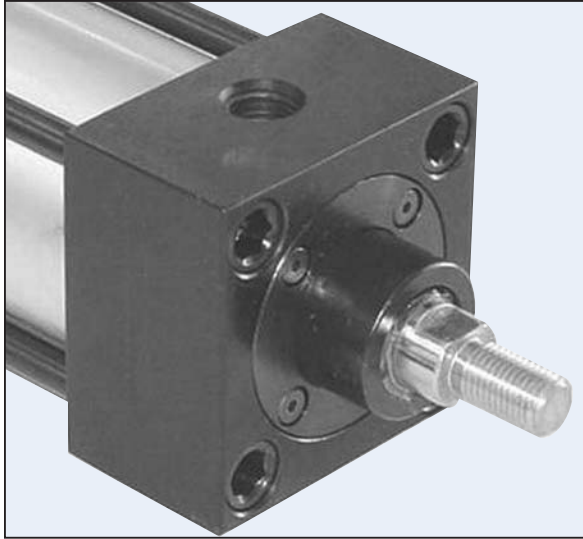


SERIES 'FM': FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



Benefits

- Same construction as 'TA' series with the added benefit of "Sleeve Nut" construction.
- Four tapped holes in Head and Cap-Standard. Optional (4) additional tapped holes in base (MS4 Mount).
- No exposed tie rods or nuts at head and cap provides a "Clean" design.
- Interchanges with many older style NFPA manufacturers' cylinders out in the field.
- Can easily add a multiple of NFPA Mounts by simply bolting in place (refer to page 30 for mount selection).
- Available in Single & Double Rod End models.

Performance options:

- **LF** - Low Friction Seals reduce breakaway and running friction. Effective at all operating pressures.
- **Extended Cushion Lengths** - Longer cushions increase the capacity of air cushions, eliminating costly hydraulic shock absorbers in some cases. Choose from three different cushion lengths for maximum performance.
- **MPR** - Magnetic Piston (for position sensing switches).
- **EN** - Electroless Nickel Plated and Stainless Steel Fasteners provide corrosion resistance.
- **SSA** - Stainless Steel Piston Rod, Tie Rods, Sleeve Nuts, and Fasteners provide corrosion resistance in outdoor applications and wet environments.
- **WB** - Piston Wear Band, recommended for pivot mounted, long strokes or cylinders that may see side loads.
- **MA** - Micro-Adjust provides a precision adjustment on the cylinder extend stroke, providing quick and accurate cylinder positioning, reducing set-up time.
- **AS** - Adjustable Retract Stroke allows for accurate adjustment on the cylinder return stroke.
- **BSP or SAE Ports** - Special ports are available and do not increase delivery time.
- **NR** - Non-Rotating option incorporates (2) internal guide rods preventing rod rotation (NFPA dimensions).

SELF-LUBRICATING CYLINDER DESIGN

PTFE coated cast iron bushing, PTFE Wear Band, Hard-Chrome Plated Piston Rod, Hard-Coated Aluminum Tube and PTFE based grease provide permanent lubrication and long cylinder life.

STANDARD PORT SIZES (ONE SIZE LESS THAN 'TA' SERIES)

(Optional Port Sizes Available - Refer to page 20 for ordering instructions)

BORE	1.50	2	2.50	3.25	4	5	6
PORT SIZE	.25 NPT	.25 NPT	.25 NPT	.38 NPT	.38 NPT	.38 NPT	.50 NPT

OPERATING PRESSURE

250 PSI AIR (17 BAR)

OPERATING TEMPERATURE

Carboxilated Nitrile: -20°F to 200°F (-25°C to 90°C)
Fluorocarbon: 0°F to 400°F (-20°C to 200°C)

HOW TO ORDER: SERIES 'FM' (FLUSH MOUNT)

Basic Cylinders

'TA'

'TD'

'FM'

Back-To-Back

3-Position

Tandem

FM - MS4 - 2.50 x 10 - HC - MPR

SERIES	
FM	250 PSI AIR

NFPA MOUNTS	
MF1	FRONT FLANGE (1.50"-6" Bore)
MF2	REAR FLANGE (1.50"-6" Bore)
MP1	REAR PIVOT CLEVIS (1.50"-6" Bore)
MP2	REAR PIVOT CLEVIS (1.50"-6" Bore)
MP4	REAR PIVOT EYE (1.50"-6" Bore)
MS1	FRONT & REAR END ANGLE (1.50"-6" Bore)
MS2	SIDE LUG (1.50"-6" Bore)
MS4	BOTTOM TAPPED HOLES (1.50"-6" Bore)
MT1	FRONT TRUNNION (1.50"-6" Bore)
MT2	REAR TRUNNION (1.50"-6" Bore)
MXO	NO MOUNT (1.50"-6" Bore)
BASE BAR	NON-NFPA (1.50"-4" Bore)

BORE	
1.50	2
2.50	3.25
4	5
6	

STROKE
0" to 120"
Made to Order

STYLE	
	SINGLE ROD (LEAVE BLANK)
	D = DOUBLE ROD END

CUSHIONS	
H	HEAD CUSHION POSITION 2 IS STANDARD SPECIFY FOR POSITIONS: 1, 3 & 4
LH	LONG HEAD CUSHION POSITION 2 IS STANDARD SPECIFY FOR POSITIONS: 1, 3 & 4
ELH	EXTRA LONG HEAD CUSHION POSITION 2 IS STANDARD SPECIFY FOR POSITIONS: 1, 3 & 4
C	CAP CUSHION POSITION 6 IS STANDARD SPECIFY FOR POSITIONS: 5, 7 & 8
LC	LONG CAP CUSHION POSITION 6 IS STANDARD SPECIFY FOR POSITIONS: 5, 7 & 8
ELC	EXTRA LONG CAP CUSHION POSITION 6 IS STANDARD SPECIFY FOR POSITIONS: 5, 7 & 8
FIXED CUSHIONS	
FCH	FIXED HEAD CUSHION (NON-ADJUSTABLE, NO ADJUSTMENT NEEDLE)
FCC	FIXED CAP CUSHION (NON-ADJUSTABLE, NO ADJUSTMENT NEEDLE)
FC	FIXED HEAD AND CAP CUSHION (NON-ADJUSTABLE, NO ADJUSTMENT NEEDLE)

Note: "L" AND "EL" CUSHION OPTIONS CAN BE ORDERED AS FIXED CUSHIONS.

Example: FCLH, FCELH

- Notes:
- Ordering example for non-standard cushion locations: H3C7
 - Refer to page 83 for assistance in cushion length selection.
 - Cushions can be ordered on same side as ports. Refer to page 87 for dimensions.

OPTIONS	
ADDS LENGTH TO CYLINDER - SEE "OPTION LENGTH ADDER" CHART BELOW.	
A =	EXTENDED PISTON ROD THREAD (Example: A = 2")
AS	ADJUSTABLE STROKE - RETRACT (SPECIFY LENGTH, Example: AS = 4")
A / O	AIR / OIL PISTON
X B	.25" URETHANE BUMPER BOTH ENDS
X BC	.25" URETHANE BUMPER CAP ONLY
X BH	.25" URETHANE BUMPER HEAD ONLY
BP	BUMPER PISTON SEALS (1.50" - 6" Bore)
BSP	BSP PORTS (SPECIFY SIZE, Example: BSP = .25")
C =	EXTENDED PISTON ROD (Example: IF C = 0.50", THEN 1" ROD EXTENSION IS C = 1.50")
EN	ELECTROLESS NICKEL PLATED (Refer to page 84 for specifications)
KK2	LARGE MALE ROD THREAD
KK3	FEMALE ROD THREAD
KK3S	STUDDER PISTON ROD (KK3 with Stud, Loctite in place)
KK4	FULL DIAMETER MALE ROD THREAD
KK5	BLANK ROD END (NO THREADS, "A" = 0")
LF	LOW FRICTION SEALS (Refer to page 84 for specifications)
MA	MICRO-ADJUST (6" MAX. STROKE) Available on Double Rod End Models
MAB	MICRO-ADJUST WITH SOUND DAMPENING BUMPER (6" MAX. STROKE)
MPR	MAGNETIC PISTON FOR REED OR SOLID STATE SWITCHES - TRD MODELS: R10, R10P, RAC, RHT & MSS (Refer to pages 107-113 for selection)
MS	METALLIC ROD SCRAPER (BRASS CONSTRUCTION)
NR	NON-ROTATING (Refer to page 86 for specifications)
OP	OPTIONAL PORT LOCATION OR SIZE (Example: Ports @ 3 & 7)
OS	OVERSIZE ROD DIAMETER (SPECIFY SIZE, Example: OS = 1.38")
SAE	SAE PORTS (SPECIFY SIZE, Example: SAE #10)
X SE	SPRING EXTEND (1.50", 2", 2.50" bore)
X SR	SPRING RETURN (1.50", 2", 2.50" bore)
SSA	STAINLESS STEEL PISTON ROD, TIE RODS & SLEEVE NUTS, AND FASTENERS
SSF	STAINLESS STEEL FASTENERS
SSR	STAINLESS STEEL PISTON ROD
SST	STAINLESS STEEL TIE RODS & SLEEVE NUTS
X ST	STOP TUBE (SPECIFY STOP TUBE LENGTH AND EFFECTIVE STROKE) (Example: TA MS4 2 X 24" EFFECTIVE STROKE-ST=3)
STEEL TUBE*	STEEL CYLINDER TUBE, BLACK EPOXY PAINT FINISH
TH	400 PSI HYDRAULIC NON-SHOCK (Refer to page 90 for specifications)
VS	FLUOROCARBON SEALS
WB	PISTON WEAR BAND
XX	SPECIAL VARIATION (SPECIFY)

*STEEL TUBES do not work with MPR magnetic pistons. Refer to pages 114-117 for Balluff end of stroke sensors.

About our Part Number System

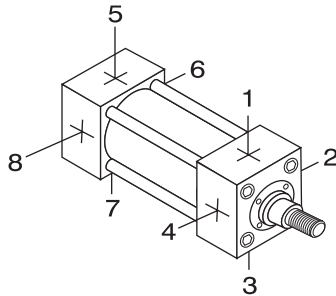
- Simple, easy to understand
- No excessive codes!
- Eliminates mistakes when ordering

Example: A 2.50" Bore by 10" Stroke NFPA cylinder, Bottom Tap Mount, Head & Cap Cushions, and Magnetic Piston for Switches.

Part Number: FM-MS4-2.50 x 10-HC-MPR

STANDARD PORT AND CUSHION ADJUSTMENT POSITIONS

- Ports - Positions 1 and 5
- Cushion Adjustment - Positions 2 and 6
- Specify Non-Standard Positions When Ordering



OPTION LENGTH ADDER							
(ADD TO CATALOG BASIC OVERALL LENGTH DIMENSIONS)							
BORE	OPTION						
	B	BC	BH	ELC	ELH	SE	SR

1.50	.50	.25	.25	1	1	Refer to page 86 for length adders and available bore sizes and strokes	2
2	.50	.25	.25	1	1		2
2.50	.50	.25	.25	1	1		2
3.25	.50	.25	.25	1.25	1.25		2
4	.50	.25	.25	1.25	1.25		2
5	.50	.25	.25	1.25	1.25		2
6	.50	.25	.25	1.50	1.50	2	

*Note: The desired Stop Tube length adds directly to the overall cylinder length.

'FM' NFPA MOUNTS

<p>1.50" - 6" Bores Page 23</p>	<p>1.50" - 6" Bores Page 23</p>	<p>1.50" - 6" Bores Page 22</p>	<p>1.50" - 6" Bores Page 22</p>	<p>1.50" - 4" Bores Page 23</p>	<p>1.50" - 6" Bores Page 23</p>
<p>1.50" - 6" Bores Page 24</p>	<p>1.50" - 6" Bores Page 25</p>	<p>1.50" - 6" Bores Page 22</p>	<p>1.50" - 6" Bores Page 22</p>	<p>1.50" - 6" Bores Page 21</p>	<p>1.50" - 4" Bores Page 24</p>

SERIES 'FM' DIMENSIONS: BASIC CYLINDER (MXO MOUNT) FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

About Rod End Styles

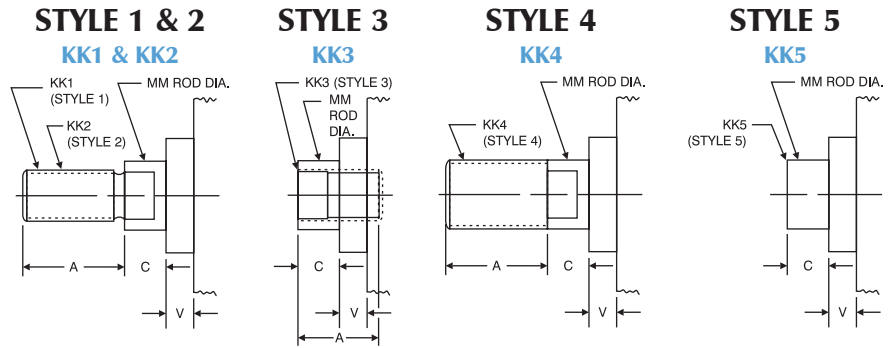
Style 1 Male Rod End is STANDARD

Other NFPA Styles can be specified (See Chart).

Need a rod end not listed?
NO PROBLEM! Each Piston Rod is made to order and does not delay shipment. Coarse (UNC) threads, Metric threads or just plain rod ends are common. Thread lengths are also made to order (Specify: "A"=Length).

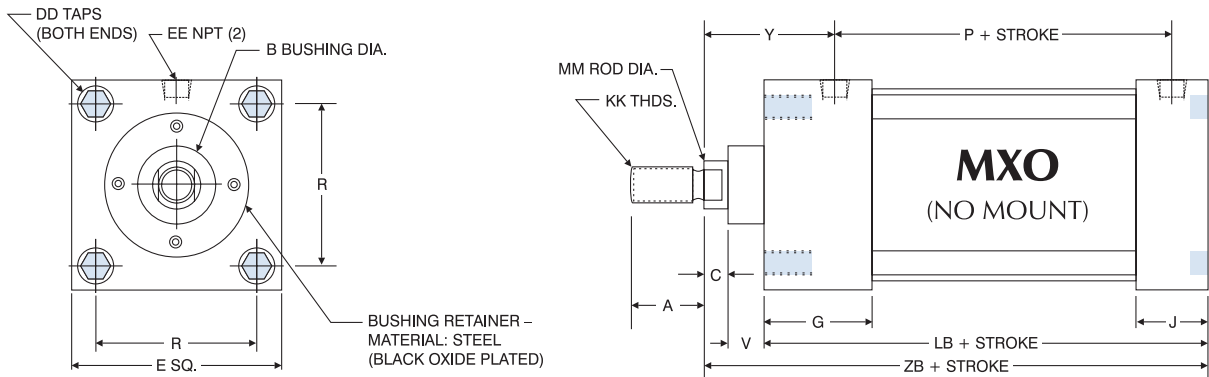
NEED SOMETHING NOT LISTED?
Just send us a sketch.
In most cases, quotes are turned around in one day!

PISTON ROD END STYLES



BORE	MM ROD DIAMETER	STANDARD				OPTIONAL						C	V
		Style 1 - Male		Style 2 - Male		Style 3 - Female		Style 4 - Male		Style 5 - Blank			
		KK1	A	KK2	A	KK3	A	KK4	A	KK5			
1.50, 2, 2.50	.63 Standard	.44-20	.75	.50-20	.75	.44-20	.75	.63-18	.75	No Threads	.38	.63	
	1 Oversize	.75-16	1.13	.88-14	1.13	.75-16	1.13	1-14	1.13	No Threads	.50	.50	
3.25, 4, 5	1 Standard	.75-16	1.13	.88-14	1.13	.75-16	1.13	1-14	1.13	No Threads	.50	.88	
	1.38 Oversize	1-14	1.63	1.25-12	1.63	1-14	1.63	1.38-12	1.63	No Threads	.63	.38	
6	1.38 Standard	1-14	1.63	1.25-12	1.63	1-14	1.63	1.38-12	1.63	No Threads	.63	1	
	1.75 Oversize	1.25-12	2	1.50-12	2	1.25-12	2	1.75-12	2	No Threads	.75	.50	

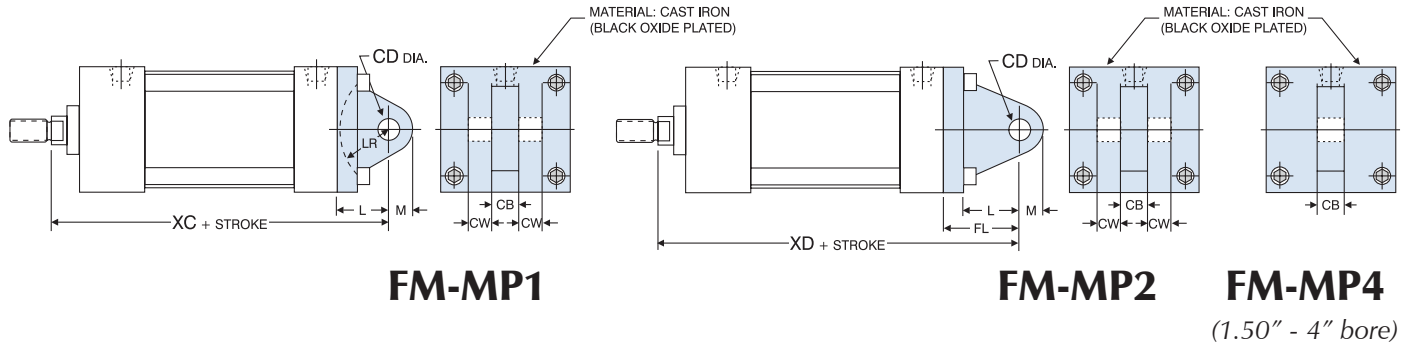
BASIC DIMENSIONS: 'MXO' (NO MOUNT)



'FM' SERIES BASIC DIMENSIONS 'MXO'																
BORE	A	B	C	DD	E	EE	G	J	KK	LB	MM	P	R	V	Y	ZB
1.50	.75	1.13	.38	.25-28	2	.25	1.50	1	.44-20	3.63	.63	2.38	1.43	.63	1.88	4.63
2	.75	1.13	.38	.31-24	2.50	.25	1.50	1	.44-20	3.63	.63	2.38	1.84	.63	1.88	4.63
2.50	.75	1.13	.38	.31-24	3	.25	1.50	1	.44-20	3.75	.63	2.50	2.19	.63	1.88	4.75
3.25	1.13	1.50	.50	.38-24	3.75	.38	1.75	1.25	.75-16	4.25	1	2.75	2.76	.88	2.38	5.63
4	1.13	1.50	.50	.38-24	4.50	.38	1.75	1.25	.75-16	4.25	1	2.75	3.32	.88	2.38	5.63
5	1.13	1.50	.50	.50-20	5.50	.38	1.75	1.25	.75-16	4.50	1	3	4.10	.88	2.38	5.88
6	1.63	2	.63	.50-20	6.50	.50	2	1.50	1-14	5	1.38	3.25	4.88	1	2.75	6.63

For oversize rod dimensions, see page 25.

SERIES 'FM' DIMENSIONS: PIVOT MOUNTS FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



FM-MP1

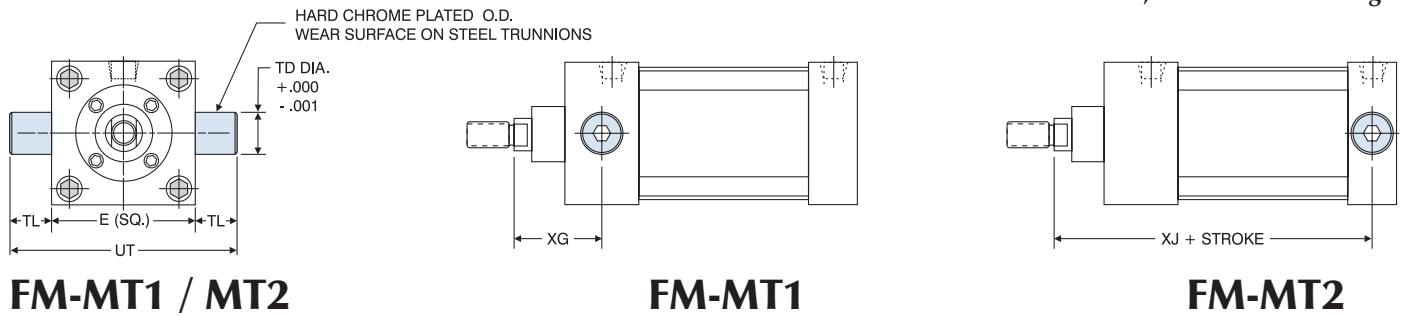
FM-MP2

FM-MP4
(1.50" - 4" bore)

'FM' SERIES 'MP1' & 'MP2' CLEVIS AND 'MP4' ROD EYE MOUNT DIMENSIONS										
BORE	ROD DIAMETER	CB	CD	CW	FL	L	LR	M	ADD STROKE	
									XC	XD
1.50	.63 Standard	.75	.50	.50	1.13	.75	.75	.63	5.38	5.75
	1 Oversize								5.75	6.13
2	.63 Standard	.75	.50	.50	1.13	.75	.75	.63	5.38	5.75
	1 Oversize								5.75	6.13
2.50	.63 Standard	.75	.50	.50	1.13	.75	.75	.63	5.50	5.88
	1 Oversize								5.88	6.25
3.25	1 Standard	1.25	.75	.63	1.88	1.25	1.25	.88	6.88	7.50
	1.38 Oversize								7.13	7.75
4	1 Standard	1.25	.75	.63	1.88	1.25	1.25	.88	6.88	7.50
	1.38 Oversize								7.13	7.75
5	1 Standard	1.25	.75	.63	1.88	1.25	1.25	.88	7.13	7.75
	1.38 Oversize								7.38	8
6	1.38 Standard	1.50	1	.75	2.25	1.50	1.50	1	8.13	8.88
	1.75 Oversize								8.38	9.13

For dimensions not shown, see page 21.

Note: MT1 and MT2 Trunnions are bolt on, non-removable design.



FM-MT1 / MT2

FM-MT1

FM-MT2

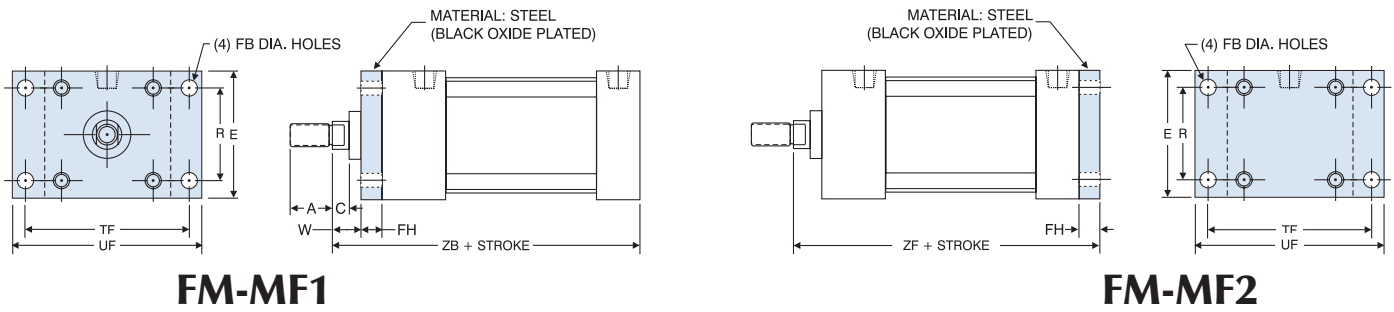
Note: MT1 standard cushion locations at 3 and 6
MT2 standard cushion locations at 2 and 7

'FM' SERIES 'MT1' HEAD TRUNNION AND 'MT2' CAP TRUNNION MOUNT DIMENSIONS							
BORE	ROD DIAMETER	E	TD	TL	UT	XG	ADD STROKE
							XJ
1.50	.63 Standard	2	1	1	4	1.75	4.13
	1 Oversize						N/A*
2	.63 Standard	2.50	1	1	4.50	1.75	4.13
	1 Oversize						2.13
2.50	.63 Standard	3	1	1	5	1.75	4.25
	1 Oversize						2.13
3.25	1 Standard	3.75	1	1	5.75	2.25	5
	1.38 Oversize						2.50
4	1 Standard	4.50	1	1	6.50	2.25	5
	1.38 Oversize						2.50
5	1 Standard	5.50	1	1	7.50	2.25	5.25
	1.38 Oversize						2.50
6	1.38 Standard	6.50	1.38	1.38	9.25	2.63	5.88
	1.75 Oversize						2.88

*No oversize rod available on 1.50" bore MT1.
For dimensions not shown, see page 21.

SERIES 'FM' DIMENSIONS: FLANGE MOUNTS

FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



FM-MF1

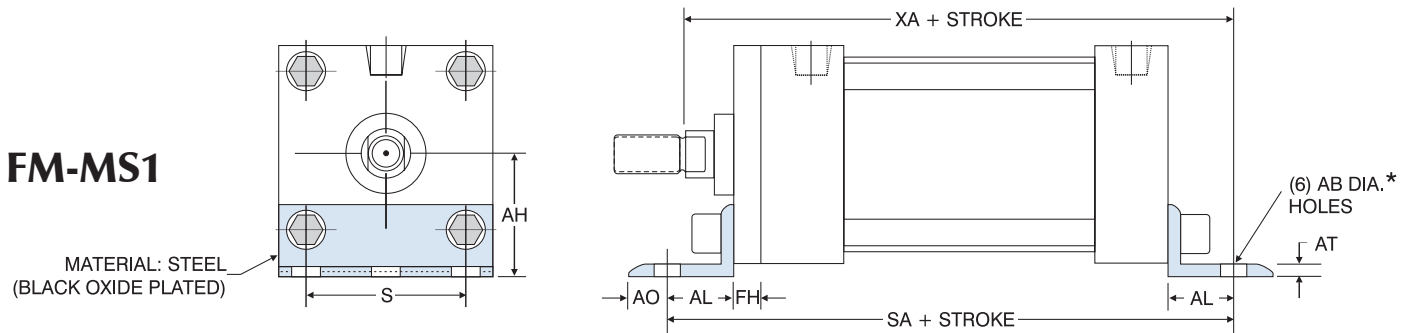
FM-MF2

'FM' SERIES 'MF1' AND 'MF2' FLANGE MOUNT DIMENSIONS												
BORE	ROD DIAMETER	A	C	E	FB	FH	R	TF	UF	W	ZB	ZF
1.50	.63 Standard	.75	.38	2	.31	.38	1.43	2.75	3.38	.63	4.63	5
	1 Oversize	1.13	.50							1	5	5.38
2	.63 Standard	.75	.38	2.50	.38	.38	1.84	3.38	4.13	.63	4.63	5
	1 Oversize	1.13	.50							1	5	5.38
2.50	.63 Standard	.75	.38	3	.38	.38	2.19	3.88	4.63	.63	4.75	5.13
	1 Oversize	1.13	.50							1	5.13	5.50
3.25	1 Standard	1.13	.50	3.75	.44	.63	2.76	4.69	5.50	.75	5.63	6.25
	1.38 Oversize	1.63	.63							1	5.88	6.50
4	1 Standard	1.13	.50	4.50	.44	.63	3.32	5.44	6.25	.75	5.63	6.25
	1.38 Oversize	1.63	.63							1	5.88	6.50
5	1 Standard	1.13	.50	5.50	.56	.63	4.10	6.63	7.63	.75	5.88	6.50
	1.38 Oversize	1.63	.63							1	6.13	6.75
6	1.38 Standard	1.63	.63	6.50	.56	.75	4.88	7.63	8.63	.88	6.63	7.38
	1.75 Oversize	2	.75							1.13	6.88	7.63

For dimensions not shown, see page 21.

SERIES 'FM' DIMENSIONS: BASE MOUNTS

FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



FM-MS1

'FM' SERIES 'MS1' ANGLE MOUNT DIMENSIONS										
BORE	ROD DIAMETER	AB	AH	AL	AO	AT	FH	S	ADD STROKE	
									SA	XA
1.50	.63 Standard	.44	1.19	1	.38	.13	.38	1.25	6	5.63
	1 Oversize									6
2	.63 Standard	.44	1.44	1	.38	.13	.38	1.75	6	5.63
	1 Oversize									6
2.50	.63 Standard	.44	1.63	1	.38	.13	.38	2.25	6.13	5.75
	1 Oversize									6.13
3.25	1 Standard	.56	1.94	1.25	.50	.13	.63	2.75	7.38	6.88
	1.38 Oversize									7.13
4	1 Standard	.56	2.25	1.25	.50	.13	.63	3.50	7.38	6.88
	1.38 Oversize									7.13
5	1 Standard	.69	2.75	1.38	.63	.19	.63	4.25	7.88	7.25
	1.38 Oversize									7.50
6	1.38 Standard	.81	3.25	1.38	.63	.19	.75	5.25	8.50	8
	1.75 Oversize									8.25

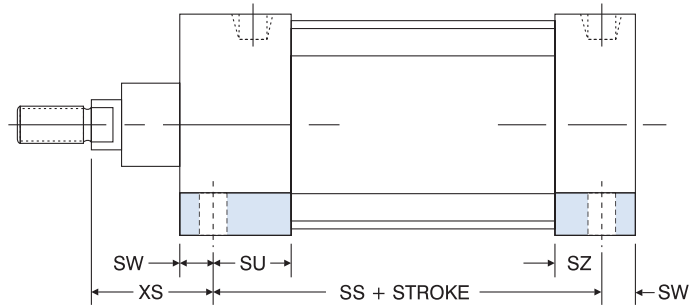
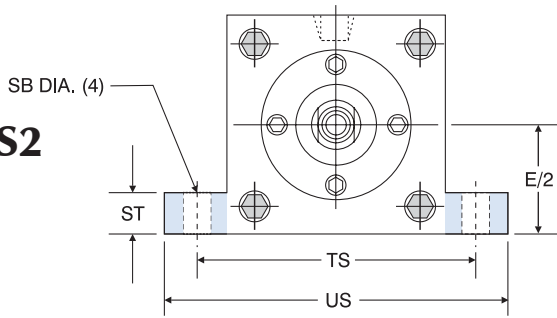
*Note: 1.50" bore has (4) "AB" holes on "S" dimension.
For dimensions not shown, see page 21.

NEW

SERIES 'FM' DIMENSIONS: BASE MOUNTS FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

NEW

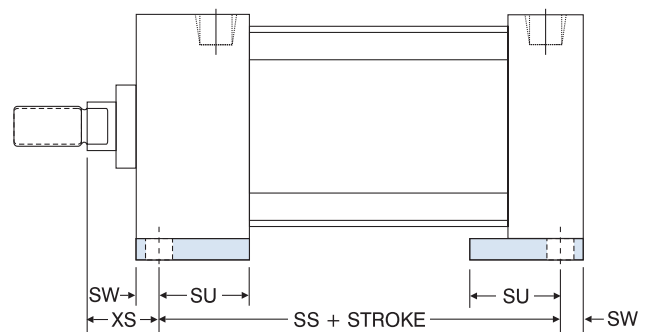
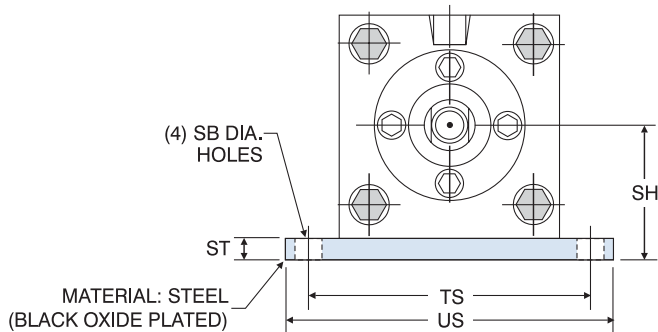
FM-MS2



'FM' SERIES 'MS2' SIDE LUG MOUNT DIMENSIONS											
BORE	ROD DIAMETER	SB	E/2	ST	SU	SW	SZ	TS	US	XS	ADD STROKE
											SS
1.50	.63 Standard	.44	1	.50	1.13	.38	.63	2.75	3.50	1.38	2.88
	1 Oversize										
2	.63 Standard	.44	1.25	.50	1.13	.38	.63	3.25	4	1.38	2.88
	1 Oversize										
2.50	.63 Standard	.44	1.50	.50	1.13	.38	.63	3.75	4.50	1.38	3
	1 Oversize										
3.25	1 Standard	.56	1.88	.75	1.25	.50	.75	4.75	5.75	1.88	3.25
	1.38 Oversize										
4	1 Standard	.56	2.25	.75	1.25	.50	.75	5.50	6.50	1.88	3.25
	1.38 Oversize										
5	1 Standard	.81	2.75	1	1.06	.69	.56	6.88	8.25	2.06	3.13
	1.38 Oversize										
6	1.38 Standard	.81	3.25	1	1.31	.69	.81	7.88	9.25	2.31	3.63
	1.75 Oversize										

For dimensions not shown, see page 21.

FM-BASE BAR (Non-NFPA)



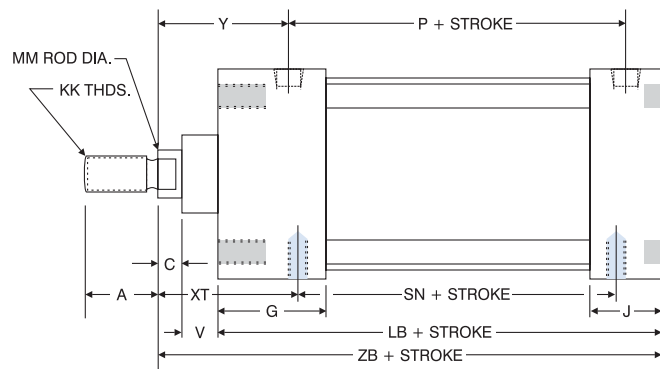
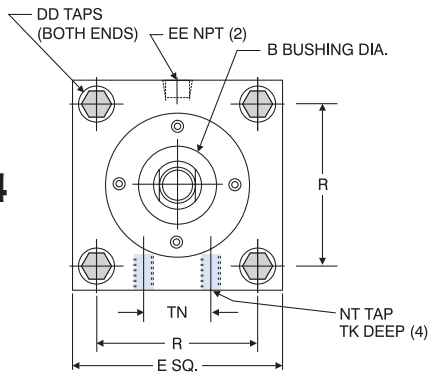
'FM' SERIES BASE BAR MOUNT (Non-NFPA) DIMENSIONS											
BORE	ROD DIAMETER	SB	SH	ST	SU	SW	TS	US	XS	ADD STROKE	
										SS	
1.50	.63 Standard	.44	1.25	.25	1.13	.38	2.75	3.50	1.38	2.88	
	1 Oversize										1.75
2	.63 Standard	.44	1.50	.25	1.13	.38	3.25	4	1.38	2.88	
	1 Oversize										1.75
2.50	.63 Standard	.44	1.88	.38	1.13	.38	3.75	4.50	1.38	3	
	1 Oversize										1.75
3.25	1 Standard	.56	2.38	.50	1.25	.50	4.75	5.75	1.88	3.25	
	1.38 Oversize										2.13
4	1 Standard	.56	2.75	.50	1.25	.50	5.50	6.50	1.88	3.25	
	1.38 Oversize										2.13

For dimensions not shown, see page 21.

SERIES 'FM' DIMENSIONS: BASE MOUNTS

FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

FM-MS4

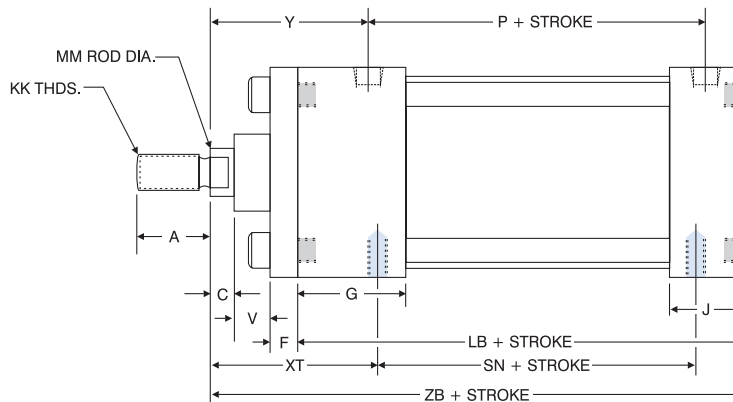
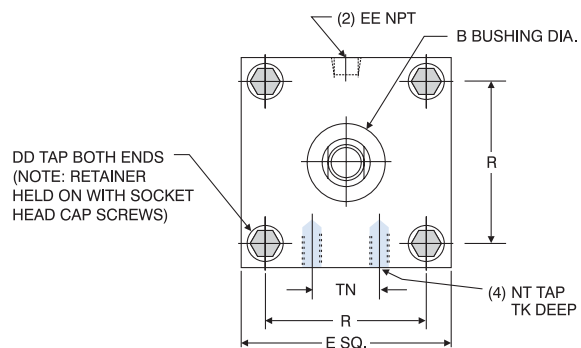


'FM' SERIES 'MS4' FLUSH MOUNT DIMENSIONS

BORE	A	B	C	DD	E	EE	G	J	KK	LB	MM	P	R	V	Y	ZB	NT	TK	TN	SN	XT
1.50	.75	1.13	.38	.25-28	2	.25	1.50	1	.44-20	3.63	.63	2.38	1.43	.63	1.88	4.63	.25-20	.38	.63	2.25	1.94
2	.75	1.13	.38	.31-24	2.50	.25	1.50	1	.44-20	3.63	.63	2.38	1.84	.63	1.88	4.63	.31-18	.50	.88	2.25	1.94
2.50	.75	1.13	.38	.31-24	3	.25	1.50	1	.44-20	3.75	.63	2.50	2.19	.63	1.88	4.75	.38-16	.63	1.25	2.38	1.94
3.25	1.13	1.50	.50	.38-24	3.75	.38	1.75	1.25	.75-16	4.25	1	2.75	2.76	.88	2.38	5.63	.50-13	.75	1.50	2.63	2.44
4	1.13	1.50	.50	.38-24	4.50	.38	1.75	1.25	.75-16	4.25	1	2.75	3.32	.88	2.38	5.63	.50-13	.75	2.06	2.63	2.44
5	1.13	1.50	.50	.50-20	5.50	.38	1.75	1.25	.75-16	4.50	1	3	4.10	.88	2.38	5.88	.63-11	1	2.69	2.88	2.44
6	1.63	2	.63	.50-20	6.50	.50	2	1.50	1-14	5	1.38	3.25	4.88	1	2.75	6.63	.75-10	1.13	3.25	3.13	2.81

For dimensions not shown, see page 21.

FM-MS4: Oversize Rod Diameter

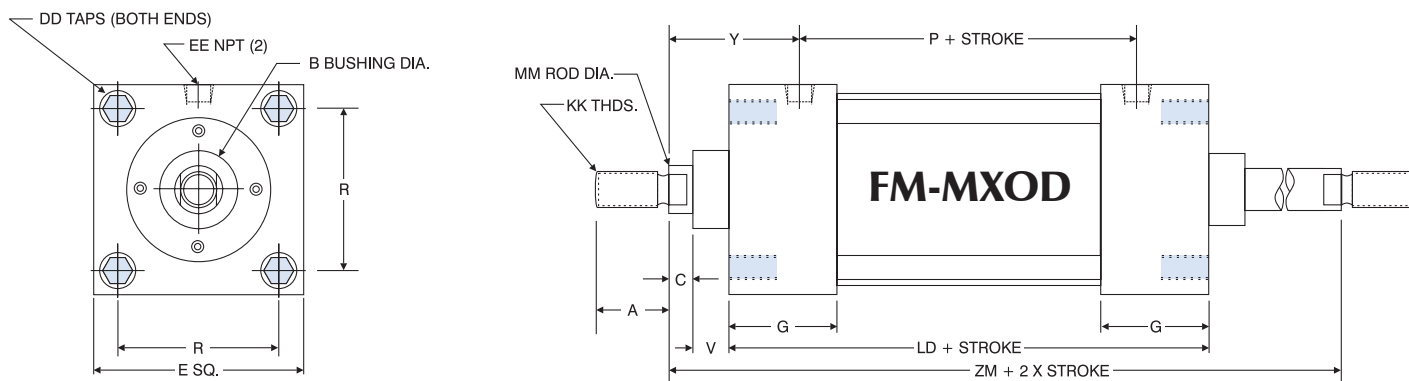


'FM' SERIES OVERSIZE ROD 'MS4' FLUSH MOUNT DIMENSIONS

BORE	A	B	C	DD	E	EE	F	G	J	KK	LB	MM	P	R	V	Y	NT	TK	TN	SN	XT	ZB
1.50	1.13	1.50	.50	.25-28	2	.25	.38	1.50	1	.75-16	3.63	1	2.38	1.43	.50	2.25	.25-20	.38	.63	2.25	2.31	5
2	1.13	1.50	.50	.31-24	2.50	.25	.38	1.50	1	.75-16	3.63	1	2.38	1.84	.50	2.25	.31-18	.50	.88	2.25	2.31	5
2.50	1.13	1.50	.50	.31-24	3	.25	.38	1.50	1	.75-16	3.75	1	2.50	2.19	.50	2.25	.38-16	.63	1.25	2.38	2.31	5.13
3.25	1.63	2	.63	.38-24	3.75	.38	.63	1.75	1.25	1-14	4.25	1.38	2.75	2.76	.38	2.63	.50-13	.75	1.50	2.63	2.69	5.88
4	1.63	2	.63	.38-24	4.50	.38	.63	1.75	1.25	1-14	4.25	1.38	2.75	3.32	.38	2.63	.50-13	.75	2.06	2.63	2.69	5.88
5	1.63	2	.63	.50-20	5.50	.38	.63	1.75	1.25	1-14	4.50	1.38	3	4.10	.38	2.63	.63-11	1	2.69	2.88	2.69	6.13
6	2	2.38	.75	.50-20	6.50	.50	.75	2	1.50	1.25-12	5	1.75	3.25	4.88	.50	3	.75-10	1.13	3.25	3.13	3.06	6.88

SERIES 'FM' DIMENSIONS: DOUBLE ROD END (NO MOUNT) FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

BASIC DIMENSIONS: DOUBLE ROD END 'MXOD' (NO MOUNT)



'FM' SERIES DOUBLE ROD END BASIC DIMENSIONS 'MXOD'

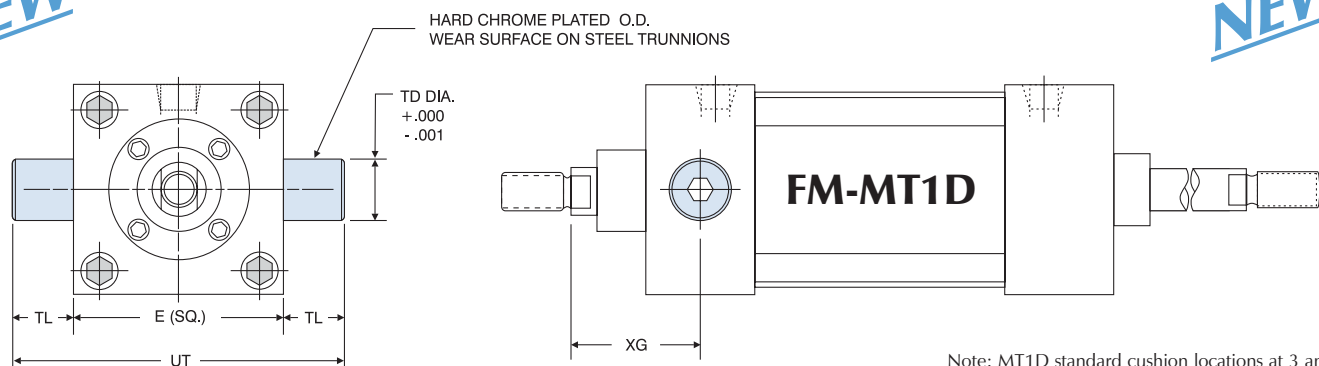
BORE	A	B	C	DD	E	EE	G	KK	LD	MM	P	R	V	Y	ZM
1.50	.75	1.13	.38	.25-28	2	.25	1.50	.44-20	4.13	.63	2.38	1.43	.63	1.88	6.13
2	.75	1.13	.38	.31-24	2.50	.25	1.50	.44-20	4.13	.63	2.38	1.84	.63	1.88	6.13
2.50	.75	1.13	.38	.31-24	3	.25	1.50	.44-20	4.25	.63	2.50	2.19	.63	1.88	6.25
3.25	1.13	1.50	.50	.38-24	3.75	.38	1.75	.75-16	4.75	1	2.75	2.76	.88	2.38	7.50
4	1.13	1.50	.50	.38-24	4.50	.38	1.75	.75-16	4.75	1	2.75	3.32	.88	2.38	7.50
5	1.13	1.50	.50	.50-20	5.50	.38	1.75	.75-16	5	1	3	4.10	.88	2.38	7.75
6	1.63	2	.63	.50-20	6.50	.50	2	1-14	5.50	1.38	3.25	4.88	1	2.75	8.75

For oversize rod dimensions, refer to page 29.

SERIES 'FM' DIMENSIONS: DOUBLE ROD END PIVOT MOUNT

NEW

NEW



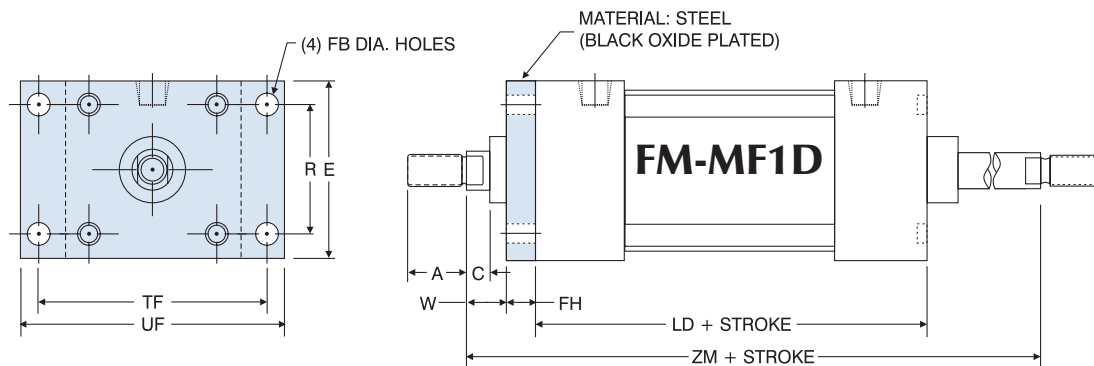
Note: MT1D standard cushion locations at 3 and 6

'FM' SERIES DOUBLE ROD END 'MT1D' HEAD TRUNNION MOUNT DIMENSIONS

BORE	ROD DIAMETER	E	TD	TL	UT	XG
1.50	.63 Standard	2	1	1	4	1.75
	1 Oversize					N/A*
2	.63 Standard	2.50	1	1	4.50	1.75
	1 Oversize					2.13
2.50	.63 Standard	3	1	1	5	1.75
	1 Oversize					2.13
3.25	1 Standard	3.75	1	1	5.75	2.25
	1.38 Oversize					2.50
4	1 Standard	4.50	1	1	6.50	2.25
	1.38 Oversize					2.50
5	1 Standard	5.50	1	1	7.50	2.25
	1.38 Oversize					2.50
6	1.38 Standard	6.50	1.38	1.38	9.25	2.63
	1.75 Oversize					2.88

*No oversize rod available on 1.50" bore MT1D.
For dimensions not shown, see chart above.

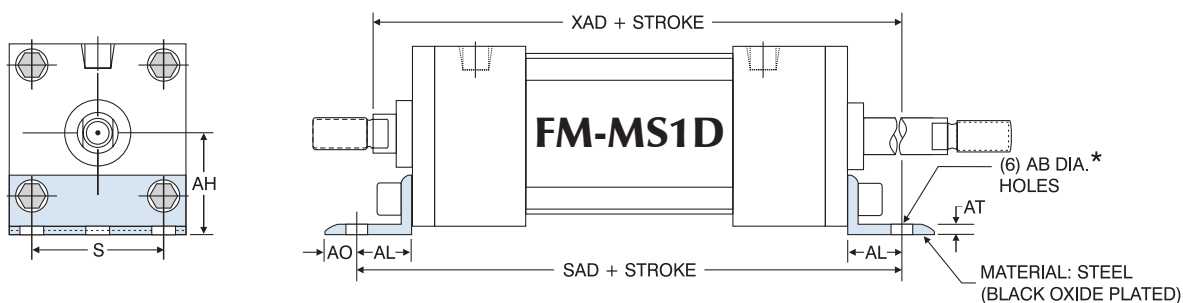
SERIES 'FM' DIMENSIONS: DOUBLE ROD END FLANGE MOUNT FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



'FM' SERIES DOUBLE ROD END 'MF1D' FLANGE MOUNT DIMENSIONS												
BORE	ROD DIAMETER	A	C	E	FB	FH	R	TF	UF	W	ADD STROKE	
											LD	ZM
1.50	.63 Standard	.75	.38	2	.31	.38	1.43	2.75	3.38	.63	4.13	6.13
	1 Oversize	1.13	.50									6.88
2	.63 Standard	.75	.38	2.50	.38	.38	1.84	3.38	4.13	.63	4.13	6.13
	1 Oversize	1.13	.50									6.88
2.50	.63 Standard	.75	.38	3	.38	.38	2.19	3.88	4.63	.63	4.25	6.25
	1 Oversize	1.13	.50									7
3.25	1 Standard	1.13	.50	3.75	.44	.63	2.76	4.69	5.50	.75	4.75	7.50
	1.38 Oversize	1.63	.63									8
4	1 Standard	1.13	.50	4.50	.44	.63	3.32	5.44	6.25	.75	4.75	7.50
	1.38 Oversize	1.63	.63									8
5	1 Standard	1.13	.50	5.50	.56	.63	4.10	6.63	7.63	.75	5	7.75
	1.38 Oversize	1.63	.63									8.25
6	1.38 Standard	1.63	.63	6.50	.56	.75	4.88	7.63	8.63	.88	5.50	8.75
	1.75 Oversize	2	.75									9.25

For dimensions not shown, see page 26.

SERIES 'FM' DIMENSIONS: DOUBLE ROD END BASE MOUNTS FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)



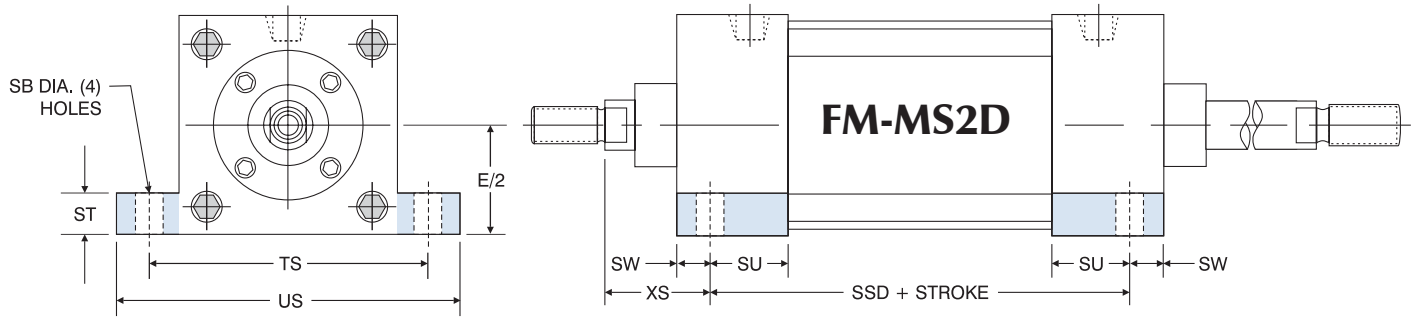
'FM' SERIES DOUBLE ROD END 'MS1D' ANGLE MOUNT DIMENSIONS										
BORE	ROD DIAMETER	AB	AH	AL	AO	AT	S	ADD STROKE		
								SAD	XAD	
1.50	.63 Standard	.44	1.19	1	.38	.13	1.25	6.88	6.50	
	1 Oversize								6.88	
2	.63 Standard	.44	1.44	1	.38	.13	1.75	6.88	6.50	
	1 Oversize								6.88	
2.50	.63 Standard	.44	1.63	1	.38	.13	2.25	7	6.63	
	1 Oversize								7	
3.25	1 Standard	.56	1.94	1.25	.50	.13	2.75	8.50	8	
	1.38 Oversize								8.25	
4	1 Standard	.56	2.25	1.25	.50	.13	3.50	8.50	8	
	1.38 Oversize								8.25	
5	1 Standard	.69	2.75	1.38	.63	.19	4.25	9	8.38	
	1.38 Oversize								8.63	
6	1.38 Standard	.81	3.25	1.38	.63	.19	5.25	9.75	9.25	
	1.75 Oversize								9.50	

*Note: 1.50" bore has (4) "AB" holes on "S" dimension.
For dimensions not shown, see page 26.

SERIES 'FM' DIMENSIONS: DOUBLE ROD END BASE MOUNTS FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

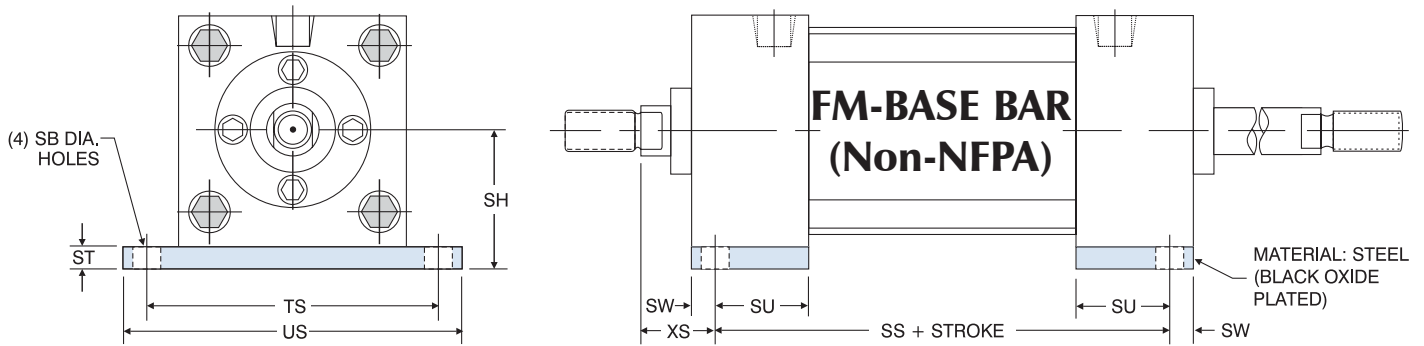
NEW

NEW



'FM' SERIES DOUBLE ROD END 'MS2D' SIDE LUG MOUNT DIMENSIONS										
BORE	ROD DIAMETER	SB	E/2	ST	SU	SW	TS	US	XS	ADD STROKE
										SSD
1.50	.63 Standard	.44	1	.50	1.13	.38	2.75	3.50	1.38	3.38
	1 Oversize									
2	.63 Standard	.44	1.25	.50	1.13	.38	3.25	4	1.38	3.38
	1 Oversize									
2.50	.63 Standard	.44	1.50	.50	1.13	.38	3.75	4.50	1.38	3.50
	1 Oversize									
3.25	1 Standard	.56	1.88	.75	1.25	.50	4.75	5.75	1.88	3.75
	1.38 Oversize								2.13	
4	1 Standard	.56	2.25	.75	1.25	.50	5.50	6.50	1.88	3.75
	1.38 Oversize								2.13	
5	1 Standard	.81	2.75	1	1.06	.69	6.88	8.25	2.06	3.63
	1.38 Oversize								2.31	
6	1.38 Standard	.81	3.25	1	1.31	.69	7.88	9.25	2.31	4.13
	1.75 Oversize								2.56	

For dimensions not shown, see page 26.

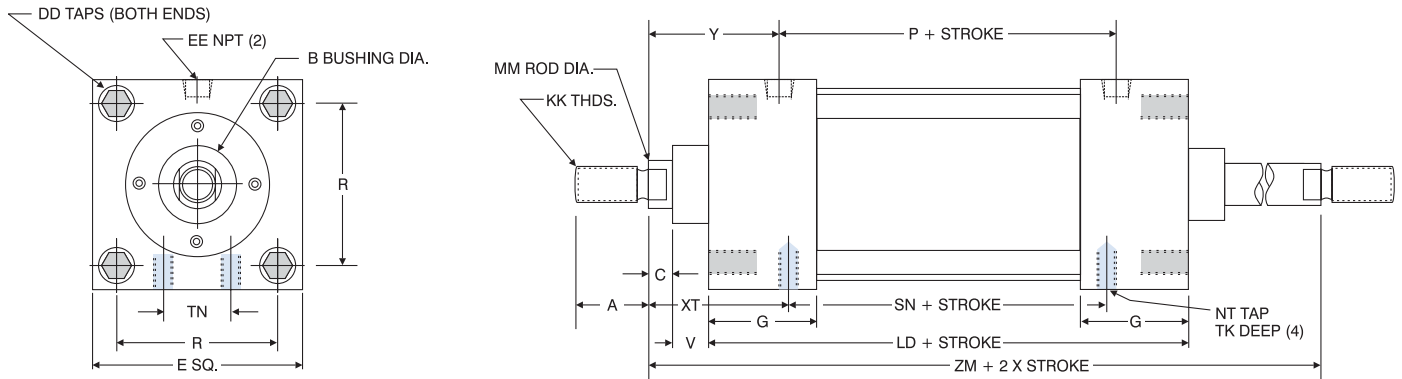


'FM' SERIES DOUBLE ROD END BASE BAR MOUNT (Non-NFPA) DIMENSIONS										
BORE	ROD DIAMETER	SB	SH	ADD STROKE	ST	SU	SW	TS	US	XS
				SS						
1.50	.63 Standard	.44	1.25	3.38	.25	1.13	.38	2.75	3.50	1.38
	1 Oversize									
2	.63 Standard	.44	1.50	3.38	.25	1.13	.38	3.25	4	1.38
	1 Oversize									
2.50	.63 Standard	.44	1.88	3.50	.38	1.13	.38	3.75	4.50	1.38
	1 Oversize									
3.25	1 Standard	.56	2.38	3.75	.50	1.25	.50	4.75	5.75	1.88
	1.38 Oversize									2.13
4	1 Standard	.56	2.75	3.75	.50	1.25	.50	5.50	6.50	1.88
	1.38 Oversize									2.13

For dimensions not shown, see page 26.

SERIES 'FM' DIMENSIONS: DOUBLE ROD END BASE MOUNT FLUSH MOUNT (WITH SLEEVE NUT CONSTRUCTION)

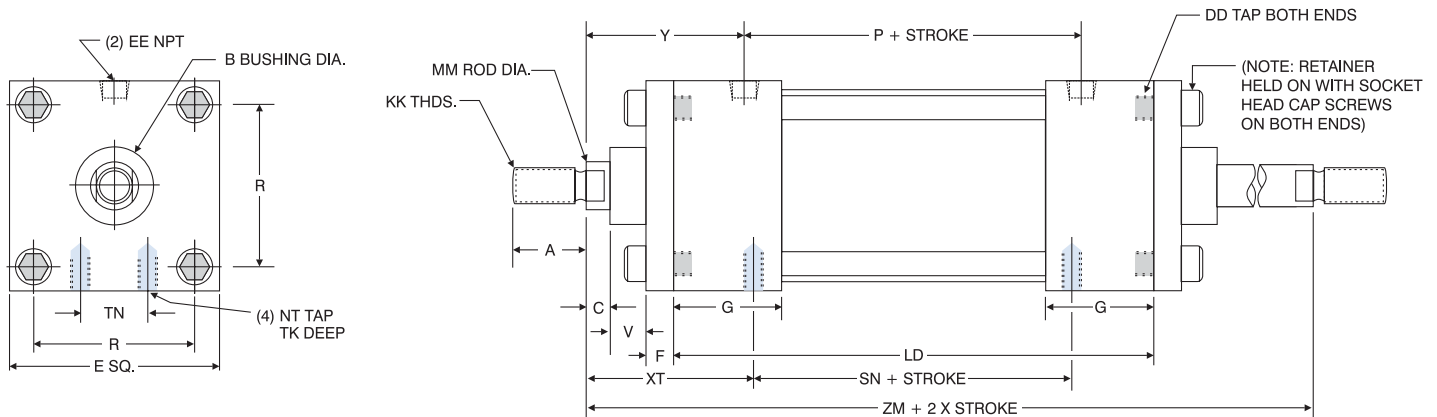
FM-MS4D: Standard Rod Diameter



'FM' SERIES DOUBLE ROD END 'MS4D' FLUSH MOUNT DIMENSIONS

BORE	A	B	C	DD	E	EE	G	KK	LD	MM	P	R	V	Y	NT	TK	TN	SN	XT	ZM
1.50	.75	1.13	.38	.25-28	2	.25	1.50	.44-20	4.13	.63	2.38	1.43	.63	1.88	.25-20	.38	.63	2.25	1.94	6.13
2	.75	1.13	.38	.31-24	2.50	.25	1.50	.44-20	4.13	.63	2.38	1.84	.63	1.88	.31-18	.50	.88	2.25	1.94	6.13
2.50	.75	1.13	.38	.31-24	3	.25	1.50	.44-20	4.25	.63	2.50	2.19	.63	1.88	.38-16	.63	1.25	2.38	1.94	6.25
3.25	1.13	1.50	.50	.38-24	3.75	.38	1.75	.75-16	4.75	1	2.75	2.76	.88	2.38	.50-13	.75	1.50	2.63	2.44	7.50
4	1.13	1.50	.50	.38-24	4.50	.38	1.75	.75-16	4.75	1	2.75	3.32	.88	2.38	.50-13	.75	2.06	2.63	2.44	7.50
5	1.13	1.50	.50	.50-20	5.50	.38	1.75	.75-16	5	1	3	4.10	.88	2.38	.63-11	1	2.69	2.88	2.44	7.75
6	1.63	2	.63	.50-20	6.50	.50	2	1-14	5.50	1.38	3.25	4.88	1	2.75	.75-10	1.13	3.25	3.13	2.81	8.75

FM-MS4D: Oversize Rod Diameter



'FM' SERIES DOUBLE ROD END OVERSIZE ROD 'MS4D' FLUSH MOUNT DIMENSIONS

BORE	A	B	C	DD	E	EE	F	G	KK	LD	MM	P	R	V	Y	NT	TK	TN	SN	XT	ZM
1.50	1.13	1.50	.50	.25-28	2	.25	.38	1.50	.75-16	4.13	1	2.38	1.43	.50	2.25	.25-20	.38	.63	2.25	2.31	6.88
2	1.13	1.50	.50	.31-24	2.50	.25	.38	1.50	.75-16	4.13	1	2.38	1.84	.50	2.25	.31-18	.50	.88	2.25	2.31	6.88
2.50	1.13	1.50	.50	.31-24	3	.25	.38	1.50	.75-16	4.25	1	2.50	2.19	.50	2.25	.38-16	.63	1.25	2.38	2.31	7
3.25	1.63	2	.63	.38-24	3.75	.38	.63	1.75	1-14	4.75	1.38	2.75	2.76	.38	2.63	.50-13	.75	1.50	2.63	2.69	8
4	1.63	2	.63	.38-24	4.50	.38	.63	1.75	1-14	4.75	1.38	2.75	3.32	.38	2.63	.50-13	.75	2.06	2.63	2.69	8
5	1.63	2	.63	.50-20	5.50	.38	.63	1.75	1-14	5	1.38	3	4.10	.38	2.63	.63-11	1	2.69	2.88	2.69	8.25
6	2	2.38	.75	.50-20	6.50	.50	.75	2	1.25-12	5.50	1.75	3.25	4.88	.50	3.13	.75-10	1.13	3.25	3.13	3.06	9.25

SERIES 'FM' FLUSH MOUNT: MOUNTING KITS

Most 'FM' cylinders are shipped ready to accept any 'FM' Series mounting kits. 'FM' cylinders can be used in different applications simply by changing the mount. In addition, the 'FM' Flush Mount feature can be used for mounting—just use the (4) tapped holes in head or cap to mount cylinder. The 'FM' Series is one of the most versatile cylinders on the market. Choose from (6) mounting kits. Each kit comes complete with fasteners.



SERIES 'FM' MOUNTING KITS

BORE	MP1	MP2	MP4	MF1	MF2	MS1	Base Bar	
	Part Number	Part Number	Part Number	Part Number	Part Number	Part Number	Part Number	SH Dimension
1.50	A85-15D	A81-15D	A83-15D	FM61-15	FM62-15	A75-15 (H) A77-15 (C)	BB-15-HC	1.25
2	A85-20D	A81-20D	A83-20D	FM61-20	FM62-20	A75-20 (H) A77-20 (C)	BB-20-HC	1.50
2.50	A85-25D	A81-25D	A83-25D	FM61-25	FM62-25	A77-25	BB-25-HC	1.88
3.25	A85-32D	A81-32D	A83-32D	FM61-32	FM62-32	A75-32	BB-32-HC	2.38
4	A85-40D	A81-40D	A83-40D	FM61-40	FM62-40	A77-40	BB-40-HC	2.75
5	A85-50D	A81-50D	N/A	FM61-50	FM62-50	A77-50	N/A	—
6	A85-60D	A81-60D	N/A	FM61-60	FM62-60	A77-60	N/A	—

*Base Bar "SH" dimension is not NFPA. Refer to pages 24 and 28.
All other dimensions are NFPA.

TECHNICAL DATA

How to determine the right size Cylinder for the job

To determine what size cylinder the task requires, you need to answer a few questions about three main points: load, velocity and air pressure.

How heavy (in pounds) is the load to be moved? The answer to this is usually given, set by the machine design. However, unless you are lifting a load vertically-with no external friction, it can be difficult to determine the true load. If the load cannot be calculated, try to physically measure the load. The closer the true load is known, the better the results. In order to move the load, you need to choose a cylinder that provides force greater than the load. So, if the load is 100 lbs., it will take of force greater than 100 lbs. to move it. In fact, it's a good idea to allow an additional factor of 25% force to allow for friction.

What's the required velocity? Although velocity may also be set by machine design, often you have some latitude within a range. Whenever possible, for best results, we recommend using moderate speed because the greater the velocity required, the greater the *additional* force needed to achieve it. Slow speeds (up to 4 in/sec) require 25% more force than the load, moderate speeds (4 to 16 in/sec) about 50% more, and high speeds (greater than 16 in/sec) about 100% more force. So, for that 100 lb. load, you need 125 lbs. of force to move it slowly, 150 lbs. of force to move it at moderate speeds, and 200 lbs. of force to move it quickly. *Don't forget to add 25 lbs. (25% of 100 lbs.) for friction!*

What's the minimum effective air pressure you can use - and is your pressure source constant?

This is important because high pressures can accelerate seal wear and create stress on the cylinder, and inconsistent pressures can cause system malfunctions or failures. So, to maximize cylinder life and performance, you need to provide consistent airflow at the minimum effective pressure to maintain the desired velocity. The idea then, is for the cylinder to be able to move the maximum load, at the minimum acceptable velocity, and at the minimum available pressure.

About bore sizes

Once you've determined the force you need to move the load at the desired velocity and allow for friction, here's how to find the cylinder bore that meets your specifications.

The force generated by a cylinder is determined by the effective piston area times the air pressure. The force chart on page 119 lists the effective piston area for each bore size, the "Push" (extend) and "Pull" (retract) stroke, at various air pressures. If you assume a maximum load of 100 lbs., a minimum velocity of 4 in/sec, and a minimum pressure of 60 psi, here's how to select the right cylinder bore. Since the velocity is slow, the force should be 25% greater than the load, or 125 lbs. After adding 25 lbs. for friction (25% of 100 lbs.), the total force needed is 150 lbs. The chart on page 119 shows that at 60 psi, the 2" bore with .63" rod extend force is 188 lbs., and retract force is 170 lbs. - the right cylinder for the application.

Horizontal Applications

Cylinder force is reduced by the coefficient of friction between the bearing surface and guide shafts. Bearing materials, and bearing types (plain or ball) all perform differently. With hardened steel shafts, the following information lists how much cylinder force is required to move a 100 lb. load, on various bearing materials. *(For reference purposes only)*

Plain Bearing Material	Cylinder Force	
	Dry Bearing	Oiled Bearing
PTFE	10 lbs.	10 lbs.
UHMW	20 lbs.	20 lbs.
Hardened Steel	25 lbs.	20 lbs.
Brass	40 lbs.	25 lbs.
Cast Iron	45 lbs.	25 lbs.
Steel (soft)	85 lbs.	25 lbs.
Ball Bearing	5-10 lb. Cylinder Force	

General Mechanics

TOGGLE

Toggles are complex mechanisms that can achieve very high force.

FORCE MULTIPLYING LEVER

Force Multiplying Levers reduce the cylinder output stroke, while increasing the output force.

4:1 Force Multiplier (400%)

FORCE REDUCING LEVER

Force Reducing Levers increase the cylinder output stroke, but reduce the output force.

1:4 Force Reduction (25%)

EXAMPLE

A 2000 lb. steel plate needs to be raised from horizontal, 90° vertical. The highest force required will be at the horizontal position. As the plate nears the vertical position, less force will be required.

The example assumes that the weight (load) is evenly distributed over the plate length. For uneven loads, estimate the center of gravity of the load.

Additional force must be added for friction (assume 25%).

LOAD CENTER OF GRAVITY = $\frac{48''}{2} = 24''$

LEVER = $\frac{24''}{12''} = 2:1$

FORCE = 2 X 2,000 LBS. = 4,000 LBS.

FORCE (INCLUDING = 4,000 X 1.25 = 5,000 LBS. FRICTION)

AT 100 PSI AIR PRESSURE, THE FORCE CHART (ON PAGE 119) SHOWS THAT AN 8" BORE HAS 5,026 LBS. FORCE.

TECHNICAL DATA: FORCE CHART

BASIC CYLINDER FORCE CHART* (TA, TD, FM)

BORE	ROD DIA.	STROKE TYPE	EFFECTIVE PISTON AREA	POUNDS OF FORCE AT PSI						CU. FT. DISPLACEMENT PER IN. OF STROKE
				60	80	100	200	250	400	
1.50	ALL	PUSH	1.767	106	142	177	353	442	706	.00102
	.63	PULL	1.460	88	117	146	292	365	584	.00084
	1	PULL	.982	59	79	98	196	246	392	.00057
2	ALL	PUSH	3.142	188	251	314	628	785	1256	.00182
	.63	PULL	2.835	170	227	284	567	708	1134	.00164
	1	PULL	2.357	141	189	236	471	589	942	.00136
2.50	ALL	PUSH	4.909	295	393	491	981	1227	1962	.00284
	.63	PULL	4.602	276	368	460	920	1150	1840	.00266
	1	PULL	4.124	247	330	412	825	1031	1650	.00239
3.25	ALL	PUSH	8.296	498	664	830	1659	2074	3318	.00480
	1	PULL	7.511	451	601	751	1502	1877	3004	.00435
	1.38	PULL	6.811	409	545	681	1362	1702	2724	.00394
4	ALL	PUSH	12.566	754	1005	1257	2513	3141	5026	.00727
	1	PULL	11.781	707	942	1178	2356	2945	4712	.00682
	1.38	PULL	11.081	665	886	1108	2216	2770	4432	.00641
5	ALL	PUSH	19.635	1178	1571	1964	3927	4908	7854	.01136
	1	PULL	18.850	1131	1508	1885	3770	4712	7540	.01090
	1.38	PULL	18.150	1089	1452	1815	3630	4537	7260	.01050
6	ALL	PUSH	28.274	1696	2262	2827	5655	7068	11310	.01636
	1.38	PULL	26.789	1607	2144	2679	5358	6697	10716	.01550
	1.75	PULL	25.869	1552	2070	2587	5174	6467	10348	.01497
8	ALL	PUSH	50.265	3016	4021	5026	10053	12566	20106	.02908
	1.38	PULL	48.780	2927	3902	4878	9756	12195	19512	.02832
	1.75	PULL	47.860	2872	3829	4786	9572	11965	19144	.02770
10	ALL	PUSH	78.540	4712	6283	7854	15708	19635	31416	.04545
	1.75	PULL	76.130	4568	6090	7613	15226	19032	30452	.04406
	2	PULL	75.400	4524	6032	7540	15080	18850	30160	.04363
12	ALL	PUSH	113.098	6786	9048	11310	22620	28275	45239	.06545
	2	PULL	109.956	6597	8796	10996	21992	27489	43982	.06363
	2.50	PULL	108.189	6491	8655	10819	21638	27047	43276	.06261

*Theoretical force. Actual force will be reduced by friction.

'NR' NON-ROTATING CYLINDER FORCE CHART*

BORE	ROD DIA.	GUIDE RODS DIA.	STROKE TYPE	EFFECTIVE PISTON AREA	POUNDS OF FORCE AT PSI						CU. FT. DISPLACEMENT PER IN. OF STROKE
					60	80	100	200	250	400	
2	ALL	.25	PUSH	3.044	182	243	304	609	761	1217	.00176
	.63		PULL	2.737	164	218	273	547	684	1094	.00158
2.50	ALL	.31	PUSH	4.755	285	380	475	951	1188	1902	.00275
	.63		PULL	4.448	266	355	444	889	1112	1779	.00257
	1		PULL	3.970	238	317	397	794	992	1588	.00229
3.25	ALL	.38	PUSH	8.076	484	646	807	1613	2016	3226	.00466
	1		PULL	7.291	437	583	729	1458	1822	2916	.00422
	1.38		PULL	6.591	395	527	659	1318	1647	2636	.00381
4	ALL	.63	PUSH	11.952	717	956	1195	2390	2988	4780	.00692
	1		PULL	11.167	670	893	1116	2233	2791	4466	.00646
	1.38		PULL	11.467	628	837	1046	2093	2616	4186	.00606
5	ALL	.63	PUSH	19.021	1141	1521	1902	3804	4755	7608	.01100
	1		PULL	18.236	1094	1458	1823	3647	4559	7294	.01050
	1.38		PULL	17.536	1052	1402	1753	3507	4384	7014	.01010
6	ALL	.63	PUSH	27.660	1659	2212	2766	5532	6915	11064	.01600
	1.38		PULL	26.175	1570	2094	2617	5235	6543	10470	.01510
	1.75		PULL	25.255	1515	2020	2525	5051	6313	10102	.01460
8	ALL	1	PUSH	48.694	2921	3895	4869	9738	12173	19477	.02810
	1.38		PULL	47.209	2832	3776	4720	9441	11802	18883	.02730
	1.75		PULL	46.289	2777	3703	4628	9257	11572	18515	.02670
10	ALL	1	PUSH	76.969	4618	6157	7696	15393	19242	30787	.04450
	1.75		PULL	74.564	4473	5965	7456	14912	18641	29825	.04310
	2		PULL	73.829	4429	5906	7382	14765	18457	29531	.04270
12	ALL	1	PUSH	111.527	6691	8922	11152	22305	27881	44610	.06450
	2		PULL	108.385	6503	8670	10838	21677	27096	43354	.06270
	2.50		PULL	106.618	6397	8529	10661	21323	26654	42647	.06170

Note: Use the pull force/volume numbers for both ends of a double end cylinder.
For TRA triple rod force chart, see page 69.
For MSE multi-stage force chart, see page 79.

*Theoretical force. Actual force will be reduced by friction.