Table of Contents

METAL MECHANICS **HYDRAULIC PRESSES**
350 SOUTH 14TH STREET
SCHOOLCRAFT, MI 49087-0447
PHONE (269) 679-2525 FAX (269) 679-2882

SERIAL # 22002	**TONS** 50
DATE 9 / 98	**VOLTS** 480
STROKE 28"	**AMPS** 33
OPEN HT. 44"	**PHASE** 3
WEIGHT 14,000#	**Hz** 60
MAX PSI 2500	**Ka** 100

ARC FLASH CATEGORY 0 WHEN FED WITH COORDINATED CLASS J FUSING

WEIGHT OF MOVING PLATEN WITHOUT TRIM TOOL

MADE IN THE USA

CAUTION- FOR YOUR OWN SAFETY

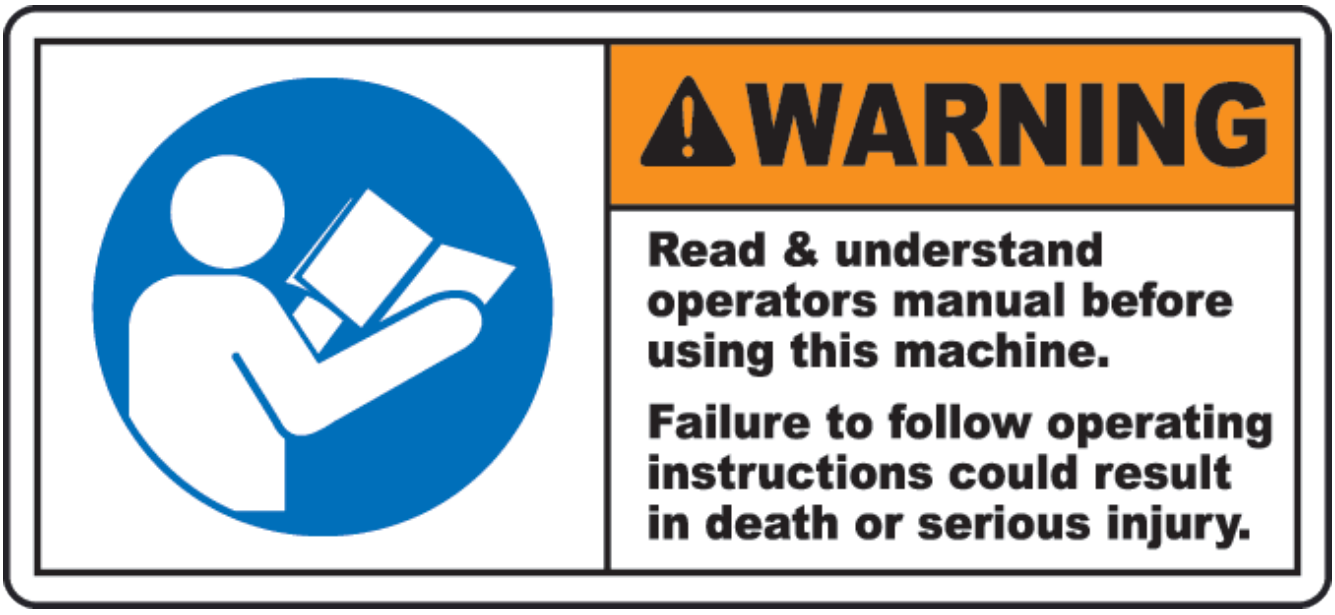
READ YOUR OWNER'S MANUAL THROUGH COMPLETELY AND CAREFULLY BEFORE ATTEMPTING TO SET-UP OR OPERATE THIS MACHINE. ALL OPERATORS OF THIS EQUIPMENT SHOULD READ AND UNDERSTAND ALL SAFETY RULES PRINTED ON THE MACHINE AND IN THIS OWNERS MANUAL BEFORE USE

Read the instructions and warnings in this manual CAREFULLY BEFORE using this machine.

Lea las instrucciones y advertencias en este manual CUIDADOSAMENTE ANTES de usar esta máquina.

WARNING

READ CAREFULLY THE PRODUCT INSTALLATION & OPERATIONS INSTRUCTIONS. FAILURE TO FOLLOW THE INSTRUCTIONS AND WARNINGS IN THE MANUAL MAY RESULT IN SERIOUS OR FATAL INJURY AND/OR PROPERTY DAMAGE, AND WILL VOID THE PRODUCT WARRANTY. THIS PRODUCT MUST BE INSTALLED BY A QUALIFIED PROFESSIONAL. FOLLOW ALL APPLICABLE LOCAL AND STATE CODES.



ALWAYS READ THE OPERATING MANUAL AND SAFETY INFORMATION PROVIDED BY THE MANUFACURER BEFORE OPERATING ANY MACHINE.

NEVER OPERATE THE PRESS WITH THE SAFETY DEVICES REMOVED.

HAVE A QUALIFIED ELECTRICAN CARRY OUT ALL ELECTRICAL WORK.

DO NOT MODIFY THE CONTROL CIRCUIT OR MACHINE PARTS.

INSPECT THE PRESS BEFORE STARTING.

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH
PELIGRO DE DESCARGA ELÉCTRICA, EXPLOSIÓN O DESTELLO POR ARQUEO

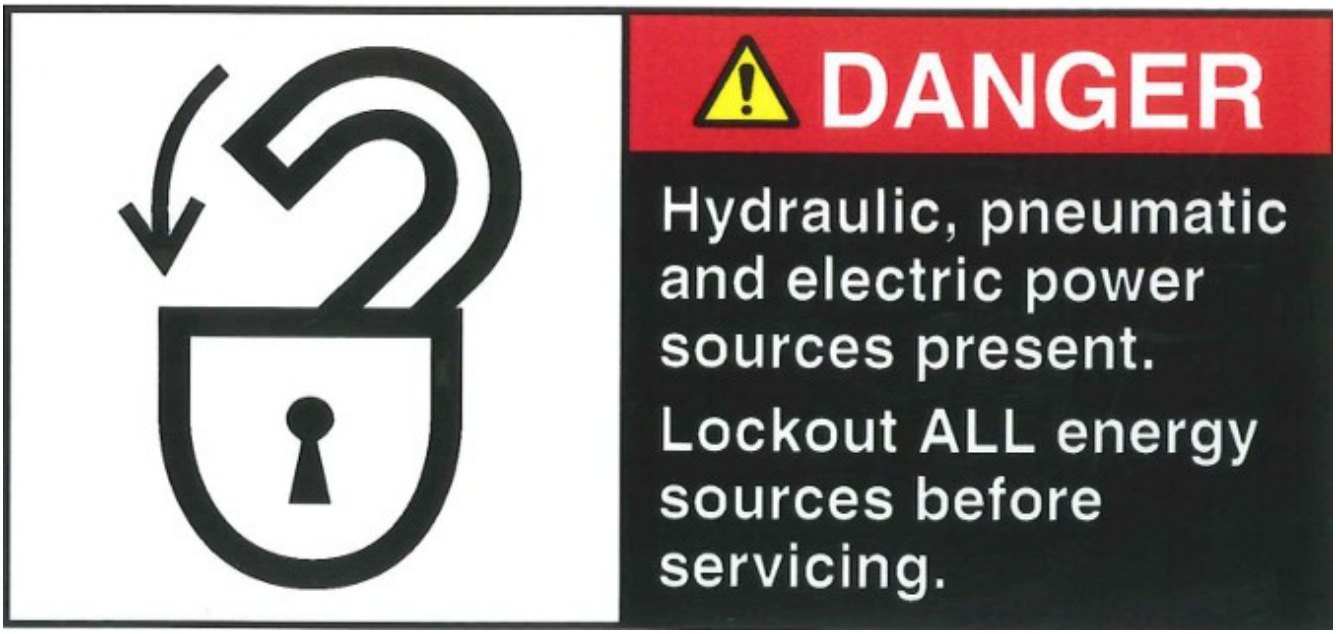
FAILURE TO FOLLOW THESE INSTRUCTIONS WILL RESULT IN DEATH OR SERIOUS INJURY.
EL INCUMPLIMIENTO DE ESTAS PRECAUCIONES PODRÁ CAUSAR LA MUERTE O LESIONES SERIAS.

Utilice equipo de protección personal (EPP) apropiado y siga las prácticas de sequridad eléctrica establecidas por su Compañía (consulte la norma NFPA 70E).	**Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.**
Solamente el personal eléctrico especializado deberá instalar y prestar servicioin de mantenimiento a este equipo.	**This equipment must only be installed and serviced by qualified electrical personnel.**
Nunca haga funcionar el interruptor con la puerta abierta cuanndo esté energizado. Mantenga la puerta asegurada.	**Never operate energized switch with door open. Keep door fastened.**
Desenergice el interrupotor antes de extraer o instalar fusibles o de hacer conexiones en el lado de carga.	**Turn off switch before removing or installing fuses or making load side connections.**
Siempre utilice un dispositivo de tensión nominal adecuado en los clips para fusibles de los lados de carga y linea para confirmar la desenergización del interruptor.	**Always use a properly rated voltage sensing device at all line and load fuse clips to confirm switch is off.**
Desenergice el interruptor antes de realizar cualquier otro trabajo en el interruptor.	**Turn off power supplying switch before doing any other work on or inside switch.**
No tuilice fusibles de cinta renovables en los interruptores de fusible.	**Do not use renewable link fuses in fused switches.**
El incumplimiento de estas precauciones podrá causar la muerte o lesiones serias.	**Failure to follow these instructions will result in death or serious injury.**
Para bloquear el interruptor, la aldaba del candado debe pasar por el agujero en la placa de inmovilización y por encima de la manija	**To lock out switch, place padlock hasp through hole in lockplate and above handle.**

WARNING

Have equipment (forklift or hydraulic jack) capable of lifting weight (identified on press data plate) of moving platen and top trim tool (identified by tool maker) at the ready to lift the moving platen off of personnel that may become trapped between the upper and lower platens in the event of main cylinder rod fracture and severance that would cause the upper platen to fall freely upon a person hand loading or unloading the lower nest. Failure to follow operating instructions could result in death or serious injury.

WARNING



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WARNING

TURN OFF MAIN POWER BEFORE INSPECTING OR SERVICING THE PRESS UNLESS POWER IS REQUIRED FOR THE INSPECTION OR SERVICING.

DO NOT OPERATE ANY MACHINE WHILE UNDER THE INFLUENCE OF ALCOHOL OR DRUGS.

ALWAYS WEAR SAFETY GLASSES WHEN OPERATING THIS MACHINE.

WEAR PROPER APPAREL. DO NOT WEAR LOOSE CLOTHING, GLOVES, NECKTIES, RINGS, BRACELETS, OR OTHER JEWELRY WHICH MAY GET CAUGHT IN MOVING PARTS. NONSLIP FOOTWEAR IS RECOMMENDED. WEAR PROTECTIVE HAIR COVERING TO CONTAIN LONG HAIR.

WARNING

FAILURE TO FOLLOW OPERATING INSTRUCTIONS COULD RESULT IN DEATH OR SERIOUS INJURY

WARNING

READ CAREFULLY THE PRODUCT INSTALLATION & OPERATIONS INSTRUCTIONS. FAILURE TO FOLLOW THE INSTRUCTIONS AND WARNINGS IN THE MANUAL MAY RESULT IN SERIOUS OR FATAL INJURY AND/OR PROPERTY DAMAGE, AND WILL VOID THE PRODUCT WARRANTY. THIS PRODUCT MUST BE INSTALLED BY A QUALIFIED PROFESSIONAL. FOLLOW ALL APPLICABLE LOCAL AND STATE CODES.

IMPORTANT

IT IS THE RESPONSIBILITY OF THE OWNER TO ESTABLISH AND MAINTAIN A SAFETY TRAINING PROGRAM THAT COVERS EQUIPMENT OPERATION AND MAINTENANCE IN ACCORDANCE WITH ALL OSHA, LOCAL, STATE, AND FEDERAL GUIDELINES. ALL PERSONNEL OPERATING THIS EQUIPMENT MUST READ AND UNDERSTAND THIS OWNERS MANUAL AND ALL WARNINGS AND SAFETY PRECAUTIONS. BE AWARE OF ALL POSTED WARNING, CAUTION, OR DANGER DECALS ON YOUR EQUIPMENT. COMPLIANCE WITH THESE WARNINGS IS MANDATORY TO PREVENT SERIOUS INJURY OR DEATH.

Per ANSI B11.2-1982 Standard for Machine Tools
Hydraulic Trim Presses
Safety Requirements for Construction, Care and Use

5.1 RESPONSIBILITY: It shall be the responsibility of the employer to provide and ensure the usage of either a point-of-operation guard or a properly applied and adjusted point-of operation device for every operation performed on a hydraulic power press consistent with the requirements of the tooling (dies) being used, or other features unique to the operation, so as to provide maximum protection to the operator.

5.2 REQUIREMENTS FOR POINT-OF OPERATION SAFEGUARDS:
One or more of the following methods shall be used for the safe guarding the point of operation.

1. **Assure that the operator is physically prevented for entering or is remove from the point of operation as the slide(s) closes; or**
2. **Prevent or stop slide(s) motion should the operator be within the point of operation; or**
3. **In applications which preclude the use of any of the above, such as certain straightening or maintenance operations, IMPLEMENT AND DOCUMENT such methods so as to protect the operator to the fullest possible.**

The complete STANDARD can be obtained by contacting the following:

American National Standards Institute
1430 Broadway
New York, NY 10018

ADVERTENCIA

PELIGRO

PELIGRO

PELIGRO

Las piezas en movimiento pueden cortar o aplastar. No aicanzar debajo, sobre o alrededor de las guardas. Incumplimiento de estas instrucciones podria ocasionar la muerte o lesiones graves

PELIGRO

PELIGRO

Fuentes de la energía eléctrica e hidráulicas, neumáticas presentes

Bloqueo de TODAS las fuentes de energía antes de realizar el mantenimiento

ADVERTENCIA

No seguir instrucciones podría resultar en leslones graves o la muerte

Metal Mechanics, Inc.

Foreword

This instruction manual has been prepared to present as clearly as possible the instructions for installation and the operation of your Metal Mechanics, Inc. hydraulic trim presses.

The instructions in this manual should be studied by the person in charge of installation, the operator, and the person in charge of maintenance. These people should follow these instructions closely to insure good results in installation and operation.

The production losses can be reduced if good practices in hydraulic maintenance are followed.

The following suggestions may be helpful in initiating good practices:

1. Recognize the fact that the user of trim presses has more control over maintenance than the manufacturer.
2. Instruct the operator on the use, care and limitations of the hydraulic trim press.
3. Select and train good personnel for your hydraulic trim press maintenance.
4. Have a program of systematic prevention care for your hydraulic trim press.
5. Analyze and isolate hydraulic trouble before dismantling any part of the hydraulic trim press.
6. Use the best grade of hydraulic oil or flame retardant fluid.
7. Maintain a stock of spare parts.
8. Call Metal Mechanics, Inc. for any problems that cannot be handled by your own personnel.

Metal Mechanics, Inc.
350 S. 14th St.
P.O. Box 447
Schoolcraft, MI 49087-0447
(269) 679-2525

SAFETY NOTICE

Metal Mechanics, Inc. has been informed of a potential safety hazard associated with the closing cylinder rod of the trim press. The end of the cylinder rod connected to the moving platen was reported to have broken on more than one occasion. While this type of failure is not typical and is in fact extremely unlikely, it is necessary to recognize the possibility and to operate the press in a safe manner.

1. Make sure all operators, die setters, and maintenance persons have the proper safety training and fully understands how the press operates.
2. Never reach into the press while the platen or core slides are moving.
3. Wait until the press is fully up and pullbacks and/or ratchet have engaged before reaching into the press.
4. Use a safety block device when working in the press.

An inspection process needs to be implemented immediately. This inspection involves looking for stress cracks in the rod. Here are the steps that need to be taken:

1. Obtain a dye penetrant suitable for detecting cracks in steel. This product can obtained from a welding or industrial supply company.
2. Make sure that the moving platen is securely blocked from moving downward. This can be done with a fully closed tool or a safety block device.
3. Remove the coupler assembly holding the end of the cylinder rod to the moving platen.
4. Following he instructions provided by the dye penetrant manufacturer, test the portion of the cylinder rod where the coupler grove has been machined.

We recommend that this inspection be carried out monthly or on a documented schedule determined by your safety department.

It is important to inspect the cylinder rod even though breakage is extremely unlikely. One break occurred on a machine that was 8.5 years old and run well in excess of 4 million cycles. The other occurred on a 12 year old machine that had run an unknown number of cycles.

Proper loading of the trim tool can minimize the likelihood of the this condition. Placing the geometric center of the casting as closely as possible to the center-line of the press evens the load across the platen and makes for less tilting of the platen and less stress on the tie bars and cylinder rod. This will also make the tie bar bushings an cylinder rod seals last much longer.

Workplace safety is our main concern. We apologize for any inconvenience this inspection process may cause. We also encourage you to perform this inspection on all presses you own, not just Metal Mechanics, Inc. brand presses.

Please do not hesitate to contact Metal mechanics at 269-679-2525 if you have any questions.

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3093 HAGER ROAD P.O. BOX 447
SCHOOLCRAFT, MI 49087-0447
PHONE (269) 679-2525 FAX (269) 679-2882

SAFEGUARDING THE POINT OF OPERATION

The following two paragraphs, taken from the ANSI B11.2-1982 Standard for Machine Tools – Hydraulic Trim Presses – Safety Requirements for Construction, Care and Use, are printed here so that Metal Mechanics, Inc. Press users shall have a clear understanding of their responsibility involving point of operation safeguards.

5.1 **RESPONSIBILITY:** It shall be the responsibility of the employer to provide and ensure the usage of either a point-of-operation guard or a properly applied and adjusted point-of-operation device for every operation performed on a hydraulic power press consistent with the requirements of the tooling (dies) being used, or other features unique to the operation, so as to provide maximum protection to the operator.

5.2 **REQUIREMENTS FOR POINT-OF-OPERATION SAFEGUARDS**
One or more of the following methods shall be used for safe guarding the point of operation:

1) Assure that the operator is physically prevented for entering or is removed from the point of operation as the slide(s) closes; or
2) Prevent or stop slide(s) motion should the operator be within the point of operation; or
3) In applications which preclude the use of any of the above, such as certain straightening or maintenance operations, **IMPLEMENT AND DOCUMENT** such methods so as to protect the operator to the fullest possible.

The complete **STANDARD** can be obtained by contacting the following:

American National Standards Institute
1430 Broadway
New York, NY 10018

Perimeter guards with interlocks have been installed on the hydraulic trim press. Please contact Metal Mechanics, Inc. for any special requirements your process may need.

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SAFE PRESS OPERATING PROCEDURE

1. Maintain a clean and uncluttered work area.
2. Check trim tool clamps for tightness
3. Be sure that machine guards are in place.
4. Keep foreign objects out of die area (air guns or other tools)
5. Keep hands on pullback or palm buttons until trim is finished (not necessary with light curtain)
6. Do not put hands in die area until platen has stopped moving.
7. Do not operate press if you feel it is unsafe (notify supervisor)
8. Do not operate press if any electrical wiring is loose or frayed (notify supervisor)
9. Do not operate press if hydraulic hoses are leaking (notify supervisor)
10. Notify supervisor of any malfunctions.
11. Do not put any loose objects on moving platen
12. Think safety

STARTUP PROCEDURE & SEQUENCE OF OPERATION

1 Thoroughly inspect machine for any damage that could occur during shipping.
2 Make sure fluid reservoir drain plug is tight and fill reservoir with specified fluid.
3 Connect main power to the machine in accordance with all applicable codes.
4 Connect a low impedance ground wire (this machine contains electronic equipment).
5 Connect coolant lines to the cooler if desired.
6 Check that suction strainer supply valve is open to allow fluid to flow to pump.
7 Turn on main disconnect.
8 Place HAND/AUTO selector switch in the HAND position (pump will not start in auto)
9 Pull out the emergency stop button, this will illuminate and energize the MCR.
10 Press the PUMP START button to start the hydraulic pump.
11 Check that the pump is rotating clockwise facing the pump shaft

MANUAL FUNCTIONS

1 Pressing the UP button will raise the moving platen.
2 Pressing the CYCLE START pushbuttons will retract the ratchet dog and lower the platen.
3 Pressing the EXTEND PUNCH button will energize the core punch valve.

AUTOMATIC CYCLE

1 Platen must be at the top limit switch to start automatic cycle.
2 Place HAND/AUTO selector switch in the AUTO position.
3 Push the CYCLE START buttons and hold.
4 The platen will begin the AUTO DOWN or rapid approach using full flow from both of the hydraulic pumps and utilizing cylinder regeneration, during this part of the cycle the operator must hold the CYCLE START buttons in.
5 When the SLOWDOWN limit switch is reached the high volume pump is vented and cylinder regeneration is terminated in order to provide the tonnage necessary to trim the part, the operator may now release the CYCLE START buttons.
6 When the BOTTOM limit switch is reached the platen will stop and then begin AUTO UP raising the platen to the top using full flow from both pumps.
7 When the TOP limit switch is reached the high volume pump is vented and the platen will slow and then stop as the valves are closed.

EMERGENCY RETURN

The EMERGENCY RETURN button function will raise the platen to the top limit, overriding and disengaging all other machine functions.

CORE PUNCH CYCLE

When the PUNCH OFF/ON selector is in the ON position the core punch sequence occurs during the automatic cycle.
1 When the BOTTOM limit switch is reached the platen will stop and the core punch solenoid will be energized, and the core cylinder will extend.
2 When the PUNCH EXTENDED limit switch(supplied by others) is reached the core punch solenoid will be de-energized, and the core cylinder will retract.
3 When the PUNCH RETRACTED limit switch(supplied by others) is reached the AUTO UP portion of the cycle will resume and the platen will rise to the top.
PROGRAMMING OTHER CORE PUNCH SEQUENCES IS THE CUSTOMERS RESPONSIBILITY (For assistance call Metal Mechanics)

AUTOMATIC AIR BLOWOFF

The timer mounted on the panel can be set to the amount of time desired for air blowoff duration. The air blowoff begins as the platen rises during the AUTO UP part of the cycle

AUTOMATIC LUBE SYSTEM

The automatic lube system provides a shot of lubricant every 20 automatic machine cycles divided among the individual lube points. The volume of lubricant dispensed on each shot can be adjusted on the lubricant pump and reservoir assembly by turning the volume adjustment screw.

CYCLE COUNTER

The cycle counter is incremented once during each automatic machine cycle, and can be reset with the button on the front of the counter.

AUTOMATIC DRIFT COMPENSATION

In time as the hydraulic cylinder piston seals wear there is a possibility that when the machine is left for long periods of time that the platen may drift down slightly. It will drift no further than the next notch of the ratchet bar. If the machine is left idling with the pump running and if the platen drifts off the TOP limit switch the automatic drift compensation will start and raise the platen to the TOP limit switch.

COUNTERBALANCE VALVE

The platen hydraulic counterbalance valve is pre-set and under normal conditions should not need adjustment unless an extremely heavy trim tool is used. In the event adjustment is necessary, turning the adjustment screw counter-clockwise increases the load and turning the screw clockwise decreases the load. Refer to the supplied data sheet for more specific information.

FILTERS AND INDICATORS

Refer to the supplied data sheets regarding operation of the indicators and filters as well as filter changing procedures.

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Preventive Maintenance for Metal Mechanics, Inc. Trim Press

1) The fluid in the reservoir should be visible in the sight level gauge at all times. If a water glycol fluid is used it should be checked monthly for viscosity. The water in the fluid can evaporate out of the reservoir and the fluid will thicken. This thickening will have a detrimental effect on the hydraulic system and will gradually lose its flame retardant properties. Water should be added to bring the viscosity back to the correct operating specifications. Obtain viscosity data from your fluid supplier.

2) Tie bar bushings should be greased everyday, or sooner if the tie bars are hot to the touch. ProGuard L-Plex EP Grease is the brand of grease used by Metal Mechanics, Inc. It is compatible with any lithium type grease. For maximum tie rod bushing life, the trim tool should be clamped in the press so that the part being trimmed is centered as closely as possible to the main cylinder rod. If your press has been equipped with an automatic lubrication system, there will be a low lube switch sending a signal to a light or HMI upon lube reservoir reaching the low level point. Check the control panel light or HMI daily and fill reservoir when panel light or HMI indicates reservoir is low.

3) The safety ratchet bar and cylinder “dog” should be greased once a week. The safety ratchet bar and cylinder “dog” should inspected monthly for wear. When the ratchet bar measures less than 1.875 inches it should be replaced. When the cylinder “dog” measures less than 4.375 inches it should be replaced.

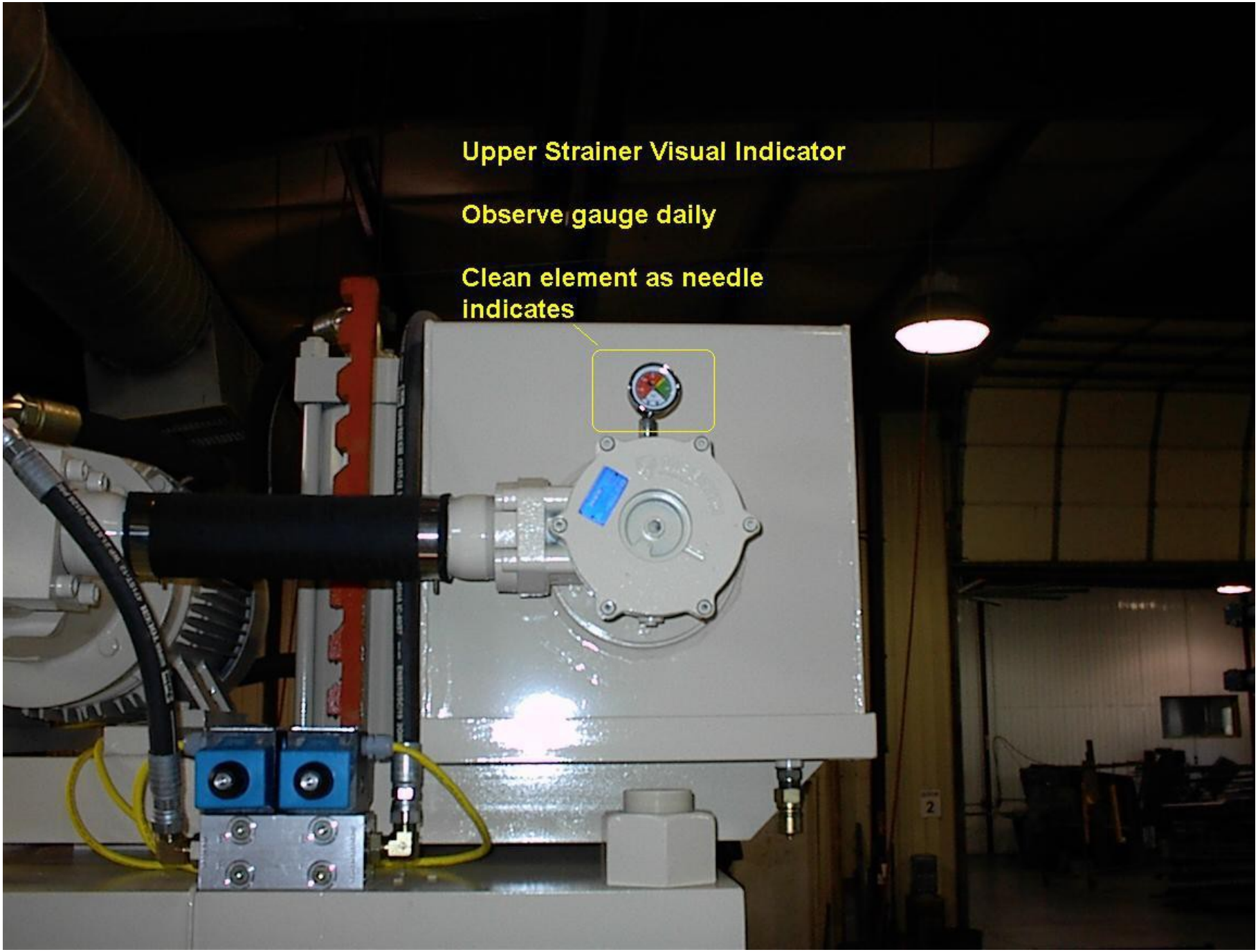
4) The suction strainer that lets fluid from the reservoir into the pump has a cleanable element. The suction strainer is equipped with a visual indicator gauge and a three color dial. Clean or replace the strainer element when the needle reaches the yellow portion of the dial, prior to reaching the red portion. Refer to the service sheet supplied with the manual for instructions and a cutaway view of the suction strainer.

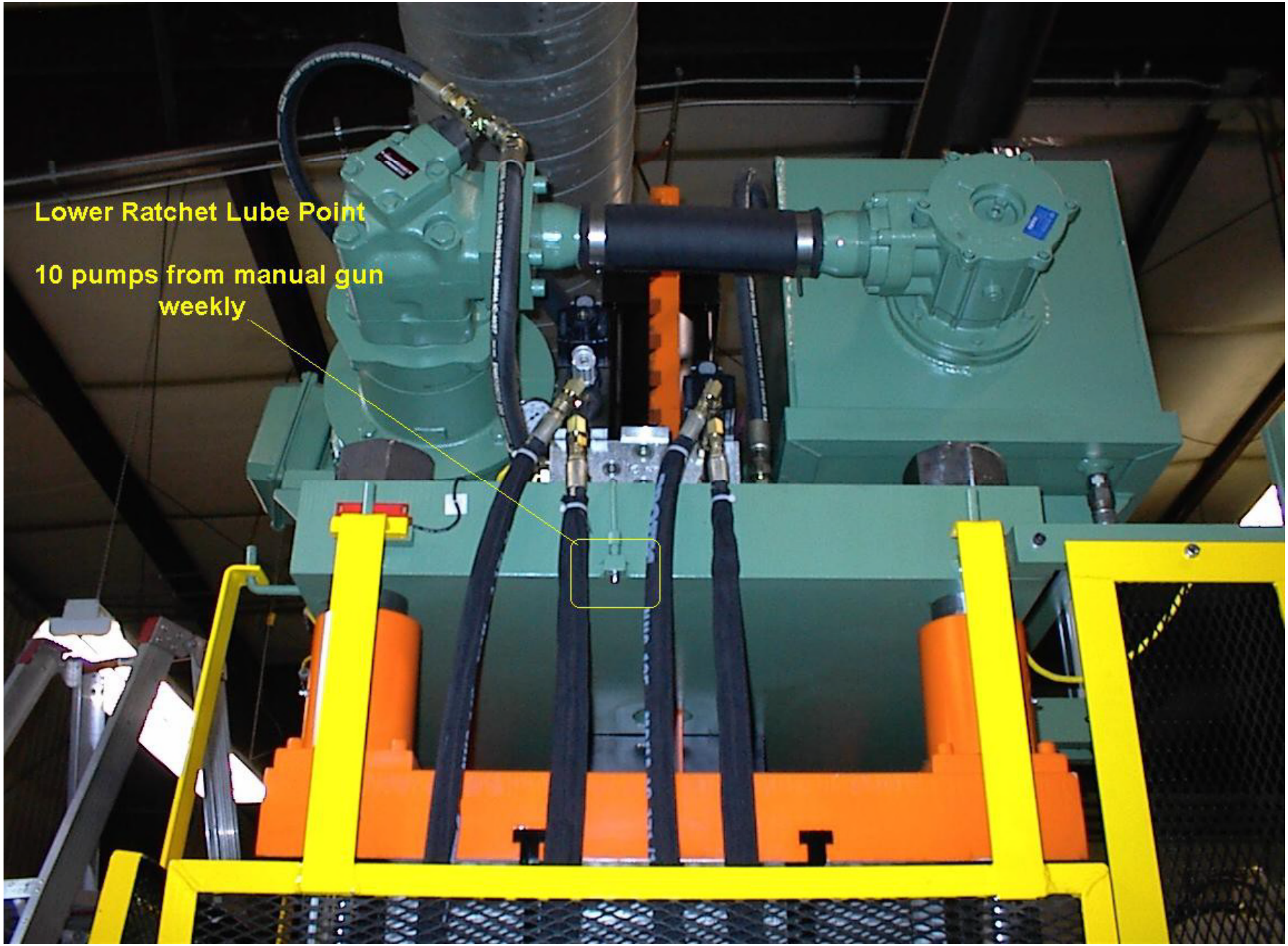
5) The return line filter has been equipped with a visual indicator gauge with a three color dial. Replace the element with new when the needle reaches the yellow portion, prior to reaching the red portion. The filter has a 25 PSI bypass check valve that will allow fluid to continue circulating in the event of the element being contaminated to the point where upon the bypass check valve opens. If this condition occurs, the system is running without any filtration. Refer to the service sheet supplied with the manual for instructions and a cutaway view of the return filter.

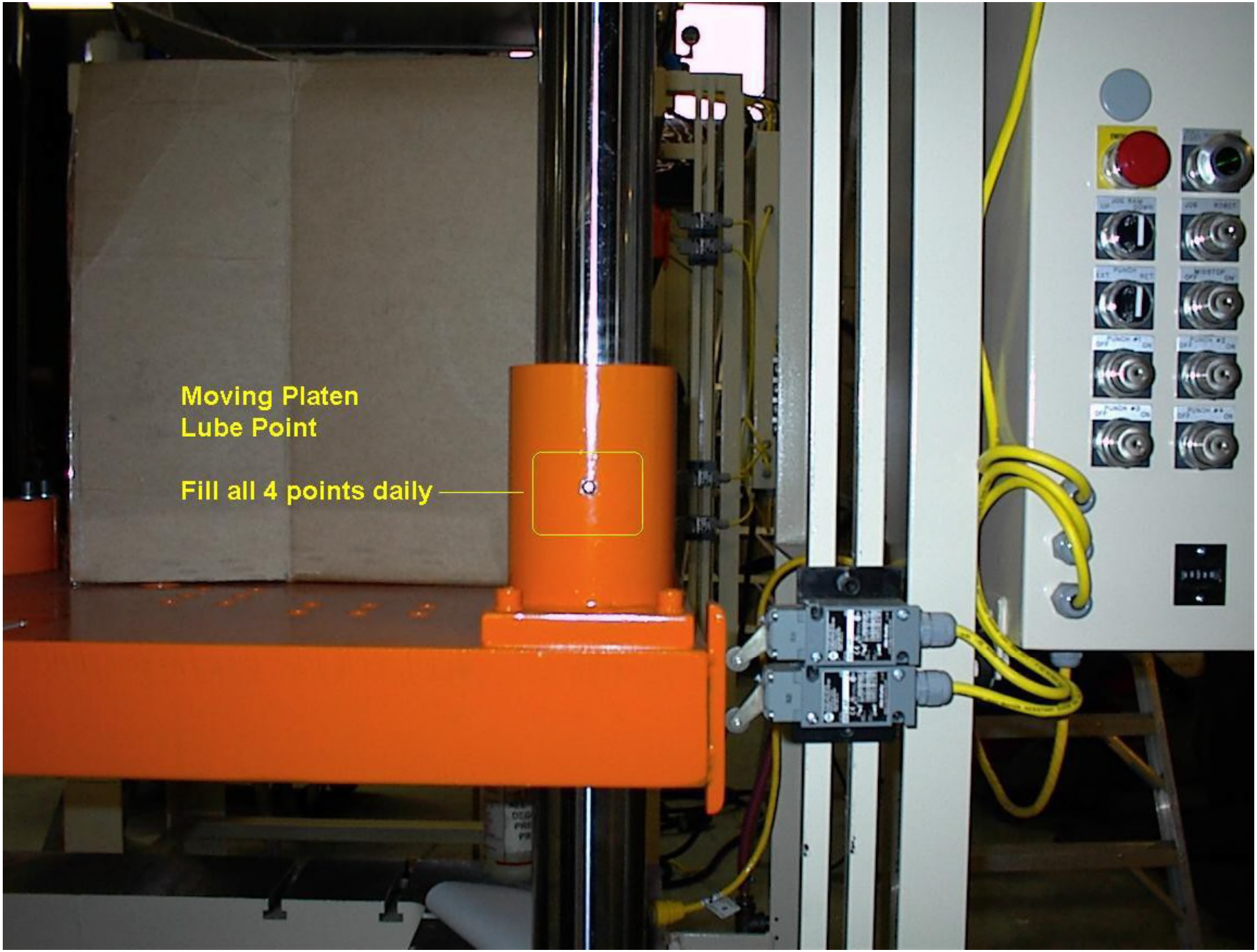
6) An air cooled heat exchanger (if so equipped) has a cleanable filter to keep the cooling fins clean. We recommend the filter be removed and cleaned twice a month for best cooling ability.

7) A water cooled heat exchanger (if so equipped) has as procedure for removing scale and other water contaminants. Flush with clean water or any good quality commercial cleaner that does not attack the particular material of construction. Straight tube heat exchangers allow for using a rod (gun cleaning kit type) to carefully remove any debris and hard water deposits. Refer to the service sheet supplied with the manual for instructions.

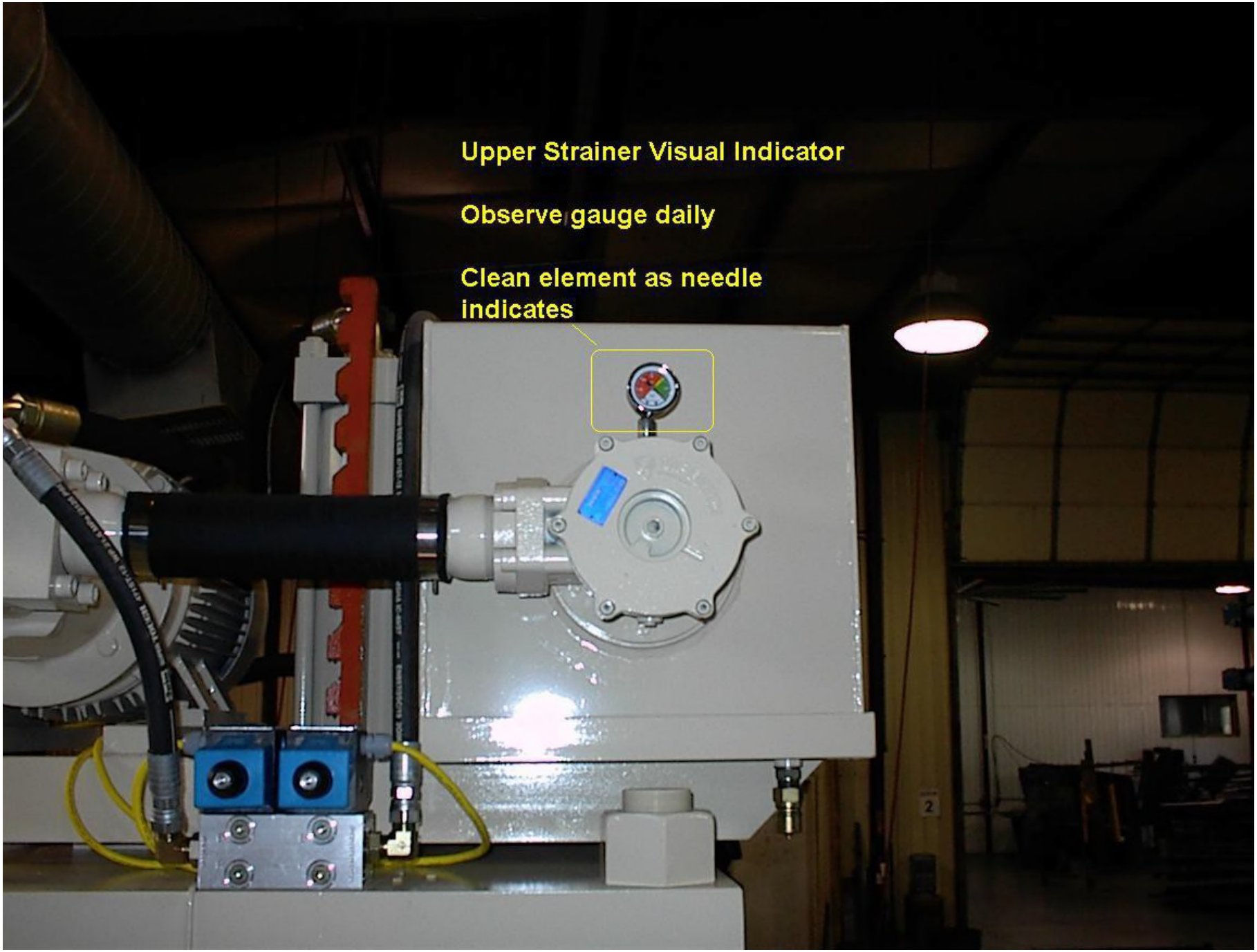

Return Filter Visual Gauge
Observe gauge daily
Replace element as indicated


Upper Strainer Visual Indicator
Observe gauge daily
Clean element as needle indicates


Lower Ratchet Lube Point
10 pumps from manual gun weekly


Moving Platen
Lube Point
Fill all 4 points daily


Return Filter Visual Gauge
Observe gauge daily
Replace element as indicated


Upper Strainer Visual Indicator
Observe gauge daily
Clean element as needle indicates


Upper Ratchet
Lube Point
5 pumps from manual
gun weekly

HYDRAULIC TROUBLE SHOOTING FOR TRIM PRESS

PUMP

1. Cavitation caused by restricted inlet or clogged or dirty strainer.
2. Oil too thick. Viscosity may be too high for the ambient temperature.

AERATION

1. Damaged inlet line; loose or defective fittings.
2. Damaged return line; loose or defective fittings. Air can leak in where the oil may not be able to leak out.
3. Oil level too low. This can cause vortexing at the pump inlet in the reservoir, thus drawing in air.
4. Damaged shaft seal permitting air to enter system.

FAILURE TO BUILD UP SYSTEM PRESSURE

1. Relief valve stuck open.
2. Pump rotating in wrong direction.
3. Broken pump shaft; sheared key or spline. On a gear-driven pump, check for proper meshing of gears.
4. Pump seizure due to improper start-up, foreign material or excessive pressure.
5. Excessive pump slippage due to unusual internal wear. Usually, this causes excessive heat.

SLOW OR ERRATIC OPERATION

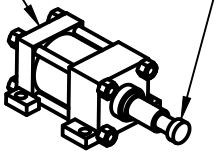
1. Pump damage; usually from wear caused by contaminants.
2. Air in the oil; causes “spongy” action.
3. Worn directional valve spool(s) or damaged relief valve.
4. Restricted pump inlet-usually accompanied by excessive noise.
5. Pump turning too slow due to improper engine governor setting.

SYSTEM WILL NOT LIFT LOADS

1. Worn pump slipping internally.
2. Relief valve setting too low, broken relief valve spring, or dirt between the poppet and seal.

RATCHET CYLINDER ROD KIT PN# 4A10S000S
RATCHET CYLINDER PISTON KIT PN# 4B00S025S

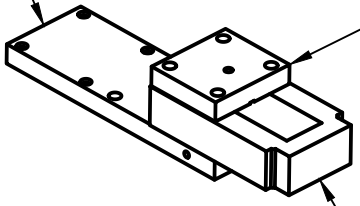
CYLINDER 2- 1/2" X 1" SIDE LUG
PN# ASL25X1



RATCHET SPACER
PN# RATCHETSPACER

RATCHET BASEPLATE
PN # 45X135

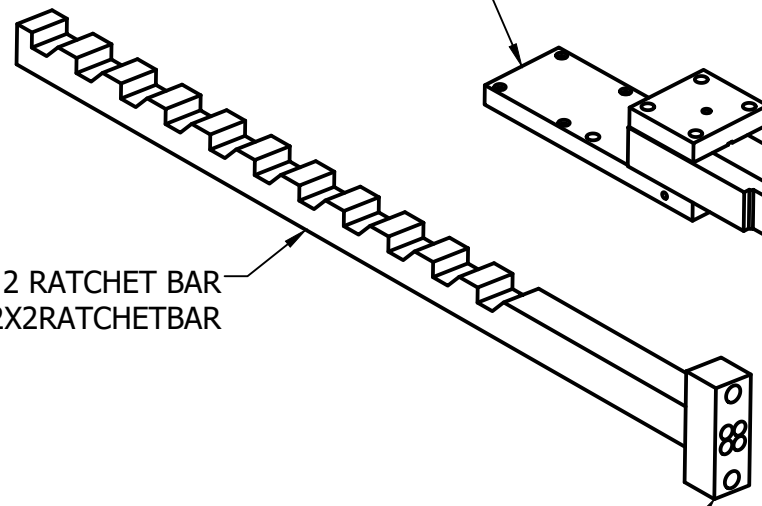
RATCHET SPRING
PN# RATCHETSPRING



RATCHET CAP
PN# 45X4

RATCHET DOG
T-SLOT - PN# 2X45TS

2 x 2 RATCHET BAR
PN# 2X2RATCHETBAR



RATCHET HORSESHOE
PN# 125X2X6

2 x 2 RATCHET MOUNT FLANGE
PN# 2X55H

*** DRAWING NOT TO SCALE ***

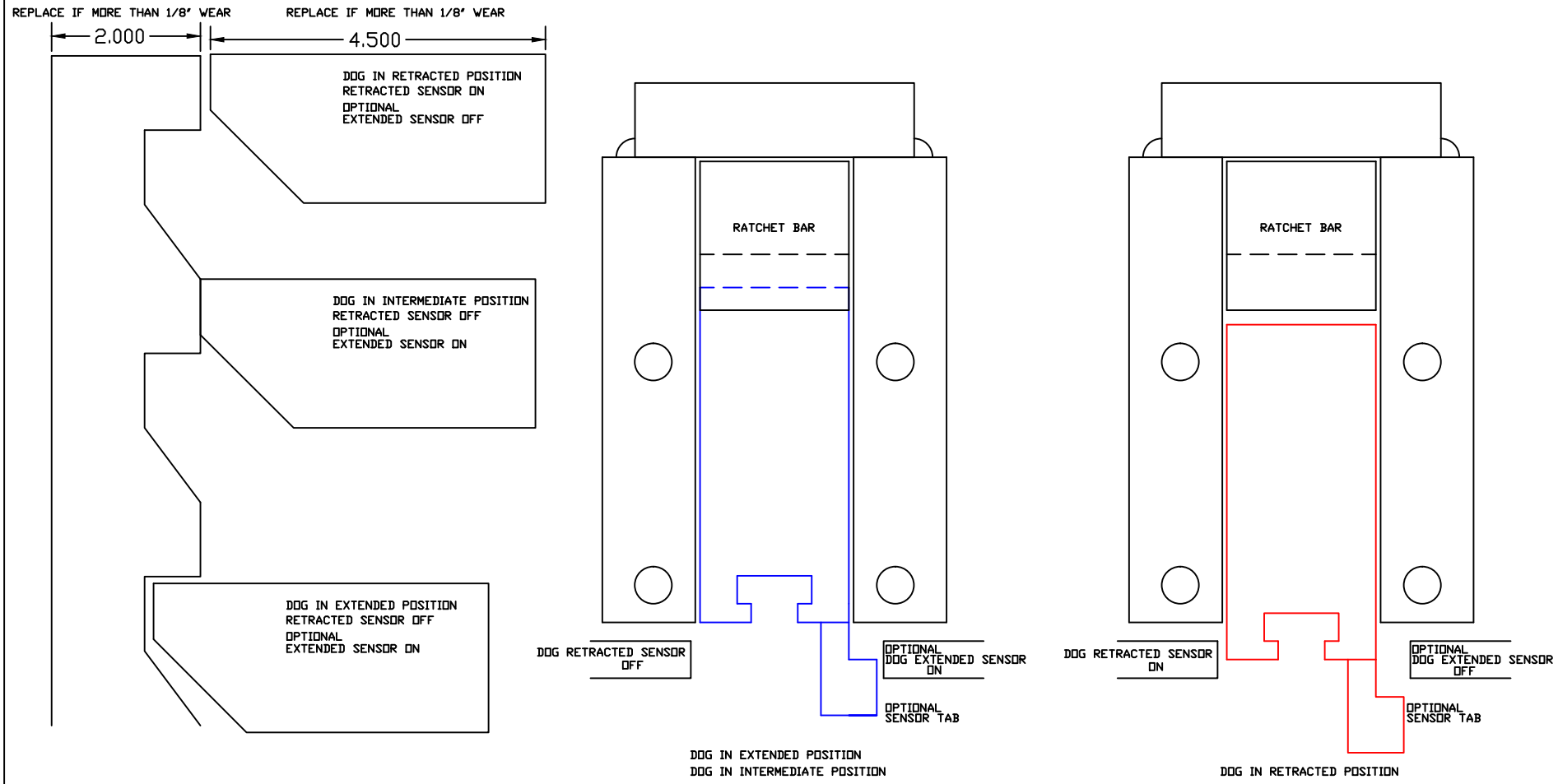
ITEM	DATE	DESCRIPTION OF REVISIONS	BY:

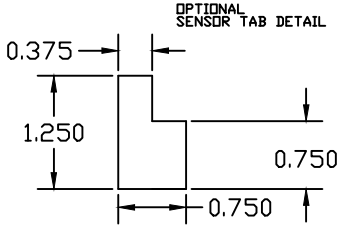
TOLERANCES UNLESS OTHERWISE SPECIFIED

.X	±	.015
.XX	±	.010
.XXX	±	.005
ANGULAR	±	1/2'
FRACTIONAL	±	1/32

METAL MECHANICS, INC.
350 S. 14TH ST., P.O.BOX447
SCHOOLCRAFT, MI 49087
www.metalmechanics.com

DWG. : RATCHET_PARTS_IDENTIFICATION_1.DWG
CUSTOMER :
TITLE : 2" x 2" RATCHET PARTS IDENTIFICATION
DRAWN BY : Z.DEMING
DATE : 2/11/2015
CHECKED BY :
SHEET : OF





METAL MECHANICS, INC. 3093 HAGER RD. SCHOOLCRAFT, MICH.	
DWG.	RATCHET_ADJ.DWG
CUSTOMER	MM
TITLE	RATCHET SENSOR ADJUSTMENT & WEAR
DRAWN	JPK
DATE	NOV/23/2005

PLATEN POSITION LIMIT SWITCH ADJUSTMENT

Proper adjustment of the trim press limit switches will provide the following benefits.

1 More machine cycles per shift.
2 Increased service life of the trim press.
3 Increased service life of the trim tools.
4 Higher quantity of good quality trimmed parts.

Full Open position limit switch

The full open position limit switch should be set to allow the press to open as far as possible without bottoming out the cylinder on the upstroke. It is false economy to “short stroke” the press because the operator (slow part of cycle) takes far more time to load through a small gap between the dies than is gained by stroke reduction (fast machine). Furthermore as the shift wears on the operator tends to slow down even more. On a press with optional bump ejection, the limit should be set to just eject the parts when the platen stops on opening.

Slowdown position limit switch

The slowdown limit switch should be normally adjusted approximately 2”-3” above the full closed position limit switch. The ideal position is when running a cycle, the press changes from rapid approach speed to slow trim speed just before part contact. Impacting he part at high speed will shorten the service life of the trim press as well as the trim tool .

Full closed position limit switch

The full closed limit switch should be adjusted to trip just as the cutter on the trim tool cuts through the parting line. Impact with positive stops should be avoided if possible. If contact with the positive stops is necessary for the function of the trim tool. As in the case with some auxiliary slides or cores, the minimum of impact contact is desirable for long press and tool service life.

Intermediate position limit switches (optional)

Depending upon the options built into the press, it may or may not have limit switches for intermediate positions.

1 An unload position limit switch is used to indicate that the moving platen is clear for the insertion of the unloader tray and/or bolster shuttle movement.
2 A mid die stop limit switch may be used when auxiliary slides or cores are used at the position other than with the press fully closed. It is important to note the direction of travel of the limit switch arm, depending on the direction of platen travel when the desired function is activated.

If you are having difficulty with the limit switch adjustments please call Metal Mechanics, Inc. for technical support at (269)-679-2525

HIGH PRESSURE PUMP ADJUSTMENT

Having the high pressure pump adjusted correctly will provide the correct pressure to generate the proper tonnage required to trim the part an to exceed the tonnage rating of the press. Adjusting the high pressure pump will set the MAIN LINE pressure of the press.

The pressure can be adjusted at the full open or full closed position or by using the manual override with the moving platen stopped at any point in the stroke.

1 If the press is equipped with bump ejection and a tool with ejector rods are installed, the full open method should not be used.

2 If the press has a tool installed that is not equipped with positive stops, the full closed method should not be used.

THE FULL OPEN POSITION METHOD

1 Open the press to the fully open position.

2 Loosen the locknut on the high pressure adjustment screw (refer to manifold illustration for identification)

3 Have a helper press the jog open pushbutton and turn the screw (clockwise for more pressure and counter clockwise for less pressure) while watching the gauge.

4 Tighten the locknut.

THE FULL CLOSED POSITION METHOD

1 Close the press to the full closed position (take precautions to avoid trim die damage).

2 Loosen the locknut on the high pressure adjustment screw (refer to manifold illustration for identification)

3 Have a helper press the jog closed pushbutton(s) and turn the adjustment screw (clockwise for more pressure and counter clockwise for less pressure) while watching the gaughe. Do not exceed nameplate pressure.

4 Tighten the locknut.

THE FULL MANUAL OVERRIDE METHOD

1 This adjustment can be performed in any position of the stroke with the moving platen stopped.

2 Loosen the locknut on the high pressure adjustment screw (refer to manifold illustration for identification)

3 Activate the manual override device for the high pressure valve (refer to manifold illustration for identification)

4 Turn the adjustment screw (clockwise for more pressure and counterclockwise for less pressure) while watching the gauge. Do not exceed nameplate pressure.

5 **Deactivate the manual override device before returning the press to service.**

6 Tighten the locknut.

HIGH VOLUME PUMP ADJUSTMENT

Having the high volume pump unloading/relief valve adjusted correctly will provide the correct volume to generate the proper flow required to provide the highest platen speed and not exceed the amperage rating of the motor. Correct adjustment will also minimize excessive heat build-up in the hydraulic fluid. Refer to the manifold illustration for adjustment screw identification.

The high volume unloading valve can only be adjusted dynamically while the press is cycling.

1 Place an inductive ammeter (Amprobe) on one of the leads between the starter and the motor.
2 Record the Service Factor Amps (SFA) from the motor nameplate. If sfa is not called out on the nameplate use the Full Load Amps (FLA) multiplied by the nameplate service factor of the motor (usually 1.15).
3 Have a helper cycle the press during the adjustment procedure. Read the ammeter while the press is moving in the RAPID APPROACH or the RAPID RETURN portion of the cycle.
4 Turn the adjusting screw clockwise for more pressure (higher speed) or turn the adjusting screw counterclockwise for less pressure (lower speed). Make sure that the ammeter does not exceed the Service Factor Amps of the motor during any portion of the cycle.
5 Tighten the locknut.

NOTES:

If in an effort to reduce rapid approach speed, the adjustment is backed off far enough, it is possible for a large quantity of the HV pump fluid to vent across the unloading/relief valve, generating excessive heating in the hydraulic fluid.

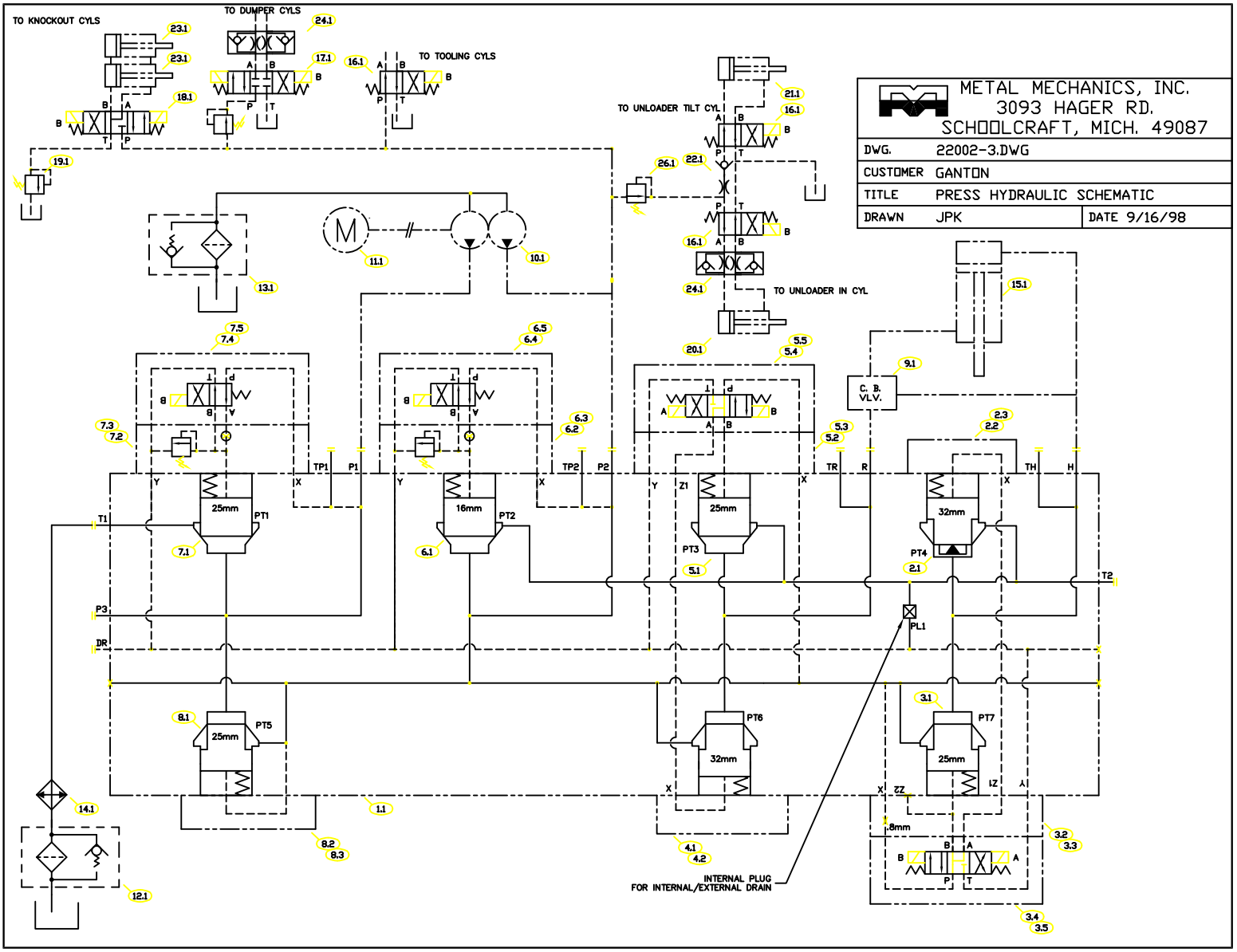
If reduced rapid approach speed is the objective, or you are having difficulty with the adjustment, please contact Metal Mechanics for technical support.

COUNTERBALANCE VALVE ADJUSTMENT PROCEDURE

1. Adjustment screw is left hand thread
2. Turning screw counterclockwise increases backpressure.
3. Turning screw clockwise decreases backpressure.
4. The counterbalance valve is preset at Metal Mechanics to accommodate a wide variety of die set tooling weights. To adjust valve for substantially heavier or lighter tooling, perform the following steps:

    1) Install tooling in press and secure to platens.
    2) Raise ram high enough to detect drift
    3) Make sure ratchet will not be hanging on the dog in this position, if necessary move ram up or down slightly.
    4) Shut off pump, turn counterbalance adjuster screw clockwise until drift is barely perceptible, then turn adjustin screw ¼ turn counterclockwise.
    5) Measure and record ram height.
    6) Wait 15 minutes.
    7) Measure ram height.
    8) If ram has drifted down, turn adjustment screw counterclockwise ¼ turn & repeat steps 5 thru 8, making sure that the ratchet is not hanging on the dog.

    For Additional information refer to the counterbalance service sheet.



METAL MECHANICS, INC. 3093 HAGER RD. SCHOOLCRAFT, MICH. 49087	
DWG.	22002-3.DWG
CUSTOMER	GANTON
TITLE	PRESS HYDRAULIC SCHEMATIC
DRAWN JPK	DATE 9/16/98

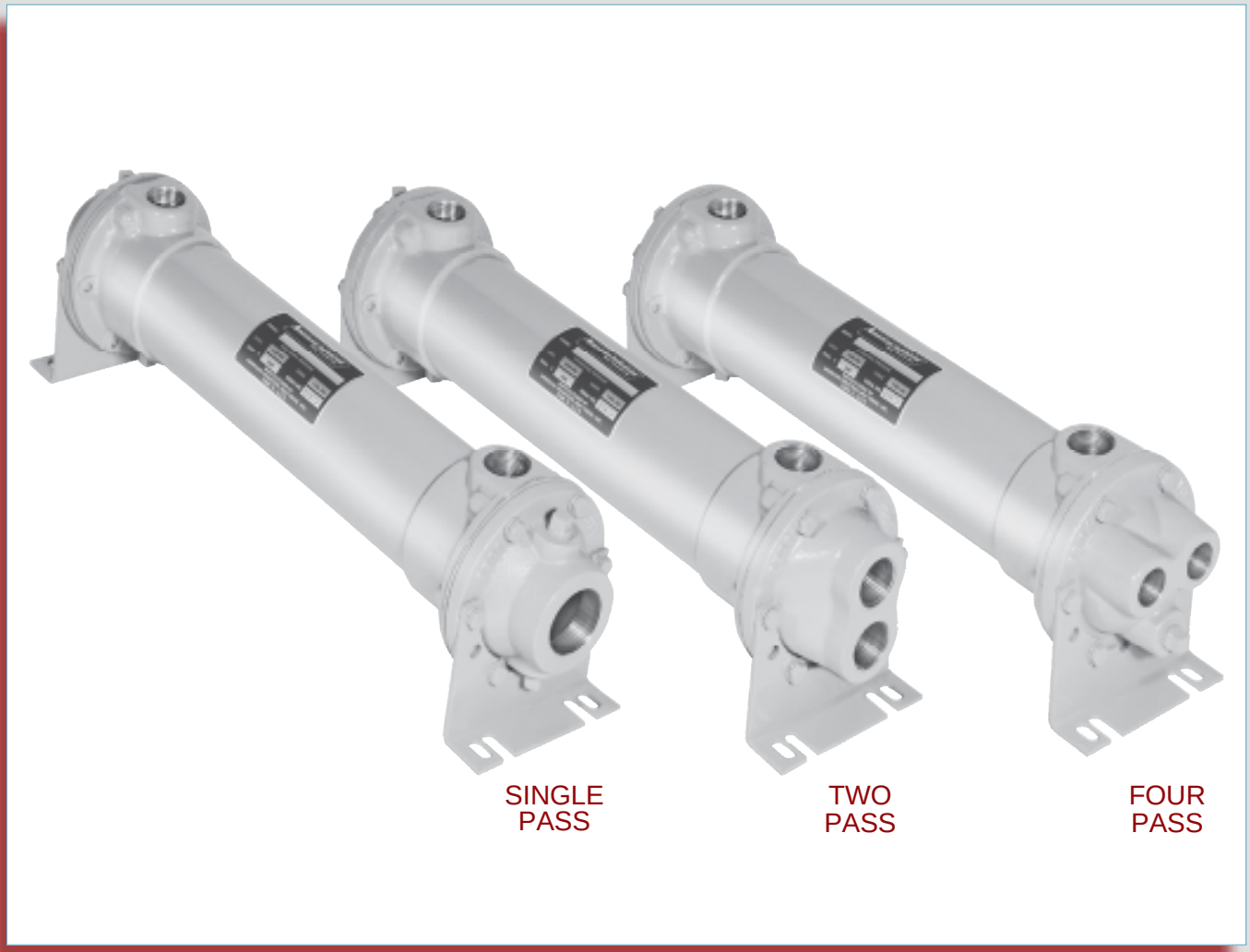
BILL OF MATERIAL #22001 METAL MECHANICS INC

ITEM #	QTY.	PART NUMBER	DESCRIPTION
1.1	1	FPE–0279	MANIFOLD, ALUMINUM
2.1	1	CVI–32–D20–2M–10	CARTRIDGE, INSERT, 32mm, 1:2 RATIO, VICKERS
2.2	1	CVCS–32–N–S2–10	CARTRIDGE, COVER, 32mm
3.1	1	CVI–25–D20–2M–10	CARTRIDGE, INSERT, 25mm, 1:2 RATIO, VICKERS
3.2	1	CVCS–25–D1–S2–10	CARTRIDGE, COVER, 25mm, WITH D03 MTG. PATTERN
3.4	1	DG4V3–S–7C–MFWB5–60	VALVE, 4–WAY, 3 POSITION, D03, VICKERS
4.1	1	CVI–25–D20–2M–10	CARTRIDGE, INSERT, 25mm , 1:2 RATIO, VICKERS
4.2	1	CVCS–25–N–S2–10	CARTRIDGE, COVER, 25mm
5.1	1	CV1–25–D20–2M–10	CARTRIDGE, INSERT, 25mm, 1:2 RATIO, VICKERS
5.2	1	CVCS–25–D1–S2–10	CARTRIDGE, COVER, 25mm, WITH D03 MTG. PATTERN
5.4	1	DG4V3–S–7C–MFWB5–60	VALVE, 4–WAY, 3 POSITION, D03, VICKERS
6.1	1	CVI–16–D10–2M–11	CARTRIDGE, INSERT, 16mm 1:1 RATIO, VICKERS
6.2	1	FPE–D247	CARTRIDGE, COVER, 16mm, W/ D03 MOUNTING & SUN RELIEF VLV.
6.3	1	RPEC–LAN	VALVE, RELIEF, SUN
6.5	1	DG4V3–S–2AL–MFWB5–60	VALVE, 4–WAY, 2 POSITION, D03, VICKERS
7.1	1	CVI–25–D10–2M–30	CARTRIDGE, INSERT, 25mm, 1:1 RATIO, VICKERS
7.2	1	FPE–D247	CARTRIDGE, COVER, 16mm, W/ D03 MOUNTING & SUN RELIEF VLV.
7.3	1	RPEC–LDN	VALVE, RELIEF, SUN
7.5	1	COVER PLATE	COVER PLATE
8.1	1	CVI–25–D11–2M–10	CARTRIDGE, INSERT, 25mm, 1:1.1 RATIO, CHECK VALVE,VICKERS
8.2	1	CVCS–25–N–S2–10	CARTRIDGE, COVER, 16mm
9.1	1	CAIA–LIV–FPE	VALVE, COUNTERBALANCE,CARTRIDGE W/BODY, SUN
10.1	1	3525V 38–A17	PUMP, VICKERS
11.1	1		MOTOR 25HP,1200 RPM
12.1	1	RF2–1–10B–PP–25	FILTER, RETURN, REPLACEMENT ELEMENT# 932409
13.1	1	DGS3–HFN	STRAINER, SUCTION, CLEANABLE ELEMENT
14.1	1	SAE–1002–C6–TP	COOLER, AMERICAN
15.1	1	N5G	CYLINDER, 7" BORE, 28" STROKE HYDROLINE
16.1	3	DG4S4–012A	VALVE, 4–WAY, 2 POSITION, D05, VICKERS
17.1	1	DG4S4–012C	VALVE, 4–WAY, 3 POSITION, D05,VICKERS
18.1	1	DG4S4–016C	VALVE, 4–WAY, 3 POSITION, D05, VICKERS
19.1	1	DE–RVA–3000	VALVE, RELIEF, DELTA
20.1	1	N5C–2.5 x 6	CYLINDER, 2–1/2" BORE, 6" STROKE, HYDROLINE
21.1	1	N5U–2.5 x 4	CYLINDER, 2–1/2" BORE, 4" STROKE, HYDROLINE
22.1	1	MCV–05–P–1–10	LOAD CHECK VALVE, SANDWICH MOUNT, INTERNATIONAL
23.1	2	N5G–3.25 x 2	CYLINDER, 3–1/4" BORE, 2" STROKE, HYDROLINE
24.1	3	MTC–05–W–0–10	FLOW CONTROL, SANDWICH MOUNT, INTERNATIONAL
25.1	1	DGMX2–5–PP–FW–S–30	PRESSURE REDUCING, SANDWICH MOUNT, VICKERS
26.1	1	PBDB–LQN–ECC	PRESSURE REDUCING, LINE MOUNT, SUN

American Industrial Heat Transfer Inc.®

Manufacturer of Quality Heat Exchangers

AB - SAE - STS - EAB SERIES



Fixed Tube Bundle / Liquid Cooled

HEAT EXCHANGERS

- Operating pressure for tubes 150 PSI.
- Operating pressure for shell 300 PSI.
- Operating temperature 300 °F.
- Can be customized to fit your needs.
- Cools: Fluid power systems, rock crushers, presses, shears, lubrication equipment for paper machinery, gear drives, marine transmissions, etc.

note: AIHTI reserves the right to make reasonable design changes without notice.

 355 American Industrial Drive LaCrosse, VA 23950 tel: 434-757-1800 fax: 434-757-1810 email: sales@aihti.com

AB, SAE, STS, & EAB Series *overview*

AB Series

Fixed tube construction heat exchangers with NPT connections. Made of brass with copper cooling tubes and cast iron end bonnets. Standard sizes from 2" through 8" diameters, and from 1.4 to 308 sq.ft. Standard one, two, and four pass models are available. Options include 90/10 copper nickel and 316 stainless steel cooling tubes, bronze bonnets and zinc anodes. Can be customized to fit your requirements.

Optional 10” diameter units in brass are available upon request.

SAB Series

Similar to AB series with the exception of steel shell material. For use in applications where the shell fluid is non-corrosive with steel. Offered in 5" through 8" shell diameter.

SAE Series

Similar to AB series with the exception of the shell ports. SAE series from 2” through 6” diameter has SAE O-ring strait thread shell port connections. Size 8” diameter has SAE code 61 four bolt flange shell port connections.

SSAE Series

Similar to SAE series with the exception of steel shell material. For use in applications where the shell fluid is non-corrosive with steel. *Offered in 5" through 8" shell diameter.*

STS Series

Similar in design to AB series with fixed tube construction and NPT connections made of all 316 stainless steel. Standard sizes from 2" through 8" diameters, and from 1.4 to 308 sq.ft. Standard one, two and four pass models are available. Larger diameters available upon request. Can be customized to fit your requirements.

EAB Series

Expansion bellow minimizes the effects of differential expansion and contraction between the shell and cooling tubing, prolonging the overall life of the heat exchanger by reducing fatigue. Fixed tube construction heat exchangers with NPT connections. Made of brass with 90/10 copper nickel cooling tubes, stainless steel expansion bellows, and cast iron end bonnets. Standard sizes from 3.5" through 8" diameters, and from 3.6 to 308 sq.ft. Standard one, two and four pass models are available.

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AB, SAE, STS, & EAB Series *construction*

TUBE JOINT
Roller expanded tube joint to integral forged hub.

THREAD
CNC precision threading to provide accurate leak-proof connections.

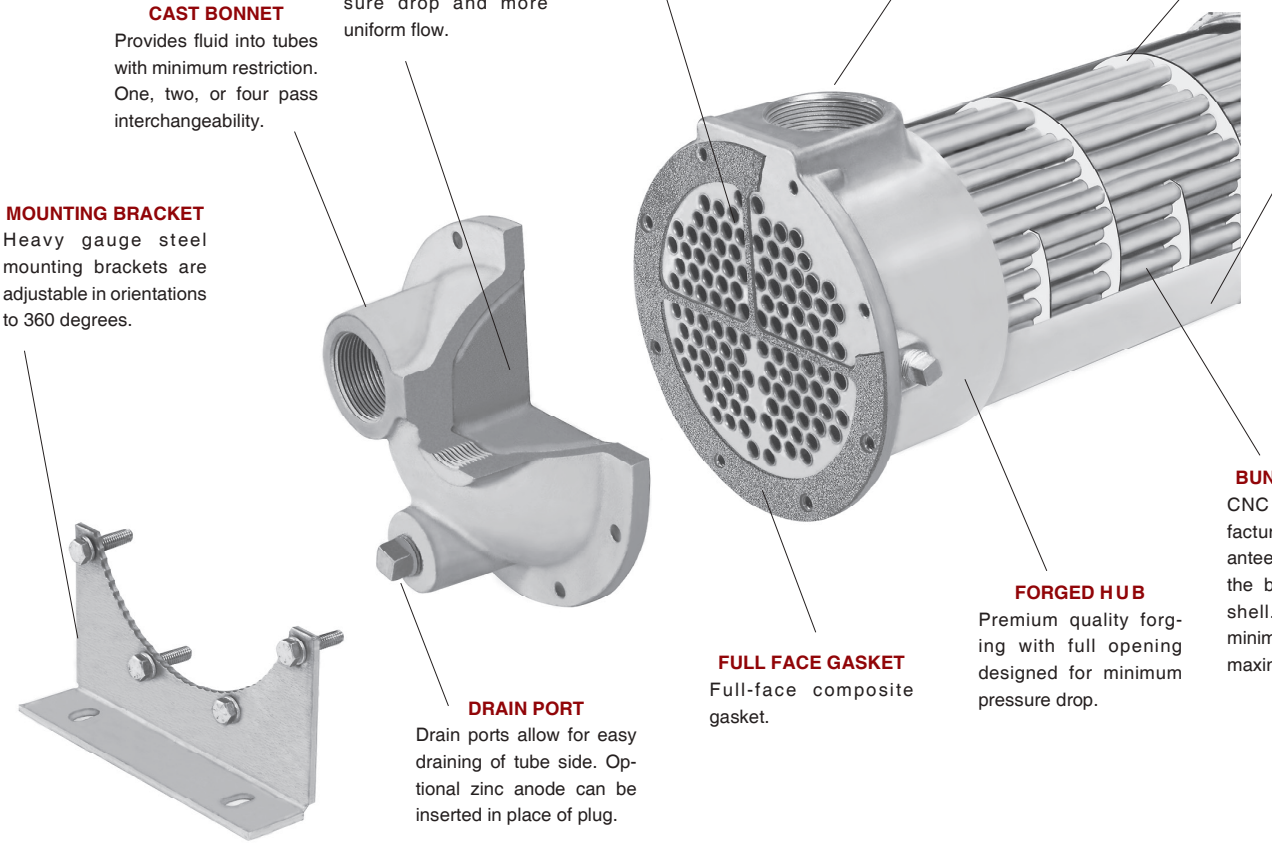
BAFFLES
CNC manufactured baffles to provide maximum turbulence and heat transfer with a minimum fluid pressure drop.

FLOW CAVITY
Generously sized to allow for minimum pressure drop and more uniform flow.

CAST BONNET
Provides fluid into tubes with minimum restriction. One, two, or four pass interchangeability.

FINISH
Gray semigloss enamel. Can be used as a base for additional coats.

MOUNTING BRACKET
Heavy gauge steel mounting brackets are adjustable in orientations to 360 degrees.



BUNDLE ASSEMBLY
CNC precision manufactured parts to guarantee a close fit between the baffles, tubes, and shell. Clearances are minimized to provide for maximum heat transfer.

FORGED HUB
Premium quality forging with full opening designed for minimum pressure drop.

FULL FACE GASKET
Full-face composite gasket.

DRAIN PORT
Drain ports allow for easy draining of tube side. Optional zinc anode can be inserted in place of plug.

UNIT CODING

Example Model

Options

AB - 1204 - C 4 - TP - CNT - B - Z

Model
AB
SAB
SAE
SSAE
STS
EAB

Shell Diameter
400 = 2.13"
700 = 3.65"
1000 = 5.13"
1200 = 6.13"
1600 = 8.00"

Effective Tube Length
(9" increments)

Baffle Spacing Code
A = 1 1/8"
B = 2 1/4"
C = 4 1/2"
D = 9 "
E = 18 "

Cooling Tube Diamenter
4 = 1/4"
6 = 3/8"
10 = 5/8"

Tube Side Passes
SP = 1 pass
TP = 2 pass
FP = 4 pass

Tubing
Blank = Copper
Options
CNT= 90/10 Cu Ni
STS = Stainless Steel
C = Carbon Steel

End Bonnets
Blank = Cast Iron
Options
B = Bronze

Zinc Anode
Z = 1 Zinc Anode
2Z = 2 Zinc Anode etc.

STANDARD CONSTRUCTION MATERIALS & RATINGS

Standard Model	AB Series	SAB & SSAE Series*	SAE Series	STS Series	EAB Series	Standard Unit Ratings
Shell	Brass	Steel	Brass	316 Stainless Steel	Steel	Operating Pressure
Tubes	Copper	Copper	Copper	316 Stainless Steel	90/10 Copper Nickel	Tubes.....150 psig
Baffle	Aluminum	Aluminum	Aluminum	316 Stainless Steel	Aluminum	
Integral End Hub	Forged Brass	Forged Brass	Forged Brass	316 Stainless Steel	Forged Brass	Operating Pressure
End Bonnets	Cast Iron	Cast Iron	Cast Iron	316 Stainless Steel	Cast Iron	Shell.....300 psig
Mounting Brackets	Steel	Steel	Steel	Steel	Steel	
Gasket	Hypalon Composite	Hypalon Composite	Hypalon Composite	Hypalon Composite	High Temp Gasket	Operating Temperature
Expansion Bellows	–	–	–	–	Stainless Steel	300 °F

*Offered in 5" through 8" shell diameter.

note: AIHTI reserves the right to make reasonable design changes without notice.

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AB, SAE, STS, & EAB Series *selection*

STEP 1: Calculate the heat load

The heat load in BTU/HR or (Q) can be derived by using several methods. To simplify things, we will consider general specifications for hydraulic system oils and other fluids that are commonly used with shell & tube heat exchangers.

Terms

GPM = Gallons Per Minute
CN = Constant Number for a given fluid
△T = Temperature differential across the potential
PSI = Pounds per Square Inch (pressure) of the operating side of the system
MHP = Horsepower of the electric motor driving the hydraulic pump
Kw = Kilowatt (watts x 1000)
T_{in} = Hot fluid entering temperature in °F
T_{out} = Hot fluid exiting temperature in °F
t_{in} = Cold fluid temperature entering in °F
t_{out} = Cold fluid temperature exiting in °F
Q = BTU / HR

For example purposes, a hydraulic system has a 125 HP (93Kw) electric motor installed coupled to a pump that produces a flow of 80 GPM @ 2500 PSIG. The temperature differential of the oil entering the pump *vs* exiting the system is about 5.3°F. Even though our return line pressure operates below 100 psi, we must calculate the system heat load potential (Q) based upon the prime movers (pump) capability. We can use one of the following equations to accomplish this:

To derive the required heat load (Q) to be removed by the heat exchanger, apply ONE of the following. Note: The calculated heat loads may differ slightly from one formula to the next. This is due to assumptions made when estimating heat removal requirements. The factor *(v)* represents the percentage of the overall input energy to be rejected by the heat exchanger. The *(v)* factor is generally about 30% for most hydraulic systems, however it can range from 20%-70% depending upon the installed system components and heat being generated (ie. servo valves, proportional valves, etc…will increase the percentage required).

Formula	Example
A) Q = GPM x CN x actual △T	A) Q =80 x 210 x 5.3°F = 89,040 BTU/HR
B) Q = [(PSI x GPM) / 1714] x (*v*) x 2545	B) Q =[(2500x80)/1714] x .30 x 2545 = 89,090 BTU/HR
C) Q = MHP x (*v*) x 2545	C) Q =125 x .30 x 2545 = 95,347 BTU/HR
D) Q = Kw to be removed x 3415	D) Q =28 x 3415 = 95,620 BTU/HR
E) Q = HP to be removed x 2545	E) Q =37.5 x 2545 = 95,437 BTU/HR

Constant for a given fluid (CN)

1) Oil ..... CN = 210
2) Water..... CN = 500
3) 50% E. Glycol..... CN = 450

STEP 2: Calculate the Mean Temperature Difference

When calculating the MTD you will be required to choose a liquid flow rate to derive the cold side △T. If your water flow is unknown you may need to assume a number based on what is available. As a normal rule of thumb, for oil to water cooling a 2:1 oil to water ratio is used. For applications of water to water or 50 % Ethylene Glycol to water, a 1:1 ratio is common.

Formula

HOT FLUID △T = Oil $\quad \dfrac{Q}{CN \times GPM}$

COLD FLUID △t = Water $\quad \dfrac{BTU / hr}{CN \times GPM}$

Example

$$\triangle T = \frac{89{,}090\ BTU/hr\ \text{(from step 1,example B)}}{210\ CN \times 80GPM} = 5.3°F = \triangle T\ Rejected$$

$$\triangle t = \frac{89{,}090\ BTU/hr}{500\ CN \times 40GPM\ \text{(for a 2:1 ratio)}} = 4.5°F = \triangle t\ Absorbed$$

T_{in} = Hot Fluid entering temperature in degrees F
T_{out} = Hot Fluid exiting temperature in degrees F
t_{in} = Cold Fluid entering temperature in degrees F
t_{out} = Cold Fluid exiting temperature in degrees F

T_{in} = 125.3 °F
T_{out} = 120.0 °F
t_{in} = 70.0 °F
t_{out} = 74.5 °F

$$\frac{T_{out} - t_{in}}{T_{in} - t_{out}} = \frac{S\text{[smaller temperature difference]}}{L\text{ [larger temperature difference]}} = \left(\frac{S}{L}\right)$$

$$\frac{120.0°F - 70.0°F = 50.0°F}{125.3°F - 74.5°F = 50.8°F} = \frac{50.0°F}{50.8°F} = .984$$

STEP 3: Calculate Log Mean Temperature Difference (LMTD)

To calculate the LMTD please use the following method;

L = Larger temperature difference from step 2.
M = S/L number (LOCATED IN TABLE A).

$LMTD_i$ = L x M

$LMTD_i$ = 50.8 x .992 (FROM TABLE A) = 50.39

To correct the $LMTD_i$ for a multipass heat exchangers calculate **R** & **K** as follows:

Formula

$$R = \frac{T_{in} - T_{out}}{t_{out} - t_{in}}$$

$$K = \frac{t_{out} - t_{in}}{T_{in} - t_{in}}$$

Example

$$R = \frac{125.3°F - 120°F}{74.5°F - 70°F} = \frac{5.3°F}{4.5°F} = \{1.17=R\}$$

$$K = \frac{74.5°F - 70°F}{124.5°F - 70°F} = \frac{4.5°F}{55.4°F} = \{0.081=K\}$$

Locate the correction factor CF_B (FROM TABLE B)
$LMTD_c = LMTD_i \times CF_B$
$LMTD_c$ = 50.39 x 1 = **50.39**

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STEP 4: Calculate the area required

Required Area sq.ft. = $\frac{\text{Q (BTU / HR)}}{\text{LMTD}_c \text{ x U (FROM TABLE C)}}$ $\frac{89{,}090}{50.39 \text{ x } 100}$ = **17.68 sq.ft.**

STEP 5: Selection

a) From TABLE E choose the correct series size, baffle spacing, and number of passes that best fits your flow rates for both shell and tube side. Note that the tables suggest minimum and maximum information. Try to stay within the 20-80 percent range of the indicated numbers.

Example

Oil Flow Rate = 80 GPM = Series Required from Table E = **1200 Series**
Baffle Spacing from Table E = **C baffle**
Water Flow Rate = 40 GPM = Passes required in 1200 series = **4 (FP)**

b) From TABLE D choose the heat exchanger model size based upon the sq.ft. or surface area in the series size that will accommodate your flow rate.

Example

Required Area = 17.68sq.ft Closest model required based upon sq.ft. & series= **AB-1202-C6-FP**

If you require a computer generated data sheet for the application, or if the information that you are trying to apply does not match the corresponding information, please contact our engineering services department for further assistance.

TABLE A- FACTOR M/LMTD = L x M

S/L	M	S/L	M	S/L	M	S/L	M
		.25	.541	.50	.721	.75	.870
.01	.215	.26	.549	.51	.728	.76	.864
.02	.251	.27	.558	.52	.734	.77	.879
.03	.277	.28	.566	.53	.740	.78	.886
.04	.298	.29	.574	.54	.746	.79	.890
.05	.317	.30	.582	.55	.753	.80	.896
.06	.334	.31	.589	.56	.759	.81	.902
.07	.350	.32	.597	.57	.765	.82	.907
.08	.364	.33	.604	.58	.771	.83	.913
.09	.378	.34	.612	.59	.777	.84	.918
.10	.391	.35	.619	.60	.783	.85	.923
.11	.403	.36	.626	.61	.789	.86	.928
.12	.415	.37	.634	.62	.795	.87	.934
.13	.427	.38	.641	.63	.801	.88	.939
.14	.438	.39	.648	.64	.806	.89	.944
.15	.448	.40	.655	.65	.813	.90	.949
.16	.458	.41	.662	.66	.818	.91	.955
.17	.469	.42	.669	.67	.823	.92	.959
.18	.478	.43	.675	.68	.829	.93	.964
.19	.488	.44	.682	.69	.836	.94	.970
.20	.497	.45	.689	.70	.840	.95	.975
.21	.506	.46	.695	.71	.848	.96	.979
.22	.515	.47	.702	.72	.852	.97	.986
.23	.524	.48	.709	.73	.658	.98	.991
.24	.533	.49	.715	.74	.864	.99	.995

LMTD correction factor for Multipass Exchangers

R

	.05	.1	.15	.2	.25	.3	.35	.4	.45	.5	.6	.7	.8	.9	1.0
.2	1	1	1	1	1	1	1	.999	.993	.984	.972	.942	.908	.845	.71
.4	1	1	1	1	1	1	.994	.983	.971	.959	.922	.855	.70		
.6	1	1	1	1	1	.992	.980	.965	.948	.923	.840				
.8	1	1	1	1	.995	.981	.965	.945	.916	.872					
1.0	1	1	1	1	.988	.970	.949	.918	.867	.770					
2.0	1	1	.977	.973	.940	.845	.740								
3.0	1	1	.997	.933	.835										
4.0	1	.993	.950	.850											
5.0	1	.982	.917												
6.0	1	.968	.885												
8.0	1	.930													
10.0	.996	.880													
12.0	.985	.720													
14.0	.972														
16.0	.958														
18.0	.940														
20.0	.915														

K

TABLE D- Surface Area

Model Number	Surface Area in Sq.ft. 1/4" O.D Tubing	3/8" O.D Tubing	5/8 O.D Tubing	Model Number	Surface Area in Sq.ft. 1/4" O.D Tubing	3/8" O.D Tubing	5/8 O.D Tubing
AB-401	1.4	–	–	AB-1602	44.4	30.3	17.6
AB-402	3.0	–	–	AB-1603	66.3	45.3	26.5
AB-403	4.6	–	–	AB-1604	88.3	60.3	35.3
				AB-1605	110.3	75.6	44.1
AB-701	3.6	2.6	–	AB-1606	132.3	90.4	53.0
AB-702	7.3	5.2	–	AB-1607	154.3	105.4	61.8
AB-703	11.1	7.9	–	AB-1608	176.3	120.4	70.6
AB-704	14.9	10.6	–	AB-1609	197.9	135.2	79.5
AB-705	18.7	13.3	–	AB-1610	219.9	150.2	88.3
				AB-1611	241.9	165.2	97.1
AB-1002	17.7	11.2	5.9	AB-1612	263.9	180.2	105.9
AB-1003	26.5	16.8	8.8	AB-1613	285.9	195.2	114.7
AB-1004	35.4	22.4	11.8				
AB-1005	44.3	28.0	14.7	AB-2004	155.1	110.7	60.8
AB-1006	53.2	33.6	17.6	AB-2005	193.8	138.4	76.1
				AB-2006	232.6	166.1	91.3
AB-1202	25.5	17.9	8.8	AB-2007	271.4	193.8	106.5
AB-1203	38.0	26.7	13.2	AB-2008	310.2	221.4	121.7
AB-1204	50.3	35.4	17.6	AB-2009	349.0	249.1	137.0
AB-1205	63.0	44.2	22.1	AB-2010	387.7	276.8	152.2
AB-1206	75.6	53.2	26.5	AB-2011	426.5	304.5	167.4
AB-1207	88.2	62.0	30.9	AB-2012	465.3	332.2	182.7
AB-1208	100.6	70.7	35.3	AB-2013	504.1	359.9	197.9
AB-1209	113.0	79.4	39.6	AB-2014	542.9	387.6	213.2
AB-1210	125.4	88.1	44.1	AB-2015	581.7	415.3	228.4

TABLE E- Flow Rate for Shell & Tube

Shell dia . Code	Max. Liquid Flow - Shell Side Baffle Spacing A	B	C	D	E	Liquid Flow - Tube Side SP Min.	SP Max.	TP Min.	TP Max.	FP Min.	FP Max.
400	10	15	20	–	–	3.5	21	–	–	–	–
700	17	29	30	35	–	9	61	4.5	30	2.2	15
1000	24	48	68	70	–	20	120	10	70	5.0	37
1200	29	56	105	115	120	30	250	15	112	7.5	56
1600	38	70	150	200	220	57	460	29	180	14	90
2000	–	–	190	370	550	90	650	45	320	25	160

TABLE C

U	TUBE FLUID	SHELL FLUID
400	Water	Water
350	Water	50% E. Glycol
100	Water	Oil
300	50% E. Glycol	50% E. Glycol
90	50% E. Glycol	Oil

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AB, SAE, STS, & EAB Series *performance*

Instructions

The selection chart provided contains an array of popular sizes for quick sizing. It does not provide curves for all models available. Refer to page 4 & 5 for detailed calculation information.

Computer selection data sheets for standard or special models are available through the engineering department of American Industrial. To use the followings graphs correctly, refer to the instruction notes "1-5".

1) HP Curves are based upon a 40°F approach temperature; for example: oil leaving a cooler at 125°F, using 85°F cooling water (125°F – 85°F = 40°F).

2) The oil to water ratio of 1:1 or 2:1 means that for every 1 gallon of oil circulated, a minimum of 1 or 1/2 gallon (respectively) of 85°F water must be circulated to match the curve results.

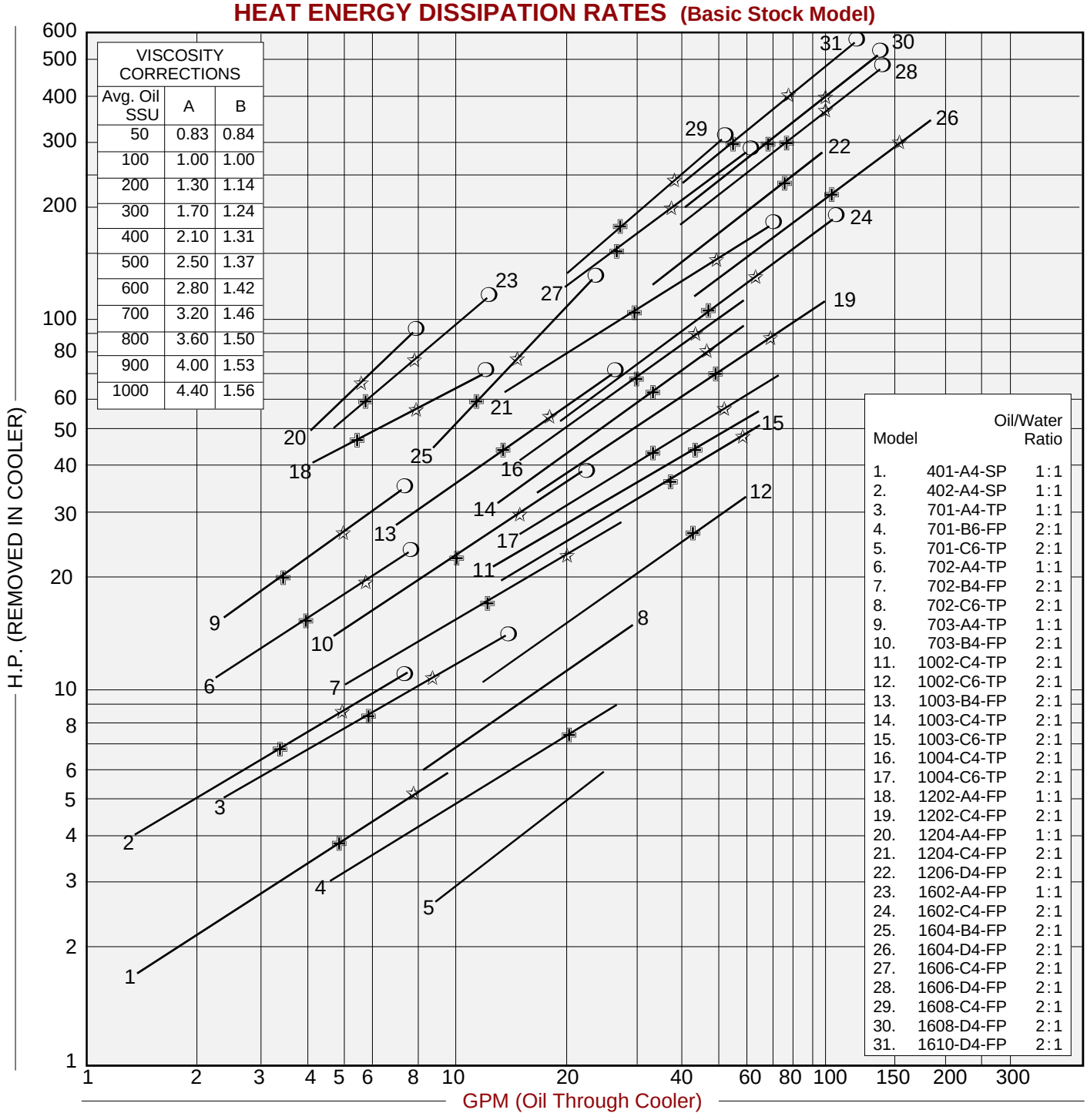
3) OIL PRESSURE DROP CODING: ✙ = 5 psi; ☆= 10 psi; ❍ = 20 psi; △ = 50psi. Curves that have no pressure drop code symbols indicate that the oil pressure drop is less than 5 psi for the flow rate shown.

4) Pressure Drop is based upon oil with an average viscosity of 100 SSU. If the average oil viscosity is other than 100 SSU, then multiply the indicated Pressure Drop by the corresponding value from corrections table A.

5) Corrections for approach temperature and oil viscosity are as follows:

$$H.P._{(\text{Removed In Cooler})} = H.P._{(\text{Actual Heat Load})} \times \left(\frac{40}{\text{Actual Approach}}\right) \times B.$$

HEAT ENERGY DISSIPATION RATES (Basic Stock Model)



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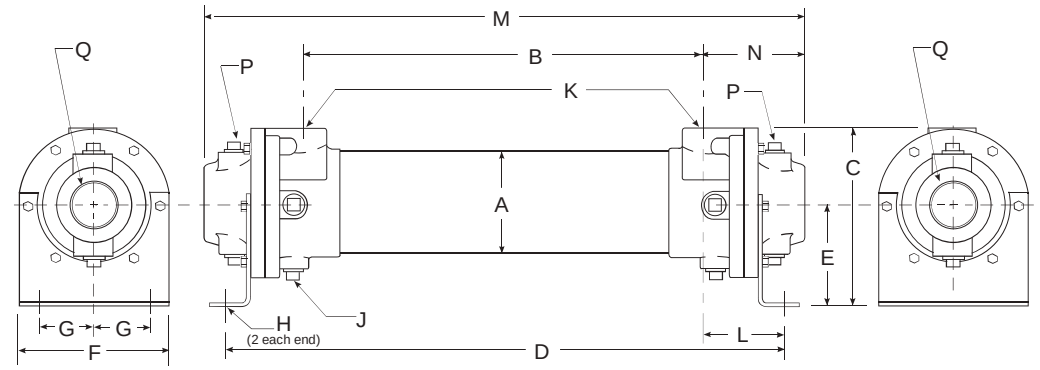
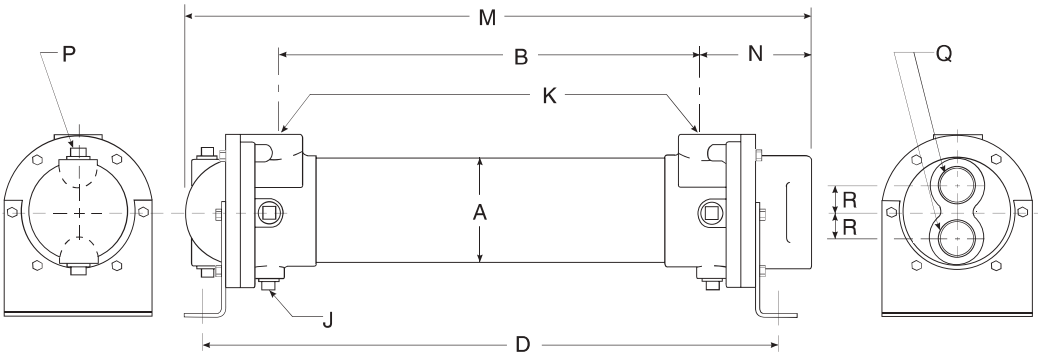
AB Series *dimensions*



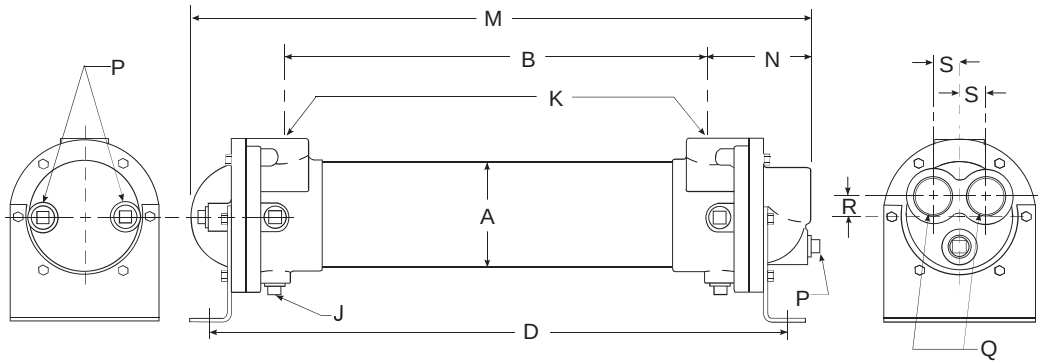
SINGLE PASS (SP)

Model	M	N	P NPT	Q NPT
AB-401	11.24	1.81	-	1.00
AB-402	20.24			
AB-701	13.47	3.24	(4) .38	1.50
AB-702	22.47			
AB-703	31.47			
AB-704	40.47			
AB-1002	23.60	4.05	(4) .38	2.00
AB-1003	32.60			
AB-1004	41.60			
AB-1202	24.38	4.88	(4) .50	3.00
AB-1203	33.25			
AB-1204	42.12			
AB-1205	51.12			
AB-1206	60.25			
AB-1207	69.25			
AB-1208	78.12			
AB-1209	87.12			
AB-1210	96.12			
AB-1602	26.62	6.52	(4) .50	4.00
AB-1603	35.62			
AB-1604	44.62			
AB-1605	53.62			
AB-1606	62.62			
AB-1607	71.62			
AB-1608	80.62			
AB-1609	89.62			
AB-1610	98.62			



TWO PASS (TP)

Model	M	N	P NPT	Q NPT	R
AB-701	13.28	3.30	(2) .38	1.00	.88
AB-702	22.28				
AB-703	31.28				
AB-704	40.28				
AB-1002	23.29	3.80	(2) .38	1.50	1.19
AB-1003	32.29				
AB-1004	41.29				
AB-1202	23.94	4.56	(2) .50	2.00	1.44
AB-1203	32.81				
AB-1204	41.69				
AB-1205	50.69				
AB-1206	59.81				
AB-1207	68.81				
AB-1208	77.69				
AB-1209	86.69				
AB-1210	95.69				
AB-1602	25.10	6.08	(2) .50	2.50	1.88
AB-1603	34.10				
AB-1604	43.10				
AB-1605	52.10				
AB-1606	61.10				
AB-1607	70.10				
AB-1608	79.10				
AB-1609	88.10				
AB-1610	97.10				



FOUR PASS (FP)

Model	M	N	P NPT	Q NPT	R	S
AB-701	13.42	3.24	(3) .38	.75	.62	.88
AB-702	22.42					
AB-703	31.42					
AB-704	40.42					
AB-1002	23.55	4.06	(3) .38	1.00	.75	1.19
AB-1003	32.55					
AB-1004	41.55					
AB-1202	24.44	4.90	(3) .50	1.50	1.06	1.44
AB-1203	33.31					
AB-1204	42.19					
AB-1205	51.19					
AB-1206	60.31					
AB-1207	69.31					
AB-1208	78.19					
AB-1209	87.19					
AB-1210	96.19					
AB-1602	26.72	6.48	(3) .50	2.00	1.38	1.88
AB-1603	35.72					
AB-1604	44.72					
AB-1605	53.72					
AB-1606	62.72					
AB-1607	71.72					
AB-1608	80.72					
AB-1609	89.72					
AB-1610	98.72					

COMMON DIMENSIONS & WEIGHTS

Model	A	B	C	D	E	F	G	H	J NPT	K NPT	L	Approx. Weight	Model
AB-401	2.13	7.62	3.50	10.91	1.94	2.62	.88	.41φ	-	.50	1.72	7	AB-401
AB-402		16.62		20.91								10	AB-402
AB-701	3.66	7.00	6.25	12.38	3.62	5.25	1.50	.44φ x 1.00	(2) .38	1.00	2.69	23	AB-701
AB-702		16.00		21.38								29	AB-702
AB-703		25.00		30.38								33	AB-703
AB-704		34.00		39.38								49	AB-704
AB-1002	5.13	15.50	7.38	21.62	4.00	6.75	2.00	.44φ x 1.00	(6) .38	1.50	3.06	54	AB-1002
AB-1003		24.50		30.62								76	AB-1003
AB-1004		33.50		39.62								82	AB-1004
AB-1202	6.13	14.62	8.81	21.50	4.75	7.50	2.50	.44φ x 1.00	(6) .38	2.00	3.44	79	AB-1202
AB-1203		23.50		30.38								98	AB-1203
AB-1204		32.38		39.25								115	AB-1204
AB-1205		41.38		48.25								130	AB-1205
AB-1206		50.50		57.38								150	AB-1206
AB-1207		59.50		66.38								170	AB-1207
AB-1208		68.38		75.25								190	AB-1208
AB-1209		77.38		84.25								210	AB-1209
AB-1210		86.38		93.25								230	AB-1210
AB-1602	8.00	13.60	12.13	22.38	6.50	10.00	3.50	.44φ x 1.00	(6) .38	3.00	4.39	145	AB-1602
AB-1603		22.60		31.38								170	AB-1603
AB-1604		31.60		40.38								200	AB-1604
AB-1605		40.60		49.38								225	AB-1605
AB-1606		49.60		58.38								250	AB-1606
AB-1607		58.60		67.38								275	AB-1607
AB-1608		67.60		76.38								315	AB-1608
AB-1609		76.60		85.38								350	AB-1609
AB-1610		85.60		94.38								390	AB-1610

note: AIHTI reserves the right to make reasonable design changes without notice.

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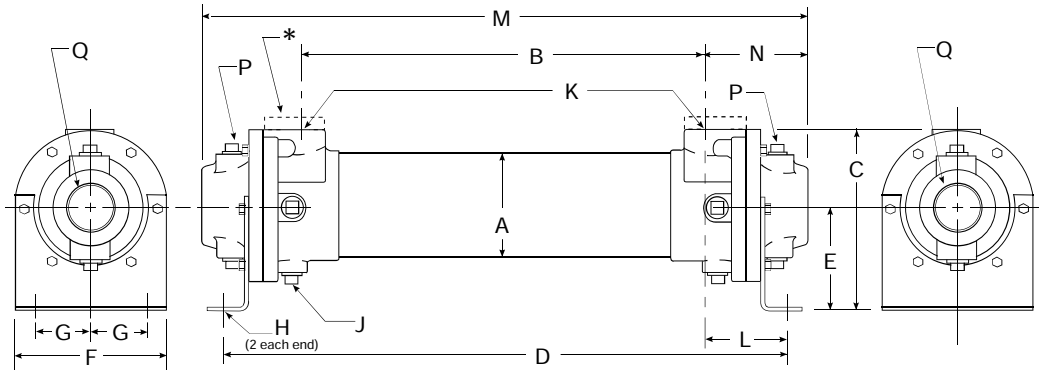
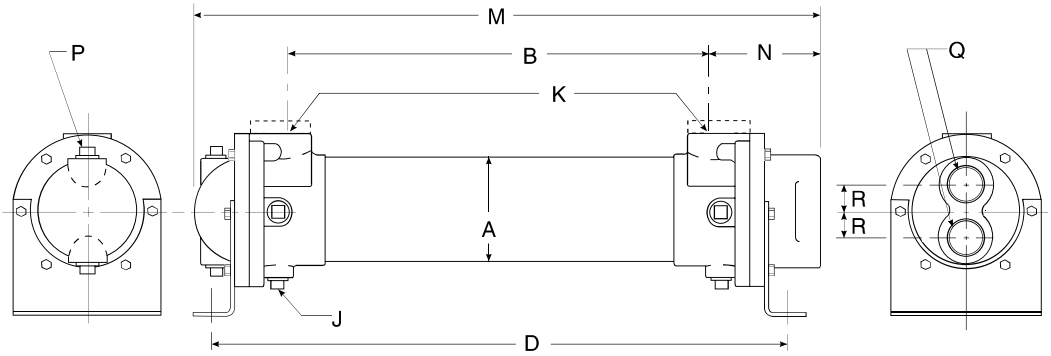
SAE Series *dimensions*



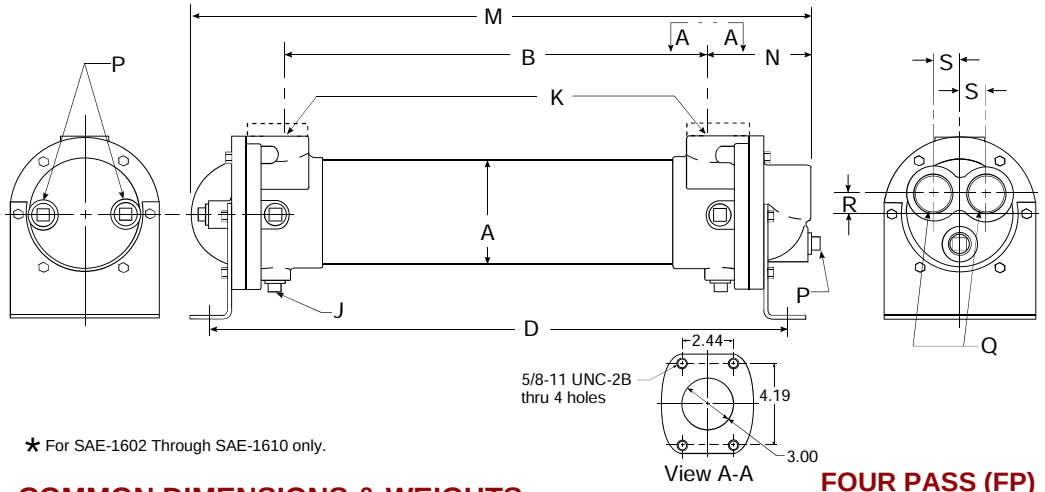
SINGLE PASS (SP)

Model	M	N	P NPT	Q NPT
SAE-401	11.24	1.81	-	1.00
SAE-402	20.24			
SAE-701	13.47	3.24	(4) .38	1.50
SAE-702	22.47			
SAE-703	31.47			
SAE-704	40.47			
SAE-1002	23.60	4.05	(4) .38	2.00
SAE-1003	32.60			
SAE-1004	41.60			
SAE-1202	24.38	4.88	(4) .50	3.00
SAE-1203	33.25			
SAE-1204	42.12			
SAE-1205	51.12			
SAE-1206	60.25			
SAE-1207	69.25			
SAE-1208	78.12			
SAE-1209	87.12			
SAE-1210	96.12			
SAE-1602	26.62	6.52	(4) .50	4.00
SAE-1603	35.62			
SAE-1604	44.62			
SAE-1605	53.62			
SAE-1606	62.62			
SAE-1607	71.62			
SAE-1608	80.62			
SAE-1609	89.62			
SAE-1610	98.62			



TWO PASS (TP)

Model	M	N	P NPT	Q NPT	R
SAE-701	13.28	3.30	(2) .38	1.00	.88
SAE-702	22.28				
SAE-703	31.28				
SAE-704	40.28				
SAE-1002	23.29	3.80	(2) .38	1.50	1.19
SAE-1003	32.29				
SAE-1004	41.29				
SAE-1202	23.94	4.56	(2) .50	2.00	1.44
SAE-1203	32.81				
SAE-1204	41.69				
SAE-1205	50.69				
SAE-1206	59.81				
SAE-1207	68.81				
SAE-1208	77.69				
SAE-1209	86.69				
SAE-1210	95.69				
SAE-1602	25.10	6.08	(2) .50	2.50	1.88
SAE-1603	34.10				
SAE-1604	43.10				
SAE-1605	52.10				
SAE-1606	61.10				
SAE-1607	70.10				
SAE-1608	79.10				
SAE-1609	88.10				
SAE-1610	97.10				



FOUR PASS (FP)

Model	M	N	P NPT	Q NPT	R	S
SAE-701	13.42	3.24	(3) .38	.75	.62	.88
SAE-702	22.42					
SAE-703	31.42					
SAE-704	40.42					
SAE-1002	23.55	4.06	(3) .38	1.00	.75	1.19
SAE-1003	32.55					
SAE-1004	41.55					
SAE-1202	24.44	4.90	(3) .50	1.50	1.06	1.44
SAE-1203	33.31					
SAE-1204	42.19					
SAE-1205	51.19					
SAE-1206	60.31					
SAE-1207	69.31					
SAE-1208	78.19					
SAE-1209	87.19					
SAE-1210	96.19					
SAE-1602	26.72	6.48	(3) .50	2.00	1.38	1.88
SAE-1603	35.72					
SAE-1604	44.72					
SAE-1605	53.72					
SAE-1606	62.72					
SAE-1607	71.72					
SAE-1608	80.72					
SAE-1609	89.72					
SAE-1610	98.72					

* For SAE-1602 Through SAE-1610 only.

COMMON DIMENSIONS & WEIGHTS

Model	A	B	C	D	E	F	G	H	J NPT	K SAE	L	Approx. Weight	Model
SAE-401	2.13	7.62	3.50	10.91	1.94	2.62	.88	.41φ	-	#8	1.72	7	SAE-401
SAE-402		16.62		20.91						3/4-16		10	SAE-402
SAE-701	3.66	7.00	6.25	12.38	3.62	5.25	1.50	.44φ x 1.00	(2) .38	#16 1 5/16-12	2.69	23	SAE-701
SAE-702		16.00		21.38								29	SAE-702
SAE-703		25.00		30.38								33	SAE-703
SAE-704		34.00		39.38								49	SAE-704
SAE-1002	5.13	15.50	7.38	21.62	4.00	6.75	2.00	.44φ x 1.00	(6) .38	#24 1 7/8-12	3.06	54	SAE-1002
SAE-1003		24.50		30.62								76	SAE-1003
SAE-1004		33.50		39.62								82	SAE-1004
SAE-1202	6.13	14.62	8.81	21.50	4.75	7.50	2.50	.44φ x 1.00	(6) .38	#32 2 1/2-12	3.44	79	SAE-1202
SAE-1203		23.50		30.38								98	SAE-1203
SAE-1204		32.38		39.25								115	SAE-1204
SAE-1205		41.38		48.25								130	SAE-1205
SAE-1206		50.50		57.38								150	SAE-1206
SAE-1207		59.50		66.38								170	SAE-1207
SAE-1208		68.38		75.25								190	SAE-1208
SAE-1209		77.38		84.25								210	SAE-1209
SAE-1210		86.38		93.25								230	SAE-1210
SAE-1602	8.00	13.60	12.13	22.38	6.50	10.00	3.50	.44φ x 1.00	(6) .38	3.0" Four bolt Flange	4.39	145	SAE-1602
SAE-1603		22.60		31.38								170	SAE-1603
SAE-1604		31.60		40.38								200	SAE-1604
SAE-1605		40.60		49.38								225	SAE-1605
SAE-1606		49.60		58.38								250	SAE-1606
SAE-1607		58.60		67.38								275	SAE-1607
SAE-1608		67.60		76.38								315	SAE-1608
SAE-1609		76.60		85.38								350	SAE-1609
SAE-1610		85.60		94.38								390	SAE-1610

note: AIHTI reserves the right to make reasonable design changes without notice.

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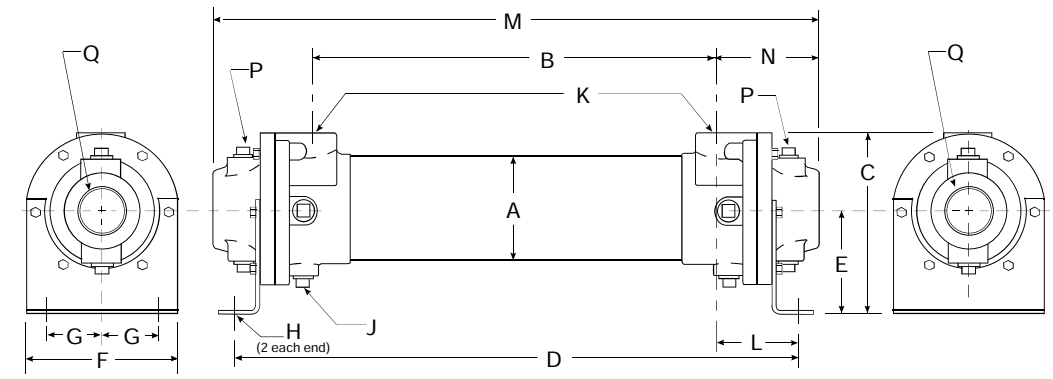
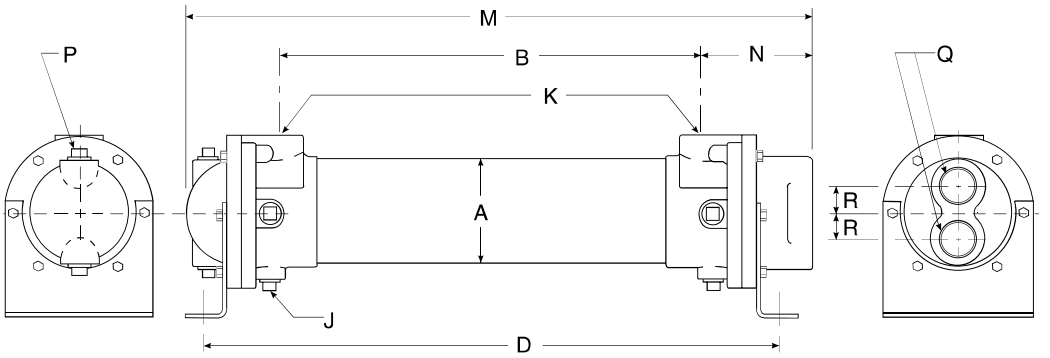
STS Series *dimensions*



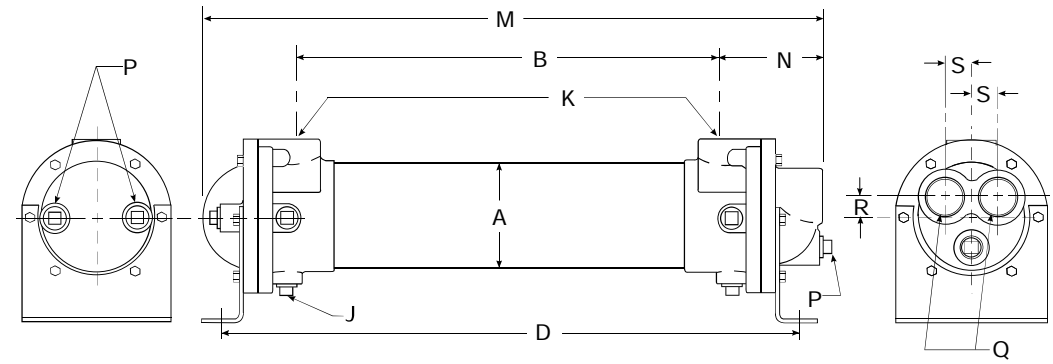
SINGLE PASS (SP)

Model	M	N	P NPT	Q NPT
STS-401	11.24	1.81	-	1.00
STS-402	20.24			
STS-701	13.47	3.24	(4) .38	1.50
STS-702	22.47			
STS-703	31.47			
STS-704	40.47			
STS-1002	23.60	4.05	(4) .38	2.00
STS-1003	32.60			
STS-1004	41.60			
STS-1202	24.38	4.88	(4) .50	3.00
STS-1203	33.25			
STS-1204	42.12			
STS-1205	51.12			
STS-1206	60.25			
STS-1207	69.25			
STS-1208	78.12			
STS-1209	87.12			
STS-1210	96.12			
STS-1602	26.62	6.52	(4) .50	4.00
STS-1603	35.62			
STS-1604	44.62			
STS-1605	53.62			
STS-1606	62.62			
STS-1607	71.62			
STS-1608	80.62			
STS-1609	89.62			
STS-1610	98.62			



TWO PASS (TP)

Model	M	N	P NPT	Q NPT	R
STS-701	13.28	3.30	(2) .38	1.00	.88
STS-702	22.28				
STS-703	31.28				
STS-704	40.28				
STS-1002	23.29	3.80	(2) .38	1.50	1.19
STS-1003	32.29				
STS-1004	41.29				
STS-1202	23.94	4.56	(2) .50	2.00	1.44
STS-1203	32.81				
STS-1204	41.69				
STS-1205	50.69				
STS-1206	59.81				
STS-1207	68.81				
STS-1208	77.69				
STS-1209	86.69				
STS-1210	95.69				
STS-1602	25.10	6.08	(2) .50	2.50	1.88
STS-1603	34.10				
STS-1604	43.10				
STS-1605	52.10				
STS-1606	61.10				
STS-1607	70.10				
STS-1608	79.10				
STS-1609	88.10				
STS-1610	97.10				



FOUR PASS (FP)

Model	M	N	P NPT	Q NPT	R	S
STS-701	13.42	3.24	(3) .38	.75	.62	.88
STS-702	22.42					
STS-703	31.42					
STS-704	40.42					
STS-1002	23.55	4.06	(3) .38	1.00	.75	1.19
STS-1003	32.55					
STS-1004	41.55					
STS-1202	24.44	4.90	(3) .50	1.50	1.06	1.44
STS-1203	33.31					
STS-1204	42.19					
STS-1205	51.19					
STS-1206	60.31					
STS-1207	69.31					
STS-1208	78.19					
STS-1209	87.19					
STS-1210	96.19					
STS-1602	26.72	6.48	(3) .50	2.00	1.38	1.88
STS-1603	35.72					
STS-1604	44.72					
STS-1605	53.72					
STS-1606	62.72					
STS-1607	71.72					
STS-1608	80.72					
STS-1609	89.72					
STS-1610	98.72					

COMMON DIMENSIONS & WEIGHTS

Model	A	B	C	D	E	F	G	H	J NPT	K NPT	L	Approx. Weight	Model
STS-401	2.13	7.62	3.50	10.91	1.94	2.62	.88	.41φ	-	.50	1.72	7	STS-401
STS-402		16.62		20.91								10	STS-402
STS-701	3.66	7.00	6.25	12.38	3.62	5.25	1.50	.44φ x 1.00	(2) .38	1.00	2.69	23	STS-701
STS-702		16.00		21.38								29	STS-702
STS-703		25.00		30.38								33	STS-703
STS-704		34.00		39.38								49	STS-704
STS-1002	5.13	15.50	7.38	21.62	4.00	6.75	2.00	.44φ x 1.00	(6) .38	1.50	3.06	54	STS-1002
STS-1003		24.50		30.62								76	STS-1003
STS-1004		33.50		39.62								82	STS-1004
STS-1202	6.13	14.62	8.81	21.50	4.75	7.50	2.50	.44φ x 1.00	(6) .38	2.00	3.44	79	STS-1202
STS-1203		23.50		30.38								98	STS-1203
STS-1204		32.38		39.25								115	STS-1204
STS-1205		41.38		48.25								130	STS-1205
STS-1206		50.50		57.38								150	STS-1206
STS-1207		59.50		66.38								170	STS-1207
STS-1208		68.38		75.25								190	STS-1208
STS-1209		77.38		84.25								210	STS-1209
STS-1210		86.38		93.25								230	STS-1210
STS-1602	8.00	13.60	12.13	22.38	6.50	10.00	3.50	.44φ x 1.00	(6) .38	3.00	4.39	145	STS-1602
STS-1603		22.60		31.38								170	STS-1603
STS-1604		31.60		40.38								200	STS-1604
STS-1605		40.60		49.38								225	STS-1605
STS-1606		49.60		58.38								250	STS-1606
STS-1607		58.60		67.38								275	STS-1607
STS-1608		67.60		76.38								315	STS-1608
STS-1609		76.60		85.38								350	STS-1609
STS-1610		85.60		94.38								390	STS-1610

note: AIHTI reserves the right to make reasonable design changes without notice.

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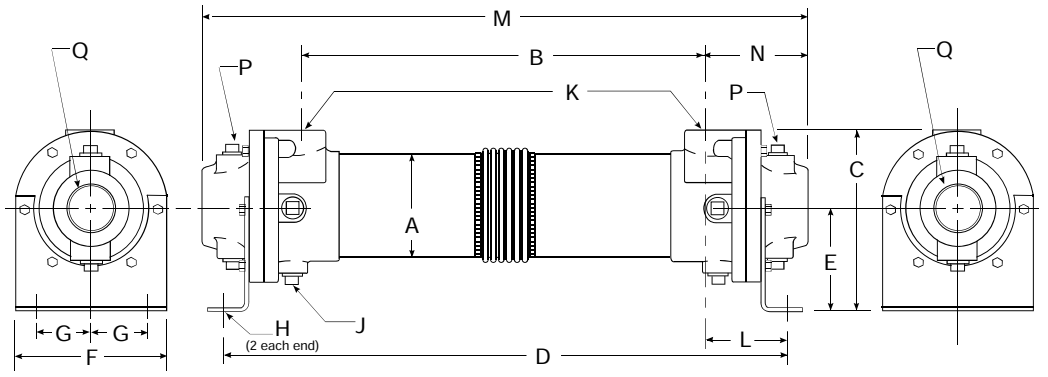
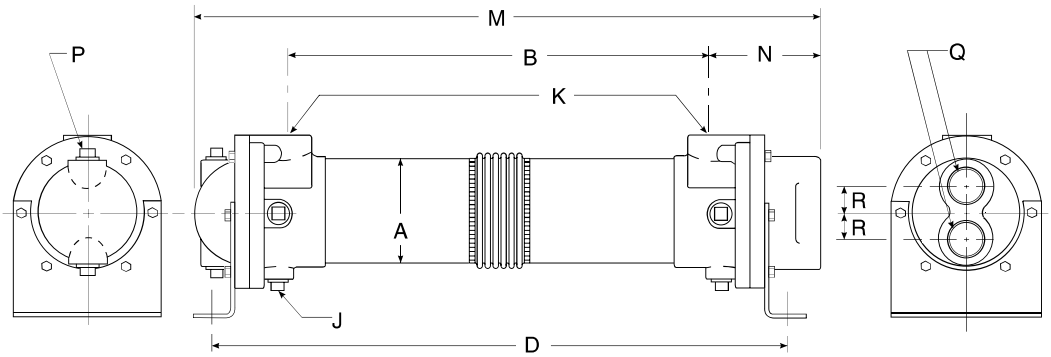
EAB Series *dimensions*



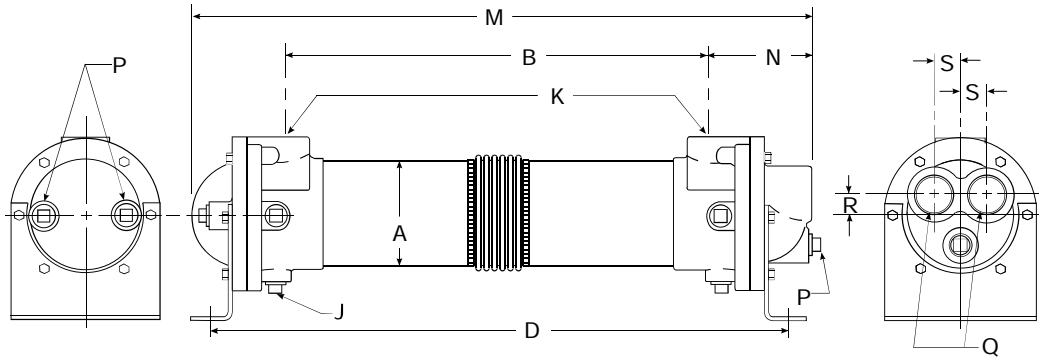
SINGLE PASS (SP)

Model	M	N	P NPT	Q NPT
EAB-701	13.47	3.24	(4) .38	1.50
EAB-702	22.47			
EAB-703	31.47			
EAB-704	40.47			
EAB-1002	23.60	4.05	(4) .38	2.00
EAB-1003	32.60			
EAB-1004	41.60			
EAB-1202	24.38	4.88	(4) .50	3.00
EAB-1203	33.25			
EAB-1204	42.12			
EAB-1205	51.12			
EAB-1206	60.25			
EAB-1207	69.25			
EAB-1208	78.12			
EAB-1209	87.12			
EAB-1210	96.12			
EAB-1602	26.62	6.52	(4) .50	4.00
EAB-1603	35.62			
EAB-1604	44.62			
EAB-1605	53.62			
EAB-1606	62.62			
EAB-1607	71.62			
EAB-1608	80.62			
EAB-1609	89.62			
EAB-1610	98.62			



TWO PASS (TP)

Model	M	N	P NPT	Q NPT	R
EAB-701	13.28	3.30	(2) .38	1.00	.88
EAB-702	22.28				
EAB-703	31.28				
EAB-704	40.28				
EAB-1002	23.29	3.80	(2) .38	1.50	1.19
EAB-1003	32.29				
EAB-1004	41.29				
EAB-1202	23.94	4.56	(2) .50	2.00	1.44
EAB-1203	32.81				
EAB-1204	41.69				
EAB-1205	50.69				
EAB-1206	59.81				
EAB-1207	68.81				
EAB-1208	77.69				
EAB-1209	86.69				
EAB-1210	95.69				
EAB-1602	25.10	6.08	(2) .50	2.50	1.88
EAB-1603	34.10				
EAB-1604	43.10				
EAB-1605	52.10				
EAB-1606	61.10				
EAB-1607	70.10				
EAB-1608	79.10				
EAB-1609	88.10				
EAB-1610	97.10				



FOUR PASS (FP)

Model	M	N	P NPT	Q NPT	R	S
EAB-701	13.42	3.24	(3) .38	.75	.62	.88
EAB-702	22.42					
EAB-703	31.42					
EAB-704	40.42					
EAB-1002	23.55	4.06	(3) .38	1.00	.75	1.19
EAB-1003	32.55					
EAB-1004	41.55					
EAB-1202	24.44	4.90	(3) .50	1.50	1.06	1.44
EAB-1203	33.31					
EAB-1204	42.19					
EAB-1205	51.19					
EAB-1206	60.31					
EAB-1207	69.31					
EAB-1208	78.19					
EAB-1209	87.19					
EAB-1210	96.19					
EAB-1602	26.72	6.48	(3) .50	2.00	1.38	1.88
EAB-1603	35.72					
EAB-1604	44.72					
EAB-1605	53.72					
EAB-1606	62.72					
EAB-1607	71.72					
EAB-1608	80.72					
EAB-1609	89.72					
EAB-1610	98.72					

COMMON DIMENSIONS & WEIGHTS

Model	A	B	C	D	E	F	G	H	J NPT	K NPT	L	Approx. Weight	Model
EAB-701	3.66	7.00	6.25	12.38	3.62	5.25	1.50	.44φ x 1.00	(2) .38	1.00	2.69	23	EAB-701
EAB-702		16.00		21.38								29	EAB-702
EAB-703		25.00		30.38								33	EAB-703
EAB-704		34.00		39.38								49	EAB-704
EAB-1002	5.13	15.50	7.38	21.62	4.00	6.75	2.00	.44φ x 1.00	(6) .38	1.50	3.06	54	EAB-1002
EAB-1003		24.50		30.62								76	EAB-1003
EAB-1004		33.50		39.62								82	EAB-1004
EAB-1202	6.13	14.62	8.81	21.50	4.75	7.50	2.50	.44φ x 1.00	(6) .38	2.00	3.44	79	EAB-1202
EAB-1203		23.50		30.38								98	EAB-1203
EAB-1204		32.38		39.25								115	EAB-1204
EAB-1205		41.38		48.25								130	EAB-1205
EAB-1206		50.50		57.38								150	EAB-1206
EAB-1207		59.50		66.38								170	EAB-1207
EAB-1208		68.38		75.25								190	EAB-1208
EAB-1209		77.38		84.25								210	EAB-1209
EAB-1210		86.38		93.25								230	EAB-1210
EAB-1602	8.00	13.60	12.13	22.38	6.50	10.00	3.50	.44φ x 1.00	(6) .38	3.00	4.39	145	EAB-1602
EAB-1603		22.60		31.38								170	EAB-1603
EAB-1604		31.60		40.38								200	EAB-1604
EAB-1605		40.60		49.38								225	EAB-1605
EAB-1606		49.60		58.38								250	EAB-1606
EAB-1607		58.60		67.38								275	EAB-1607
EAB-1608		67.60		76.38								315	EAB-1608
EAB-1609		76.60		85.38								350	EAB-1609
EAB-1610		85.60		94.38								390	EAB-1610

note: AIHTI reserves the right to make reasonable design changes without notice.

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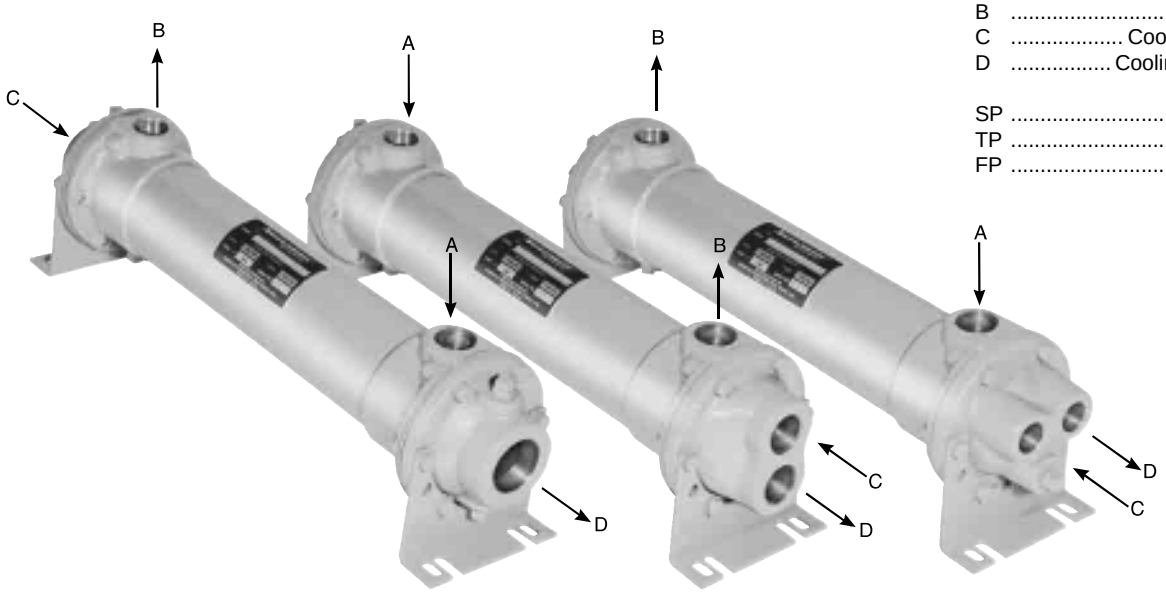
PIPING HOOK-UP

A ..... Hot fluid to be cooled
B ..... Cooled fluid
C ..... Cooling water in
D ..... Cooling water out

SP ..... Single Pass
TP ..... Two Pass
FP .....Four Pass



SINGLE PASS **TWO PASS** **FOUR PASS**

Receiving / Installation

a) Inspect unit for any shipping damage before uncrating. Indicate all damages to the trucking firms' delivery person, and mark it on the receiving bill before accepting the freight. Make sure that there is no visible damage to the outside surface of the heat exchanger. The published weight information located in this brochure is approximate. True shipment weights are determined at the time of shipping and may vary. Approximate weight information published herein is for engineering approximation purposes and should not be used for exact shipping weight. Since the warranty is based upon the unit date code located on the model identification tags, removal or manipulation of the identification tags will void the manufacturers warranty.

b) When handling the shell & tube heat exchanger, special care should be taken to avoid dropping the unit since mishandling could cause the heat exchanger to crack and leak externally. Mishandling of the unit is not covered under the manufacturers warranty. All units are shipped with partial wood/corrugated cardboard containers for safe handling.

c) Storage: American Industrial heat exchangers are protected against the elements during shipment. If the heat exchanger cannot be installed and put into operation immediately upon receipt, certain precautions are required to prevent deterioration during storage. The responsibility for integrity of the heat exchanger(s) is assumed by the user. American Industrial will not be responsible for damage, corrosion, or other deterioration of the heat exchanger during transit or storage.
Proper storage practices are important when considering the high costs of repair or replacement, and the possible delays for items which require long lead times for manufacture. The following listed practices are provided solely as a convenience to the user, who shall make their own decision on whether to use all or any of them.

1) Heat exchangers not to be placed in immediate service, require precautionary measures to prevent corrosion or contamination.
2) Heat exchangers made of ferrous materials, may be pressure-tested using compressed air at the factory. Residual oil coating on the inside surfaces of the heat exchanger(s) as a result of flushing does not discount the possibility of internal corrosion. Upon receipt, fill the heat exchanger(s) with the appropriate grade of oil or apply a corrosion preventing inhibitor for storage.
3) Corrosion protection compounds for interior surfaces for long term storage or other applications are applied solely at the request of customers. Upon request, American Industrial can provide a customer approved corrosion preventative if available when included in the original purchase order specifications.
4) Remove all dirt, water, ice, or snow and wipe dry before moving heat exchanger(s) into storage. Heat exchangers are generally shipped empty, open drain plugs to remove any accumulated condensation moisture, then reseal. Accumulation of moisture usually indicates corrosion has already started and remedial action should be taken.
5) Store in a covered, environmentally stable area. The ideal storage environment for heat exchangers is in a dry, low-humidity atmosphere which is sealed to prevent the entry of blowing dust, rain, or snow. Maintain in atmospheric temperatures between 70°F and 105°F (Large temperature swings may cause condensation and moisture to form on steel components, threads, shell, etc...) Use thermometers and humidity indicators and maintain the atmosphere at 40% relative humidity, or lower.

d) Standard Enamel Coating: American Industrial provides its standard products with a normal base coat of oil base air cure enamel paint. The enamel paint is applied as a temporary protective and esthetic coating prior to shipment. While the standard enamel coating is durable, American Industrial does not warranty it as a long-term finish coating. It is strongly suggested that a more durable final coating be applied after installation or prior to long-term storage in a corrosive environment to cover any accidental scratches, enhance esthetics, and further prevent corrosion. It is the responsibility of the customer to provide regular maintenance against chips, scratches, etc... and regular touch up maintenance must be provided for long-term benefits and corrosion prevention.

e) Special Coatings: American Industrial offers as customer options, Air-Dry Epoxy, and Heresite (Air-Dry Phenolic) coatings at additional cost. American Industrial offers special coatings upon request, however American Industrial does not warranty coatings to be a permanent solution for any equipment against corrosion. It is the responsibility of the customer to provide regular maintenance against chips, scratches, etc... and regular touch up maintenance must be provided for long-term benefits and corrosion prevention.

f) American Industrial recommends that the equipment supplied should be installed by qualified personnel who have solid understanding of system design, pressure and temperature ratings, and piping assembly. Verify the service conditions of the system prior to applying any shell & tube heat exchanger. If the system pressure or temperature does not fall within the parameters on model rating tag located on the heat exchanger, contact our factory prior to installation or operation.

g) Plan the installation to meet the requirements indicated on the piping installation diagram as illustrated above. It is recommended to put the hot fluid to be cooled through the shell side and the cold fluid through the tube side. The indicated port assembly sequence in the diagram maximizes the performance, and minimizes the possibility of thermal shock.

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In instances where the fluids are required to be reversed, *hot fluid in the tubes and cold fluid in the shell* the heat exchanger will work with reduced performance. Installation may be vertical or horizontal or a combination thereof. However, the installation must allow for complete draining of the heat exchanger regardless of single pass, two pass, or four pass construction. Complete drainage is important to prevent the heat exchanger from freezing, over-heating of a fluid, or mineral deposit buildup.
For fixed bundle heat exchangers, provide sufficient clearance at one end to allow for the removal or replacement of tubes. On the opposite end, provide enough space to allow removal of the complete bonnet to provide sufficient clearance to permit tube rolling and cleaning. Allow accessible room for scheduled cleaning as needed. Include thermometer wells and pressure gauge pipe ports in piping to and from the heat exchanger located as close to the heat exchanger as possible. For more information please contact American Industrial.

h) When installing a series EAB heat exchanger (expansion bellow), it is recommended to use a shoulder bolt to allow the heat exchanger to move freely while expanding and contracting due to high differential temperatures.

i) It is recommended to use flexible hose wherever possible to reduce vibration and allow slight movement. However, hoses are not required. Hydraulic carrying lines should be sized to handle the appropriate flow and to meet system pressure drop requirements based upon the systems parameters, and not based upon the units supply and return connection size. We recommend that a low cracking pressure direct acting relief valve be installed at the heat exchanger inlet to protect it from pressure spikes by bypassing oil in the event the system experiences a high flow surge. If preventative filtration is used it should be located ahead of the cooler on both shell and tube side to catch any scale or sludge from the system before it enters the cooler. Failure to install filters ahead of the heat exchanger could lead to possible heat exchanger failure due to high pressure if the system filters plug.

j) Standard shell & tube coolers are built with a rolled tube-sheet construction. However, the differential operating temperature between the entering shell side fluid and the entering tube side fluid should not exceed 150°F. If this condition exists, a severe thermal shock could occur leading to product failure and mixing of the fluids. For applications with a differential temperatures of 150°F or more, we recommend using a series with a floating tube-sheet, u-tube, or expansion joint to reduce the potential for the effects of thermal shock.

k) Water requirements vary from location to location. If the source of cooling water is from other than a municipal water supply, it is recommended that a water strainer be installed ahead of the heat exchanger to prevent dirt and debris from entering and clogging the flow passages. If a water modulating valve is used it is recommended to be installed at the inlet to the cooler to regulate the water flow.

l) For steam service, or other related applications, please consult our engineering department for additional information.

Maintenance
a) Inspect the heat exchanger for loosened bolts, connections, rust spots, corrosion, and for internal or external fluid leakage. Any corroded surfaces should be cleaned and recoated with paint.

b) Shell side: In many cases with clean hydraulic system oils it will not be necessary to flush the interior of the shell side of the cooler. In circumstances where the quality of hydraulic fluid is in question, the shell side should be disconnected and flushed on a yearly basis with a clean flushing oil/solvent to remove any sludge that has been deposited. For severe cases where the unit is plugged and cannot be flushed clean with solvent, the heat exchanger should be replaced to maintain the proper cooling performance.

c) Tube side: In many cases it will be necessary to clean the tube side of the heat exchanger due to poor fluid quality, debris, calcium deposits, corrosion, mud, sludge, seaweed, etc.... To clean the tube side, flush with clean water or any good quality commercial cleaner that does not attack the particular material of construction. With straight tube heat exchangers you can use a rod to carefully push any debris out of the tubes.

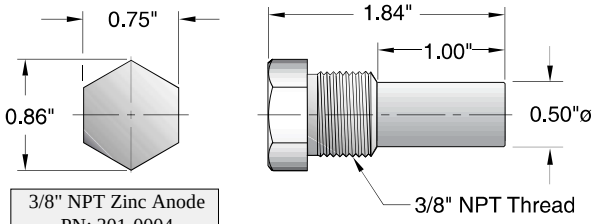
d) Zinc anodes are normally used to reduce the risk of failure due to electrolysis. Zinc anodes are a sacrificial component designed to wear and dissolve through normal use. Normally, zinc anodes are applied to the water supply side of the heat exchanger. Depending upon the amount of corrosive action, one, two, three, or more anodes can be applied to help further reduce the risk of failure. American Industrial Heat Transfer, Inc. offers zinc anodes as an option, to be specified and installed at the request our customers. It is the responsibility of the customer to periodically check and verify the condition of the zinc anode and replace it as needed.

Applications vary due to water chemical makeup and quality, material differences, temperature, flow rate, piping arrangements, and machine grounding. For those reasons, zinc anodes do not follow any scheduled factory predetermined maintenance plan moreover they must be checked routinely by the customer, and a maintenance plan developed based upon the actual wear rate.

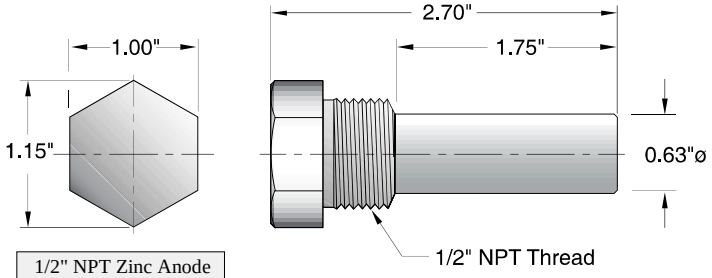
If substantial wear occurs or zinc dissolves without replacement, premature failure or permanent damage may occur to the heat exchanger. American Industrial does not warranty customer applications. It is the responsibility of the customer to verify and apply the proper system materials of construction and overall system requirements. Failures resulting from properly applied or misapplied use of zinc anode(s) into non-specified or specified applications will be the sole responsibility of the customer.

e) A routine maintenance schedule should be developed and adjusted to meet your systems requirements based upon water quality, etc….Failure to regularly maintain and clean your heat exchanger can result in a reduction in operational performance and life expectancy.

Note: *Since applications can vary substantially, the installation and maintenance information contained in this catalog should be used as a basic guideline. The safe installation, maintenance, and use of any American Industrial Heat Transfer, Inc. heat exchanger are solely the responsibility of the user.*



3/8" NPT Zinc Anode PN: 301-0004
AB-400 thru AB-1000 AA-400 thru AA-1000 CS-600 thru CS-1000



1/2" NPT Zinc Anode PN: 301-0003
AB-1200 thru AB-2000 AA-1200 thru AA-1600 CS-1200 thru CS-1700

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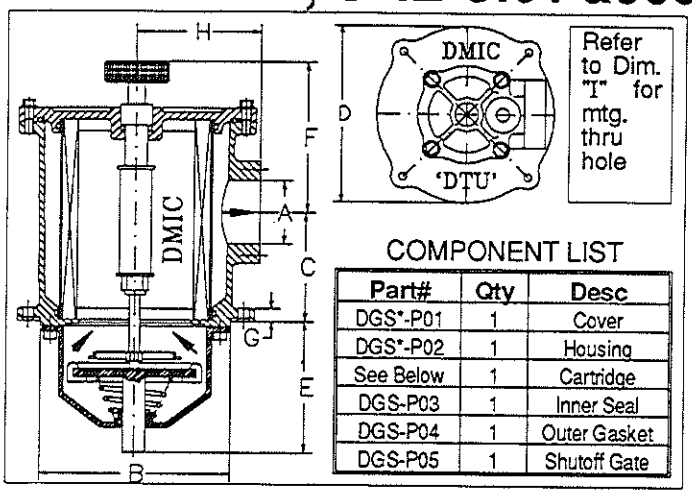
'DGS' Giant Suction Filter

Low restriction high flow capacity for big power units to 100+ GPM; SAE C.61 accepts 'SSW' System; 2"-4" port



COMPONENT LIST

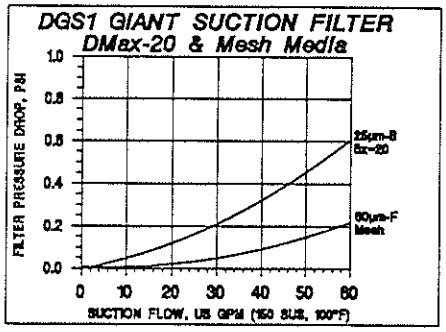
Part#	Qty	Desc
DGS*-P01	1	Cover
DGS*-P02	1	Housing
See Below	1	Cartridge
DGS-P03	1	Inner Seal
DGS-P04	1	Outer Gasket
DGS-P05	1	Shutoff Gate

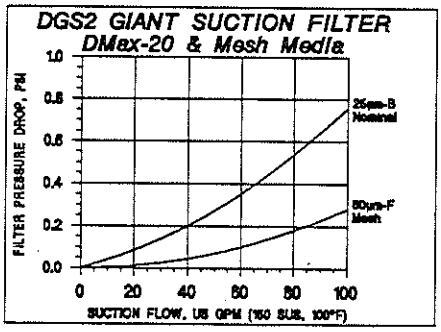
Expensive, high flow pumps need more than just a suction strainer

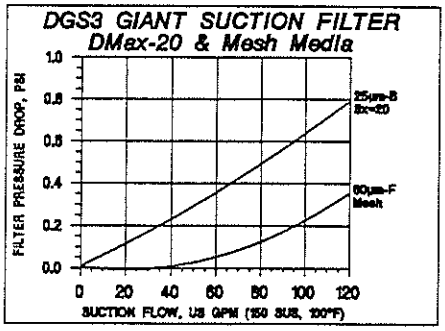
The **'DGS'** reservoir side mounted filter is the optimum choice for power units woitlarge suction systems. Huge flow capacities in large port sizes virtually eliminate cavitation, especially when used in conjunction with the 'SSW' Ball Valve System. The knob-actuated gate is used to close the filter housing from the tank for almost drip-free element changes.

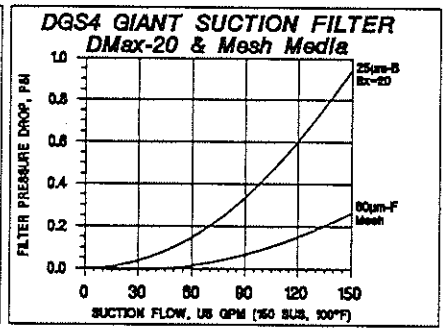
Optional indicators and "Gate Open" indicators can be ordered to integrate with power unit electrical warning systems, for the total, quality-oriented design solution.

'DGS' Flow Characteristic Curves









Ordering Codes for 'DGS' Filters

DGS3 – F F V -

Cartridge:
B: 25µm, β_x=20
F: 60µm, β_x=75

Indicator:
N: None
V: Gauge, #DM-VIS
B: Popup, #DM-BIS
E: Electric, #DM-EIS

Gate Safety Swch:
Indicates if valve open. Append "/GS"

Connection:
SAE Code 61 Flange

Seal Override:
Blank for Buna-N
E: EPR/Skydrol
V: Viton

'DGS' Performance Parms:

BODY	Aluminum Alloy
COVER	Aluminum Alloy
PORTING	SAE C.61 Flange
FLOW FATIGUE	ISO 3724
FILTRATION MEDIUM	Microglass / Mesh
FLUID COMPATIBILITY	Petroleum, ISO 2943
FLOW TEST GUIDELINE	ISO 3968
WORKING PRESSURE	Suction Line
BYPASS SETTING	None
TEMPERATURE RANGE	-5°F/195°F (-20/120°C)

Selection Guide and Specifications for 'DGS' Giant Suction Filters:

Filter Line	Filter Model	Port A	Cartridge	Flow GPM[1]	DIMENSIONS (inches) B	C	D	E	F	G	H	I	Repl. Element
DGS1	DGS1-BF*	2" C.61	25 µm, β_x=20	21	4.41	4.76	5.16	5.12	6.14	0.39	3.31	0.35	D16120BN
	DGS1-FF*		60 µm, β_x=75	32									D16120FN
DGS2	DGS2-BF*	2½" C.61	25 µm, β_x=20	30	5.35	4.76	6.34	5.12	6.14	0.39	3.74	0.51	D16200BN
	DGS1-FF*		60 µm, β_x=75	52									D16200FN
DGS3	DGS3-BF*	3" C.61	25 µm, β_x=20	50	5.91	4.76	7.09	5.12	6.14	0.47	4.33	0.51	D16300BN
	DGS1-FF*		60 µm, β_x=75	78									D16300FN
DGS4	DGS4-BF*	4" C.61	25 µm, β_x=20	65	7.09	4.76	8.27	5.12	6.14	0.47	4.72	0.51	D16400BN
	DGS1-FF*		60 µm, β_x=75	105									D16400FN

Notes: (1) Flows are quoted in U.S. gallons at 18 PSI pressure drop through a clean filter element using 150 SUS hydraulic oil at

PARKER MODUFLOW™ FILTER
Types CF2, RF2, IL2

- More dirt holding capacity
- Lower pressure drop
- No trickling bypass
- Five mounting and porting options
- Tells-All indicator* shows when no element installed
- Easy to service

*Patent pending

ModuFlow™
A breakthrough in filter technology

From inlet port to element to bypass valve, Parker ModuFlow Filters provide the high level of hydraulic filtration and long-term dependability so vital to today's hydraulic systems being used on precision tools, sophisticated control systems, and hydraulic-powered vehicles.

Greater efficiency

This filter generates less pressure drop than comparably sized filters. Yet it maintains maximum filtration of particles as small as 1 micron in size. A unique Parker-developed flow diverter minimises turbulence in the fluid flow; this lessens the pressure drop of fluid passing through the ModuFlow Filter. Dead air space between the unique concave cover and the improved filter element has been reduced to a minimum. This reduces the potential loss of prime encountered on variable volume pumps when used with conventional suction filters.

Mounting/Porting Configurations

Mount the Parker ModuFlow Filter in-line, or on the tank in suction or return lines...in any of the five setups illustrated. Mounting is made easy with optional brackets, or by welding directly into the tank. Your local Parker distributor can put together any combination of components to get the filter your job requires. He can do it promptly, using off-the-shelf stock. The result will be a top-efficiency ModuFlow Filter with all the benefits...greater dirt-holding ability, maximum flexibility of fluid system design and filter location, easy servicing, and Tells-All scrutiny of filter conditions at all times.

No more trickling bypass

The Parker ModuFlow bypass valve is either positively **closed** when normal filtration is in progress, or is positively **open** when the filter has reached its bypass setting. There is no continuous trickle bypassing the element to reduce filter efficiency.

The poppet-type bypass valve acts instantly when the bypass setting is reached; minimum pressure drop is maintained because of the large valve area. A unique knife-edge face on the poppet practically eliminates hydrostatic friction, sticking, and hysteresis when the bypass actuates.

A variety of filter elements

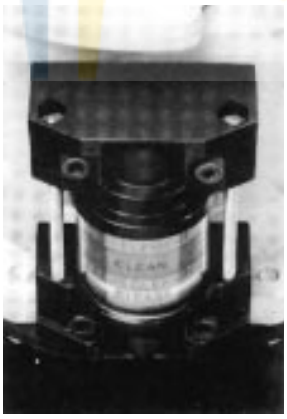
A superior type of filter element has been developed to allow the ModuFlow filter to operate at top designed effectiveness.

Pleats are deeper and there are more of them. This gives the ModuFlow element 60% more surface area in the same filter housing size than many comparable filters. More surface means more dirt-holding capacity, less need for service and replacement.

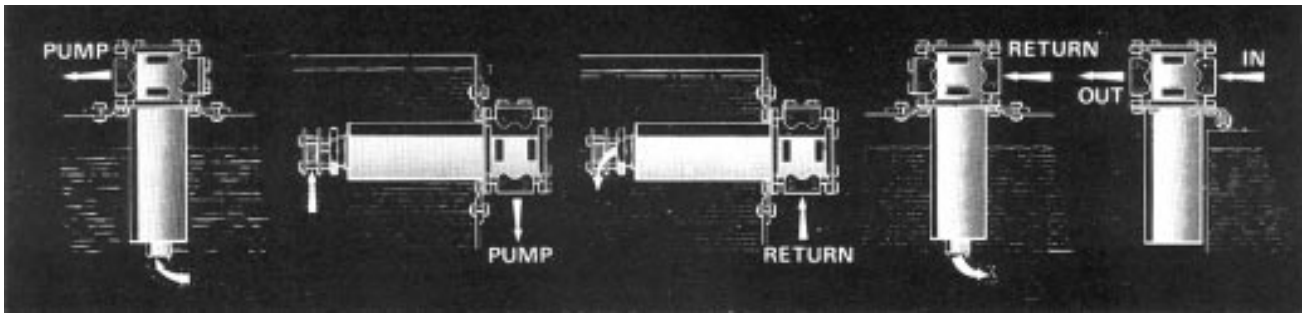
Three filter media are available: wire mesh...25, 40 and 74 micron rating; special paper...3, 10 and 20 micron; and composite...1 micron rating. Flow direction is always from inside to outside the element. This, plus a special element seal, helps ensure that dirt trapped in the element stays in when the element is removed.

No guessing at filter conditions

The PARKER Tells-All indicator lets you know at a glance...and at every instant...just what condition the ModuFlow Filter is in. How clean is the element, or how dirty? Is the filter functioning, or by-passing? And did the service engineer re-install an element in the unit? The indicator operates on differential pressure, this eliminates problems with conventional mechanical linkages to bypass valves. Another plus...the Tells-All indicator doesn't have to be mounted right on the filter; install it just about anywhere on your equipment to make regular checks more convenient.



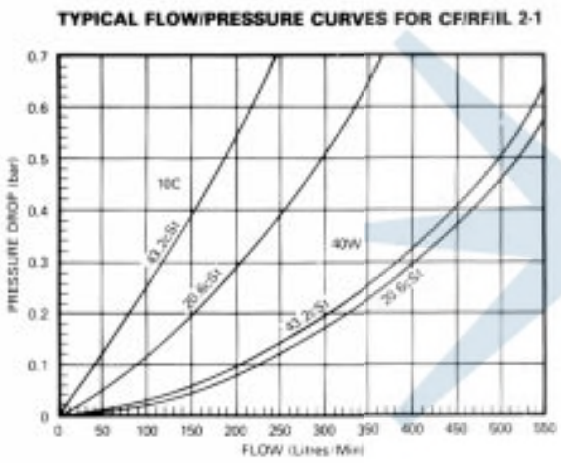
Five separate mounting/porting schemes

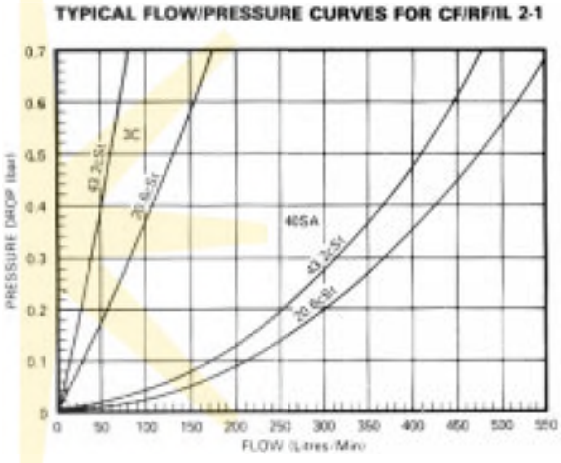


Flow/Pressure curves

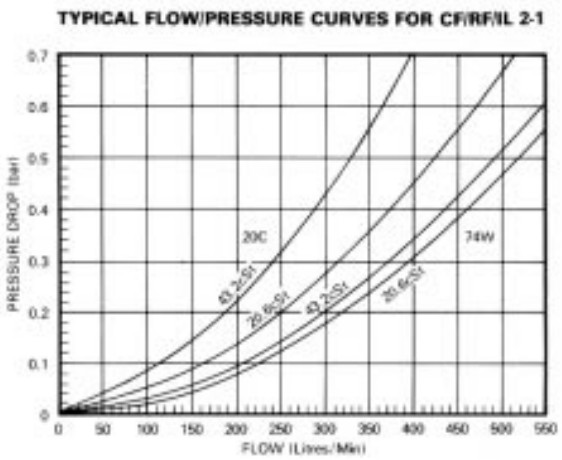
Minimum flows required to move indicator from "No Element", to "Clean"

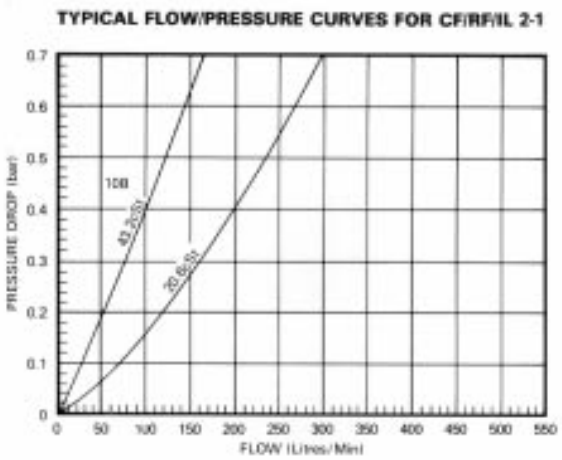
Media Type	Approx. flow through single element, 1pm	Approx. flow through double element, 1pm
10B, 03C, 10C	8	19
20C	19	38
40W, 40SA, 74W	57	76

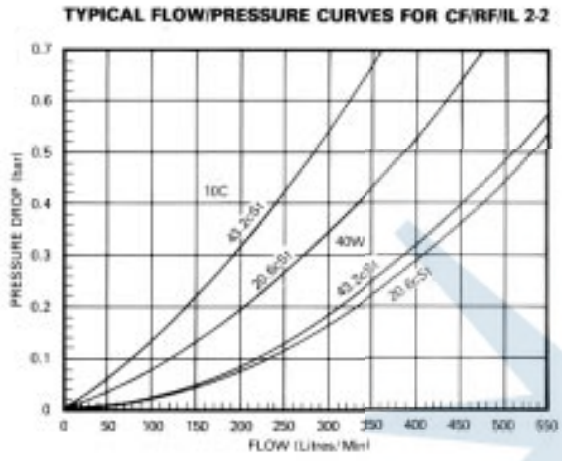


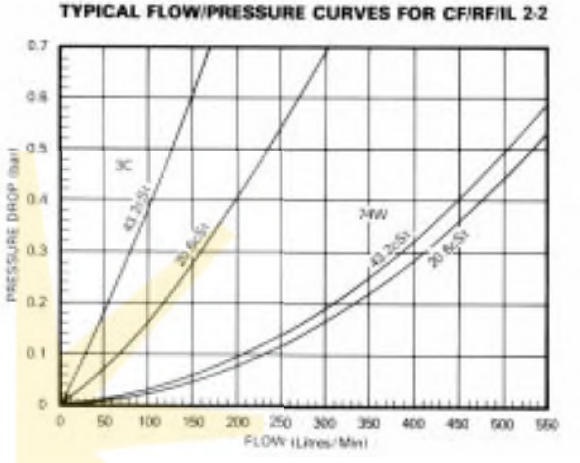


Note: Curves for Models CF2 and RF2 are identical to curves for Model IL2





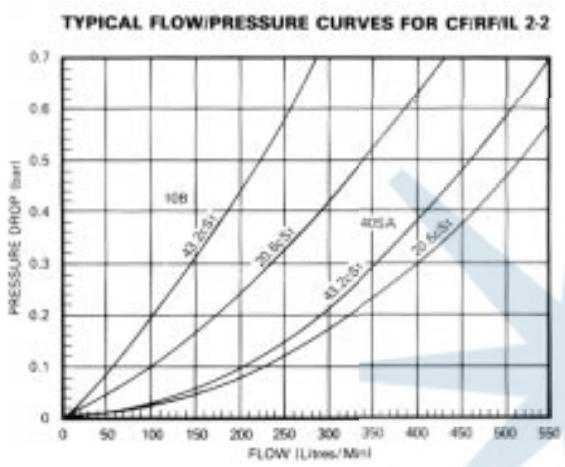


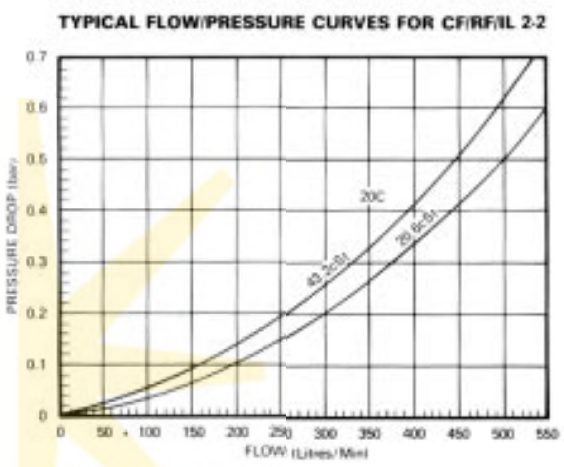


Note: Curves for Models CF2 and RF2 are identical to curves for Model IL2

Parker Model No.	Element Type	Filter Media	Beta (10) Minimum	Beta (10) Mean
149W	Surface	Woven Wire	*	*
74W	Surface	Woven Wire	*	*
40W	Surface	Woven Wire	*	*
25W	Surface	Woven Wire	*	*
40SA	Depth	Synthetic	1.03	1.09
20C	Depth	Paper	1.05	1.11
10C	Depth	Paper	1.30	2.00
03C	Depth	Paper	11.80	23
10B	Depth	Composite	200	1500
03B	Depth	Composite	400	3000+

*Not Beta (10) Rated.





Note: Curves for Models CF2 and RF2 are identical to curves for Model IL2

Submersible ModuFlow Filters

When there is a limited amount of space on top of the reservoir, installing a tank-mounted filter can get complicated. Parker's Submersible ModuFlow filter solves the problem. Whether it's a suction or return-line application these filters can be mounted in the **side** of a reservoir **below** the surface of the fluid.

Check valve prevents fluid loss

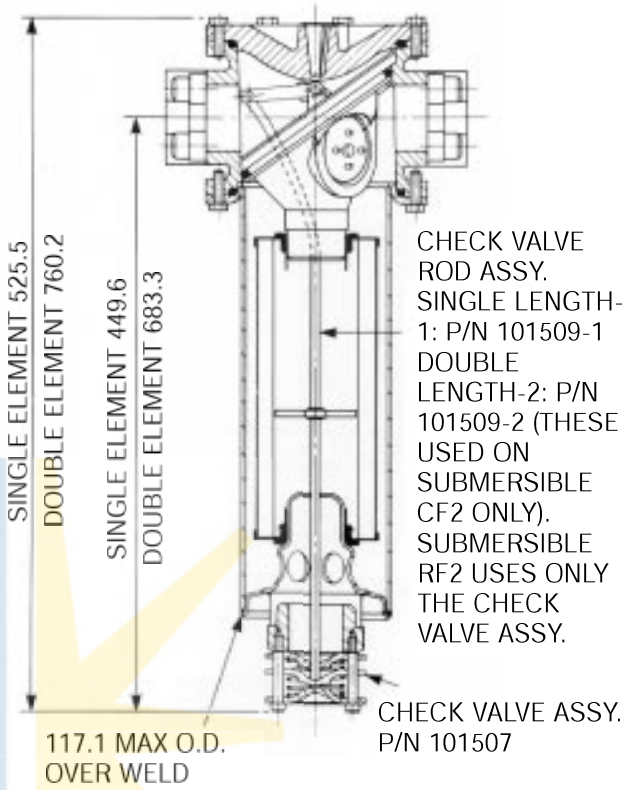
An external check valve mounted in a two-inch BSPF coupling located at the bottom of the filter bowl prevents the reservoir from being drained during servicing of the filter element. The only fluid you have to consider is that inside the filter.

The ModuFlow RF2, for return-line applications, is designed so that the fluid returning to the reservoir holds the check valve open during normal operation. When the system is shut down, the check valve automatically closes. In the case of the ModuFlow CF2, for suction applications, the check valve is held open by a rod assembly extending from the cover to the check valve at the base of the filter bowl. When the cover is in place, fluid enters the filter. When the system is shut down and the cover removed for servicing, the check valve closes automatically.

Simple mounting

The ModuFlow bowl assembly is welded directly into the side of the tank. Since the bowl assembly end fitting has a minimal weld bead and clears a hole which is typically .062" larger than the O.D. of the bowl tubing, the filter can be easily welded into the tank without using inconvenient adaptors.

An optional tank flange can be used for mounting CF/RF2 filters into the side of a reservoir. The flange, supplied with an elastomer seal assuring leak-free mounting, is bolted to the filter head with bolts supplied with the filter. It is then bolted to the tank using customer supplied hardware.



ModuFlow, the adaptable, modular filter

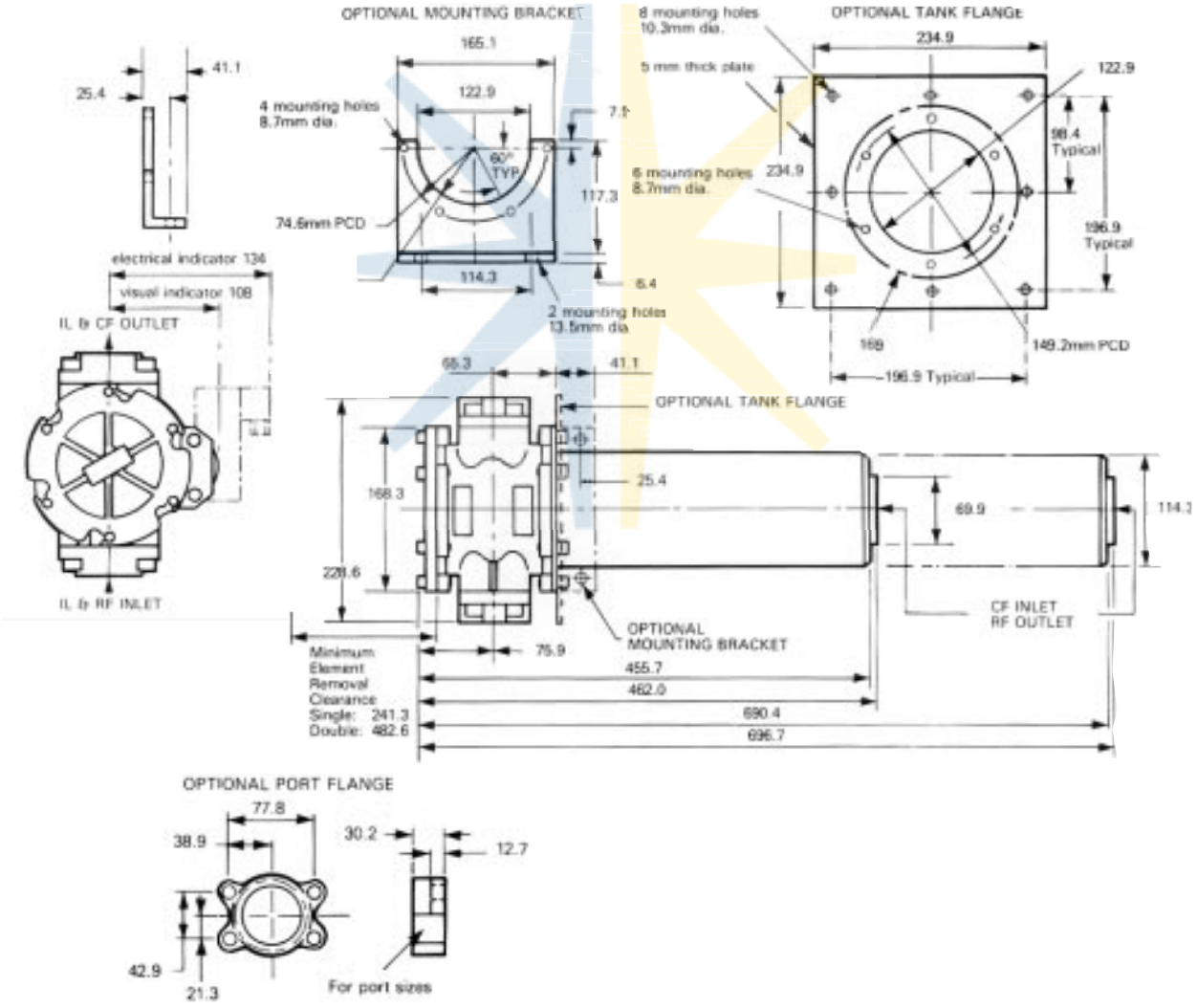
Any ModuFlow CF/RF2 filter can be outfitted with options that allow easy conversion of a standard unit into a submersible filter. Simply order the filter with the 2" BSPF coupling on the bowl, the external check valve, or the check valve plus the rod and cam assembly for suction applications.

Options also include the Tells-All indicator which can be remotely mounted for a visual reading on the element's condition.

Specifications: Working Pressure, maximum: 20 bar (300 psi).
Safety Factor: 3 to 1; minimum burst of 60 bar (900 psi).
Operating Temperatures:
Buna Seals: +121°C to -40°C
Viton Seals: +204°C to -40°C
Element Collapse Rating: 3.4 bar (50 psid).
Standard Duty: AC/DC rating: 0.5A at 125v
Heavy Duty: AC rating: 15A at 480v-AC
DC rating: 0.5A at 125v-DC
Fluid Compatibility: Suitable for use with mineral oils. For other fluids, please consult Parker Filtration.

Filter Housing:
Head, Cover and Flanges: Aluminium die castings.
Bowl: Electric-welded hot-rolled steel
Permanent magnet: Optional
Approximate shipping weight:
Single: 9 kg
Double: 11 kg
Porting: Standard: 2" SAE Flange Face.
Bypass Settings: 2, 3, 15, 25 psid are standard.
Options: Electrical Indicator and Port Flanges.

Dimensions



How to order filters:

MODEL CF: Bottom Inlet, Side Outlet
MODEL RF: Side Inlet, Bottom Outlet
MODEL IL: In-line

Select the feature you want from each of the eight boxes below. Put the proper symbol for each feature you want together, in order, into any nine-element code number. See the example below.

Select symbols from the numbered boxes below

F3	IL2	1	10C	MP	25	Y9Y9	3	-

1. SEALS

Omit	Buna (Standard)
†F3	Viton (Optional)

2. BASIC ASSEMBLY

CF2	Tank-mounted suction filter. Inlet on bottom; outlet on side. SAE 2" flange face on side outlet.
RF2	Tank-mounted return-line filter. Inlet on side; outlet on bottom. SAE 2" flange face on side inlet.
IL2	In-line filter. SAE 2" flange faces on inlet and outlet.

3. NUMBER OF ELEMENTS

1	Single element
2	Double elements

4. FILTER MEDIA

149W	149-micron wire mesh
74W	74-micron wire mesh
40W	40-micron wire mesh
40SA	40-micron synthetic
20C	20-micron paper
10C	10-micron paper
03C	3-micron paper
10B	1-micron composite

5. OPTIONAL "TELLS-ALL" INDICATORS (See Note A)

P	Pressure ports drilled and plugged two sides; no indicator
†M	"Tell-All" visual indicator
†E	Heavy-duty electrical switch; no visual indicator

Note A: Two symbols required. First letter = left side of filter head when looking into inlet with bowl down; second letter = right side of filter head when looking into inlet with bowl down

6. BYPASS AND INDICATOR SETTING

2	2 psi	Pink
3	3 psi	Yellow
15	15 psi	Lt. Blue
25	25 psi	Alum'n

Note: Indicators will be matched to the bypass valve pressure setting.

8. MODIFICATIONS†

1	None
3	Magnet
11	No bypass
12	No bypass with magnet

9. DESIGN NUMBER
STAMPED ON FILTER BY FACTORY, USE WHEN ORDERING REPLACEMENT PARTS OR STAND-BY ELEMENTS.

ACCESSORIES KITS

	Part No.
In-tank mounting flange kit	924903
In-line bracket kit	924904
Port flange kits (contain flange, Buna O-ring, and four socket-head screws.)	
Flange thread:	
3/4" BSPF	G01005
1" BSPF	G01006
1 1/4" BSPF	G01007
1 1/2" BSPF	G01008
2" BSPF	G01009
Blank flange kit for sealing ports on CF and RF models	G01043
Magnet assembly	924948

7. PORT OPTIONS (See Notes 1 and 2)

	CF2/RF2 bowl	No fitting, no flange	99
†	CF2/RF2 bowl	2" BSPF fitting, no flange	B9
†	CF2/RF2 bowl	External check valve	F8
	IL2/CF2/RF2[3] head	2" SAE flange face, no flange	Y9
†	IL2/CF2/RF2[3] head	2" SAE flange face, plus flange (see Table A)	

TABLE A. AVAILABLE PORT FLANGE OPTIONS FOR FILTER HEAD †

YR	3/4" BSPF flange
YS	1" BSPF flange
YT	1 1/4" BSPF flange
YU	1 1/2" BSPF flange
YV	2" BSPF flange

(1) First pair of symbols denotes inlet for all filter styles; second pair of symbols denotes outlet
(2) Four symbols required: two for inlet, two for outlet
(3) Unused ports in CF2 and RF2 filters come plugged with a blank flange
(4) On CF2, F8 option including internal rod assembly

Vickers® Vane Pumps

V Series - Low Noise Vane Pumps

High Performance Intravane Pumps
For Industrial Applications

EATON
Powering Business Worldwide

Introduction

Vickers offers the most complete line of hydraulic intravane pumps for industrial applications. A wide variety of single and multiple configurations enables you to select the precise pump or combination best suited for your application.

Your choice of pump is backed by more than 70 years of Vickers engineering and manufacturing skill.

Performance

These cost–effective pumps provide volumetric efficiencies of more than 90% and sound levels as low as 62 dB(A) with operating pressures to 207 bar (3000 psi).

General Description

Intravane pumps provide longer life, increased productivity and application versatility. Extremely low sound levels are compatible with the most demanding industrial applications.

Compact size and ease of service allow maximum equipment design flexibility. Pumps are available in single, double and thru-drive configurations.

Features and Benefits

- High operating pressure capabilities in compact packages provide high power to weight ratios and lower installed costs.
- Low noise characteristics inherent in intravane design enhance operator comfort.
- Twelve vane system provides low amplitude flow pulsations resulting in low system noise characteristics.
- Hydraulic balancing, designed to prevent internally-induced radial shaft and bearing loads, provides long life.
- Double pumps and thru-drive arrangements save installation space and cost by eliminating double shaft extension electric motors or by reducing the number of motors and drive couplings.
- Thru-drive models provide valuable circuit design flexibility, such as having fixed and variable displacement models on a single input drive.
- Sixteen flow displacements and high operating pressure capabilities provide optimum selection and single-source capability for your complete range of flow and pressure requirements.
- Factory tested cartridge kits provide new pump performance upon installation.
- The cartridge kit design offers fast and efficient field serviceability. The cartridge is independent of the drive shaft, allowing for easy change of flow capacity and servicing without removing the pump from its mounting.
- Inlet and outlet ports can be oriented in four different positions relative to each other, providing greater installation flexibility and ease of machine design.

Table of Contents

Performance Data Single, Double & Thru-Drive Vane Pumps

Pressure limits, inlet port - bar (psi):

Minimum -0,17 bar (5" Hg) for anti-wear oil
-0,10 bar (3" Hg) for water containing fluids and phosphate esters

Maximum 1,4 bar (20 psi) all fluids

Range 0 to 0,35 bar (0 to 5 psi) all fluids

Maximum continuous pressures in bar (psi), outlet ports

Model	Code	Using anti-wear oil or phosphate ester fluid*	Using water-in-oil emulsions	Using water glycol fluid
20V	2	138 (2000)	69 (1000)	138 (2000)
20V	5,8,11	207 (3000)	69 (1000)	159 (2300)
**20V	12	159 (2300)	69 (1000)	159 (2300)
**20V	14	138 (2000)	69 (1000)	138 (2000)
25V	10,12,14,17,21	172 (2500)	69 (1000)	159 (2300)
25VT	12,14,17,21	172 (2500)	69 (1000)	159 (2300)
25**V	12,14,17,21	172 (2500)	69 (1000)	159 (2300)
**25V	12,14,17,21	172 (2500)	69 (1000)	159 (2300)
35V	25,30,35,38	172 (2500)	69 (1000)	159 (2300)
35VT	25,30,35,38	172 (2500)	69 (1000)	159 (2300)
35**V	25,30,35,38	172 (2500)	69 (1000)	159 (2300)
**35V	25,30,35,38	172 (2500)	69 (1000)	159 (2300)
45V	42,45,50,60	172 (2500)	69 (1000)	159 (2300)
45VT	42, 50, 60	172 (2500)	69 (1000)	159 (2300)
45**V	42, 50, 60	172 (2500)	69 (1000)	159 (2300)

* A transient (peak) pressure 10% over the continuous pressure rating for 0.5 seconds or less duration is allowed.

Speed limits

Minimum speed, all models and fluid combinations ..... 600 rpm

Maximum speed - standard models using anti-wear fluid..... 1800 rpm

Standard models using synthetic and water-in-oil emulsions..... 1200 rpm*

Models using water glycol fluid..... 1500 rpm*

* See Vickers brochure #579.

Double Pump Model Code

(F3) - ****V (M) ** A (M) ** (F) - * ** 22 * - *

1 2 3 4 5 6 7 8 9 10 11 12 13

1 F3 - Viton Seals

Omit if not required

2 Series Designation

Displacements cm^3/r (in^3/r)

Model	Shaft End	Cover End
2520V -	33 - 67	7 - 45
	(2.0 - 4.1)	(0.45 - 2.8)
2525V -	(2.0 - 4.1)	33 - 67
	(0.45 - 2.8)	33 - 67
3520V -	(2.0 - 4.1)	81 - 121
	(2.0 - 4.1)	7 - 45
3525V -	(4.9 - 7.4)	81 - 121
	(0.45 - 2.2)	33 - 67
4520V -	(4.9 - 7.4)	138 - 193
	(2.0 - 4.1)	7 - 45
4525V -	(8.4 - 11.8)	138 - 193
	(0.45 - 2.2)	33 - 67
4535V -	(8.4 - 11.8)	138 - 193
	(2.0 - 4.1)	81 - 121
	(8.4 - 11.8)	(4.9 - 7.4)

3 Pilot Designation

Omit - Standard pilot
S – SAE per ISO 3019/1 (SAE J744) (N/A on 2525V)
M – Metric per ISO 3019/2 100A2HW (N/A on 2525V)

4 Geometric Displacement - Shaft End Pump

Rated capacity (USgpm) at 1200 rpm, 6,9 bar (100 psi)

Frame Size	Code (USgpm)	cm^3/r	in^3/r
25**V	10	33	2.0
	12	40	2.5
	14	45	2.8
	17	55	3.4
	21	67	4.1
35**V	25	81	4.9
	30	97	5.9
	35	112	6.8
	38	121	7.4
45**V	42	138	8.4
	45	147	9.0
	50	162	9.9
	60	193	11.8

5 Port Connections

A - SAE 4-bolt flange

6 Port Connection Modifier

Omit - Inch thread port connection (4-bolt flange)
M - Metric port connection (4-bolt flange)

7 Geometric Displacement - Cover End Pump

Rated capacity (USgpm) at 1200 rpm, 6,9 bar (100 psi)

Frame Size	Code (USgpm)	cm^3/r	in^3/r
**20V	2	7	0.43
	5	18	1.1
	8	27	1.7
	9	30	1.9
	11	36	2.2
	12	40	2.5
	14	45	2.8
**25V	10	33	2.0
	12	40	2.5
	14	45	2.8
	17	55	3.4
	21	67	4.1
4535V	25	81	4.9
	30	97	5.9
	35	112	6.8
	38	121	7.4

8 Mounting

Omit - Flange mounting
F – Foot mounting

9 Shaft

Std. Pilot Shafts

Model	Str. Key	HD Str. Key	Spline
25**V - 45**V	1	N/A	151

"S" SAE Pilot & "M" Metric ISO Pilot Shafts

Model	Str. Key	HD Str. Key	Metric Str. Key	Spline
25**VS - 45**VS	202	203	N/A	297
25**VM - 45**VM	N/A	N/A	292N	N/A

10 Port Orientation

(Viewed from cover end of pump)
All series except 2525V & 4535V
With No. 1 outlet opposite inlet:
AA - No. 2 outlet 135 CCW from inlet
AB - No. 2 outlet 45 CCW from inlet
AC - No. 2 outlet 45 CW from inlet
AD - No. 2 outlet 135 CW from inlet
With No.1 outlet 90 CCW from inlet:
BA - No. 2 outlet 135 CCW from inlet
BB - No. 2 outlet 45 CCW from inlet
BC - No. 2 outlet 45 CW from inlet
BD - No. 2 outlet 135 CW from inlet
With No.1 outlet inline with inlet:
CA - No. 2 outlet 135 CCW from inlet
CB - No. 2 outlet 45 CCW from inlet
CC - No. 2 outlet 45 CW from inlet
CD - No. 2 outlet 135 CW from inlet
With No.1 outlet 90 CW from inlet:
DA - No. 2 outlet 135 CCW from inlet
DB - No. 2 outlet 45 CCW from inlet
DC - No. 2 outlet 45 CW from inlet
DD - No. 2 outlet 135 CW from inlet

Series 2525V & 4535V
With No.1 outlet opposite inlet:
AA - No. 2 outlet opposite inlet
AB - No. 2 outlet 90 CCW from inlet
AC - No. 2 outlet inline with inlet
AD - No. 2 outlet 90 CW from inlet
With No.1 outlet 90 CCW from inlet:
BA - No. 2 outlet opposite inlet
BB - No. 2 outlet 90 CCW from inlet
BC - No. 2 outlet inline with inlet
BD - No. 2 outlet 90 CW from inlet
With No.1 outlet inline with inlet:
CA - No. 2 outlet opposite inlet
CB - No. 2 outlet 90 CCW from inlet
CC - No. 2 outlet inline inlet
CD - No. 2 outlet 90 CW from inlet
With No.1 outlet 90 CW from inlet:
DA - No. 2 outlet opposite inlet
DB - No. 2 outlet 90 CCW from inlet
DC - No. 2 outlet inline with inlet
DD - No. 2 outlet 90 CW from inlet

11 Design

12 Rotation

(Viewed form shaft end of pump)
L – Left hand for counter clockwise
R – Right hand for clockwise

13 Special Suffix

167 – 2-bolt, 5" dia. pilot (25**V only - N/A for VS or VM models)

Note: For options other than listed in the model code, i.e. shafts, ports, displacements and mountings, contact your Vickers representative.

Sound Levels

Average sound levels are at 138 bar (2000 psi) using SAE 10W (26 cSt) – (128 SUS) oil at 50°C (120°F).

Model	dB(A) - 1200 rpm	1500 rpm	- 1800 rpm
20V	62	64	66
25V	63	65	67
35V	64	66	69
45V	67	69	71

Sound levels for double pumps are on the average 1 to 3 dB(A) higher when both pumping sections are pressurized.

Sound levels are per NFPA T3.970.12 test standards.

Hydraulic Fluids

Use antiwear industrial hydraulic oils or automotive crankcase oils having letter designations SC, SD, SE or SF with viscosity grades of 32 to 68 cSt at 40° C (140° F). Preferred viscosity at rated speed and pressures:

Minimum	13 cSt (70 SUS)
Maximum	54 cSt (251 SUS)

Minimum	49°C (120°F)
Maximum	65°C (150°F)

Cold Starts

When operating with SAE 10W oil in the 860 to 54 cSt (4000 to 251 SUS) range, the speed and pressure should be limited to 50% or less of their respective rated values until the system has warmed up. Extreme caution must be used when starting units when fluid viscosities are greater than 860 cSt (4000 SUS). Care should be exercised to warm up the entire system, including remote cylinders and motors.

High Temperature

Viscosities must not be less than the respective minimum values listed for each series of pumps. Temperatures should not exceed 99° C (210° F) because the life expectancy of cartridge kits and elastomers will decrease.

Water-in-oil Emulsions

Water-in-oil emulsions may be used. However, they require careful selection and monitoring of the fluid. For assistance contact your Vickers representative. Soluble oil-in-water solutions are not recommended.

Synthetic Fire Resistant Fluids

Phosphate esters and their blends with operating viscosity of the petroleum oil described above may be used. These fluids are generally compatible with fluorocarbon and silicone elastomers. Add F3 prefix to the model code for special seals.

For operating conditions exceeding recommendations listed in this section, consult your Vickers representative. For details, refer to Vickers data sheet I-286-S, M-2950-S or GB-B-920, "Hydraulic Fluid and Temperature Recommendations."

Filtration Requirements

For satisfactory service life of components, use full flow filtration to provide fluid cleanliness conforming to ISO code (see next page). Vickers OFP, OFR and OFRS series filters are recommended. Contact your Vickers representative for further filtration advice.

Drive Data

Pumps are assembled for CW or CCW rotation. Right hand or clockwise rotation and left hand or counterclockwise rotation is viewed from the shaft end.

Inlet and outlet ports remain the same regardless of the direction of shaft rotation. Assembly change of internal parts is necessary, when change of shaft rotation is required.

Pump Drive

Direct coaxial drive is recommended. If drives imposing radial shaft loads are considered, please consult your Vickers representative.

Air Bleed

At the time of first-starting, if the pump does not immediately prime, air should be bled from the pump delivery line. This may be accomplished by loosening a connection in the delivery line close to the pump until oil flows – indicating the pump has primed. An air bleed valve is available for this purpose.

CAUTION: – No Case Drain The pump is drained internally into its inlet. System pressure at the pump inlet connection may not exceed 1,4 bar (20 psi).

CAUTION: – Low Outlet Pressure Do not run a pump with the outlet pressure lower than the inlet pressure. This causes operating noise and vane instability.

Start-up Procedure

Make sure the reservoir and circuit are clean and free of dirt/debris prior to filling with hydraulic fluid.

Fill the reservoir with filtered oil and fill to a level sufficient enough to prevent vortexing at suction connection to pump inlet. It is good practice to clean up the system by flushing and filtering using an external slave pump.

Before starting the pump, fill with fluid through one of the ports. This is particularly important if the pump is above the fluid level of the reservoir.

When initially starting the pump, remove all trapped air from the system. This can be accomplished by loosening the pump outlet fittings or connections before starting the pump or by using an air bleed valve. All inlet connections must be tight to prevent air leaks.

Once the pump is started it should prime within a few seconds. If the pump does not prime, check to make sure that there are no restrictions between the reservoir and the inlet to the pump, and that there are no air leaks in the inlet line and connections. Also check to make sure that trapped air can escape at the pump outlet.

After the pump is primed, tighten the loose outlet connections, then operate for five to ten minutes unloaded to remove all trapped air from the circuit.

If reservoir has a sight gage, make sure the fluid is clear – not milky.

Add fluid to the reservoir to bring it up to the proper fill level.

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials, and additives for protection against wear of components, elevated viscosity, and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561 "Vickers Guide to Systemic Contamination Control" available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles, or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers will often recommend levels above those specified. Experience has shown, however, that life of any hydraulic component is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long, trouble-free service life for the products shown, regardless of the manufacturer.

Product	System Pressure Level bar (psi)		
	<70 (<1000)	**70-207 (1000-3000)**	**207+ (3000+)**
Vane Pumps – Fixed	20/18/15	19/17/14	18/16/13
Vane Pumps – Variable	18/16/14	17/15/13	
Piston Pumps – Fixed	19/17/15	18/16/14	17/15/13
Piston Pumps – Variable	18/16/14	17/15/13	16/14/12
Directional Valves	20/18/15	20/18/15	19/17/14
Pressure/Flow Control Valves	19/17/14	19/17/14	19/17/14
CMX Valves	18/16/14	18/16/14	17/15/13
Servo Valves	16/14/11	16/14/11	15/13/10
Proportional Valves	17/15/12	17/15/12	15/13/11
Cylinders	20/18/15	20/18/15	20/18/15
Vane Motors	20/18/15	19/17/14	18/16/13
Axial Piston Motors	19/17/14	18/16/13	17/15/12
Radial Piston Motors	20/18/14	19/17/13	18/16/13

Fluids and Seals

Flourocarbon seals are available and are suitable for use with phosphate ester type fluids or their blends, water glycol, water-in-oil emulsion fluids and petroleum oil.

Moment of Inertia

Model	Nm/sec²	Moment lb-in-sec²
25V	0,000757	(.00670)
35V	0,001395	(.01235)
45V	0,003073	(.02720)
2520V	0,001309	(.01159)
2525V	0,001469	(.01300)
3520V	0,001629	(.01495)
3525V	0,002042	(.01807)
4520V	0,003186	(.02820)
4525V	0,003732	(.03303)
4535V	0,004554	(.04031)

Vane Pump Approximate Weights

Frame size	kg (lbs.)	
20V	12.0	(26)
25V	14.8	(33)
25V(T)	19.4	(43)
35V	22.7	(50)
35V(T)	28.7	(63)
45V	34.0	(75)
45V(T)	38.1	(84)
2520V	20.5	(45)
2525V	23,1	(51)
3520V	34.0	(75)
3525V	34.5	(76)
4520V	43.0	(95)
4525V	46.0	(101)
4535V	53.5	(118)

Mounting Options

Mounting attitude of all pumps is unrestricted except for any limitations in respect to rear-end pumps to be titled to **VT pumps. Such limitations will be found in the technical literature for those specific pumps.

Ordering Procedure

State full model designation(s) when ordering pumps. Port flange kits are available from Vickers and must be ordered as separate items.

Specify "BP" adapter when coupling PVE12119/21 as second pump on thru-drives.

Existing "B" thru-drives can be converted to "BP" using the following kits:

25VT: 941295 Adapter kit

452865 Coupling

35VT/45VT: 941295 Adapter kit only

Note: Adaptor kit and couplings are included with unit when ordered with "BP" designation in model code.

Service Information

Refer to specific Vickers part drawing or overhaul manual (below) for service information or consult your Vickers representative.

Service Literature:

20V	1-3195-5
25V	1-3196-5
35V	1-3197-5
45V	1-3199-5
2520V	1-3200-5
2525V	1-3212-5
3520V	1-3202-5
3525V	1-3203-5
4520V	1-3204-5
4525V	1-3208-5
4535V	1-3209-5
25VT	1-3154-5
35VT	1-3149-5
45VT	1-3151-5

Overhaul Manuals:

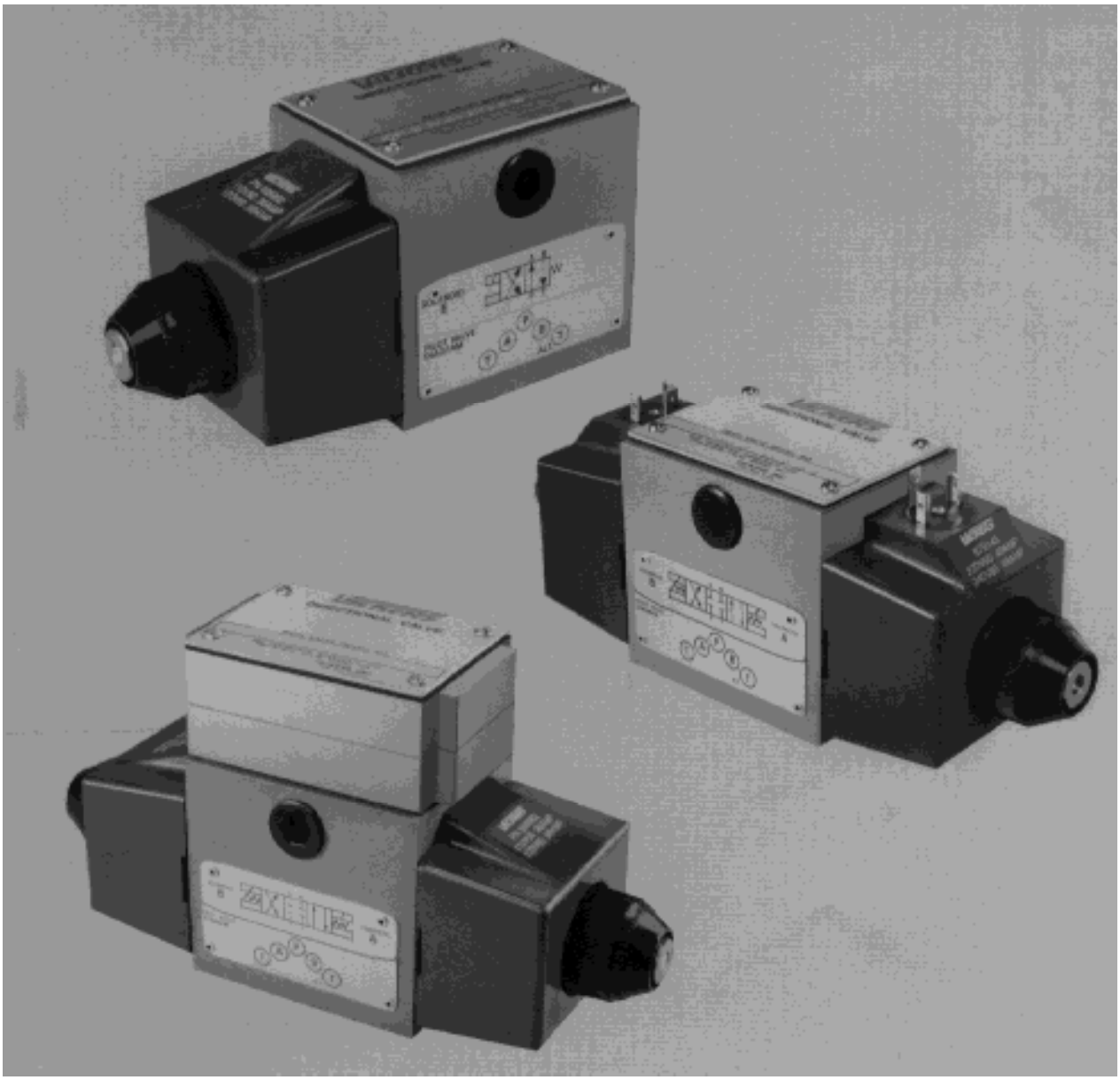
25V	1-3157-5
25VT	1-3157-5
35V	1-3157-5
35VT	1-3157-5
45V	1-3157-5
45VT	1-3157-5
2520V	1-3155-5
3520V	1-3155-5
3525V	1-3155-5
4520V	1-3155-5
4525V	1-3155-5
4535V	1-3155-5

Vickers®

Directional Controls

Wet Armature Solenoid Operated Directional Control Valves

DG4S*-01, 60 design



VICKERS

Revised 3/92

Basic characteristics

Max. pressure	Up to 250 bar (3600 psi) dependent on fluid
Max. flow rates	Up to 95 l/min (25 USgpm) dependent on spool
Mounting pattern	ISO 4401–05/ CETOP 5/NFPA–D05

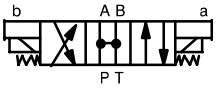
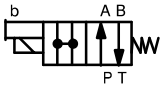
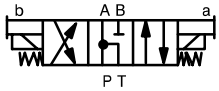
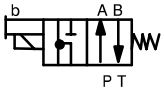
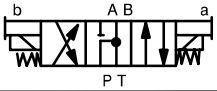
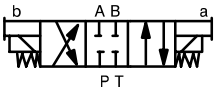
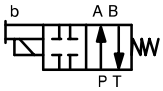
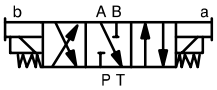
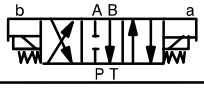
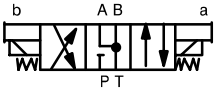
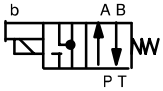
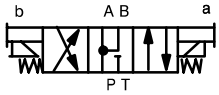
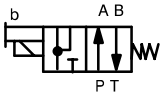
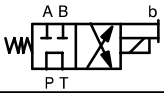
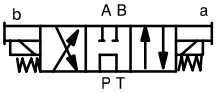
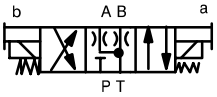
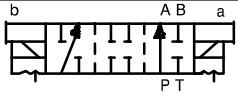
General description

DG4S* models are direct solenoid operated, 2–way or 4–way directional control valves. Their primary function in a hydraulic circuit is to direct fluid flow to a work cylinder or to control the direction of rotation of a hydraulic motor.

Port connections are made by mounting the valve on a manifold or subplate containing the interface.

Valves are available with AC or DC wet–armature solenoid(s). Electrical connections to the valve are made in an electrical wiring housing or by various plug–in devices. A ground terminal is provided.

Functional symbols

Standard Spool Types	Graphic Symbol Center Condition	"A" Models ▲ Spring Offset	"B" Models ▲ Spring Centered	"C" Models Spring Centered	"F" Models ▲ Spring Offset	"N" Models Detented (No Spring)
0						
1						
11						
2						
3						
31						
6						
7						
8						
33						
2 (2–way)						

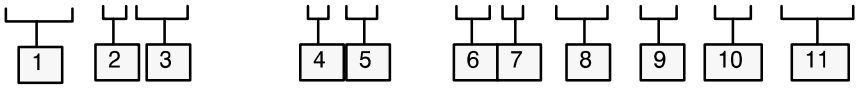
▲ Standard (right hand) build shown. "A" solenoid omitted.

Note

On all models, when solenoid "a" is energized, flow is always "P" to "A". When solenoid "b" is energized, flow is always "P" to "B". This is in accordance with the ANSI–B93.9 standard. Solenoid designations "a" and "b" are identified on the diagram plate on the side of the valve.

Model Code

(F3) - * * DG4S * ** - 01 ** * - (U) - ** - 60 - (LH)**



1 Seals
Blank — Standard seals
F3 — Special seals

2 Monitor switch
S — Monitor switch (Available as "A" spring offset model only)
Omit if not required.

3 Electrical plug options
PA — Insta—plug (male only)
PB — Insta—plug male & female receptacles
PA3 — 3 pin connector
PA5 — 5 pin connector
Omit if not required.

4 Flow direction
2 — 2 way
4 — 4 way

5 Electrical accessories
L — Solenoid indicator lights
W — Wiring housing
LW — Wiring housing with indicator lights
WT — Wiring housing with terminal strip
Omit if not required.

6 Spool types
See "Functional symbols" section.

7 Spool/spring arrangement
A — Spring offset, P to A
B — Spring centered, solenoid "a" removed
C — Spring centered, three position
F — Spring offset, P to A; shift to center
N — No spring, detented

8 Wet armature solenoid(s)
(Non—serviceable core tubes)
Blank — Flying lead coil(s)
U — DIN 43650 coil(s) without electrical plug

9 Coil identification letter(s)
See "Solenoids" section.

10 Design number
Subject to change.
Installation dimensions remain as shown for designs 60 through 69.

11 Left hand assembly
Omit for right hand assembly with solenoid "a" removed.

For DIN 46350 electrical plug(s)
See "U models" in "Installation dimensions" section.

For mounting subplates and bolt kits
See "Installation dimensions" and "Ordering procedure" sections.

Maximum pressure

Ports P, A & B	250 bar (3600 psi)*
Port T	70 bar (1000 psi)

*70 bar (1000 psi) with high water base fluids (95% maximum water content)

Solenoid energizing

Spring centered and spring offset valves will be spring positioned unless the solenoid is energized continuously. No—spring detented valves may be energized momentarily, approximately .15 second; when the solenoid is de—energized the spool will remain in the last position attained, provided there is no shock, vibration or unusual pressure transients.

NOTE
Any sliding spool valve, if held shifted under pressure for long periods, may stick and not spring return, due to silting. Therefore, it is recommended that the valve be cycled periodically to prevent this from occurring.

Solenoids

Solenoid Identification Letter	Solenoid Voltage Rating	Inrush Amps (rms)	Holding Amps (rms)	Holding Watts
B	120 VAC 60 Hz	3.80	0.69	35
	110 VAC 50 Hz	4.10	0.85	33
D	240 VAC 60 Hz	2.10	0.34	36
	220 VAC 50 Hz	2.30	0.45	34
ED	240 VAC 50 Hz	1.85	0.27	28
A	110 VAC 50 Hz	3.80	0.63	29
C	220 VAC 50 Hz	2.00	0.30	28
G	12 VDC	——	3.67	44
H	24 VDC		1.83	44
J	48 VDC		0.92	44
X	250 VDC		0.17	44
DP	125 VDC		0.35	44

Response time

The following response times were measured from the point of energization/ de—energization to the point of first indication of inlet pressure change.

Response up to full system pressure is dependent on the system's compressed volume and can vary with each application.

Model	Valve type	AC Solenoid		DC Solenoid	
		Shift	Return	Shift	Return
B/C	Spring centered	20 ms	40 ms	50 ms	80 ms
A	Spring offset	18 ms	25 ms	50 ms	60 ms
F	Spring offset	18 ms	18 ms	30 ms	80 ms
N	Detented	25 ms		60 ms	

Drain

On 2–way valves, “T” is the drain and must be connected to the tank through a surge–free line, so there will be no back pressure at this port.

NOTE

Surges of oil in a common line serving these and other valves can be of sufficient magnitude to cause inadvertent shifting of these valves. This is particularly critical in the no–spring detented type valves. Separate tank lines, or a vented manifold with a continuous downward path to tank, are necessary.

Pressure drops

The pressure drop curves give approximate pressure drop (ΔP) when passing 21 cSt (100 SUS) fluid (having .865 specific gravity) through the indicated flow path.

Pressure drop curve reference chart

Spool type	Curve numbers				
	P–A	B–T	P–B	A–T	P–T
0C/N	2	1	3	1	2
1C	1	2	3	1	–
11C	2	1	2	2	–
2C/N	2	2	3	2	–
3C	3	2	3	1	–
31C	3	1	3	2	–
6C/N	4	1	4	1	–
7C/N	1	2	1	2	–
8C	3	4	3	4	6
33C/N	3	2	3	2	–
2 way					
2A		2	–	7	–
2A–LH		7	–	2	–
2N		2	–	2	–

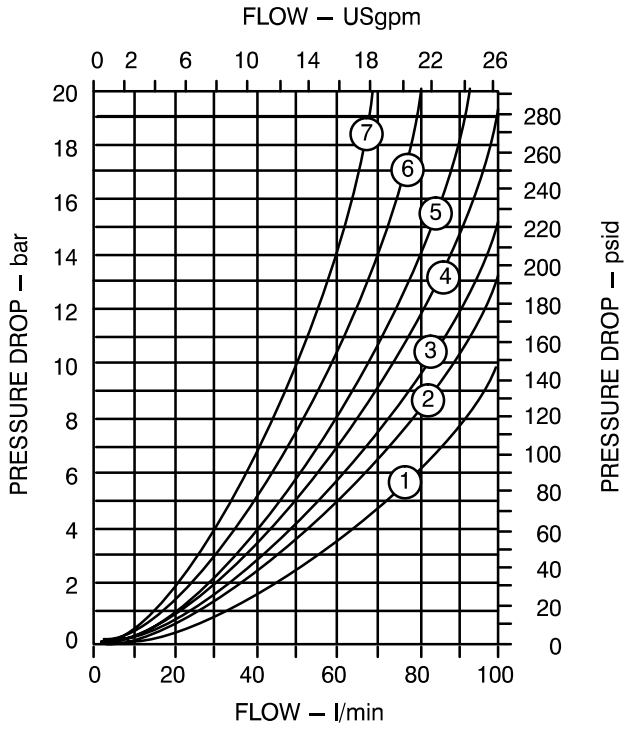
Pressure drop curve reference chart

Spool type	Curve numbers			
	P–A	B–T	P–B	A–T
0A/F	1	2	2	2
0A/F–LH	2	2	2	2
1F	1	2	–	–
1F–LH	–	–	2	2
2A/F	2	2	5	4
2A/F–LH	4	4	3	2
3F	2	1	–	–
3F–LH	–	–	2	2
6A/F	2	1	6	3
6A/F–LH	4	2	3	2
7A/F	1	2	2	4
7A/F–LH	2	3	2	2

For any other viscosity, the pressure drop (ΔP) will change as follows:

Viscosity cSt (SUS)	14 (75)	32 (150)	43 (200)	54 (250)	65 (300)	76 (350)	86 (400)
% of ΔP (Approx)	93	111	119	126	132	137	141

For any other specific gravity (G1), the pressure drop (ΔP1) will be approximately: $\Delta P1 = \Delta P\ (G1/G)$



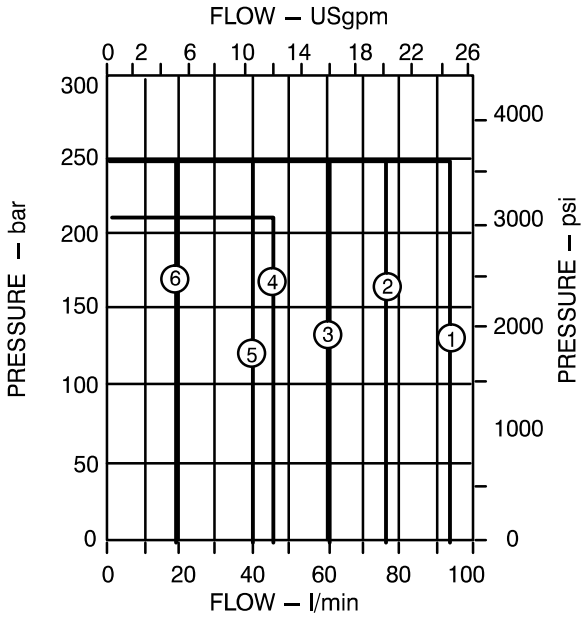
Maximum flow data

Maximum recommended flow data is for AC or DC solenoids at 90% nominal voltage in a 4–way circuit with cylinder ports either looped or blocked and containing 2,5 liter (.66 USgpm) compressed volume. Reduced performance may result when certain spools are used in 3–way circuits.

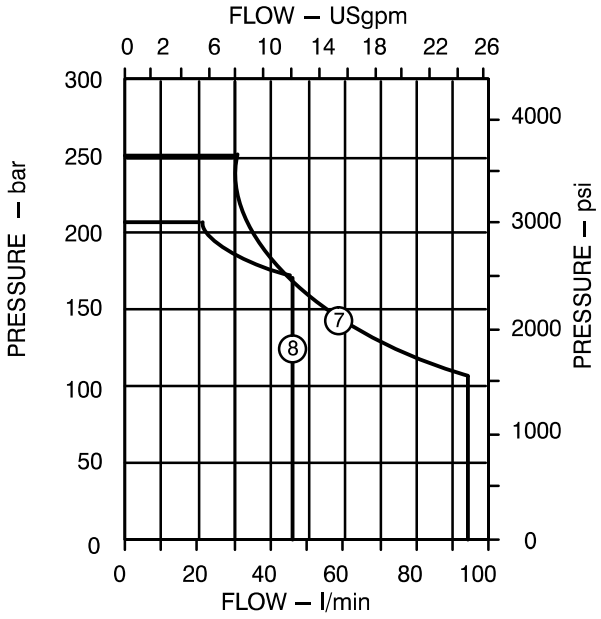
Maximum flow chart reference

Model	Spool type	Curve number AC	Curve number DC
A	0	1	1
	2	2	2
	6	3	3
	7	2	2
B/C	0	1	1
	1	6	6
	11	6	6
	2	1	1
	3	2	2
	31	2	2
	6	2	2
	7	1	1
	8	4	8
	33	1	1
F	0	1	1
	1	5	5
	2	1	1
	3	1	7
	6	1	7
	7	1	1
N	0	1	1
	2	1	1
	6	1	1
	7	2	2
	33	1	1
2–way			
A	2	5	5
N	2	3	3

AC & DC solenoid valves



AC & DC solenoid valves



Seals/fluids

Special F3 seals are required for use with phosphate ester type fluids or their blends. Standard seals are suitable for use with water glycol, water–in–oil emulsion fluids, HWBF (95% maximum water content), and petroleum oil.

Application recommendations

Filtration.....ISO 4406 Code 18/15

Operating temp.....20° to 50°C (70° to 120°F)

Fluid viscosity.....16 – 51 cSt (75–250 SUS)

Installation dimensions

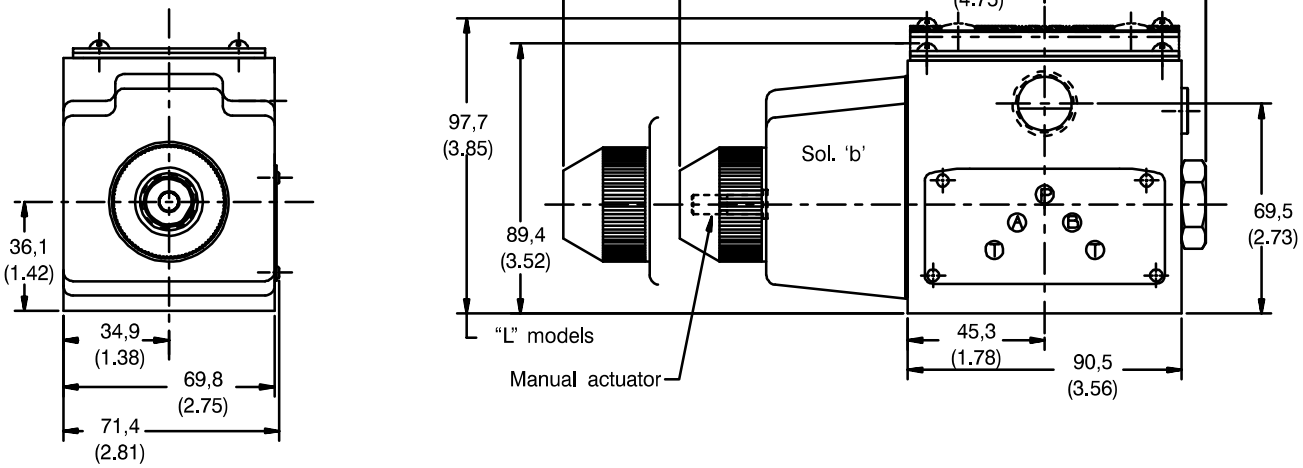
in mm (inches)

3rd angle projection

Applicable models

DG4S2–012A–*–60 Spring offset
DG4S4–01*A–*–60 Spring offset
DG4S4–01*B–*–60 Spring centered
DG4S4–01*F–*–60 Spring offset

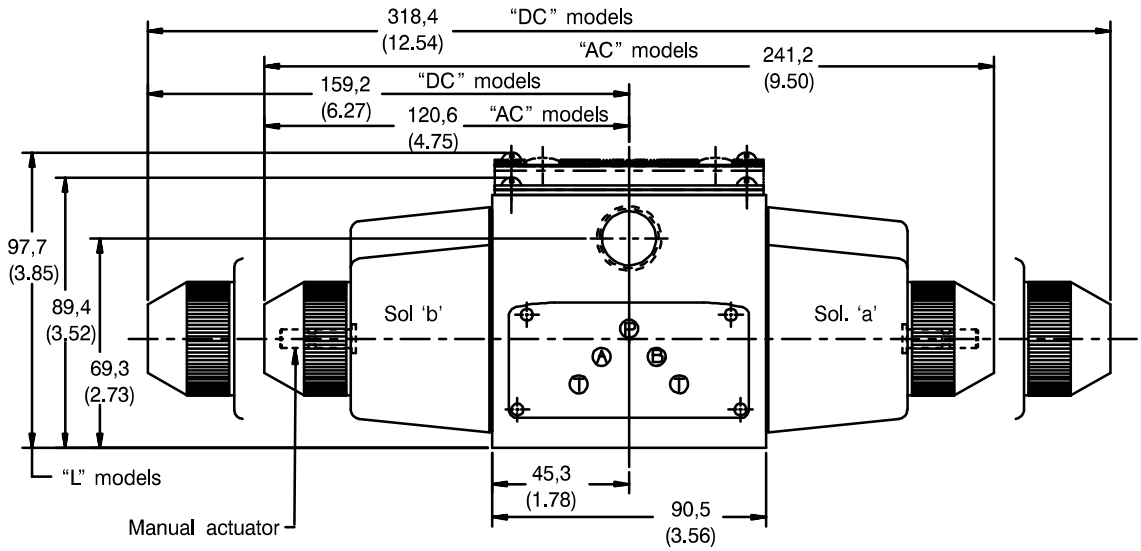
Right hand model shown ●



● "8B" right hand build model has solenoid 'b' on opposite end ("B" port end).

Applicable models

DG4S4–01*C–*–60 Spring centered ●
DG4S4–01*N–*–60 No spring detented
DG4S2–01*N–*–60 No spring detented



● "8C" models have solenoid designations reversed.

Applicable models

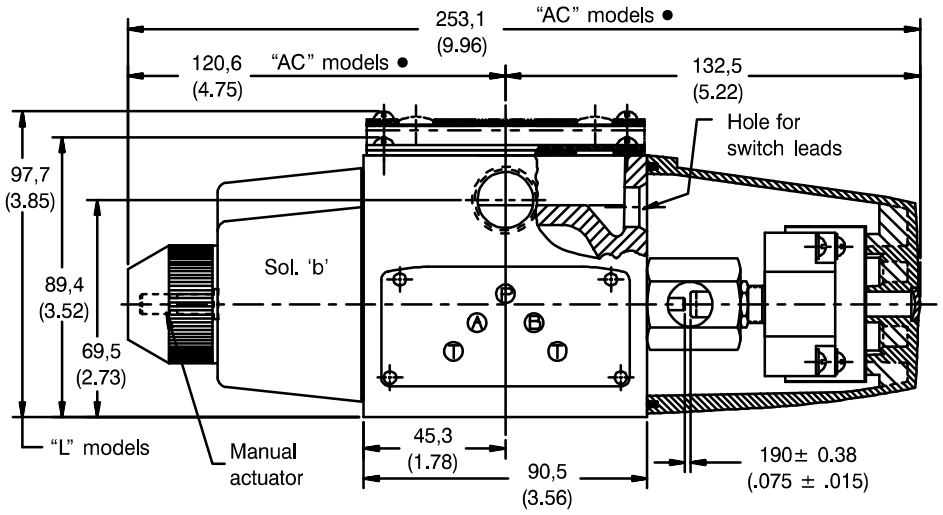
SDG4S4–01*A–*–60 Spring offset
Right hand model shown

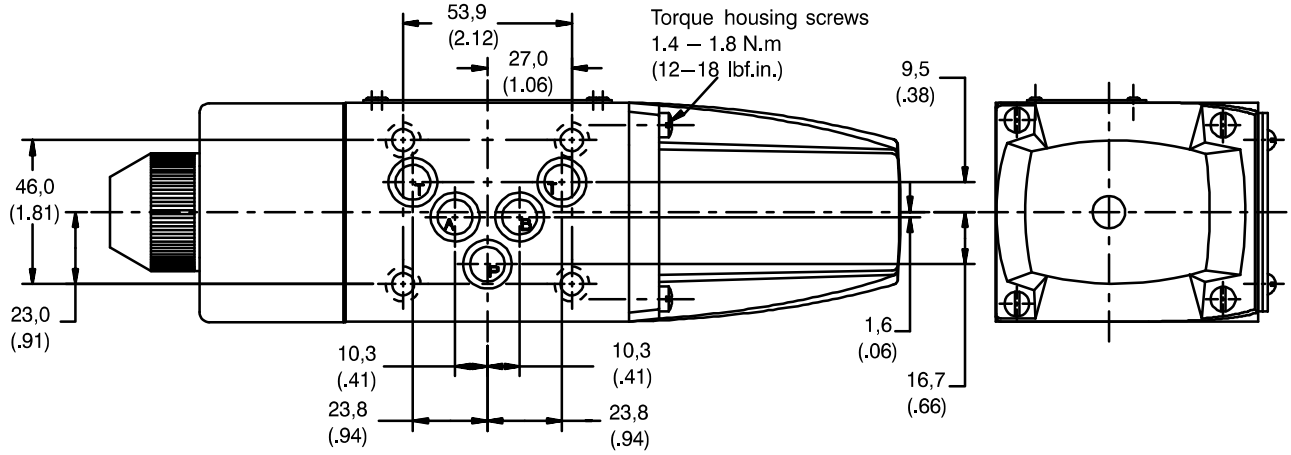
Integral monitor switch permits electrical interlocking of various hydraulically controlled motions without resorting to external mechanical contrivances. The switch monitors the valve spool position and may be wired into the control circuit.

Monitor switch data:
Plunger type
– panel mounting
– single pole
– double throw contact arrangement
– “A” normally closed
– “B” normally open.

Volts	AC amp	DC amp
28	20	10
125	20	0.5
250	20	0,2
480	20	
600	5	

Monitor switch housing does not provide for manual operation.



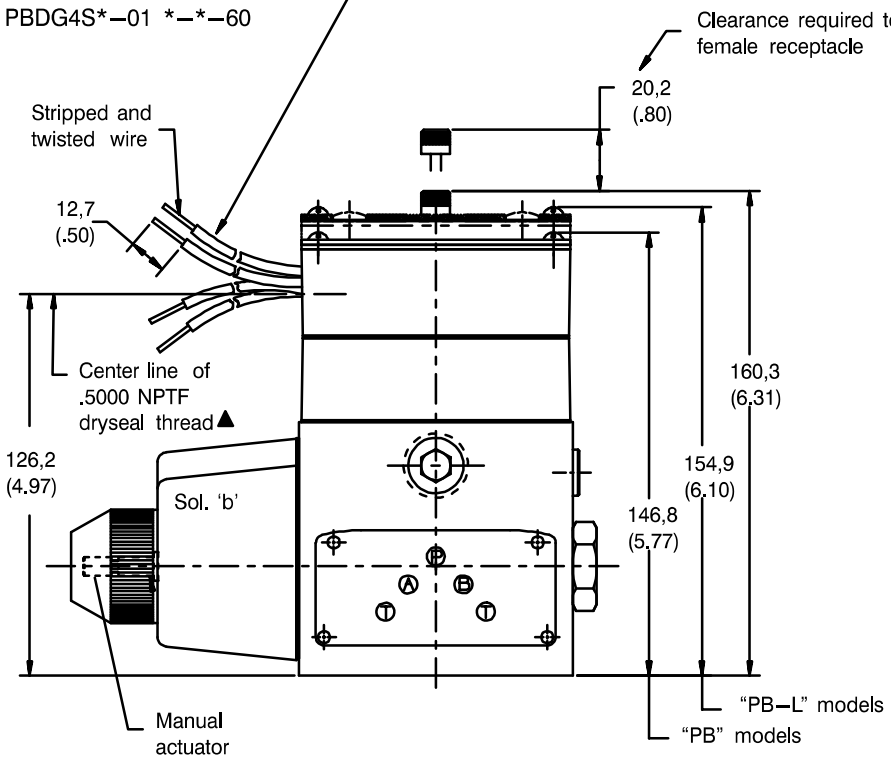


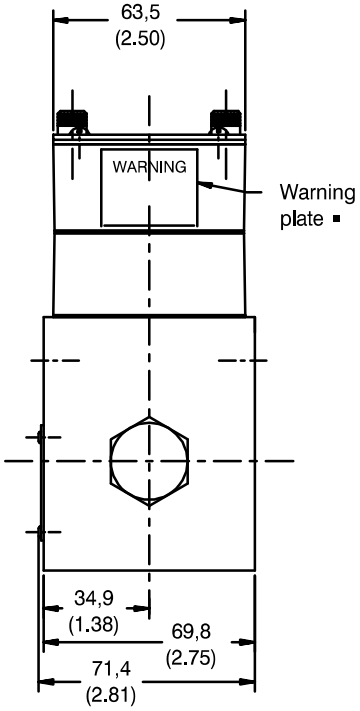
● For DC model length, see A models at top of facing page.

Applicable models

PBDG4S*–01 *–*–60

4 leads approx. 178 mm (7.00") long. White leads are connected to solenoid 'a' and black leads are connected to solenoid 'b'. (See diagram plate) For type "8" spool and left hand models, conduit connection location is reversed.





▲ Electrical conduit connection is over solenoid on single solenoid models, and over "b" solenoid on dual solenoid models. See diagram plate for "b" solenoid location.

▪ Warning

Electrical power must be disconnected before removing or replacing this receptacle.

The "insta–plug" consists of the following features:

1. Section "A", a four–pronged self aligning electrical plug secured in a housing that is mounted on top center of the valve body where the solenoid leads terminate; or:
2. A "B" complete insta–plug assembly that includes the "A" housing on top of which rests a similar housing containing the mating receptacle. The two housings are keyed to assure proper hook–up.

The top housing is removed from the lower ("A") housing to break the electrical connections to the valve solenoids, or pressed onto the "A" housing to complete the circuit. The assembly is held together by two slotted thumb screws.

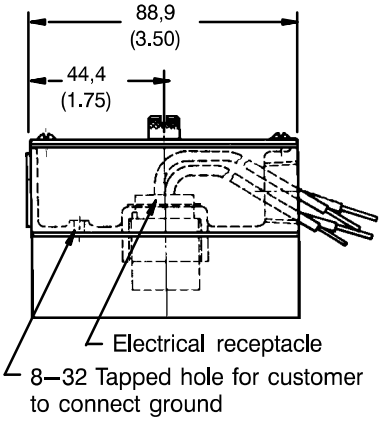
Solenoids "A" and "B" are identified on the plug–in and receptacle housings; they correspond with solenoid identification plate.

Connections to the electric power are made through the end of the receptacle housing and can be prewired by the customer. End location of electrical conduit port permits space–saving side–by–side valve mounting.

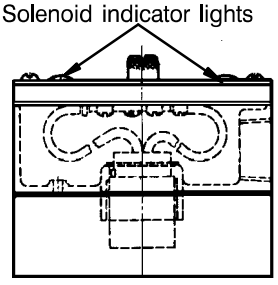
Wire leads approximately 177.8 mm (7.00") long are provided when no lights are specified. Models with lights have terminals inside the receptacle housing.

A nameplate and solenoid indicator lights are part of the receptacle when specified.

After initial installation, electrical and hydraulic connections need not be disturbed when valve with insta–plug is removed.

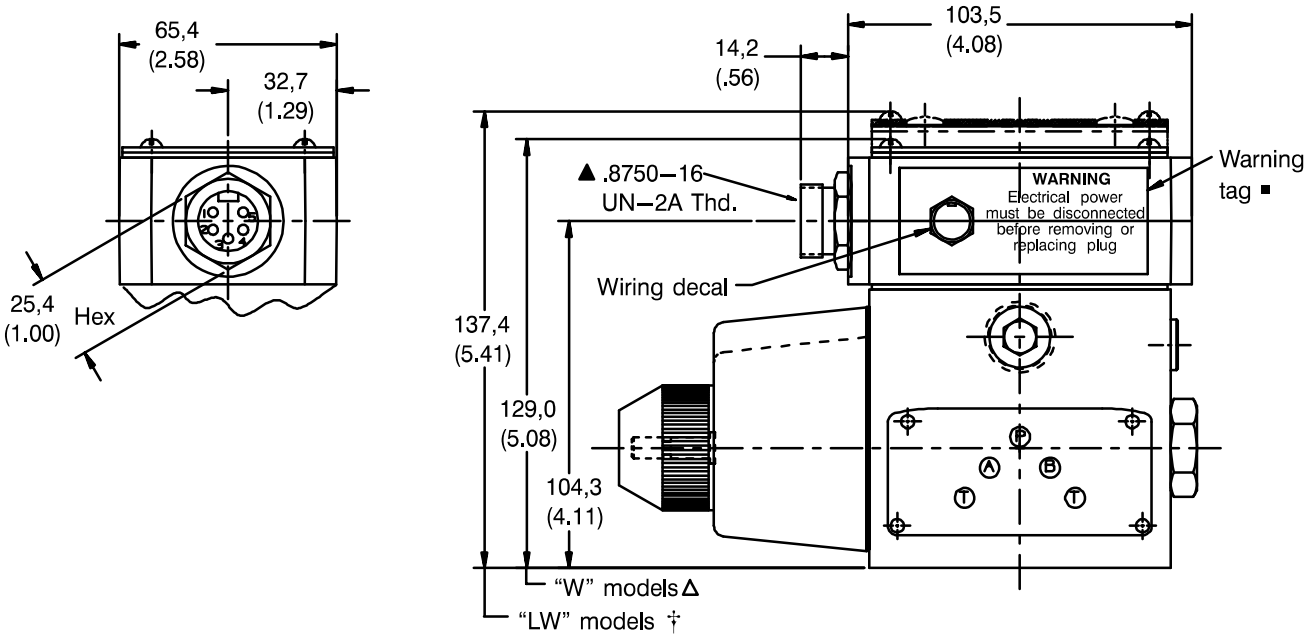


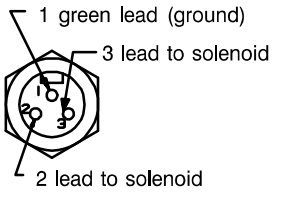
Solenoid indicator lights

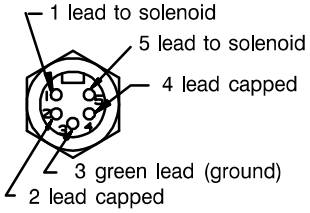


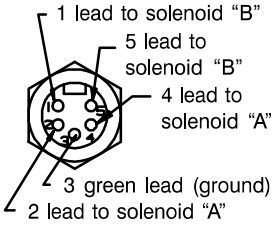
Applicable models

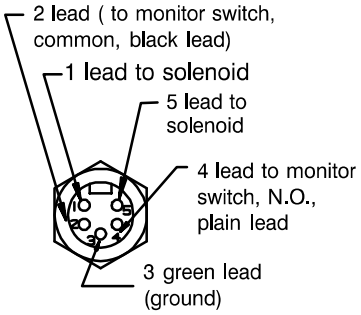
PA*DG4S*W/LW–01*A–*–60
PA*DG4S*W/LW–01*B–*–60
PA*DG4S*W/LW–01*F–*–60
PA5DG4S4W/LW–01*C–*–60
PA5DG4S4W/LW–01*N–*–60
SPA5DG4S4W/LW–01*A–*–60











PA3DG4S*W/LW–01–*–60**
A models
B models
F models

PA5DG4S*W/LW–01–*–60**
A models
B models
F models

PA5DG4S4W/LW–01–*–60**
C models
N models

SPA5DG4S4W/LW–01–*–60**
A models only

▲ Electrical connection is over solenoid on single solenoid models, and over "b" solenoid on dual solenoid models. See diagram plate for "b" solenoid location.

Electrical rating 600 volts, 3 pole, 10 amps and 5 pole, 8 amps. The female portable plug to be furnished by customer.

■ **Warning**
Electrical power must be disconnected before removing or replacing this receptacle.

† Receptacle will be prewired directly to the ● terminals on the solenoid indicator light package. (For exception see note "●").

Δ Receptacle will be prewired to the solenoid eyelets. The connection will be made via No. 6 screws and nuts insulated with black electrical tape. (For exception see note "●").

● For models with monitor switch, wires to be supplied and connected by customer.

Vickers®

Solenoid Operated Directional Valves Catalog

DG4V-3 flows to 80 l/min (21 USgpm), 6* design

DG4V-3S flows to 40 l/min (10.5 USgpm), 6* design

ISO 4401, size 03; ANSI/ B93.7M-D03

EATON

Powering Business Worldwide

General description

These solenoid operated directional control valves are for directing and stopping flow at any point in a hydraulic system. This 60-design series has been specially designed and developed to cover expanded demands in the industry as well as the many traditional uses of the earlier designs. Some of the more important benefits to users are outlined.

- Efficient control of greater hydraulic powers without increasing solenoid power consumption.
- Installed cost and space savings from higher power/weight-and-size ratios.
- Increases system efficiency; the result of improved manufacture of spools and bores.
- Installation flexibility resulting from choice of numerous combinations of solenoid connectors and locations.
- Multi-fluid capability without need to change seals.
- Higher sustained machine productivity and higher uptime because of proven fatigue life and endurance, tested over 20 million cycles.
- Solenoid coils can be changed quickly and easily without leakage from hydraulic system.
- Compact, cost effective system design when used with Vickers® SystemStak™ valves and subplates.

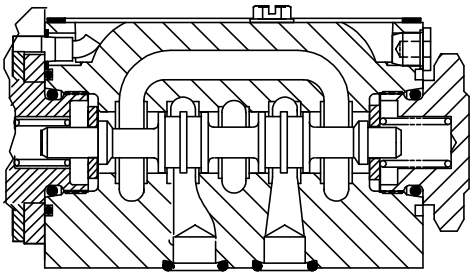
DG4V-3 and DG4V-3S High and standard performance models:

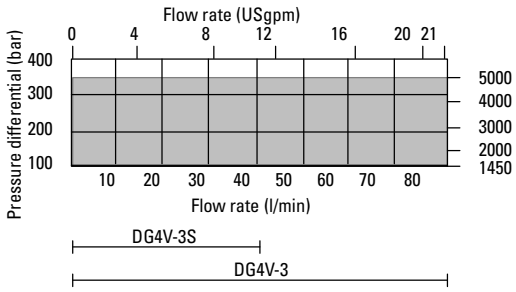
- Up to 80 l/min (21 USgpm) and up to 40 l/min (10.5 USgpm) respectively at 350 bar (5000 psi).
- Builds on Eaton's experience as the major supplier of size 03 valves worldwide.
- Offers designers the opportunity to select the optimum value package for each application.
- International standard interface. The valve mounting face conforms to ISO 4401, size 03 and is compatible with related international standards.

Features and Benefits

- **High pressure and flow capabilities, thanks to special design features**

Highly reliable operation up to 80 l/min (21 USgpm) at 350 bar (5000 psi). Establishes new market standards and opens new possibilities to design engineers on valve size selection.





Typical maximum pressure differential (P-A-B-T) flow envelope, blocked center spool.

High performance
DG4V-3, 6* design

Standard performance
DG4V-3S, 6* design

Mounting interface

ISO 4401 size 03
ANSI/B93.7M size D03
CETOP RP65H, size 3
DIN 24340, NG6

Basic characteristics

Maximum pressure:
DG4V-3 350 bar (5075 psi)
DG4V-3S 350 bar (5075 psi)

Maximum flow:
DG4V-3 up to 80 l/min (21 USgpm)
DG4V-3S up to 40 l/min (10.5 USgpm)

DG4V-3 models are direct solenoid operated four-way directional control valves. Their primary function in a hydraulic circuit is to direct fluid flow. This, in turn, would determine the direction of movement of a fluid cylinder, or the direction of rotation of a fluid motor.

Port connections are made by mounting the valve on a subplate or manifold. The valve has wet armature type solenoids.

Electrical connections to the valve are made in the electrical wiring housing or thru various plug-in connectors such as a DIN 43650 type coil.

Good hydraulic design practice suggests that detented models be mounted with longitudinal axis horizontal. Other models may be mounted in any position.

Operating considerations

1. Dependent on the application and the system filtration, any sliding spool valve if held shifted under pressure for long periods of time, may stick and not move readily due to fluid residue formation. It may therefore need to be cycled periodically to prevent this from happening.

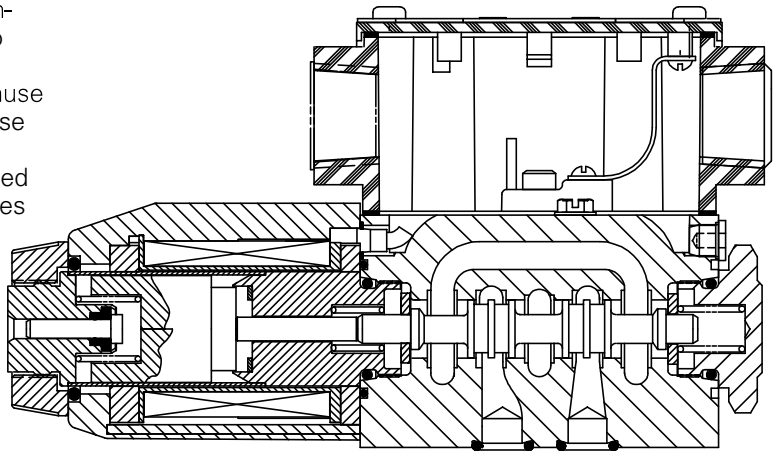
2. Surges of fluid in a common tank line serving two or more valves can be of sufficient magnitude to cause inadvertent shifting of these valves. This is particularly critical in no-spring detented models, separate drain lines are necessary.

Temperature limits

Minimum ambient
-20°C (-4° F)

Maximum ambient
Valves with coils listed in model code and at stated percentages of rated voltage.

Construction of a typical single solenoid model



Fluid temperature

FLUID TEMP.	MINERAL OIL	WATERCONTAINING
Min	–20°C (-4°F)	+10°C (+50°F)
Max.*	+70°C (+158°F)	+54°C (+129°F)

* To obtain optimum service life from both fluid and hydraulic system, 65°C (150°F) normally is the maximum temperature except for watercontaining fluids.

COIL TYPE AND FREQUENCY	PERCENTAGE VOLTAGE	MAXIMUM AMBIENT TEMPERATURE DG4V-3	DG4V-3S
Dual frequency coils			
@ 50 Hz	107%	40°C (104°F)	65°C (149°F)
@ 50 Hz	110%	30°C (86°F)	65°C (149°F)
@ 60 Hz	107%	50°C (122°F)	65°C (149°F)
@ 60 Hz	110%	40°C (104°F)	65°C (149°F)
Single frequency (50 Hz) coils			
@ 50 Hz	110%	40°C (104°F)	65°C (149°F)
DC coils	110%	70°C (158°F)	70°C (158°F)

For synthetic fluids consult manufacturer or Eaton representative where limits are outside those for mineral oil.

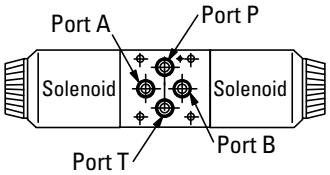
Whatever the actual temperature range, ensure that viscosities stay within the limits specified in the "Hydraulic fluids" section.

Functional Symbols

Spool types shown represent the highest proportion of market requirements. For other spool functions that may be required, consult your Eaton sales representative.

Solenoids identified to U.S. standards

Functional symbols related to solenoid identity "A" and/or "B" according to NFPA/ANSI standards, i.e. energizing solenoid "A" gives flow P to A, solenoid "B" gives flow P to B (as applicable).

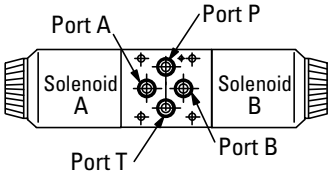


SOLENOID	FOR SPOOL TYPE	SOLENOID
B	All	A
	except	
	"8"	
A	"8"only	B

For valves with type "8"spools, solenoid identity to U.S. convention is the same as for European convention.

Solenoids identified to European standards (specify "V" in model code)

Functional symbols related to solenoid identity "A" and/or "B" according to European convention i.e. solenoid "A" adjacent to "A" port, solenoid "B" adjacent to "B" port of valve.

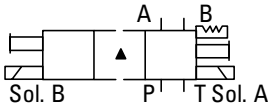


- For differences in valve function, refer to Performance Data page 11.

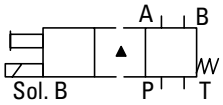
◇ F build spools.

U.S. solenoid standard

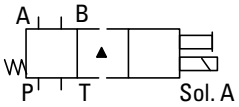
Double solenoid valves, two position, detented



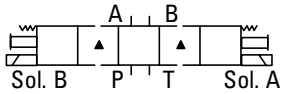
Single solenoid valves, solenoid at port A end



Single solenoid valves, solenoid at port B end



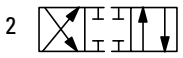
Double solenoid valves, spring centered



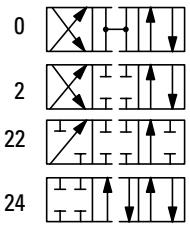
▲ Transient condition only

The valve function schematics apply to both U.S. and European valves.

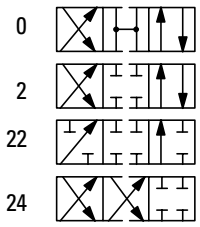
DG4V-3(S)-*N(V)



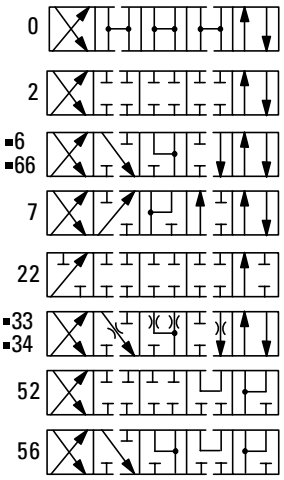
DG4V-3(S)-*A(V)



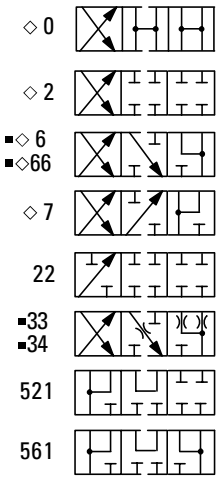
DG4V-3(S)-*AL(V)



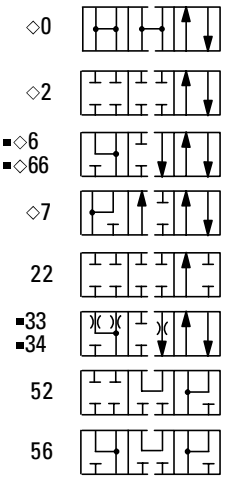
DG4V-3(S)-*C(V)



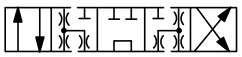
DG4V-3(S)-*B/F(V)



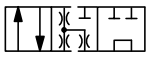
DG4V-3(S)-*BL/FL(V)



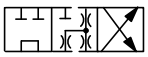
DG4V-3(S)-8C(V)



DG4V-3(S)-8BL(V)

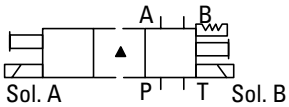


DG4V-3(S)-8B(V)

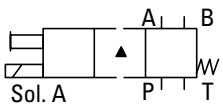


European solenoid standard

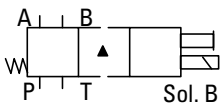
Double solenoid valves, two position, detented



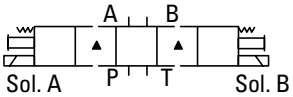
Single solenoid valves, solenoid at port A end



Single solenoid valves, solenoid at port B end



Double solenoid valves, spring centered



▲ Transient condition only

Model Code

DG4V—3(S)— *(L)—(**)—(V)M—(S*)—* ** * D* (L)—* *—6*—(EN***)—(P**—A**—B**—T**)**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

1 Model Series

D – Directional valve

G – Subplate/manifold mounted

4 – Solenoid operated

V – Pressure rating 350 bar (5075 psi) on P, A & B ports

2 Standard or high performance

3 – High performance specification: up to 80 l/min (21 USgpm) at 350 bar (5075 psi)

3S – Standard performance specification: up to 40 l/min (10.5 USgpm) at 350 bar (5075 psi)

3 Spool type

See "Functional symbols" section.

4 Spool Spring Arrangement

A – Spring offset, end-to-end

AL – Same as "A" but left hand build

B – Spring offset, end to center

BL – Same as "B" but left hand build

C – Spring centered

F – Spring offset, shift to center

FL – Same as "F" but left hand build

N – No-spring detented

5 Manual override option

No symbol – Plain override(s) in solenoid end(s) only ▲

H – Water-resistant override(s) on solenoid end(s) ▲

H2 – Water-resistant override both ends of solenoid.

P2 – Plain override both ends of single solenoid.

Y● – Latching manual override on solenoid ends (includes "H" feature seal) ▲

Z – No overrides at either end

▲ No override in non-solenoid end of single solenoid valves

● Not available on DG4V-3S, AC models

6 Solenoid energization identity

V – Solenoid "A" is at port "A" end and/ or solenoid "B" is at port "B" end, independent of spool type

Omit for U.S. ANSI B93.9 standard requiring solenoid "A" energization to connect P to A and/or solenoid "B" to connect P to B, independent of solenoid location.

NOTE: Type "8" spool valves conform to both U.S. and European solenoid designations. When ordering an "8" spool, designate a "V" in the model code.

7 Flag symbol

M – Electrical options and features

8 Spool indicator switch

Available on high performance models, DG4V-3, only. Omit when not required.

DG4V-3-*A(L)-(V)M models with type U (ISO4400) electrical connector to solenoid; spool type 0, 2 or 22 only:

S6 – LVDT type DC switch with Pg7 connector plug.

DG4V-3-*A(L)-(Z)-(V)M-S*-FPA5W valves with mechanical type AC (~) switch, wired to 5-pin receptacle:

S3 – Switch, wired normally open

S4 – Switch, wired normally closed

DG4V-3-*A(L)-(Z)-(V)M-S5-F(T) W/J valves with mechanical type AC (~) switch:

S5 – Switch, free leads

9 Coil type

U – ISO 4400 (DIN 43650) mounting ◆

U1– Connector fitted

U6 – Connector fitted w/lights

U11 – Connector fitted w/rectifier & lights**

U12 – Connector fitted w/rectifier**

F – 1/2" NPT thread conduit box

KU – Top exit flying leads*

SP1 – Single 6,3 mm spade* ◆

SP2 – Dual 6,3 mm spade* ◆

X1 – Flame resistant solenoids TP EEx-d-11B-T4

X2 – Hazardous location solenoids to meet UL & CSA approval

X3 – Special protection solenoids to BASEEFA standar SFA009:1972, protection class EX-S-11-T4

◆ Female connector to be supplied by customer

* DC service only

** AC service only

10 Electrical connector

T – Wired terminal block

PA – Instaplug male receptacle only

PB – Instaplug male & female receptacle

PA3 – Three pin connector

PA5 – Five pin connector

11 Housing (F type coils only)

W – 1/2" NPT thread wiring housing

J – 20 mm thread wiring housing

12 Surge suppressor/ damper

D1 – Encapsulated diode (Industrial applications)

D2 – Encapsulated diode (Mobile applications)

D7 – Transzorb type (F,KU,U,SP1,SP2 only)

13 Solenoid indicator lights

Not available on PA, KU, U, SP1& SP2

14 Coil rating

Full power coils, see "Operating Data".

A – 110V AC 50Hz

B◇ – 110V AC 50Hz/120V AC 60 Hz

C – 220V AC 50 Hz

D◇ – 220V AC 50 Hz/240V AC 60 Hz

G – 12V DC

H – 24V DC

For DG4V-3 only (not usable with DG4V-3S):
Low power coils, see "Operating Data". (Not available with "N" – No-spring detented models)

BL – 110V 50 Hz/120V 60 Hz

DL – 220V AC 50 Hz/240V AC 60 Hz

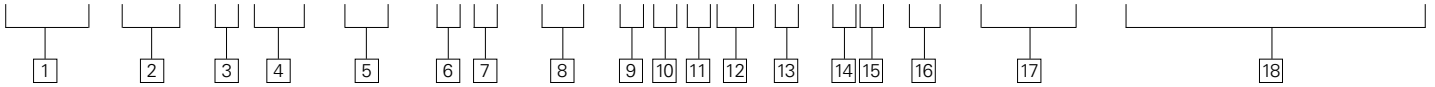
GL – 12V DC

HL – 24V DC

◇ For 60 Hz or dual frequency

Contact your Eaton representative for additional coil voltage options.

DG4V—3(S)— *(L)—(**)—(V)M—(S*)—* ** * D* (L)—* *—6*—(EN***)—(P**—A**—B**—T**)**



15 Port T code

Refer to "Operating Data" for port T pressure ratings.

2 – 10 bar (150 psi) for spool position indicator models S3, S4 and S5.

4 – 70 bar (1000 psi)

5 – 100 bar (1500 psi) for standard performance models, DG4V-3S, with AC or DC solenoids.

6 – 207 bar (3000 psi) for AC high performance models, DG4V-3, including spool position indicator type S6.

7 – 207 bar (3000 psi) for DC high performance models, DG4V-3, including spool position indicator type S6.

16 Design number

60 – Basic design

61 – Type 8 spool

17 Special features

"EN***" code number assigned as required.

EN21 – CSA approved models with 1/2" NPT entry conduit box, type FW and solenoid coil letter B,D,G, or H.

18 Port restrictor plugs

For details of plug orifice sizes and how to specify in model code see page 15. May be fitted to valves by agreement with your Eaton representative.

Omit – No restrictor plugs fitted

Operating Data

Performance data is typical with fluid at 36cSt (168 SUS) and 50°C (122°F).

FEATURE	STANDARD PERFORMANCE VALVE DG4V-3S		HIGH PERFORMANCE VALVE DG4V-3	
Pressure Limits				
P, A and B ports	350 bar (5075 psi) ■		350 bar (5075 psi)	
T port:				
Spool indicator switch models				
Types S3, S4, S5	N/A		10 bar (145 psi)	
Type S6	N/A		210 bar (3045 psi)	
All other models	100 bar (1450 psi)		210 bar (3045 psi)	
Flow rating	See performance data		See performance data	
Relative duty factor	Continuous; ED = 100%		Continuous; ED = 100%	
Type of protection:				
ISO 4400 coils with plug fitted correctly	IEC 144 class IP65		IEC 144 class IP65	
SP1 – Single spade 6,3 mm	IEC 760		IEC 760	
SP2 – Dual spade 6,3 mm	IEC 760		IEC 760	
Coil winding	Class H		Class H	
Lead wires (coils type F***)	Class H		Class H	
Coil encapsulation	Class F		Class F	
Permissable voltage fluctuation:				
Maximum	Refer to temperature limits.		Refer to temperature limits.	
Minimum	90% rated		90% rated	
Typical response times at 100% rated volts measured from application/removal of voltage to full spool displacement of "2C" spool at:				
Flow rate P-A, B-T	20 l/min (5.3 USgpm)		40 l/min (10.6 USgpm)	
Pressure	175 bar (2537 psi)		175 bar (2537 psi)	
AC (~) energizing	18 ms		15 ms	
AC (~) de–energizing	32 ms		23 ms	
DC (=) energizing	60 ms		45 ms	
DC (=) de–energizing	40 ms		28 ms	
Power consumption, AC solenoids	Initial ▲	Holding	Initial ▲	Holding
(for coils listed in model code).	VA (RMS)	VA (RMS)	VA (RMS)	VA (RMS)
Full power coils:				
Single frequency coils AC 50 Hz	225	39	265	54
Dual frequency coils at 50 Hz	265	49	280	61
Dual frequency coils at 60 HZ	260	48	300	58
Low power coils, "BL" and "DL":				
(Not available with "N" – No-spring detented models)	Low power coils not usable		170	37
Dual frequency coils at 50 Hz	with DG4V-3S valves.		190	37
Dual frequency coils at 60 Hz				
Power consumption, DC solenoids at rated voltage and 20 C (68 F).				
Full power coils:				
12V, model type "G"	30W	–	30W	–
24V, model type "H"	30W	–	30W	–
Low power coils:				
12V, model type "GL"	Low power coils not usable		18W	–
24V, model type "HL"	with DG4V-3S valves.		18W	–

■ For applications where valves are to remain pressurized (either energized or de-energized) at pressures over 210 bar (3045 psi) without frequent switching, it is recommended to use the high performance model, DG4V-3.

▲ 1st half cycle; armature fully retracted.

Spool Position Indicator Models, high performance valve DG4V-3 ONLY

Spool/spring arrangement types 0A (L), 2A(L), 22A(L)

DC model type "S6" (see page 14 for Installation Dimension)

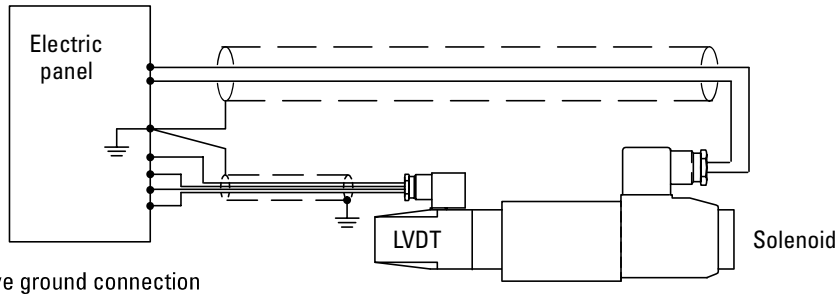
CE This product has been designed and tested to meet specific standards outlined in the European Electromagnetic Compatibility.

Directive (EMC) 89/336/EEC, amended by 91/263/EEC, 92/31/EEC and 93/68/EEC, article 5. For instructions on installation requirements to achieve effective protection levels see this leaflet and the Installation Wiring Practices for Eaton's Vickers® Electronic Products leaflet 2468. Wiring practices relevant to this Directive are indicated by ⚠ Electromagnetic Compatibility (EMC).

Input:	
Supply voltage	10 to 35V DC inclusive of a maximum 4V pk-to-pk ripple
Current, switch open	5 mA
Current, switch closed	255 mA
Output:	
Voltage	1V below input at maximum load
Maximum continuous current	250 mA
Maximum load impedance	136Ω at maximum input volts
Maximum switching frequency	10 Hz
Plug connections:	
Pin 1 (output 1)	Normally open (ie. not connected to pin 3)
Pin 2	Supply +ve
Pin 3	0V
Pin 4 (output 2)	Normally closed (ie.connected to pin 3)
Switching point	Within the spool spring offset condition •
Connector	Pg7 plug (supplied with valve)
Protection	Overload and short-circuit protected; self re-setting. IEC 144 class IP65 with connector correctly fitted.

• Factory setting ensures this condition under all combinations of manufacturing tolerance and of temperature drift (see "Temperature Limits").

Wiring Connections



⏚ Customer's protective ground connection

Warning

All power must be switched off before connecting or disconnecting any plugs

WARNING: *Electromagnetic Compatibility (EMC)*

It is necessary to ensure that the unit is wired up in accordance with the connection arrangements shown above. For effective protection the user's electrical cabinet, the valve subplate or manifold and the cable screens should be connected to efficient ground points.

In all cases both valve and cable should be kept as far away as possible from any sources of electromagnetic radiation such as cables carrying heavy current, relays and certain kinds of portable radio transmitters, etc. Difficult environments could mean that extra screening may be necessary to avoid the interference.

Micro-switch type "S3", "S4" and "S5"	
Voltage	250V maximum 50/60 Hz
Maximum current	5A

Typical with mineral oil at 36 cSt (168.6 SUS) and a specific gravity of 0.87.

Maximum flow rates

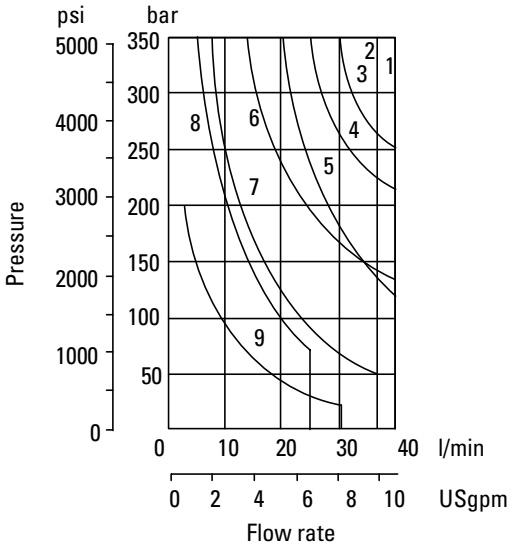
Performance based on full power solenoid coils warm and operating at 90% rated voltage.

See note at bottom of next page when using low power coils (DG4V-3 models only).

DG4V-3S models (standard performance)

Graph 1

AC solenoid valves with dual frequency coils operating at 50 Hz

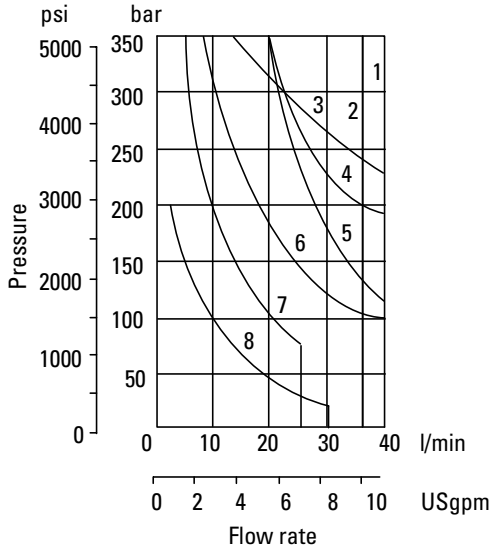


Graph 2

AC solenoid valves with

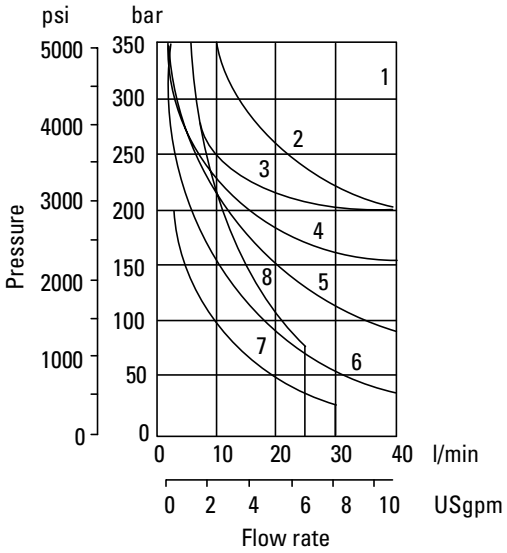
– Dual frequency coils operating at 60 Hz

– Single frequency (50 Hz) coils operating at 50 Hz



Graph 3

DC solenoid valves



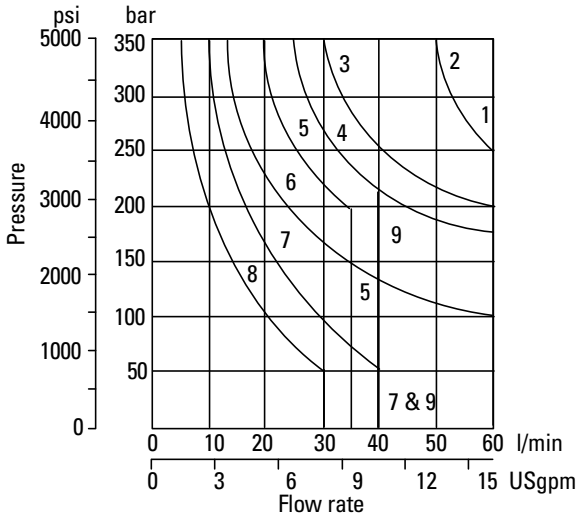
Spool/spring code	Graph 1 curve	Graph 2 curve	Graph 3 curve
0A(L)	1	1	3
0B(L) & 0C, 0F	1	1	1
2A(L)	5	5	3
2B(L) & 2C, 2F	2	2	3
2N	1	1	1
6B(L) & 6C, 6F	6	6	5
7B(L) & 7C, 7F	6	6	2
8B(L) & 8C	8 ▲	7 ▲	8 ▲
22A(L)	9	8	7
22B(L) & 22C	7	7	6
24A(L)	6	6	5
33B(L) & 33C	4	4	4
34B(L) & 34C	6	6	5
52BL, 52C,	6	6	5
56BL & 56C	6	6	5
66B(L) & 66C	3	3	5
521B & 561B	6	6	5

▲ Consult Eaton regarding each application that will jointly have flow rates approaching this curve and a pressurized volume exceeding 2000 cm^3 (122 cu.in.)

DG4V-3 models (high performance)

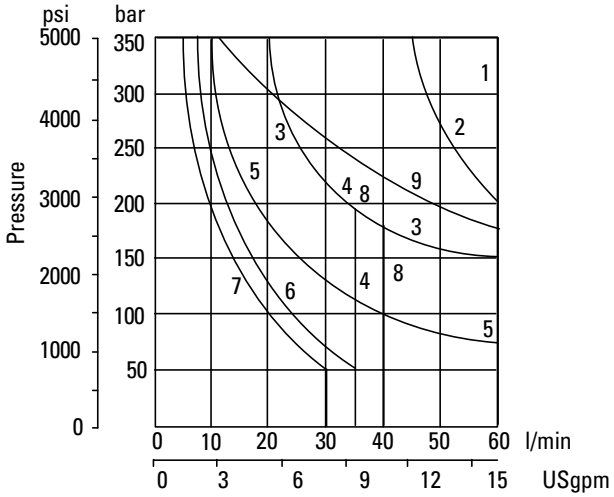
Graph 4

AC solenoid valves with: – Single-frequency coils
– Dual-frequency coils operating at 50 Hz



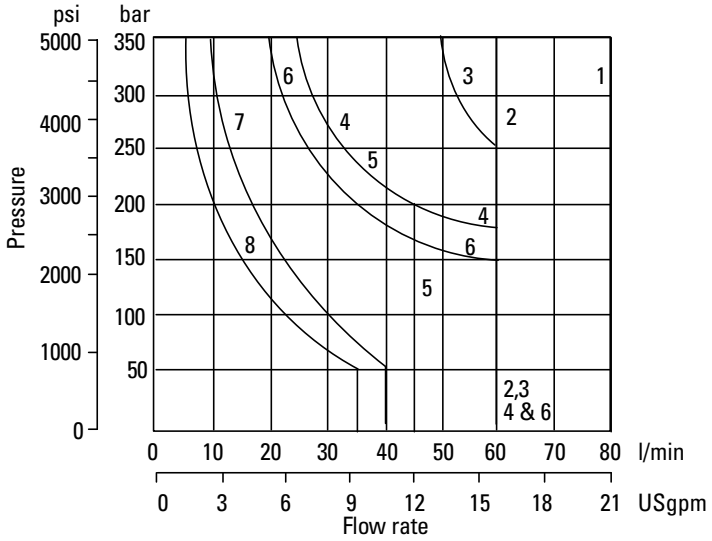
Graph 5

AC solenoid valves with dual-frequency coils operating at 60 Hz



Graph 6

DC solenoid valves



Spool/ spring code	Graph 4 curve	Graph 5 curve	Graph 6 curve
0A(L)	2	2	3
0B(L) & 0C, 0F	1	1	2
2A(L)	2	2	3
2B(L) & 2C, 2F	1	1	1
2N	1	1	2
6B(L) & 6C, 6F	6	5	6
7B(L) & 7C, 7F	1	1	2
8B(L) & 8C	5 ▲	4 ▲	5 ▲
22A(L)	8	7	8
22B(L) & 22C	7	6	7
24A(L)	9	8	5
33B(L) & 33C	4	3	4
34B(L) & 34C	4	3	6
52BL, 52C,	6	5	6
56BL & 56C	6	5	6
66B(L) & 66C	3	9	6
521B & 561B	6	5	6

▲ Consult Eaton regarding each application that will jointly have flow rates approaching this curve and a pressurized volume exceeding 2000 cm3 (122 cu.in.)

Flow limits applicable to the following usages:

1. All valves except types 22 and 52 spools having simultaneous equal flow rates from P to A or B and from B or A to T and S3, S4, S5 (limit switch) models.
2. Valves with type 22 spools having flow from P to A or B, the other being plugged. T is drained at all times.
3. Valves with type 52 spools having one service port (A or B as appropriate) connected to the full bore end of a 2:1 area ratio double-acting cylinder and the other to the annulus end.
4. Consult Eaton, with application details, if either of the following usages are required:
   (a) Single flow path, i.e. P to A, P to B, A to T or B to T.
   (b) Substantially different simultaneous flow rates between P to A or B and B or A to T, e.g. when A and B are connected to a cylinder having a large differential area.

Low Power Coils
(DG4V-3 models only)

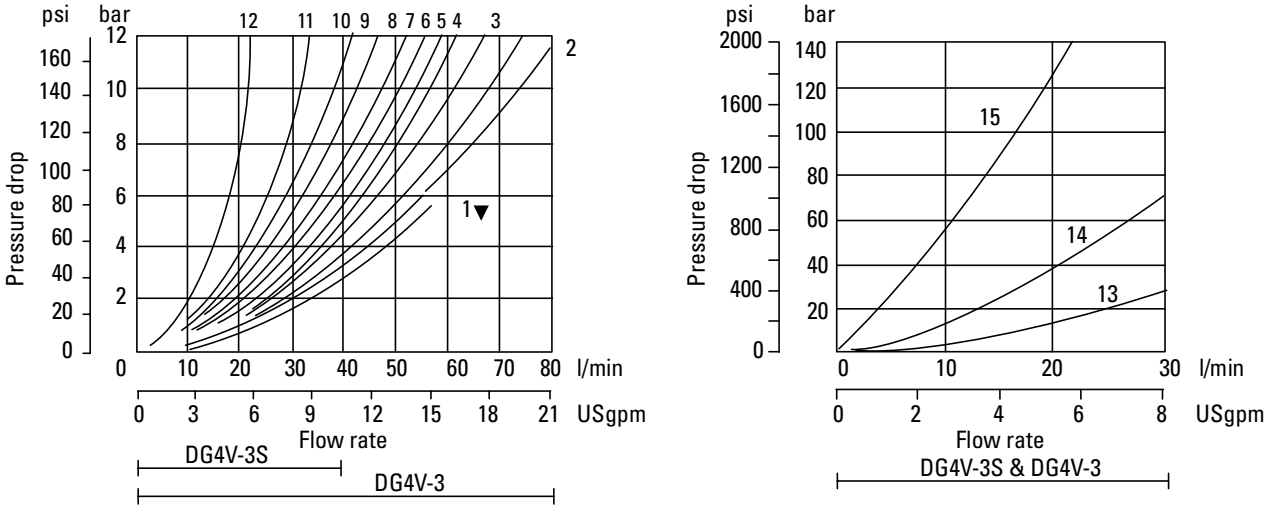
When using low power coils (coil designations *L in model code) the maximum flow is reduced from values given on this page (graphs 4, 5 and 6) by up to:

70% – for DC coils

50% – for AC coils

depending on spool type. Consult your Eaton representative relative to specific applications for low power coils.

Pressure drops



▼ Curve for spool type 6: not recommended for flows in excess of 60 l/min (15.8 USgpm).

Pressure drops in offset positions except where otherwise indicated

Spool/spring code	Spool positions covered	P to A	P to B	A to T	B to T	P to T	B to A or A to B
0A(L)	Both	5	5	2	2	–	–
0B(L) & 0C, 0F	De-energized	–	–	–	–	4▲Δ	–
	Energized	4	4	2	2	–	–
2A(L)	Both	6	6	5	5	–	–
2B(L) & 2C, 2F	Energized	5	5	2	2	–	–
2N	Both	6	6	3	3	–	–
6B(L) & 6C, 6F	De-energized	–	–	3▲	3Δ	–	–
	Energized	6	6	1	1	–	–
7B(L) & 7C, 7F	De-energized	6▲	6Δ	–	–	–	7❍
	Energized	4	4	3	3	–	–
8B(L) & 8C	All	9	9	5	5	3	–
22A(L), 22B(L) & 22C	All	6	6	–	–	–	–
24A(L)	De-energized	6	6	2	2	–	–
33B(L) & 33C	De-energized	–	–	15▲	15Δ	–	–
	Energized	5	5	2	2	–	–
34B(L) & 34C	De-energized	–	–	14▲	14Δ	–	–
	Energized	5	5	2	2	–	–
52BL & 52C	Energized	6▲	6Δ	2	–	–	10❍
56BL	Both	6▲	6Δ	11▲	10Δ	–	10❍
56C	De-energized	–	–	11▲	10Δ	–	10❍
	Energized	6▲	6Δ	2	–	–	10❍
66B(L) & 66C	De-energized	–	–	12	12	–	13
	Energized	6	6	2	2	–	–
521B	All	6▲	6Δ	–	–	–	10❍
561B	De-energized	–	–	10▲	11Δ	–	10❍
	Energized	6	6Δ	–	–	–	10❍

▲"B" plugged Δ"A" plugged ❍"P" plugged

For other viscosities, pressure drops approximate to:

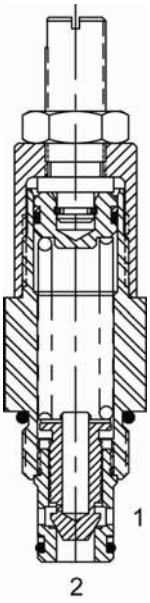
Viscosity cSt (SUS)						
14	20	43	54	65	76	85
(17.5)	(97.8)	(200)	(251)	(302)	(352)	(399)
% of Δp						
81	88	104	111	116	120	124

A change to another specific gravity will yield an approximately proportional change in pressure drop.

The specific gravity of a fluid may be obtained from its producer. Fire resistant fluids usually have higher specific gravities than oil.

Delta Power Company
4484 Boeing Drive - Rockford, IL 61109

DE-RVA Direct Acting Relief Valve



DESCRIPTION

10 size, 7/8-14 thread, “Delta” series, direct acting relief valve.

OPERATION

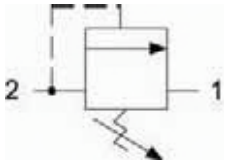
The DE-RVA blocks flow from (2) to (1) until sufficient pressure is present at (2) to force the poppet to open and allow metered flow from (2) to (1)

The cartridge offers smooth transition in response to load changes in common hydraulic circuits.

FEATURES

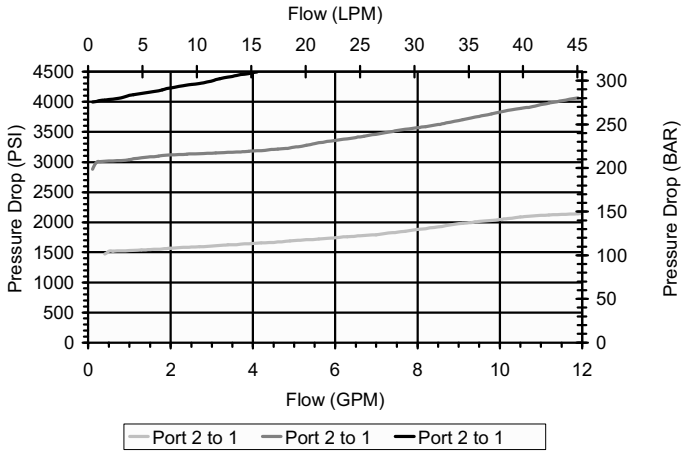
- Hardened parts for long life.
- Industry common cavity.

HYDRAULIC SYMBOL



PERFORMANCE

Actual Test Data (Cartridge Only)



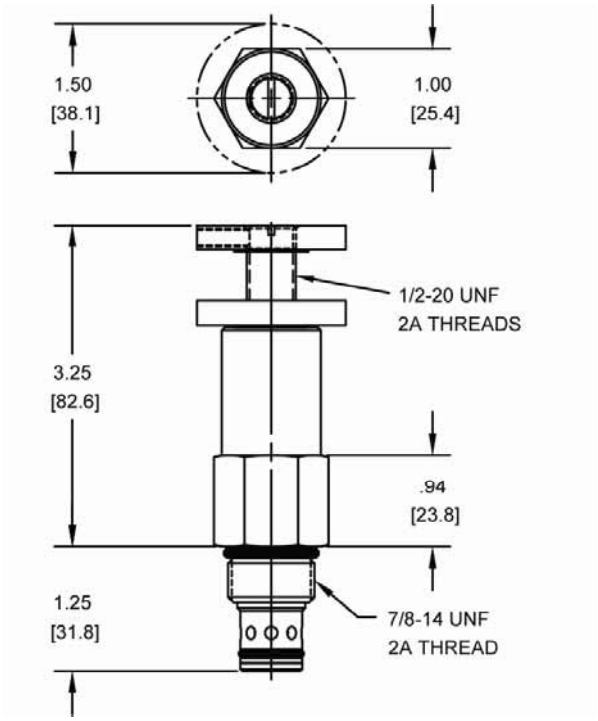
VALVE SPECIFICATIONS

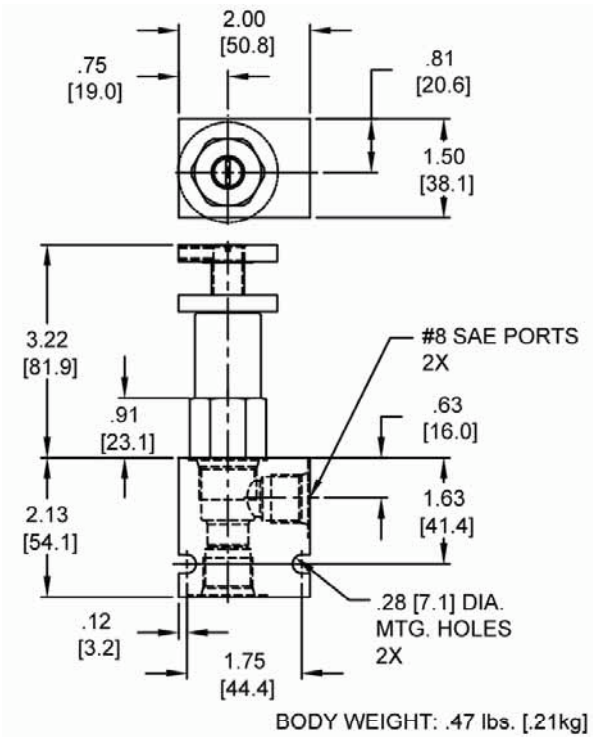
Nominal Flow	4 GPM (15.6 LPM) 4000 PSI 8 GPM (30 LPM) 3000 PSI
Rated Operating Pressure	4000 PSI (276 bar)
Viscosity Range	36 to 3000 SSU (3 to 647 cSt)
Filtration	ISO 18/16/13
Media Operating Temperature Range	-40° to 250° F (-40° to 120° C)
Weight	.56 lbs. (.25 kg)
Operating Fluid Media	General Purpose Hydraulic Fluid
Cartridge Torque Requirements	30 ft-lbs (40.6 Nm)
Cavity	DELTA 2W
Cavity Form Tool (Finishing)	40500000
Seal Kit	21191200

Phone: (815) 397-6628 Fax: (815) 397-2526 E-mail: delta@delta-power.com

Delta Power Company
4484 Boeing Drive - Rockford, IL 61109

DIMENSIONS





ORDERING INFORMATION

DE-RVA - ____ - ____ - ____

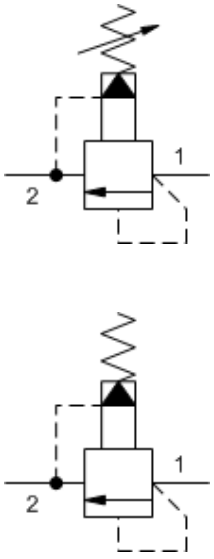
OPTIONS		BODIES	
Buna Standard	**00**	Blank	Without Body
Viton Standard	**V0**	**N**	3/8 NPTF Ports
Buna, Knob	**0K**	**S**	#8 SAE Ports
Viton, Knob	**VK**		

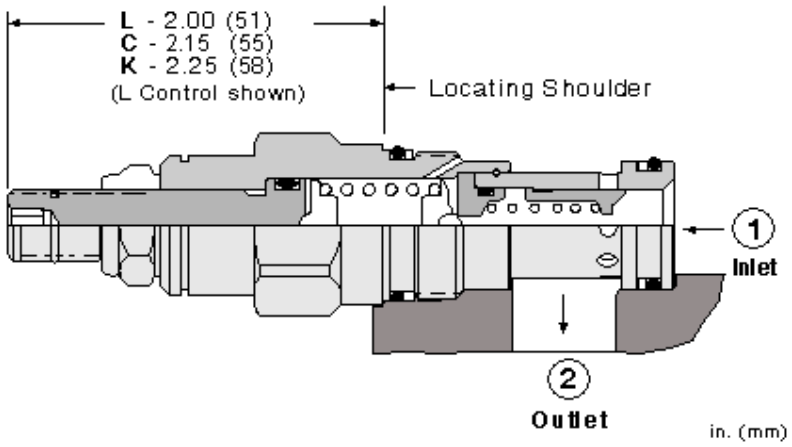
PRESSURE RANGE/SETTING	
1500	200 – 1500 PSI
3000	1500 – 3000 PSI
4000	2500 – 4000 PSI

Phone: (815) 397-6628 Fax: (815) 397-2526 E-mail: delta@delta-power.com

Pilot-operated, balanced piston relief valve
SERIES 1 / CAPACITY: 25 gpm / CAVITY: T-10A

snhy.com/RPEC





Pilot-operated, balanced-piston relief cartridges are normally closed pressure regulating valves. When the pressure at the inlet (port 1) reaches the valve setting, the valve starts to open to tank (port 2), throttling flow to regulate the pressure. These valves are accurate, have low pressure rise vs. flow, they are smooth and quiet, and are moderately fast.

TECHNICAL DATA

NOTE: DATA MAY VARY BY CONFIGURATION. SEE CONFIGURATION SECTION.

Cavity	T-10A
Series	1
Capacity	25 gpm
Factory Pressure Settings Established at	4 gpm
Maximum Operating Pressure	5000 psi
Maximum Valve Leakage at 110 SUS (24 cSt)	2 in^3/min.@1000 psi
Response Time - Typical	10 ms
Adjustment - No. of CW Turns from Min. to Max. setting	5
Valve Hex Size	7/8 in.
Valve Installation Torque	30 - 35 lbf ft
Adjustment Screw Internal Hex Size	5/32 in.
Locknut Hex Size	9/16 in.
Locknut Torque	80 - 90 lbf in.
Seal kit - Cartridge	Buna: 990010007
Seal kit - Cartridge	EPDM: 990010014
Seal kit - Cartridge	Polyurethane: 990010002
Seal kit - Cartridge	Viton: 990010006
Model Weight	0.31 lb.

NOTES

For Series 1 cartridges configured with an O control (panel mount handknob), a .75 in. (19 mm) diameter hole is required in the panel.

CONFIGURATION OPTIONS

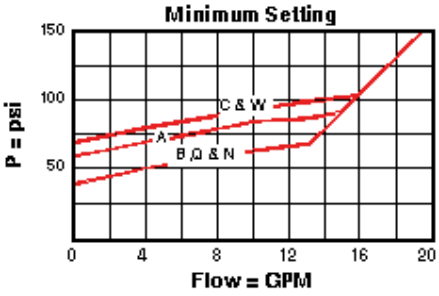
Model Code Example: RPECLAN

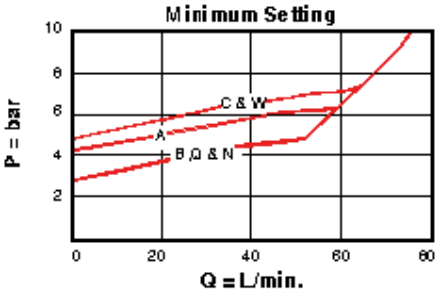
CONTROL (L)	ADJUSTMENT RANGE (A)	SEAL MATERIAL (N)	MATERIAL/COATING
L Standard Screw Adjustment	**A** 100 - 3000 psi (7 - 210 bar), 1000 psi (70 bar) Standard Setting	**N** Buna-N	Standard Material/Coating
C Tamper Resistant - Factory Set	**W** 150 - 4500 psi (10,5 - 315 bar), 1000 psi (70 bar) Standard Setting	**E** EPDM	**/AP** Stainless Steel, Passivated
K Handknob	**B** 50 - 1500 psi (3,5 - 105 bar), 1000 psi (70 bar) Standard Setting	**V** Viton	**/LH** Mild Steel, Zinc-Nickel
O Handknob with Panel Mount	**C** 150 - 6000 psi (10,5 - 420 bar), 1000 psi (70 bar) Standard Setting		
W Hex Wrench Adjustment	**N** 60 - 800 psi (4 - 55 bar), 400 psi (28 bar) Standard Setting		
Y Tri-Grip Handknob	**Q** 60 - 400 psi (4 - 28 bar), 200 psi (14 bar) Standard Setting		

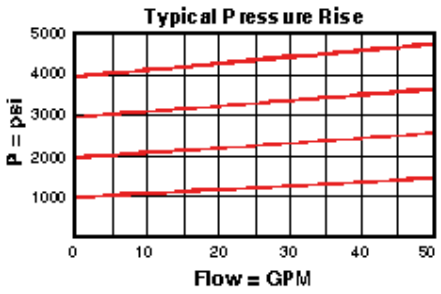
TECHNICAL FEATURES

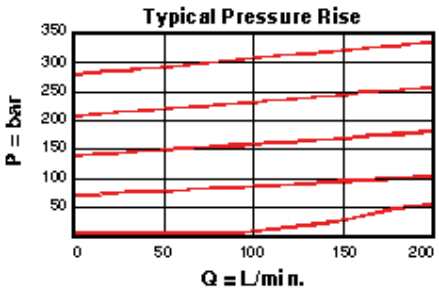
- All 2-port relief cartridges (except pilot reliefs) are physically and functionally interchangeable (same flow path, same cavity for a given frame size).
- Cartridges configured with EPDM seals are for use in systems with phosphate ester fluids. Exposure to petroleum based fluids, greases and lubricants will damage the seals.
- Will accept maximum pressure at port 2; suitable for use in cross port relief circuits. If used in cross port relief circuits, consider spool leakage.
- Main stage orifice is protected by a 150-micron stainless steel screen.
- Not suitable for use in load holding applications due to spool leakage.
- Back pressure on the tank port (port 2) is directly additive to the valve setting at a 1:1 ratio.
- W and Y controls (where applicable) can be specified with or without a special setting. When no special setting is specified, the valve is adjustable throughout its full range using the W or Y control. When a special setting is specified, this setting represents the maximum setting of the valve.
- Corrosion resistant cartridge valves are intended for use in corrosive environments and are identified by the model code suffix /AP for external stainless steel components, or /LH for external zinc-nickel plated components. See the CONFIGURATION section for all options. For further details, please see the Materials of Construction page located under TECH RESOURCES.
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES









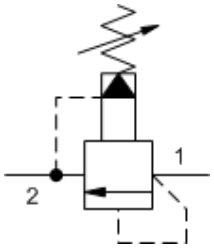
RELATED MODELS

- RPEC8 Pilot-operated, balanced piston relief main stage with integral T-8A control cavity

MODEL
RPEC

Pilot-operated, balanced piston relief valve
SERIES 1 / CAPACITY: 25 gpm / CAVITY: T-10A

snhy.com/RPEC



Pilot-operated, balanced-piston relief cartridges are normally closed pressure regulating valves. When the pressure at the inlet (port 1) reaches the valve setting, the valve starts to open to tank (port 2), throttling flow to regulate the pressure. These valves are accurate, have low pressure rise vs. flow, they are smooth and quiet, and are moderately fast.

CONFIGURATION

L	Control	Standard Screw Adjustment
D	Adjustment Range	25 - 800 psi (1,7 - 55 bar), 400 psi (28 bar) Standard Setting
N	Seal Material	Buna-N
(none)	Material/Coating	Standard Material/Coating

TECHNICAL DATA

NOTE: DATA MAY VARY BY CONFIGURATION. SEE CONFIGURATION SECTION.

Cavity	T-10A
Series	1
Capacity	25 gpm
Factory Pressure Settings Established at	4 gpm
Maximum Operating Pressure	5000 psi
Maximum Valve Leakage at 110 SUS (24 cSt)	2 in³/min.@1000 psi
Response Time - Typical	10 ms
Adjustment - No. of CW Turns from Min. to Max. setting	5
Valve Hex Size	7/8 in.
Valve Installation Torque	30 - 35 lbf ft
Adjustment Screw Internal Hex Size	5/32 in.
Locknut Hex Size	9/16 in.
Locknut Torque	80 - 90 lbf in.
Seal kit - Cartridge	Buna: 990010007
Seal kit - Cartridge	EPDM: 990010014
Seal kit - Cartridge	Polyurethane: 990010002
Seal kit - Cartridge	Viton: 990010006
Model Weight	0.31 lb.

NOTES

For Series 1 cartridges configured with an O control (panel mount handknob), a .75 in. (19 mm) diameter hole is required in the panel.

CONFIGURATION OPTIONS

Model Code Example: RPECLDN

CONTROL (L)

- **L** Standard Screw Adjustment
- **C** Tamper Resistant - Factory Set
- **K** Handknob
- **O** Handknob with Panel Mount
- **W** Hex Wrench Adjustment
- **Y** Tri-Grip Handknob

ADJUSTMENT RANGE (D)

- **D** 25 - 800 psi (1,7 - 55 bar), 400 psi (28 bar) Standard Setting
- **A** 100 - 3000 psi (7 - 210 bar), 1000 psi (70 bar) Standard Setting
- **W** 150 - 4500 psi (10,5 - 315 bar), 1000 psi (70 bar) Standard Setting
- **B** 50 - 1500 psi (3,5 - 105 bar), 1000 psi (70 bar) Standard Setting
- **C** 150 - 6000 psi (10,5 - 420 bar), 1000 psi (70 bar) Standard Setting
- **N** 60 - 800 psi (4 - 55 bar), 400 psi (28 bar) Standard Setting
- **Q** 60 - 400 psi (4 - 28 bar), 200 psi (14 bar) Standard Setting

SEAL MATERIAL (N)

- **N** Buna-N
- **E** EPDM
- **V** Viton

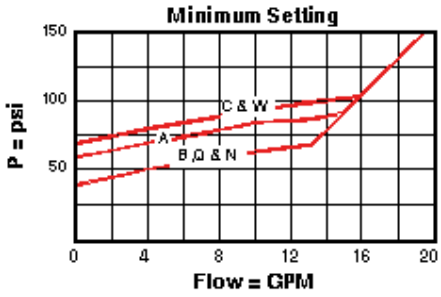
MATERIAL/COATING

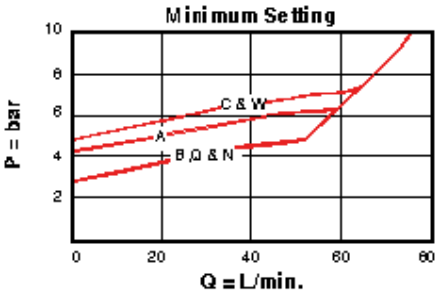
- Standard Material/Coating
- **/AP** Stainless Steel, Passivated
- **/LH** Mild Steel, Zinc-Nickel

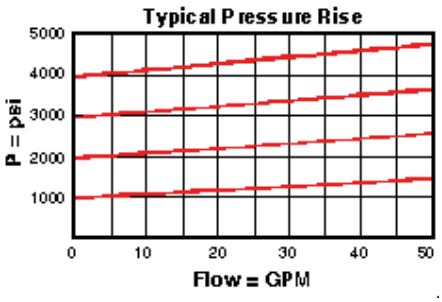
TECHNICAL FEATURES

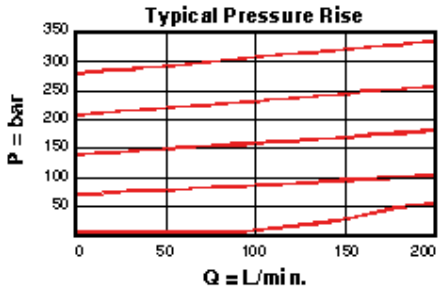
- All 2-port relief cartridges (except pilot reliefs) are physically and functionally interchangeable (same flow path, same cavity for a given frame size).
- Cartridges configured with EPDM seals are for use in systems with phosphate ester fluids. Exposure to petroleum based fluids, greases and lubricants will damage the seals.
- Will accept maximum pressure at port 2; suitable for use in cross port relief circuits. If used in cross port relief circuits, consider spool leakage.
- Main stage orifice is protected by a 150-micron stainless steel screen.
- Not suitable for use in load holding applications due to spool leakage.
- Back pressure on the tank port (port 2) is directly additive to the valve setting at a 1:1 ratio.
- W and Y controls (where applicable) can be specified with or without a special setting. When no special setting is specified, the valve is adjustable throughout its full range using the W or Y control. When a special setting is specified, this setting represents the maximum setting of the valve.
- Corrosion resistant cartridge valves are intended for use in corrosive environments and are identified by the model code suffix /AP for external stainless steel components, or /LH for external zinc-nickel plated components. See the CONFIGURATION section for all options. For further details, please see the Materials of Construction page located under TECH RESOURCES.
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES







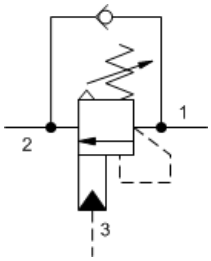


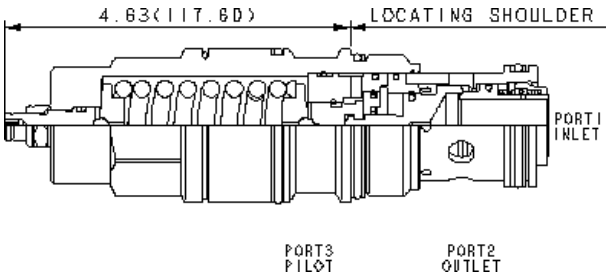
RELATED MODELS

- RPEC8 Pilot-operated, balanced piston relief main stage with integral T-8A control cavity

MODEL
CAIALIV

3:1 pilot ratio, vented counterbalance valve - atmospherically referenced
CAPACITY: 120 gpm | **CAVITY:** T-19A





CONFIGURATION

L	Control	Standard Screw Adjustment
I	Functional Setting Range	400 - 1500 psi (28 - 105 bar), 1000 psi (70 bar) Standard Setting
V	Seal Material	Viton

Atmospherically-vented counterbalance valves with pilot assist are meant to control an overrunning load. The check valve allows free flow from the directional valve (port 2) to the load (port 1) while a direct-acting, pilot-assisted relief valve controls flow from port 1 to port 2. Pilot assist at port 3 lowers the effective setting of the relief valve at a rate determined by the pilot ratio. Backpressure at port 2 does not affect the valve setting because the spring chamber is atmospherically referenced.

Other names for this valve include motion control valve and over center valve.

TECHNICAL DATA

Cavity	T-19A
Series	4
Capacity	120 gpm
Pilot Ratio	3:1
Maximum Recommended Load Pressure at Maximum Setting	3075 psi
Maximum Setting	4000 psi
Factory Pressure Settings Established at	2 in^3/min.
Maximum Valve Leakage at Reseat	5 drops/min.
Check Cracking Pressure	20 psi
Adjustment - Number of Counterclockwise Turns to Increase Setting	5
Operating Characteristic	Standard
Reseat	>85% of setting
Valve Hex Size	1 5/8 in.
Valve Installation Torque	350 - 375 lbf ft
Adjustment Screw Internal Hex Size	5/32 in.
Locknut Hex Size	9/16 in.
Locknut Torque	80 - 90 lbf in.
Seal kit - Cartridge	Buna: 990-119-007
Seal kit - Cartridge	Polyurethane: 990-119-002
Seal kit - Cartridge	Viton: 990-119-006
Model Weight	3.45 lb.

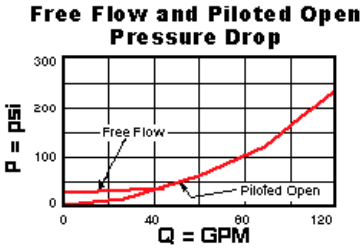
TECHNICAL FEATURES

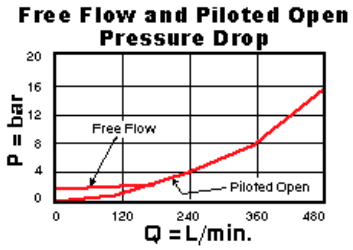
- Counterbalance valves should be set at least 1.3 times the maximum load induced pressure.
- Turn adjustment clockwise to decrease setting and release load.
- Full clockwise setting is 200 psi (14 bar).
- Approximately 1 drop (0,07 cc) of fluid will pass from the pilot area to the vented spring chamber every 4000 cycles.
- Reseat exceeds 85% of set pressure when the valve is standard set. Settings lower than the standard set pressure may result in lower reseat percentages.
- Sun counterbalance cartridges can be installed directly into a cavity machined in an actuator housing for added protection and improved stiffness in the

circuit.

- This valve has positive seals between all ports.
- With vented valves, a lower pilot ratio may be required to achieve machine stability compared to non-vented valves.
- Three-port vented valves are atmospherically referenced and considered problem solvers for existing circuits using non-vented valves. Over time, the vented valves may leak externally or allow moisture into the spring chamber. Four-port vented counterbalance valves are recommended for new applications.
- All 3-port counterbalance, load control, and pilot-to-open check cartridges are physically interchangeable (i.e. same flow path, same cavity for a given frame size).
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES

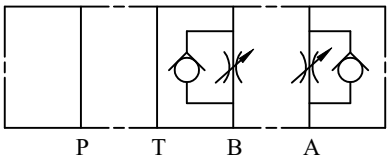




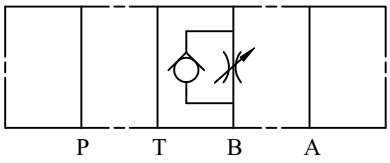
IFP MTC05 FLOW REGULATOR MODULE/ CHECK VALVE

- **ISO4401-05 SIZE/NFPA D05**
- **ADJUSTABLE MICROMETER KNOB**
- **EXTREMELY PRECISE CONTROL**
- **LEAK FREE POSITIVE SEAT**

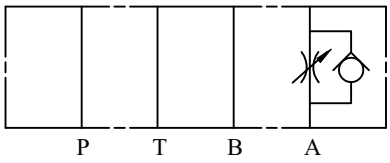
MTC-05- W - 0



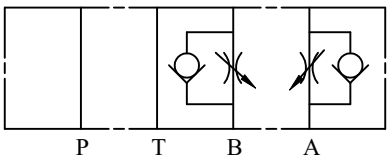
MTC-05-B - 0



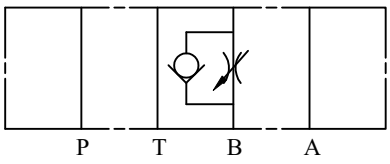
MTC-05-A- 0



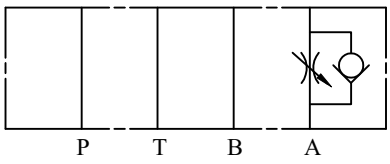
MTC-05-W - I



MTC-05-B - I



MTC-05-A - I



ORDERING CODE

MTC - 05 - W - *

MODULAR REGULAR VALVE

SIZE D05

CONTROL PORT W ~ A&B
A ~ A
B ~ B

0 - METER OUT
I - METER IN

SPECIFICATIONS

TYPES	SIZE	MAX. PRESSURE (PSI)	RATED FLOW (GPM)	WEIGHT lbs
MTC-05-W-*				6.83
MTC-05-A (B) - *	D05	4500 PSI	30	6.61

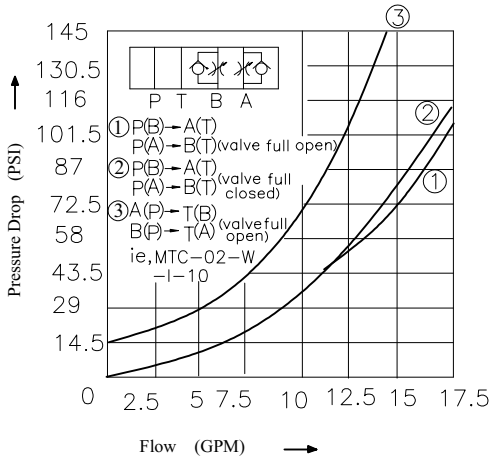
IFP offers a Flow Regulator with Check assemblies in a modular design for applications requiring extremely fine adjustment, especially at low flows. These valves regulate flow by means of an adjustable orifice and flow through the valve is dependent upon pressure drop at any particular setting of the orifice. The internal check valve around each control orifice provide for meter in or meter out control with dual or single service line versions. The use of stackable modules offers cost effective, compact hydraulic systems in which the modules are "sandwiched" between a directional valve and standard mounting surface.

IFP MTC05 FLOW REGULATOR MODULE/ CHECK VALVE

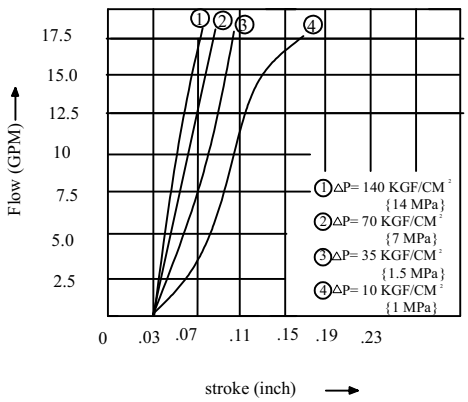
PERFORMANCE CURVES Viscosity (100-150 SUS)

MTC-05-W-*

Pressure Drop characteristic

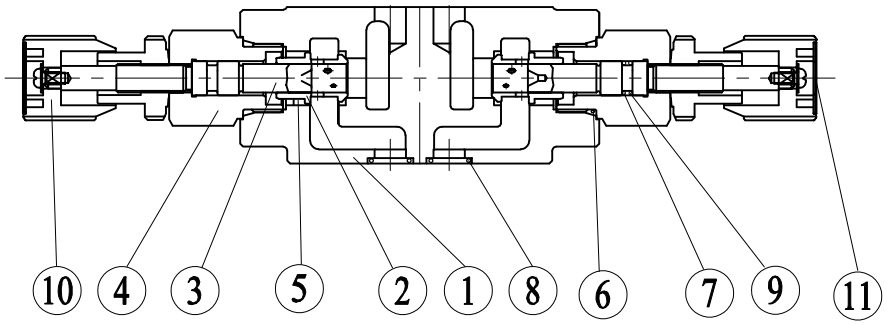


Stroke - Flow characteristic



CROSS SECTION DIAGRAM

MTC-05-W-*



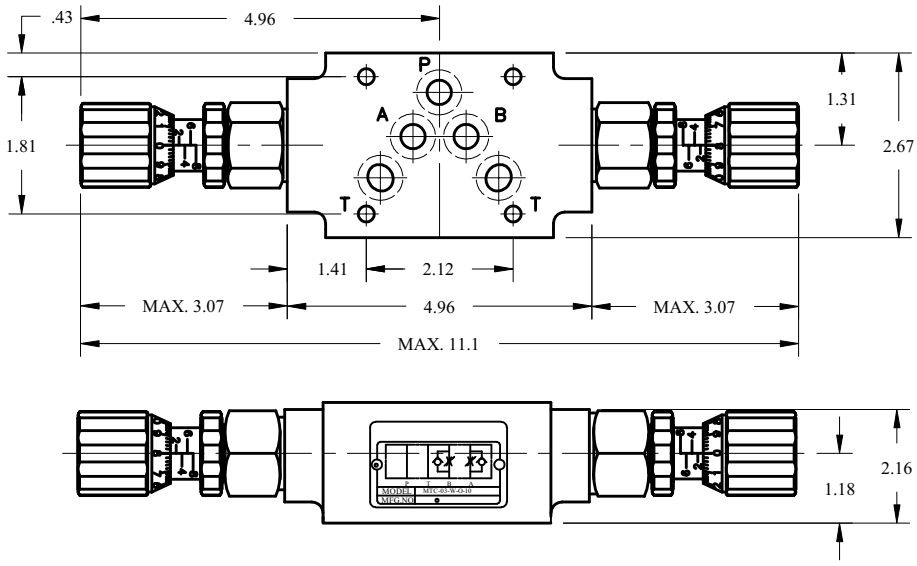
NO.	DESCRIPTION
1	BODY
2	THROTTLE
3	ADJUST SCREW
4	RETAINER
5	SPRING
6	O-RING
7	O-RING
8	O-RING
9	B/U RING
10	KNOB UNIT
11	PLATE

NO.	DESCRIPTION	PART NO.	Q'TY
6	O-RING	P22, 90°	2
7	O-RING	P8, 90°	2
8	O-RING	AS-568-014	5

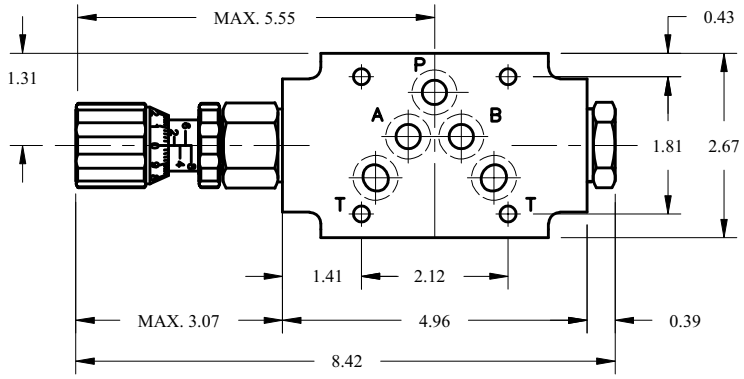
IFP MTC05 FLOW REGULATOR MODULE/ CHECK VALVE

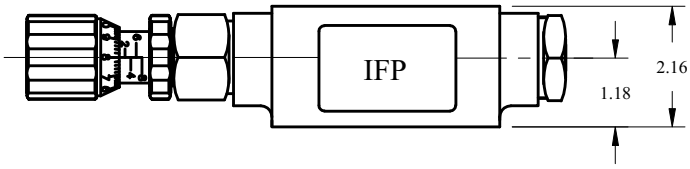
DIMENSIONS

MTC-05-W-*

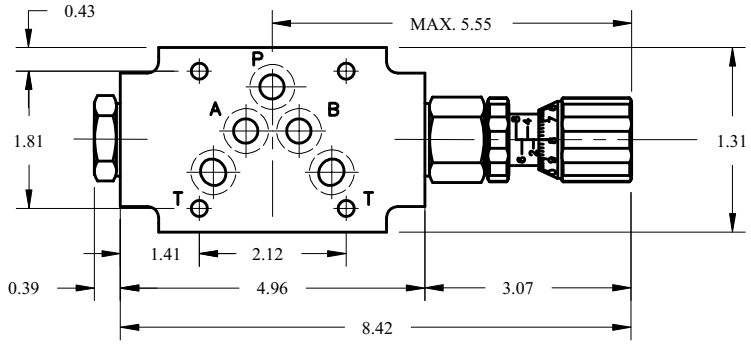


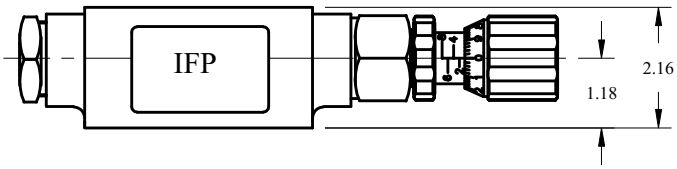
MTC-05-A - *





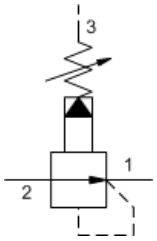
MTC-05-B - *

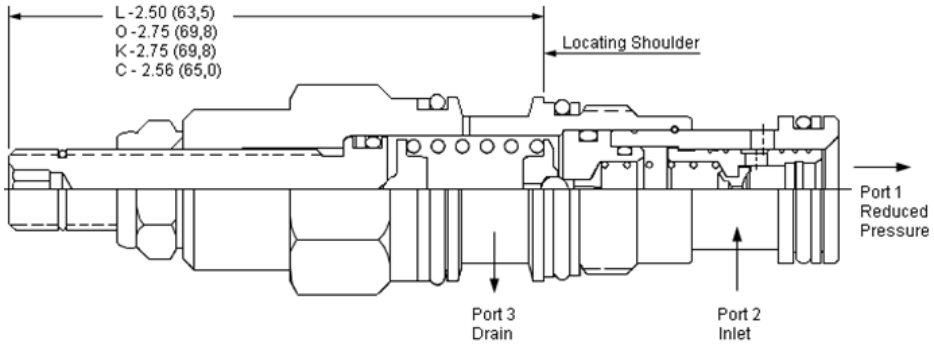




MODEL
PBDB

Pilot operated, pressure reducing valve
CAPACITY: 10 gpm | **CAVITY:** T-11A





CONFIGURATION

L	Control	Standard Screw Adjustment
A	Adjustment Range	100 - 3000 psi (7 - 210 bar), 200 psi (14 bar) Standard Setting
N	Seal Material	Buna-N
(none)	Material/Coating	Standard Material/Coating

NOTES

Maximum pressure differentials for spring ranges: A and B are 3000 psi (210 bar) N and Q are 2000 psi (140 bar) W is 5000 psi (350 bar)inlet pressure

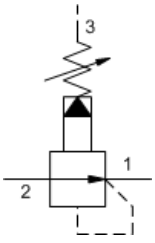
For cartridges configured with an O control (panel mount handknob), a .75 in. (19 mm) diameter hole is required in the panel.

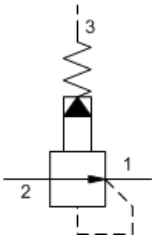
Pilot-operated, pressure reducing valves reduce a high primary pressure at the inlet (port 2) to a constant reduced pressure at port 1, allowing circuits with multiple pressure requirements to be operated using a single pump.

TECHNICAL DATA

Cavity	T-11A
Series	1
Capacity	10 gpm
Factory Pressure Settings Established at	blocked control port (dead headed)
Maximum Operating Pressure	5000 psi
Control Pilot Flow	7 - 10 in³/min.
Adjustment - Number of Clockwise Turns to Increase Setting	5
Valve Hex Size	7/8 in.
Valve Installation Torque	30 - 35 lbf ft
Adjustment Screw Internal Hex Size	5/32 in.
Locknut Hex Size	9/16 in.
Locknut Torque	80 - 90 lbf in.
Seal kit - Cartridge	Buna: 990-011-007
Seal kit - Cartridge	Polyurethane: 990-011-002
Seal kit - Cartridge	Viton: 990-011-006
Model Weight	0.35 lb.

SYMBOLS

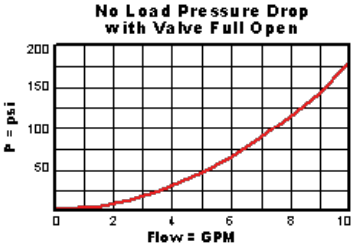


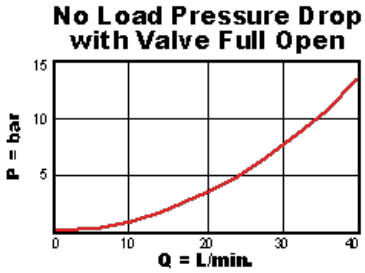


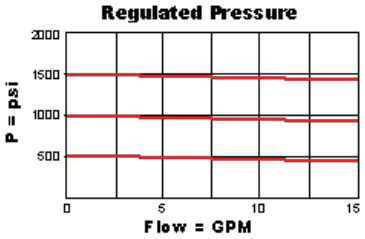
TECHNICAL FEATURES

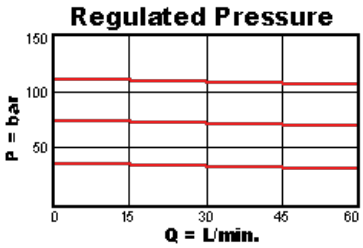
- All three-port pressure reducing and reducing/relieving cartridges are physically interchangeable (i.e. same flow path, same cavity for a given frame size). When considering mounting configurations, it is sometimes recommended that a full capacity return line (port 3) be used with reducing/relieving cartridges.
- Full reverse flow from reduced pressure (port 1) to inlet (port 2) may cause the main spool to close. If reverse free flow is required in the circuit, consider adding a separate check valve to the circuit.
- If pilot flow consumption is critical, consider using direct acting reducing/relieving valves.
- Main stage orifice is protected by a 150 micron stainless steel screen.
- Recommended maximum inlet pressure is determined by the adjustment range. Ranges D, E, N, and Q are tested with a 2000 psi (140 bar) maximum differential between inlet and reduced pressure. Ranges A, B, and H are tested with a 3000 psi (210 bar) maximum differential between inlet and reduced pressure. Ranges C and W are tested with 5000 psi (350 bar) of inlet pressure.
- Pilot operated valves exhibit exceptionally flat pressure/flow characteristics, are very stable and have low hysteresis.
- Pressure at port 3 is directly additive to the valve setting at a 1:1 ratio and should not exceed 5000 psi (350 bar).
- Pilot operated reducing, reducing/relieving valves by nature are not fast acting valves. For superior dynamic response, consider direct acting valves.
- W and Y controls (where applicable) can be specified with or without a special setting. When no special setting is specified, the valve is adjustable throughout its full range using the W or Y control. When a special setting is specified, this setting represents the maximum setting of the valve.
- Cartridges with EPDM seals are for use in systems with phosphate ester fluids. Exposure to petroleum based fluids, greases and lubricants will damage the seals.
- Corrosion resistant cartridge valves are intended for use in corrosive environments and are identified by the model code suffix /AP for external stainless steel components, or /LH for external zinc-nickel plated components. See the CONFIGURATION section for all options. For further details, please see the Materials of Construction page located under TECH RESOURCES.
- Incorporates the Sun floating style construction to minimize the possibility of internal parts binding due to excessive installation torque and/or cavity/cartridge machining variations.

PERFORMANCE CURVES









CONFIGURATION OPTIONS

	CONTROL	
Preferred Options	L	Standard Screw Adjustment
Standard Options	C	Tamper Resistant - Factory Set
	K	Handknob
	W	Hex Wrench Adjustment
	Y	Tri-Grip Handknob
	ADJUSTMENT RANGE	
Preferred Options	A	100 - 3000 psi (7 - 210 bar), 200 psi (14 bar) Standard Setting
	W	150 - 4500 psi (10,5 - 315 bar), 200 psi (14 bar) Standard Setting
Standard Options	B	50 - 1500 psi (3,5 - 105 bar), 200 psi (14 bar) Standard Setting
	N	60 - 800 psi (4 - 55 bar), 200 psi (14 bar) Standard Setting

	Q	60 - 400 psi (4 - 28 bar), 200 psi (14 bar) Standard Setting
	SEAL MATERIAL	
Preferred Options	N	Buna-N
Standard Options	E	EPDM
	V	Viton
	MATERIAL/COATING	
Standard Options		Standard Material/Coating
	/AP	Stainless Steel, Passivated
	/LH	Mild Steel, Zinc-Nickel

RELATED MODELS

PBDB8

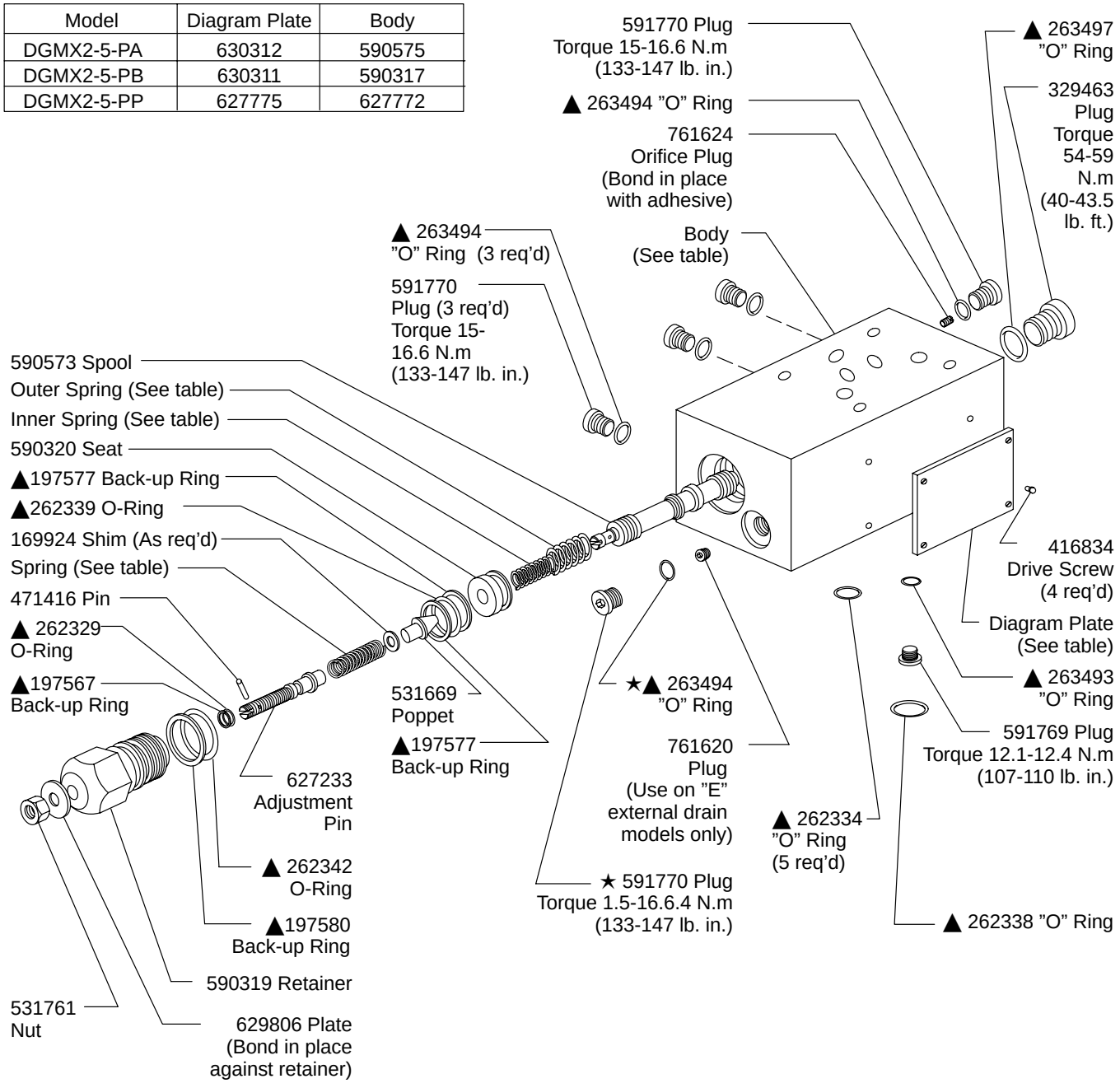
Pilot operated, pressure reducing main stage with integral T-8A control cavity

Service Parts Information

Pressure Reducing Module

DGMX2-5-P*-*-*-W-20

Model	Diagram Plate	Body
DGMX2-5-PA	630312	590575
DGMX2-5-PB	630311	590317
DGMX2-5-PP	627775	627772



Model	Pressure Range		Spring	Inner Spring	Outer Spring
	bar	(PSI)			
DGMX2-5-P*-A-	1.7-35	(24.7-507.5)	629808	629810	–
DGMX2-5-P*-B-	8.5-140	(123.3-1015)	590321	595526	590322
DGMX2-5-P*-C-	8.5-140	(123.3-2030)	590574		
DGMX2-5-P*-F-	8.5-250	(123.3-3625)	595527		

★ Omit on “E” external drain models

▲ Included in F3 Seal Kit 920269

Model Code

(F3) - DGMX2 - 5 - P * - * - * - W - 20

1 2 3 4 5 6 7 8 9

1 Seal Material

F3 - Seals for mineral oil and fire resistant fluids

2 Model Series

DGMX2 - Directional valve, manifold or subplate mounted, module, pressure reducing overlap vent type spool

3 Interface

CETOP, RP35, Size 5
02 - NFPA-D02
05 - (ISO 4401-05)

6 Port Operated Upon

P - Pressure port

7 Pilot Control Port

A - Cylinder A port
B - Cylinder B port
P - Pressure port

8 Pressure Range

A - 1.7-35 bar
B - 8.5-70 bar
C - 8.5-140 bar
F - 8.5-250 bar

11 Drain

E - External drain
Omit for standard internal drain

12 Screw & Locknut Adjustment

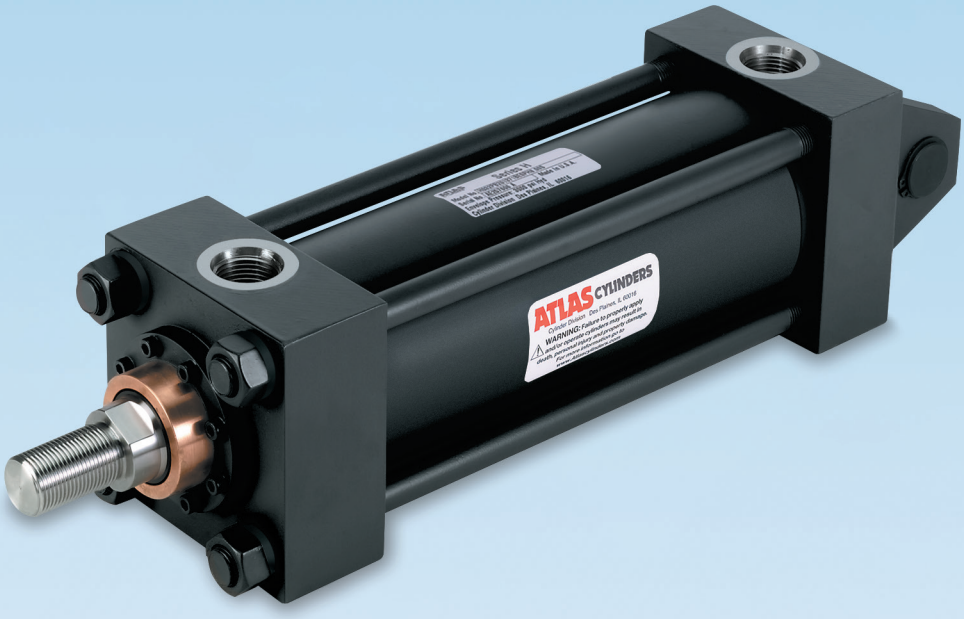
13 Design

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 20/18/15 or cleaner. Selections from Eaton OFP,OFR and OFRS filter series are recommended.

Printed in U.S.A.

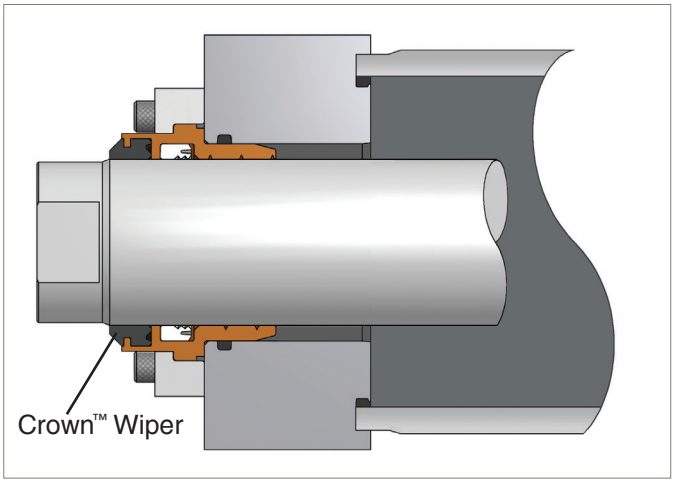
Series H Heavy Duty Hydraulic Cylinders

Catalog HY08-AC1314-1/NA
May 2018



ATLAS™ CYLINDERS

Abrasive particulate can cause significant wear to precision components when it enters the cylinder and migrates into the hydraulic system. The Atlas Crown Wiper is extremely effective in keeping contamination out of the cylinder to prevent if from shortening the actuator and system service life. Atlas showcases its commitment to reducing hydraulic system problems with the Crown Wiper. This innovative solution goes a long way toward improving equipment operation, lowering costs, extending component life and machine availability.



Product Features:

- The sharp leading edge cleans the piston rod on the retract stroke.
- The Crown Wiper acts as a secondary seal by wiping away any oil film adhering to it on the extended stroke.
- Durable polyurethane material works well for both Seal Class 1 and 4 Service.
- Available in fluorocarbon material for Class 5 service in elevated temperatures.
- Beveled design sheds abrasive contamination away from the bushing.
- Available in rod diameters 0.625" - 5.500".
- Does not change cylinder mounting dimensions.

⚠ 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.

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Table of Contents

Piston Sealing Solutions for the Most Demanding Applications

Piston Seal Technology For The 21st Century

The new Atlas universal piston seal design addresses the performance balance between low pressure sealability, low friction, extrusion resistance and seal life.

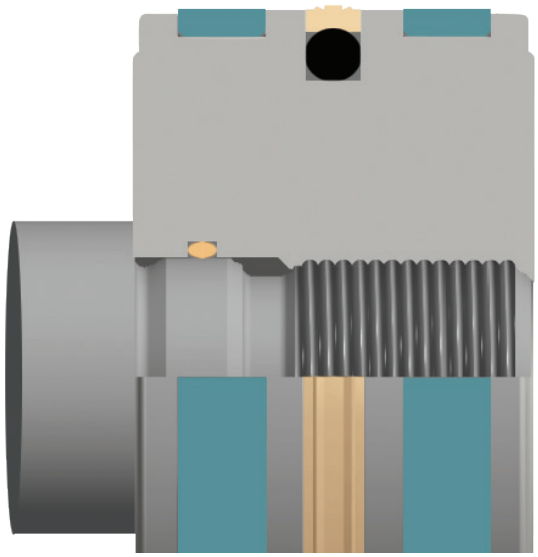
One piston style is used for all piston seal and wear ring configurations and will suit all application requirements. A common piston design permits field changing of seal configuration or seal and wear band material without replacing costly machined components when variations in application parameters occur, such as fluid, temperature or duty cycle.

All piston options include dual non-metallic wear rings to provide maximum stability and bearing area for protection against eccentric loads.

WearGard™ wear rings are internally lubricated for reduced friction and formulated for heavy-duty load-bearing applications.

The standard piston style for Class 1 and 4 service is HP; for 2, 3, 5, 6 and 8 service the standard is KP. If a different piston style is desired for an eligible seal class, enter an 'S' in the Special Modification field of the model number and specify the piston style in text.

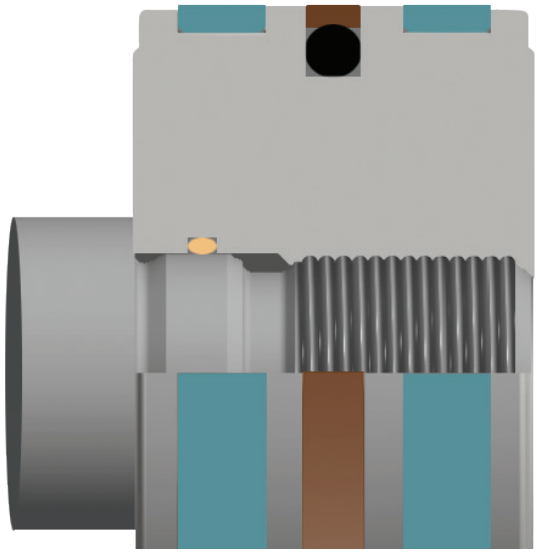
Atlas HP Polyurethane Piston Seal



The Atlas HP energized bi-directional piston seal improves upon the low friction and long wear of lipseals by including excellent low pressure sealing performance. Specially formulated polyurethane is long wearing and abrasion resistant with running friction comparable to lipseals. An o-ring energizer ensures virtually zero leakage in low pressure applications. Also, pressure trapping that can result with energized lipseals is not possible with a single energized seal.

The Atlas HP piston seal is an excellent choice for most industrial applications operating with mineral based hydraulic oil and is available in Seal Classes 1 and 4.

Atlas KP Filled PTFE Piston Seal



The Atlas KP bronze filled PTFE seal ring material has low running friction for accurate positioning in closed loop servo applications.

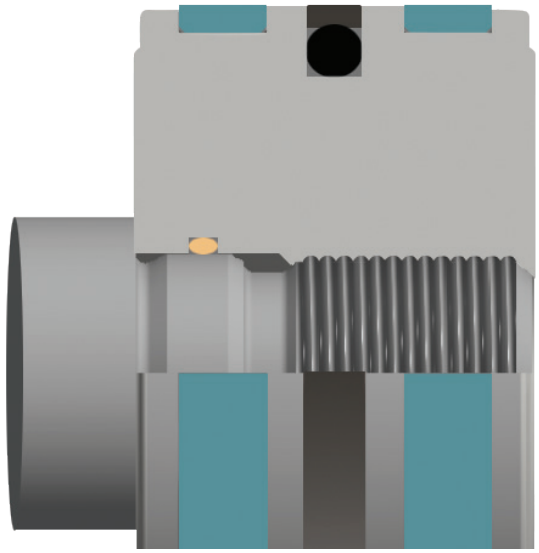
When combined with a fluorocarbon energizing ring the Atlas KP seal is rated for 400° F and will increase service intervals in high temperature applications even when compared to fluorocarbon lipseals.

By combining the Atlas KP seal with other energizer o-ring compounds and wear ring materials, the KP seal offers excellent service in all Seal Class environments.

Selection Guide

Application Demand	HP Seal	KP Seal	RP Seal	WP Seal
Load Holding	Best	Good	Good	Best
Fluid Compatibility	Good	Best	Better	Better
Heat Resistance	Good (200° F Max.)	Best (400° F Max.)	Better (300° F Max.)	Better (250° F Max.)
Dynamic Friction	Best	Best	Good	Better
Breakaway Friction	Good	Best	Good	Better
Extrusion Resistance	Good	Better	Best	Good
Fluid Isolation	N/A	N/A	N/A	Best

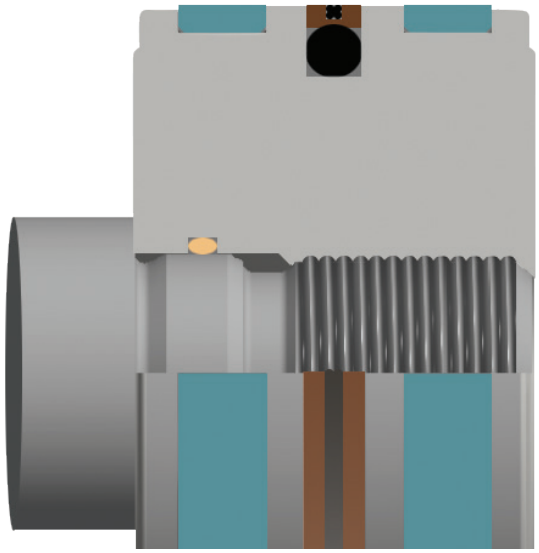
Atlas RP Thermoplastic Seal



The Atlas RP step cut ring is made of self-lubricating, glass reinforced, thermoplastic and is o-ring energized. Unlike cast iron rings that bypass oil, the Atlas RP seal provides drift free operation throughout the operating pressure range. This tough seal is fully extrusion resistant, even in the face of extreme pressure spikes, thus ensuring superior wear resistance in the most demanding applications.

Atlas RP can operate up to 300° F and is compatible with Seal Classes 1, 2, 3, 4, 5 and 6.

Atlas WP Mixed Media Seal

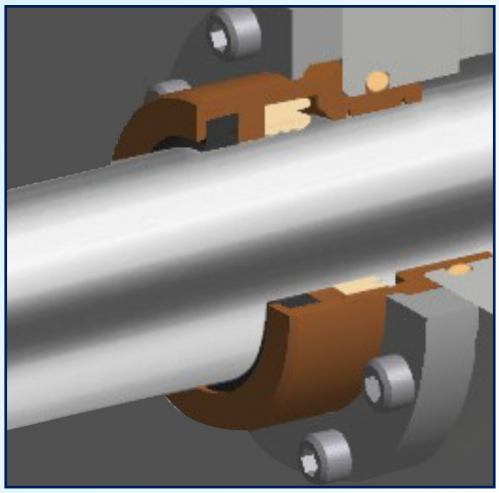


The Atlas WP Mixed Media seal is designed for applications requiring different media on either side of the piston. This option is ideal when hydraulic oil is on one side of the piston and air is on the opposite side; and it can be equally effective when dissimilar fluids are on either side of the piston.

Superior low-friction bi-directional sealing is accomplished by combining an energized filled PTFE seal with a redundant elastomer seal. Energizer and redundant elastomer seal materials are available for compatibility with seal classes 1, 2, 3, 5 and 6. Note: WP piston seal groove is not universal in 1.50" bore.

Versatile Piston Rod Sealing Systems Deliver Dry Rod Performance

Atlas offers the best performing and broadest selection of rod sealing options. Our Tri-lip bolted bushing sealing system is a proven anchor of the offering.



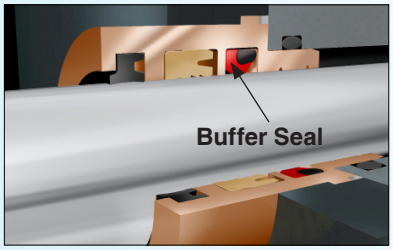
As the rod strokes out, its motion and friction dynamically flex the multi-sealing edges of the Tri-Lip rod seal to maintain their contact with the rod. This provides a cutting action to shear the oil from the rod, allowing the rod to pass out of the rod seal practically dry. Any oil film that remains on the rod is stopped by the inner lip of the Wiperseal and held between it and the rod seal.

On the return stroke any dirt or foreign matter collected on the rod is wiped off by the leading edge, or outer lip of the Wiperseal. At the same time, any oil which may be trapped between the Wiperseal and the rod seal is returned into the cylinder. In other words, we have an automatic check valve that prevents any appreciable amount of oil to leak past the seals, and then returns any oil that has managed to wipe by the rod seal.

Tri-Lip bushings are easily removed for service without loosening tie rods and disturbing the pressure envelope. Material options allow compatibility with Seal Classes 1, 2, 3, 4, 5 & 6.

Buffer Seal Bushing

The Atlas Buffer Seal, installed ahead of the primary rod seal, protects the primary seal from the effects of pressure spikes. The result is increased primary rod seal and wiperseal performance life when in severe applications.



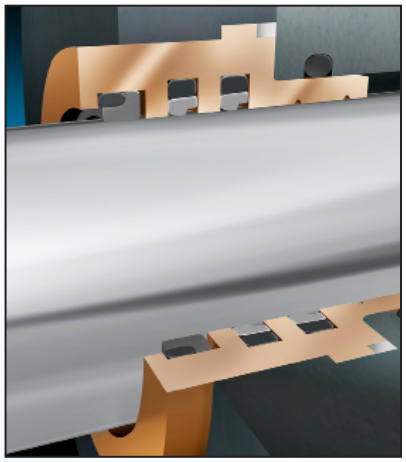
The Atlas Buffer Seal is a unique design that allows trapped pressure back into the cylinder. When the rod extends from the cylinder the Buffer Seal is riding on a high compression sealing point to limit leakage. On the retract stroke the seal rocks forward to allow trapped fluid to pass under the seal and return to the system.

Buffer Seals are available with Seal Classes 1, 2, 4 & 5. To order, enter an 'S' in the Special Modification field of the model number and specify Buffer Seal.

To accommodate the Buffer Seal, rod bushing length is extended 0.31" to 0.81", depending on rod diameter. See Buffer Seal Bushing page for piston rod extension details.

Low Friction Bushing

The Atlas Low Friction Bushing is designed to minimize ‘slip-stick’ and ‘chatter’ in servo and ‘dither’ applications. Two unidirectional bronze filled PTFE primary rod seals and a bronze filled PTFE wiperseal minimize both breakaway and running friction.



Low Friction Rod Seals are available for rod diameters 1.000" - 5.500" in 1.50" - 8.00" bores.

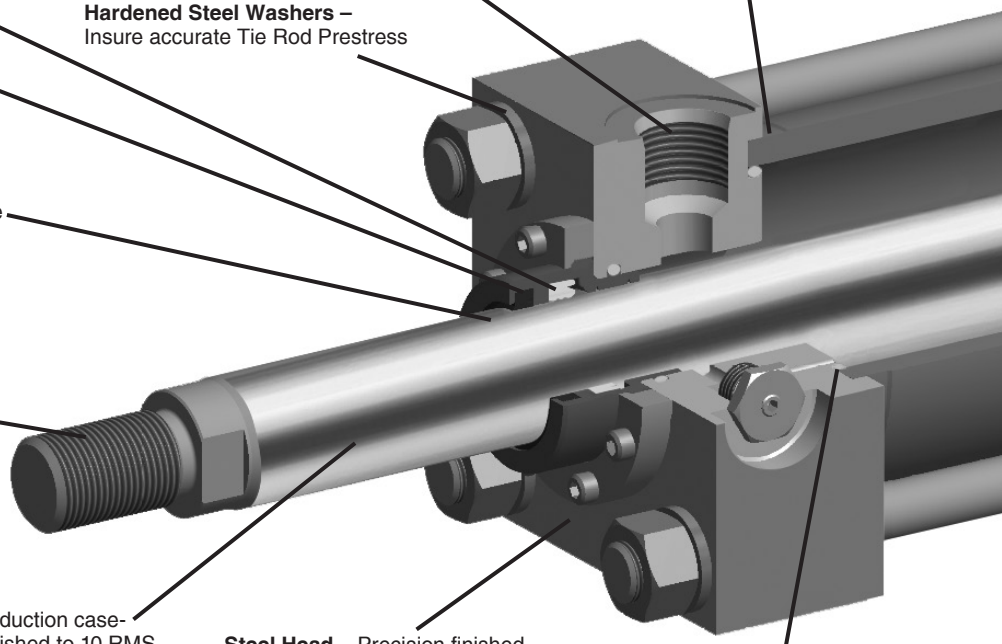
See Piston & Bushing Friction page for comparative seal friction data.

To order, enter an 'S' in the Special Modification field of the model number and specify Low Friction Bushing. Available with Seal Classes 1, 2, 3, 4 ,5, 6 & 8.

View Table of Contents

A Overview

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



Primary Seal – 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.

Secondary Seal – Double-Service urethane Wiperseal™ wipes clean any oil film adhering to the rod on the extend stroke and cleans the rod on the return stroke.

Rod Bushing Assembly – Externally removable without cylinder disassembly. Long bearing surface is inboard of the seals, assuring positive lubrication from within the cylinder. An o-ring is used as a seal between bushing and head.

Piston Rod Thread – Male rod end styles #4A and #8A are integral cut threads on the piston rod. Optional studded KK small male thread, for piston rod diameters 2.000" and smaller, is available by specifying rod end style #4H.

Ports – SAE "O" ring ports are standard.

Optional Ports – NPTF ports are optional at no extra charge. Oversize NPTF and SAE ports are available at extra charge.

Hardened Steel Washers – Insure accurate Tie Rod Prestress

Align-A-Groove – A 3/16" wide surface machined at each end of the cylinder body. Makes precise mounting quick and easy.

Piston Rod – Medium carbon steel, induction case-hardened, hard chrome-plated and polished to 10 RMS finish. Piston rods are made from 85,000 to 100,000 psi minimum yield material in .625" through 4.000" diameters. Larger diameters vary between 57,000 and 90,000 psi minimum material, depending on rod diameter.

Steel Head – Precision finished on all sides; bored and grooved to provide concentricity for mating parts.

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

Atlas's 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. Atlas cylinder cushions are a stepped design and combine the best features of known cushion technology.

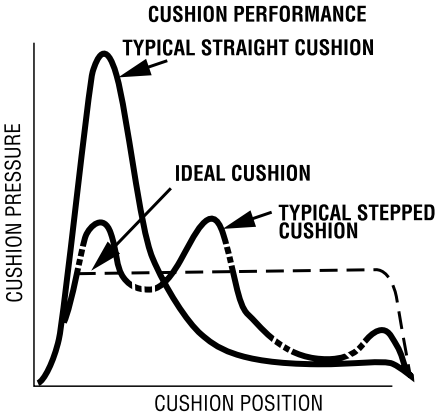
Standard straight or tapered cushions have been used in industrial cylinders over a very broad range of applications. Atlas research has found that both designs have their limitations.

As a result, Atlas has taken a new approach in cushioning of industrial 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 area 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.

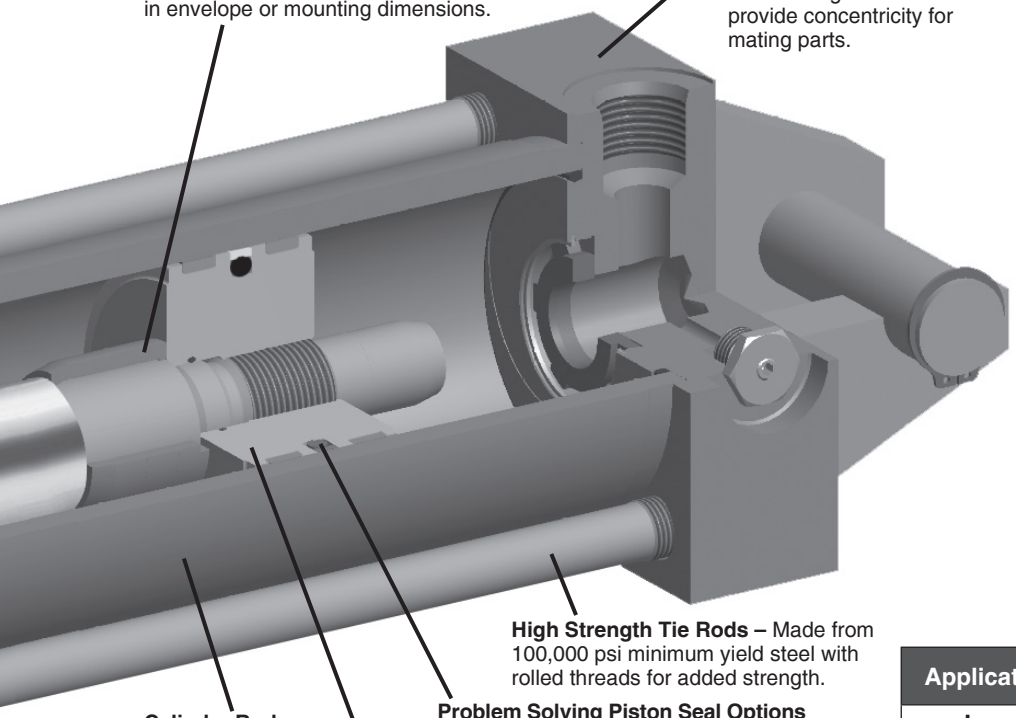
All Atlas H cushions are adjustable.

The H Series 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.



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.

Steel Cap – Precision finished on all sides; bored and grooved to provide concentricity for mating parts.



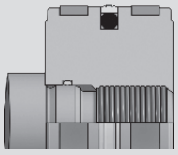
High Strength Tie Rods – Made from 100,000 psi minimum yield steel with rolled threads for added strength.

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

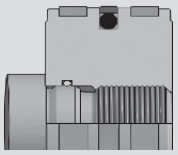
Problem Solving Piston Seal Options – Atlas's new piston seal designs address the performance balance between low pressure seal ability, low friction, extrusion resistance and seal life.

One-Piece Nodular Iron Piston – Two non-metallic wear bands that minimize tube scoring are standard with all seal styles. Piston to rod connection is pre-stressed to maximize fatigue life. An o-ring on the piston ID ensures a leak free joint and anaerobic adhesive further secures the threaded connection.

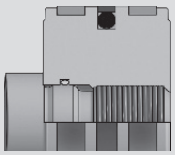
One Common Piston for 4 Seal Styles



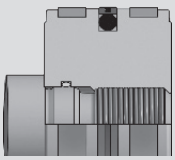
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

Application Demand	HP Seal	KP Seal	RP Seal	WP Seal
Load Holding	Best	Good	Good	Best
Fluid Compatibility	Good	Best	Better	Better
Heat Resistance	Good	Best	Better	Better
Dynamic Friction	Best	Best	Good	Better
Breakaway Friction	Good	Best	Good	Better
Extrusion Resistance	Good	Better	Best	Good
Fluid Isolation	N/A	N/A	N/A	Best

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

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

b. A cartridge style needle valve is provided that is flush with the side of the head even when wide open. It is located on side number 2, in all mounting style models except ME5, ME6, TM1, TM2, TM3 and TM4. In these styles it is located on side number 3.

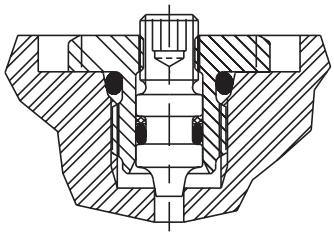
c. All cylinder bores utilize a slotted sleeve as a check valve.

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

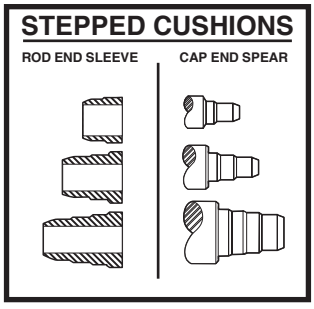
a. A stepped cushion spear is provided on the piston rod.

b. A "float check" self-centering bushing is provided in 1.50" - 6.00" bore cylinders, which incorporates a large flow check valve for fast "out-stroke" action. 7.00" bore and larger cylinders utilize a springless check valve located and identified in the same manner as the head end.

c. A cartridge style 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 models except ME5, ME6, TM1, TM2, TM3 and TM4. In these styles it is located on side number 3.



Cartridge Style Needle Valve



View Table of Contents

A Overview

H Model Code

5.00	C	K	F	P	TB	H	H	N	H
Bore Dia.	Cushion Head	Double Rod End Cylinder	Mounting Style	Mounting Modification	Combination Mounting Style[5]	Series Designator	Piston Seal	Piston Magnet	Bushing & Seal

Bore Dia. — Specify bore dia. in inches
1.50
2.00
2.50
3.25
4.00
5.00
6.00
7.00
8.00

Cushion Head — Use "C" only if head end cushion is required.

Double Rod End Cylinder — Use "K" only if a double rod end cylinder is required.[1]

Mounting Style — Mounting style offering varies by series. See 'Standard Specifications' pages for availability.
T = Basic, No Mount MX0
TB = Tie Rods Extended Head MX3
TC = Tie Rods Extended Cap MX2
TD = Tie Rods Extended Both Ends MX1
J = Head Rectangular Flange MF1
JB = Head Square Flange MF5
JJ = Head Rectangular ME5
H = Cap Rectangular Flange MF2
HB = Cap Square Flange MF6
HH = Cap Rectangular ME6
C = Side Lug[2] MS2
F = Side Tapped[2] MS4
BB = Cap Fixed Clevis MP1
D = Head Trunnion MT1
DB = Cap Trunnion MT2
DD = Intermediate Fixed Trunnion[3] MT4
DE = Heavy Duty Intermediate Fixed Trunnion[3]
SB = Spherical Bearing
SE = Heavy Duty Spherical Bearing
TX = Special Mounting (Consult Factory)[4]

Mounting Modification
P = Use only if Thrust Key required. (Style C or F.)
M = Use only for Manifold Port O-Ring Seal. Applies to C Mount only.

Combination Mounting Style[5] — Any practical mounting style listed.

Series Designator — 1.50"- 8.00" Bore H
See Section C for 10.00 - 20.00" bores

Piston Seal
H = HP (standard) Piston Seal
K = KP (universal) Piston Seal[6]
R = RP (extrusion resistant) Piston Seal
W = WP (mixed media) Piston Seal

Piston Magnet
N = No Magnet
3 = Magnet Piston with SS Cylinder Tube for Global Switches
7 = Magnet with Carbon Steel Cylinder Tube for ALS Switches

Bushing & Seal
H = Bolt-on Bushing with Tri Lip Rod Seal (for Class 1 & 4 service) – additional Seal Classes are available
K = Bolt-on Lipseal Bushing with Buffer Seal (Not available 0.625" rod)
All Series
F = Bushing with dual PTFE Rod Seals and PTFE Wiperseal[6]

Series H Minimum Stroke Table

Bore Ø	All Mounting Styles Except DD & DE	Mounting Styles DD & DE
1.50	1.062	2.875
2.00	1.562	3.750
2.50	1.437	3.625
3.25	1.687	4.375
4.00	1.937	5.000
5.00	1.937	5.437
6.00	2.562	6.687
7.00	3.437	8.062
8.00	2.937	8.250

Shaded boxes identify required model number fields.

[1] Available mounting styles for K Type cylinders are located at the end of Section A. When ordering a double rod end cylinder, the piston rod number and piston rod end threads are to be specified for both rod ends.

The model number should be created as viewing the primary rod end on the left hand side.
Example: K Type Cylinder:
4.00CKTDHT14A28AC10.000

[2] Mounting Styles C and F should have a minimum stroke length equal to or greater than their bore size.

[3] Specify XI dimension.

[4] Special mounting styles that do not resemble a standard catalog offering will be designated as style TX by the factory.

[5] In general, the model numbers as read left to right corresponding to the cylinder as viewed from left to right with the primary end at the left. The second or subsequent mountings are mountings called out as they appear in the assembly moving away from the rod end. Except when tie rod extension mountings are part of a combination, all combinations should have a "S" (Special) in the model code and a note in the body of the order clarifying the mounting arrangement. The "P", as used to define a thrust key is not considered to be a mounting. However it is located at the primary end.

[6] Piston seal code K and Bushing & Seal code F must be selected for Class 8 service. Dual PTFE rod seals with PTFE wiperseal not available for 0.625" rod.

H Model Code

T	1	S	1	4	2	A	C	16.000
Port Type	Seals	Special Modification	Piston Rod Number[9]	Piston Rod End	Piston Rod Alternate Thread[11]	Piston Rod Threads	Cushion Cap	Stroke[8]

Seals
- 1 = Standard Seals
- 2 = Water Base Fluid Seals
- 3 = EPR Seals
- 4 = Low Temperature Seals
- 5 = Fluorocarbon Seals
- 6 = High Water Content Fluid
- 8 = Energized PTFE Seals
- E = Fluorocarbon Seals – Piston Rod only
- N = High Temperature Rod Bushing[7]

Special Modification
Use only if special modifications are required:
- Oversize Ports
- Port Position Change
- Special Seals
- Stop Tube[8]
- Stroke Adjusters
- Tie Rod Supports
- Other

Piston Rod Number[9]
- 1
- 2
- 3
- 4
- 5

Piston Rod Alternate Thread[11]
Use only for male thread two times longer than standard.

Cushion Cap
- C = Standard Floating Cushion Bushing Design

1.50" - 6.00" Bore
- F = Solid Cap Orifice Design

Stroke[8]
Specify in inches

Piston Rod Threads
- A = UNF Standard Integral Cut Thread
- H = UNF Optional High Strength Stud (Style 4 through 2.000" rod only)
- M = Metric
- N = No Thread[12]

Piston Rod End

4	=	Style 4 Small Male
4B	=	Style 4 Small Male with Buffer Seal Bushing
7	=	Style 7 Female Thread for Spherical Rod Eye for Piston Rod Codes larger than Code #1 (Style SB only)
7B	=	Style 7 Female Thread with Buffer Seal Bushing
8	=	Style 8 Intermediate Male
8B	=	Style 8 Intermediate Male with Buffer Seal Bushing
9	=	Style 9 Short Female[9]
9B	=	Style 9 Short Female[9] with Buffer Seal Bushing
55	=	Style 55 Rod End for Flange Coupling
55B	=	Style 55 Rod End with Buffer Seal Bushing
3	=	Style 3 Special (Specify)[10]
3B	=	Style 3 Special (Specify)[10] with Buffer Seal Bushing

Port Type
- T = SAE Straight Thread O-Ring (Std.)
- U = NPTF Ports (Dry Seal Pipe Thread)
- R = BSP Ports (Parallel Thread ISO 228)
- P = SAE 4-Bolt Flange Ports (3,000 psi)
- B = BSPT Ports (Taper Thread)
- G = Metric Thread Ports
- Y = Metric Thread Ports per ISO 6149
- M = Used only for Manifold Port O-ring Seal. M option must be specified (Mounting Modification), applies to Mounting Style C only.

Shaded boxes identify required model number fields.

[7] Energized PTFE rod seals & wiperseal. All other cylinder seals are fluorocarbon. Not available for 0.625" rod.

[8] S = Stop Tube. Specify: stop tube length, net stroke and gross stroke. Gross stroke = stop tube length + net stroke. Gross stroke to be placed in the model number field.

Example:

2.000 inches long stop tube

+14.000 inches net stroke

16.000 inches gross stroke

See tables on these pages for minimum allowable strokes for Series H and Piston Rod End Styles 9 & 9B.

[9] Style 9 stroke restrictions may apply. See Style 9 Minimum Stroke Table for details.

[10] Provide dimensions for KK, A, W or WF. If otherwise special, furnish dimensioned sketch.

[11] Available only in combination with Style 4 or Style 8.

[12] Must be specified for Piston Rod End Style 55.

Style 9 Minimum Stroke Table

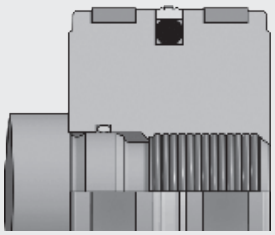
Bore Ø	Rod Ø	Minimum Stroke	
		Style 9	Style 9B
1.50 - 4.00	All	None	None
5.00	2.000	None	None
	2.500	1.000	0.56
	3.000	1.375	0.94
	3.500	1.625	1.19
6.00	2.500	None	None
	3.000	1.375	0.94
	3.500	1.375	0.94
	4.000	2.000	1.56
7.00	3.000	1.250	0.81
	3.500	1.500	1.06
	4.000	1.500	1.06
	4.500	2.500	2.06
	5.000	3.125	2.31
8.00	3.500	1.500	1.06
	4.000	1.500	1.06
	4.500	2.375	1.94
	5.000	2.875	2.06
	5.500	3.625	2.81

Piston Seal Selection

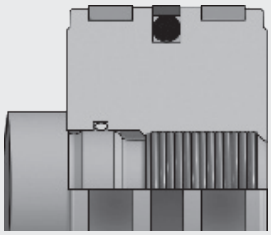
Atlas Piston Seal options HP, KP, RP and WP are available in a number of different Seal Classes. Because the Atlas Model Number includes Seal Class but does not include a code for piston seal style, a default piston seal style is designated for each seal class. In the table below rows list each seal class and columns column list each piston style. Available piston styles for each seal class are identified with an 'X' and the default piston seal style is in the shaded cell. To specify an available piston seal style that is not standard, place an 'S' in the Special Modification field of the model number and specify the required piston seal style with text.

Seal Class	Piston Seal Options (Shaded cell is default standard)			
	HP	**KP**	**RP**	**WP**
Class 1 - Polyurethane & Nitrile	X	X	X	X
Class 2 - Nitrile	N/A	X	X	X
Class 3 - EPR	N/A	X	X	X
Class 4 - Low Temperature Nitrile	X	X	X	N/A
Class 5 - Fluorocarbon	N/A	X	X	X
Class 5 Rod Bushing Seals Only	N/A	X	X	X
Class 6 - Nitroxile	N/A	X	X	X
Class 8 - Filled PTFE High Temperature	N/A	X	N/A	N/A
Class 8 Rod Bushing Seals Only (all others Fluorocarbon	N/A	N/A	X	X

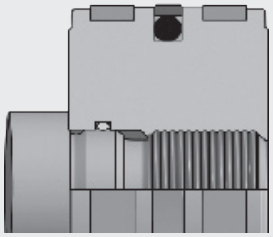
One Common Piston for 4 Seal Styles



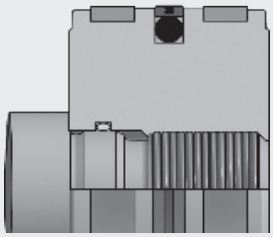
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

View Table of Contents

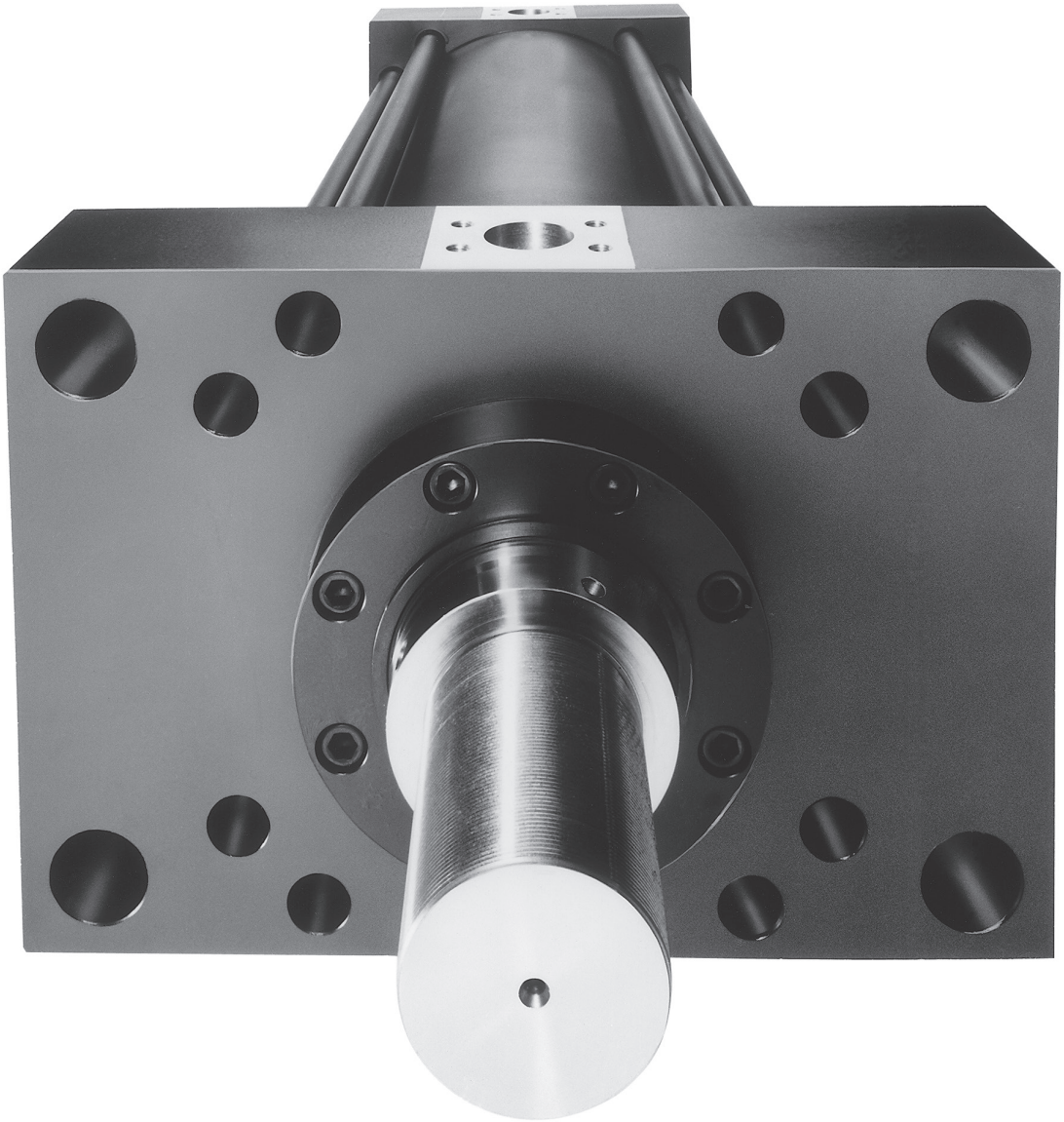
The large bore, high pressure hydraulic cylinder Atlas designed to meet your needs

Atlas H Series large bore cylinders provide unmatched reliability, performance, and innovative design features that aid in increasing productivity while reducing operating costs.

Atlas's externally removable bolted bushing assembly makes preventive and routine maintenance quick and easy! In many cases, the cylinder does not have to be removed or disassembled to facilitate service. Our innovative design provides for fast turn around, reduced downtime, and increased productivity.

In addition to our removable bushing assembly, H Series cylinders also include a multitude of innovative design features such as: anti-extrusion body end seals, floating cushions, hi load piston (standard), and various port and rod end options to meet your application requirements.

Every H Series cylinder is individually tested before leaving our plant to assure proper and leak free operation. All H Series cylinders come with an eighteen month warranty standard.



View Table of Contents

These innovative design features make Atlas H Series your best choice...

for all your large bore heavy duty hydraulic cylinder applications.

Primary Seal – High-performance urethane design combines ease of installation with rugged construction. The ultimate seal in extra heavy duty applications. Completely self-compensating and self-relieving to withstand pressure variations and conform to mechanical deflection that may occur.

Piston Rod – Hard chrome-plated and polished for maximum seal and rod bearing life. Two standard thread styles. Rod end is supplied with spanner wrench holes.

Align-A-Groove – A $^{3}/_{16}$" wide surface machined at each end of the cylinder body. Makes precise mounting quick and easy.

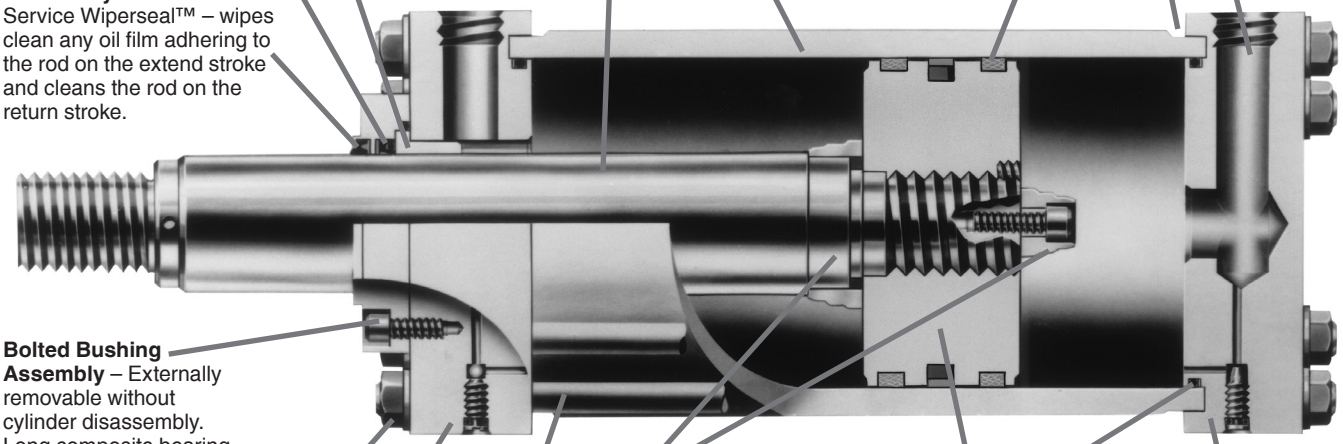
Rod Bushing – Standard Composite Load Bearing Bushing offers superior performance in comparison to metal and nylon filled alternatives.

The Cylinder Body – Heavy-wall steel tubing is honed to a micro finish bore, providing a wear surface for long lasting piston bearing and seal life.

Piston Seals – Problem solving piston seal options.

Ports – SAE O-ring straight thread ports are standard.

Secondary Seal – Double-Service Wiperseal™ – wipes clean any oil film adhering to the rod on the extend stroke and cleans the rod on the return stroke.



Bolted Bushing Assembly – Externally removable without cylinder disassembly. Long composite bearing surface is inboard of the seals, assuring positive lubrication from within the cylinder. An "O" ring is used as a seal between bushing and head.

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.

End Seals – Pressure-actuated cylinder body-to-head and cap "O" rings (urethane 10.00" - 14.00") and back-up washers.

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

Alloy Steel Tie Rod Nuts – With hardened washer.

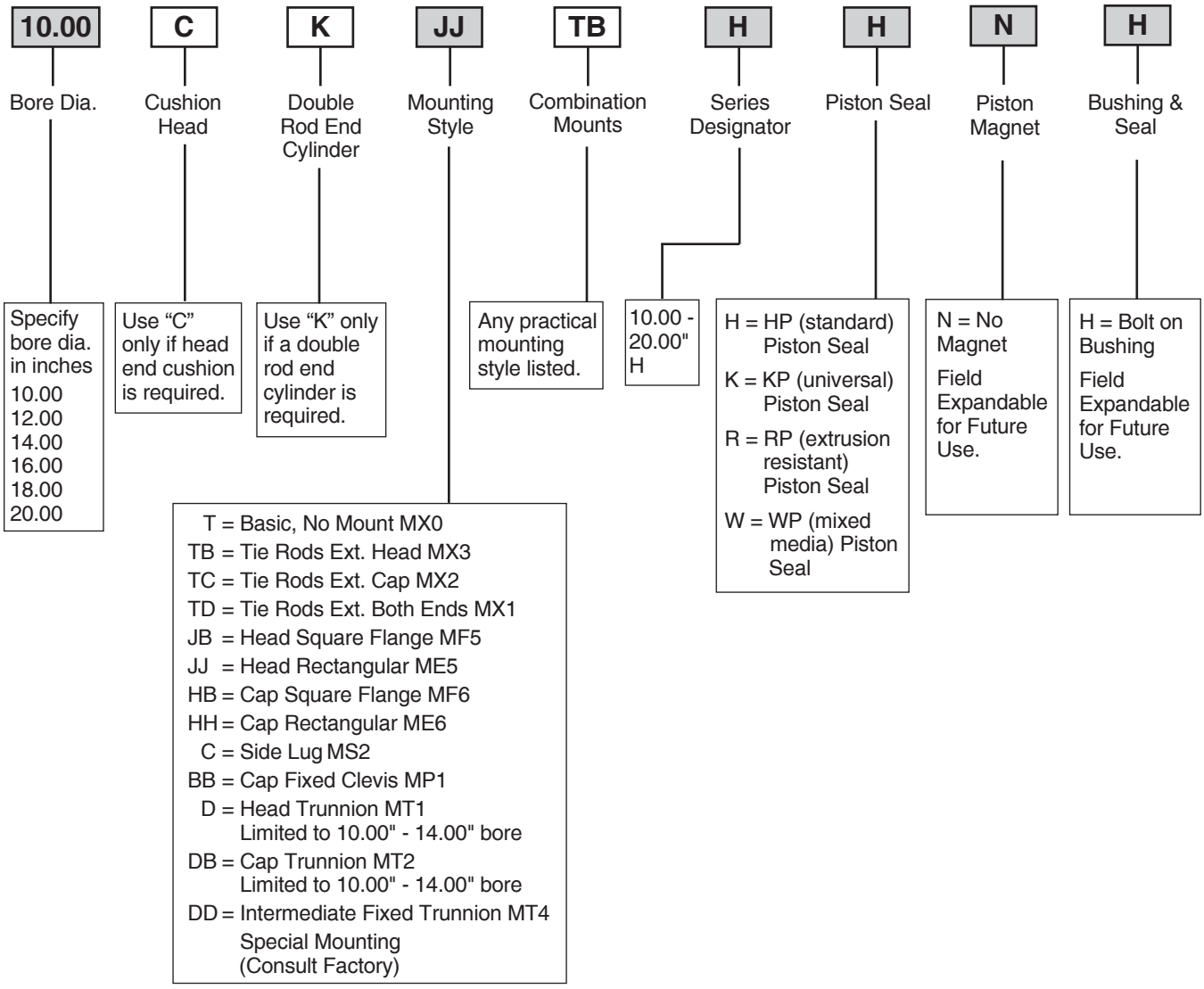
Steel Head – Bored and grooved to provide concentricity for mating parts.

High Strength Tie Rods – Made from 100,000 PSI minimum yield steel with rolled threads for added strength.

One-Piece Nodular Iron Piston – The wide piston surface contacting cylinder bore reduces bearing loads. One piece design is piloted to piston rod assuring concentricity. Piston is locked with set screw. Anaerobic adhesive and peening of set screw locks and seals piston to rod.

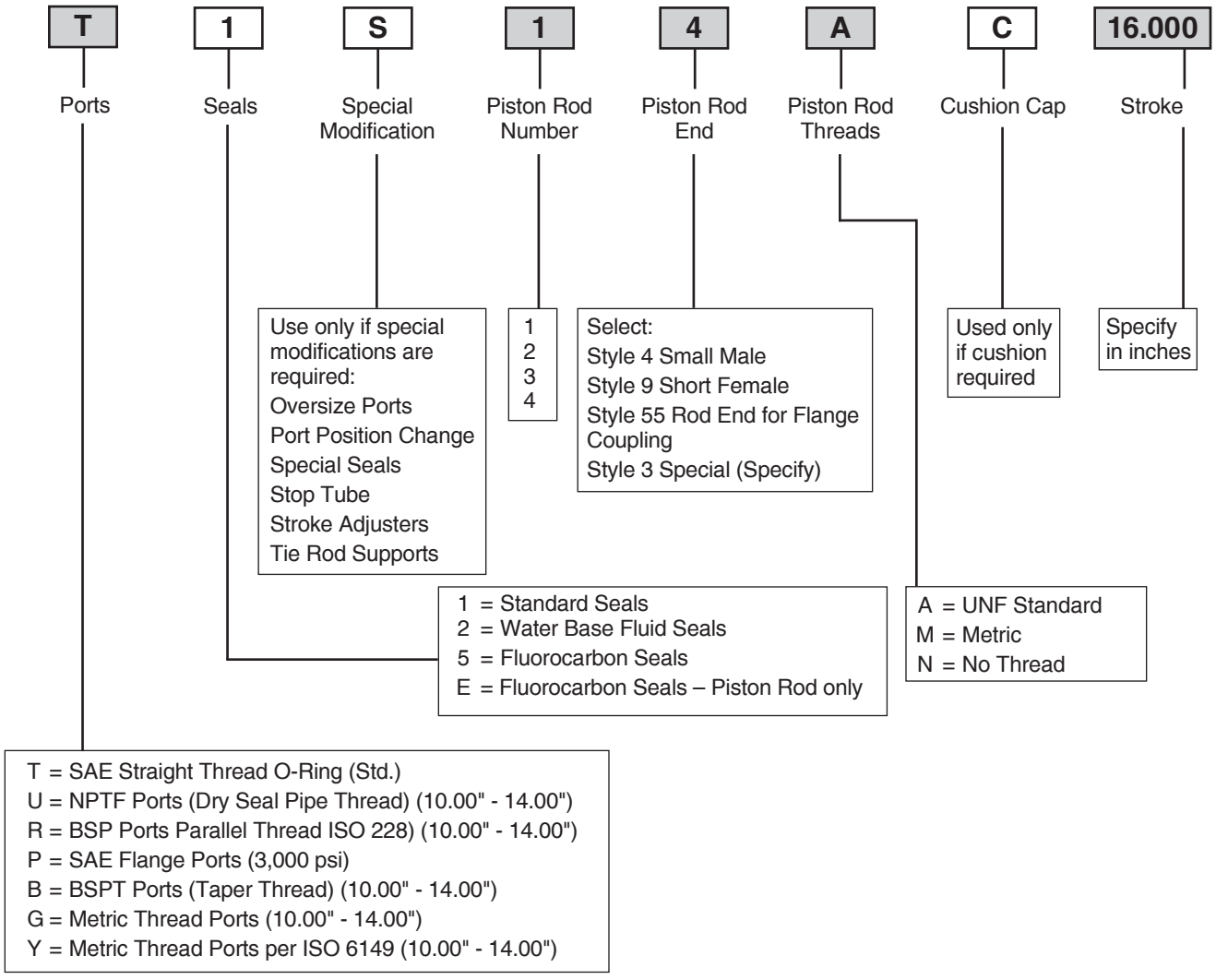
View Table of Contents

H Model Code



Shaded boxes identify required model number fields.

H Model Code



Style 9 Minimum Stroke Table

Bore Ø	Rod Ø	Minimum Stroke
10.00	4.500	1.125
	5.000	1.375
	5.500	2.000
	7.000	3.125
12.00	5.500	1.250
	7.000	2.375
	8.000	3.125
14.00	7.000	2.000
	8.000	2.750
	10.000	4.250

Bore Ø	Rod Ø	Minimum Stroke
16.00	8.000	1.750
	9.000	2.500
	10.000	3.250
18.00	9.000	1.500
	10.000	2.250
20.00	10.000	1.250

Shaded boxes identify required model number fields.

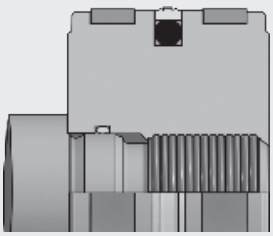
View Table of Contents

Piston Seal Selection

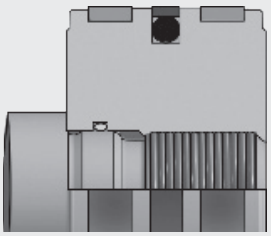
Atlas Piston Seal options HP, KP, RP and WP are available in a number of different Seal Classes. Because the Atlas Model Number includes Seal Class but does not include a code for piston seal style, a default piston seal style is designated for each seal class. In the table below rows list each seal class and columns column list each piston style. Available piston styles for each seal class are identified with an 'X' and the default piston seal style is in the shaded cell. To specify an available piston seal style that is not standard, place an 'S' in the Special Modification field of the model number and specify the required piston seal style with text.

Seal Class	Piston Seal Options (Shaded cell is default standard)			
	HP	KP	RP	WP
Class 1 - Polyurethane & Nitrile	X	X	X	X
Class 2 - Nitrile	N/A	X	X	X
Class 5 - Fluorocarbon	N/A	X	X	X
Class 5 Rod Bushing Seals Only	N/A	X	X	X

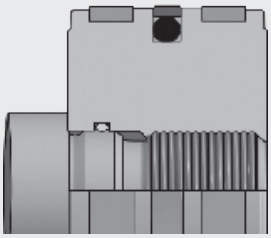
One Common Piston for 4 Seal Styles



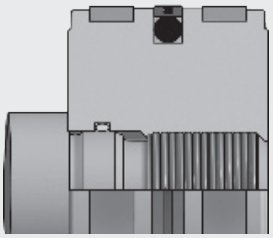
Standard HP style with polyurethane piston seal – excellent for most cycling and load holding applications.



Optional RP style with thermoplastic piston seal – superior extrusion resistance to extreme pressure spikes with drift-free performance.



Optional KP style with filled PTFE piston seal – low friction, high heat resistance for cycling and load holding service.



Optional WP style mixed media piston seal – low friction primary seal with redundant elastomer delivers superior performance with dissimilar media on either side of the piston.

View Table of Contents

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

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

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

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

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

1.0 General Instructions

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

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

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

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

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

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

2.0 Cylinder and Accessories Selection

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The rod end pressure is approximately equal to:

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

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

3.0 Cylinder and Accessories Installation and Mounting

3.1 Installation

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

View Table of Contents

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

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

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

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

3.2 Mounting Recommendations

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

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

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

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

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

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

4.0 Cylinder and Accessories Maintenance, Troubleshooting and Replacement

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

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

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

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

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

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

4.2 Cylinder Trouble Shooting

4.2.1 – External Leakage

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

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

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

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

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

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

4.2.2 – Internal Leakage

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

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

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

4.2.3 – Cylinder Fails to Move the Load

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

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

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

4.3 Erratic or Chatter Operation

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

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

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

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

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

View Table of Contents

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

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

2. Price Adjustments; Payments. Prices stated on Seller's quote or other documentation offered by Seller are valid for 30 days, and do not include any sales, use, or other taxes unless specifically stated. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2010). Payment is subject to credit approval and is due 30 days from the date of invoice or such other term as required by Seller's Credit Department, after which Buyer shall pay interest on any unpaid invoices at the rate of 1.5% per month or the maximum allowable rate under applicable law.

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

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5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon delivery. No claims for shortages will be allowed unless reported to the Seller within 10 days of delivery. No other claims against Seller will be allowed unless asserted in writing within 30 days after delivery. Buyer shall notify Seller of any alleged breach of warranty within 30 days after the date the defect is or should have been discovered by Buyer. Any action based upon breach of this agreement or upon any other claim arising out of this sale (other than an action by Seller for an amount due on any invoice) must be commenced within 12 months from the date of the breach without regard to the date breach is discovered.

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

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

8. Loss to Buyer's Property. Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, will be considered obsolete and may be destroyed by Seller after two consecutive years have elapsed without Buyer ordering the items 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. Special Tooling. A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture Products. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the Products, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

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

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

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

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

14. Force Majeure. Seller does not assume the risk 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, strikes or labor disputes, acts of any government or government agency, acts of nature, delays or failures in delivery from carriers or suppliers, shortages of materials, or any other cause beyond Seller's reasonable control.

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

16. Termination. Seller may terminate this agreement for any reason and at any time by giving Buyer thirty (30) days written notice of termination. Seller may immediately terminate this agreement, in writing, if Buyer: (a) commits a breach of any provision of this agreement (b) appointments a trustee, receiver or custodian for all or any part of Buyer's property (c) files a petition for relief in bankruptcy on its own behalf, or by a third party (d) makes an assignment for the benefit of creditors, or (e) dissolves or liquidates all or a majority of its assets.

17. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to this agreement.

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

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

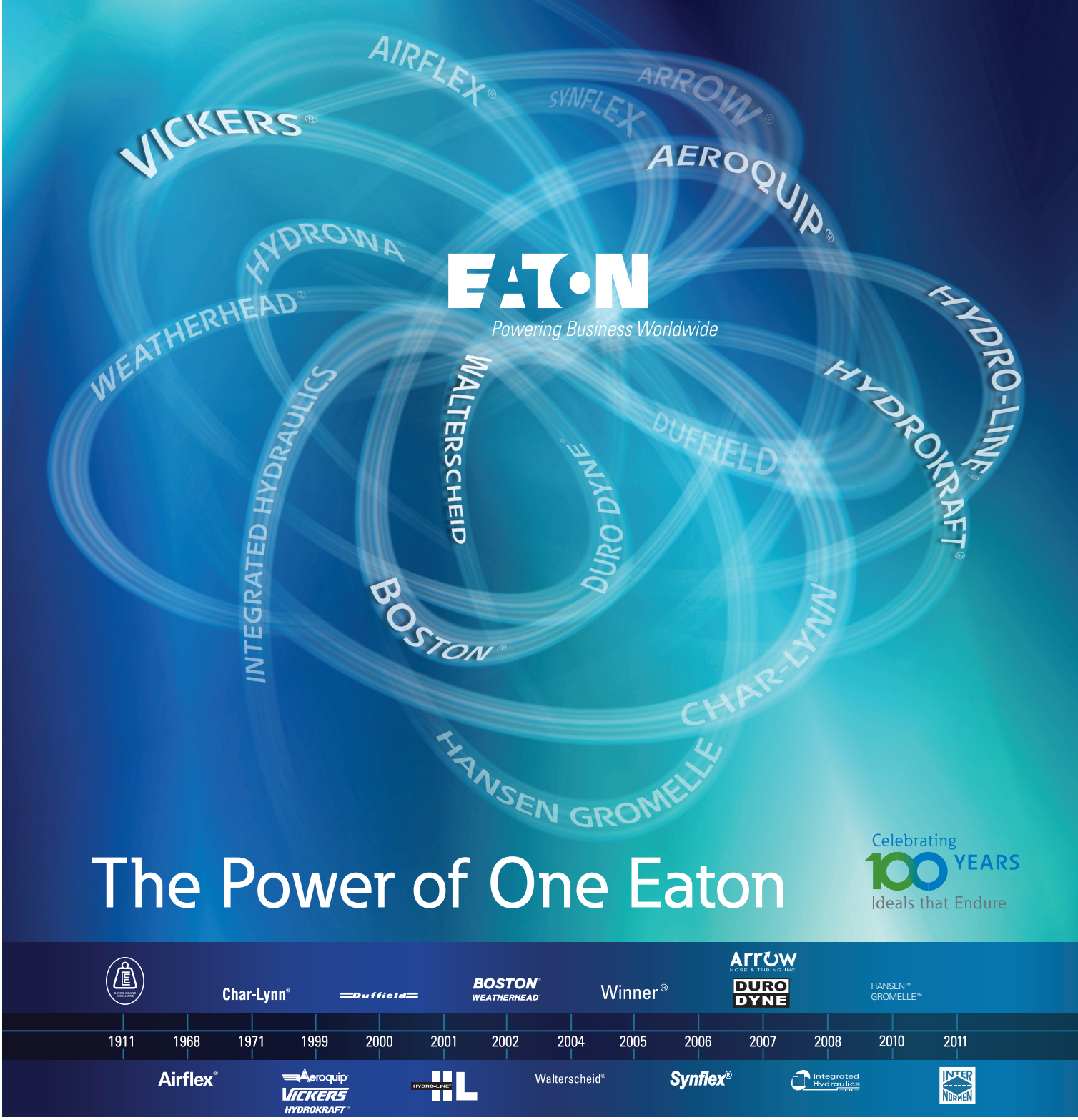
20. Compliance with Law, U. K. Bribery Act and U.S. Foreign Corrupt Practices Act. Buyer agrees to comply with all applicable laws and regulations, including both those of the United Kingdom and the United States of America, and of the country or countries of the Territory in which Buyer may operate, including without limitation the U. K. Bribery Act, the U.S. Foreign Corrupt Practices Act ("FCPA") and the U.S. Anti-Kickback Act (the "Anti-Kickback Act"), and agrees to indemnify and hold harmless Seller from the consequences of any violation of such provisions by Buyer, its employees or agents. Buyer acknowledges that they are familiar with the provisions of the U. K. Bribery Act, the FCPA and the Anti-Kickback Act, and certifies that Buyer will adhere to the requirements thereof. In particular, Buyer represents and agrees that Buyer shall not make any payment or give anything of value, directly or indirectly to any governmental official, any foreign political party or official thereof, any candidate for foreign political office, or any commercial entity or person, for the purpose of influencing such person to purchase products or otherwise benefit the business of Seller.

Hydro-Line Industrial Tie Rod Cylinders

NFPA Interchangeable Technical Manual

N5
AN5
LAN5

Powering Business Worldwide



EATON
Powering Business Worldwide

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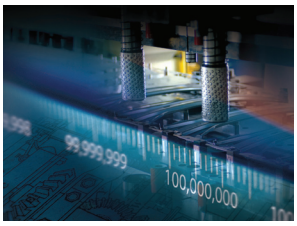

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Produce at peak efficiency with the superior precision and repeatability of Eaton products. Eaton hydraulic components provide the precise control and consistent operation required for virtually every step in your manufacturing operation. With Eaton, we'll help you redefine the meaning of raw productivity.

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Whatever your industry, no matter which processes you manage, Eaton parts and systems help keep you up and running. Our components make equipment more efficient and easier to use, so you get optimal machine performance and maximum productivity.

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Eaton technologies can make your driving operation more successful. Greater comfort and productivity help increase driver retention, while reduced emissions, leaks, and noise improve environmental performance. Increased efficiencies overall mean lower costs and higher net revenue.

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Eaton is a leading diversified power management company

Eaton provides reliable, efficient and safe power management for a growing number of industries.

Understanding and helping our customers succeed

- Listening and understanding to requirements and business drivers
- Delivering solutions with value propositions to solve the critical business needs

Knowing what's important to our customers and integrating that knowledge into the fabric of our business

- ...to deliver innovative, quality products
- ...to respond fast
- ...to provide dedicated customer service and support around the globe

Our strength is global reach with local responsiveness and support

- Customers served in more than 150 countries
- Diverse channels ensure reliable availability and support
- Design and engineering teams provide support for standard products and custom solutions
- Eaton experts offer efficient product and application training

Table of Contents

N5 Design Features

A Heavy Duty Rod Cartridge

- Machined from gray iron for maximum bearing support and wear resistance
- Unitized, threadless assembly is pilot-fitted into the head on a precision bored diameter to assure true concentricity (See Fig. 3-1)

B Piston Seals

- Step cut iron piston rings standard on N5
- Nitrile lip-type seals standard on AN5 and LAN5
- Viton lip seals available for special fluid compatibility or temperatures to 400°F
- Special seals for high speed, low friction and other requirements are available

C Long Life Urethane Rod Seals

- Urethane "Ultra-Seal" standard through 8" rod diameters on N5 cylinders providing the optimum in long life and sealing up to 200°F (see Fig. 3-3)
- Viton PolyPak seals available on N5 for special fluids or temperatures to 400°F
- Nitrile lip-type seals standard on AN5 and LAN5
- Special seals available

D Double-lipped Rod Wiper

- Carboxylated double-lipped rod wiper removes foreign materials from the exposed rod to extend rod seal life
- The standard rod wiper is carboxylated material through 5½"; Viton for 7" through 10" diameter rods
- Metallic rod scraper and low friction wipers available

E SAE Ports

- SAE ports standard on N5; NPTF ports available at no extra charge
- NPTF ports standard on AN5 and LN5; SAE ports available at no extra charge
- Metric, BSP, Manifold, Flange and other porting options available

F Teflon Tube Seals

- Superior design to prevent leakage
- Compatible with virtually all fluids
- Operating temperatures to 500°F

G Floating Cap Cushion Insert

- Floating design allows closer tolerance, yet minimum wear (see Fig. 3-2)

Key Features

Unitized Rod Cartridge Construction

- The unitized construction contains all cartridge seals in one assembly
- Standard removable retainer allows cartridge removal with hex wrench without loosening the tie rods
- See Page 7 for exceptions

Sculptured Floating Cushions

Self-centering cushions are sculptured to allow the cylinder driving force and load to be absorbed gradually and smoothly over the entire cushion length maintaining near constant pressure. Refer to pages 22 and 23 to determine your specific cushion requirements.

Urethane Ultra-Seal Rod Seal

Hydro-Line's Ultra-Seal Rod Seal provides much longer wear life than conventional rod seals. Special urethane formulation allows superior resistance to abrasion, tearing and extrusion. The balanced radial cross-sectional design with back-beveled Floating Cap Cushion Insert sealing lips provides excellent low pressure sealability. Higher pressures energize the sealing lips increasing the contact stress profile and giving the added sealing needed at increased pressures.

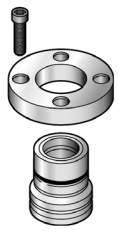


Figure 3-1

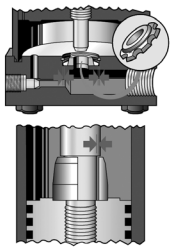


Figure 3-2

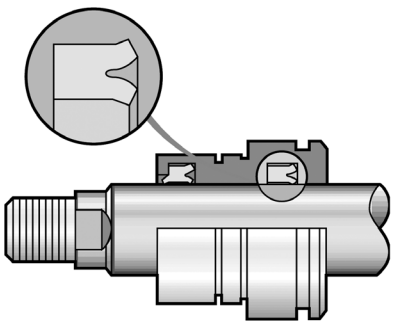


Figure 3-3

- Replaces ball check to provide greater flow area for fast breakaway

H Captive Cushion Adjustment

- Inner hex allows safe cushion adjustment under pressure
- Fine threads and special tip design allows for precise adjustment over a broad range of operating conditions

I Precision Steel Heads and Caps

- Provides truly flat and parallel mounting surfaces
- Insures correct alignment of tube and rod cartridge

J Self Centering Head Cushion

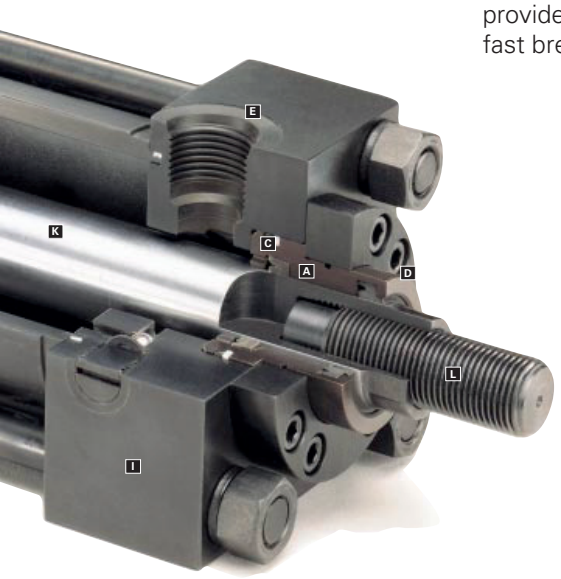
- Floating design allows closer tolerances, yet minimum wear (see Fig. 3-2)
- Sculptured shape provides constant deceleration curve
- Large size ball check provided at head end for fast breakaway

K Damage Resistant Piston Rod

- 5/8" through 4½" diameters use 90,000 to 100,000 minimum psi yield steel, case hardened and hard chrome plated
- Over 5" diameter uses 41,000 to 80,000 psi yield steel, hard chrome plated
- All rods polished to 8-14 micro inch finish for long seal life
- 17-4 PH stainless steel and other materials also available

L Studded Piston Rod End

- Roll-threaded 125,000 minimum psi yield steel
- Greater strength and fatigue resistance
- Standard on ⅝", 1" and 1⅜" diameter rods in styles 1, 1X, 2 and 2X
- Available on 1¾", 2" and 2½" rods in styles 1, 1X, 2 and 2X upon request



Specifications

Bore Sizes

11/2" through 30"

Pressure Ratings

N5 – 3000 psi hydraulic – nominal AN5, LAN5 – 250 psi air. See page 25 for specific pressure ratings and safety factors.

Temperature

-40°F to 200°F standard

NFPA interchangeable mountings

N5

Hydraulic cylinders incorporate urethane Ultra-Seal rod seals, carboxylated double-lipped rod wipers, cast iron piston rings, honed steel tubing I.D. and SAE ports.

AN5

Pneumatic cylinders incorporate carboxylated lip-type rod seals, carboxylated double-lipped rod wipers, carboxylated piston seals, .0003/.0005" thick chrome plated tube I.D. and NPTF ports.

LAN5

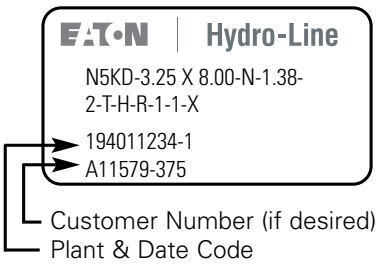
Pneumatic cylinders incorporate all AN5 features and are also permanently lubricated at assembly by filling the piston and rod seals "V" groove with molybdenum disulfide grease.

How to Order an N5 Cylinder

Eaton Hydro-Line standard cylinders can be completely and accurately identified with a model number that encodes construction specifications. To develop the model number for ordering a cylinder, see the following example:

How to Order

1. Quantity
2. Model number
3. Special modifications if required
4. Completed Application Data Sheet(s) (page 8) if required
5. Required ship date



N5 KD - 3.25 X 8.00 - N - 1.38 - 2 - T - H - R - 1 - 1 - X

1 2 3 4 5 6 7 8 9 10 11 12 13 14

	FEATURE	DESCRIPTION	SYMBOL
1	Model Series	Hydraulic high pressure	**N5**
		Air heavy duty	AN5
		Air heavy duty prelubricated	LAN5
2	Mounting Style	Side lugs, MS2	A
		Side tapped, MS4	B
		Cap fixed clevis, MP1	C
		Cap spherical bearing	CS
		Cap detachable clevis, MP2	DC
		Side end lugs, MS7	E
		Head rectangular flange, MF1	F
		Head rectangular, ME5	G
		Center-line lugs, MS3	H
		Head square flange, MF5	J
		No mount	**K**
		All tie rods extended, MX1	L
		Head end tie rods extended, MX3	M
		Cap end tie rods extended, MX2	N
		Cap rectangular, ME6	P
		Cap rectangular flange, MF2	R
		Cap square flange, MF6	S
		Intermediate fixed trunnion, MT4	TT
		Head trunnion, MT1	U
		Cap trunnion, MT2	W
3	Double Rod	Include ONLY for double-rod cylinder	**D**
4	Bore	Specify in inches (2 position decimal)	–
5	Stroke	Specify in inches (2 position decimal)	–
6	Cushions	Noncushioned	**N**
		Cushioned both ends	B
		Cushioned head end	H
		Cushioned cap end	C
7	Rod Diameter	Specify in inches (2 position decimal)	–
8	Rod End Style	Male, large	1
		Male, large, extended	1X
		Male, small (standard)	**2**
		Male, small, extended	2X
		Male modified	2M
		Female	4
		Female modified	4M
		Plain end	5
		Male, full rod diameter	6
		Male, for rod end coupling	10
		Modified	M

* To order standard SAE #12 ports on 31/4", 4" and 5" bore, use T.

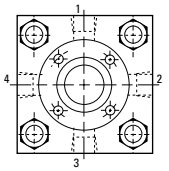
† To order oversize SAE #16 ports on 31/4", 4" and 5" bore, use S.

‡ Consider specifying pinning the piston to the piston rod for temperatures over 250° F.

	FEATURE	DESCRIPTION	SYMBOL
9	Ports	NPTF	N
		†SAE	S
		*SAE #12, standard for 31/4", 4" and 5" bore cylinders Manifold	**T** M
		Flange	F
		BSP/G	G
		Special	X
10	Rod Seals	Urethane Ultra-Seal	**H**
		Carboxylated lip type	N
		PolyPak	P
		‡Viton PolyPak	F
		‡Viton lip type	V
		Ultra-Seal with scraper	J
		Nitrile lip type with scraper	S
		‡Viton PolyPak with scraper	G
		‡Viton lip type with scraper	U
		Special	X
11	Piston Seals	Carboxylated lip type	N
		Low friction PolyPak	D
		PolyPak	P
		Cast iron rings	**R**
		‡Viton lip type	V
		Low breakaway Teflon radial seal with wearband	B
		Special	X
12	Port Locations	Head end positions	**1**-4
		Special	X
13	Port Locations	Cap end positions	**1**-5
		Special X	
14	Special Modifications	Include ONLY if special modifications are required.	**X**
		Air bleeders	Rod boots
		Drainbacks	Indicator switches
		Special seals	Four rod end flats
		Nonstd. mount	Port or cushion modifications
		Oversize ports	Double-end rod with different rod ends
		Bronze bushings	Special paint/plating
		Key Plate	Stainless steel rod
		Stop tube	

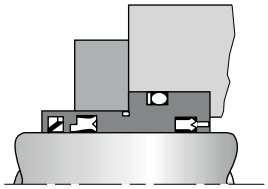
Port Locations

Port location 5 is on the center of the back face of the end cap.



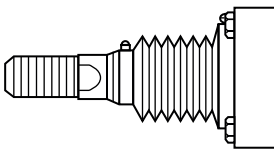
N5 Series Standard Design Options

Metallic Rod Scrapers



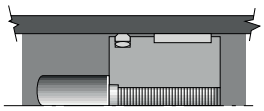
A Metallic Rod Scraper provides increased rod seal life by removing abrasive contamination from the rod in severe applications.

Rod Boots



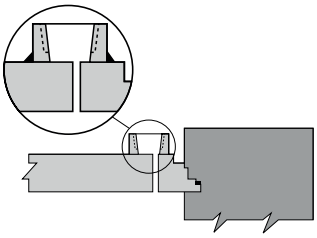
A rod boot surrounds the piston rod with an external, expandable cover to protect the rod surface from external contamination. Requires additional rod length which is determined by the cylinder stroke.

Low Breakaway Piston



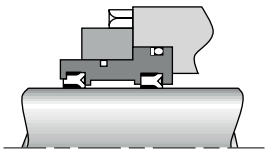
A low breakaway piston reduces running friction and metal-to-metal contact by utilizing a bronze-filled Teflon wearband and a bi-directional, O-ring energized, bronze-filled Teflon piston seal.

Air Bleeders



⅛" NPTF bleeders are located in the tube or in the head and cap when specified. SAE #2 bleeders located in the head and cap are also available when specified. All bleeders may be located in positions 1, 2, 3 or 4.

Wearbands



Wearbands fitted to the piston and/or rod cartridge eliminate metal-to-metal contact on the piston/tube I.D. and the cartridge/ rod O.D. Bronze-filled Teflon wearband material reduces friction and wear in applications where side-load is present.

Special Rod Ends

Modifications of standard rod ends or completely special rod end styles are available to meet unique rod end connection requirements. (See page 37.)

Special Ports

Metric, BSP, Manifold and other porting options are available to meet specific requirements. (See page 28).

Extra Heavy Chrome Tubes and Rods

Added wear and corrosion resistance are available by specifying Extra Heavy Chrome (.002" to .003" thick).

Electronic Feedback

A complete line of precision cylinder position sensing and feedback devices are available. These packaged cylinder systems can handle virtually any application requiring feedback throughout the cylinder stroke — pneumatic or hydraulic, large or small bore, long or short strokes, with or without velocity monitoring — with resolutions of ± 0.001" or better. (See the Hydro-Line Systems Catalog).

Stainless Steel Piston Rods

Piston rods in 300 and 400 series, 17-4 PH and others are available for those applications requiring increased corrosion resistance.

Special Coating and Painting

Cylinders can be prepared with a primer coat, epoxy, lacquer or enamel paint finish coatings to customer specifications. Synergistic, Nitrocarburizing and other material treatments are also available for special applications.

Plating

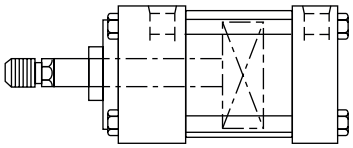
Electroless Nickel, Cadmium and other plating finishes are available for corrosive, washdown, pharmaceutical and other applications.

Special Materials

Bronze rod cartridges, brass, aluminum and composite tubing, complete stainless steel cylinders or other special materials are available to meet most unique material requirements.

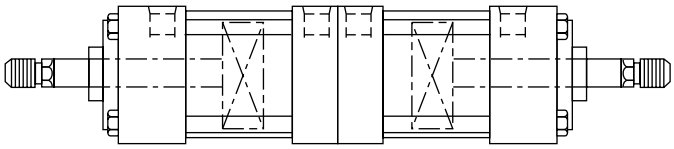
N5 Series Cylinder Types

Single/Double Acting Cylinders



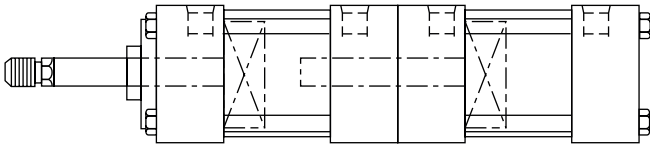
Standard N5 Series cylinders are double acting, with fluid power driving the piston in both directions. Single acting cylinders have fluid power driving the piston in one direction, relying on either the load or an external force to return the piston after the pressure is released.

Back-to-back Cylinders



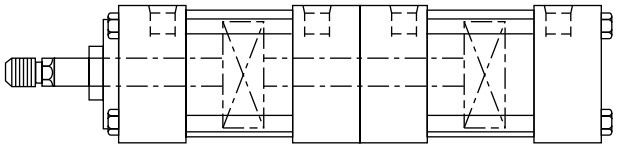
Back-to-back cylinders are two single rod cylinders mounted together at the caps. Combinations of positions are possible through various combinations of piston actuation. Consult Eaton for maximum operating pressure.

Multiple Position Cylinders



Multiple position cylinders are similar to tandem cylinders (except that the piston and rod assemblies are not connected) in that the output force is increased. Additionally, they may act as a precision multiple positioning device by actuating each cylinder successively or independently. Consult Eaton for maximum operating pressure.

Tandem Cylinders

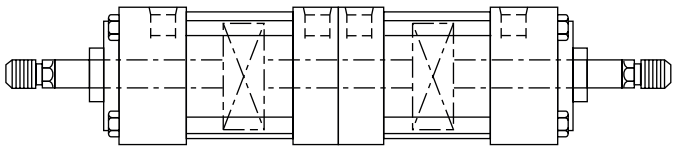


Tandem cylinders consist of two cylinders interconnected (piston and rod assemblies are connected). Pressure can act on two effective piston areas allowing the cylinder to be used as a force multiplier. This type of cylinder can also be used in air/oil systems to provide smooth, metered flow because of equal volumes in one chamber of both cylinders. Consult Eaton for maximum operating pressure.

Note

Front cylinder stroke is ⅛" longer at front cylinder when strokes are the same.

Double End Cylinders Back-to-Back



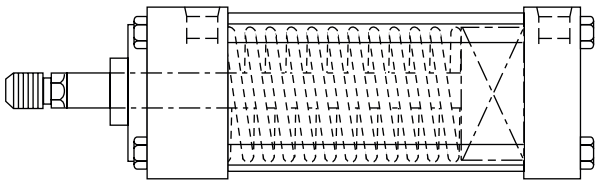
Double end cylinders mounted back-to-back have common piston rod and tie rods and the same stroke length. Consult Eaton for maximum operating pressure.

Note

Cylinder length is ⅛" longer on one cylinder.

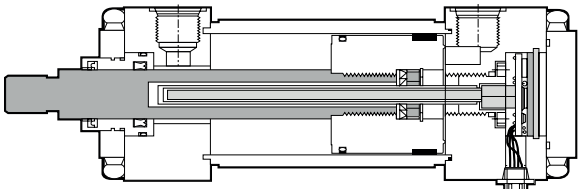
N5 Series Cylinder Types

Spring Return/Extend Cylinders



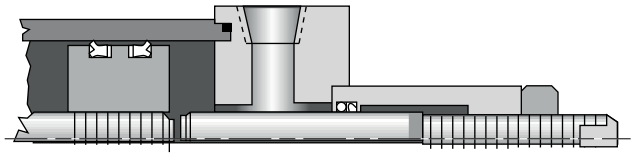
Spring return/extend cylinders provide thrust in one direction only (can be either direction). One port is used for pressure to act against the load while the inactive port is vented. An internal spring is used to return the cylinder to its normal position.

Electronic Feedback Cylinders



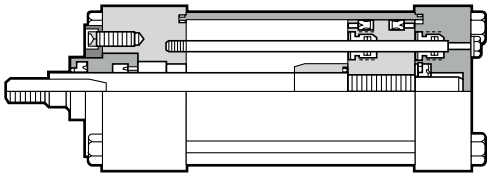
These cylinders integrate position sensing and control valves to produce a complete servoactuator package. Eaton's unique HLT In- Cylinder magnetostrictive feedback sensor provides a compact, robust package. External magnetostrictive (with protective covers) or internally mounted linear potentiometer transducers provide additional options. Valve, manifold blocks and a variety of servocontrol valves may be added to yield a complete control solution.

Adjustable Stroke Cylinders



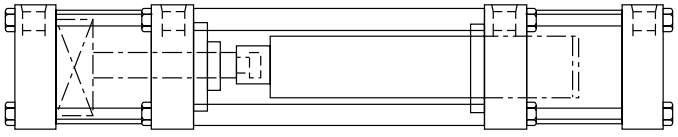
Adjustable stroke cylinders are furnished with a stroke adjusting screw in the cap end of the cylinder. Adjusting this screw in or out limits the retract stroke to the precise length desired.

Non-rotating Cylinders



Non-rotating cylinders are furnished with internal guide rods which prevent piston rod rotation throughout the stroke. Rotational torque and stroke length determine the amount and diameter of the guide rods.

Pumping Units



Pumping units consist of a standard hydraulic cylinder coupled with a volume displacing lance cylinder via tiebars. Special seals and lance surface treatments are available to provide compatibility with resins and chemicals used in the pumping process. Single and double ended designs are available.

Eaton Application Data Sheet

Company Name: _____
Contact: _____
Phone Number: _____ Fax Number: _____

Distributor Name: _____
Contact: _____
Phone Number: _____ Fax Number: _____

Model Numbering System

QUANTITY

Model/Series Mount | Bore | Stroke | Cushion | Rod Diameter | Rod End Style | Seals: Ports, Rod, Piston | Port Location: Head, Cap, Model

Double End Rod Style | Additional Rod Length | Needle Location: C HEAD, C CAP | Keyplate | 4-Flat | Bleeders: HEAD CAP | Bronze Bushing | Drain-back | Ind. Switch: HEAD CAP | Model Prefix

Stop Tube Length | Trunnion XI Dimension | Stainless Steel Rod Type

Please fill in all available information above. Refer to the Hydro-Line Model Numbering System on Pages 2.

WHAT IS THE OPERATING ENVIRONMENT?

Fluid Media	Operating Pressure	Temperature at Cylinder
Air _____	Minimum _____psi	Minimum _____°F
Oil _____	Typical _____psi	Typical _____ °F
Other _____	Maximum _____psi	Maximum _____°F

Fluid Type _____

WHAT IS THE WORK BEING PERFORMED?

Load	Rod Speed	Cycles per Minute
Push _____ lbs.	Extend _____ in./sec.	
Pull _____ lbs.	Retract _____ in./sec.	_____ (in and out)

WHAT IS MOUNTING?

Attitude

Vertical _____ Angle _____ Horizontal _____
Degrees From Vertical _____
Rod Up _____ Rod Up _____
Rod Down _____ Rod Down _____

Rod End Connection / **Known Side Load**

Firmly Guided _____
Supported _____ _____lbs.
Unsupported _____

WHAT ENVIRONMENTAL CONDITIONS IS THE CYLINDER SUBJECTED TO?

Standard Factory _____ Corrosive Washdown _____ Chemical? _____ Outdoors _____ Other _____

WHAT IS THE PRESENT CYLINDER TYPE AND MODEL NUMBER?

WHAT IS THE PRESENT PROBLEM?

WHAT INDUSTRY IS THE CYLINDER USED IN?	WHAT TYPE OF MACHINE IS THE CYLINDER USED ON?	WHAT IS THE CYLINDER NAME THE APPLICATION?

APPLICATION SKETCH:

DESCRIPTION OF APPLICATION OR SPECIAL REQUIREMENT:

PREPARED BY:	DATE:	REVIEWED BY:	DATE:

CUSTOMER DRAWING NUMBER:	REVISION DATES:	HYDRO-LINE QUOTE NUMBER:

FRM-24-005

N5 Series Mounting Application Data

Side- and Center-line Mountings

These mounts should be keyed or pinned to prevent shifting during operation. Keys or pins must be strong enough to resist the full thrust of the cylinder. The lugs on A and H mounts are large enough to accommodate dowel pins. Extended key plates for stock and custom cylinder models are available when specified. Pin or key the head whenever possible. Do not pin or key both ends. Cylinders become longer when pressure is applied and tube will tend to buckle.

The alignment and center-line height on the E mount are maintained by accurately machined surfaces on the head and cap which are held against the mounting surface by the end lugs.

DESCRIPTION	MOUNT	NFPA DESIGNATION	N5 BORES AVAILABLE
Side Lugs	A	MS2	1½″ - 8″
Side Tapped	B	MS4	1½″ - 8″
Center-Line Lugs	H **	MS3	1½″ - 20″
Side End Lugs	E	MS7	1½″ - 8″

End and Intermediate Pivot Mountings

Trunnion and pivot pins are designed to carry shear loads only. Trunnion and pivot bearings must fit closely for the entire length of the pin. Hold the trunnion bearings rigidly and in accurate alignment

DESCRIPTION	MOUNT	NFPA DESIGNATION	N5 BORES AVAILABLE
Cap Fixed Clevis	C	**MP1	1½″ - 30″
Cap Spherical Bearing	CS	N/A	1½″ - 6″
Detachable Clevis	DC	MP2	1½″ - 8″
Head Trunnion	U	**MT1	1″ - 30″
Cap Trunnion	W	**MT2	1½″ - 30″
Intermediate Fixed Trunnion	TT	**MT4	1½″ - 30″

End Mountings

The head and cap rectangular mounts G and P should be used for hydraulic applications to avoid excessive deflection which occurs on the F and R mountings.

Refer to the chart on page 15 for pressure ratings for F mounts in push and R mounts in pull.

The G, P, J and S mounts are usable in both push and pull at full rated hydraulic pressures as shown on page 29.

Piston Securing Methods

Piston to rod joints are threaded, anaerobically sealed and secured, and staked (single rod ends). Under normal operating conditions, additional securing is not necessary. However, in applications where: 1) temperatures exceed 250°F, 2) pressure spike or impact shock is present, or 3) a piston previously detached, the piston should be pinned; this must be specified when ordering. Consult factory for other securing methods.

Double Rod Cylinders

Double rod cylinders are available in all mountings except C, CS, DC, N, P, R, S and W. Use the basic dimensional information on page 17 combined with dimensions in the drawings on pages 13-21.

Mounting Accessories

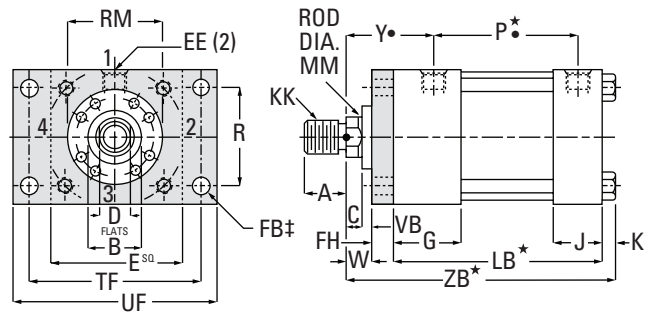
See pages 30-34 for mounting accessories.

DESCRIPTION	MOUNT	NFPA DESIGNATION	N5 BORES AVAILABLE
Head Rectangular Flange	F	MF1	1½" - 8"
Cap Rectangular Flange	R	MF2	1½" - 8"
Head Square Flange	J	MF5	1½" - 8"
Cap Square Flange	S	MF6	1½" - 8"
Integral Square Head	J	**	10" - 30"
Integral Square Cap	S	**	10" - 30"
Tie Rods Extended	L, N, M	MX1, MX2, MX3	1½" - 8"
Head Rectangular	G	**ME5	1½" - 14"
Cap Rectangular	P	**ME6	1½" - 14"
No Mount	K	N/A	1½" - 30"

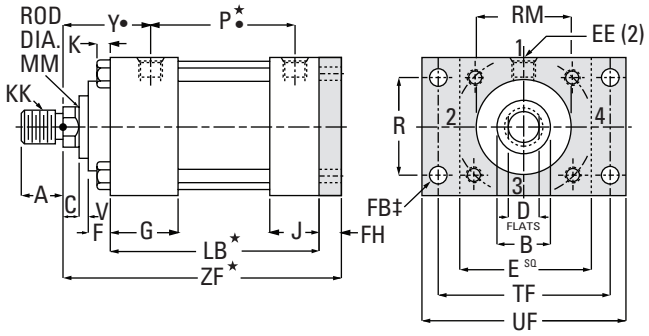
** NFPA mounting dimensions are available on all cylinders 1½" - 8" bore. For larger cylinders, see pages 11-19 for mounting dimensions.

N5 Series Mounting Dimensions

1½"-8" bore cylinders



N5F – Head Rectangular Flange Mount (NFPA Style MF1)



N5R – Cap Rectangular Flange Mount (NFPA Style MF2)

MAXIMUM OPERATING PRESSURES IN PSI FOR F MOUNTING IN PUSH

CYLINDER BORE	STANDARD ROD2:1 PISTON ROD			
	Heavy Duty	Nonshock	Heavy Duty	Nonshock
5 & 6	1440	2400	1120	1840
7	1040	1760	720	1200
8	800	1350	640	1120

MAXIMUM OPERATING PRESSURES IN PSI FOR R MOUNTING IN PULL

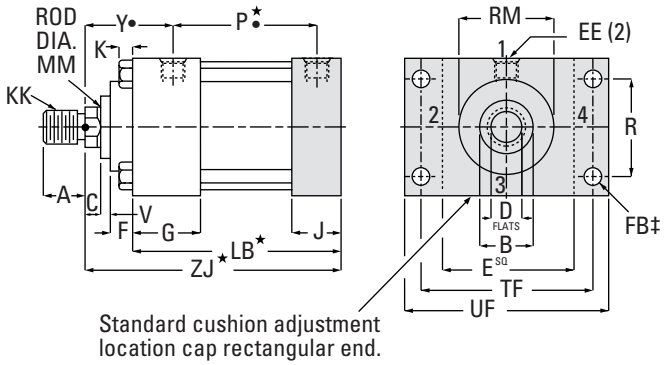
CYLINDER BORE	STANDARD ROD2:1 PISTON ROD			
	Heavy Duty	Nonshock	Heavy Duty	Nonshock
5 & 6	1800	3000	1400	2300
7	1300	2200	900	1500
8	1000	1700	800	1400

Note

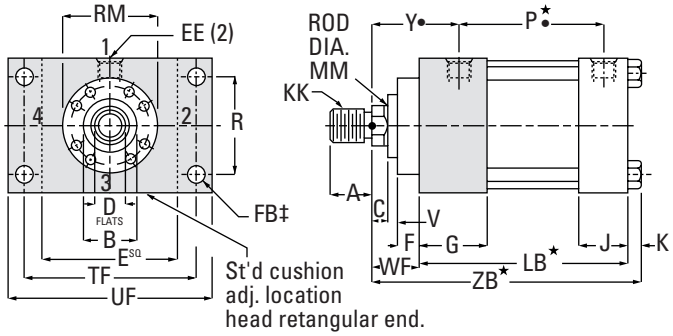
When pressure must exceed the limitations above for mountings F and R, specify J or S mounting. (Up to a maximum of 3000 psi heavy duty, 5000 psi nonshock).

N5 Series Mounting Dimensions

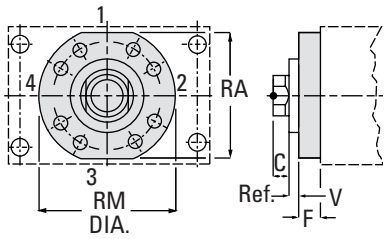
1 1/2"-8" bore cylinders



N5P – Cap Rectangular Mount (NFPA Style ME6)



N5G – Head Rectangular Mount (NFPA Style ME5)



Mounting G Only

Note

Use the chart below for the cartridge retainer plate dimensions for the bore and rod combinations listed. See page 15 for all other mounting dimensions.

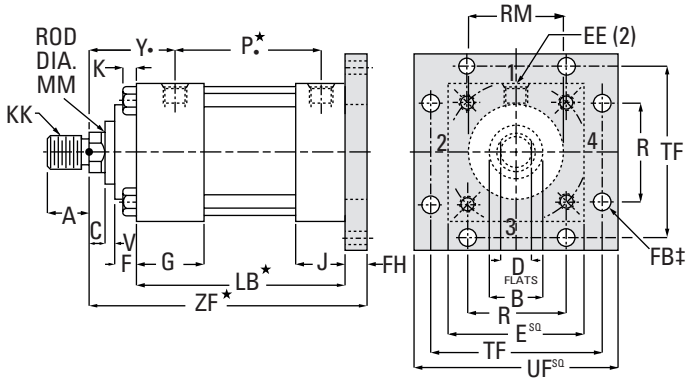
G MOUNTING

BORE	ROD DIAG.		F	RA	RM	V
1 ½	⅝	11/32		-	2 ⅜	9/32
	1	½		2.44	2 ⅝	⅜
2	1	½		-	2 ⅝	⅜
	1 ⅜	19/32		2.94	3 ¼	13/32
2 ½	1 ⅜	19/32		-	3 ¼	13/32
	1 ¾	19/32		3.44	3 ⅞	17/32
3 ¼	1 ¾	19/32		-	3 ⅞	17/32
	2	19/32	-	4	17/32	

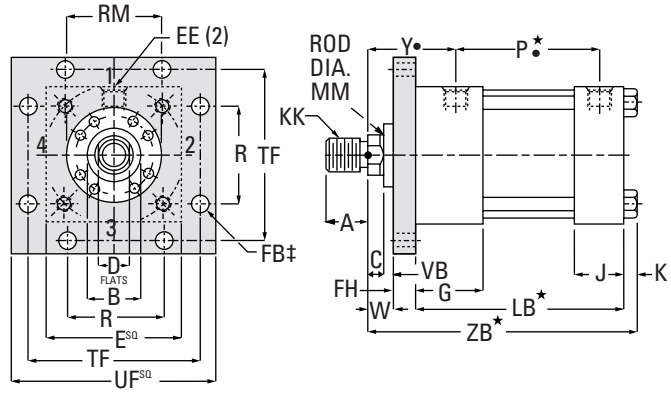
N5 Series Mounting Dimensions

End Mountings

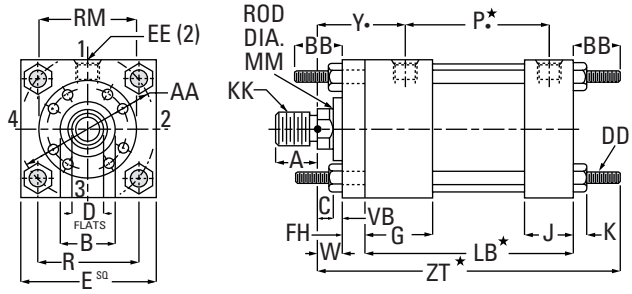
(See important application data on pages 22-25.)



N5S – Cap Square Flange Mount (NFPA Style MF6)



N5J – Head Square Flange Mount (NFPA Style MF5)



N5K (No Mount), N5L (NFPA Style MX1), N5N (NFPA Style MX2), N5M (NFPA Style MX3) – Tie Rods Extended Mounts

K – No Mount

(MX1) L – Both tie rods extended

(MX2) N – Cap end tie rods extended

(MX3) M – Head end tie rods extended

Note

Mounting styles L and M use filler plate at the head end when cylinder has circular retainer

CYLINDER DIMENSIONS

BORE	1½	2	2 ½	3¼	4	5	6	7	8
A	¾	1⅛	1⅛	1⅝	2	2¼	3	3½	3½
AA	2.3	2.9	3.6	4.6	5.4	7.0	8.1	9.3	10.6
AC	1⅛	1½	1½	1¾	2	2⅝	3¼	3¾	4⅜
AD	⅝	15⁄16	15⁄16	1 1⁄16	1 5⁄16	1 11⁄16	1 15⁄16	2 7⁄16	2 11⁄16
AE	¼	⅜	⅜	⅜	½	⅝	¾	⅞	1
AF	⅜	11⁄16	11⁄16	⅞	1⅛	1⅜	1¾	2¼	2½
B -.001 -.003	1⅛	1½	1½	2	2⅜	2⅝	3⅛	3¾	4¼
BB	1⅜	1 13⁄16	1 13⁄16	2 5⁄16	2 5⁄16	3 3⁄16	3⅝	4⅛	4½
C	⅜	½	½	⅝	¾	⅞	1	1	1
CC	½-20	⅞-14	⅞-14	1¼-12	1½-12	1¾-12	2¼-12	2¾-12	3¼-12
D	17⁄32	⅞	⅞	1⅛	1½	1¾	2⅛	2⅝	3
DD	⅜-24	½-20	½-20	⅝-18	⅝-18	⅞-14	1-14	1⅛-12	1¼-12
E	2½	3	3½	4½	5	6½	7½	8½	9½
EE (SAE)	10	10	10	12	12	12	16	20	24
EE (NPTF)	½	½	½	¾	¾	¾	1	1¼	1½
F	▲	▲	½	19⁄32	19⁄32	19⁄32	19⁄32	23⁄32	23⁄32
FB‡	7⁄16	9⁄16	9⁄16	11⁄16	11⁄16	15⁄16	1 1⁄16	1 3⁄16	1 5⁄16
FH	⅜	⅝	⅝	¾	⅞	⅞	1	1	1
FT	⅝-18	1-14	1-14	1⅜-12	1¾-12	2-12	2½-12	3-12	3½-12
G	1¾	1¾	1¾	2	2	2	2¼	2¾	3
J	1½	1½	1½	1¾	1¾	1¾	2¼	2¾	3
K	⅜	7⁄16	7⁄16	9⁄16	9⁄16	13⁄16	15⁄16	1	1⅛
KK	7⁄16-20	¾-16	¾-16	1-14	1¼-12	1½-12	1⅞-12	2¼-12	2½-12
LB★	4⅝	4⅝	4¾	5½	5¾	6¼	7⅜	8½	9½
MM	⅝	1	1	1⅜	1¾	2	2½	3	3½
P★•	2 11⁄16	2 11⁄16	2 13⁄16	3 9⁄16	3 13⁄16	4 5⁄16	4 11⁄16	5⅛	5⅞
R	1.63	2.05	2.55	3.25	3.82	4.95	5.73	6.58	7.50
RM	■	■	2⅝	3¼	3⅞	4	4 7⁄16	5¼	5⅝
TF	3 7⁄16	4⅛	4⅝	5⅞	6⅜	8 3⁄16	9 7⁄16	10⅝	11 13⁄16
UF	4¼	5⅛	5⅝	7⅛	7⅝	9¾	11¼	12⅝	14
V	▲	▲	⅜	13⁄32	17⁄32	17⁄32	21⁄32	17⁄32	17⁄32
VB	¼	¼	¼	¼	¼	¼	¼	¼	¼
W	⅝	¾	¾	⅞	1	1⅛	1¼	1¼	1¼
WF	1	1⅜	1⅜	1⅝	1⅞	2	2¼	2¼	2¼
Y•	2 15⁄32	2 15⁄32	2 15⁄32	2 23⁄32	2 31⁄32	3 3⁄32	3 19⁄32	3 15⁄16	4 1⁄16
ZB★	6	6 7⁄16	6 9⁄16	7 1⁄16	8 3⁄16	9 1⁄16	10 9⁄16	11¾	12⅞
ZF★	6	6⅝	6¾	7⅞	8½	9⅛	10⅝	11¾	12¾
ZJ★	5⅝	6	6⅛	7⅛	7⅝	8¼	9⅝	10¾	11¾
ZT★	7	7 13⁄16	7 15⁄16	9 7⁄16	9 15⁄16	11 7⁄16	13¼	14⅞	16¼
PISTON THICKNESS	1⅜	1⅜	1½	1¾	2	2½	2⅞	3	3½

Dimensions shown in blue are mounting dimensions.

Oversize rods affect dimensions in blueshaded areas. See pages 38-39 for these dimensions.

★ Add stroke to all starred dimensions.

■ Refer to page 29.

Note - Additional port information on page 26.

▲ Use FH dimension in place of F dimension and VB dimension in place of V dimension.

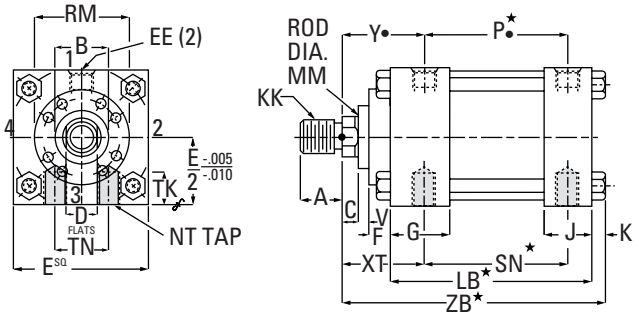
‡ Use screws 1⁄16" smaller than mounting holes.

• Port dimensions for standard ports only. Consult Eaton for flange, manifold and special ports.

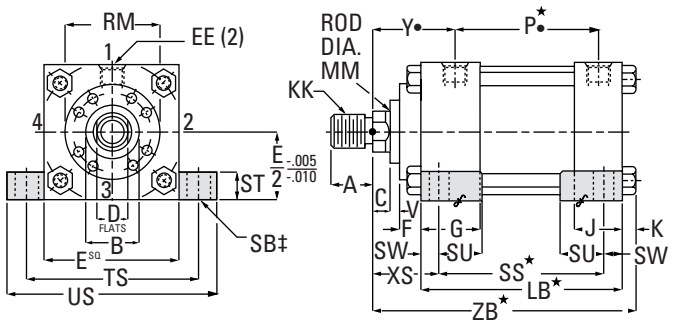
Note - Overall length dimensions that require addition of stroke may vary from dimensions shown, due to manufacturing tolerances.

N5 Series Mounting Dimensions

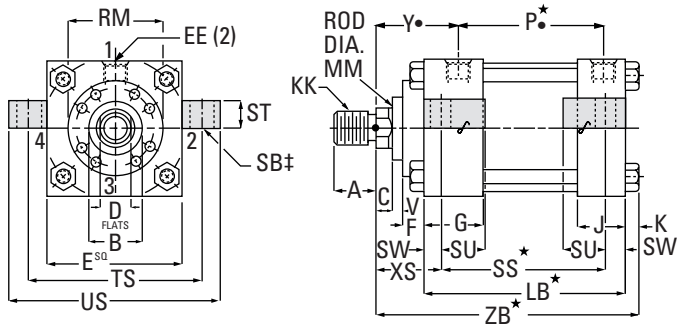
1 1/2"-8" bore cylinders



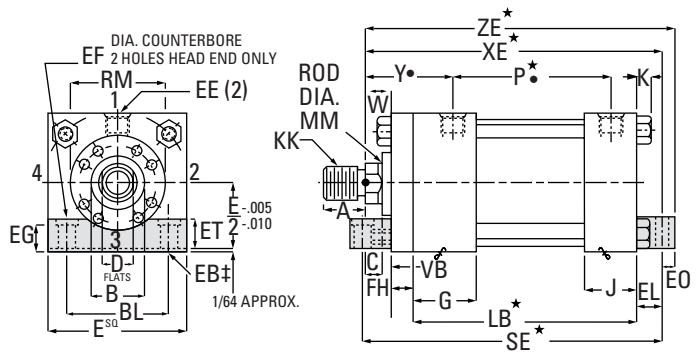
N5B – Side Tapped Mount (NFPA Style MS4)



N5A – Side Lugs Mount (NFPA Style MS2)



N5H – Center-Line Lugs Mount (NFPA Style MS3)



N5E – Side End Lugs (NFPA Style MS7)

Note

See page 19 for double rod cylinder mounting dimensions.

Note

See page 19 for double rod cylinder mounting dimensions.

Note

See page 19 for double rod cylinder mounting dimensions.

Note

Bottoms of heads and caps are mounting surfaces. Lugs hold cylinders against mounting surface.

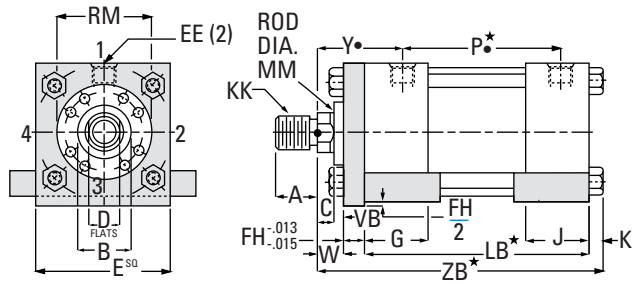
Note

Port at Position 3 not available on 11/2", 2", 21/2", 31/4" and 4" bore.

N5 Series Mounting Dimensions

Side- and Center-line Mountings

(See important application data on pages 22-25)



N5 – Extended Key Plate – Available when specified

Note

To order, specify extended key plate after the N5 series and mounting style

(Example: N5A with extended key plate).

Dimensions shown in blue are mounting dimensions.

Oversize rods affect dimensions in blueshaded areas. See pages 38-39 for these dimensions.

★ Add stroke to all starred dimensions.

■ Refer to page 29.

Note - Overall length dimensions that require addition of stroke may vary from dimensions shown, due to manufacturing tolerances.

▲ Use FH dimension in place of F dimension and VB dimension in place of V dimension.

‡ Use screws 1/16" smaller than mounting holes.

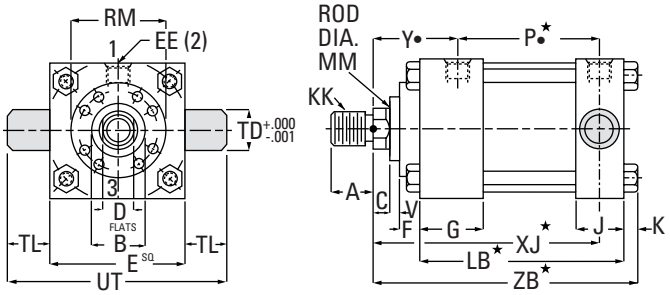
• Port dimensions for standard ports only. Consult Eaton for flange, manifold and special ports.

CYLINDER DIMENSIONS

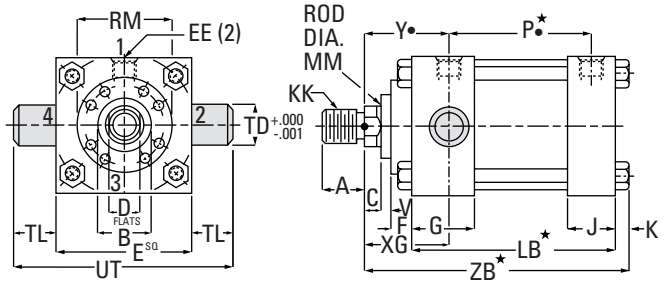
BORE	1½	2	2 ½	3¼	4	5	6	7	8
A	¾	1⅛	1⅛	1⅝	2	2¼	3	3½	3½
AC	1⅛	1½	1½	1¾	2	2⅝	3¼	3¾	4⅜
AD	⅝	15/16	15/16	1 1/16	1 5/16	1 11/16	1 15/16	2 7/16	2 11/16
AE	¼	⅜	⅜	⅜	½	⅝	¾	⅞	1
AF	⅜	11/16	11/16	⅞	1⅛	1⅜	1¾	2¼	2½
B -.001 -.003	1⅛	1½	1½	2	2⅜	2⅝	3⅛	3¾	4¼
BL	1.63	2.07	2.56	3.27	3.84	4.95	5.74	6.58	7.51
C	⅜	½	½	⅝	¾	⅞	1	1	1
CC	½-20	⅞-14	⅞-14	1¼-12	1½-12	1¾-12	2¼-12	2¾-12	3¼-12
D	17/32	⅞	⅞	1⅛	1½	1¾	2⅛	2⅝	3
E	2½	3	3½	4½	5	6½	7½	8½	9½
EB‡	7/16	9/16	9/16	11/16	11/16	15/16	1 1/16	1 3/16	1 5/16
EE (SAE)	10	10	10	12	12	12	16	20	24
EE (NPTF)	½	½	½	¾	¾	¾	1	1¼	1½
EF	⅝	13/16	13/16	1	1	1⅜	1⅝	1⅝	2 3/32
EG	11/16	¾	¾	1 1/16	⅞	1¼	1½	1½	1¾
EL	⅞	15/16	15/16	1⅛	1⅛	1½	1 11/16	1 13/16	2
EO	⅜	½	½	⅝	⅝	¾	⅞	1	1⅛
ET	⅞	1	1	1¼	1¼	1½	1¾	2	2
F	▲	▲	½	19/32	19/32	19/32	19/32	23/32	23/32
FH	⅜	⅝	⅝	¾	⅞	⅞	1	1	1
FT	⅝-18	1-14	1-14	1⅜-12	1¾-12	2-12	2½-12	3-12	3½-12
G	1¾	1¾	1¾	2	2	2	2¼	2¾	3
J	1½	1½	1½	1¾	1¾	1¾	2¼	2¾	3
K	⅜	7/16	7/16	9/16	9/16	13/16	15/16	1	1⅛
KK	7/16-20	¾-16	¾-16	1-14	1¼-12	1½-12	1⅞-12	2¼-12	2½-12
LB★	4⅝	4⅝	4¾	5½	5¾	6¼	7⅜	8½	9½
MM	⅝	1	1	1⅜	1¾	2	2½	3	3½
NT	⅜-16	½-13	⅝-11	¾-10	1-8	1-8	1¼-7	1½-6	1½-6
P★•	2 11/16	2 11/16	2 13/16	3 9/16	3 13/16	4 5/16	4 11/16	5⅛	5⅞
RM	■	■	2⅝	3¼	3⅞	4	4 7/16	5¼	5⅝
SB‡	7/16	9/16	13/16	13/16	1 1/16	1 1/16	1 5/16	1 9/16	1 9/16
SE★	6¾	7⅛	7¼	8½	8⅞	10⅛	11¾	13⅛	14½
SN★	2⅞	2⅞	3	3½	3¾	4¼	5⅛	5⅞	6⅝
SS★	3⅞	3⅝	3⅜	4⅛	4	4½	5⅛	5¾	6¾
ST	½	¾	1	1	1¼	1¼	1½	1¾	1¾
SU	15/16	1¼	1 9/16	1 9/16	2	2	2½	2⅞	2⅞
SW	⅜	½	11/16	11/16	⅞	⅞	1⅛	1⅜	1⅜
TK	9/16	½	13/16	¾	1	1⅛	1 5/16	2⅛	1 9/16
TN	¾	15/16	1 5/16	1½	2 1/16	2 15/16	3 5/16	3¾	4¼
TS	3¼	4	4⅞	5⅞	6¾	8¼	9¾	11¼	12¼
US	4	5	6¼	7¼	8½	10	12	14	15
V	▲	▲	⅜	13/32	17/32	17/32	21/32	17/32	17/32
VB	¼	¼	¼	¼	¼	¼	¼	¼	¼
W	⅝	¾	¾	⅞	1	1⅛	1¼	1¼	1¼
XE★	6½	6 15/16	7 1/16	8¼	8¾	9¾	11 5/16	12 9/16	13¾
XS	1⅜	1⅞	2 1/16	2 5/16	2¾	2⅞	3⅜	3⅝	3⅝
XT	2	2⅜	2⅜	2¾	3	3⅛	3½	3 13/16	3 15/16
Y•	2 15/32	2 15/32	2 15/32	2 23/32	2 31/32	3 3/32	3 19/32	3 15/16	4 1/16
ZB★	6	6 7/16	6 9/16	7 11/16	8 3/16	9 1/16	10 9/16	11¾	12⅞
ZE★	6⅞	7 7/16	7 9/16	8⅞	9⅜	10½	12 3/16	13 3/16	14⅞
PISTON THICKNESS	1⅜	1⅜	1½	1¾	2	2¼	2⅞	3	3½

N5 Series Mounting Dimensions

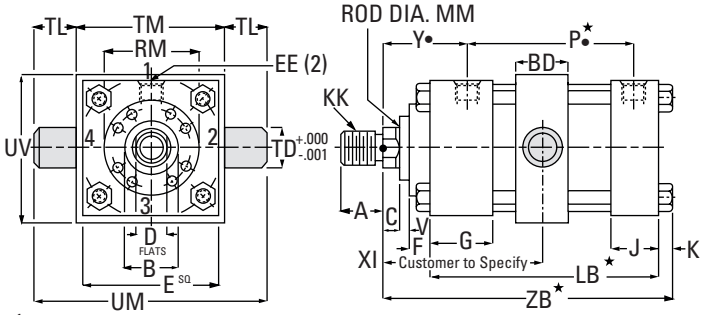
1 1/2"-8" bore cylinders



N5W – Cap Trunnion Mount (NFPA Style MT2)

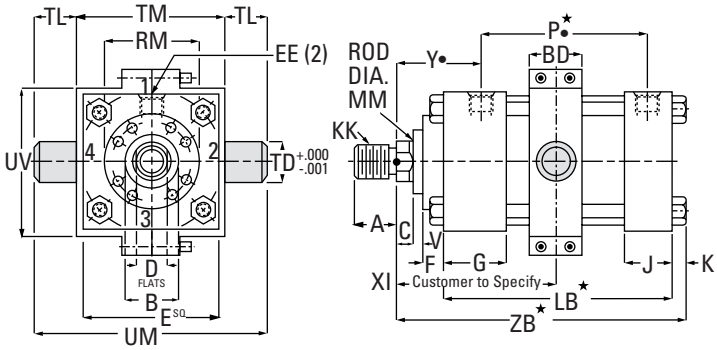


N5U – Head Trunnion Mount (NFPA Style MT1)



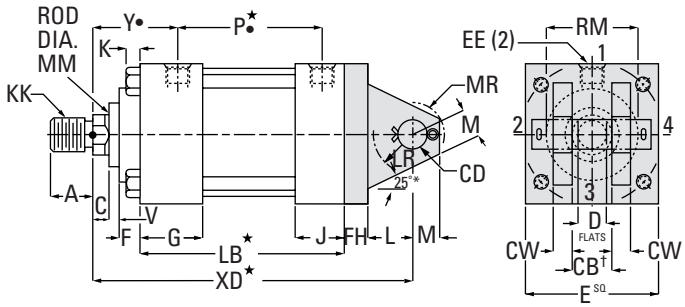
1 1/2" -5" bores have one-piece trunnion.

N5TT – Intermediate Fixed Trunnion Mount (NFPA Style MT4)



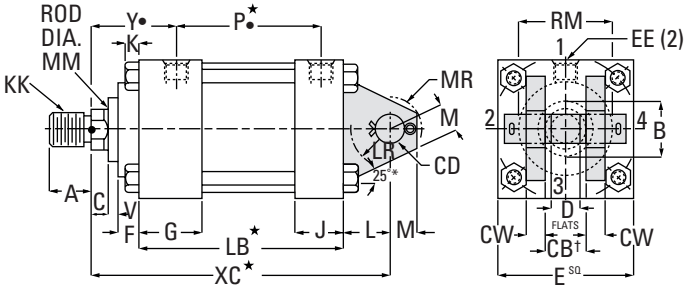
6"-8" bores have split trunnion.

N5TT – Intermediate Fixed Trunnion Mount (NFPA Style MT4)



‡Maximum width of mating part.

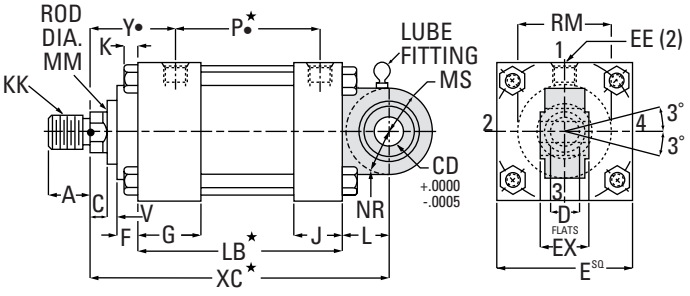
N5DC – Cap Detachable Clevis Mount (NFPA Style MP2)



‡Maximum width of mating part.

N5C – Cap Fixed Clevis Mount (NFPA Style MP1)

Pivot Mountings and Double Rod Cylinders



N5CS – Cap Spherical Bearing Mount

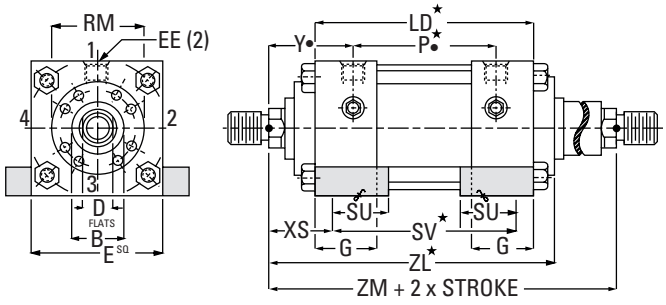
MAXIMUM OPERATING PRESSURE

1½	2	2½	3¼	4	5	6
1650	2200	1400	1500	1750	1900	1700

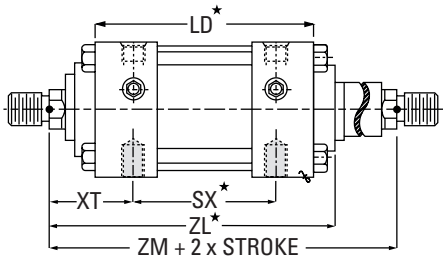
N5 Series Mounting Dimensions

Pivot Mountings and Double Rod Cylinders (continued)

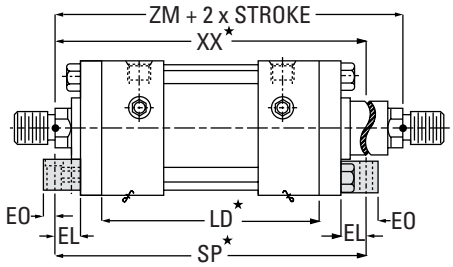
(See important application data on pages 22-25.)



N5AD – Side Lugs Mount – Double Rod



N5BD – Side Tapped Mount – Double Rod



N5ED – Side End Lugs Mount – Double Rod

Note

N5HD has mounting dimensions identical to N5AD.

Note

Add D for double end after the N5 series and mounting style. (Example: N5AD)

Note

Dimensions not shown are same as single rod cylinders.

Note

Double rod cylinders available in all mounts except C, DC and W.

Dimensions shown in blue are mounting dimensions.

Note - Additional port information on pg 28.

Oversize rods affect dimensions in blueshaded areas. See pages 38-39 for these dimensions.

★ Add stroke to all starred dimensions.

■ Refer to page 29.

Note - Overall length dimensions that require addition of stroke may vary from dimensions shown, due to manufacturing tolerances.

▲ Use FH dimension in place of F dimension and VB dimension in place of V dimension.

‡ Plus 2X stroke.

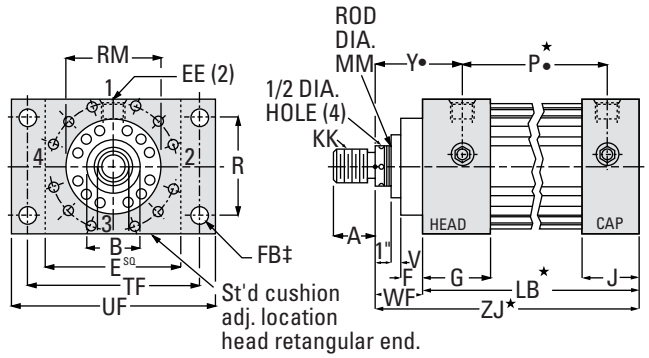
• Port dimensions for standard ports only. Consult Eaton for flange, manifold and special ports

CYLINDER DIMENSIONS

BORE	1½	2	2 ½	3¼	4	5	6	7	8
A	¾	1⅛	1⅛	1⅝	2	2¼	3	3½	3½
AC	1⅛	1½	1½	1¾	2	2⅝	3¼	3¾	4⅜
AD	⅝	15/16	15/16	1 1/16	1 5/16	1 11/16	1 15/16	2 7/16	2 11/16
AE	¼	⅜	⅜	⅜	½	⅝	⅜	⅞	1
AF	⅜	11/16	11/16	⅞	1⅛	1⅜	1¾	2¼	2½
B -.001 -.003	1⅛	1½	1½	2	2⅜	2⅝	3⅛	3¾	4¼
BD	1½	1½	1½	2	2	2½	3	3	3½
C	⅜	½	½	⅝	¾	⅞	1	1	1
CB	¾	1¼	1¼	1½	2	2½	2½	3	3
CC	½-20	⅞-14	⅞-14	1¼-12	1½-12	1¾-12	2¼-12	2¾-12	3¼-12
CD	½	¾	¾	1	1⅜	1¾	2	2½	3
CW	½	⅝	⅝	¾	1	1¼	1¼	1½	1½
D	17/32	⅞	⅞	1⅛	1½	1¾	2⅛	2⅝	3
E	2½	3	3½	4½	5	6½	7½	8½	9½
EE (NPTF)	½	½	½	¾	¾	¾	1	1¼	1½
EE (SAE)	10	10	10	12	12	12	16	20	24
EL	⅞	15/16	15/16	1⅛	1⅛	1½	1 11/16	1 13/16	2
EO	⅜	½	½	⅝	⅝	¾	⅞	1	1⅛
EX	7/16	21/32	21/32	⅞	1 3/16	1 17/32	1¾	–	–
F	▲	▲	½	19/32	19/32	19/32	19/32	23/32	23/32
FH	⅜	⅝	⅝	¾	⅞	⅞	1	1	1
FT	⅝-18	1-14	1-14	1⅜-12	1¾-12	2-12	2½-12	3-12	3½-12
G	1¾	1¾	1¾	2	2	2	2¼	2¾	3
J	1½	1½	1½	1¾	1¾	1¾	2¼	2¾	3
K	⅜	7/16	7/16	9/16	9/16	13/16	15/16	1	1⅛
KK	7/16-20	¾-16	¾-16	1-14	1¼-12	1½-12	1⅞-12	2¼-12	2½-12
L	¾	1¼	1¼	1½	2⅛	2¼	2½	3	3¼
LB★	4⅝	4⅝	4¾	5½	5¾	6¼	7⅜	8½	9½
LD★	4⅞	4⅞	5	5¾	6	6½	7⅜	8½	9½
LR	9/16	1 1/16	1 1/16	1¼	1⅞	1 15/16	2 1/16	2 9/16	2 11/16
M	½	¾	¾	1	1⅜	1¾	2	2½	2¾
MM	⅝	1	1	1⅜	1¾	2	2½	3	3½
MR	9/16	1 1/16	1 1/16	1⅛	1¾	1⅞	2⅛	2½	2¾
MS	15/16	1⅜	1⅜	1 11/16	2 7/16	2⅞	3 5/16	–	–
NR	⅝	1	1	1¼	1⅝	2 1/16	2⅜	–	–
P★•	2 11/16	2 11/16	2 13/16	3 9/16	3 13/16	4 5/16	4 11/16	5⅛	5⅞
RM	■	■	2⅝	3¼	3⅞	4	4 7/16	5¼	5⅝
SP★	7⅜	8	8⅛	9½	10	11¼	12¾	14⅛	15½
SU	15/16	1¼	1 9/16	1 9/16	2	2	2½	2⅞	2⅞
SV★	4⅛	3⅞	3⅝	4⅜	4¼	4¾	5⅛	5¾	6¾
SX★	2⅞	2⅞	3	3½	3¾	4¼	4⅞	5⅜	6⅛
TD	1	1⅜	1⅜	1¾	1¾	1¾	2	2½	3
TL	1	1⅜	1⅜	1¾	1¾	1¾	2	2½	3
TM	3	3½	4	5	5½	7	8½	9¾	11
UM	5	6¼	6¾	8½	9	10½	12½	14¾	17
UT	4½	5¾	6¼	8	8½	10	11½	13½	15½
UV	2¾	3⅜	37/8	4⅞	5½	7¼	9½	11½	13¼
V	▲	▲	⅜	13/32	17/32	17/32	21/32	17/32	17/32
VB	¼	¼	¼	¼	¼	¼	¼	¼	¼
W	⅝	¾	¾	⅞	1	1⅛	1¼	1¼	1¼
XC★	6⅜	7¼	7⅜	8⅝	9¾	10½	12⅛	13¾	15
XD★	6¾	7⅞	8	9⅜	10⅝	11⅜	13⅛	14¾	16
XG	1⅞	2¼	2¼	2⅝	2⅞	3	3⅜	3⅝	3¾
XJ★	4⅞	5¼	5⅜	6¼	6¾	7⅜	8⅜	9⅜	10¼
XS	1⅜	1⅞	2 1/16	2 5/16	2¾	2⅞	3⅜	3⅝	3⅝
XT	2	2⅜	2⅜	2¾	3	3⅛	3½	3 13/16	3 15/16
XX★	7⅛	7 13/16	7 15/16	9¼	9⅞	10⅞	12 5/16	13 9/16	14¾
Y•	2 15/32	2 15/32	2 15/32	2 23/32	2 31/32	3 3/32	3 19/32	3 15/32	4 1/16
ZB★	6	6 7/16	6 9/16	7 11/16	8 3/16	9 1/16	10 9/16	11¾	12⅞
ZL★	6¼	6⅞	6⅞	7 31/32	8 15/32	9 3/32	10 7/32	11 15/32	12 15/32
ZM★★	6⅞	7⅝	7¾	9	9¾	10½	11⅞	13	14
PISTON THICKNESS	1⅜	1⅜	1½	1¾	2	2¼	2⅞	3	3½

N5 Series Mounting Dimensions

10”-20”, 24” and 30” bore cylinders

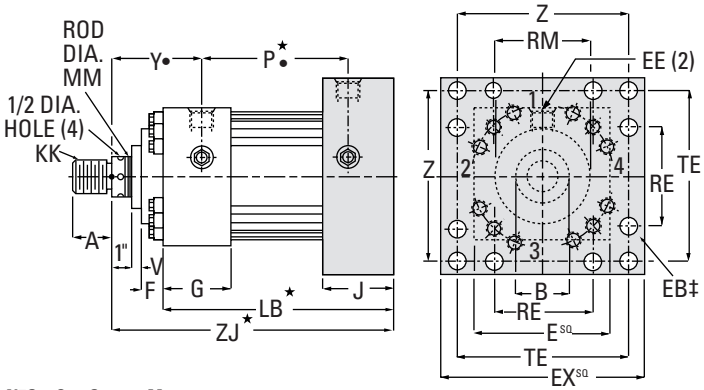


N5G – Head Rectangular Mount
N5P – Cap Rectangular Mount

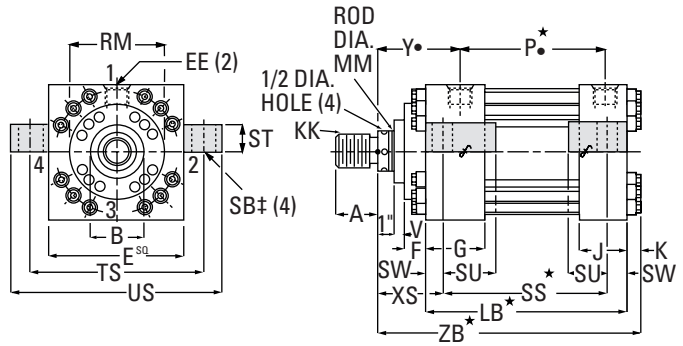
Note

Tie rod nuts will extend past the end cap K thickness on the end opposite flange mounting.

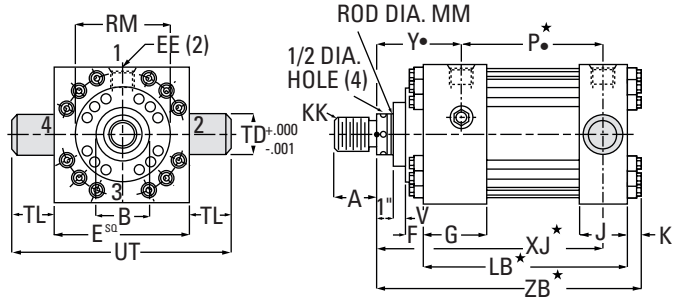
Available in 10", 12" and 14" bores only. Over 14" bore, use J or S mount.



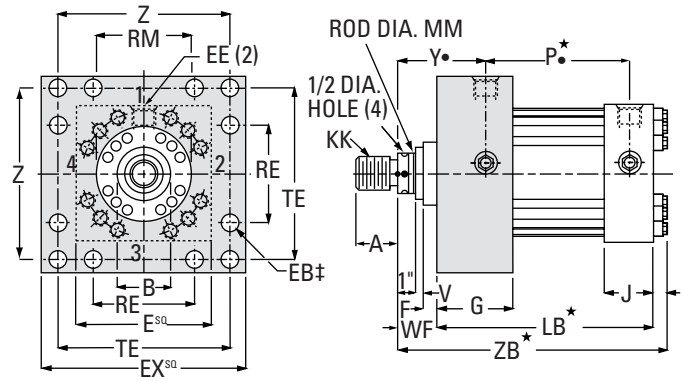
N5S – Cap Square Mount



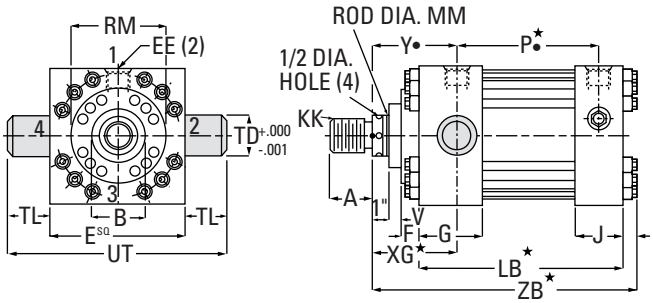
N5H – Center-line Lugs Mount



N5W – Cap Trunnion Mount



N5J – Head Square Mount

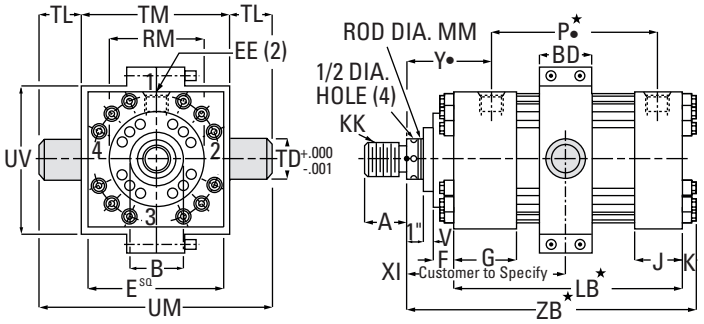


N5U – Head Trunnion Mount

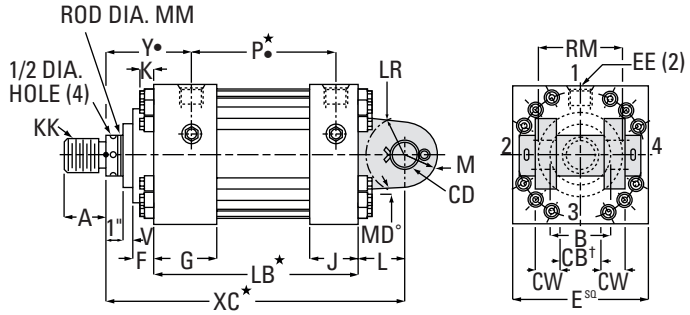
N5 Series Mounting Dimensions

All Mountings

(See important application data on pages 22-25.)



For trunnion dimensions over 14" bore, consult factory.



† Maximum width of mating part.

N5C – Cap Fixed Clevis Mount

Dimensions shown in blue are mounting dimensions.

Oversize rods affect dimensions in blueshaded areas. See pages 38-39 for these dimensions.

★ Add stroke to all starred dimensions.

† Maximum width of mating part.

‡ Use screws 1/16" smaller than mounting holes.

Note - Overall length dimensions that require addition of stroke may vary from dimensions shown, due to manufacturing tolerances.

- Port dimensions for standard ports only. Consult Eaton for flange, manifold and special ports.

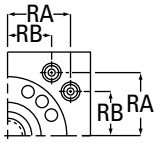
CYLINDER DIMENSIONS

BORE	10	12	14	16	18	20	24	30
A	4½	5½	7	8	9	10	11	14
AC	5¼	6¼	6½	6½	6¾	7¼	–	–
AD	3 3/16	3 15/16	4 1/16	4 1/16	4⅛	4⅝	–	–
AE	1½	1⅞	2	2	2	2⅜	–	–
AF	3½	4⅜	5¾	6½	7¼	8	–	–
B -.001 -.003	5¼	6¼	8	9	10	11	12	15
BD	4	5	5½	–	–	–	–	–
CB†	4	4½	6	7	8	9	10	12
CC	4¼-12	5¼-12	6½-12	7½-12	8½-12	9½-12	–	–
CD	3½	4	5	6	6½	7½	9	11
CW	2	2¼	3	3½	4	4½	5	6
E	12⅝	14⅞	17⅛	19¼	22	23⅝	31	37½
EB	1 5/16	1 9/16	1 13/16	1 13/16	2 1/16	2 1/16	2 9/16	3 1/16
EE				SEE PAGE 22				
EX	16⅝	19¾	21¾	24½	26½	29	36	47
F	⅞	1⅜	1⅝	1⅞	2 3/16	2 11/16	2 11/16	3⅛
FB‡	1 13/16	2 1/16	2 5/16	–	–	–	–	–
FT	4½-12	5½-12	7-12	8-12	9-12	10-12	11-12	14-12
G	3 11/16	4 7/16	4⅞	5⅞	6⅞	77/8	10	12⅜
J	3 11/16	4 7/16	4⅞	5⅞	6⅞	77/8	10	12⅜
K	1⅝	1 3/16	1 13/16	2	2	2	3	3½
KK	3¼-12	4-12	5-12	5¾-12	6½-12	7¼-12	8-8	11-8
L	4	4½	5¾	7	7⅝	8¾	17	21
LB★	12⅛	14½	15⅝	18⅛	21⅛	23⅝	29½	36¼
LR	3⅜	3⅞	4 3/16	4¾	5 1/16	6 3/16	–	–
M	3½	4	5	6	6½	7½	9	11
MD	10°	14°	0	0	0	0	0	0
MM	4½	5½	7	8	9	10	11	14
P★•	8⅛	9½	9⅞	11	12	12½	18	21 15/16
R	9.62	11.45	13.26	–	–	–	–	–
RE	9.89	11.75	12.90	15.28	16.45	18.07	22.125	23.75
RM	7⅛	8⅜	10 13/16	12⅜	13⅛	14⅝	16	19
SB‡	1 9/16	1 9/16	2 5/16	2 9/16	2 13/16	3 1/16	–	–
SS★	8⅞	10½	11⅛	12⅝	14⅝	15⅞	–	–
ST	2¼	3	4	4½	5¼	6½	–	–
SU	3½	4¼	4¾	5¼	5½	6⅜	–	–
SW	1⅝	2	2¼	2¾	3¼	3⅞	–	–
TD	3½	4	4½	5	5¾	6¼	7½	9½
TE	14.13	16.79	18.43	21.03	22.65	24.87	31.25	40.75
TF	15⅞	18½	21	–	–	–	–	–
TL	3½	4	4½	5	5¾	6¼	7½	9½
TM	14	16½	19½	–	–	–	–	–
TS	15⅞	18⅞	21⅝	24¼	27½	30⅛	–	–
UF	19	22	25	–	–	–	–	–
UM	21	24½	28½	–	–	–	–	–
US	19⅛	22⅞	26⅛	29¼	33	36⅝	–	–
UT	19⅝	22⅞	26⅛	29¼	33½	36⅛	46	56½
UV	17½	20¾	24¾	–	–	–	–	–
V	1 1/16	13/16	⅞	1⅛	1 1/16	13/16	13/16	3/8
WF	2 15/16	3 3/16	3½	4	4¼	4½	4½	4½
XC★	19 1/16	22 3/16	24⅞	29⅛	33	36⅞	51	61¾
XG	4¾	5⅜	5 15/16	61 5/16	7 11/16	8 7/16	9½	10¾
XJ★	13¼	15½	16 1/16	19 3/16	21 15/16	24 3/16	29	34½
XS	4 9/16	5 3/16	5¾	6¾	7½	8⅜	–	–
Y•	4 15/16	5 1/16	6⅜	7 9/16	8 13/16	10 1/16	10¼	11 7/16
Z	–	–	–	–	–	–	–	40¾
ZB★	16 1/16	19½	20 15/16	24⅛	27⅜	30⅛	37	44¼
ZJ&#1;	15 1/16	17 11/16	19⅛	22⅛	25⅜	28⅛	34	40¾
PISTON THICKNESS	4¾	5⅝	5⅞	6⅜	7⅜	7⅞	9½	11½

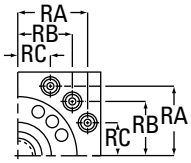
Tie Rod Information

10"- 20", 24" AND 30" BORE

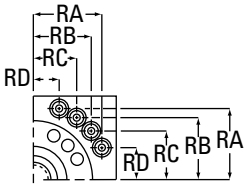
DIM	10	12	14	16	18	20	24	30
RA	5.291	6.270	7.485	8.086	9.589	10.437	13.589	16.585
RB	3.775	4.555	6.143	6.093	7.910	8.750	11.722	14.380
RC	–	–	4.409	–	5.761	6.649	9.158	11.439
RD	–	–	–	–	–	–	6.050	7.911
TIE ROD THREAD	1⅛-12	1¼-12	1¼-12	1½-12	1½-12	1½-12	2-12	2¼-12



10", 12" and 16" bores



14", 18" and 20" bores



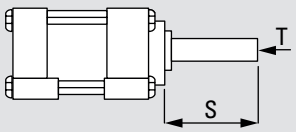
24" and 30" bores

Note

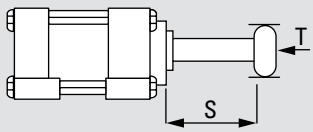
The interchangeability of the 10"- 20", 24" and 30" bores with other cylinder brands has not been established by the NFPA. The above dimensions are Eaton Hydro-Line standards.

Technical Data

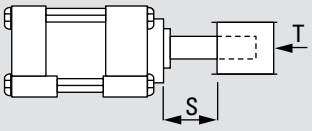
Rod Size and Stop tube selection



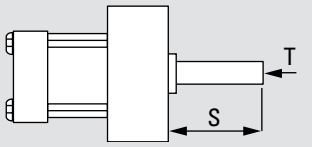
D = 4S
Unsupported Rod End



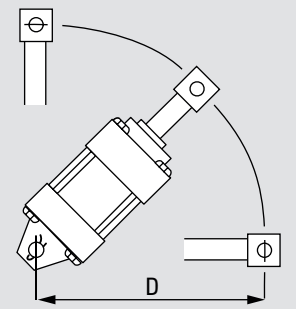
D = S
Supported Rod End



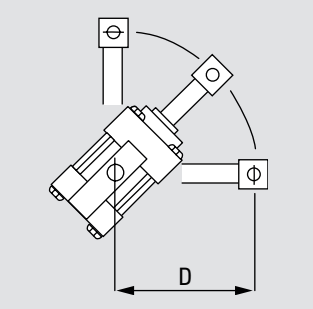
D = ½S
Firmly Guided Rod End



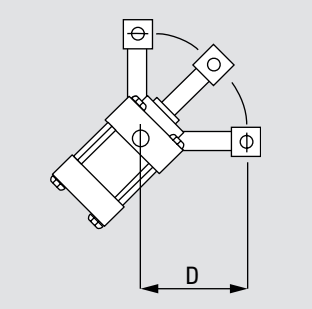
D = 4S
Unsupported Rod End



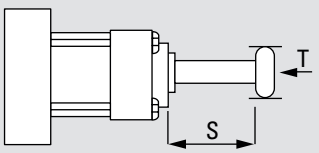
Cap Clevis or Trunnion



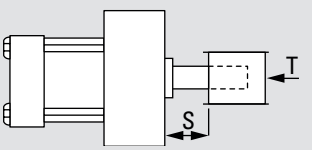
Intermediate Trunnion



Head Trunnion



D = S
Supported Rod End



D = ½S
Firmly Guided Rod End

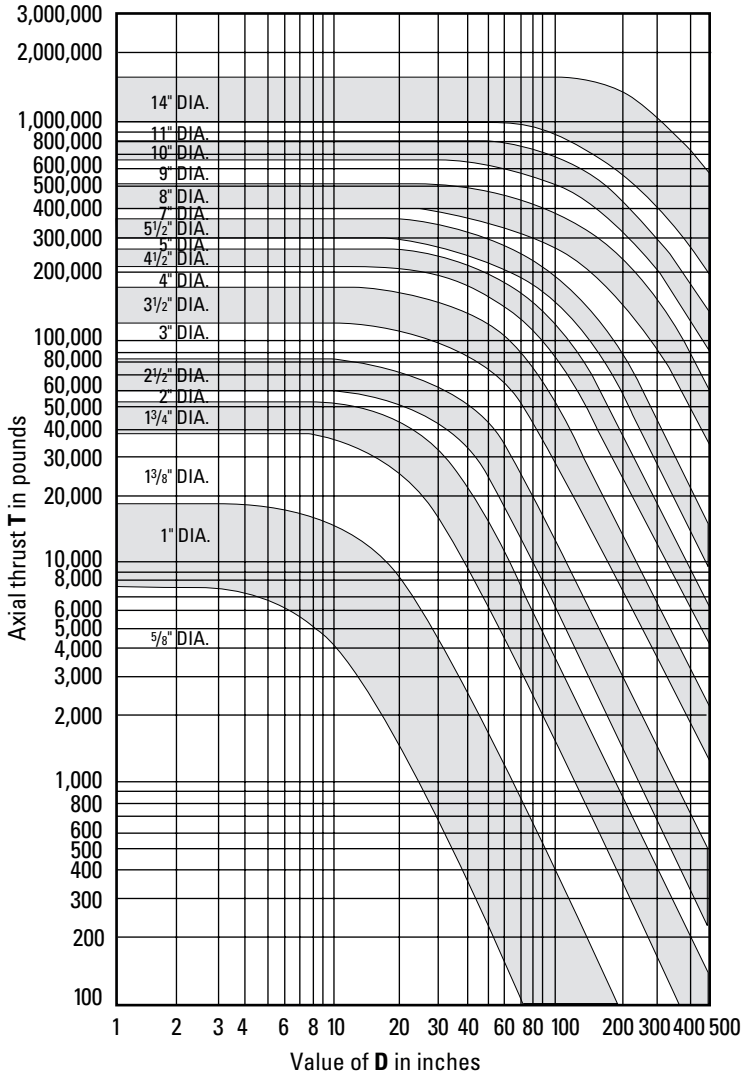
Technical Data

Rod Size and Stop Tube Selection (continued)

Rod Size Selection

Standard rod sizes are normally suitable for all applications except for long stroke or high thrust applications. Proper selection of minimum rod size may be determined by the following steps:

1. If you know the bore size and operating pressure, thrust can be determined. Refer to the graph in the next column.
2. Select from illustrations on page 22 the type of mounting needed, and determine the length of D with the piston rod in the fully extended position.
3. Find the value of D at the bottom of the graph and follow its line vertically until it until it intercepts the horizontal line, which represents the maximum push thrust to be applied to your cylinder. The intersection of these two lines will fall within a stripe representing the minimum recommended piston rod diameter for your needs.



Stop Tubes

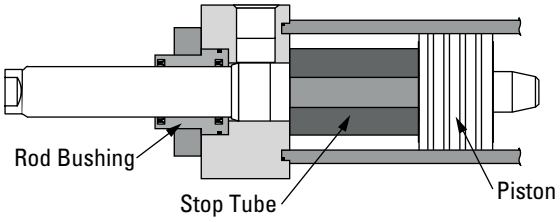
Stop tubes are located between the piston and the rod shoulder on the head end of the cylinder. Bearing loading is reduced by separating the piston and the rod bushing. Bearing wear and tendency to buckle is reduced.

To determine if a stop tube is required and the length of stop tube needed, use the following procedure:

Determine the value of **D** with the piston rod in the fully extended position. If the value of **D** is under 40", no stop tube is needed. If **D** is greater than 40", one inch of stop tube is recommended for each 10", or fraction thereof, beyond 40".

Special Note

When specifying stroke and stop tube lengths, please include net working stroke plus stop tube length.



Technical Data

Pressure-Thrust Consumption-Flow Charts

Standard Operating Pressure Rating			Out-Stroke Thrust In Pounds Force													Consumption Per Inch Of Stroke in One Direction		
			Pressures of Operating Medium – Air or Hydraulic															
Cyl. Bore in inches	Air AN5 LAN5	Hyd. N5	Piston Area sq. in.	50 psi	60 psi	80 psi	100 psi	200 psi	250 psi	500 psi	750 psi	1000 psi	1500 psi	2000 psi	3000 psi	Oil Gallons Displaced	Air Pressure Cubic Ft. Displaced	Free Air Cubic Ft. at 80 psi Displaced
11/2	250	3000	1.84	92	110	147	184	368	460	920	1,380	1,840	2,760	3,680	5,520	.00797	.00106	.00683
2	250	3000	3.24	162	194	259	324	648	810	1,620	2,430	3,240	4,860	6,480	9,720	.01403	.00188	.01211
21/2	250	3000	5.03	252	302	402	503	1,006	1,258	2,520	3,773	5,030	7,545	10,060	15,090	.02177	.00291	.01875
31/4	250	3000	8.45	423	507	676	845	1,690	2,113	4,230	6,338	8,450	12,675	16,900	25,350	.03658	.00489	.03149
4	250	2700	12.76	638	766	1,021	1,276	2,552	3,190	6,380	9,570	12,760	19,140	25,520	38,280	.05524	.00738	.04755
5	250	3000	19.87	994	1,192	1,590	1,987	3,974	4,968	9,940	14,903	19,870	29,805	39,740	59,610	.08602	.01150	.07405
6	250	2700	28.56	1,428	1,714	2,285	2,856	5,712	7,140	14,280	21,420	28,560	42,840	57,120	85,680	.12364	.01653	.10644
7	250	3000	38.82	1,941	2,329	3,106	3,882	7,764	9,705	19,410	29,115	38,820	58,230	77,640	116,460	.16805	.02247	.14468
8	250	3000	50.64	2,532	3,038	4,051	5,064	10,128	12,660	25,320	37,980	50,640	75,960	101,280	151,920	.21922	.02931	.18873
10	250	3000	79.01	3,951	4,741	6,321	7,901	15,802	19,753	39,510	59,258	79,010	118,515	158,020	237,030	.34203	.04572	.29446
12	250	3000	113.66	5,683	6,820	9,093	11,366	22,732	28,415	56,830	85,245	113,660	170,490	227,320	340,980	.49203	.06578	.42359
14	250	2700	154.60	7,730	9,276	12,368	15,460	30,920	38,650	77,300	115,950	154,600	231,900	309,200	463,800	.66926	.08947	.57617
16	250	3000	201.82	10,091	12,109	16,146	20,182	40,364	50,455	109,910	151,365	201,820	302,730	403,640	605,460	.87368	.11679	.75215
18	250	3000	255.32	12,766	15,319	20,426	25,532	51,064	63,830	127,660	191,490	255,320	382,980	510,640	765,960	1.10528	.14775	.95154
20	250	3000	315.10	15,755	18,906	25,208	31,510	63,020	78,775	157,550	236,325	315,100	472,650	630,200	945,300	1.36407	.18235	1.17433
24	250	3000	453.12	22,676	27,211	36,282	45,352	90,704	113,380	226,760	340,140	453,520	680,280	907,040	1,360,560	1.96329	.26245	1.69020
30	250	3000	708.27	35,414	42,496	56,662	70,827	141,654	177,068	354,140	531,203	708,270	1,062,405	1,416,540	2,124,810	3.06610	.40988	2.63962

Below are cylinder sizes and their standard rod diameters (to the left). Consult bulletins for rods larger than standard.

Thrusts for pressures not shown in table, add the thrust for two or more operating pressures which combined equal the desired pressure.

1 Gallon = 231 Cubic Inches
Oil consumption gal. per min = Gal. per in. times in. per min. piston speed

Air consumption cubic ft. per min = Cu. ft. per in. times in. per min. piston speed Free air consumption per in. of stroke = Cu. ft. displaced x (press. + 14.7) – 14.7

In-Stroke Pull In Pounds Force Deduct The Following Force Or Consumptions Corresponding To Rod Size From Out-Stroke Thrust Or Consumptions To Determine In-Stroke Pull Or Consumptions																Consumption Per Inch Of Stroke in One Direction		
			Pressures of Operating Medium – Air or Hydraulic															
Piston Rod Dia. in inches	Bore Size N5 AN5 LAN5	Piston Rod Area sq. in.	50 psi	60 psi	80 psi	100 psi	200 psi	250 psi	500 psi	750 psi	1000 psi	1500 psi	2000 psi	3000 psi	Oil Gallons Displaced	Air Pressure Cubic Ft. Displaced	Free Air Cubic Ft. at 80 psi Displaced
5/8	11/2	.31	16	19	25	31	62	78	155	233	310	465	620	930	.00138	.00018	.00116
1	2 & 21/2	.79	40	47	63	79	158	198	395	593	790	1,185	1,580	2,370	.00342	.00046	.00294
1 3/8	31/4	1.49	75	89	119	149	298	373	745	1,118	1,490	2,235	2,980	4,470	.00645	.00086	.00555
1 3/4	4	2.41	121	145	193	241	482	603	1,205	1,808	2,410	3,615	4,820	7,230	.01043	.00139	.00898
2	5	3.14	157	188	251	314	628	785	1,570	2,355	3,140	4,710	6,280	9,420	.01359	.00182	.01170
2 1/2	6	4.91	246	295	393	491	982	1,228	2,455	3,683	4,910	7,365	9,820	14,730	.02126	.00284	.01830
3	7	7.07	354	424	566	707	1,414	1,768	3,535	5,303	7,070	10,605	14,140	21,210	.03061	.00409	.02635
3 1/2	8	9.62	481	577	770	962	1,924	2,405	4,810	7,215	9,620	14,430	19,240	28,860	.04165	.00557	.03585
4	–	12.57	629	754	1,006	1,257	2,514	3,143	6,285	9,428	12,570	18,855	25,140	37,710	.05442	.00727	.04685
4 1/2	10	15.90	795	954	1,272	1,590	3,180	3,975	7,950	11,925	15,900	23,850	31,800	47,700	.06883	.00920	.05926
5	–	19.63	982	1,178	1,570	1,963	3,926	4,908	9,815	14,723	19,630	29,445	39,260	58,890	.08498	.01136	.07316
5 1/2	12	23.76	1,188	1,426	1,901	2,376	4,752	5,940	11,880	17,820	23,760	35,640	47,520	71,280	.10286	.01375	.08855
7	14	38.48	1,924	2,309	3,078	3,848	7,696	9,620	19,240	28,860	38,480	57,720	76,960	115,440	.16658	.02227	.14341
8	16	50.27	2,514	3,016	4,022	5,027	10,054	12,568	25,135	37,703	50,270	75,405	100,540	150,810	.21762	.02909	.18735
9	18	63.62	3,181	3,817	5,090	6,362	12,724	15,905	31,810	47,715	63,620	95,340	127,240	190,860	.27541	.03682	.23710
10	20	78.54	3,927	4,712	6,283	7,854	15,708	19,638	39,270	58,905	78,540	117,810	157,080	235,620	.34000	.04545	.29271
11	24	95.03	4,752	5,702	7,602	9,503	19,006	23,758	47,515	71,272	95,030	142,545	190,060	285,090	.41138	.05499	.35413
14	30	153.94	7,697	9,236	12,315	15,394	30,788	38,485	76,970	115,455	153,940	230,910	307,880	461,820	.66641	.08908	.57367

Note

Bore Dimensions Are 0.030" Larger Than NOMINAL.

PIPE SIZE CHART FOR HYDRAULIC CYLINDERS AND SYSTEMS

Standard Weight Pipe			Oil Flow Gallons Per Minute And Friction Pressure Drop Pounds Per Square Inch Per Foot Length Of Pipe											
			Vel. = 5 Ft. Per Sec.		Vel. = 10 Ft. Per Sec.		Vel. = 15 Ft. Per Sec.		Vel. = 20 Ft. Per Sec.		Vel. = 25 Ft. Per Sec.		Vel. = 30 Ft. Per Sec.	
Pipe Size	Inside Diameter*	Area Sq. In.	Gallons Per Minute	Pressure Drop In psi	Gallons Per Minute	Pressure Drop In psi	Gallons Per Minute	Pressure Drop In psi	Gallons Per Minute	Pressure Drop In psi	Gallons Per Minute	Pressure Drop In psi	Gallons Per Minute	Pressure Drop In psi
½	.622	.304	4.7	.157	9.4	.585	14.1	1.215	18.6	2.065	23.5	3.130	28.2	4.34
¾	.824	.533	8.3	.117	16.6	.370	24.9	.710	33.2	1.520	41.5	2.300	49.8	3.17
1	1.049	.864	13.5	.090	26.9	.323	40.4	.673	53.8	1.555	67.3	1.725	80.8	2.44
1¼	1.380	1.495	23.3	.064	46.5	.231	69.8	.488	93.0	.755	116.3	1.240	139.6	1.74
1½	1.610	2.036	31.7	.054	63.4	.181	95.1	.404	126.8	.691	158.5	1.042	190.2	1.48
2	2.067	3.355	52.3	.047	104.5	.169	156.8	.360	209.0	.609	261.3	.927	313.6	1.11

The pressure drop shown in the above table is for ordinary wrought iron pipe. For smooth, new wrought iron pipes, multiply the values shown by .7; for very smooth, straight tubing, multiply the values shown by .54. Pressure drop is the same regardless of operating pressure. Avoid large pressure drops in low pressure systems. Please note that oil flows through large pipes at a high velocity (up to 30 ft/sec) with small pressure loss. The pressure drop shown is for hydraulic oil with approximately 225 SSU at 100°F under average operating conditions. The values also apply to water. In order to accommodate large pump volumes without severe pressure drops, all Eaton hydraulic cylinders are available with oversize ports with welded half pipe couplings or flange fitting.

Standard Weight Pipe			Equivalent Length of Straight Pipe In Feet For Various Fitting					
Pipe Size	Inside Diameter*	Area Sq. In.	Std. Elbow	Std. Tee	Gate Valve	Globe Valve	Cylinders & 2-3-Way Valves	4-Way Valves
1/2	.622	.304	1.5	3.3	.35	17	6 to 30	12 to 60
3/4	.824	.533	2.2	4.5	.47	22	10 to 50	20 to 100
1	1.049	.864	2.7	5.8	.60	28	13 to 65	25 to 125
11/4	1.380	1.495	3.7	7.7	.81	37	15 to 75	30 to 150
11/2	1.610	2.036	4.4	9.2	.92	44	20 to 100	40 to 200
2	2.067	3.355	5.5	12.0	1.20	57	25 to 125	50 to 250

* Inside diameter and areas shown are standard pipe. For tubing or extra heavy and double extra heavy pipe, use I.D. in table closest to your pipe or tubing I.D.

Technical Data

Cushion Formulas and Factors

Cushions are recommended when piston speed is in excess of 20-25 feet per minute. Cushions decelerate the piston and rod assembly at the end of the stroke, lessening the noise and shock and increasing cylinder life. Heavy loads attached to the piston and rod assembly should be stopped by external means, such as shockabsorbers, springs, decelerating valves, etc.

Use the information below, along with the examples on page 27 to determine if standard cushioning is sufficient for your application.

FORCE FACTOR CHART

Force Factors (a = v2 x .001294)

PISTON VELOCITY	
ips	**a**
1	.00129
2	.00518
3	.0117
4	.0208
5	.0324
6	.0466
7	.0635
8	.0829
9	.105
10	.129
11	.157
12	.186
13	.219
14	.254
15	.291
16	.332
17	.374
18	.420
19	.467
20	.518
21	.571
22	.627
23	.685
24	.746
25	.809

(continued)

PISTON VELOCITY	
ips	**a**
26	.875
27	.944
28	1.02
29	1.09
30	1.16
31	1.24
32	1.33
33	1.41
34	1.50
35	1.59
36	1.68
37	1.77
38	1.87
39	1.97
40	2.07
41	2.18
42	2.28
43	2.39
44	2.51
45	2.62
46	2.74
47	2.86
48	2.98
49	3.11
50	3.24

GENERAL FORMULAS

Horizontal motion	F_{acc} or F_{dec} = W x ⅘
Vertical motion, decelerating downward or accelerating upward	F_{acc} or F_{dec} = (W x ⅘) + W
Vertical motion, decelerating upward or accelerating downward	F_{acc} or F_{dec} = (W x ⅘) – W
Frictional force	F_f = u x W
Total cushioning force	F_t = F_{acc} or F_{dec} + F_p ± F_f (+ F_f if load accelerating, — F_f if load decelerating)
Contained pressure	P_c = F_t/A_{cc} or F_t/A_{hc}

FORCE FACTOR TERMINOLOGY

TERM USED	EXPLANATION	UNITS
W	Weight of the load	pounds
Ab	Bore area	square inches
Ah	Ab less rod area	square inches
Acc	Ab less cap plunger cross-sectional area	square inches
Ahc	Ab less head plunger cross-sectional area	square inches
a	Force factor	–
s	Acceleration or deceleration distance	inches
u	Coefficient of friction of load's motion	Horizontal = .15; Vertical = 0
v	Velocity	inches per second (ips)
Facc	Force needed to accelerate a weight	pounds
Fdec	Force needed to decelerate a weight	pounds
Ff	Friction force due to load motion	pounds
Fp	Driving pressure force	pounds
Ft	Total cushioning force	pounds
Pp	Pump pressure	pounds per square inch (psi)
Pc	Contained cushioning pressure	pounds per square inch (psi)

Acceleration and Deceleration Forces

- The a force factors shown are used to determine the forces required to accelerate or decelerate a weight through a given distance, s (Refer to **Force Factor Chart).**
- If the motion of the load is horizontal, use the general formula **F_{acc} or F_{dec} = W x ⅘.**
- If the motion of the load is vertical and is being decelerated downward or accelerated upward, use the general formula **F_{acc} or F_{dec} = (W x ⅘) + W.**
- If the motion of the load is vertical and is being decelerated upward or accelerated downward, use the general formula **F_{acc} or F_{dec} = (W x ⅘) – W.**
- Friction due to load motion affects **F_t**. Add Ff to **F_t** if the load is accelerating. Subtract **F_f** from **F_t** if the load is decelerating.
- Cylinder friction is negligible.

Note

The contained cushioning pressure must not exceed 5000 psi. If the standard cushion results in a too high pressure, then a longer cushion spud must be specified.

Technical Data

How to Calculate Your Cushion Requirements

HYDRAULIC EXAMPLES

Example A

Horizontal deceleration

N5 series cylinder, 3¼" bore, 1⅜" rod (standard), cushioning at cap.

A weight of 3000 lbs., moving at 25 ips, and driven by a pump pressure of 1000 psi should stopped in 11⁄4". Assume the coefficient of friction to be .15.

1. **F_f = u x W**
   = .15 x 3000 lbs.
   F_f = 450 lbs.
2. **F_p = A_h x P_p**
   A_h = A_b – rod area
   = 8.45 sq. in.–1.49 sq. in.
   A_h = 6.96 sq. in.
   F_p = 6.96 sq. in. x 1000 psi
   F_p = 6960 lbs.
3. F_{dec} = **W x ⅘**
   = 3000 lbs. x .809/1.25 in.
   F_{dec} = 1942 lbs.
4. **F_t = F_{dec} + F_p – F_f**
   = 1942 + 6960 – 450
   F_t = 8452 lbs.
5. P_c = F_t⁄A_{cc}
   = 8452 lbs./7.85 sq. in.
   P_c = 1077 psi

This figure does not exceed the pressure capability of the cylinder, therefore, the standard cushion is acceptable.

Example B

Vertical deceleration

N5 series cylinder, 6" bore, 2½" rod (standard), cushioning at head.

The cylinder is mounted vertical rod down, with a 2000 lb. load attached to the rod end. Pump pressure is 750 psi, the load is moving at 40 ips, and must be stopped in 1⅜" There is no load friction.

1. **F_p = P_p x A_b**
   = 750 psi x 28.56 sq. in.
   F_p = 21,420 lbs.
2. F_{dec} = (W x a⁄s) + W
   = (2000 lbs. x 2.07/1.375) + 2000 lbs.
   F_{dec} = 5011 lbs.
3. **F_t = F_p + F_{dec}**
   = 21,420 lbs. + 5011 lbs.
   F_t = 26,431 lbs.
4. P_c = F_t⁄A_{hc}
   = 26,431 lbs. /22.07 sq. in.
   P_c = 1198 psi

This does not exceed the pressure capability of the cylinder, therefore, the standard cushion is acceptable.

Note

If your calculations show you need a longer cushion than standard, longer cushions are available in 1⁄4 inch increments

STANDARD CUSHION INFORMATION N5 SERIES

Bore Size	Rod Dia.	Cushion Length (in.)		Effective Cushion Area (in.²)	
		Head	Cap	Head (A_{hc})	Cap (A_{cc})
1½	⅝	1⅛	1 3⁄16	1.24	1.70
	1	1⅛	1 3⁄16	.73	1.70
2	1	1⅛	1⅛	2.13	2.91
	1⅜	1⅛	1⅛	1.17	2.90
2½	1	1⅛	1⅛	3.92	4.77
	1⅜	1⅛	1⅛	2.96	4.77
	1¾	1⅛	1⅛	1.89	4.77
3¼	1⅜	1⅜	1¼	6.38	7.85
	1¾	1⅜	1¼	5.31	7.85
	2	1⅜	1¼	4.02	7.85
4	1¾	1⅜	1¼	9.62	12.16
	2	1⅜	1¼	8.33	12.16
	2½	1⅜	1¼	6.27	12.16
5	2	1⅜	1¼	15.44	18.64
	2½	1⅜	1¼	13.38	18.64
	3	1 5⁄16	1¼	10.93	18.64
	3½	1 5⁄16	1¼	8.08	18.64
6	2½	1⅜	1½	22.07	26.16
	3	1 5⁄16	1½	19.62	26.16
	3½	1 5⁄16	1½	16.77	26.16
	4	1½	1½	15.20	26.16
7	3	2	2	29.88	36.42
	3½	2	2	27.03	36.42
	4	2	2	25.46	36.42
	4½	2	2	19.29	36.42
	5	2	2	17.70	36.42
8	3½	2	2	38.85	48.24
	4	2	2	37.28	48.24
	4½	2	2	31.11	48.24
	5	2	2	29.52	48.24
	5½	2	2	29.52	48.24
10	4½	2	2	59.48	74.12
	5	2	2	57.89	74.12
	5½	2	2	57.89	74.12
	7	2	2	31.91	74.12
12	5½	2	2	92.54	108.77
	7	2	2	66.56	108.77
	8	2	2	53.61	108.77
14	7	2	2	107.50	143.36
	8	2	2	94.55	143.36
	9	2	2	80.04	143.36
	10	2	2	63.95	143.36
16	8	2	2	141.77	192.26
	9	2	2	127.26	192.26
	10	2	2	111.17	192.26
18	9	2	2	180.76	245.76
	10	2	2	164.67	245.76
20	10	2	2	224.45	304.12
24	11	2	2	325.99	439.82
30	14	2	2	512.03	687.22

Port Data

Ports

Standard ports for N5 are SAE straight thread. AN5 and LAN5 standard ports are NPTF.

Optional and Oversize Ports

The chart to the right lists port sizes. Larger welded half-pipe coupling ports are available in some sizes; please contact Eaton. For oversize ports where short restrictions in dash pot areas cannot be allowed, specify "full flow porting."

Port, Cushion Adjustment, Ball Check Locations

Standard port locations are at #1, with optional locations at #2, 3, 4 or 5 furnished when specified, except where H, U or W mounts interfere at #2 and #4. Ports at #3 in B and the cap end of E mountings need special construction. Note possible piping interference with mounting screws in A cylinders ported at Pos. 2 and 4. Mounting holes are counterbored to allow access to them with piping in place.

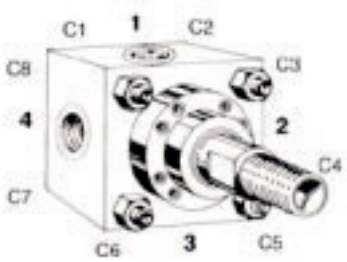
In the end view shown, standard position of cushion adjustment is above port location #2 in location C3; ball check above port location #4 at C8 when ports are at position #1. On **H,** the head on **G, U** and the cap on **P, W** cushion adjustments are on the right side of port location #3 at C5, and checks are on the left side at C6.

Locations 1 through 4 indicate possible port positions.

Number 1 is standard.

Optional location #5 is available on cap end centerline.

Locations C1 through C8 indicate possible cushion adjustment positions. When ports are at position #1, C3 is standard needle location.



* Fitting hex may interfere with mountings **S, R** and **P.** Consult factory for additional information.

** Flanges may overhang head and caps. Consult factory for additional information.

*** Manifold dimension is for flow passage diameter.

Cylinder Bore Dia. (inch.)	Rod Dia. (inch.)	SAE*			NPTF			** 4-Bolt SAE	Manifold ***
		Std.	Oversize Head	Cap	Std.	Oversize Head	Cap		
1½"	⅝"	#10	N/A	N/A	½"	¾"	¾"	N/A	9/16"
	1"	#10	N/A	N/A	½"	N/A	¾"	N/A	9/16"
2"	1"	#10	N/A	N/A	½"	¾"	¾"	N/A	9/16"
	1⅜"	#10	N/A	N/A	½"	N/A	¾"	N/A	9/16"
2½"	1"	#10	N/A	N/A	½"	¾"	¾"	½"	9/16"
	1⅜"	#10	N/A	N/A	½"	¾"	¾"	½"	9/16"
	1¾"	#10	N/A	N/A	½"	N/A	3/4"	N/A	9/16"
4"	1¾"	#12	#16	#16	¾"	1"	1"	¾"	¾"
	2"	#12	#16	#16	¾"	1"	1"	¾"	¾"
	2½"	#12	#16	#16	¾"	1"	1"	¾"	¾"
5"	2"	#12	#16	#16	¾"	1"	1"	¾"	¾"
	2½"	#12	#16	#16	¾"	1"	1"	¾"	¾"
	3"	#12	#16	#16	¾"	1"	1"	¾"	¾"
	3½"	#12	#16	#16	¾"	1"	1"	¾"	¾"
6"	2½"	#16	N/A	#20	1"	1¼"	1¼"	1"	1"
	3"	#16	N/A	#20	1"	1¼"	1¼"	1"	1"
	3½"	#16	N/A	#20	1"	1¼"	1¼"	1"	1"
	4"	#16	N/A	#20	1"	1¼"	1¼"	1"	1"
7"	3"	#20	#24	#24	1¼"	1½"	1½"	1¼ "	1⅜"
	3½"	#20	#24	#24	1¼"	1½"	1½"	1¼ "	1⅜"
	4"	#20	#24	#24	1¼"	1½"	1½"	1¼ "	1⅜"
	4½"	#20	#24	#24	1¼"	1½"	1½"	1¼"	1⅜"
	5"	#20	#24	#24	1¼"	1½"	1½"	1¼"	1⅜"
8"	3½"	#24	N/A	N/A	1½"	2"	2"	1½"	1⅝"
	4"	#24	N/A	N/A	1½"	2"	2"	1½"	1⅝"
	4½"	#24	N/A	N/A	1½"	2"	2"	1½"	1⅝"
	5"	#24	N/A	N/A	1½"	2"	2"	1½"	1⅝"
	5½"	#24	N/A	N/A	1½"	2"	2"	1½"	1⅝"
10"	4½"	#32	N/A	N/A	2"	2½"	2½"	2"	N/A
	5"	#32	N/A	N/A	2"	2½"	2½"	2"	N/A
	5½"	#32	N/A	N/A	2"	2½"	2½"	2"	N/A
	7"	#32	N/A	N/A	2"	2½"	2½"	2"	N/A
12"	5½"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
	7"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
	8"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
14"	7"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
	8"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
	9"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
	10"	#32	N/A	N/A	2½"	3"	3"	2½"	N/A
16"	8"	#32	N/A	N/A	3"	3½"	3½"	2½"	N/A
	9"	#32	N/A	N/A	3"	3½"	3½"	2½"	N/A
	10"	#32	N/A	N/A	3"	3½"	3½"	2½"	N/A
18"	9"	#32	N/A	N/A	3"	3½"	3½"	3"	N/A
	10"	#32	N/A	N/A	3"	3½"	3½"	3"	N/A
20"	10"	#32	N/A	N/A	3"	3½"	3½"	3"	N/A
24"	11"	#32	N/A	N/A	3"	3½"	3½"	4"	N/A
30"	14"	#32	N/A	N/A	3"	3½"	3½"	5"	N/A

N5 Series Hydraulic Pressure Ratings

	Piston Rod Diameters (inches)			Pressure Ratings (psi)	
Cylinder Bore (inches)	**Standard**	**Oversize**	**2:1**	**4:1 Tensile**	**4:1 Yield**
1½	⅝	–	1	3750	3008
2	1	–	1⅜	2900	2335
2½	1	1⅜	1¾	3150	2531
3¼	1⅜	1¾	2	3050	2477
4	1¾	2	2½	2400	2214
5	2	2½, 3	3½	3100	2836
6	2½	3, 3½	4	2800	2406
7	3	3½, 4, 4½	5	2850	2336
8	3½	4, 4½, 5	5½	2375	1975
10	4½	5, 5½	7	2900	2499
12	5½	7	8	2550	2069
14	7	8, 9	10	2600	1796
16	8	9,10	–	2150	1864
18	9	10	–	2550	1919
20	10	–	–	2100	1822
24	11	–	–	2750	1921
30	14	–	–	2750	1835

N5 Series cylinders comply with NFPA specifications and ANSI B93.15-1981 mounting dimensions are standard.

Rod Cartridge Retainers Simplify Cartridge Removal

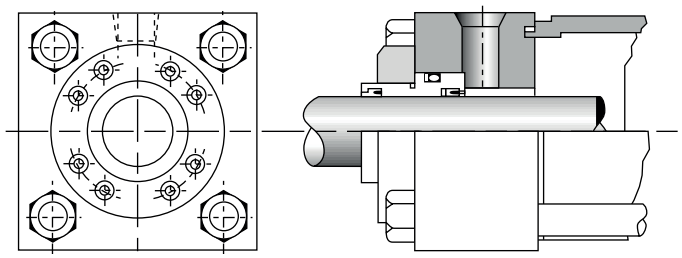
Cylinders with the following bore and rod combinations use circular retainers which permit removal of rod cartridge without disassembling the cylinder:

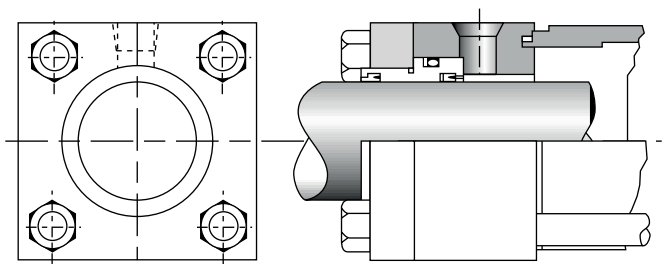
- 2½" bore with 1" rod
- 3¼" bore with 1⅜" rod
- 4" bore and larger with all rod diameters

Refer to Engineering File number 188 for alternate removable cartridge constructions.

Cylinders use above retainer construction on the following bore and rod combinations:

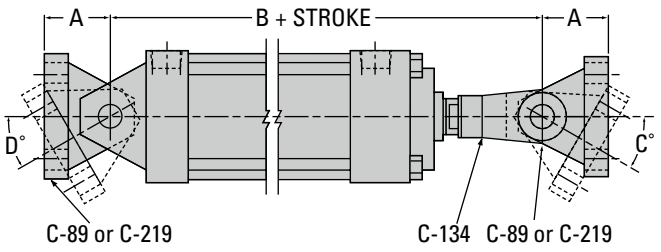
- 1½" bore with ⅝" and 1" rods
- 2½" bore with 1⅜" and 1¾" rods
- 2" bore with 1" and 1⅜" rods
- 3¼" bore with 1¾" and 2" rods





Typical Mounting Accessories

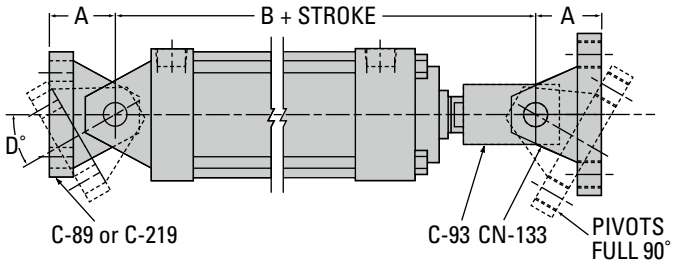
For Standard Rod Diameters Style #2



N5, AN5 and LN5 Cylinder

	Eye Bracket							
Bore	**A**	**B**	**Standard**	**Swivel**	**Female Clevis**	**Pivot Pin**	**C°**	**D°**
1½	1⅛	7⅞	C-8903	C-219-3-1	C-134-05	C-9003-3	90°	60°
2	1⅞	9⅝	C-8904	C-219-3-2	C-134-08	C-9004-3	90°	65°
2½	1⅞	9¾	C-8904	C-219-3-2	C-134-08	C-9004-3	90°	65°
3¼	2⅜	11¾	C-89065X	C-219-3-3X	C-134-11	C-9065-3	80°	65°
4	3	13⅞	C-8908	C-219-3-4	C-134-14	C-9008-3	90°	70°
5	3⅜	15	C-8910X	C-219-3-5X	C-134-16	C-9010-3	75°	65°
6	4	17⅝	C-8912X	C-219-3-6X	C-134-20	C-9012-3	75°	65°
7	4	20¼	C-8914		C-134-24	C-9014-3	70°	65°
8	4¼	21¾	C-8916		C-134-28	C-9016-3	70°	65°
10	5 11/16	27 9/16	C-8920		C-134-36	C-9020-3	70°	60°
12	6 7/16	32 3/16	C-8924		C-134-44	C-9024-3	65°	60°

For mounting dimensions over 12" bore, consult Eaton.



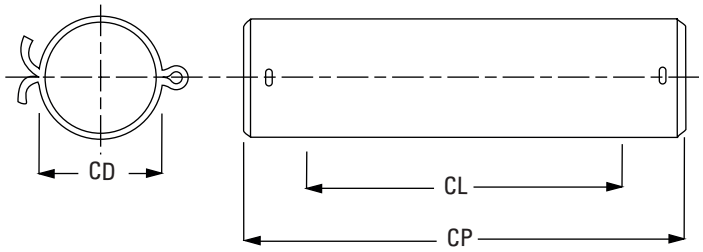
N5, AN5 and LN5 Cylinder

	Eye Bracket							
Bore	**C**	**B**	**Standard**	**Swivel**	**Clevis Bracket**	**Pivot Pin**	**Female Eye**	**D°**
1½	1⅛	7⅞	C-8903	C-219-3-1	CN-133-03	C-9003-3	C-9303	60°
2	1⅞	9 15/16	C-8904	C-219-3-2	CN-133-04	C-9004-3	C-9304	65°
2½	1⅞	9 7/16	C-8904	C-219-3-2	CN-133-05	C-9004-3	C-9304	65°
3¼	2⅜	11 7/16	C-89065X	C-219-3-3X	CN-133-065	C-9065-3	C-93065	65°
4	3	13 3/16	C-8908	C-219-3-4	CN-133-08	C-9008-3	C-9308	70°
5	3⅜	14½	C-8910X	C-219-3-5X	CN-133-10	C-9010-3	C-9310	65°
6	4	17⅛	C-8912X	C-219-3-6X	CN-133-12	C-9012-3	C-9312	65°
7	4	19 9/16	C-8914		CN-133-14	C-9014-3	C-9314	65°
8	4¼	21⅛	C-8916		CN-133-16	C-9016-3	C-9316	65°
10	5 11/16	26 11/16	C-8920		CN-133-20	C-9020-3	C-9320	60°
12	6 7/16	31 5/16	C-8924		CN-133-24	C-9024-3	C-9324	60°

For mounting dimensions over 12" bore, consult Eaton.

Cylinder Mounting Accessories

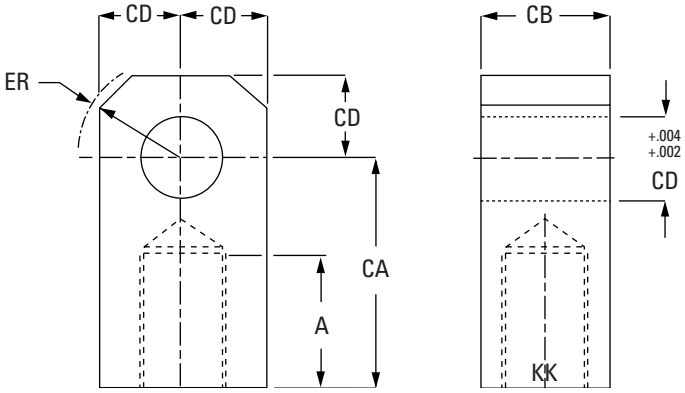
Pivot Pin



Part No.	CD	CL	CP
C-9003-3	½	1¾	2⅜
C-9004-3	¾	2½	3⅛
C-90065-3	1	3	3¾
C-9008-3	1⅜	4	4¾
C-9010-3	1¾	5	6 1/32
C-9012-3	2	5	6 1/32
C-9014-3	2½	6	7 1/32
C-9016-3	3	6	7⅛
C-9020-3	3½	8	9⅝
C-9024-3	4	9	10⅝

1. Pivot pins are furnished with clevis mounted cylinders.
2. Pivot pins must be ordered as a separate item if used with female eye, female clevis, standard eye bracket and clevis bracket. They are included only with swivel eye bracket.
3. CL = (2 x CW) + CB

Female Eye

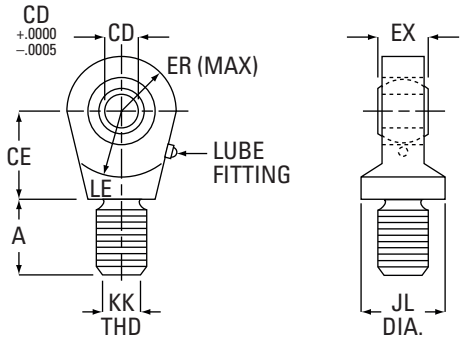


Part No.	A	CA	CB	CD	ER	KK
C-9302	¾	1½	7/16	7/16	19/32	5/16-24
C-9303	¾	1½	¾	½	⅝	7/16-20
C-9304	1⅛	2 1/16	1¼	¾	⅞	¾-16
C-93065	1⅝	21 3/16	1½	1	1 3/16	1-14
C-9308	2	3 7/16	2	1⅜	1 9/16	1¼-12
C-9310	2¼	4	2½	1¾	2	1½-12
C-9312	3	5	2½	2	2¼	1⅞-12
C-9314	3½	5 13/16	3	2½	2 13/16	2¼-12
C-9316	3½	6⅛	3	3	3¼	2½-12
C-9320	4½	7⅝	4	3½	3⅞	3¼-12
C-9324	5½	9⅛	4½	4	4 7/16	4-12

Cylinder Mounting Accessories

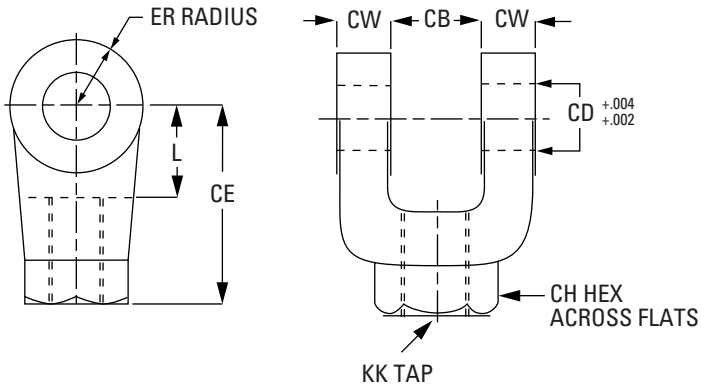
(continued)

Spherical Rod Eye



Part No.	A	CD +.0000 -.0005	CE	EX	ER	JL	KK	LE	Load Capacity (lbs.)
CS-9303	1 1/16	1/2	7/8	7/16	7/8	7/8	7/16-20	3/4	2,600
CS-9304	1	3/4	1 1/4	21/32	1 1/4	1 5/16	3/4-16	1 1/16	9,400
CS-93065	1 1/2	1	1 7/8	7/8	1 3/8	1 1/2	1-14	1 7/16	16,800
CS-9308	2	1 3/8	2 1/8	1 3/16	11 3/16	2	1 1/4-12	1 7/8	28,600
CS-9310	2 1/8	1 3/4	2 1/2	11 7/32	2 3/16	2 1/4	1 1/2-12	2 1/8	43,000
CS-9312	2 7/8	2	2 3/4	1 3/4	2 5/8	2 3/4	1 7/8-12	2 1/2	70,000

Female Clevis

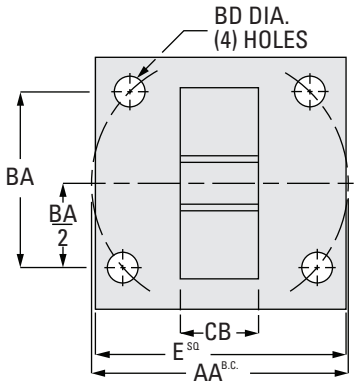


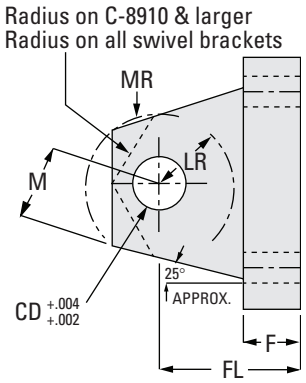
Part No.	CB	CD	CE	CH	CW	ER	KK	L
C-134-05	3/4	1/2	1 1/2	7/8	1/2	1/2	7/16-20	3/4
C-134-08	1 1/4	3/4	2 3/8	1 3/8	5/8	3/4	3/4-16	1 1/4
C-134-11	1 1/2	1	3 1/8	1 5/8	3/4	1	1-14	1 1/2
C-134-14	2	1 3/8	4 1/8	2	1	1 3/8	1 1/4-12	2 1/8
C-134-16	2 1/2	1 3/4	4 1/2	2 3/8	1 1/4	1 3/4	1 1/2-12	2 1/4
C-134-20	2 1/2	2	5 1/2	2 15/16	1 1/4	2	1 7/8-12	2 1/2
C-134-24	3	2 1/2	6 1/2	3 1/2	1 1/2	2 1/2	2 1/4-12	3
C-134-28	3	3	6 3/4	3 7/8	1 1/2	2 3/4	2 1/2-12	3 1/4
C-134-36	4	3 1/2	8 1/2	5	2	3 1/2	3 1/4-12	4
C-134-44	4 1/2	4	10	6 1/8	2 1/4	4	4 -12	4 1/2

Mounting Accessories

Swivel Eye Bracket Standard Eye Bracket

(Includes spacers to allow swivel action up to 7° and to make dimensions interchangeable with standard eye bracket.)



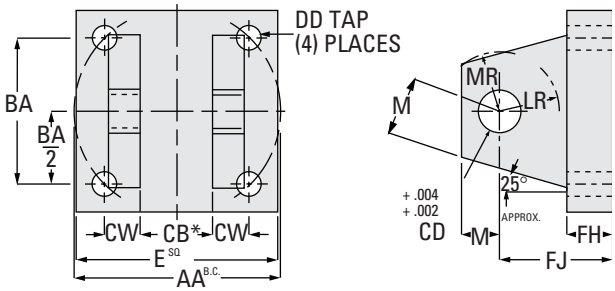


* To assure precision fit-up, pivot pins machined to special tolerances are furnished with all swivel eye brackets, unless otherwise specified.

** Dimensions F and FL reflect revised NFPA standards. Part numbers with suffix letter X are affected.

Part Number		Dimensions									Standard Bracket		Swivel Bracket		Swivel Bracket Recommended Static Load Limit in lbs.
Standard	Swivel*														
Part No.	Part No.	AA	BA	BD	CB	CD	E	F**	FL**	LR	M	MR	M	MR	
C-8903	C-219-3-1	2.3	1 5/8	1 3/32	3/4	1/2	2 1/2	3/8	1 1/8	1/2	1/2	9/16	11/16	11/16	8,100
C-8904	C-219-3-2	3.6	2 9/16	17/32	1 1/4	3/4	3 1/2	5/8	1 7/8	1	3/4	1 1/16	1 3/16	1 3/16	18,800
C-89065X	C-219-3-3X	4.6	3 1/4	21/32	1 1/2	1	4 1/2	7/8	2 3/8	1	1	1 1/8	1 3/8	1 3/8	33,300
C-8908	C-219-3-4	5.4	3 13/16	21/32	2	1 3/8	5	7/8	3	1 1/8	1 3/8	1 3/4	2	2	59,800
C-8910X	C-219-3-5X	7.0	4 15/16	29/32	2 1/2	1 3/4	6 1/2	1 1/8	3 3/8	1 3/4	1 3/4	1 7/8	2 1/8	2 1/8	102,000
C-8912X	C-219-3-6X	8.1	5 3/4	1 1/32	2 1/2	2	7 1/2	1 1/2	4	2	2	2 1/8	2 3/8	2 3/8	132,000
C-8914X		9.3	6 19/32	1 5/32	3	2 1/2	8 1/2	1 3/4	4 3/4	2 1/2	2 1/2	2 1/2			
C-8916X		10.6	7 1/2	1 9/32	3	3	9 1/2	2	5 1/4	2 3/4	2 3/4	2 3/4			
C-8920		13.6	9 5/8	1 25/32	4	3 1/2	12 5/8	1 11/16	5 11/16	3 1/2	3 1/2	3 1/2			
C-8924		16.2	11 1/2	2 1/32	4 1/2	4	14 7/8	1 15/16	6 7/16	3 7/8	4	4			

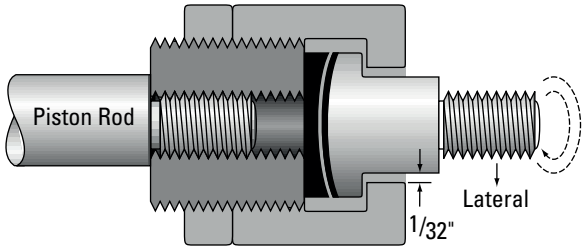
Clevis Bracket



Part No.	AA	BA	CB	CD	CW	DD	E	FH	FJ	LR	M	MR
CN-133-03	2.3	1 5/8	25/32	1/2	1/2	3/8-24	2 1/2	3/8	1 1/8	1/2	1/2	9/16
CN-133-04	2.9	2 1/16	1 9/32	3/4	5/8	1/2-20	3	5/8	1 7/8	1	3/4	1 1/16
CN-133-05	3.6	2 9/16	1 9/32	3/4	5/8	1/2-20	3 1/2	5/8	1 7/8	1 1/16	3/4	1 1/16
CN-133-065	4.6	3 1/4	1 17/32	1	3/4	5/8-18	4 1/2	3/4	2 1/4	1 1/4	1	1 1/8
CN-133-08	5.4	3 13/16	2 1/32	1 3/8	1	5/8-18	5	7/8	3	1 7/8	1 3/8	1 3/4
CN-133-10	7.0	4 15/16	2 17/32	1 3/4	1 1/4	7/8-14	6 1/2	7/8	3 1/8	2	1 3/4	1 7/8
CN-133-12	8.1	5 3/4	2 17/32	2	1 1/4	1-14	7 1/2	1	3 1/2	2 1/8	2	2 1/8
CN-133-14	9.3	6 19/32	3 1/32	2 1/2	1 1/2	1 1/8-12	8 1/2	1	4	2 5/8	2 1/2	2 1/2
CN-133-16	10.6	7 1/2	3 1/32	3	1 1/2	1 1/4-12	9 1/2	1	4 1/4	2 7/8	2 3/4	2 3/4
CN-133-20	13.6	9 5/8	4 1/16	3 1/2	2	1 3/4-12	12 5/8	1 11/16	5 11/16	3 5/8	3 1/2	3 1/2
CN-133-24	16.2	11 1/2	4 9/16	4	2 1/4	2-12	14 7/8	1 15/16	6 7/16	4	4	4

Self-Aligning Coupler

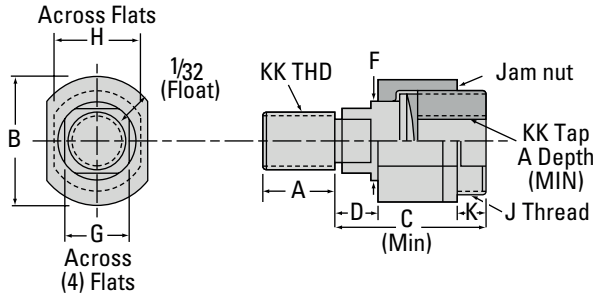
Lateral movement (on push only) and radial movement provide precision alignment between cylinder and machine. Couplers preset with proper clearances and completely lubricated at factory before shipping.



Self-aligning Coupler

Note

When ordering oversize and 2:1 rod cylinders, specify modification to suit standard rod diameter's coupler.



Self-aligning Rod End Coupler

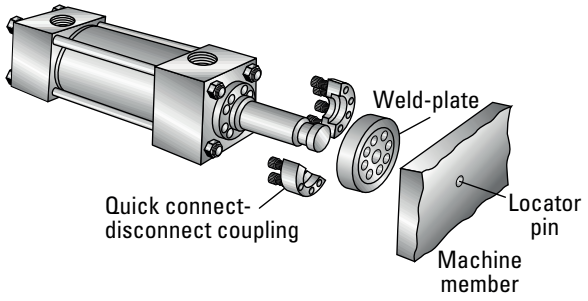
Part No.	Rod Dia.	A	B	C	D	F	G	H	J	K	KK	Max. Pull At Yield
AC-2-05	5/8	3/4	1 1/4	2	1/2	5/8	1/2	13/16	1-14	5/16	7/16-20	8,320
AC-2-08	1	1 1/8	1 11/16	2 5/16	1/2	31/32	13/16	1 1/8	1 3/8-12	1/2	3/4-16	35,000
AC-2-11	1 3/8	1 5/8	2 3/8	2 29/32	1/2	1 11/32	1 5/32	1 5/8	1 7/8-12	11/16	1-14	64,500
AC-2-14	1 3/4	2	2 5/8	3 19/32	3/4	1 23/32	1 7/16	2	2 1/4-12	27/32	1 1/4-12	82,550
AC-2-16	2	2 1/4	3	4 5/32	7/8	1 31/32	1 3/4	2 3/8	2 5/8-12	29/32	1 1/2-12	128,340
AC-2-20	2 1/2	3	3 3/4	5 7/16	1	2 15/32	2 1/8	3	3 1/4-12	1 5/16	1 7/8-12	231,000
AC-2-24	3	3 1/2	4 1/4	6 3/16	1	2 31/32	▲	3 3/8	3 3/4-12	1 3/16	2 1/4-12	289,200
AC-2-28	3 1/2	3 1/2	5	6 7/16	1	3 15/32	▲	4	4 1/2-12	1 1/2	2 1/2-12	342,400
AC-2-36	4 1/2	4 1/2	6	7 7/8	1	4 15/32	▲	4 3/4	5 1/4-12	1 5/8	3 1/4-12	475,500
AC-2-44	5 1/2	5 1/2	7 1/4	9 3/8	1	5 15/32	▲	5 3/4	6 1/2-12	1 7/8	4-12	750,010

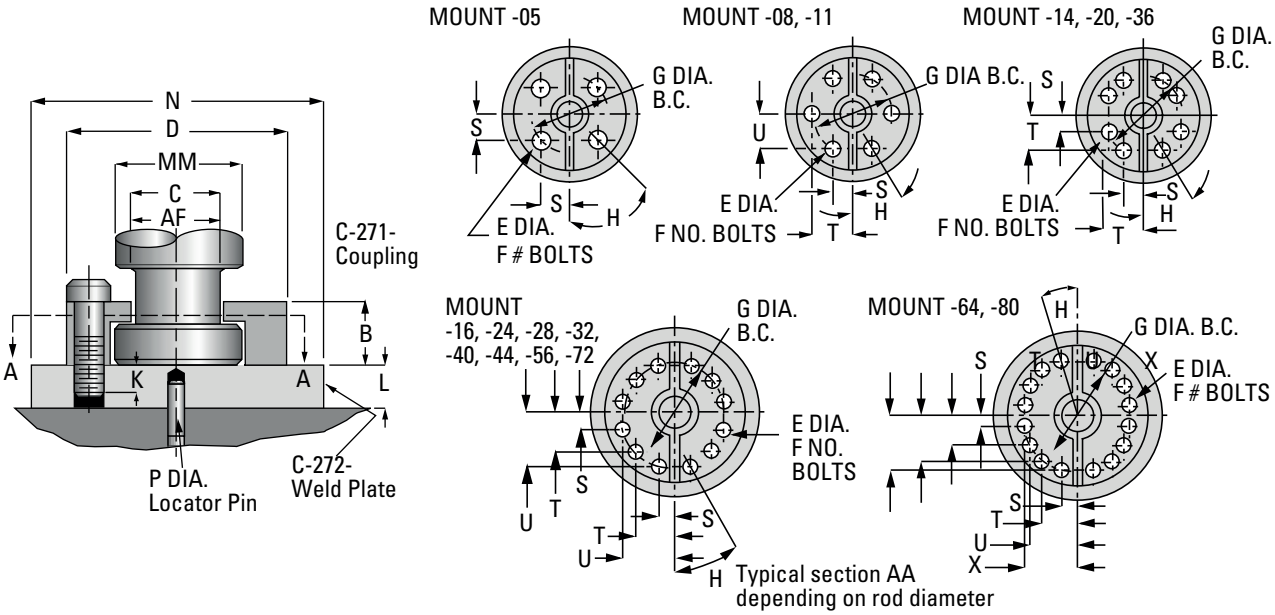
▲ Four ½" diameter x ½" deep spanner holes instead of flats.

Rod End Coupling

Used with the Hydro-Line style 10 Rod End, the Hydro-Line Rod End Coupling provides for close lateral alignment between the rod end and machine member.

The two-piece steel coupling features high tensile strength socket head cap screws (with safety factor designed to take full load), permits quick assembly/disassembly for fast and easy installation and servicing.





Coupling C-271-	Rod Dia. MM	AF	B	C	D	E	F	G	H	K	Weld Plate C-272-	L	N	P	Soc. Hd. Cap Screws	Bolt Torq. Ft. lb.	S	T	U	X
C-271-05	.625	.38	.44	.41	1.50	.218	4	1.12	45°	.44	C-272-05	.50	2.00	.25	#10-24x.88	5	.398	–	–	–
C-271-08	1.000	.69	.62	.75	2.00	.281	6	1.50	30°	.38	C-272-08	.50	2.50	.25	1/4″-20x1.0	14	.375	.750	.650	–
C-271-11	1.375	.88	.69	.94	2.50	.343	6	2.00	30°	.56	C-272-11	.62	3.00	.25	5/16″-18x1.25	30	.500	1.000	.866	–
C-271-14	1.750	1.12	.88	1.18	3.00	.406	8	2.38	22° 30′	.62	C-272-14	.75	3.50	.25	3/8″-16x1.5	52	.454	1.097	–	–
C-271-16	2.000	1.38	1.25	1.44	3.50	.406	12	2.69	15°	.75	C-272-16	.88	4.00	.38	3/8″-16x2.0	52	.348	.950	1.298	–
C-271-20	2.500	1.75	1.38	1.88	4.25	.531	8	3.44	22° 30′	.88	C-272-20	1.00	5.00	.38	1/2″-13x2.25	128	.658	1.588	–	–
C-271-24	3.000	2.25	1.88	2.38	5.00	.531	12	4.00	15°	.88	C-272-24	1.00	5.50	.38	1/2″-13x2.75	128	.518	1.414	1.932	–
C-271-28	3.500	2.50	2.00	2.62	5.88	.656	12	4.69	15°	1.00	C-272-28	1.12	6.50	.38	5/8″-11x3.0	255	.607	1.657	2.264	–
C-271-32	4.000	3.00	2.00	3.12	6.38	.656	12	5.18	15°	1.00	C-272-32	1.12	7.00	.38	5/8″-11x3.0	255	.671	1.834	2.505	–
C-271-36	4.500	3.50	2.38	3.62	6.88	.781	8	5.69	22° 30′	1.12	C-272-36	1.25	7.50	.38	3/4″-10x3.5	450	1.088	2.627	–	–
C-271-40	5.000	3.88	2.50	4.00	7.38	.656	12	6.18	15°	1.25	C-272-40	1.38	8.00	.38	5/8″-11x3.75	255	.801	2.188	2.988	–
C-271-44	5.500	4.38	3.12	4.50	8.25	.781	12	6.88	15°	1.38	C-272-44	1.50	9.00	.38	3/4″-10x4.5	450	.890	2.431	3.320	–
C-271-56	7.000	5.75	4.00	5.94	10.38	1.031	12	8.75	15°	1.50	C-272-56	1.75	11.00	.50	1″-8x5.5	1090	1.132	3.094	4.226	–
C-271-64	8.000	6.50	4.00	6.69	11.38	1.031	16	9.75	11° 15′	1.50	C-272-64	2.00	12.00	.50	1″-8x5.5	1090	.951	2.708	4.053	4.781
C-271-72	9.000	7.25	4.00	7.50	13.12	1.281	12	11.12	15°	2.00	C-272-72	2.25	14.00	.50	1 1/4″-7x6	2180	1.440	3.933	5.373	–
C-271-80	10.000	8.00	4.50	8.25	14.12	1.281	16	12.12	11° 15′	2.00	C-272-80	2.50	15.00	.50	1 1/4″-7x6.5	2180	1.183	3.368	5.040	5.946

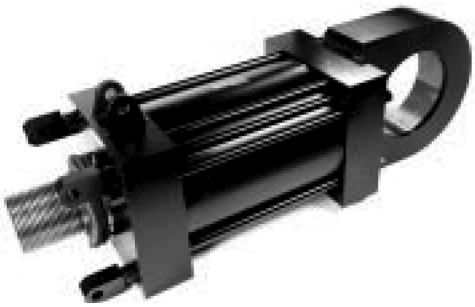
To order C-271-_ and C-272-_ as an assembly, use part no. C-275-_

Custom Cylinders

For Special Applications

Eaton's full line of cylinder products and options fit most customers' application requirements, however, a special cylinder is often required to meet custom specifications. These custom cylinders are often needed to solve difficult application problems, upgrade existing equipment or are designed into new machinery.

Eaton's Sales, Engineering and Manufacturing groups are cylinder specialists and have many years of experience in the interpretation of requirements, design and manufacture of custom cylinder products.



Our capabilities include

- Bore diameters to 30"
- Stroke lengths to 300"
- Operating pressures to 10,000 psi or higher
- Operating mediums ranging from shop air to nitrogen, or from standard hydraulic fluid to special synthetic fluids
- Tie rod, threaded and bolted cylinder construction
- Finite element analysis
- Application simulation in our testing laboratories

Commitment to Quality

Eaton's policy is to design, produce and deliver defect-free products and provide superior services, the first time and every time, that consistently meet the needs of our customers. Our philosophy calls upon every employee to strive for excellence in customer satisfaction through continuous improvement.

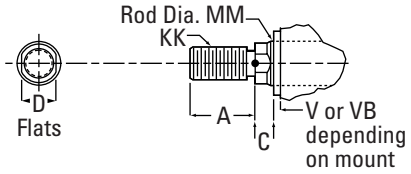
Eaton would appreciate an opportunity to submit a proposal to solve your application problem or fulfill your current cylinder requirements. Simply copy and complete the Application Data Sheet on page 9 and fax to your authorized Eaton Hydro-Line distributor.

Rod End Styles

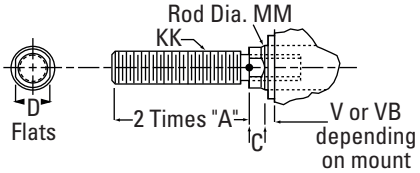
Choose from Eight

ROD END STYLE NO. **DIMENSIONS**

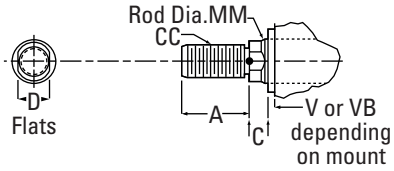
2 STD. * *** ****



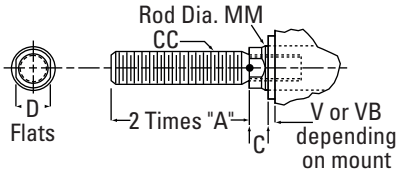
2X ***



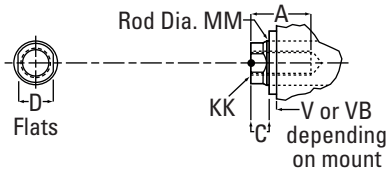
1 ***



1X ***



4 STD. **



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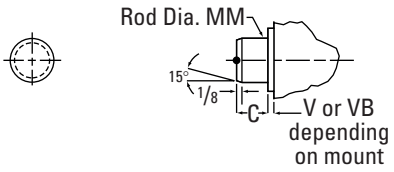

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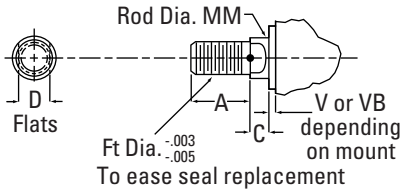

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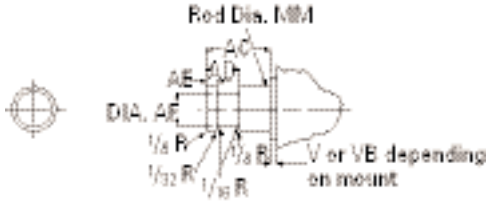


* Male Rod End Style No. 2 is standard and will be furnished unless otherwise specified.

** Rod End Style No. 4 will be furnished when female thread is required unless otherwise specified.

*** Rod End Styles No. 1, 1X, 2 and 2X are furnished studded on 5/8", 1" and 13/8" diameter rods. Larger sizes are of one-piece construction.

**** All Hydro-Line mounting accessories are designed to fit No. 2 and 2X rod end styles only.

Note

A 1/8" long taper begins 1/16" from pilot face and leads to the turned down diameter, except on Rod Styles No. 5 and 6.

Note

Consult distributor for rod end configurations other than those shown.

Oversize Rod Information

The dimensions listed on these two pages are those that change when oversize rods are used.

Bore	MM	KK	CC	FT	A	AC	AD	AE	AF	B +.001 -.003	C	D	F‡	V‡	W	WF	Y• NPTF SAE
1 1/2	▲1	3/4-16	7/8-14	1-14	1 1/8	1 1/2	15/16	3/8	11/16	1 1/2	1/2	7/8	–	–	1	1 3/8	2 15/32
2	▲1 3/8	1-14	1 1/4-12	1 3/8-12	1 5/8	1 3/4	1 1/16	3/8	7/8	2	5/8	1 1/8	–	–	1	1 5/8	2 23/32
2 1/2	▲1 3/8	1-14	1 1/4-12	1 3/8-12	1 5/8	1 3/4	1 1/16	3/8	7/8	2	5/8	1 1/8	–	–	1	1 5/8	2 23/32
	▲1 3/4	1 1/4-12	1 1/2-12	1 3/4-12	2	2	1 5/16	1/2	1 1/8	2 3/8	3/4	1 1/2	–	–	1 1/4	1 7/8	2 31/32
3 1/4	1 3/4	1 1/4-12	1 1/2-12	1 3/4-12	2	2	1 5/16	1/2	1 1/8	2 3/8	3/4	1 1/2	–	–	1 1/8	1 7/8	2 31/32
	▲2	1 1/2-12	1 3/4-12	2-12	2 1/4	2 5/8	1 11/16	5/8	1 3/8	2 5/8	7/8	1 3/4	–	–	1 1/4	2	3 3/32
4	▲2	1 1/2-12	1 3/4-12	2-12	2 1/4	2 5/8	1 11/16	5/8	1 3/8	2 5/8	7/8	1 3/4	19/32	17/32	1 1/8	2	3 3/32
	▲2 1/2	1 7/8-12	2 1/4-12	2 1/2-12	3	3 1/4	1 15/16	3/4	1 3/4	3 1/8	1	2 1/8	19/32	21/32	1 3/8	2 1/4	3 11/32
5	2 1/2	1 7/8-12	2 1/4-12	2 1/2-12	3	3 1/4	1 15/16	3/4	1 3/4	3 1/8	1	2 1/8	19/32	21/32	1 3/8	2 1/4	3 11/32
	3	2 1/4-12	2 3/4-12	3-12	3 1/2	3 5/8	2 7/16	7/8	2 1/4	3 3/4	1	2 5/8	23/32	17/32	1 3/8	2 1/4	3 11/32
	▲3 1/2	2 1/2-12	3 1/4-12	3 1/2-12	3 1/2	4 3/8	2 11/16	1	2 1/2	4 1/4	1	3	23/32	17/32	1 3/8	2 1/4	3 11/32
6	3	2 1/4-12	2 3/4-12	3-12	3 1/2	3 3/4	2 7/16	7/8	2 1/4	3 3/4	1	2 5/8	23/32	17/32	1 1/4	2 1/4	3 19/32
	3 1/2	2 1/2-12	3 1/4-12	3 1/2-12	3 1/2	4 3/8	2 11/16	1	2 1/2	4 1/4	1	3	23/32	17/32	1 1/4	2 1/4	3 19/32
	▲4	3-12	3 3/4-12	4-12	4	4 1/2	2 11/16	1	3	4 3/4	1	❑	7/8	3/8	1 1/4	2 1/4	3 19/32
7	3 1/2	2 1/2-12	3 1/4-12	3 1/2-12	3 1/2	4 3/8	2 11/16	1	2 1/2	4 1/4	1	3	23/32	17/32	1 1/4	2 1/4	3 15/16
	4	3-12	3 3/4-12	4-12	4	4 1/2	2 11/16	1	3	4 3/4	1	❑	7/8	3/8	1 1/4	2 1/4	3 15/16
	▲4 1/2	3 1/4-12	4 1/4-12	4 1/2-12	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	5 1/4	1	❑	7/8	3/8	1 1/4	2 1/4	3 15/16
	▲5	3 1/2-12	4 3/4-12	5-12	5	5 3/8	3 3/16	1 1/2	3 7/8	5 3/4	1	❑	7/8	3/8	1 1/4	2 1/4	3 15/16
8	4	3-12	3 3/4-12	4-12	4	4 1/2	2 11/16	1	3	4 3/4	1	❑	7/8	3/8	1 1/4	2 1/4	4 1/16
	4 1/2	3 1/4-12	4 1/4-12	4 1/2-12	4 1/2	5 1/4	3 3/16	1 1/2	3 1/2	5 1/4	1	❑	7/8	3/8	1 1/4	2 1/4	4 1/16
	5	3 1/2-12	4 3/4-12	5-12	5	5 3/8	3 3/16	1 1/2	3 7/8	5 3/4	1	❑	7/8	3/8	1 1/4	2 1/4	4 1/16
	▲5 1/2	4-12	5 1/4-12	5 1/2-12	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	6 1/4	1	❑	7/8	3/8	1 1/4	2 1/4	4 1/16
10	5	3 1/2-12	4 3/4-12	5-12	5	5 3/8	3 3/16	1 1/2	3 7/8	5 3/4	–	❑	1 1/8	1 1/16	–	3 3/16	5 3/16
	5 1/2	4-12	5 1/4-12	5 1/2-12	5 1/2	6 1/4	3 15/16	1 7/8	4 3/8	6 1/4	–	❑	1 3/8	13/16	–	3 3/16	5 3/16
	7	5-12	6 1/2-12	7-12	7	6 1/2	4 1/16	2	5 3/4	8	–	❑	1 5/8	7/8	–	3 1/2	5 1/2
12	7	5-12	6 1/2-12	7-12	7	6 1/2	4 1/16	2	5 3/4	8	–	❑	1 5/8	7/8	–	3 1/2	6
	8	5 3/4-12	7 1/2-12	8-12	8	6 1/2	4 1/16	2	6 1/2	9	–	❑	1 7/8	1 1/8	–	4	6 1/2
14	8	5 3/4-12	7 1/2-12	8-12	8	6 1/2	4 1/16	2	6 1/2	9	–	❑	1 7/8	1 1/8	–	4	6 7/8
	9	6 1/2-12	8 1/2-12	9-12	9	6 3/4	4 1/8	2	7 1/4	10	–	❑	2 3/16	1 1/16	–	4 1/4	7 1/8
	10	7 1/4-12	9 1/2-12	10-12	10	7 1/4	4 5/8	2 3/8	8	11	–	❑	2 11/16	13/16	–	4 1/2	7 3/8
16	9	6 1/2-12	8 1/2-12	9-12	9	6 3/4	4 1/8	2	7 1/4	10	–	❑	2 3/16	1 1/16	–	4 1/4	7 13/16
	10	7 1/4-12	9 1/2-12	10-12	10	7 1/4	4 5/8	2 3/8	8	11	–	❑	2 11/16	13/16	–	4 1/2	8 1/16
18	10	7 1/4-12	9 1/2-12	10-12	10	7 1/4	4 5/8	2 3/8	8	11	–	❑	2 11/16	13/16	–	4 1/2	9 1/2

Dimensions shown in blue are mounting dimensions.

▲ Mount B not available with standard dimensions in these sizes. Contact Hydro-Line for special dimensions.

‡ If no dimension is given, use FH dimension in place of F dimension and VB dimension in place of V dimension.

❑ Four 1/2" diameter spanner holes used instead of wrench flats on 4" diameter and larger.

Note - Consult Hydro-Line for 20", 24" and 30" bore dimensions.

* Add stroke to all starred dimensions.

■ Refer to lower half of page 23.

** Plus 2 x stroke.

• Port dimensions for standard ports only. Consult Hydro-Line for flange, manifold and special ports.

RM	TK	VB	XC*	XD*	XE*	XG	XI	XJ*	XS	XT	XX*	ZB*	ZE*	ZF*	ZJ*	ZL*	ZM**	ZT*
■	1/2	1/2	6 3/4	7 1/8	6 7/8	2 1/4	Customer to specify	5 1/4	1 3/4	2 3/8	7 1/2	6 3/8	7 1/4	6 3/8	6	6 5/8	7 5/8	7 3/8
■	1/2	3/8	7 1/2	8 1/8	7 3/16	2 1/2		5 1/2	2 1/8	2 5/8	8 1/16	6 11/16	7 11/16	6 7/8	6 1/4	7 1/8	8 1/8	8 1/16
■	9/16	3/8	7 5/8	8 1/4	7 5/16	2 1/2		5 5/8	2 5/16	2 5/8	8 3/16	6 13/16	7 13/16	7	6 3/8	7 1/4	8 1/4	8 3/16
■	5/16	1/2	7 7/8	8 1/2	7 9/16	2 3/4		5 7/8	2 9/16	2 7/8	8 7/16	7 1/16	8 1/16	7 1/4	6 5/8	7 1/2	8 3/4	8 7/16
■	3/4	3/8	8 7/8	9 5/8	8 1/2	2 7/8		6 1/2	2 9/16	3	9 1/2	7 15/16	9 1/8	8 1/8	7 3/8	8 3/8	9 1/2	9 11/16
■	1/2	3/8	9	9 3/4	8 5/8	3		6 5/8	2 11/16	3 1/8	9 5/8	8 1/16	9 1/4	8 1/4	7 1/2	8 1/2	9 3/4	9 13/16
4	3/4	1/4	9 7/8	10 3/4	8 7/8	3		6 7/8	2 7/8	3 1/8	10	8 5/16	9 1/2	8 5/8	7 3/4	8 19/32	10	10 1/16
4 7/16	11/16	3/8	10 1/8	11	9 1/8	3 1/4		7 1/8	3 1/8	3 3/8	10 1/4	8 9/16	9 3/4	8 7/8	8	8 27/32	10 1/2	10 5/16
4 7/16	1 1/8	3/8	10 3/4	11 5/8	10	3 1/4		7 5/8	3 1/8	3 3/8	11 1/8	9 5/16	10 3/4	9 3/8	8 1/2	9 11/32	11	11 11/16
5 1/4	1 1/8	3/8	10 3/4	11 5/8	10	3 1/4		7 5/8	3 1/8	3 3/8	11 1/8	9 5/16	10 3/4	9 3/8	8 1/2	9 15/32	11	11 11/16
5 5/8	3/4	3/8	10 3/4	11 5/8	10	3 1/4		7 5/8	3 1/8	3 3/8	11 1/8	9 5/16	10 3/4	9 3/8	8 1/2	9 15/32	11	11 11/16
5 1/4	1 5/16	1/4	12 1/8	13 1/8	11 5/16	3 3/8		8 3/8	3 3/8	3 1/2	12 5/16	10 9/16	12 3/16	10 5/8	9 5/8	10 11/32	11 7/8	13 1/4
5 5/8	1 5/16	1/4	12 1/8	13 1/8	11 5/16	3 3/8		8 3/8	3 3/8	3 1/2	12 5/16	10 9/16	12 3/16	10 5/8	9 5/8	10 11/32	11 7/8	13 1/4
6 7/16	7/8	1/4	12 1/8	13 1/8	11 5/16	3 3/8		8 3/8	3 3/8	3 1/2	12 5/16	10 9/16	12 3/16	10 5/8	9 5/8	10 1/2	11 7/8	13 1/4
5 5/8	2 1/8	1/4	13 3/4	14 3/4	12 9/16	3 5/8		9 3/8	3 5/8	3 13/16	13 9/16	11 3/4	13 9/16	11 3/4	10 3/4	11 15/32	13	14 7/8
6 7/16	1 3/4	1/4	13 3/4	14 3/4	12 9/16	3 5/8		9 3/8	3 5/8	3 13/16	13 9/16	11 3/4	13 9/16	11 3/4	10 3/4	11 5/8	13	14 7/8
7 1/8	7/8	1/4	13 3/4	14 3/4	12 9/16	3 5/8		9 3/8	3 5/8	3 13/16	13 9/16	11 3/4	13 9/16	11 3/4	10 3/4	11 5/8	13	14 7/8
7 9/16	7/8	1/4	13 3/4	14 3/4	12 9/16	3 5/8		9 3/8	3 5/8	3 13/16	13 9/16	11 3/4	13 9/16	11 3/4	10 3/4	11 5/8	13	14 7/8
6 7/16	1 9/16	1/4	15	16	13 3/4	3 3/4		10 1/4	3 5/8	3 15/16	14 3/4	12 7/8	14 7/8	12 3/4	11 3/4	12 5/8	14	16 1/4
7 1/8	1 9/16	1/4	15	16	13 3/4	3 3/4		10 1/4	3 5/8	3 15/16	14 3/4	12 7/8	14 7/8	12 3/4	11 3/4	12 5/8	14	16 1/4
7 9/16	1 9/16	1/4	15	16	13 3/4	3 3/4		10 1/4	3 5/8	3 15/16	14 3/4	12 7/8	14 7/8	12 3/4	11 3/4	12 5/8	14	16 1/4
8 3/8	1 3/8	1/4	15	16	13 3/4	3 3/4		10 1/4	3 5/8	3 15/16	14 3/4	12 7/8	14 7/8	12 3/4	11 3/4	12 5/8	14	16 1/4
7 5/8	–	–	19 5/16	–	–	5		13 1/2	4 13/16	–	–	17	–	17	15 5/16	–	–	–
8 3/8	–	–	19 5/16	–	–	5		13 1/2	4 13/16	–	–	17	–	17	15 5/16	–	–	–
10 13/16	–	–	19 3/4	–	–	5 5/16		13 13/16	5 1/8	–	–	17 5/16	–	17 5/16	15 5/8	–	–	–
10 13/16	–	–	22 1/2	–	–	5 11/16		15 13/16	5 1/2	–	–	20	–	19 15/16	18	–	–	–
12 3/8	–	–	23	–	–	6 3/16		16 5/16	6	–	–	20 1/2	–	20 7/16	18 1/2	–	–	–
12 3/8	–	–	25 3/8	–	–	6 7/16		17 3/16	6 1/4	–	–	21 7/16	–	21 7/8	19 5/8	–	–	–
13 1/8	–	–	25 5/8	–	–	6 11/16		17 7/16	6 1/2	–	–	21 7/8	–	22 1/8	19 7/8	–	–	–
14 5/8	–	–	25 7/8	–	–	6 15/16		17 11/16	6 3/4	–	–	21 15/16	–	22 3/8	20 1/8	–	–	–
13 1/8	–	–	29 3/8	–	–	7 3/16		19 7/16	7	–	–	24 3/8	–	25 1/8	22 3/8	–	–	–
14 5/8	–	–	29 5/8	–	–	7 7/16		19 11/16	7 1/4	–	–	24 5/8	–	25 3/8	22 5/8	–	–	–
14 5/8	–	–	33 1/4	–	–	7 15/16		22 3/16	7 3/4	–	–	27 5/8	–	28 5/8	25 5/8	–	–	–

N5 SERIES CYLINDERS

- NFPA interchangeable
- N5 – 3000 psi nominal hydraulic
- AN5 – to 250 psi very heavy-duty pneumatic
- LAN5 – to 250 psi very heavyduty pneumatic – permanently lubricated
- All steel construction

R5 SERIES CYLINDERS

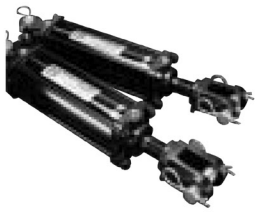
- NFPA interchangeable
- A5/R5 – to 250 psi pneumatic
- LA5/LR5 – to 250 psi pneumatic – permanently lubricated
- HA5 – to 400 psi hydraulic
- HR5 – 1500 psi nominal hydraulic

Q6 SERIES CYLINDERS

- NFPA interchangeable
- Q6 – to 250 psi pneumatic permanently lubricated
- HQ6 – to 400 psi hydraulic
- 3/4″ to 8″ Bores

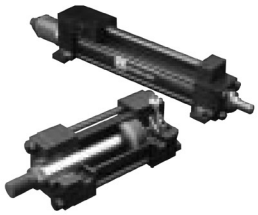
HM SERIES CYLINDERS

- Conform to international metric specifications ISO 6020/2 and DIN 24 554
- 25 mm to 200 mm bore sizes
- 210 BAR nominal hydraulic
- All steel construction



FIELD-MATE^{PLUS} SERIES CYLINDERS

- ASAE interchangeable agricultural cylinders
- Rated to 3000 psi hydraulic



ELECTRONIC FEEDBACK CYLINDERS

Hydraulic or pneumatic cylinders which incorporate cylinder position sensing and feedback throughout the stroke. Available in N5, R5, A5, Q5, HM, HW, SM or special cylinders.

SERIES 20/30 BOOSTERS

- Standard series to 5000 psi output
- Custom designs to 20,000 psi

T SERIES AIR/OIL TANKS

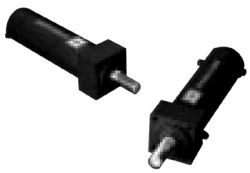
- All steel construction

QT SERIES AIR/OIL TANKS

- Aluminum end caps and translucent tubing

HW SERIES CYLINDERS

- Welded construction
- 3000 psi nominal hydraulic



TSAVER CYLINDERS

- Threaded body construction
- To 200 psi pneumatic
- To 1000 psi nominal hydraulic

SM SERIES CYLINDERS

- Steel mill type construction
- MSM–2000 psi nominal hydraulic
- HSM–3000 psi nominal hydraulic
- ASM–Pneumatic

CUSTOM CYLINDERS

Custom cylinders to meet special requirements

- Bores to 48″
- Strokes to 300″
- Pressures to 10,000 psi or higher

Eaton
Hydraulics Group USA
14615 Lone Oak Road
Eden Prairie, MN 55344
USA
Tel: 952-937-9800
Fax: 952-294-7722
www.eaton.com/hydraulics

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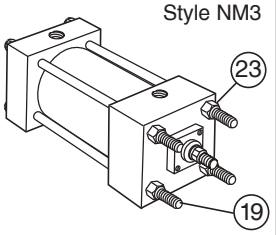
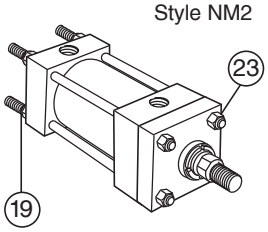
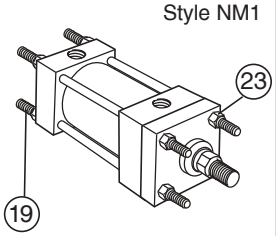
Style NM3



Style NM2



Style NM1



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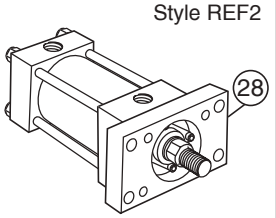

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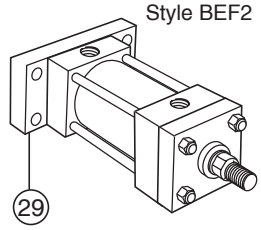

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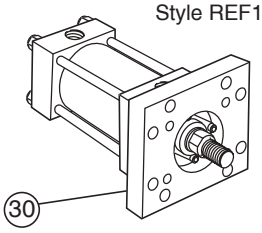

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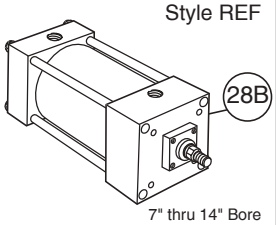
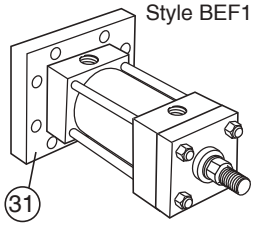


7" thru 14" Bore

Style BEF1



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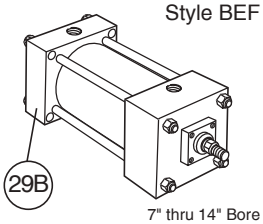
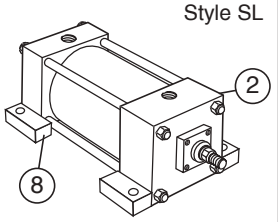


7" thru 14" Bore

Style SL



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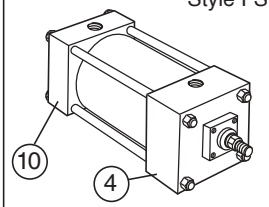

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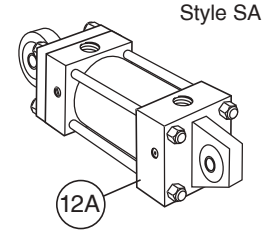

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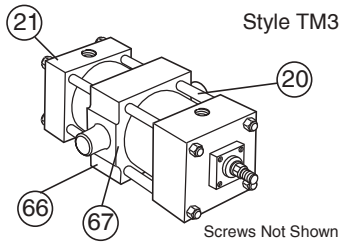
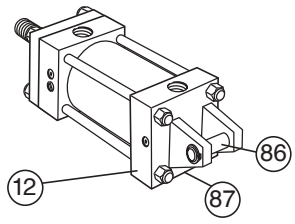
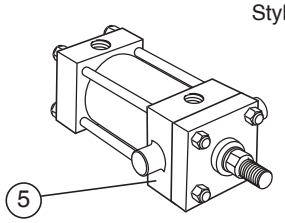


Screws Not Shown

Style PB2



Style TM1



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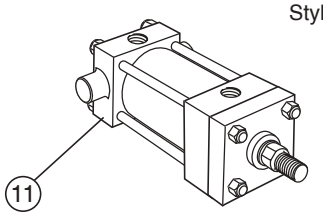
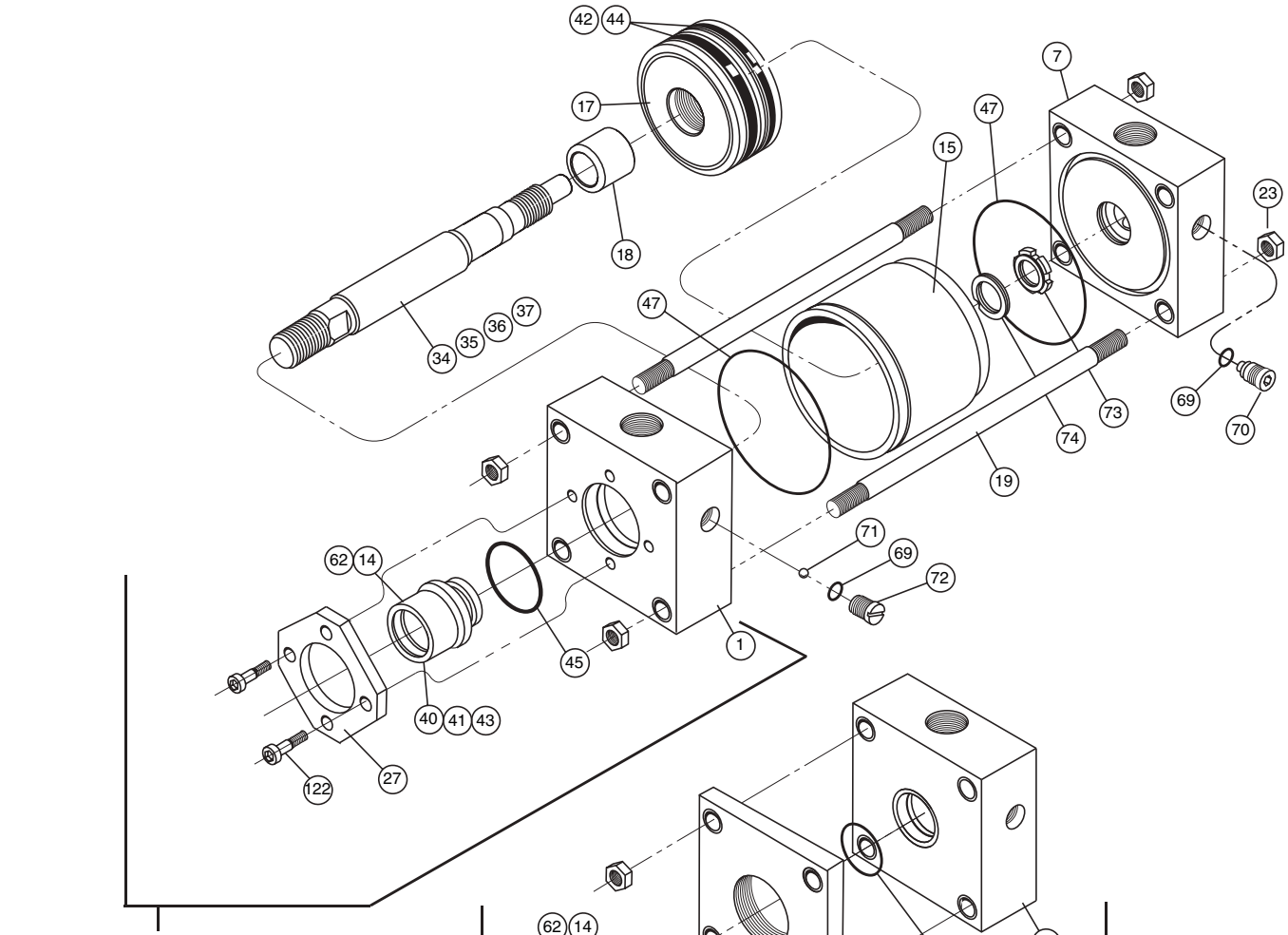


Replacement Mountings & Hardware

Symbol	Description
2	Head, side lug mount
4	Head, side tap mount
5	Head, trunnion mount
8	Cap, side lug mount
10	Cap, side tap mount
11	Cap, trunnion mount
12	Cap, fixed clevis mount
12A	Cap, fixed eye, with spherical bearing
19	Tie rod
20	Tie rod, head end mount
21	Tie rod, cap end mount
23	Tie rod nut
28	Flange, rectangular, head mount
28B	Head, square mount
29	Flange, rectangular, cap mount
29B	Cap, square mount
30	Flange, square, head mount
31	Flange, square, cap mount
66	Intermediate trunnion
67	Screws, intermediate trunnion mount
86	Clevis pin
87	Retaining ring for clevis pin

How to Order

Give cylinder model number, bore, stroke, serial number and symbol number shown above to insure proper replacement.



Up to and including 2-1/2" diameter rods

3" diameter rods and over

Parts		Assemblies (Includes Symbol Numbers Shown)		
Symbol	**Description**	**Symbol**	**Description**	**Lipseal Type Piston**
1	Head, ported, non-cushioned	C1SA	Head, ported, cushioned	1, 69, 70, 71 & 72
7	Cap, ported, non-cushioned	C7SA	Cap, ported, cushioned	7, 69, 70, 73 & 74
14	Gland	62	Rod gland kit	14, 40, 41, 43 & 45
15	Tube	–	–	–
17	Piston, lipseal type	–	–	–
18	Cushion sleeve, cushioned cylinder only	–	–	–
19	Tie rod	–	–	–
23	Tie rod nut	–	–	–
27	Retainer	–	–	–
34	Piston rod, single rod type, non-cushioned	34SA	Piston & rod assembly, single rod type — non-cushioned	17, 34, 42 & 44
35	Piston rod, single rod type, cushioned head end	35SA	Piston & rod assembly, single rod type — cush. head end	17, 18, 35, 42 & 44
36	Piston rod, single rod type, cushioned cap end	36SA	Piston & rod assembly, single rod type — cush. cap end	17, 36, 42 & 44
37	Piston rod, single rod type, cushioned both ends	37SA	Piston & rod assembly, single rod type — cush. both ends	17, 18, 37, 42 & 44
40	Rod wiper	–	Seal Kits	–
41	Rod seal	–		–
42	Piston seal	–		–
43	Back-up washer, gland	–		–
44	Back-up washer, piston	–		–
45	O-ring, gland to head seal	–		–
47	O-ring, cylinder tube end seal	–		–
69	O-ring, cushion adjustment & check valve screw	–	Cushion Kits See table below.	–
70	Needle valve, cushion adjustment	–		–
71	Ball, check valve	–		–
72	Plug screw, check valve	–		–
73	Cushion bushing, cap end floating check valve	–		–
74	Retaining ring, floating cushion bushing	–		–
121	Piston Wear Ring	–		–
122	Socket cap screws	–		–

Standard Design Cushion Hardware Kits

Cushion Hardware Kits*

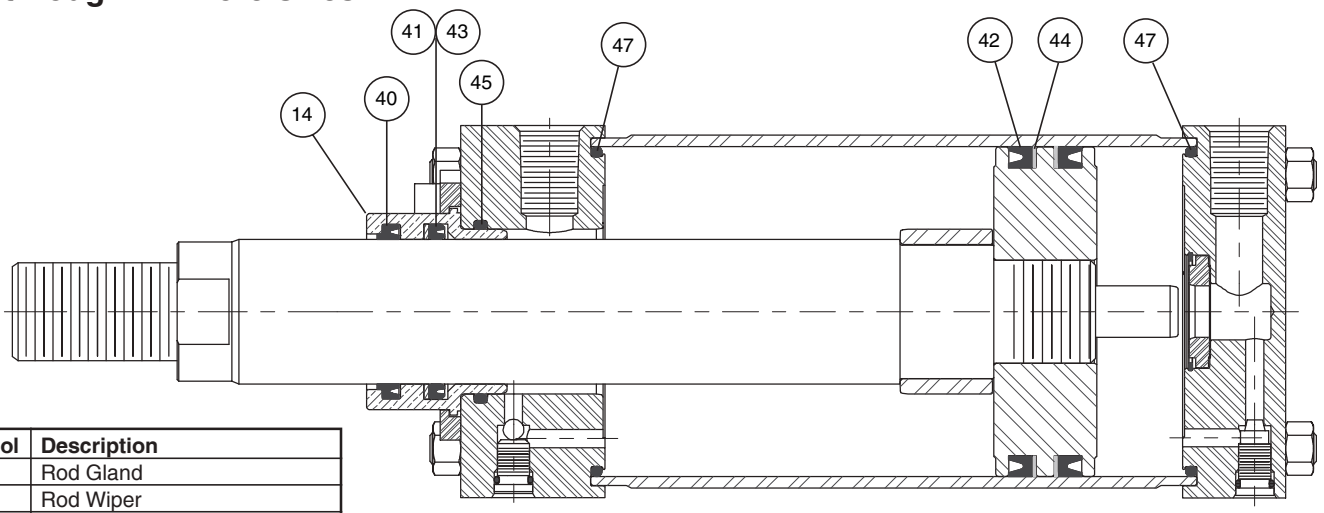
Bore Size	Rod Dia.	For Head Assemblies	For Cap Assemblies
1 1/2	5/8	ACUKH518	ACUKC522
	1	ACUKH518M	
2	5/8, 1	ACUKH518	ACUKC522
	1 3/8	ACUKH518M	
2 1/2	5/8 - 1 3/8	ACUKH518	ACUKC522
	1 3/4	ACUKH518M	
3 1/4	All	ACUKH519	ACUKC523
4	All	ACUKH519	ACUKC523
5	All	ACUKH519	ACUKC523
6	All	ACUKH521	ACUKC524
7	All	ACUKH521	ACUKC524
8	All	ACUKH521	ACUKC524
10	All	ACUKH521	ACUKC525
12	All	ACUKH521	ACUKC526
14	All	ACUKH521	ACUKC527

Micro-Adjust Cushion Hardware Kits*

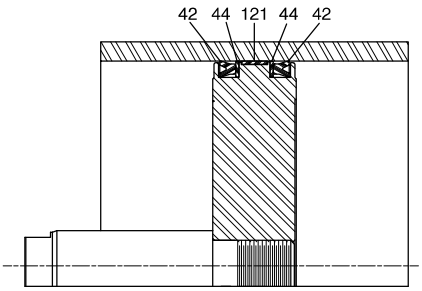
Bore Size	Rod Dia.	For Head and Cap Assemblies
1 1/2 - 2 1/2	All	AMAKHC15
3 1/4 - 14	All	AMAKHC25

* Cushion kits contain fluorocarbon seals and are suitable for class 1 & 5 service.

1½" through 14" Bore Sizes



Symbol	Description
14	Rod Gland
40	Rod Wiper
41	Rod Seal
42	Piston Lipseal
43	Rod Seal Back-up Washer
44	Piston Seal Back-up Washer
45	Gland to Head O-ring
47	End Seal O-ring
121	Piston Wear Ring



Lipseal Piston with Wear Ring
Bores 8, 10, 12 & 14

Seal Kits

See Operating Fluids and Temperature Range Page for compatibility.

Rod Gland and Rod Seal Kits

Rod Dia.	Class 1 Nitrile		Class 5 Fluorocarbon		Gland Wrench	Spanner Wrench	Retainer Screw Torque Inch Lbs. (-0%, +5% tolerance)
	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43 & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43 & 45)	Rod Gland Kits (Contains: 1 Each Sym. #14, 40, 41, 43 & 45)	Rod Seal Kits (Contains: 1 Each Sym. #40, 41, 43 & 45)			
5/8	BH06RA000	BH06SA000	VH06RA000	VH06SA000	Not Required	Not Required	15
1	BH10RA000	BH10SA000	VH10RA000	VH10SA000			15
1 3/8	BH13RA000	BH13SA000	VH13RA000	VH13SA000			60
1 3/4	BH17RA000	BH17SA000	VH17RA000	VH17SA000			120
2	BH20RA000	BH20SA000	VH20RA000	VH20SA000			120
2 1/2	BH25RA000	BH25SA000	VH25RA000	VH25SA000			120
3	BH30RA000	BH30SA000	VH30RA000	VH30SA000	0695960000	0116770000	240
3 1/2	BH35RA000	BH35SA000	VH35RA000	VH35SA000	0695970000	0116770000	240
4	BH40RA000	BH40SA000	VH40RA000	VH40SA000	0695980000	0116780000	240

Piston Seal Kits

Bore Size	Class 1 Nitrile Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Class 5 Fluorocarbon Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Tie Rod Nut Specification Foot Lbs.* (-0%, +5% tolerance)
1 1/2	BH00LA015	VH00LL015	5
2	BH00LA020	VH00LL020	11
2 1/2	BH00LA025	VH00LL025	11
3 1/4	BH00LA032	VH00LL032	25
4	BH00LA040	VH00LL040	25
5	BH00LA050	VH00LL050	60

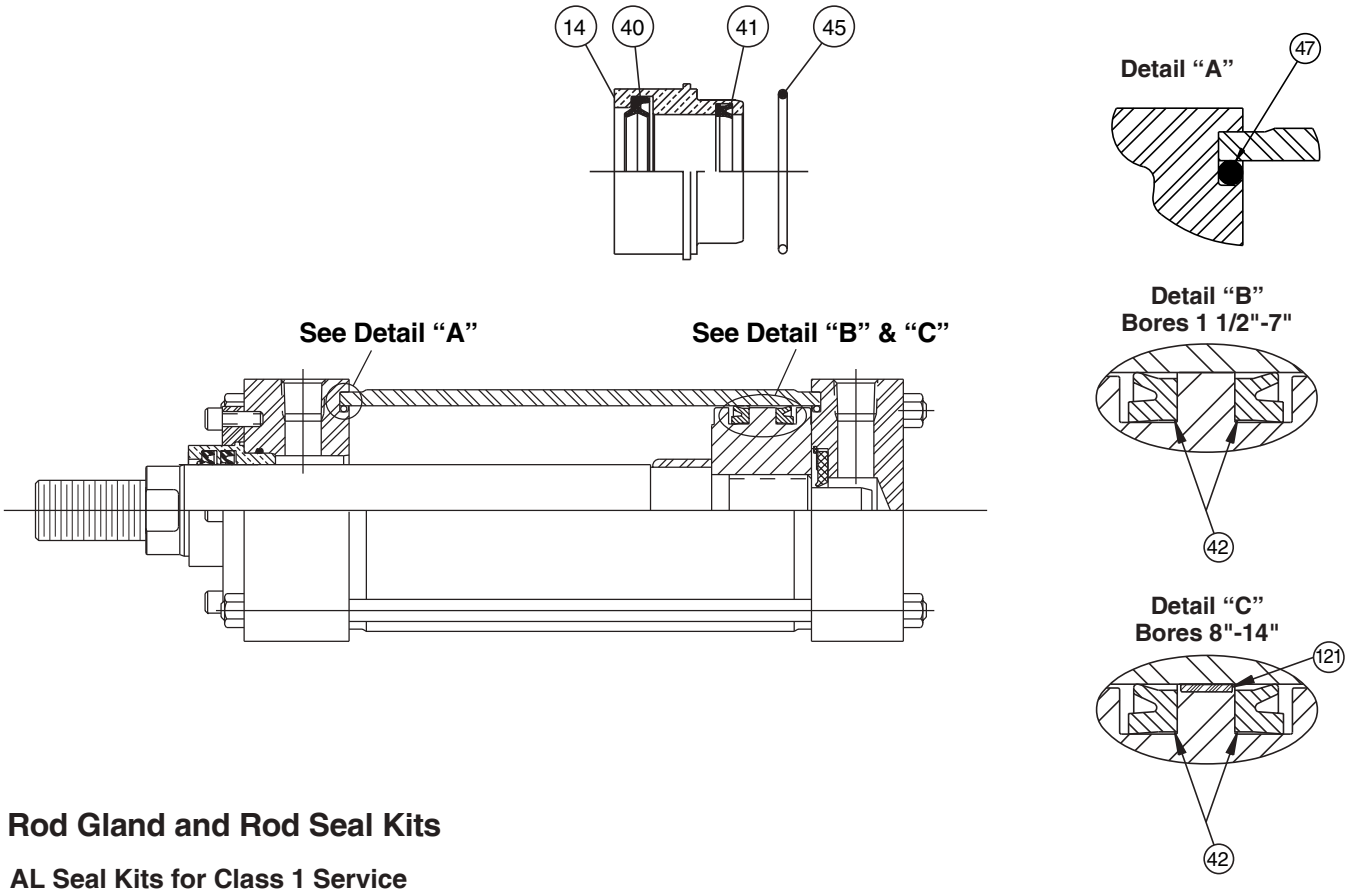
Bore Size	Class 1 Nitrile Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Class 5 Fluorocarbon Piston Seal Kits (Contains: 2 Each Sym. #42, 44, 47)	Tie Rod Nut Specification Foot Lbs.* (-0%, +5% tolerance)
6	BH00LA060	VH00LL060	60
7	BH00LA070	VH00LL070	90
8	BH00LA080	VH00LL080	110
10	BH00LA100	VH00LL100	150
12	BH00LA120	VH00LL120	172
14	BH00LA140	VH00LL140	275

*When assembling the cylinder, be sure to torque the tie rods evenly.

Standard Seals — Class 1 Service Kits are standard. In addition to standard seals, each kit includes the special composite components ready for installation. These seals are suitable for use when air is the operating medium.

The recommended operating temperature range for Class 1 seals is -10° F to +165°F.

Series AL Seal Kits



Rod Gland and Rod Seal Kits

AL Seal Kits for Class 1 Service

Rod Dia.	**Rod Gland Kits** (Contains: 1 Each Sym. #14, 40, 41, & 45)	**Rod Seal Kits** (Contains: 1 Each Sym. #40, 41, & 45)	**Retainer Screw Torque Inch Lbs.** (-0%, +5% tolerance)
5/8	BH06RL000	BH06SL000	15
1	BH10RL000	BH10SL000	15
1 3/8	BH13RL000	BH13SL000	60
1 3/4	BH17RL000	BH17SL000	120
2	BH20RL000	BH20SL000	120
2 1/2	BH25RL000	BH25SL000	120
3	BH30RL000	BH30SL000	240
3 1/2	BH35RL000	BH35SL000	240
4	BH40RL000	BH40SL000	240

Bore Size	**Piston Seal Kits** (Contains: 2 Each Sym. #42 & 47)	**Tie Rod Nut Specification Foot Lbs.** (-0%, +5% tolerance)
1 1/2	BH00LL015	5
2	BH00LL020	11
2 1/2	BH00LL025	11
3 1/4	BH00LL032	25
4	BH00LL040	25
5	BH00LL050	60
6	BH00LL060	60
7	BH00LL070	90
8	BH00LL080	110
10	BH00LL100	150
12	BH00LL120	172
14	BH00LL140	275

How to Order Series A Cylinders

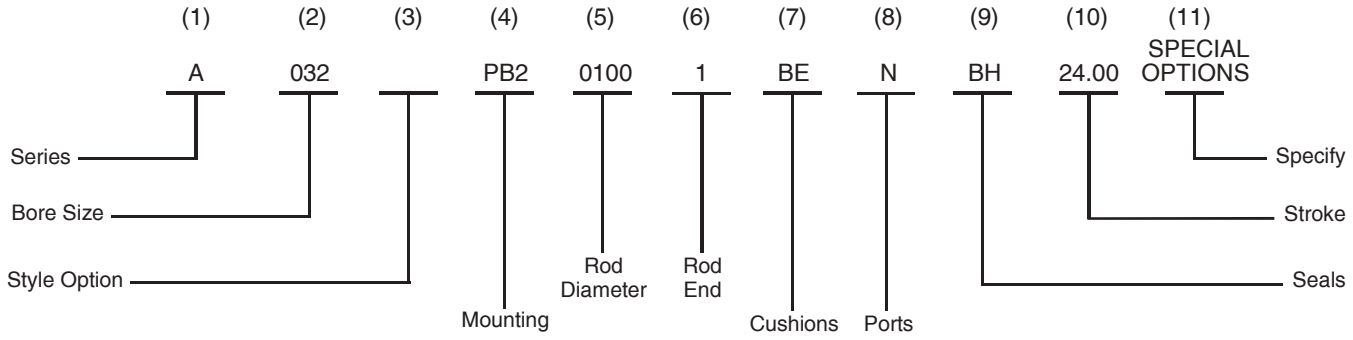
Data Required On All Cylinder Orders

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

(**NOTE:** – Duplicate cylinders can be ordered by giving the SERIAL NUMBER from the original cylinder. Factory records supply a quick, positive identification.)

1. **Series Designation ("A")**
2. **Bore**
3. **Style Option (X for double rod or Y for duplex designs, 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**
   NPTF is standard.
9. **Seals**
   Nitrile piston seals, rod seal, Buna-N static seals and a wiper seal are all standard, for use with lubricated compressed air. Fluorocarbon and EPR can be specified, subject to application temperature range.
10. **Stroke**
    Specify length required.
11. **Special Options**
    Specify. Consult factory for questions.

Sample Model Code



NOTE: On double rod end cylinders, repeat rod size and specify rod end threads for each side.
For duplex cylinders, the entire model code for each cylinder should be included and indicated as "back to back" or "rod to rod."
If replacing existing cylinder or ordering parts, include the serial number.

Style 4 Rod End

A style 4 rod end indicates a special rod end configuration. All special rod ends must be described by at least **all three**: KK; A; or W/WF specified with the rod fully retracted. A sketch or drawing should be submitted for rod ends requiring special machining such as snap ring grooves, keyways, tapers, multiple diameters, etc. It is good design practice to have this machining done on a diameter at least 0.065 inches smaller than the piston rod diameter. This allows the piston rod to have a chamfer preventing rod seal damage during assembly or maintenance.

Service Policy

When cylinders are returned to the factory for repairs, it is standard policy for 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 exceed the cost of a new one, you will be notified.

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.

Series A 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
A	**015** (1.50")	***(Leave***	**BEF**	See "Piston Rod	***1 (KK Male)***	***NC (None)***	***N (NPTF)***	See "Operating	**XXX.XX**	**S***
AL*	**020** (2.00")	***Blank***	**BEF1**	Selection Chart"	**2** (CC Male)	**HE** (Head End)	**S** (SAE)	Fluids" on	(Specify	(See
AW*	**025** (2.50")	***if***	**BEF2**	on page 54.	**3** (KK Female)	**CE** (Cap End)	**I** (ISO 6149)	page 50.	Gross Stroke	Below)
	032 (3.25")	***Standard)***	**FS**	**0062** (.63")	**4** (Special†)	**BE** (Both Ends)	**X** (Other)	**BH** Nitrile Seals	if Stop Tube	
	040 (4.00")		**NM1**	**0100** (1.00")	**5** (Split Coupler)	**HM** (Head Micro	(Specify)	(Nitroxile	is	
	050 (5.00")	**X**	**NM2**	**0137** (1.38")	**6** (Stub End)	Adjust)		Dynamic Seals)	Required)	
	060 (6.00")	(Double	**NM3**	**0175** (1.75")		**CM** (Cap Micro		(Class 1 Seals)		
	070 (7.00")	Rod End)	**PB2**	**0200** (2.00")		Adjust)		**VH** Fluorocarbon		
	080 (8.00")		**REF**	**0250** (2.50")	† Must Specify:	**BM** (Both Micro		Seals		
	100 (10.0")	**Y**	**REF1**	**0300** (3.00")	**WF** (Rod Extension)	Adjust)		(Class 5 Seals)		
	120 (12.0")	(Duplex)	**REF2**	**0350** (3.50")	**A** (Thread Length)			**EH** EPR Seals		
	140 (14.0")		**SA**	**0400** (4.00")	**KK** (Thread Size			(Class 3 Seals)		
			SL		and Pitch)			**XH** Special -		
			TM1					Specify		
			TM2							
			TM3							
			|							
			(specify dimension XI)							

* AL – Non-Lube Air Cylinder - see pages 39-41.
AW – Wood Products Series A Cylinder - see below.

S* The letter S refers to special options or modifications that deviate from the standard product offering. Non-standard modifications and options not identified in the cylinder model number should be added in the notes when placing an order.

Modifications which can be placed under the designator "S" are as follows:

- End-of-Stroke Switches
  - EPS-6, EPS-7, CLS-1, CLS-4 Styles (See bulletin AC0840-B11)
  - MagnaSwitch
- Piston Bumper Seals (1½" - 5" Bores except 1½" x 1, 2" x 1⅜, 3¼" x 2", 4" x 1¾" and 4" x 2")

Note: The standard #1 port location is at the top of the cylinder, and the standard cushion adjustment screw is in position #2 when facing the rod end of the cylinder. If multiple ports are required, the last character of the part number should be "S", indicating modified and the desired port location specified in the notes.

Cylinders for Wood Products Applications

Atlas Cylinders has built a solid reputation in the Wood Products Industry where demanding applications require a cylinder that is up to the task. That is why we offer an option that makes Atlas Cylinders the most dependable and long lasting actuator for Timber Industry service.

- **Set screw piston to piston rod**
  Two axial screws in the piston-to-rod joint prevent the assembly from unthreading.
- **Polyurethane rod wiperseal**
  Durable rod wiperseal cleans the rod on the extend stroke and wipes the rod on the return stroke.
- **Full square tie rod retained gland (up to 6" bore)**
  More secure gland retention to resist impact loading at cylinder head end.

To order your Atlas cylinder with the **Wood Products** options specify **'AW'** Series in the model code. See the example below.

AW	**032**	**PB2**	**0137**	**1**	**BE**	**N**	**BH**	**10.000**
Series	Bore	Mount	Rod	Rod End	Cushions	Ports	Seals	Stroke

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

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

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

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

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

1.0 General Instructions

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

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

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

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

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

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

2.0 Cylinder and Accessories Selection

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The rod end pressure is approximately equal to:

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

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

3.0 Cylinder and Accessories Installation and Mounting

3.1 Installation

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

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

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

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

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

3.2 Mounting Recommendations

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

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

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

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

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

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

4.0 Cylinder and Accessories Maintenance, Troubleshooting and Replacement

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

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

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

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

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

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

4.2 Cylinder Trouble Shooting

4.2.1 – **External Leakage**

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

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

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

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

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

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

4.2.2 – **Internal Leakage**

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

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

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

4.2.3 – **Cylinder Fails to Move the Load**

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

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

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

4.3 Erratic or Chatter Operation

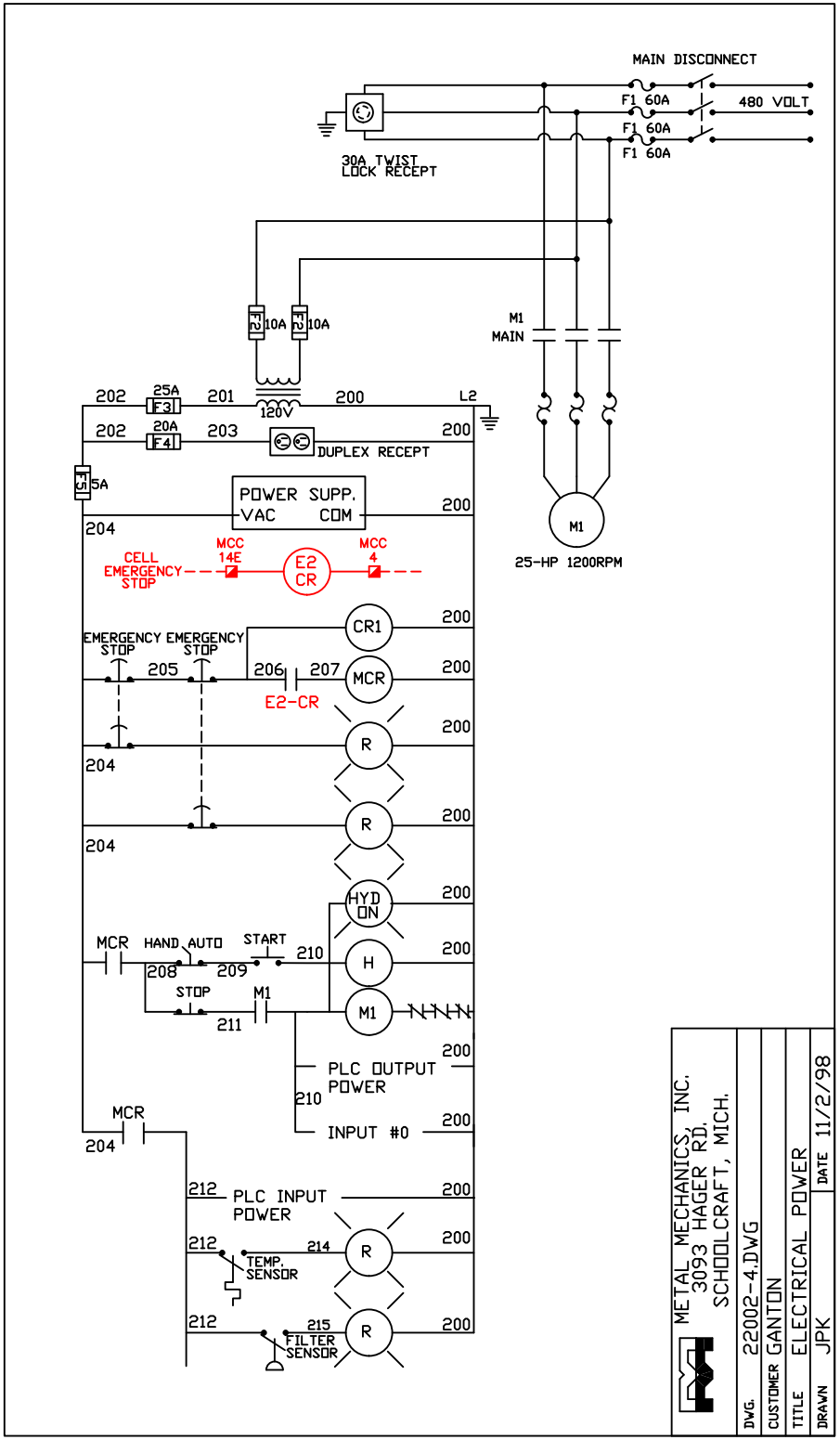
4.3.1 – Excessive friction at rod gland or piston bearing due to load misalignment – Correct cylinder-to-load alignment.

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

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

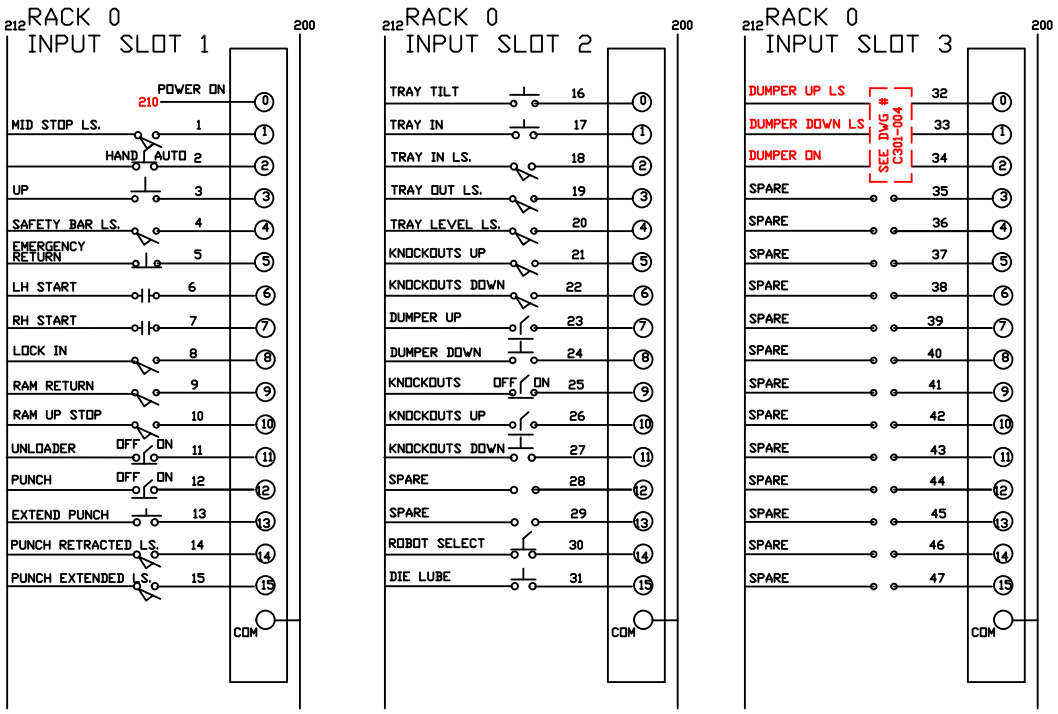
4.4 Cylinder Modifications, Repairs, or Failed Component – Cylinders as shipped from the factory are not to be disassembled and or modified. If cylinders require modifications, these modifications must be done at company locations or by the Company's certified facilities. The Industrial Cylinder Division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

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

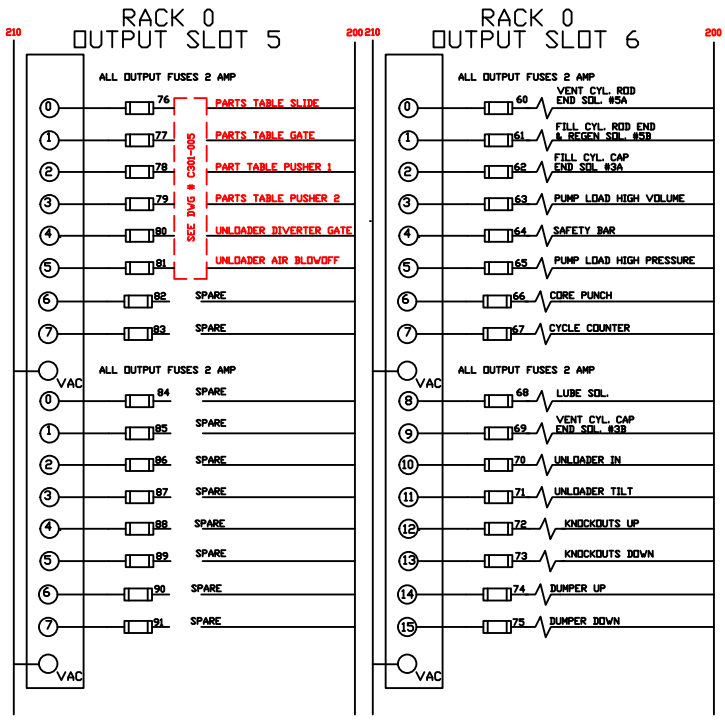


METAL MECHANICS, INC.
3093 HAGER RD.
SCHOOLCRAFT, MICH.

DWG.	22002-4.DWG
CUSTOMER	GANTON
TITLE	ELECTRICAL POWER
DRAWN	JPK
DATE	11/2/98



METAL MECHANICS, INC. 3093 HAGER RD. SCHOOLCRAFT, MICH.	
DWG.	22002-5.DWG
CUSTOMER	GANTON
TITLE	PLC I/O SCHEMATIC
DRAWN	JPK
DATE	11/2/98



METAL MECHANICS, INC. 3093 HAGER RD. SCHOOLCRAFT, MICH.	
DWG.	22002-6.DWG
CUSTOMER	GANTON
TITLE	PLC I/O SCHEMATIC
DRAWN	JPK
DATE	11/2/98

Lyden Oil Company

MATERIAL SAFETY DATA SHEET

ADDRESS:
3711 LeHarps Road
Youngstown, Ohio 44515
Emergency Phone Number (s)
Business: 330-792-1100
Off Hours: 1-800-362-9410

Product Identification

Product Name
ProGuard L-Plex EP Grease 0, 1 & 2 (All Grades)

Code No.
11,063

Date: 12-18-07

Synonyms
none

Chemical Family
Hydrocarbon

Ingredients

MATERIALS OR COMPONENTS	% wt.	CAS NUMBER	CARCINOGEN OSHA or IARC
Lithium 12 Hydroxystearate Sebacate	5 - 12	68815-49-6	No
Mineral Oil	54 - 59	64742-65-0	No
Zinc Alkyldithiophosphate	0.5 - 2.0	68649-42-3	No
Mineral Oil	22 - 27	64742-62-7	No
Polyethylene	0 - 2.0	9002-88-4	No
Calcium Carbonate	2.0 - 5.0	471-34-1	No
Red Dye	<.06	NA	No

Shipping Information

Not Restricted

Physical Properties

Boiling Point/Range Deg. C 700 Deg. F	Melting Point Deg. C 500 Deg. F	Freezing Point Deg. C Deg. F	Molecular weight (calculated) N/A
Specific Gravity (water=1) 0.87 @ 16 Deg C	Vapor Pressure (mm Hg) N/A Deg. C Deg. F	Vapor Density (Air = 1) N/A	
Solubility in Water Nil	% Volatiles by Volume 0	Evaporation Rate N/A ☐ Either = 1 ☐ Water = 1 ☐ Butylacetate = = 1	
Appearance and Odor Red Smooth Semi-Solid Grease - Bland		Other	

Fire and Explosion Data

Flash Point Test Method
Deg. C 425 Deg. F D-92

Flammable limits
Lower N/A Upper %

Autoignition temperature/Fire Point
Deg C >600 Deg. F

EXTINQUISHING MEDIA
☐ Water Spray ☒ Water - fog ☐ Water - Stream ☒ Carbon dioxide ☒ Dry chemical ☐ Alcohol foam ☒ Foam ☒ Earth or sand

SPECIAL FIRE FIGHTING PROCEDURES
☐ Do not enter building ☐ Allow fire to burn ☒ Water may cause frothing ☐ Do not use water

UNUSUAL FIRE AND EXPLOSION HAZARDS
☐ Dust Explosion hazard ☐ Sensitive to shock ☐ Contamination ☐ Temperature ☒ Other (specify) **None**

Reactivity Data

Stability
☒ Stable ☐ Unstable

Conditions Contributing to Instability
☐ Thermal decomposition ☐ Photo degradation ☐ Polymerization ☐ Contamination

Incompatibility - Avoid Contact With
☐ Strong Acids ☐ Strong Alkalis ☒ Strong Oxidizers ☐ Other (Specify)

Hazardous Decomposition Products - Thermal and Other (list)

CO & CO2 if Incomplete Combustion

Reactivity Date continued….

CONDITIONS TO AVOID

[ ] Heat [x] Open Flames [ ] Sparks [ ] Ignition Sources [ ] Other (specify)

Spill or Leak

Steps to be Taken if material is Released or Spilled

[ ] Flush with Water [x] Absorb with Sand [ ] Neutralize [x] Sweep or Scoop up and remove [ ] Keep upwind Evacuate enclosed spaces [ ] Prevent Spread or Spill

[ ] Dispose of Immediately [ ] Other (specify)

Waste Disposal Method - Consult federal, state or local authorities for proper disposal procedures.

All Disposals Must Comply with Federal, State and Local Regulations.

Toxicity Information

Conditions to Avoid: Excessive Contact

Primary Routes of Entry

[ ] Inhalation [x] Skin Contact [ ] Other (specify)

This product has been used for years with no known Ill effects. It contains no known carcinogens or mutagens as defined by OSHA or IARC.

This product contains the following toxic chemicals subject to the reproting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (40 CFR 372)

CAS Number	Chemical Name	Percent by Weight
68649-42-3	Zinc Alkyldithiophosphate	0 - 2

Health and Hazzard Information

NFPA Rating

Health	0
Flammability	1
Reactivity	0
Protective Equipment	B

NFPA HAZARD RATING CODES

Least	0	High 3
Slight	1	Extreme 4
Moderate	2	

Effects of Exposure

Permissible Exposure Limit (Specify if TLV/TWA or Ceiling [c])		Other:
ACGIH 20	OSHA 2007	5 mg/m3 for mineral oil

Irritation	[x]	Skin	[ ] Severe	[ ] Moderate	[x]	Mild (Transient)	
	[x]	Eye	[ ] Severe	[ ] Moderate	[x]	Mild (Transient)	
Corrosivity	[ ]	Skin	[ ] 4 hrs. (DOT)		[ ]	24 hrs (CPSC)	
	[ ]	Eye	[ ] May Cause Blindness		[x]	Not Corrosive	

Sensitization: [ ] Skin [ ] Respiratory [x] None

Inhalation Effects: [ ] Narcotic Effect [ ] Cyanosis [ ] Asphyxiant

Lung Effects (Specify): **None**

Other (Specify):

[ ] Repeated Contact-skin Defatter [ ] Other (Specify) **NONE**

Emergency First Aid

Ingestion

[ ] Induce Vomiting [x] Do Not Induce Vomiting [ ] Give Plenty of Water [x] Get Medical Attention [ ] Other (specify)

Dermal

[x] Flush with Soap and Water [ ] Get Medical Attention [x] Contaminated Clothing-Remove and Launder [ ] Contaminated Shoes - destroy [ ] Other (specify)

Eye Contact

[x] Flush with plenty of water for at least 15 minutes [x] Get Medical Attention [ ] Other (specify)

Inhalation

[ ] Remove to fresh air [ ] If not breathing give artificial respiration [ ] Give Oxygen [ ] Get Medical Attention [ ] Other (specify) **None**

Special Protection Information

Ventilation Requirements - Always maintain exposure below permissible limits.

- [ ] Consult an Individual Hygienist or environmental health specialist
- [ ] Local Exhaust
- [x] Use with Adequate Ventilation
- [ ] Check for Air Contamination and oxygen deficiency
- [ ] Other (specify)

Eye

- [ ] Face Shield
- [ ] Goggles
- [X] Safety Glasses

Hand (Glove Type)

- [x] Polyvinyl Chloride
- [x] Neoprene
- [x] Butyl Rubber
- [ ] Natural Rubber
- [ ] Polyvinyl Alcohol
- [x] Other - Nitrile
- [x] Polyethylene

Respirator Type - Use Only NIOSH/MESA Approved Equipment

- [ ] Self-Contained
- [ ] Supplied Air
- [ ] Can or Cartridge Gas or Vapor
- [ ] Filter-dust Fume, Mist
- [ ] Other (specify) **NONE**

Other Protective Equipment

- [ ] Rubber Boots
- [ ] Apron
- [ ] Other (specify) **NONE**

Special Precautions

Precautionary Notes

- [x] Wash Thoroughly after Handling
- [X] Do Not Get in Eyes, or on Clothing
- [ ] Do not Breathe Dust, Vapor, Mist Gas
- [x] Keep Container Closed
- [x] Keep Away from Sparks, and Open Flames
- [ ] Store in Tightly Closed Container
- [ ] Do Not Store Near Combustables
- [ ] Keep From Contact with Clothing and other Combustible Materials
- [ ] Empty Container may Contain Hazardous Residues
- [ ] Use Explosion Proof Equipment
- [ ] Other (specify):

Other Handling and Storage Conditions - NO SPECIAL CONDITIONS

Disclaimer: Lyden Oil Company, Inc. believes this information is accurate but not all-inclusive in all circumstances. It is the responsibility of the user to determine suitability of the material for their purposes. No Warranty, Expressed or Implied is Given.

METAL MECHANICS
350 S. 14th ST. P.O. BOX 447
SCHOOLCRAFT, MI 49087-0447
PHONE (269) 679-2525 FAX (269) 679-2882

DAILY

DATE	DAILY MAINTENANCE RECOMMENDED (or every 8 hours)	PERFORMED BY	PARTS REQUIRED
	CHECK SIGHT GAUGE FOR FLUID IN RESERVOIR		
	GREASE ALL TIE BAR BUSHINGS		
	VERIFY THAT ALL GUARDING IS IN PLACE & SAFETY SWITCHES FUNCTIONAL		
	CHECK FOR HYDRAULIC LEAKS AND REPORT THEM IMMEDIATELY		

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WEEKLY

DATE	WEEKLY MAINTENANCE RECOMMENDED (or every 120 hours)	PERFORMED BY	PARTS REQUIRED
	GREASE SAFETY RATCHET BAR AND CYLINDER "DOG"		
	CHECK LEVELING OF PRESS		
	VERIFY THAT PRESS IS SOLIDY ANCHORED TO THE FLOOR		
	CHECK FOR LOOSE TIE BAR BOLTS		
	CHECK FOR LOOSE CYLINDER MOUNTING BOLTS		
	VERIFY THAT COOLANT WATER IS ADJUSTED		
	CHECK ELECTRICAL PANEL MOUNTINGS		
	VERIFY ELECTRICAL GROUNDING		

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MONTHLY

DATE	MONTHLY MAINTENANCE RECOMMENDED (or every 520 hours)	PERFORMED BY	PARTS REQUIRED
	CHECK WATER GLYCOL FLUID IN RESERVOIR FOR VISCOSITY		
	VISCOSITY SHOULD BE 310 TO 330 AT 77 DEGREES FAHRENHEIT		
	CHECK SAFETY RATCHET BAR AND CYLINDER "DOG" FOR WEAR		
	REPLACE IF IT MEASURES LESS THAN 1.875"		
	MEASURE RATCHET CYLINDER DOG REPLACE IF IT MEASURES LESS THAN 4.375"		
	PRESS DRIFTING		
	SAFETY WARNING TAGS ARE CLEAN AND LEGIBLE		
	ELECTRICAL SWITCHES AND PUSHBUTTONS CHECKED TO ENSURE GOOD WORKING ORDER		

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QUARTERLY

DATE	QUARTERLY MAINTENANCE RECOMMENDED (or every 1560 hours)	PERFORMED BY	PARTS REQUIRED
	LUBRICATE MOTOR		
	CLEAN SUCTION STRAINER		

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BI-ANNUALLY

DATE	BI-ANNUALLY MAINTENANCE RECOMMENDED (or every 3120 hours)	PERFORMED BY	PARTS REQUIRED
	CLEAN OR REPLACE SUCTION STRAINER FILTER ELEMENT		
	REPLACE RETURN LINE FILTER		

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350 S. 14th ST. P.O. BOX 447
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YEARLY

DATE	YEARLY MAINTENANCE RECOMMENDED (or every 6240 hours)	PERFORMED BY	PARTS REQUIRED
	CHANGE HYDRAULIC FLUID		
	CLEAN PRESS OF DEBRIS, GREASE, OIL, ETC.		