50	1 1/4	7/8	15/16
3 1/4	1 1/2	1.001	7/8	3/4	4 1/2	#12	3/4	2	1 3/4	.63	1 1/2	1 1/8	1 1/4
4	2	1.376	1 3/16	1	5	#12	3/4	2	1 3/4	.63	2 1/8	1 1/2	1 3/4
5	2 1/2	1.751	1 17/32	1 1/4	6 1/2	#12	3/4	2	1 3/4	.88	2 1/4	1 15/16	2 1/16
6	2 1/2	2.001	1 3/4	1 1/4	7 1/2	#16	1	2 1/4	2 1/4	1.00	2 1/2	2 3/16	2 5/16
7	3	2.501	—	1 1/2	8 1/2	#20	1 1/4	2 3/4	2 3/4	1.13	3	—	2 3/4
8	3	3.001	—	1 1/2	9 1/2	#24	1 1/2	3	3	1.25	3 1/4	—	3 1/4

Envelope and Mounting Dimensions—Continued

BORE	M	MA	MR	SL	Add Stroke		MIN STROKE
					LB	P	
1 1/2	1/2	1 1/4	5/8	3/4	4 5/8	2 7/8	1.63
2	3/4	1 1/4	15/16	1 1/4	4 5/8	2 7/8	1.63
2 1/2	3/4	1 1/4	15/16	1 1/4	4 3/4	3	1.50
3 1/4	1	1 1/2	1 3/16	1 1/2	5 1/2	3 1/2	1.75
4	1 3/8	1 3/4	1 5/8	2 1/8	5 3/4	3 3/4	1.50
5	1 3/4	2 1/4	2 1/8	2 1/4	6 1/4	4 1/4	1.50
6	2	2 3/4	2 3/8	2 1/2	7 3/8	4 7/8	2.38
7	2 1/2	—	2 7/8	—	8 1/2	5 1/2	3.25
8	2 3/4	—	3 1/8	—	9 1/2	6 1/4	4.75

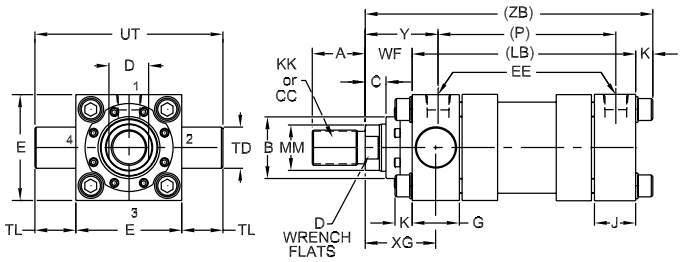
Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	Y	Add Stroke			
		Style 1 & 3 KK	Style 2 CC											XC	XH	ZC	ZH
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	2	6 3/8	6 3/8	6 7/8	7 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	6 3/4	6 3/4	7 1/4	7 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	7 1/4	7 1/4	8	8 1/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	7 1/2	7 1/2	8 1/4	8 1/2
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 3/8	7 3/8	7 3/8	8 1/8	8 3/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	7 5/8	7 5/8	8 3/8	8 5/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	7 7/8	7 7/8	8 5/8	8 7/8
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 3/4	8 5/8	8 5/8	9 5/8	9 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	8 7/8	8 7/8	9 7/8	10 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	9	9	10	10 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	3	9 3/4	9 3/4	11 1/8	11 5/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	9 7/8	9 7/8	11 1/4	11 3/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	10 1/8	10 1/8	11 1/2	12
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3 1/8	10 1/2	10 1/2	12 1/8	13
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	10 3/4	10 3/4	12 1/2	13 1/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 3/8	10 3/4	10 3/4	12 1/2	13 1/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/8	10 3/4	10 3/4	12 1/2	13 1/4
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/2	12 1/8	12 1/8	14 1/8	14 5/8
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/8	1	2 5/8	15/16	5/16	—	2 1/4	3 1/2	12 1/8	12 1/8	14 1/8	14 5/8
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 1/2	12 1/8	12 1/8	14 1/8	14 5/8
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 1/2	12 1/8	12 1/8	14 1/8	14 5/8
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 3/4	13 3/4	—	16 1/4	—
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/4	13 3/4	—	16 1/4	—
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 3/4	13 3/4	—	16 1/4	—
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 3/4	13 3/4	—	16 1/4	—
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 3/4	13 3/4	—	16 1/4	—
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 7/8	15	—	17 3/4	—
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 7/8	15	—	17 3/4	—
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 7/8	15	—	17 3/4	—
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 7/8	15	—	17 3/4	—
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	—	15/16	5/16	—	2 1/4	3 7/8	15	—	17 3/4	—

1½" THRU 8" "MH" TRUNNION MOUNT

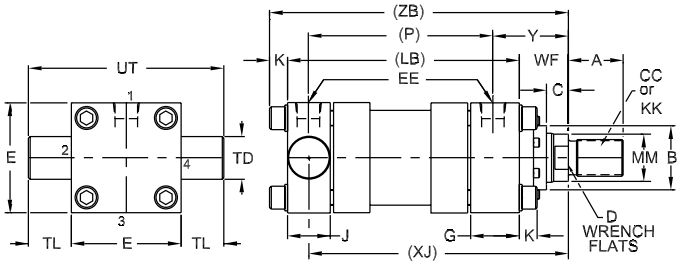
MH-TM-1
1.5" thru 8" Bore

NFPA STYLE MT1
ROD END TRUNNION



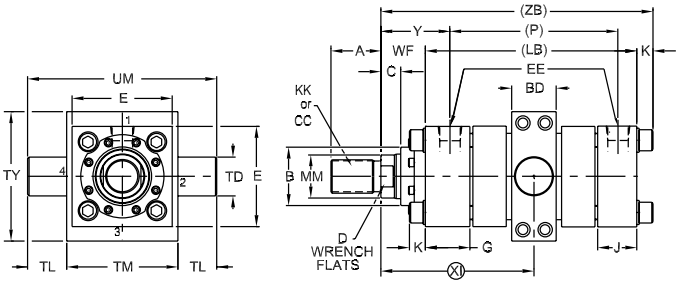
MH-TM-2
1.5" thru 8" Bore

NFPA STYLE MT2
CAP END TRUNNION



MH-TM-3
1.5" thru 8" Bore

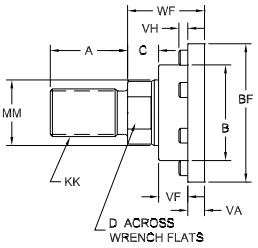
NFPA STYLE MT4
INTERMEDIATE TRUNNION



XI–Customer must specify when ordering. See chart for minimum XI.
Maximum XI = minimum XI plus stroke.

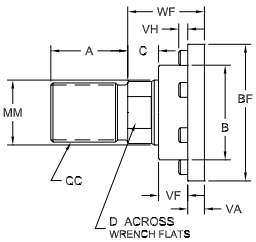
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

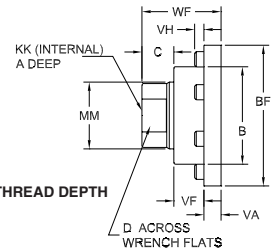


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread



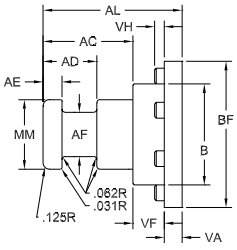
STYLE 4

"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

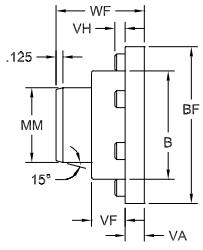
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	BD	E	EE		G	J	K	TD	TL	TM	TY	UM	UT
			SAE	NPTF									
1 1/2	1 1/4	2 1/2	#8	1/2	1 3/4	1 1/2	.38	1.000	1	3	3 3/8	5	4 1/2
2	1 1/2	3	#8	1/2	1 3/4	1 1/2	.50	1.375	1 3/8	3 1/2	4 1/8	6 1/4	5 3/4
2 1/2	1 1/2	3 1/2	#8	1/2	1 3/4	1 1/2	.50	1.375	1 3/8	4	4 5/8	6 3/4	6 1/4
3 1/4	2	4 1/2	#12	3/4	2	1 3/4	.63	1.750	1 3/4	5	5 13/16	8 1/2	8
4	2	5	#12	3/4	2	1 3/4	.63	1.750	1 3/4	5 1/2	6 3/8	9	8 1/2
5	2	6 1/2	#12	3/4	2	1 3/4	.88	1.750	1 3/4	7	7 3/4	10 1/2	10
6	3	7 1/2	#16	1	2 1/4	2 1/4	1.00	2.000	2	8 1/2	10 3/8	12 1/2	11 1/2
7	3	8 1/2	#20	1 1/4	2 3/4	2 3/4	1.13	2.500	2 1/2	9 3/4	11 1/2	14 3/4	13 1/2
8	3 1/2	9 1/2	#24	1 1/2	3	3	1.25	3.000	3	11	13 3/8	17	15 1/2

Envelope and Mounting Dimensions—Continued

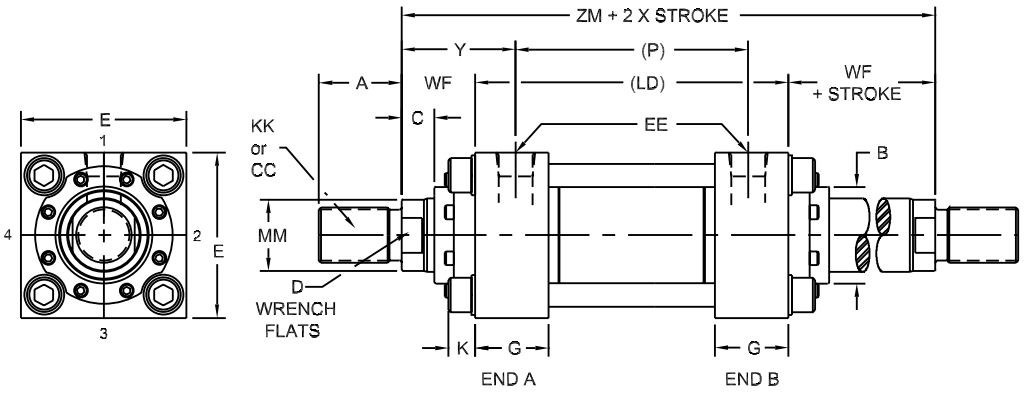
BORE	Add Stroke		Minimum Stroke TM-3	Minimum Stroke TM-1 & TM-2
	LB	P		
1 1/2	4 5/8	2 7/8	3.00	1.63
2	4 5/8	2 7/8	3.25	1.63
2 1/2	4 3/4	3	3.13	1.50
3 1/4	5 1/2	3 1/2	3.88	1.75
4	5 3/4	3 3/4	3.63	1.50
5	6 1/4	4 1/4	3.63	1.50
6	7 3/8	4 7/8	5.50	2.38
7	8 1/2	5 1/2	6.38	3.25
8	9 1/2	6 1/4	8.38	4.75

Dimensions Affected by Rod Size

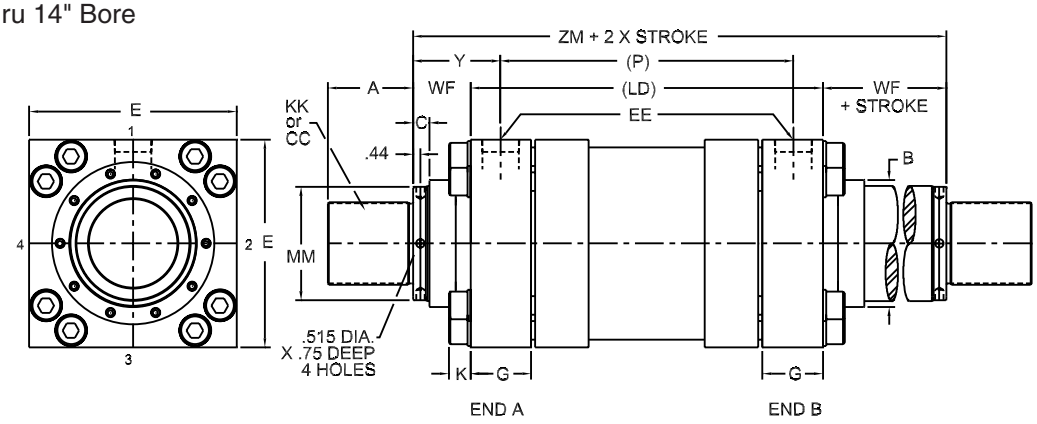
BORE	MM Rod Size	Thread		A	B	BF	C	D	VA	VF	VH	WF	XG	XI	Y	Add Stroke	
		Style 1 & 3	Style 2											Min		XJ	ZB
		KK	CC														
1 1/2	5/8	7/16 - 20	1/2 - 20	3/4	1.124	1 15/16	3/8	1/2	3/8	1/4	3/16	1	1 7/8	4 15/16	2	4 7/8	6 1/8
	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	5 5/16	2 3/8	5 1/4	6 1/2
2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	5 7/16	2 3/8	5 1/4	6 5/8
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	5 11/16	2 5/8	5 1/2	6 7/8
2 1/2	1	3/4 - 16	7/8 - 14	1 1/8	1.499	2 3/8	1/2	7/8	3/8	1/2	3/16	1 3/8	2 1/4	5 7/16	2 3/8	5 3/8	6 3/4
	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 1/2	5 11/16	2 5/8	5 5/8	7
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 3/4	5 15/16	2 7/8	5 7/8	7 1/4
3 1/4	1 3/8	1 - 14	1 1/4 - 12	1 5/8	1.999	2 7/8	5/8	1 1/8	3/8	5/8	3/16	1 5/8	2 5/8	6 7/16	2 3/4	6 1/4	7 7/8
	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	6 11/16	3	6 1/2	8 1/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	6 13/16	3 1/8	6 5/8	8 1/4
4	1 3/4	1 1/4 - 12	1 1/2 - 12	2	2.374	3 1/2	3/4	1 1/2	5/8	1/2	3/16	1 7/8	2 7/8	6 11/16	3	6 3/4	8 3/8
	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	6 13/16	3 1/8	6 7/8	8 1/2
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	7 1/16	3 3/8	7 1/8	8 3/4
5	2	1 1/2 - 12	1 3/4 - 12	2 1/4	2.624	3 3/4	7/8	1 11/16	5/8	1/2	1/4	2	3	7 1/16	3 1/8	7 3/8	9 1/4
	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 1/4	7 5/16	3 3/8	7 5/8	9 1/2
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 1/4	7 5/16	3 3/8	7 5/8	9 1/2
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 1/4	7 5/16	3 3/8	7 5/8	9 1/2
6	2 1/2	1 7/8 - 12	2 1/4 - 12	3	3.124	4 1/4	1	2 1/16	5/8	5/8	1/4	2 1/4	3 3/8	8 11/16	3 1/2	8 3/8	10 3/4
	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/8	1	2 5/8	15/16	5/16	—	2 1/4	3 3/8	8 11/16	3 1/2	8 3/8	10 3/4
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/8	8 11/16	3 1/2	8 3/8	10 3/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 3/8	8 11/16	3 1/2	8 3/8	10 3/4
7	3	2 1/4 - 12	2 3/4 - 12	3 1/2	3.749	5 7/16	1	2 5/8	15/16	5/16	—	2 1/4	3 5/8	9 11/16	3 3/4	9 3/8	12
	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 5/8	9 11/16	3 3/4	9 3/8	12
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 5/8	9 11/16	3 3/4	9 3/8	12
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 5/8	9 11/16	3 3/4	9 3/8	12
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 5/8	9 11/16	3 3/4	9 3/8	12
8	3 1/2	2 1/2 - 12	3 1/4 - 12	3 1/2	4.249	5 15/16	1	3	15/16	5/16	—	2 1/4	3 3/4	11 3/16	3 7/8	10 1/4	13 1/4
	4	3 - 12	3 3/4 - 12	4	4.749	6 5/16	1	3 3/8	15/16	5/16	—	2 1/4	3 3/4	11 3/16	3 7/8	10 1/4	13 1/4
	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	—	15/16	5/16	—	2 1/4	3 3/4	11 3/16	3 7/8	10 1/4	13 1/4
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	—	15/16	5/16	—	2 1/4	3 3/4	11 3/16	3 7/8	10 1/4	13 1/4
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	—	15/16	5/16	—	2 1/4	3 3/4	11 3/16	3 7/8	10 1/4	13 1/4

SERIES "MH" DOUBLE ROD END MOUNTS

MH-DRE NFPA STYLE MD
1.5" thru 8" Bore

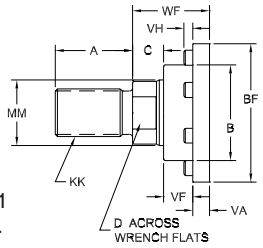


MH-DRE NFPA STYLE MD
10" thru 14" Bore



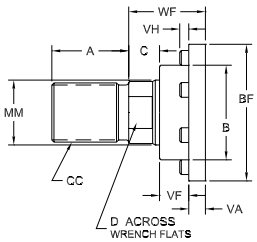
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

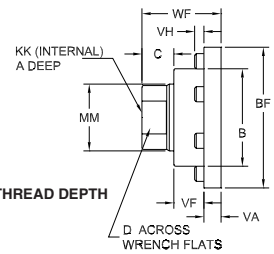


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread

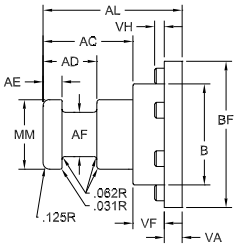


STYLE 4
"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

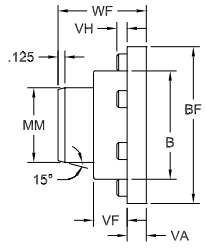
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

How to Use Double Rod Cylinder Drawings

To determine dimensions for a double rod cylinder, refer to the desired mounting style in this catalog. After selecting dimensions from that drawing, return to this page and supplement the single rod dimensions with those shown below. Mountings are supplied on one end only (except CL, FS, SL).

Double rod cylinders have a G dimension at both ends, replacing J on a standard cylinder. Dimension LD replaces LB, ZL replaces ZB, etc. The dimensions below provide the information needed to completely dimension a double rod cylinder.

When the two rod ends are different it is necessary to clearly specify the differences and which rod end is located at which end of the cylinder.

All dimensions are for the smallest rod size in each bore. For larger rod sizes, use basic dimensions (LD, etc.) and add in rod size from standard charts. ZM will increase by the additional WF for the increased rod size.

Basic Dimensions for Small Rod Size

Bore	LD	SN	SS	ZM
1 1/2	4 7/8	2 7/8	4 1/8	6 7/8
2	4 7/8	2 7/8	3 7/8	7 5/8
2 1/2	5	3	3 5/8	7 3/4
3 1/4	5 3/4	3 1/2	4 3/8	9
4	6	4	4 1/4	9 3/4
5	6 1/2	4 1/4	4 3/4	10 1/2
6	7 3/8	4 7/8	5 1/8	11 7/8
7	8 1/2	5 3/8	5 3/4	13
8	9 1/2	6 1/8	6 3/4	14
10	—	—	—	18
12	—	—	—	20 7/8
14	—	—	—	20 5/8

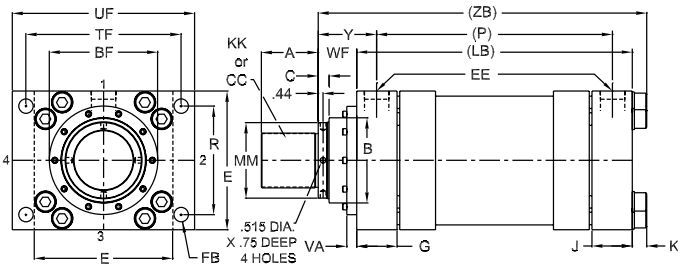
Envelope dimensions for 10-14" sizes do not change from single rod end style.

Mountings available in double rod end style:
ME-5, IH-3, CL, FS, SL, TM-1, TM-3

10" THRU 14" "MH" RECTANGULAR ROD HEAD, RECTANGULAR CAP HEAD, SQUARE ROD HEAD AND SQUARE CAP HEAD

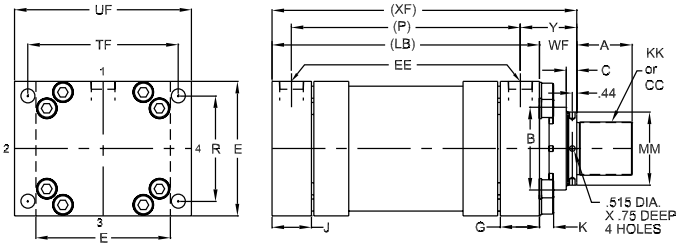
MH-ME-5
10" thru 14" Bore

NFPA STYLE ME5
ROD HEAD FLANGE



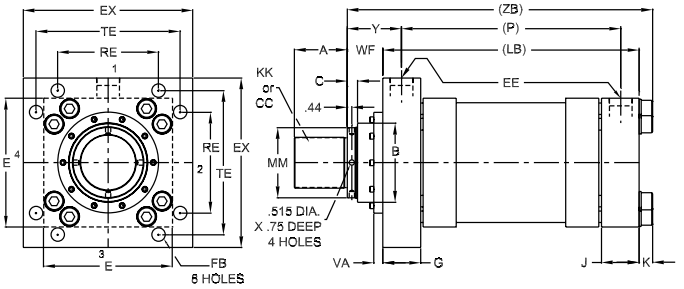
MH-ME-6
10" thru 14" Bore

NFPA STYLE ME6
CAP HEAD FLANGE



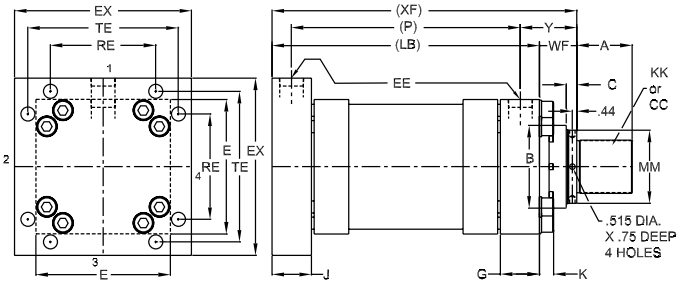
MH-IH-3
10" thru 14" Bore

NFPA STYLE MF5
ROD HEAD FLANGE



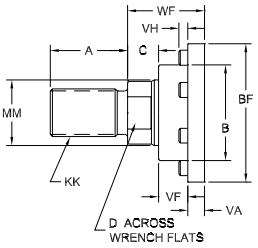
MH-IH-4
10" thru 14" Bore

NFPA STYLE MF6
CAP HEAD FLANGE



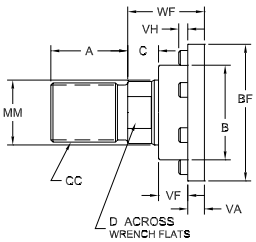
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

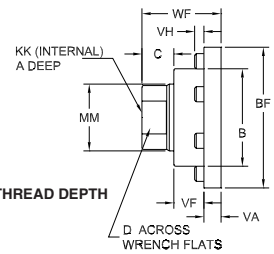


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread



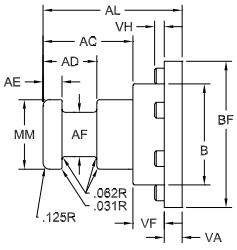
STYLE 4

"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

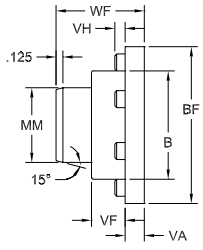
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	E	EB	EE		FB	G	J	K	R	TF	UF
			SAE	NPTF							
10	12 5/8	1 5/16	#24	2	1 13/16	3 11/16	3 11/16	1.13	9.62	15.88	19
12	14 7/8	1 9/16	#24	2 1/2	2 1/16	4 7/16	4 7/16	1.25	11.45	18.50	22
14	17 1/8	1 4/5	#24	2 1/2	2 5/16	4 7/8	4 7/8	1.25	13.26	21.00	25

Envelope and Mounting Dimensions—Continued

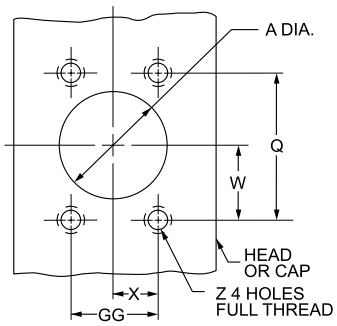
BORE	EJ	EX	RA	RE	TE	ADD STROKE		MIN STROKE
						LB	P	
10	—	16 5/8	—	9.89	14.13	12 1/8	8 1/2	3.50
12	—	19 3/4	—	11.75	16.79	14 1/2	10 1/8	2.63
14	—	21 3/4	—	12.90	18.43	15 5/8	10 7/8	2.38

Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	VA	VF	WF	Y	Add Stroke	
		Style 1 & 3	Style 2									XF	ZB
		KK	CC										
10	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	15/16	1	2 15/16	4 3/4	15 1/16	16 11/32
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	15/16	1	3 3/16	5	15 5/16	16 19/32
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5	15 5/16	16 19/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1	15/16	1 1/4	3 1/2	5 5/16	15 5/8	16 29/32
12	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5 3/8	17 11/16	19 3/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 11/16	18	19 13/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/16	18 1/2	19 29/32
14	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 7/8	19 1/8	20 17/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/8	19 5/8	21 1/32
	10	7 1/4 - 12	—	10	10.749	14	1	1 5/8	5/16	4 1/2	6 7/8	20 1/8	21 17/32

Table 4—Optional SAE Flange Port Pattern SAE Code 61

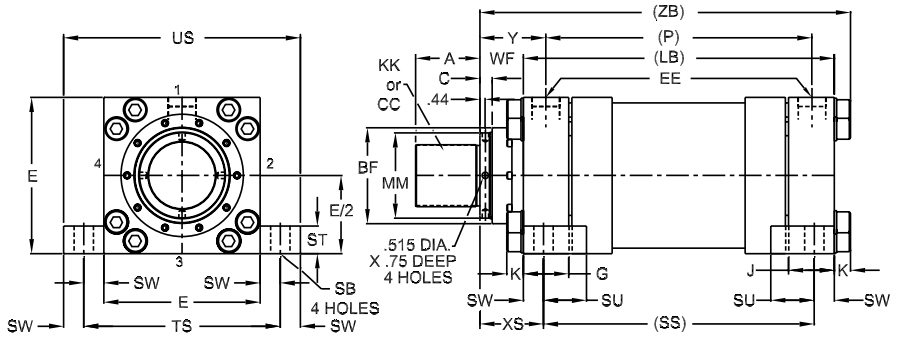
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19



10" THRU 14" "MH" SIDE LUG AND CENTER LUG

MH-SL
10" thru 14" Bore

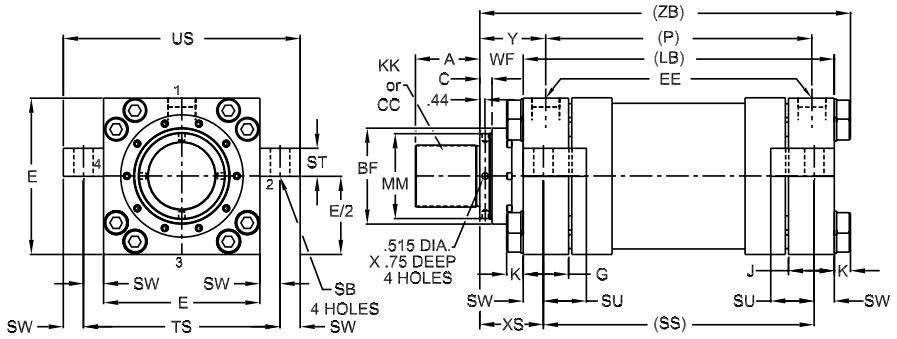
NFPA STYLE MS2
SIDE LUGS MOUNTING



***Note: Stroke lengths on lug mounted cylinders should not be shorter than the cylinder bore diameter. Consult factory for recommendations on shorter stroke lengths.**

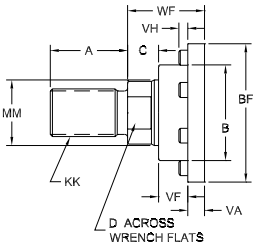
MH-CL
10" thru 14" Bore

NFPA STYLE MS3
CENTERLINE LUGS MOUNTING



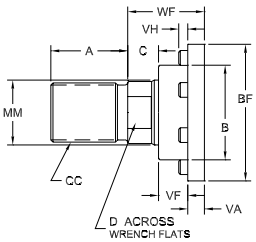
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

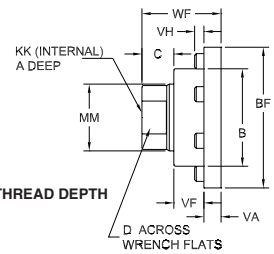


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread

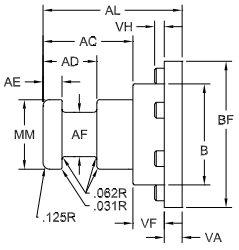


STYLE 4
"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

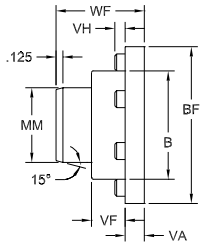
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	E	EE		G	J	K	SB	ST	SU
		SAE	NPTF						
10	12 5/8	#24	2	3 11/16	3 11/16	1.13	1 9/16	2 1/4	3 1/2
12	14 7/8	#24	2 1/2	4 7/16	4 7/16	1.25	1 9/16	3	4 1/4
14	17 1/8	#24	2 1/2	4 7/8	4 7/8	1.25	2 5/16	4	4 3/4

Envelope and Mounting Dimensions—Continued

BORE	SW	TS	US	ADD STROKE			MIN* STROKE
				LB	P	SS	
10	1 5/8	15 7/8	19 1/8	12 1/8	8 1/2	8 7/8	3.50
12	2	18 7/8	22 7/8	14 1/2	10 1/8	10 1/2	2.63
14	2 1/4	21 5/8	26 1/8	15 5/8	10 7/8	11 1/8	2.38

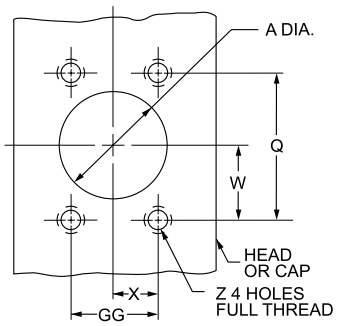
*Consult SL drawing on page 22.

Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	VA	VF	WF	Y	XS	Add Stroke
		Style 1 & 3	Style 2										
		KK	CC										ZB
10	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	15/16	1	2 15/16	4 3/4	4 9/16	16 11/32
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	15/16	1	3 3/16	5	4 13/16	16 19/32
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5	4 13/16	16 19/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1	15/16	1 1/4	3 1/2	5 5/16	5 1/8	16 29/32
12	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5 3/8	5 3/16	19 3/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 11/16	5 1/2	19 13/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/16	6	19 29/32
14	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 7/8	5 3/4	20 17/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/8	6 1/4	21 1/32
	10	7 1/4 - 12	—	10	10.749	14	1	1 5/8	5/16	4 1/2	6 7/8	6 3/4	21 17/32

Table 4—Optional SAE Flange Port Pattern SAE Code 61

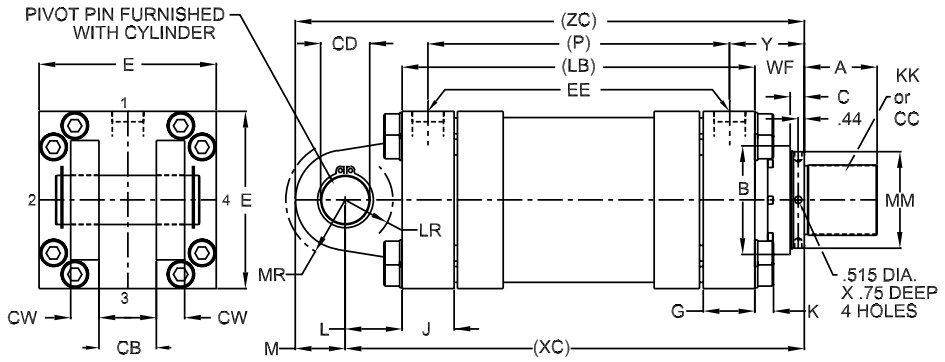
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19



10" THRU 14" "MH" FIXED CLEVIS AND PIVOT EYE

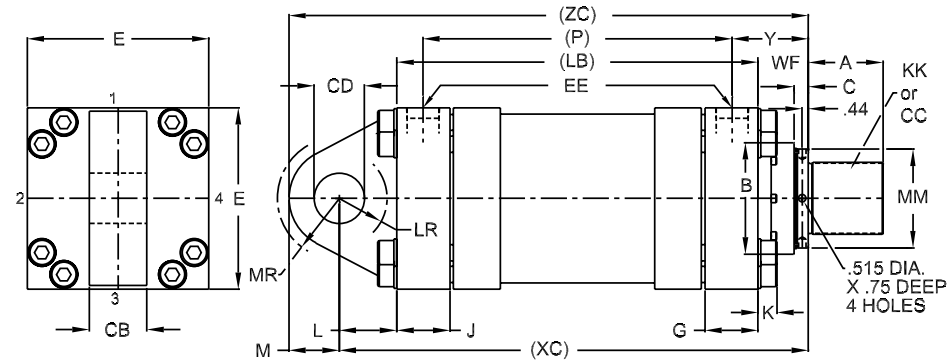
MH-PB-2
10" thru 14" Bore

NFPA STYLE MP1
CAP FIXED CLEVIS MOUNTING



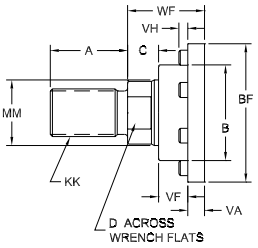
MH-PB-1
10" thru 14" Bore

NFPA STYLE MP3
PIVOT EYE



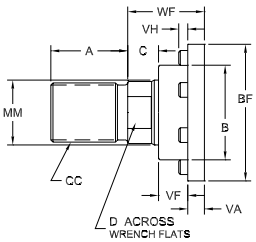
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

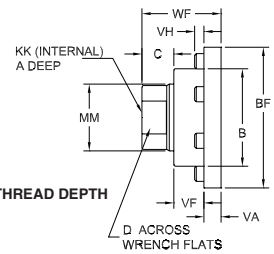


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread



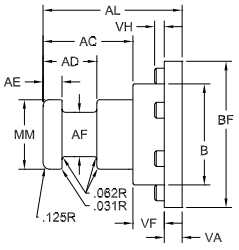
STYLE 4

"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

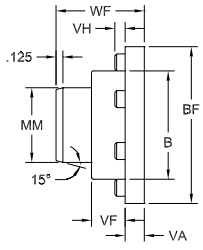
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	CB	CD	CW	E	EE		G	J	K
					SAE	NPTF			
10	4	3.50	2	12 5/8	#24	2	3 11/16	3 11/16	1.13
12	4 1/2	4.00	2 1/4	14 7/8	#24	2 1/2	4 7/16	4 7/16	1.25
14	6	5.00	3	17 1/8	#24	2 1/2	4 7/8	4 7/8	1.25

Envelope and Mounting Dimensions—Continued

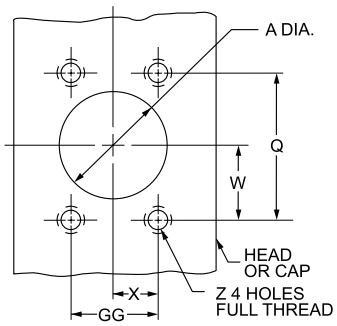
BORE	L	LR	M/MR	ADD STROKE		MIN STROKE
				LB	P	
10	4 1/16	3 3/8	3 1/2	12 1/8	8 1/2	3.50
12	4 1/2	3 7/8	4	14 1/2	10 1/8	2.63
14	5 3/4	4 3/16	5	15 5/8	10 7/8	2.38

Dimensions Affected by Rod Size

BORE	MM Rod Size	Thread		A	B	BF	C	VA	VF	WF	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC									XC	ZC
10	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	15/16	1	2 15/16	4 3/4	19 1/16	22 9/16
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	15/16	1	3 3/16	5	19 5/16	22 13/16
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5	19 5/16	22 13/16
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1	15/16	1 1/4	3 1/2	5 5/16	19 5/8	23 1/8
12	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	1 1/4	3 3/16	5 3/8	22 3/16	26 3/16
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 11/16	22 1/2	26 1/2
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/16	23	27
14	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	15/16	1 1/4	3 1/2	5 7/8	24 7/8	29 7/8
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	15/16	1 1/2	4	6 3/8	25 3/8	30 3/8
	10	7 1/4 - 12	—	10	10.749	14	1	1 5/8	5/16	4 1/2	6 7/8	25 7/8	30 7/8

Table 4—Optional SAE Flange Port Pattern SAE Code 61

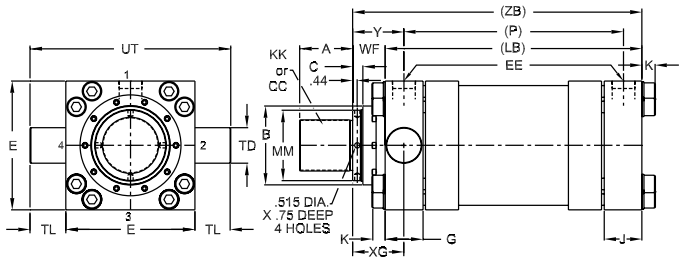
Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19



10" THRU 14" "MH" TRUNNION MOUNT

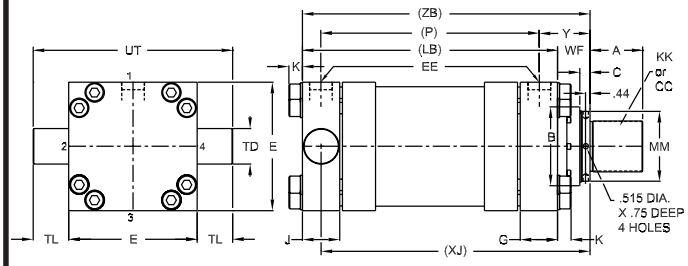
MH-TM-1
10" thru 14" Bore

NFPA STYLE MT1
HEAD TRUNNION MOUNTING



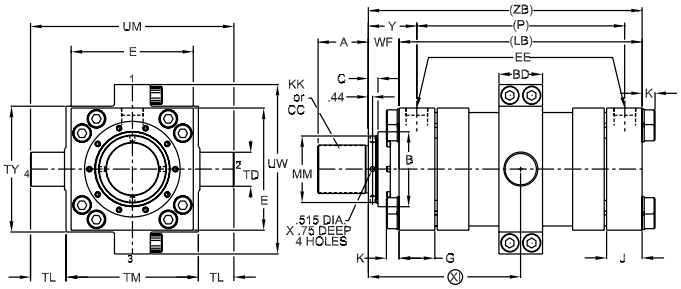
MH-TM-2
10" thru 14" Bore

NFPA STYLE MT2
CAP TRUNNION MOUNTING



MH-TM-3
10" thru 14" Bore

NFPA STYLE MT4
INTERMEDIATE FIXED
TRUNNION MOUNTING

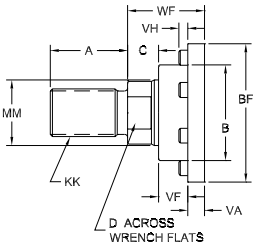


XI–Customer must specify when ordering. See chart for minimum XI.
Maximum XI = minimum XI plus stroke.

For larger bores consult factory

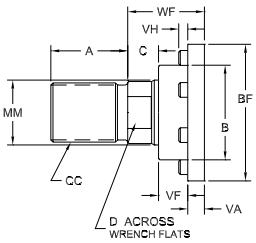
ROD END DIMENSIONS

STYLE 1
Standard Male Thread

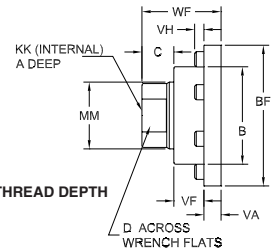


If rod end is not specified Style 1 will be supplied.

STYLE 2
Oversize Male Thread



STYLE 3
Female Thread

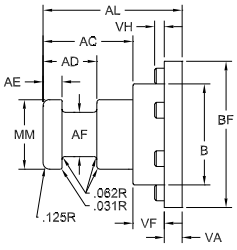


STYLE 4
"SPECIALS" THREAD STYLE 4

Special thread, extension, rod eye, blank, etc., are also available.

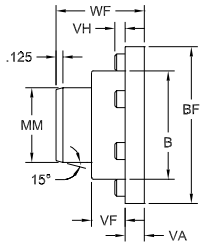
To order, specify "Style 4" and give desired dimensions for CC or KK, A and WF. If otherwise special, supply dimensioned sketch.

STYLE 5
Safety Coupler



See Page 32 for dimensional data.

STYLE 6
Stub End



4 1/2" rod and larger have spanner wrench holes in place of wrench flats.

Envelope and Mounting Dimensions

BORE	BD	E	EE		G	J	K	TD	TL	TM
			SAE	NPTF						
10	4 1/2	12 5/8	#24	2	3 11/16	3 11/16	1.13	3.500	3 1/2	14
12	5 1/2	14 7/8	#24	2 1/2	4 7/16	4 7/16	1.25	4.000	4	16 1/2
14	5 1/2	17 1/8	#24	2 1/2	4 7/8	4 7/8	1.25	4.500	4 1/2	19 1/2

Envelope and Mounting Dimensions—Continued

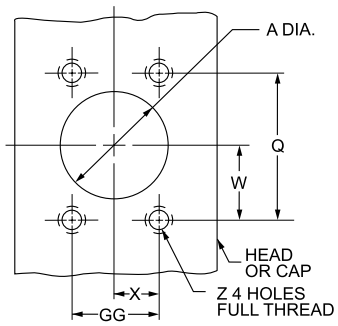
BORE	TY	UM	UT	UW	ADD STROKE		MIN STROKE TM-3	MIN STROKE TM-1 & TM-2
					LB	P		
10	13	21	19 5/8	17 1/2	12 1/8	8 1/2	8.13	3.50
12	15 1/2	24 1/2	22 7/8	20 3/4	14 1/2	10 1/8	8.25	2.63
14	19 1/4	28 1/2	26 1/8	24 3/4	15 5/8	10 7/8	8.00	2.38

Dimensions Affected by Rod Size

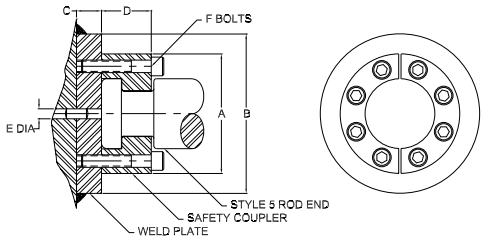
BORE	MM Rod Size	Thread		A	B	BF	C	KA	VA	VF	WF	XG	XI MIN	Y	Add Stroke	
		Style 1 & 3 KK	Style 2 CC												XJ	ZB
10	4 1/2	3 1/4 - 12	4 1/4 - 12	4 1/2	5.249	6 15/16	1	15/16	15/16	1	2 15/16	4 3/4	13 1/16	4 3/4	13 3/8	16 11/32
	5	3 1/2 - 12	4 3/4 - 12	5	5.749	7 7/16	1	15/16	15/16	1	3 3/16	5	13 5/16	5	13 5/8	16 19/32
	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	15/16	15/16	1 1/4	3 3/16	5	13 5/16	5	13 5/8	16 19/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1	15/16	15/16	1 1/4	3 1/2	5 5/16	13 5/8	5 5/16	13 15/16	16 29/32
12	5 1/2	4 - 12	5 1/4 - 12	5 1/2	6.249	7 15/16	1	1 1/32	15/16	1 1/4	3 3/16	5 3/8	14 9/16	5 3/8	15 1/2	19 3/32
	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	1 1/32	15/16	1 1/4	3 1/2	5 11/16	14 7/8	5 11/16	15 13/16	19 13/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	1 1/32	15/16	1 1/2	4	6 3/16	15 3/8	6 3/16	16 5/16	19 29/32
14	7	4 - 12	5 1/2 - 12	5 1/2	7.749	9 7/8	1 1/4	1 1/32	15/16	1 1/4	3 1/2	5 15/16	15 5/16	5 7/8	16 11/16	20 17/32
	8	4 1/2 - 12	6 - 12	8	8.749	10 15/16	1	1 1/32	15/16	1 1/2	4	6 7/16	15 13/16	6 3/8	17 3/16	21 1/32
	10	7 1/4 - 12	—	10	10.749	14	1	1 1/32	1 5/8	5/16	4 1/2	6 15/16	16 5/16	6 7/8	17 11/16	21 17/32

Table 4—Optional SAE Flange Port Pattern SAE Code 61

Nom. Flange Size	A	Q	GG	W	X	Z-THD UNC-2B	AA Min.
1 1/2	1.50	2.750	1.406	1.38	0.70	1/2-13	1.06
2	2.00	3.062	1.688	1.53	0.84	1/2-13	1.06
2 1/2	2.50	3.500	2.000	1.75	1.00	1/2-13	1.19
3	3.00	4.188	2.438	2.09	1.22	5/8-11	1.19

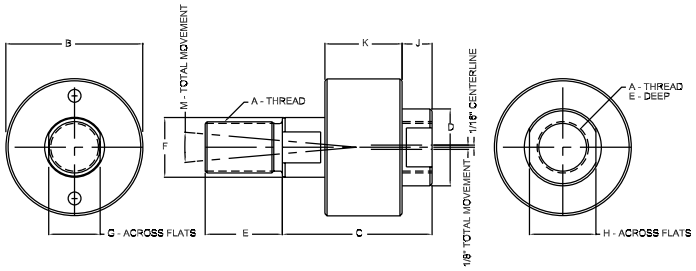


ROD END MOUNTING ACCESSORY DIMENSIONS



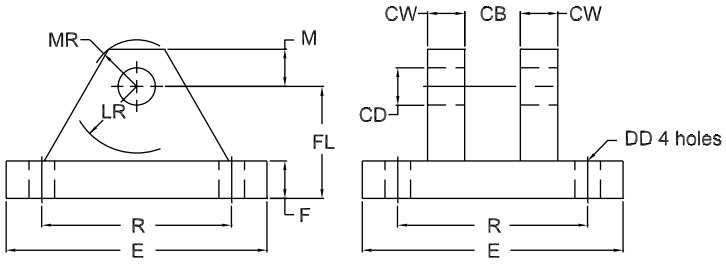
ROD DIA.	A	B	C	D	E	F	BOLT SIZE	SAFETY COUPLER PART NO.	WELD PLATE PART NO.
.625	1.50	2.00	.50	.56	.250	4	#10-24 x .94 LG	SC.062	WP-062
1.00	2.00	2.50	.50	.88	.250	6	.250-20 x 1.25 LG	SC-100	WP-100
1.375	2.50	3.00	.63	1.00	.250	6	.312-18 x 1.0" LG	SC-138	WP-138
1.75	3.00	4.00	.63	1.25	.250	8	.312-18 x 1.75 LG	SC-175	WP-175
2.00	3.50	4.00	.75	1.63	.375	12	.375-16 x 2.25 LG	SC-200	WP-200
2.50	4.00	4.50	.75	1.88	.375	12	.375-16 x 2.50 LG	SC-250	WP-250
3.00	5.00	5.50	1.00	2.38	.375	12	.500-13 x 3.25 LG	SC-300	WP-300
3.50	5.88	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-350	WP-350
4.00	6.38	7.00	1.00	2.63	.375	12	.625-11 x 3.50 LG	SC-400	WP-400
4.50	6.88	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-450	WP-450
5.00	7.38	8.00	1.00	3.13	.375	12	.625-11 x 4.00 LG	SC-500	WP-500
5.50	8.25	9.00	1.25	3.88	.375	12	.750-10 x 5.00 LG	SC-550	WP-550
7.00	10.38	11.00	1.75	4.00	.500	12	1.00-8 x 5.50 LG	SC-700	WP-700
8.00	11.38	12.00	2.00	4.00	.500	16	1.00-8 x 5.50 LG	SC-800	WP-800
8.50	12.38	13.00	2.00	4.00	.500	16	1.00-8 x 5.50 LG	SC-850	WP-850
9.00	13.12	14.00	2.25	4.00	.500	12	1.25-7 x 6.00 LG	SC-900	WP-900
10.00	14.12	15.00	2.50	4.50	.500	16	1.25-7 x 6.50 LG	SC-1000	WP-1000

Note: Screws are not included with safety coupler or weld plate.



Atlas Part No.	PART NO.	A	B	C	D	E	F	G	H	J	K	M	MAX. PULL LOAD (LBS.)	APPROX. WT. (LBS.)
01019102	RC-3-5	5/16 - 24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	1200	.35
01019103	RC-3-6	3/8 - 24	1 1/8	1 3/4	15/16	1/2	1/2	3/8	3/4	3/8	15/16	6°	2425	.35
01019104	RC-3-7	7/16 - 20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	3250	.55
01019105	RC-3-8	1/2 - 20	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	4450	.55
01019106	RC-3-10	5/8 - 18	1 3/8	2	1 1/8	3/4	5/8	1/2	7/8	3/8	1 3/32	6°	6800	.55
01019107	RC-3-12	3/4 - 16	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	9050	1.4
01019108	RC-3-14	7/8 - 14	2	2 5/16	1 5/8	1 1/8	15/16	3/4	1 5/16	7/16	1 9/32	6°	14450	1.4
01019109	RC-3-16	1 - 14	3 1/8	2 15/16	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	5/8	1 25/32	6°	19425	4.8
01019110	RC-3-20	1 1/4 - 12	3 1/8	2 15/16	2 3/8	1 5/8	1 7/16	1 1/4	1 7/8	5/8	1 25/32	6°	30500	4.8
01006819	RC-2-24	1 1/2 - 12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	45750	9.8
10002671	RC-2-28	1 3/4 - 12	4	4 3/8	2 1/4	2 1/4	1 3/4	1 1/2	1 15/16	7/8	2 3/4	10°	58350	9.8
10002672	RC-2-30	1 7/8 - 12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	67550	19.8
01009554	RC-2-32	2 - 12	5	5 5/8	3	3	2 1/4	1 15/16	2 5/8	1 3/8	3 3/8	10°	77450	19.8
10002673	RC-2-36	2 1/4 - 12	6 3/4	6 3/8	3 1/4	3 1/2	2 3/4	2 3/8	2 7/8	1 5/8	3 3/4	10°	99250	35.3
01009449	RC-2-40	2 1/2 - 12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	123750	45.3
01009555	RC-2-44	2 3/4 - 12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	150950	45.3
01009556	RC-2-48	3 - 12	7	6 1/2	4	3 1/2	3 1/4	2 7/8	3 3/8	1 5/8	3 7/8	10°	180850	45.3
01009557	RC-2-52	3 1/4 - 12	9 1/4	8 1/2	5 1/4	4 1/2	4	3 3/8	4 1/2	2	5 1/2	10°	213450	-
01009560	RC-2-68	4 1/4 - 12	12 7/8	11 1/4	7 3/4	4 1/2	5 1/2	4 7/8	7	1 1/2	8 3/4	10°	370850	-

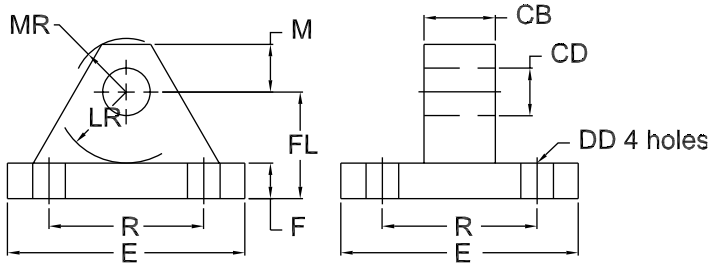
ROD END AND MOUNTING ACCESSORY DIMENSIONS



PART NUMBERS FOR CLEVIS BRACKET INCLUDE PINS AND KEEPERS

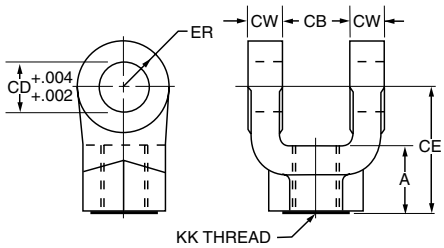
CLEVIS BRACKET												
PART	CB-205	CB-206	CB-207	CB-208	CB-209	CB-210	CB-211	CB-212	CB-213	CB-242	CB-243	CB-244
PART NO.	10012783	10012784	10012785	10012786	10012787	10012788	10012789	10012790	10012791	10012881	10012882	10012883
CB*	3/4	1 1/4	1 1/2	2	2 1/2	2 1/2	3	3	3 1/2	4	4 1/2	5
CD	1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3	3 1/2	4	4
CW	1/2	5/8	3/4	1	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2
DD	13/32	17/32	21/32	21/32	29/32	1 1/16	1 3/16	1 5/16	1 5/16	1 13/16	2 1/16	2 1/16
E	3 1/2	5	6 1/2	7 1/2	9 1/2	12 3/4	12 3/4	12 3/4	12 3/4	15 1/2	17 1/2	17 1/2
F	1/2	5/8	3/4	7/8	7/8	1	1	1	1	1 11/16	1 15/16	1 15/16
FL	1 1/2	1 7/8	2 1/4	3	3 5/8	4 1/4	4 1/2	6	6	6 11/16	7 11/16	7 11/16
LR	3/4	1	1 1/4	1 7/8	2 1/2	2 7/8	3 1/8	4 1/2	4 1/2	4 1/2	5 1/4	5 1/4
M	1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3	3 1/2	4	4
MR	5/8	29/32	1 1/4	1 21/32	-	-	-	-	-	-	-	-
R	2.55	3.82	4.95	5.73	7.50	9.40	9.40	9.40	9.40	12.00	13.75	13.75
LOAD RATING LBS.	7300	14000	19200	36900	34000	33000	34900	33800	36900	83500	102600	108400

*Acceptable Tang Thickness



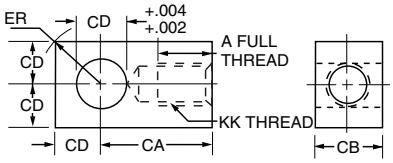
EYE BRACKET AND MOUNTING PLATE										
PART	EB-195	EB-196	EB-197	EB-198	EB-199	EB-200	EB-201	EB-202	EB-38	EB-39
PART NO.	10002567	10002568	10002569	10002570	10002571	10002572	10002573	10002574	10002575	10002576
CB	3/4	1 1/4	1 1/2	2	2 1/2	2 1/2	3	3	4	4 1/2
CD	1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4
DD	13/32	17/32	21/32	21/32	28/32	1 1/16	1 3/16	1 5/16	1 13/16	2 1/16
E	2 1/2	3 1/2	4 1/2	5	6 1/2	7 1/2	8 1/2	9 1/2	12 5/8	14 7/8
F	3/8	5/8	3/4	7/8	7/8	1	1	1	1 11/16	1 15/16
FL	1 1/8	1 7/8	2 1/4	3	3 1/8	3 1/2	4	4 1/4	5 11/16	6 7/16
LR	3/4	1 1/4	1 1/2	2 1/8	2 1/4	2 1/2	3	3 1/4	4	4 1/2
M	1/2	3/4	1	1 3/8	1 3/4	2	2 1/2	2 3/4	3 1/2	4
MR	9/16	7/8	1 1/4	-	-	-	-	-	-	-
R	1.63	2.55	3.25	3.82	4.95	5.73	6.58	7.50	9.62	11.45
LOAD RATING LBS.	4100	10500	20400	21200	49480	70000	94200	121900	57400	75000

All load ratings based on 4:1 factor of safety

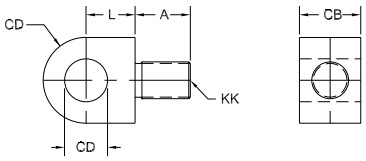


PART NUMBERS FOR
FEMALE ROD CLEVIS
INCLUDE PINS AND KEEPERS

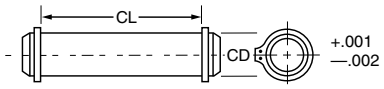
FEMALE ROD CLEVIS																							
PART	JIC-40	JIC-41	JIC-42A	JIC-42	JIC-43A	JIC-43	JIC-44A	JIC-44	JIC-45A	JIC-45	JIC-46	JIC-47	JIC-48	JIC-49	JIC-50	JIC-51	JIC-52A	JIC-52	JIC-53A	JIC-53	JIC-54A	JIC-54
PART NO.	10012755	10012756	10012757	10012874	10012758	10012875	10012759	10012876	10012760	10012877	10012761	10012762	10012763	10012764	10012765	10012766	10012767	10012878	10012768	10012879	10012769	10012880
A	3/4	3/4	1 1/8	1 1/8	1 5/8	1 5/8	1 5/8	1 5/8	2	2	2 1/4	3	3	3 1/2	3 1/2	3 1/2	3 1/2	4 1/2	4	5	4	5 1/2
CB	3/4	3/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2	2	2	2 1/2	2 1/2	2 1/2	3	3	3	4	4	4 1/2	4 1/2	4 1/2	4 1/2
CD	1/2	1/2	3/4	3/4	1	1	1	1	1 3/8	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4	4	4
CE	1 1/2	1 1/2	2 1/8	2 3/8	2 15/16	3 1/8	2 15/16	3 1/8	3 3/4	4 1/8	4 1/2	5 1/2	5 1/2	6 1/2	6 3/4	6 3/4	7 3/4	8 1/2	8 13/16	9 13/16	8 13/16	10
CW	1/2	1/2	5/8	5/8	3/4	3/4	3/4	3/4	1	1	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	2	2	2 1/4	2 1/4	2 1/4	2 1/4
ER	1/2	1/2	3/4	3/4	1	1	1	1	1 3/8	1 3/8	1 3/4	2	2	2 1/2	2 3/4	2 3/4	3 1/2	3 1/2	4	4	4	4
KK	7/16 - 20	1/2 - 20	3/4 - 16	3/4 - 16	7/8 - 14	7/8 - 14	1 - 14	1 - 14	1 1/4 - 12	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 7/8 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/4 - 12	3 1/2 - 12	3 1/2 - 12	4 - 12	4 - 12
LOAD RATING LBS.	2950	4000	11200	9300	18800	12700	19500	16875	33500	26800	39500	54700	56250	84375	84375	84375	156700	157500	193200	202500	221200	202500



FEMALE ROD EYE																
PART	REE-89	REE-90	REE-91	REE-92	REE-93	REE-94	REE-95	REE-96	REE-97	REE-98	REE-99	REE-100	REE-36	REE-37	REE-38	REE-39
PART NO.	10002638	10002639	10002640	10002641	10002643	10002644	10002646	10002647	10002648	10002649	10002650	10002651	10002652	10002653	10002654	10002655
A	3/4	3/4	1 1/8	1 1/8	1 5/8	2	2 1/4	2 1/4	3	3 1/2	3 1/2	3 5/8	4 1/2	5	5 1/2	5 1/2
CA	1 1/2	1 1/2	2 1/16	2 3/8	2 13/16	3 7/16	4	4 3/8	5	5 13/16	6 1/8	6 1/2	7 5/8	7 5/8	9 1/8	9 1/8
CB	3/4	3/4	1 1/4	1 1/2	1 1/2	2	2 1/2	2 1/2	2 1/2	3	3	3 1/2	4	4	4 1/2	5
CD	1/2	1/2	3/4	1	1	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4
ER	11/16	11/16	1	1 1/4	1 1/4	1 7/8	2 1/2	2 13/16	2 13/16	3 1/8	4 1/4	4 1/4	4 1/2	4 1/2	5 1/4	5 1/4
KK	7/16 - 20	1/2 - 20	3/4 - 16	7/8 - 14	1 - 14	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 7/8 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/2 - 12	4 - 12	4 1/2 - 12
LOAD RATING LBS.	2950	3375	8400	12700	13500	24750	39375	45000	45000	67500	81000	94500	126000	126000	162000	180000



MALE ROD END EYE																
PART	MRE-89	MRE-90	MRE-91	MRE-92	MRE-93	MRE-94	MRE-95	MRE-96	MRE-97	MRE-98	MRE-99	MRE-100	MRE-36	MRE-37	MRE-38	MRE-39
PART NO.	1000262	10002623	10002624	10002625	10002626	10002627	10002628	10002629	10002630	10002631	10002632	10002633	10002634	10002635	10002636	10002637
A	3/4	3/4	1 1/8	1 1/8	1 5/8	2	2 1/4	2 1/4	3	3 1/2	3 1/2	3 1/2	4	5	5 1/2	5 1/2
CB	3/4	3/4	1 1/4	1 1/2	1 1/2	2	2 1/2	2 1/2	2 1/2	3	3	3 1/2	4	4	4 1/2	5
CD	1/2	1/2	3/4	1	1	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	3 1/2	4	4
L	5/8	5/8	7/8	7/8	1 1/8	1 5/8	2	2	2 1/4	2 3/4	4 1/4	4 1/4	5	5	5 3/4	5 3/4
KK	7/16 - 20	1/2 - 20	3/4 - 16	7/8 - 14	1 - 14	1 1/4 - 12	1 1/2 - 12	1 3/4 - 12	1 7/8 - 12	2 1/4 - 12	2 1/2 - 12	2 3/4 - 12	3 1/4 - 12	3 1/2 - 12	4 - 12	4 1/2 - 12
LOAD RATING LBS.	1925	2600	6100	8250	11050	17450	25700	35550	41050	60000	74700	90900	126000	126000	162000	180000



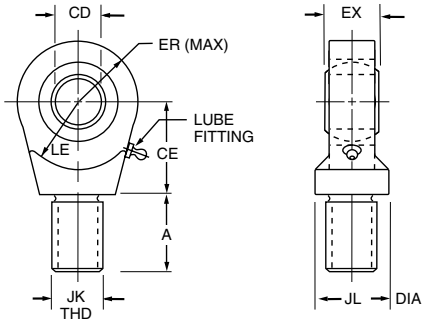
PIVOT PINS ARE FURNISHED
WITH (2) RETAINER RINGS

PIVOT PIN													
PART	PP-368A	PP-369A	PP-370A	PP-371A	PP-372A	PP-373A	PP-215A	PP-374A	PP-375A	PP-216A	PP-545A	PP-546A	PP-547A
PART NO.	10012770	10012771	10012772	10012773	10012774	10012775	10012776	10012777	10012778	10012779	10012780	10012791	10012782
CD	1/2	3/4	1	1 3/8	1 3/4	2	2	2 1/2	3	3	3 1/2	4	4
CL	1 7/8	2 5/8	3 1/8	4 1/8	5 3/16	5 3/16	5 11/16	6 3/16	6 1/4	6 3/4	8 1/4	8 5/8	9
LOAD RATING LBS.	5890	13250	23560	44550	72150	94250	94250	147250	212050	212050	288600	288600	377000

All load ratings based on 4:1 factor of safety

Spherical Bearing Mounting Accessories

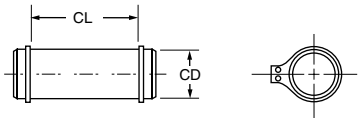
SPHERICAL ROD EYE



Order to fit Piston Rod Thread Size

PART	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6
PART NO.	01012646	01012647	01012648	01012649	01012650	01012651
CD	.5000	.7500	1.0000	1.3750	1.7500	2.0000
A	11/16	1	1 1/2	2	2 1/8	2 7/8
CE	7/8	1 1/4	1 7/8	2 1/8	2 1/2	2 3/4
EX	7/16	21/32	7/8	1 3/16	1 17/32	1 3/4
ER	7/8	1 1/4	1 3/8	1 13/16	2 3/16	2 5/8
LE	3/4	1 1/16	1 7/16	1 7/8	2 1/8	2 1/2
JK	7/16 - 20	3/4 - 16	1 - 14	1 1/4 - 12	1 1/2 - 12	1 7/8 - 12
JL	7/8	1 5/16	1 1/2	2	2 1/4	2 3/4
LOAD CAPACITY LBS	2082	4675	8325	15325	25500	33250

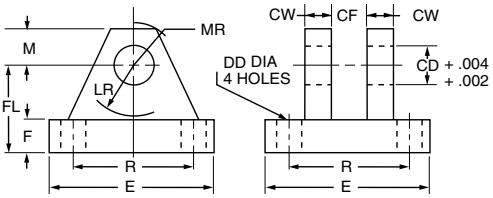
PIVOT PIN



Pivot Pins are furnished with
(2) Retainer Rings

PART	PP-616	PP-624	PP-632	PP-644	PP-656	PP-664
PART NO.	10012798	10012799	10012800	10012801	10012802	10012803
CD	.4997-.0004	.7497-.0005	.9997-.0005	1.3746-.0006	1.7496-.0006	1.9996-.0007
CL	1 9/16	2 1/32	2 1/2	3 5/16	4 7/32	4 15/16
SHEAR CAPACITY LBS	8600	19300	34300	65000	105200	137400

CLEVIS BRACKET



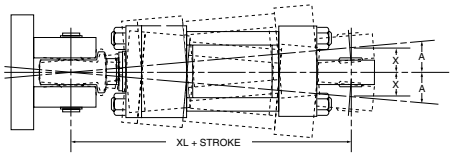
Order to Fit Mounting Plate or Rod Eye

*Part numbers for clevis bracket include pins and keepers

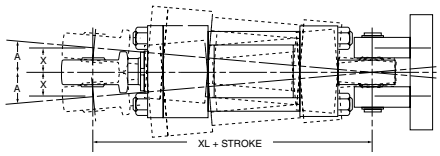
PART	SAB-1	SAB-2	SAB-3	SAB-4	SAB-5	SAB-6
PART NO.	10012792	10012793	10012794	10012795	10012796	10012797
CD	1/2	3/4	1	1 3/8	1 3/4	2
CF	7/16	21/32	7/8	1 3/16	1 17/32	1 3/4
CW	1/2	5/8	3/4	1	1 1/4	1 1/2
DD	13/32	17/32	17/32	21/32	29/32	29/32
E	3	3 3/4	5 1/2	6 1/2	8 1/2	10 5/8
F	1/2	5/8	3/4	7/8	1 1/4	1 1/2
FL	1 1/2	2	2 1/2	3 1/2	4 1/2	5
LR	15/16	1 3/8	1 11/16	2 7/16	2 7/8	3 5/16
M	1/2	7/8	1	1 3/8	1 3/4	2
MR	5/8	1	1 3/16	1 5/8	2 1/16	2 3/8
R	2.05	2.76	4.10	4.95	6.58	7.92
LOAD CAPACITY LBS	5770	9450	14300	20322	37800	50375

MOUNTING INFORMATION

HEAD END MOUNTING



CAP END MOUNTING



All load ratings based on 4:1 factor of safety

Recommended maximum swivel angle on each side of the cylinder centerline.

TABLE 1

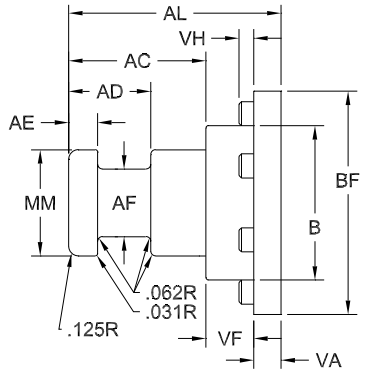
BORE	HEAD END MTD.		CAP END MTD.	
	ANGLE a	TAN. OF a	ANGLE a	TAN. OF a
1/2	2°	.035	2°	.035
2	2 1/2°	.044	4 1/2°	.079
2 1/2	2 1/2°	.044	4 1/2°	.079
3 1/4	3°	.052	3°	.052
4	2 1/2°	.044	3°	.052
5	3°	.052	3°	.052
6	3°	.052	3°	.052

NOTE: Dimension X is the maximum off center mounting of the cylinder. To determine dimension X for various stroke lengths multiply the distance between pivot pin holes by tangent of angle a. For extended position use X = XL times 2X stroke.

SAFETY COUPLER
ROD END DIMENSIONS

STYLE 5 ***Safety Coupler***

Mating Couplers and Weld Plates on page 28



BORE	MM ROD DIA	AC	AD	AE	AF	AL	B	BF	VA	VH	VF
1½	5/8	1 1/8	5/8	1/4	3/8	1 3/4	1.124	1 15/16	3/8	1/4	1/4
	1	1 5/8	15/16	3/8	11/16	2 1/2	1.499	2 3/8	3/8	1/4	1/2
2	1	1 1/2	15/16	3/8	11/16	2 1/2	1.499	2 3/8	3/8	1/4	1/2
	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.999	2 7/8	3/8	1/4	5/8
2½	1	1 5/8	15/16	3/8	11/16	2 1/2	1.499	2 3/8	3/8	1/4	1/2
	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.999	2 7/8	3/8	1/4	5/8
	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	2.374	3 1/2	5/8	5/16	1/2
3¼	1 3/8	1 3/4	1 1/16	3/8	7/8	2 3/4	1.999	2 7/8	3/8	1/4	5/8
	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	2.374	3 1/2	5/8	5/16	1/2
	2	2 5/8	1 11/16	5/8	1 3/8	3 3/4	2.624	3 3/4	5/8	5/16	1/2
4	1 3/4	2	1 5/16	1/2	1 1/8	3 1/8	2.374	3 1/2	5/8	5/16	1/2
	2	2 5/8	1 11/16	5/8	1 3/8	3 3/4	2.624	3 3/4	5/8	5/16	1/2
	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	3.124	4 1/4	5/8	5/16	5/8
5	2	2 5/8	1 11/16	5/8	1 3/8	3 3/4	2.624	3 3/4	5/8	5/16	1/2
	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	3.124	4 1/4	5/8	5/16	5/8
	3	3 5/8	2 7/16	7/8	2 1/4	4 7/8	3.749	5 7/16	15/16	—	5/16
	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	4.249	5 15/16	15/16	—	5/16
6	2 1/2	3 1/4	1 15/16	3/4	1 3/4	4 1/2	3.124	4 1/4	5/8	5/16	5/8
	3	3 5/8	2 7/16	7/8	2 1/4	4 7/8	3.749	5 7/8	15/16	—	5/16
	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	4.249	5 15/16	15/16	—	5/16
	4	4 1/2	2 11/16	1	3	5 3/4	4.749	6 5/16	15/16	—	5/16
7	3	3 5/8	2 7/16	7/8	2 1/4	4 7/8	3.749	5 7/16	15/16	—	5/16
	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	4.249	5 15/16	15/16	—	5/16
	4	4 1/2	2 11/16	1	3	5 3/4	4.749	6 5/16	15/16	—	5/16
	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	6 1/2	5.249	6 15/16	15/16	—	5/16
	5	5 3/8	3 3/16	1 1/2	3 7/8	6 5/8	5.749	7 7/16	15/16	—	5/16
8	3 1/2	4 3/8	2 11/16	1	2 1/2	5 5/8	4.249	5 15/16	15/16	—	5/16
	4	4 1/2	2 11/16	1	3	5 3/4	4.749	6 5/16	15/16	—	5/16
	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	6 1/2	5.249	6 15/16	15/16	—	5/16
	5	5 3/8	3 3/16	1 1/2	3 7/8	6 5/8	5.749	7 7/16	15/16	—	5/16
	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	7 1/2	6.249	7 15/16	15/16	—	5/16
10	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	7 3/16	5.249	6 15/16	15/16	—	1
	5	5 3/8	3 3/16	1 1/2	3 7/8	7 5/16	5.749	7 7/16	15/16	—	1
	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	8 7/16	6.249	7 15/16	15/16	—	1 1/4
	7	6 1/2	4 1/16	2	5 3/4	8 11/16	7.749	9 7/8	15/16	—	1 1/4
12	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	8 7/16	6.249	7 15/16	15/16	—	1 1/4
	7	6 1/2	4 1/16	2	5 3/4	8 11/16	7.749	9 7/8	15/16	—	1 1/4
	8	6 1/2	4 1/16	2	6 1/2	8 15/16	8.749	10 15/16	15/16	—	1 1/2
	8 1/2	6 5/8	4 1/8	2	7	9 1/16	9.249	11 7/16	15/16	—	1 1/2
14	7	6 1/2	4 1/16	2	5 3/4	8 11/16	7.749	9 7/8	15/16	—	1 1/4
	8	6 1/2	4 1/16	2	6 1/2	8 15/16	8.749	10 15/16	15/16	—	1 1/2
	10	7 1/4	4 5/8	2 3/8	8	9 3/16	10.749	14	1 5/8	—	5/16

Modifications: The following modifications can be supplied on most Atlas cylinders. For specific availability see modification chart on page 5.

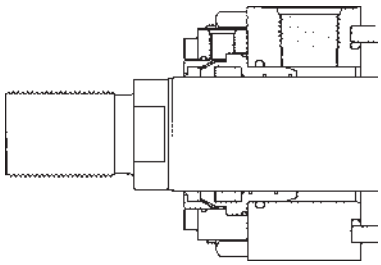
Metallic Rod Wiper

When specified metallic rod wipers can be supplied instead of the standard synthetic rubber wiperseal. Recommended in applications where contaminants tend to cling to the extended piston rod and would damage the synthetic rubber wiperseal. Installation of metallic rod wiper does not affect cylinder dimensions. It is available at extra cost.

Gland Drain

Hydraulic fluids tend to adhere to the piston rods during the extend stroke and an accumulation of fluid can collect in the cavity behind the wiperseal on long stroke cylinders.

An SAE #4 gland drain port can be provided in the gland retainer. A passage in the gland between the wiperseal and Tri-Lip seal is provided to drain off any accumulation of fluid between the seals. See drawing below.



It is recommended that the gland drain port be piped back to the fluid reservoir and that the reservoir be located below the level of the head of the cylinder.

Air Bleeds

In most hydraulic circuits, cylinders are considered self-bleeding when cycled full stroke. If air bleeds are required and specified, 1/8" NPTF Air Bleed Ports for venting air can be provided at both ends of the cylinder body, or on the head or cap. To order, specify "Bleed Port", and indicate position desired.

Rod End Boots

Cylinders have a hardened bearing surface on the piston rod to resist external damage, and are equipped with the high efficiency "Wiperseal" to remove external dust and dirt. Exposed piston rods that are subjected to contaminants with air hardening properties, such as paint, should be protected. In such applications, the use of a collapsing cover should be considered. This is commonly referred to as a "boot". Calculate the longer rod end required to accommodate the collapsed length of the boot from the following data.

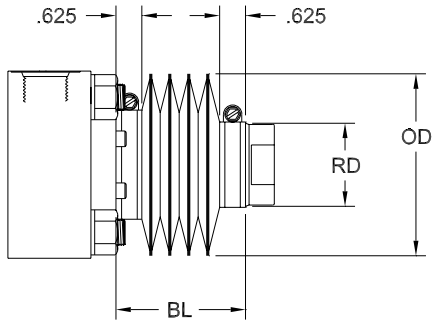
LF	.13	.13	.13	.13	.13	.13	.13	.10	.10	.10	.10	.10
OD	2 1/4	2 1/4	2 5/8	3	3 3/8	3 3/4	4 3/8	5 1/8	5 5/8	6 1/4	7	7 1/2
RD	1/2	5/8	1	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4	5	5 1/2

To determine extra length of piston rod required to accommodate boot, calculate

BL = Stroke x LF + 1 1/8"

BL + VA + C = WF for piston rod with rod boot.

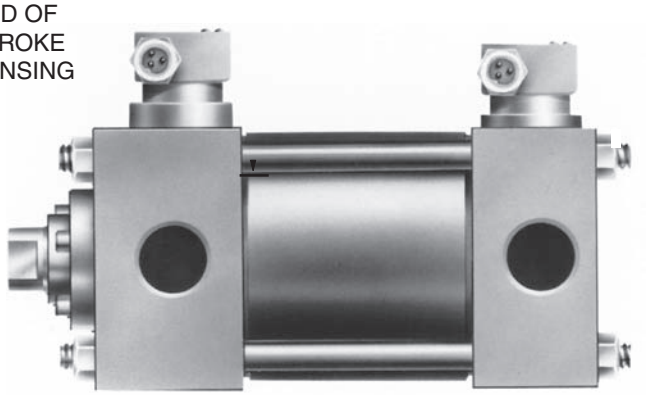
NOTE: Check all Boot O.D's against std. "E" dimension from catalog. This may be critical on footmounted cylinders.



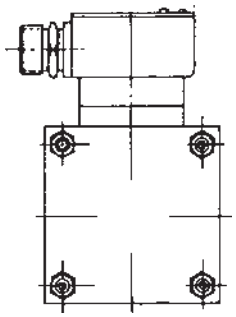
SWITCH OPTIONS

PROXSWITCH

END OF
STROKE
SENSING



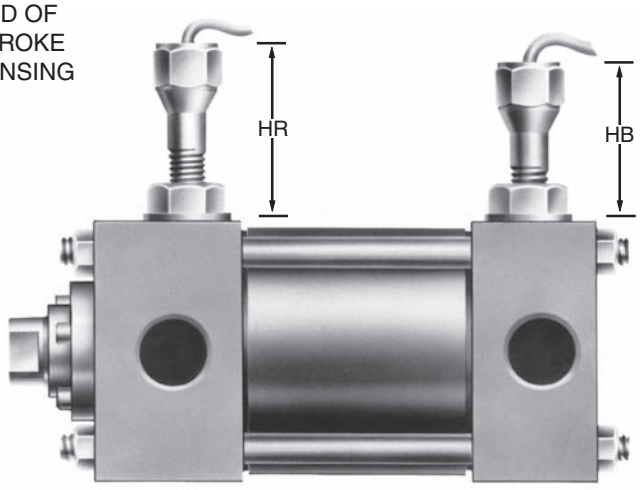
Standard position is #3 unless otherwise specified.



Consult factory for proxswitch options.

MAGNASWITCH

END OF
STROKE
SENSING

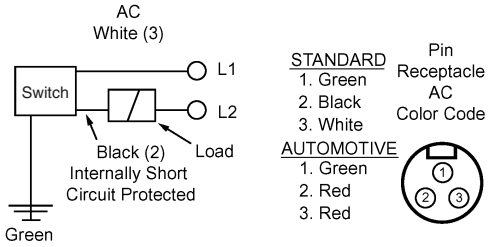


Standard position is #3 unless otherwise specified.

BORE	HB	ROD DIA.	HR
1 1/2	2 15/16	5/8 1 **	3 1/16 3 1/4
2	2 13/16	1 1 3/8	3 1/16 3 1/8
2 1/2	2 9/16	1 1 3/8 1 3/4	2 3/4 3 3 5/16
3 1/4	2 3/16	1 3/8 1 3/4 2	2 1/2 2 5/8 3
4	2	1 3/4 2 2 1/2	2 1/2 2 3/4 3
5	3 1/8 *	2 2 1/2 3 3 1/2	2 2 3/8 2 5/8 2 7/8
6	3 *	2 1/2 3 3 1/2 4	1 7/8 2 1/8 2 3/8 2 5/8
7	2 1/2 *	3 3 1/2 4 4 1/2 5	3 1/4 * 1 3/4 2 2 1/4 2 9/16
8	2 *	3 1/2 4 4 1/2 5 5 1/2	2 7/8 * 3 1/8 * 3 3/8 * 2 1/16 2 5/16

* Atlas style 80 MAGNASWITCH (all others are style 70)
**Not available in non-cushioned rod end

Wiring Diagrams and Information



Connectors

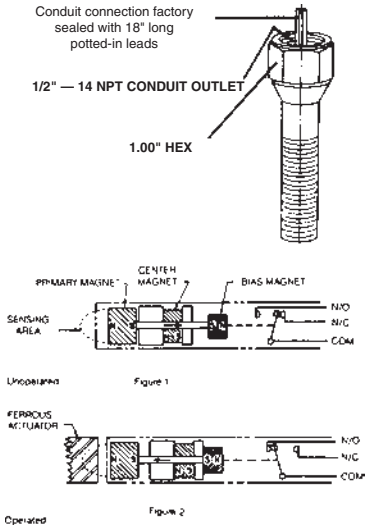
The male quick disconnect on this switch is a Brad Harrison 40909 connector. Female connectors must be purchased with one of the following cable lengths.

Cable Length	Brad Harrison Part No.
3'	40958
6'	40959
9'	40978
12'	40960

Supply Voltage ..... 20-220V AC/DC
Off State Leakage Current ..... 1.7 mA
Inrush Current (Rms/cycle) ..... 3 Amp
Load Current ..... Maximum .5 Amp
..... Minimum 5 mA
On state Voltage ..... 10V @ 5-30 mA
..... 6V @ 1-500 mA
Actuation Point ..... .125" Stroke to Go
Operating Temperature ..... -4° to +158°F.
Switching Differential ..... .004"
Repeatability ..... ±.004"
Switching Speed ..... 33mS ± 8mS
Led Indicators ..... Power On and Contact
Ratings ..... UL Approved

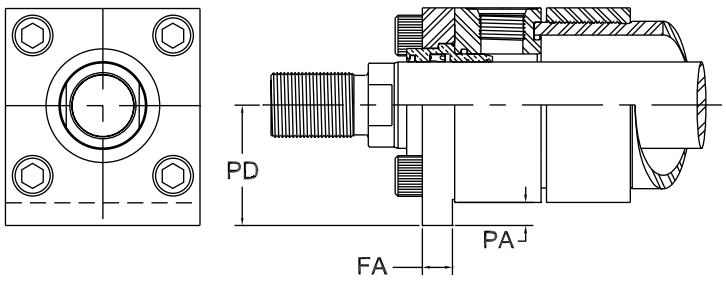
The Magnaswitch uses three magnets to move a common terminal between two contacts. The primary magnet is held in the retracted position, with one of its magnetic poles attracted to the unlike pole of the center magnet. At the same time, the bias magnet is being repelled by the like pole of the bias magnet. In this mode (Figure 1), the rod connected to the primary magnet keeps the common terminal in the Normally Closed (N/C) contact position.

When a ferrous actuator enters the sensing area of the switch (Figure 2), the magnetic attraction of the primary magnet to the center magnet is weakened. The primary magnet moves toward the actuator, pulling the connecting rod forward and moving the common terminal to the Normally Open (N/O) contact position. Conduit connection factory sealed with 18" (457.2mm) minimum potted-in leads.



Contacting Rating ..... 2 Amp @ 240VAC
..... 4 Amp @ 110VAC
..... 3 Amp @ 24VDC
Switch Speed ..... 8 mS
Operating Temperature ..... -30° to +400°F.
Switching Differential ..... .020"
Repeatability ..... ±.002"
Actuation Point ..... .18" Stroke to Go
Housing ..... Stainless Steel
Ratings ..... UL Approved, other ratings available

THRUST-KEY RETAINER PLATE OPTION



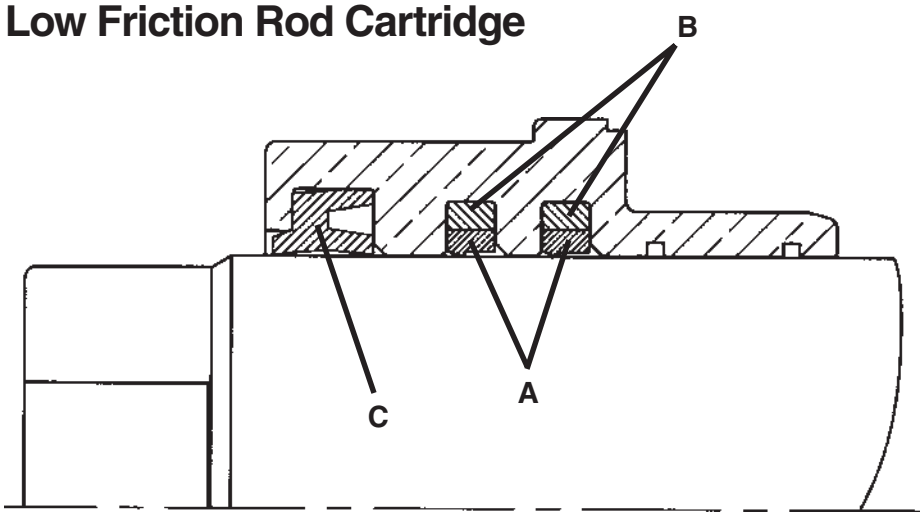
BORE	E	FA+.000	PA	PD
1.50	2.50	.312—.002	.188	1.437
2.00	3.00	.562—.002	.312	1.812
2.50	3.50	.562—.002	.312	2.062
3.25	4.50	.687—.003	.375	2.625
4.00	5.00	.812—.003	.437	2.937
5.00	6.50	.812—.003	.437	3.687
6.00	7.50	.937—.003	.500	4.250
7.00	8.50	.937—.003	.500	4.750
8.00	9.50	.937—.003	.500	5.250

NOTE: A full retainer plate can be included as an option instead of the packing cap on bore sizes 1 1/2" through 6".

Atlas Series MH Hydraulic Cylinders with Low Friction Seal Option High Performance Cylinders For Your Demanding Applications

- Smooth-running operation – reduces "slip-stick" or "chatter"
- Ideally suited for use in servo applications
- Bronze-filled PTFE material for low friction, rapid break-in and long service life
- Innovative seal geometry for maximum sealing efficiency

Low Friction Rod Cartridge

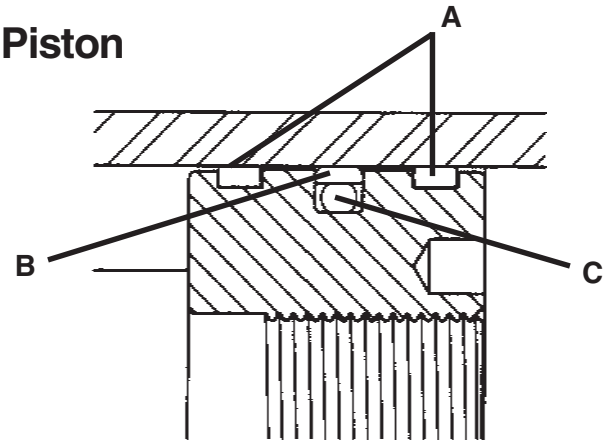


A - Dual step-seal rod seals insure positive sealing and smooth operation up to 2,000 PSI.

B - Elastomer expander for pressure compensation and low pressure effectiveness.

C - Dual lip wiper keeps contaminants out.

Low Friction Piston



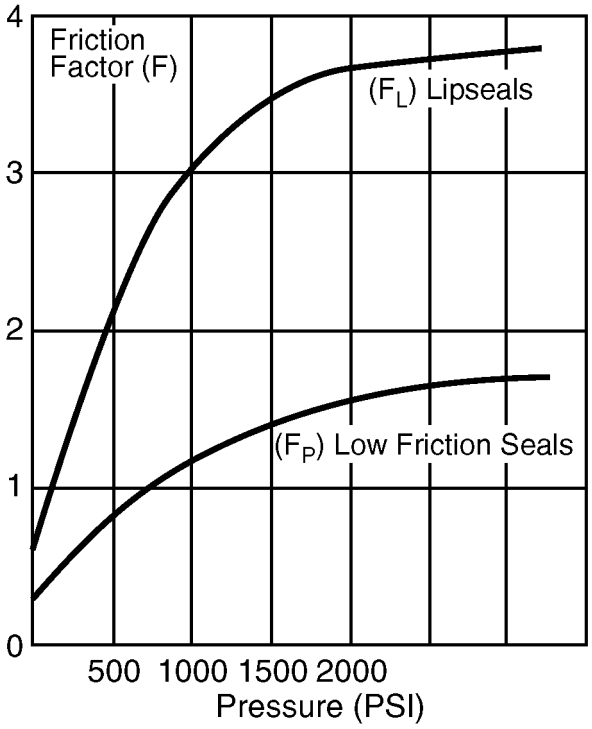
A - Dual bronze-filled PTFE piston bearings for high load capacity, low friction and no metal-to-metal contact.

B - Bronze filled PTFE piston seal insures maximum sealing efficiency.

C - Elastomer expander for pressure compensation

Seal Friction

Seal friction under a given set of working conditions is not easily calculated due to the multiplicity of variables involved. The following graphs are offered as a guide for use in performance calculations, but for critical application measurements should be made under simulated or actual working conditions.



Calculation of Running Friction

The seal friction attributable to the cylinder is calculated as the sum of the friction due to the individual sealing elements = (wiper seal friction + rod seal friction + piston seal friction), using the following formulae:

Seal Option:	**Formula:**
Lipseal Rod + Piston	$12d + 12 F_Ld + 24 F_LD$
Lipseal Rod w/Low Friction Piston	$12d + 12 F_Ld + 12F_pD$
Low Friction Rod + Piston	$12 + 30 F_pd + 6 F_pD$

Where: d = rod dia. (in.) D = bore dia. (in.)
F_L = friction factor for lipseals (F_L)
F_p = friction factor for PTFE (F_p)

Breakaway Friction:

Breakaway friction may be calculated by applying the following correction factors:

Correction factors:
Lipseals: F_L x 1.5
Low Friction: F_p x 1.0

Sample Calculation:

MH Cylinder with 3.25 dia. bore + 1.75 dia. piston rod with low friction seals at 1500 PSI.

Running Friction Calculation:

Friction (lbs. force) ≈ $12d + 30F_pd + 6F_pD$

Friction (lbs. force) ≈ $12(1.75) + 30 (1.3 \times 1.75) + 6(1.3 \times 3.25)$

Friction (lbs.force) ≈ 115

Breakaway Friction Calculation:

$F_p \times 1.0 \approx F_p$

Based on zero pressure:

Friction (lbs. force) ≈ $12d + 30F_pd + 6F_pD$

Friction (lbs. force) ≈ $12(1.75) + 30(.3 \times 1.75) + 6(.3 \times 3.25)$

Friction (lbs. force) ≈ 43

Specifications for Low Friction Option:

Operating Pressure: 0 - 2000 PSI

Operating Temperature: -10˚F to +160˚F.
For higher temperatures, consult factory.

Fluid Media: Petroleum based hydraulic oils.
For other fluids, consult factory.

How to Order Low Friction Option

When ordering series MH cylinders, place an "S" in the model number for "special" and specify the following:

"Low friction piston and rod seals."

Ports

Atlas hydraulic cylinders are available with SAE straight thread o-ring ports or NPTF pipe thread ports. SAE ports are standard and are recommended for a leak proof connection. If specified on your order, extra ports can be supplied on the sides of heads or caps not occupied by mountings or cushion valves or checks.

Standard port location is position 1 as shown on Figure 1 below. Cushion adjust needles and checks are generally at positions 2 and 4, or 3 (depending on mounting style and bore size). Heads or caps without an integral mounting can be rotated so that ports are at 90 or 180 degrees from standard. Mounting styles on which ports can be rotated without charge are shown in Table A below. To order, indicate port position number. In these cases, cushion features will rotate accordingly, since their relationship with the port does not change.

Code	Description
S	SAE straight thread o-ring port. Size indicated in line sheets. Recommended for hydraulic applications.
N	NPTF port. Size indicated in line sheets. Generally recommended for pneumatic applications.
F	SAE code 61 4 bolt flange port. Size will be the same as the standard NPT port. Recommended for larger port sizes.
I	ISO 6149 metric straight thread port. Recommended for hydraulic applications designed to ISO standards.
X	Special port. Use to indicate any other port type, including BSPP, BSPT, and other metric ports.

Figure 1

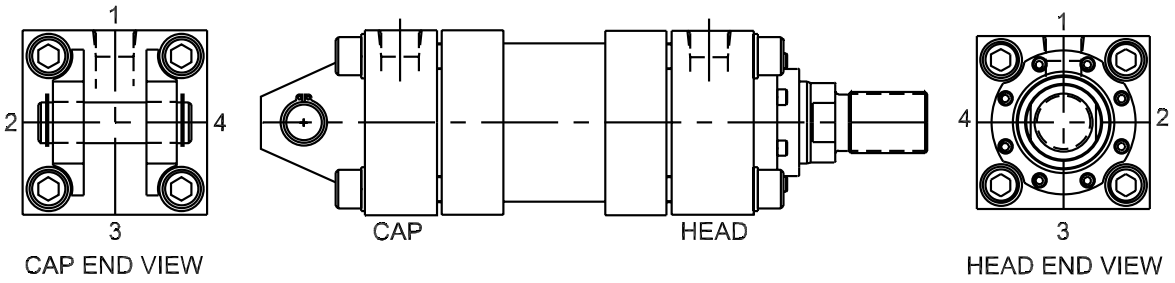


Table A

Mounting Style	Port Position Available at No Charge	
	Rod End	Cap End
IH3, IH4, TM3	1, 2, 3, or 4	1, 2, 3, or 4
CL, SL, FS	1	1
PB1, PB2, SA, TM2, ME6	1, 2, 3, or 4	1 or 3
TM1, ME5	1 or 3	1, 2, 3, or 4

Ports can be supplied at positions other than shown in Table A, but at extra charge. To order, specify port position as shown on Figure 1. Keep in mind that some mountings will interfere with port location changes.

Standard Port Sizes

Bore	S	N	F	I	BSPT BSPP	Metric
1.50	#8	0.50	N/A	M22x1.5	0.50	M22x1.5
2.00	#8	0.50	N/A	M22x1.5	0.50	M22x1.5
2.50	#8	0.50	0.50*	M22x1.5	0.50	M22x1.5
3.25	#12	0.75	0.75	M27x2	0.75	M27x2
4.00	#12	0.75	0.75	M27x2	0.75	M27x2
5.00	#12	0.75	0.75	M27x2	0.75	M27x2
6.00	#16	1.00	1.00	M33x2	1.00	M33x2
7.00	#20	1.25	1.25	M42x2	1.25	M42x2
8.00	#24	1.50	1.50	M48x2	1.50	M48x2
10.00	#24	1.50	2.00	M48x2	1.50	M48x2
12.00	#24	1.50	2.50	M48x2	1.50	M48x2
14.00	#24	1.50	2.50	M48x2	1.50	M48x2

* Available with 1.00'' rod size only

HYDRAULIC CYLINDER SPEEDS

Figures in the body of this chart are cylinder rod travel speeds in "inches per minute." Lines with rod diameter as NONE are extension speeds, using the full piston area. Lines with rod diameters are retraction speeds, using "net" piston area

CYL BORE	ROD DIA	1 GPM	3 GPM	5 GPM	8 GPM	12 GPM	15 GPM	20 GPM	25 GPM	30 GPM	40 GPM	50 GPM	75 GPM
1½	NONE	130	392	654	1034								
	5/8	158	476	792	1265								
	1	235	706	1176	1880								
2	NONE	73	221	368	588	883	1120						
	1	97	294	490	782	1175	1465						
	1 3/8	139	418	697	1115	1673	2090						
2½	NONE	47	141	235	376	565	675	940	1175				
	1	56	168	280	448	672	840	1120	1400				
	1 3/8	67	203	339	542	813	1015	1355	1695				
	1 3/4	92	277	463	740	1110	1385	1850	2310				
3¼	NONE	28	83	139	223	334	417	557	696	836	1115		
	1 3/8	34	102	170	271	407	510	680	850	1020	1360		
	1 3/4	39	118	196	313	472	588	784	980	1176	1568		
	2	44	134	224	358	537	672	896	1120	1344	1792		
4	NONE	18	55	92	147	220	276	368	460	552	736	920	
	1 3/4	22	68	113	182	273	339	452	565	678	904	1130	
	2	24	73	122	196	294	366	488	610	732	976	1220	
	2 1/2	30	90	150	241	362	450	600	750	900	1200	1500	
5	NONE	12	35	58	94	141	174	232	290	348	464	500	870
	2	14	42	70	112	168	210	280	350	420	560	700	1050
	2 1/2	16	47	78	125	188	235	315	390	470	630	780	1170
	3	18	55	92	147	221	276	368	460	551	735	919	1379
	3 1/2	22	66	111	178	266	333	444	555	665	888	1110	1665
6	NONE	8	24	41	65	98	123	162	202	245	320	405	606
	2 1/2	10	30	50	79	118	150	200	250	300	400	495	750
	3	11	33	54	87	130	165	217	270	325	435	545	810
	3 1/2	12	37	62	99	149	186	248	310	372	495	619	929
	4	15	44	73	117	176	220	295	365	440	585	735	1095
7	NONE	6	18	30	48	72	90	120	150	180	240	300	450
	3	7	22	37	59	88	110	145	185	220	295	365	555
	3 1/2	8	24	40	64	96	120	160	200	240	320	400	600
	4	9	27	45	71	107	134	178	223	267	357	446	668
	4 1/2	10	31	51	82	123	153	205	256	307	409	512	767
	5	12	37	61	98	147	185	245	305	370	490	615	915
8	NONE	4	14	23	36	55	69	92	115	135	185	230	345
	3 1/2	5.5	17	28	45	68	85	115	140	170	230	285	420
	4	6	18	30	49	73	90	122	150	180	240	305	450
	4 1/2	7	20	34	54	81	101	134	168	202	269	336	504
	5	8	23	38	60	90	113	151	189	226	302	377	566
	5 1/2	8.5	26	43	70	104	129	172	215	255	345	430	645
10	NONE	3	9	15	23	35	44	60	73	88	115	145	220
	4 1/2	3.5	11	18	29	44	55	75	92	111	150	185	275
	5	4	12	20	31	47	59	78	98	118	157	196	294
	5 1/2	4.5	13	21	34	50	63	84	105	132	165	210	315
	7	5.5	17	29	46	69	87	115	145	174	230	285	435
12	NONE	2	6	10	16	25	31	41	51	61	82	102	153
	5 1/2	2.5	8	13	21	31	39	52	65	78	103	129	194
	7	3	9	15	25	37	46	62	77	93	124	155	232
	8	3.5	11	18	29	44	55	74	92	110	147	184	276
	8 1/2	4	12	20	33	49	61	82	102	123	164	205	307
14	NONE	1.5	4.5	7.5	12.0	18.0	22.5	30.0	37.5	45.0	60.0	75.0	112.5
	7	2.0	6.0	10.0	16.0	24.0	30.0	10.0	50.0	60.0	80.0	100.0	150.0
	8	2.22	6.7	11.0	17.8	26.7	33.4	11.6	55.7	66.8	89.0	111.4	167.0
	10	3.06	9.2	15.3	24.5	36.8	46.0	61.27	76.59	91.9	122.5	153.18	229.8

Stop Tubing

Long stroke cylinders tend to jackknife or buckle on push load applications, resulting in high bearing loads at the rod bearing or piston. Use of a stop tube to lengthen the distance between the gland and piston when the rod is fully extended is recommended. Drawing A below shows shop tube construction for a cushioned cylinder. Non-cushioned cylinders use the same construction, but the cushion sleeves are eliminated. Dual piston stop tubes can also be utilized to add additional bearing when the stop tube length is significant. Refer to the chart to determine recommended stop tube length.

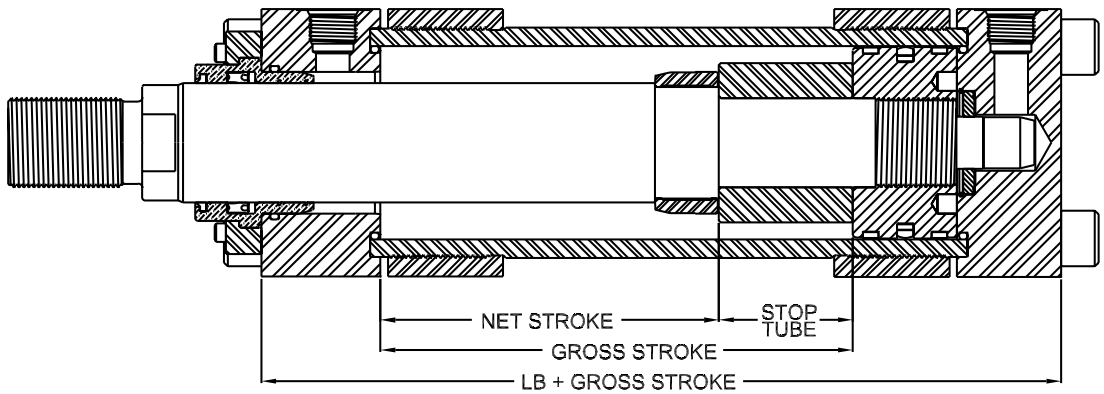
When specifying stop tubes, use the gross stroke in the stroke field of the model code, and indicate 'S' in the special field at the end of the code. Then specify the stop tube length and the desired net stroke.

Stop Tube Information: Max. Stroke per Mount

Bore	Case 1, 2 Rigid Mounts with rod support	Case 3 Rigid Mounts without Support	Case 4, 5, 6 Pivot Mounts
11/2 & 2"	48 in.	30 in.	24 in.
2 1/2 to 4"	48 in.	38 in.	30 in.
5 to 14"	48 in.	40 in.	36 in.

Extra rod extension is added into stroke
1" of stop tube for every 10" over maximum

Drawing A



Mounting Classes
Standard mountings fall into three basic groups, which are summarized as follows:

Group 1 Straight line force transfer with fixed mounting which absorbs forces on the cylinder centerline.

Heavy duty service		
	thrust	CL, IH4, ME6
	tension	CL, IH3, ME5

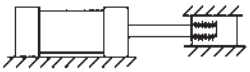
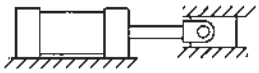
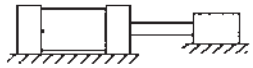
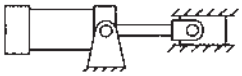
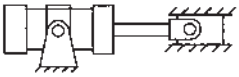
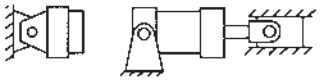
Group 2 Pivot force transfer with mounting which permits alignment to change in a single plane along cylinder centerline. Stroke length will influence service rating.

Heavy duty service		
	thrust	TM1, TM3
	tension	PB1, PB2, TM1, TM2, TM3
Medium duty service		
	thrust	PB1, PB2

Group 3 Straight line force transfer with fixed mounting which does not absorb force on the centerline.

Heavy duty service		
	thrust	SL
	tension	SL
Medium duty service		
	thrust	FS
	tension	FS

Stroke Factor

Recommended Mounting Styles for Maximum Stroke and Thrust Loads	ROD END CONNECTION	CASE	STROKE FACTOR
GROUP 1 OR 3 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. Consult factory for a guide. Machine mounting pads can be adjustable for support mountings to achieve proper alignment.	Fixed and Rigidly Guided	**1** 	.50
	Pivoted and Rigidly Guided	**2** 	.70
	Supported but not Rigidly Guided	**3** 	2.00
GROUP 2 Trunnion on Head	Pivoted and Rigidly Guided	**4** 	1.00
Intermediate Trunnion	Pivoted and Rigidly Guided	**5** 	1.50
Trunnion on Cap or Clevis on Cap	Pivoted and Rigidly Guided	**6** 	2.00

HOW TO USE CHARTS

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 above and find the "stroke factor" that corresponds to the conditions used.

2. Using this stroke factor, determine the "basic length" from the equation:

$$\text{Basic Length} = \text{Actual Stroke} \times \text{Stroke Factor}$$

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".

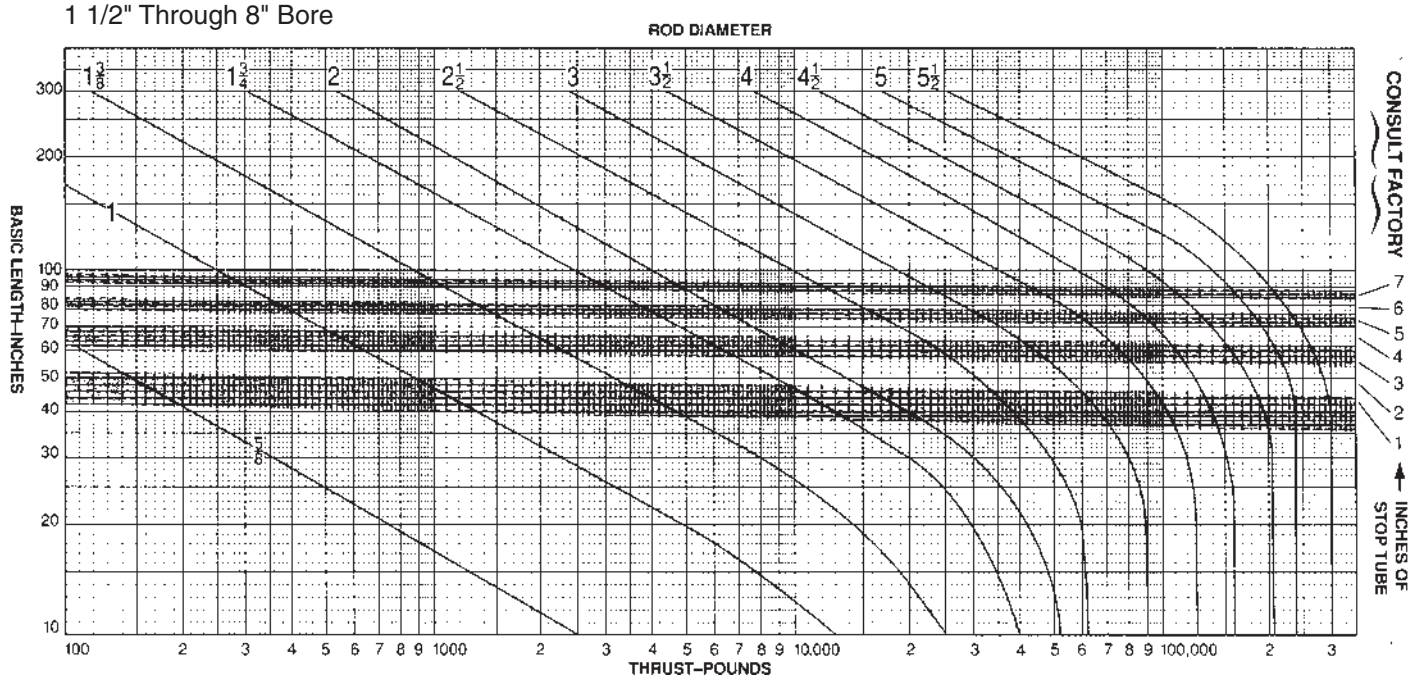
3. Find the load imposed for the thrust application by multiplying the full bore area of the cylinder by the system pressure.

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. "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 limited to less than standard pressure for cylinder selected.

WARNING!
Piston rods are not normally designed to absorb bending moments or cads 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.

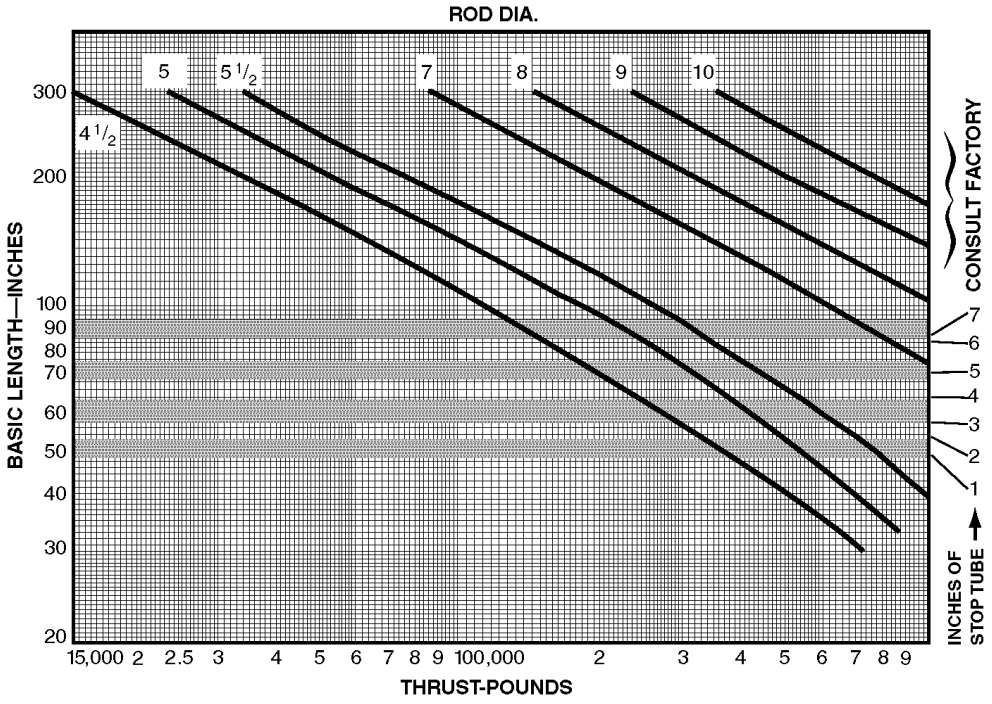
Piston Rod — Stroke selection Chart

1 1/2" Through 8" Bore



Piston Rod — Stroke selection Chart

10" Through 14" Bore



Acceleration and Deceleration Force Determination

The uniform acceleration force factor chart and the accompanying formula can be used to rapidly determine the forces required to accelerate and decelerate a cylinder load. To determine these forces, the following factors must be known: total weight to be moved, maximum piston speed, distance available to start or stop the weight (load), direction of movement i.e. horizontal or vertical, and load friction. By use of the known factors and the "g" factor from chart, the force necessary to accelerate or decelerate a cylinder load may be found by solving the formula (as shown in chart below) application to a given set of conditions.

Nomenclature

V	=	Velocity in feet per minute
S	=	Distance in inches
F	=	Force in lbs.
W	=	Weight of load in lbs.
g	=	Force factor
f	=	Friction of load on machine ways in pounds

To determine the force factor "g" from the chart, locate the intersection of the maximum piston velocity line and the line representing the available distance. Project downward to locate "g" on the horizontal axis. To calculate the "g" factor for distances and velocities exceeding those shown on the chart, the following formula can be used:

$$g = v^2/s \times .0000517$$

Example: Horizontal motion of a free moving 25,000 lb. load is required with a distance of ½" to a maximum speed of 120 feet per minute.

Formula (1) F = Wg should be used.

F = 25,000 pounds x 1.50 (from chart) = 37,500 lbs.

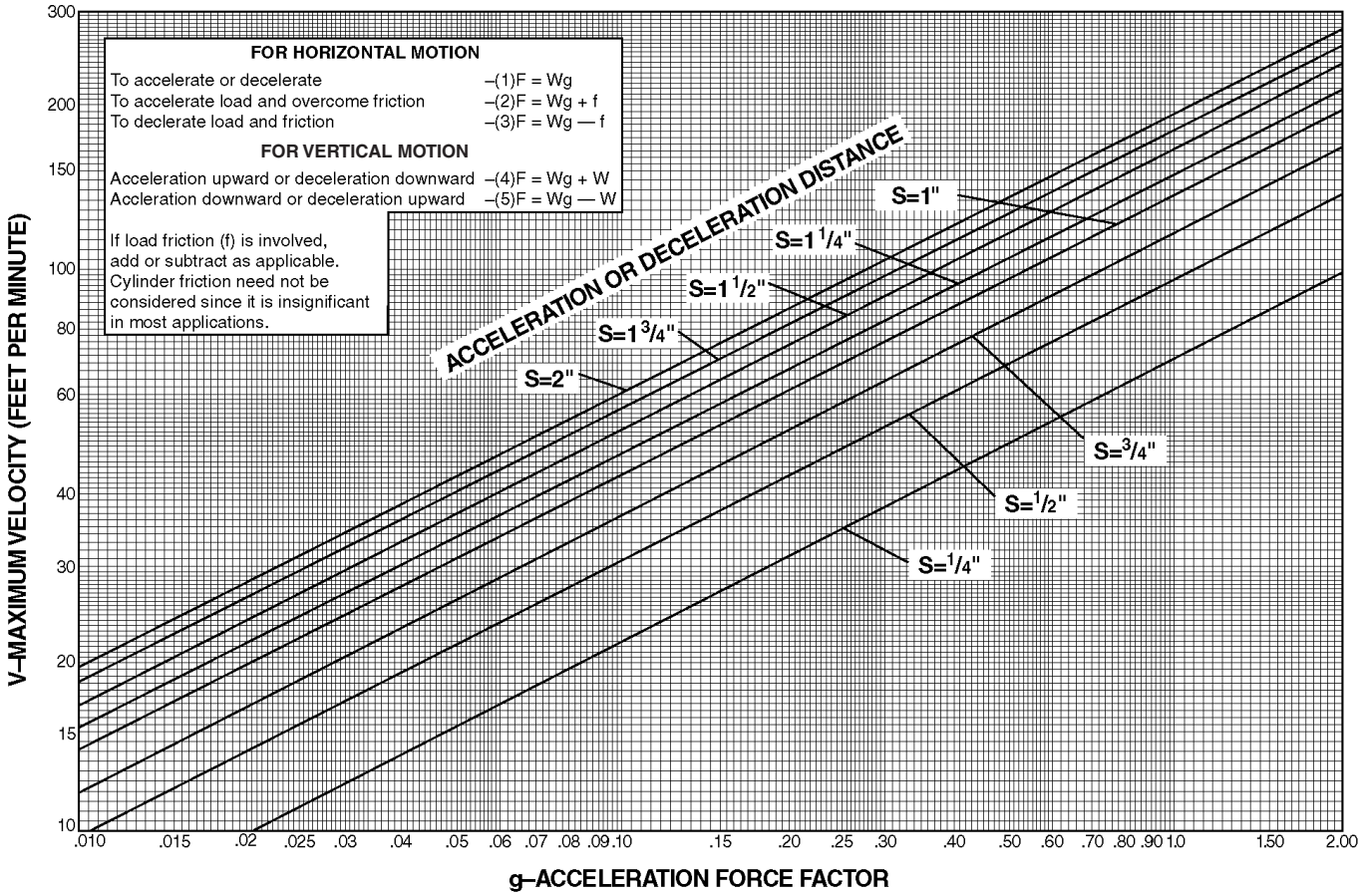
Assuming a maximum available pump pressure of 750 psi, a 10" bore cylinder should be selected, operating on push stroke at approximately 500 psi pressure at the cylinder.

Assume the same load to be sliding on ways with a coefficient of friction of 0.15. The resultant friction load would be 2,500 x 0.15 = 3,750 lbs.

Formula (2) F = Wg + f should be used.

F = 25,000 lbs. x 1.5 (from chart) + 3,750 = 41,250 lbs.

Again allowing 500 psi pressure at the cylinder, a 12" bore cylinder is indicated.



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.

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

Installation

1. Cleanliness is an important consideration, and Atlas 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.
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. 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.

Mounting Recommendations

1. The use of high tensile alloy steel socket head screws 1/16" smaller than the mounting hole size is recommended for all mounting styles.
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. 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.
4. Trunnion Mountings – Cylinders require lubricated pillow blocks with minimum bearing clearances. Pillow 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.
5. 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.

Cylinder Trouble Shooting
External Leakage

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 bearing wear. If clearance is excessive, replace rod gland and seal.

   Rod seal leakage can also be traced to seal deterioration. If seals are soft or gummy, check compatibility of seal material with lubricant used if air cylinder, or operating fluid if hydraulic cylinder. Replace with a seal material which is compatible with the lubricant or operating fluid. 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.
2. Cylinder body seal leak can generally be traced to loose head screws. Torque the head screws 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 head screws as in paragraph above.

   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.

   Soft or gummy seals are evidence of exposure to fluid with which they are not compatible. Hard seals or seals which have lost their elasticity are a symptom of exposure to excessive temperature. Replace seals as per paragraph above.

Internal Leakage

1. Piston seal leak (by-pass) 1 to 3 cubic inches per minute leakage is considered normal for piston ring construction. Virtually no 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.
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 and cylinder barrel as required.
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.

Cylinder Fails to Move the Load

1. Pneumatic or hydraulic pressure is too low. Check the pressure at the cylinder to make sure it is to circuit requirements.
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.
3. Cylinder is undersized for the load – Replace cylinder with one of a larger bore size.
4. Piston rod broken at piston end – Disassemble cylinder and replace piston rod.

Erratic or Chatter Operation

1. Excessive friction at gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.
2. Cylinder sized too close to load requirements – Reduce load or install larger cylinder.
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.

SELECTING THE PROPER SIZE CYLINDER

DETERMINE THE FORCE REQUIRED — To select a cylinder for an application, first determine the maximum push and/or pull force required to do the job. Then use the pressure table to select the cylinder that gives the necessary force for your application. It should be noted that the force requirements derived by formula are only theoretically correct. Other factors must be provided for.

Pressure drop—which means that working pressure at the cylinder port will be somewhat less than system pressure—should be allowed for in such calculations. A margin for overcoming friction in the cylinder likewise must be added.

After selecting the proper size cylinder for the job use the envelope and mounting dimension charts to determine cylinder dimensions.

PRESSURE TABLE

CYL. BORE DIA.	PRESSURE RATINGS HEAVY DUTY SERVICE	PRESSURE RATINGS 4:1 SAFETY FACTOR	PISTON ROD DIA.	CYL. WORK ACTION	WORK AREA (SQ. IN.)	HYDRAULIC WORKING PRESSURE PSI 350	500	750	1000	1500	2000	FLUID REQUIRED PER IN. OF STROKE GAL.	CU. FT.
1.50	2000	1246	5/8	Push	1.767	618	884	1325	1767	2651	3534	.00765	.00102
				Pull	1.460	511	730	1095	1460	2190	2920	.00632	.00084
			1	Pull	.982	344	491	737	982	1473	1964	.00425	.00057
2.00	2000	1000		Push	3.141	1099	1571	2356	3141	4712	6282	.01360	.00182
			1	Pull	2.356	825	1178	1767	2356	3534	4712	.01020	.00136
			1 3/8	Pull	1.656	580	828	1252	1656	2484	3312	.00717	.00096
2.50	2000	1000		Push	4.909	1718	2455	3682	4909	7364	9818	.02125	.00284
			1	Pull	4.124	1443	2062	3093	4124	6186	8248	.01785	.00239
			1 3/8	Pull	3.424	1198	1712	2568	3424	5136	6848	.01482	.00198
			1 3/4	Pull	2.504	876	1252	1878	2504	3756	5008	.01084	.00145
3.25	2000	1912		Push	8.296	2904	4148	6222	8296	12444	16592	.0359	.00480
			1 3/8	Pull	6.811	2384	3406	5108	6811	10217	13622	.0295	.00394
			1 3/4	Pull	5.891	2062	2946	4418	5891	8837	11782	.0255	.00341
			2	Pull	5.154	1804	2577	3866	5154	7731	10308	.0223	.00298
4.00	2000	1490		Push	12.566	4398	6283	9425	12566	18849	25132	.0544	.00727
			1 3/4	Pull	10.161	3556	5081	7621	10161	15242	20322	.0440	.00588
			2	Pull	9.424	3298	4712	7068	9424	14136	18848	.0408	.00545
			2 1/2	Pull	7.657	2680	3829	5743	7657	11486	15314	.0331	.00443
5.00	2000	1348		Push	19.635	6872	9818	14726	19635	29453	39270	.0850	.01136
			2	Pull	16.492	5772	8246	12369	16492	24738	32984	.0714	.00954
			2 1/2	Pull	14.726	5154	7363	11045	14726	22089	29452	.0637	.00852
			3	Pull	12.566	4398	6283	9425	12566	18849	25132	.0544	.00728
			3 1/2	Pull	10.014	3505	5007	7511	10014	15021	20028	.0433	.00580
6.00	2000	1099		Push	28.274	9896	14137	21206	28274	42411	56548	.1224	.01636
			2 1/2	Pull	23.365	8178	11683	17524	23365	35048	46730	.1011	.01352
			3	Pull	21.205	7422	10603	15904	21205	31808	42410	.0918	.01227
			3 1/2	Pull	18.653	6529	9327	13990	18653	27980	37306	.0808	.01079
			4	Pull	15.708	5498	7854	11781	15708	23562	31416	.0680	.00909
7.00	2000	1384		Push	38.485	13470	19243	28864	38485	57728	76970	.1666	.02227
			3	Pull	31.416	10996	15708	23562	31416	47124	62832	.1360	.01818
			3 1/2	Pull	28.864	10102	14432	21648	28864	43296	57728	.1250	.01670
			4	Pull	25.915	9070	12958	19436	25915	38873	51830	.1122	.01500
			4 1/2	Pull	22.585	7905	11293	16939	22585	33878	45170	.0977	.01307
			5	Pull	18.850	6598	9425	14138	18850	28375	37700	.0816	.01091
8.00	2000	1121		Push	50.265	17593	25133	37699	50265	75398	100530	.2176	.02909
			3 1/5	Pull	40.644	14225	20322	30483	40644	60966	81288	.1759	.02352
			4	Pull	37.699	13195	18850	28274	37699	56549	75398	.1632	.02182
			4 1/2	Pull	34.365	12028	17183	25774	34365	51548	68730	.1488	.01989
			5	Pull	30.630	10721	15315	22973	30630	45945	61260	.1326	.01772
			5 1/2	Pull	26.507	9277	13254	19880	26507	39761	53014	.1147	.01534
10.00	2000	2000		Push	78.540	27489	39270	58905	78540	117810	157080	.3400	.04545
			4 1/2	Pull	62.636	21923	31318	46977	62636	93954	125272	.2712	.03625
			5	Pull	58.905	20617	29453	44179	58905	88358	117810	.2549	.03408
			5 1/2	Pull	54.782	19174	27391	41087	54782	82173	109564	.2372	.03170
			7	Pull	40.055	14019	20028	30041	40055	60083	80110	.1740	.02319
12.00	2000	1112		Push	113.100	34585	56550	84825	113100	169650	226200	.4896	.06545
			5 1/2	Pull	89.399	31269	44670	67004	89339	134009	178678	.3868	.05170
			7	Pull	74.613	26115	37307	55960	74613	111920	149226	.3230	.04333
			8	Pull	62.830	21991	31415	47123	62830	94245	125660	.2719	.03636
			8 1/2	Pull	56.352	19723	28176	42264	56352	84528	112704	.2441	.03259
14.00	2000	1221		Push	153.94	53879	76970	115455	153940	230910	307880	.6664	.0089
			7	Pull	115.45	40408	57725	86588	115450	173175	230900	.4998	.0668
			8	Pull	103.67	36285	51835	77753	103670	155505	207340	.4488	.06
			10	Pull	75.40	26390	37700	56550	75400	113100	150800	.3264	.0436

4:1 SAFETY FACTOR BASED ON BURST PRESSURE ONLY

RECOMMENDED HEAD SCREW TORQUE VALUES FOR SERIES "MH" CYLINDERS

BORE	1 1/2	2	2 1/2	3 1/4	4	5	6	7	8	10	12	14	16, 18, 20
HEAD BOLT THREAD	3/8 - 24	1/2 - 20	1/2 - 20	5/8 - 18	5/8 - 18	7/8 - 14	1-14	1 1/8 -12	1 1/4 -12	1 1/8 -12	1 1/4-12	1 1/4-12	Consult
TORQUE FT. LBS.	11	28	30	50	75	160	220	325	375	350	620	500	Factory

RECOMMENDED RETAINER SCREW TORQUE VALUES SERIES "MH"

Screw Size	#10-24 UNC	1/4-20 UNC	3/8-16 UNC
Torque	24 in. lb.	120 in. lb.	240 in. lb.

APPROXIMATE NET WEIGHTS OF SERIES "MH" CYLINDERS BASED ON STANDARD ROD DIAMETERS

(All weights expressed in lbs.)

BORE	ROD DIA.	SINGLE ROD END		DOUBLE ROD END	
		MH BASE	MH PER INCH	MH DRE BASE	MH DRE PER INCH
1.50	0.63	11.5	0.4	13.2	0.5
	1	11.8	0.5	13.3	0.7
2.00	1	16.4	0.6	20.0	0.8
	1.38	20.3	0.8	23.8	1.2
2.50	1	23.2	0.9	28.2	1.1
	1.75	29.2	1.3	33.7	2.0
3.25	1.38	48.8	1.5	59.8	1.9
	2	53.8	1.9	64.8	2.8
4.00	1.75	64.9	2.2	74.9	2.9
	2	69.9	2.9	108.9	4.3
5.00	2	98.1	2.8	118.1	4.2
	3.5	102.1	4.6	139.1	7.3
6.00	2.5	156.2	4.4	182.2	5.8
	4	163.2	6.5	213.2	10.1
7.00	3	276.2	5.7	373.2	7.7
	5	287.2	9.3	394.2	14.9
8.00	3.5	325.0	7.8	380.0	10.5
	5.5	358.0	11.8	460.0	18.5

BORE	ROD DIA.	SINGLE ROD END					DOUBLE ROD END	
		MH TM1,2 BASE	MH TM3, ME5,6 BASE	MH IH3,4 BASE	MH PB1,2, CL,SL BASE	MH PER INCH OF STROKE	MH ADD TO ALL	MH ADD PER INCH
10.00	4.50	672.4	756.4	794.4	717.4	13.0	43	18.0
	5.00	684.4	766.4	805.4	729.4	14.0	50	19.0
	5.50	693.4	777.4	815.4	738.4	15.0	64	22.0
	7.00	730.4	814.4	852.4	775.4	19.0	101	30.0
12.00	5.50	1068.5	1201.5	1280.5	1144..5	19.5	64	26.5
	7.00	1105.5	1238.5	1317.5	1180.5	23.5	101	34.5
	8.00	1166.5	1299.5	1378.5	1241.5	26.5	162	40.5
14.00	7.00	1480.0	1665.0	1727.0	1630.0	24.3	101	35.3
	8.00	1541.0	1726.0	1788.0	1691.0	27.3	162	41.3
	10.00	1641.0	1826.0	1888.0	1791.0	35.3	262	57.3

CYLINDER INSTALLATION

All cylinders are individually tested before shipment to assure proper operation. It is recommended that the shipping plugs in the cylinder ports not be removed during installation until actual piping connections are to be made.

Align the cylinder carefully, keeping mounting surfaces square, parallel, concentric, and true.

Trunnion and pivot-mounted cylinders swivel in one direction only with trunnion pins and pivot pins designed to carry shear loads only. Trunnion and pivot bearings must fit closely for the entire length of the pin with trunnion bearings held rigidly and in accurate alignment.

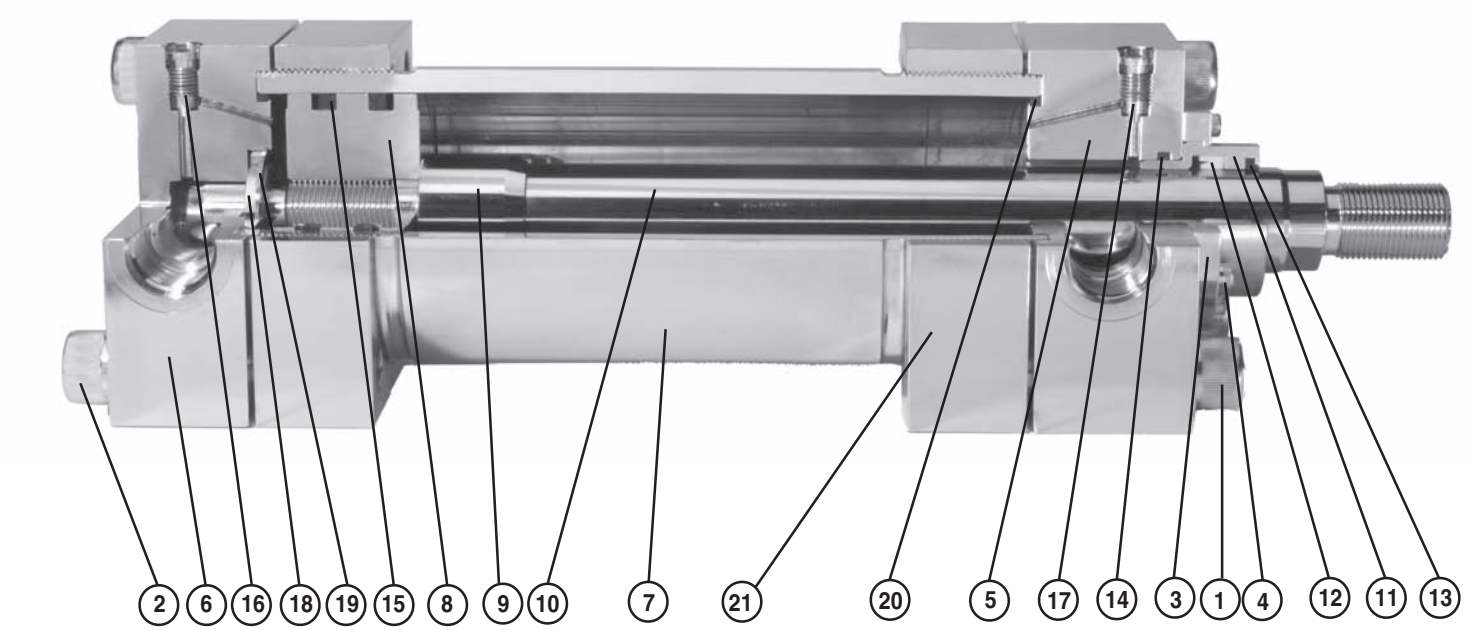
Flush mounting cylinders (styles SL and FS) should be pinned or keyed to prevent shifting from load application. Keys should be bolted or welded against cylinder heads in maximum pressure or shock applications. Pins or keys must be large enough to withstand the full force developed by the cylinder.

In making the piston rod connection, always use wrench flats on rod and never apply wrench to smooth section of rod (score marks or nicks on piston rod will cause premature rod seal failure).

Operate the cylinder several times to make sure it is functioning properly. Check piping for leakage. Clean fluid is essential to long and satisfactory operation of not only cylinders, but pumps and valves as well. Keep oil tanks covered and provide an adequate oil filter.

Service Policy

On cylinders returned to the factory for repairs, it is standard policy for the Atlas Cylinders to make such part replacements as will put the cylinder in as good as new condition. Should the condition of the returned cylinder be such that expenses for repair would exceed the costs of a new one, you will be notified.



01. Rod Head Screw
02. Cap Head Screw
03. Packing Cap
04. Packing Cap Screw
05. Rod Head
06. Cap Head
07. Cylinder Barrel
08. Piston
09. Rod End Cushion Sleeve
10. Piston Rod
11. Rod Cartridge
12. Rod Seal
13. Rod Wiper
14. Cartridge O.D. Seal
15. Piston O.D. Seal
16. Adjustable Cushion Assembly
17. Cushion Check Assembly
18. Cushion Bushing
19. Retainer Ring
20. Barrel Seal
21. Barrel Flange

Cylinder Repair Kit Contents

Items 11, 12, 13, 14, 15, 20

To speed the handling of orders for parts or Repair kits, please specify:

1. Cylinder serial number
2. Cylinder bore diameter
3. Stroke
4. Piston rod diameter
5. Operating medium

NOTES

WARNING

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from Atlas Cylinders or its authorized distributors provide product and/or system options for further investigation by users having technical expertise. It is important that you analyze all aspects of your application, including consequences of any failure and review the information concerning the product or system in the current product catalog. Due to the variety of operating conditions and applications for these products or systems, the user, through its own analysis and testing, is solely responsible for making the final selection of the products and systems and assuring that all performance, safety and warning requirements of the application are met.

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Offer of Sale

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1. Terms and Conditions of Sale: All descriptions, quotations, proposals, offers, acknowledgments, acceptances and sales of Seller's products are subject to and shall be governed exclusively by the terms and conditions stated herein. Buyer's acceptance of any offer to sell is limited to these terms and conditions. Any terms or conditions in addition to, or inconsistent with those stated herein, proposed by Buyer in any acceptance of an offer by Seller, are hereby objected to. No such additional, different or inconsistent terms and conditions shall become part of the contract between Buyer and Seller unless expressly accepted in writing by Seller. Seller's acceptance of any offer to purchase by Buyer is expressly conditional upon Buyer's assent to all the terms and conditions stated herein, including any terms in addition to, or inconsistent with those contained in Buyer's offer. Acceptance of Seller's products shall in all events constitute such assent.

2. Payment: Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Amounts not timely paid shall bear interest at the maximum rate permitted by law for each month or portion thereof that Buyer is late in making payment. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer's receipt of the shipment.

3. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F. O. B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of shipment to Buyer. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.**

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5. Limitation of Remedy: SELLER'S LIABILITY ARISING FROM OR IN ANY WAY CONNECTED WITH THE ITEMS SOLD OR THIS CONTRACT SHALL BE LIMITED EXCLUSIVELY TO REPAIR OR REPLACEMENT OF THE ITEMS SOLD OR REFUND OF THE PURCHASE PRICE PAID BY BUYER, AT SELLER'S SOLE OPTION. IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY KIND OR NATURE WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS ARISING FROM OR IN ANY WAY CONNECTED WITH THIS AGREEMENT OR ITEMS SOLD HEREUNDER, WHETHER ALLEGED TO ARISE FROM BREACH OF CONTRACT, EXPRESS OR IMPLIED WARRANTY, OR IN TORT, INCLUDING WITHOUT LIMITATION, NEGLIGENCE, FAILURE TO WARN OR STRICT LIABILITY.

6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges therefor by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer therefor. 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.

8. 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 (2) 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.

9. Taxes: Unless otherwise indicated on the face hereof, 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 the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. 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 Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereinafter "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 an item sold pursuant to this contract 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 an item sold hereunder 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 said item, replace or modify said item so as to make it non-infringing, or offer to accept return of said item 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 items 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 item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, act of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of the action accrues.

ATLAS
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