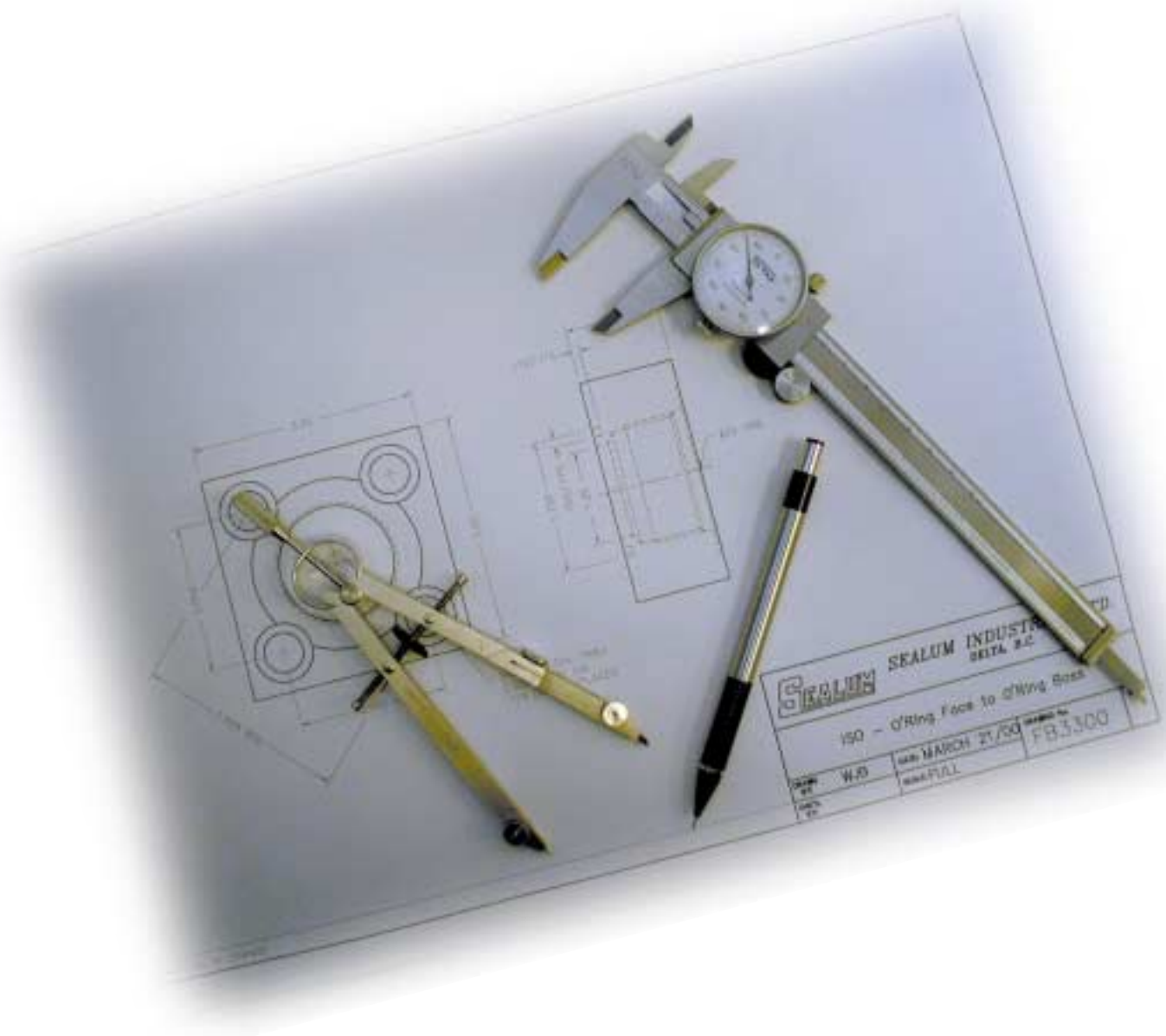




ENGINEERING SPECIFICATIONS

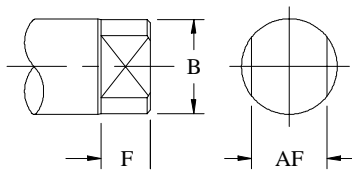


Overview

Rod Specifications

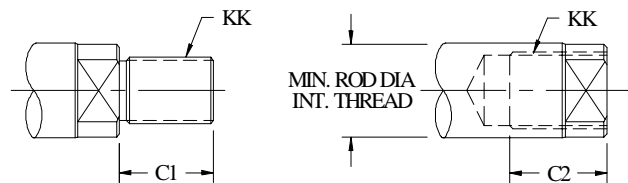
Standard rod material is CPO (*C1045 steel with 0.0005 thick hard chrome plating*). We also offer IHCP (*Induction hardened chrome plated*) or else stainless steel SS (*S316L stainless with 0.001 thick hard chrome*) as readily available options. Rod accessories can be welded or threaded to the rod. Usually, a female thread is recommended over a male thread because a broken end can be easily replaced as opposed to changing a rod that had a male thread. Also, a female thread can be converted to a male thread by using a rod stud (see page 02-16). Note that the thread size is governed by the pin size “CD” of the threaded accessory being used on the rod end.

Rod End Wrench Flats



Rod Dia.	F	AF	B
0.38	0.25	0.25	0.31
0.50	0.25	0.38	0.44
0.63	0.38	0.50	0.56
0.75	0.38	0.63	0.69
1.00	0.63	0.81	0.94
1.25	0.63	1.06	1.19
1.38	0.63	1.13	1.31
1.50	0.75	1.25	1.44
1.75	0.75	1.44	1.69
2.00	0.88	1.69	1.94
2.50	0.88	2.06	2.44
3.00	0.88	2.44	2.94
3.50	1.00	3.00	3.44
4.00	1.00	3.38	3.94
4.50	1.00	3.75	4.44
5.00	1.25	4.25	4.94
6.00	1.25	5.00	5.94

Threaded Rod Ends



CD Pin Dia	KK	C1	C2	MIN ROD DIA.
0.25	1/4-28	0.94	0.91	0.50
0.31	5/16-24	1.13	1.06	0.50
0.38	3/8-24	1.19	1.13	0.63
0.44	7/16-20	1.25	1.13	0.63
0.50	1/2-20	0.88	0.69	0.75
0.63	5/8-18	1.63	1.38	1.00
0.75	3/4-16	1.13	0.81	1.00
1.00	1-14	1.63	1.25	1.38
1.25	1 1/4-12	2.00	1.38	1.75
1.38	1 1/4-12	2.00	1.38	1.75
1.50	1 1/2-12	2.00	1.38	2.50
1.75	1 1/2-12	2.00	1.38	2.50
2.00	1 7/8-12	3.00	2.31	3.00
2.50	2 1/4-12	3.50	2.63	3.50
3.00	2 1/2-12	3.50	2.50	3.50
3.50	3 1/4-12	4.50	3.25	4.50
4.00	3 1/2-12	5.00	3.63	5.00

Proximity Switch

A high pressure GO proximity switch can be installed at the ends of the cylinder. This signals the extended or the retracted positions. These are available as an option only on the series B and EX.

Valves

Valves such as directional, counterbalance, flow control and many others can be added to the cylinder in many ways. We normally mount the valve in a manifold, and mount the manifold to the cylinder with SAE Code 61 or Code 62 connections, and then run a steel tube to the other end.

Overview

Ports

Cylinder ports are machined into the barrel end and barrel ring. This eliminates the local distortion and stress concentration due to welding a half coupling on the outside of the barrel. The result is a strong, clean cylinder barrel. However, the downside is that because we pre-manufacture and stock these parts, changing the port size is difficult. Therefore, it is more cost effective to use an adapter to change the port type and size.

Port sizes and threads

Dash Size	NPT	ORB & JIC	BSPP	ORFS
-02	1/8"-27	5/16"-24	1/8"-28	
-03		3/8"-24		
-04	1/4"-18	7/16"-20	1/4"-19	9/16"-18
-05		1/2"-20		
-06	3/8"-18	9/16"-18	3/8"-19	11/16"-16
-08	1/2"-14	3/4"-16	1/2"-14	13/16"-16
-10		7/8"-14	5/8"-14	1"-14
-12	3/4"-14	1-1/16"-12	3/4"-14	1-3/16"-12
-14		1-3/16"-12		
-16	1"-11.5	1-5/16"-12	1"-11	1-7/16"-12
-20	1-1/4"-11.5	1-5/8"-12	1-1/4"-11	1-11/16"-12
-24	1-1/2"-11.5	1-7/8"-12	1-1/2"-11	2"-12
-32	2"-11.5	2-1/2"-12	2"-11	

Seals

All of our cylinders utilize the latest in seal design from major manufacturers. Seals are one of the most critical components in a hydraulic cylinder. It is very important to keep the nearby operating environment as clean as possible and to keep the oil as contaminant free as possible.

Our piston seals are carefully chosen to perform in the requirements of each individual series of cylinder. Most of our piston seals will be of the "slipper" style, while the Series B offers the option of using a loaded "u-cup" style. In general, u-cup seals are used where the cylinder must support a load without creeping. The slipper style of seals offer low friction and are more tolerant of contamination. Materials range from hard plastic to urethane to glass filled PTFE, all with nitrile energizers.

Our rod seals are a loaded u-cup style with back beveled sealing lips. They also have a greater depth than cross section to resist roll over in the groove under pressure.

Our rod wipers are polyurethane either of the metal encased style or the snap in style. The metal encased rod wipers are used on the Series B, EX and TH.

All wear rings are reinforced nylon.

All O'rings and backup rings are nitrile.

Overview

Torque Specifications

The torque on a bolt or nut must be sufficient to create a preload that is greater than the load to be carried. The values given in the charts are for SAE Gr.8 bolts and C1045 rod material and a nut material with a minimum yield strength of

Head Gland bolts

Bolt size	Preload (lb)	Torque (lb-ft) ±10%
1/4"-20	2860	12
5/16"-18	4720	24
3/8"-16	7000	45
7/16"-14	9550	70
1/2"-13	12,750	105
9/16"-12	16,400	155
5/8"-11	20,350	210
3/4"-10	30,100	375
7/8"-14	45,800	675
1"-14	61,000	1015

Piston Nut (use Loctite #262)

Nut size	Preload (lb)	Torque (lb-ft) ±10%
1/2"-20	11,510	70
3/4"-16	26,850	250
1"-14	48,950	610
1 1/4"-12	57,325	960
1 3/8"-12	75,740	1300
1 1/2"-12	91,100	1710
1 5/8"-12	118,200	2400
1 3/4"-12	131,400	2875
1 7/8"-12	151,800	3560
2"-12	169,650	4240
2 1/4"-12	221,400	6230
2 1/2"-12	230,900	7215
3"-12	381,700	14,300
3 1/2"-12	471,250	20,620

Thread locking compound

All threaded components of the cylinder should be assembled using a thread locking compound. This will ensure that items such as head gland bolts and piston nuts stay tight. We use products such as Loctite Threadlocker. It is important to closely follow the manufacturers instructions regarding cleaning and priming before applying these threadlocking compounds.

Request for Quotation

At the end of this section is a Request for Quotation form. Fill this out and fax it to Sealum Industries Ltd.

The fax # is (604-522-0070). We will then contact you with a price and delivery or for any further information.

If the cylinder is one that has been ordered before, write in the model number on the comments line at the bottom of the page (include any changes that may have been made since the original delivery).

Overview

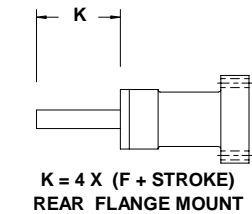
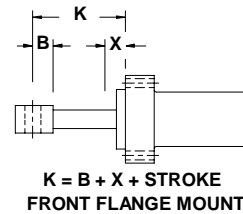
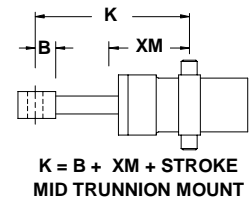
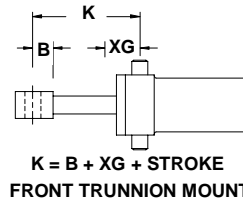
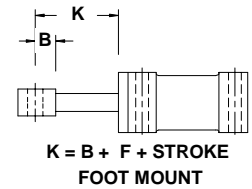
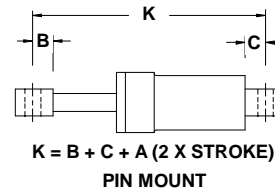
Buckling

A major concern with long stroke cylinders under a compressive load is the buckling of the rod. This can be reduced or eliminated by various means:-

- Use a stop tube to increase the overlap between the piston and the head gland.
- Use spherical bearings to reduce eccentricity.
- Use a mounting style that will reduce the “K” dimension.

The chart below should be used as a reference guide only. The customer will have to consider the cylinder application to select a rod size and stop tube to avoid any cylinder buckling.

THRUST (in lbs.)	VALUE OF 'K' IN INCHES											
	5/8	1	1 3/8	1 3/4	2	2 1/2	3	3 1/2	4	5	5 1/2	7
400	35	84	134									
700	30	68	119									
1,000	26	60	105	156	190							
1,400	24	54	93	144	175	244	308					
1,800	23	48	84	127	160	230	294	366				
2,400	18	45	75	114	145	214	281	347				
3,200	16	40	68	103	131	196	262	329	398			
4,000	12	38	63	93	119	174	240	310	373			
5,000	9	36	60	87	112	163	225	289	359			
6,000		30	56	82	102	152	209	274	342	476		
8,000		25	51	76	93	136	186	244	310	448		
10,000		21	45	70	89	125	172	221	279	412		
12,000		17	41	64	85	117	155	210	270	388	455	
16,000			35	57	75	110	141	188	233	350	421	
20,000			28	52	66	103	136	173	218	325	385	
30,000				39	56	87	120	156	190	285	330	
40,000				24	43	75	108	142	177	248	293	
50,000					30	66	97	131	165	234	268	408
60,000						57	88	119	154	226	256	384
80,000						36	71	104	136	204	240	336
100,000							56	91	120	199	224	324
120,000							45	76	108	174	207	313
140,000								64	98	162	194	301
160,000								47	87	149	182	279
200,000									65	131	160	260
250,000										109	143	236
300,000										85	120	212
350,000										53	100	195
400,000											72	182



DIMENSIONS

K = Column Length

A = Dimension added to stroke to determine collapsed cylinder length. See Cylinder dimensional data pages.

B = Length to center of rod mounting accessory. Equal to dimension L, LS, CE, or E, depending on rod accessory selected. See Mounting Accessory data pages

C = Length to center of barrel mounting accessory. Equal to dimensions L, LS, or E, depending on mounting accessory selected. See Mounting Accessory data pages .

F = Length of rod extension when cylinder is collapsed. 'F' is included in dimensions A, X, XG, and XM. See Cylinder dimensional data pages.

When a rod extension is used, the extra length must be added to 'K'.

Overview

Cylinder Force

THEORETICAL CYLINDER FORCES (values do not reflect losses due to friction or other variables)

Force (lb) = Pressure (psi) x Piston Area (sq.in.)

BORE SIZE	ROD DIA	FORCE (lbs)	SYSTEM PRESSURE (psi)									VOLUME
			1000	1500	2000	2500	3000	3500	4000	4500	5000	Gallons per inch of Stroke
1 1/2	3/4	PUSH	1,770	2,650	3,530	4,420	5,300	6,180	7,070	7,950	8,830	0.0076
		PULL	1,320	1,990	2,650	3,310	3,970	4,640	5,300	5,960	6,630	0.0057
2	1	PUSH	3,140	4,710	6,280	7,850	9,420	11,000	12,560	14,140	15,700	0.0136
		PULL	2,360	3,530	4,710	5,890	7,070	8,250	9,420	10,600	11,780	0.0102
		PULL	1,660	2,480	3,310	4,140	4,970	5,800	6,630	7,450	8,280	0.0072
2 1/2	1	PUSH	4,910	7,360	9,820	12,270	14,720	17,180	19,630	22,090	24,540	0.0213
		PULL	4,120	6,180	8,250	10,300	12,370	14,430	16,490	18,550	20,610	0.0179
		PULL	3,420	5,130	6,850	8,560	10,270	11,980	13,700	15,400	17,120	0.0148
		PULL	2,500	3,750	5,010	6,260	7,510	8,760	10,010	11,260	12,510	0.0108
3	1 3/8	PUSH	7,070	10,600	14,130	17,670	21,200	24,740	28,270	31,810	35,340	0.0306
		PULL	5,580	8,370	11,160	13,960	16,750	19,540	22,330	25,120	27,920	0.0242
		PULL	4,660	6,990	9,330	11,660	13,990	16,320	18,650	20,980	23,310	0.0202
		PULL	3,930	5,890	7,850	9,820	11,780	13,740	15,700	17,670	19,630	0.0170
3 1/4	1 3/8	PUSH	8,300	12,440	16,590	20,740	24,900	29,030	33,180	37,330	41,480	0.0359
		PULL	6,810	10,210	13,620	17,020	20,430	23,840	27,240	30,650	34,050	0.0295
		PULL	5,890	8,830	11,780	14,720	17,670	20,610	23,560	26,500	29,450	0.0255
		PULL	5,150	7,730	10,300	12,880	15,460	18,040	20,610	23,190	25,770	0.0223
3 1/2	2	PUSH	9,620	14,430	19,240	24,050	28,860	33,670	38,480	43,290	48,100	0.0416
		PULL	8,130	12,200	16,270	20,340	24,410	28,470	32,540	36,610	40,680	0.0352
		PULL	7,210	10,820	14,430	18,040	21,650	25,250	28,860	32,470	35,080	0.0312
		PULL	6,480	9,720	12,960	16,200	19,440	22,680	25,910	29,160	32,400	0.0280
		PULL	4,710	7,070	9,420	11,780	14,140	16,490	18,850	21,200	23,560	0.0204
4	2 1/2	PUSH	12,550	18,850	25,130	31,410	37,700	43,980	50,260	56,550	62,830	0.0544
		PULL	10,160	15,240	20,320	25,400	30,480	35,560	40,640	45,720	50,800	0.0440
		PULL	9,420	14,130	18,850	23,560	28,270	32,980	37,700	42,410	47,120	0.0408
		PULL	7,660	11,480	15,310	19,140	22,970	26,800	30,630	34,460	38,290	0.0332
		PULL	5,500	8,250	11,000	13,740	16,490	19,240	21,990	24,740	27,490	0.0238
4 1/2	3	PUSH	15,900	23,850	31,810	39,760	47,710	55,660	63,610	71,570	79,520	0.0688
		PULL	12,760	19,140	25,520	31,900	38,290	44,670	51,050	57,430	63,810	0.0552
		PULL	10,990	16,490	21,990	27,490	32,980	38,480	43,980	49,480	54,980	0.0476
		PULL	8,830	13,250	17,670	22,090	26,500	30,920	35,340	39,760	44,180	0.0383
5	3 1/2	PUSH	19,630	29,450	39,270	49,090	58,900	68,720	78,540	88,360	98,170	0.0850
		PULL	16,490	24,740	32,980	41,230	49,480	57,720	65,970	74,220	82,460	0.0714
		PULL	12,560	18,850	25,130	31,410	37,700	43,980	50,260	56,550	62,830	0.0544
		PULL	10,010	15,020	20,030	25,030	30,040	35,050	40,050	45,060	50,070	0.0434
5 1/2	4	PUSH	23,760	35,640	47,510	59,390	71,270	83,150	95,030	106,910	118,790	0.1028
		PULL	14,130	21,200	28,270	35,340	42,410	49,480	56,550	63,610	70,680	0.0162
6	4 1/2	PUSH	28,270	42,410	56,550	70,680	84,820	98,960	113,100	127,230	141,370	0.1224
		PULL	23,360	35,050	46,730	58,410	70,100	81,780	94,460	107,140	119,830	0.1011
		PULL	21,200	31,810	42,410	53,010	63,610	74,220	84,820	95,420	106,030	0.0918
		PULL	18,650	27,980	37,300	46,630	55,960	65,280	74,610	83,940	93,260	0.0807
6 1/2	5	PUSH	33,180	49,770	66,360	82,960	99,550	116,140	132,730	149,320	165,910	0.1436
		PULL	20,610	30,920	41,230	51,540	61,850	72,150	82,460	92,770	103,080	0.0892
7	5 1/2	PUSH	38,480	57,720	76,970	96,210	115,450	134,690	153,940	173,180	192,420	0.1666
		PULL	31,410	47,120	62,830	78,540	94,250	109,950	125,660	141,370	157,080	0.1360
		PULL	25,920	38,870	51,800	64,800	77,750	90,710	103,670	116,630	129,590	0.1122
8	6	PUSH	48,850	73,270	97,690	122,110	146,530	170,950	195,370	219,790	244,210	0.2112
		PULL	38,480	57,720	76,970	96,210	115,450	134,690	153,940	173,180	192,420	0.1666
		PULL	31,410	47,120	62,830	78,540	94,250	109,950	125,660	141,370	157,080	0.1360
		PULL	25,920	38,870	51,800	64,800	77,750	90,710	103,670	116,630	129,590	0.1122
		PULL	18,850	28,270	37,700	47,120	56,550	65,970	75,400	84,820	94,250	0.0816
10	7 1/2	PUSH	50,260	75,400	100,530	125,660	150,800	175,930	201,060	226,200	251,330	0.2176
		PULL	40,640	60,960	81,290	101,610	121,930	142,250	162,580	182,900	203,220	0.1760
		PULL	37,700	56,550	75,400	94,250	131,100	131,940	150,800	169,640	188,500	0.1632
		PULL	30,630	45,940	61,260	76,570	91,890	107,200	122,520	137,840	153,150	0.1326
		PULL	26,500	39,760	53,010	66,270	79,520	92,770	106,030	119,280	132,530	0.1148
10	8	PUSH	78,540	117,810	158,080	196,350	235,620	274,890	314,160	353,430	392,700	0.3400
		PULL	58,900	88,360	117,810	147,260	176,710	206,170	235,620	265,070	294,520	0.2550
		PULL	50,260	75,400	100,530	125,660	150,800	175,930	201,060	226,200	251,330	0.2176
		PULL	40,050	60,080	80,110	100,140	120,160	140,190	160,220	180,250	200,270	0.1734

Overview

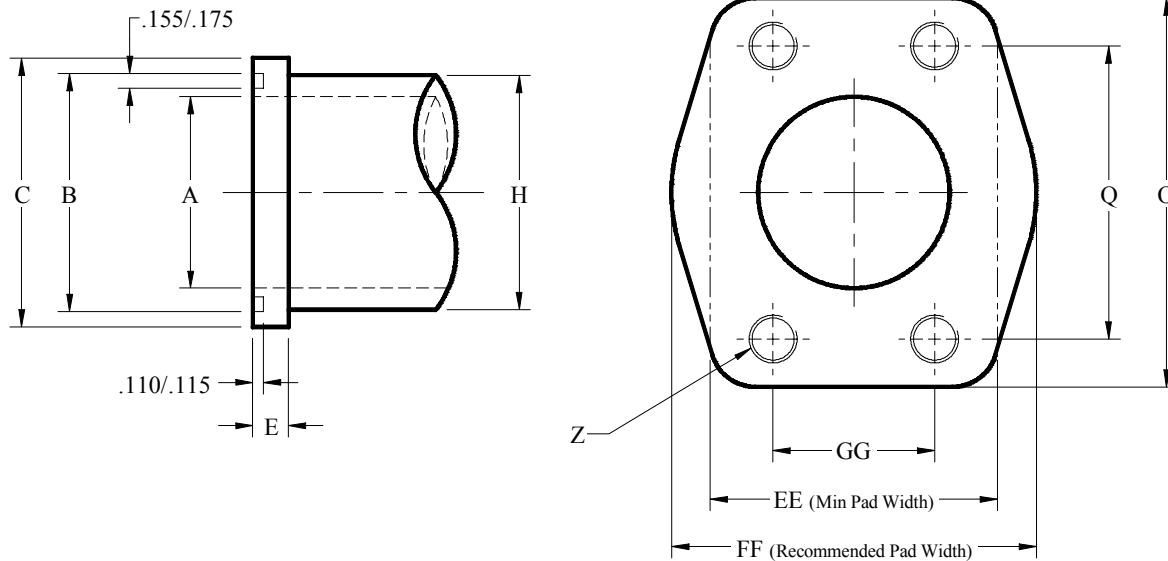
Cylinder Speed

THEORETICAL CYLINDER SPEEDS (inches per second)

Speed (in/sec) = 3.85 x Flow (GPM) ÷ Area (sq.in.)

BORE SIZE	ROD DIA.	FLOW (GPM)																	
		1	2	5	7	10	12	15	20	25	30	35	40	45	50	60	70	90	100
1 1/2	3/4	2.2	4.4	10.9	15.3	21.8													
		2.9	5.8	14.5	20.3	29.1													
2	1	1.2	2.5	6.1	8.6	12.3	14.7	18.4											
	1 3/8	1.6	3.3	8.2	11.4	16.4	19.6	24.5											
	1 3/8	2.3	4.7	11.6	16.3	23.3	27.9	34.9											
2 1/2	1	0.8	1.6	3.9	5.5	7.9	9.4	11.8	15.7	19.6									
	1 3/8	0.9	1.9	4.7	6.5	9.3	11.2	14.0	18.7	23.5									
	1 3/4	1.1	2.3	5.6	7.9	11.3	13.5	16.9	22.5	28.1									
	1 3/4	1.5	3.1	7.7	10.8	15.4	18.5	23.1	30.8	38.5									
3	1 3/8	0.5	1.1	2.7	3.8	5.5	6.5	8.2	10.9	13.6	16.4	19.1							
	1 3/4	0.7	1.4	3.5	4.8	6.9	8.3	10.4	13.8	17.3	20.7	24.2							
	1 3/4	0.8	1.7	4.1	5.8	8.3	9.9	12.4	16.5	20.7	24.8	28.9							
	2	1.0	2.0	5.0	6.9	9.8	11.8	14.7	19.6	24.5	29.4	34.3							
3 1/4	1 3/8	0.5	0.9	2.3	3.3	4.6	5.6	7.0	9.3	11.6	13.9	16.3	18.6						
	1 3/8	0.6	1.1	2.8	3.9	5.7	6.8	8.5	11.3	14.1	17.0	19.8	22.6						
	1 3/4	0.7	1.3	3.3	4.6	6.5	7.9	9.8	13.1	16.4	19.6	22.9	26.2						
	2	0.8	1.5	3.7	5.2	7.5	9.0	11.2	15.0	18.7	22.4	26.1	29.9						
3 1/2	1 3/4	0.4	0.8	2.0	2.8	4.0	4.8	6.0	8.0	10.0	12.0	14.0	16.0	18.0					
	1 3/4	0.5	1.1	2.7	3.7	5.3	6.4	8.0	10.7	13.4	16.0	18.7	21.4	24.0					
	2	0.6	1.2	3.0	4.2	5.9	7.1	8.9	11.9	14.7	17.8	20.8	23.8	26.8					
	2 1/2	0.8	1.6	4.1	5.7	8.2	9.8	12.3	16.4	20.4	24.5	28.6	32.7	36.8					
4	1 3/4		0.6	1.5	2.2	3.1	3.7	4.6	6.1	7.7	9.2	10.7	12.3	13.8	15.3	18.4			
	1 3/4		0.8	1.9	2.7	3.8	4.6	5.7	7.6	9.5	11.4	13.3	15.2	17.1	19.0	22.8			
	2		0.8	2.0	2.9	4.1	4.9	6.1	8.2	10.2	12.3	14.3	16.4	18.4	20.4	24.5			
	3		1.4	3.5	4.9	7.0	8.4	10.5	14.0	17.5	21.0	24.5	28.0	31.5	35.0	42.0			
4 1/2	2		0.5	1.2	1.7	2.4	2.9	3.6	4.8	6.1	7.3	8.5	9.7	10.9	12.1	14.5	17.0		
	2		0.6	1.5	2.1	3.0	3.6	4.5	6.0	7.6	9.1	10.6	12.1	13.6	15.1	18.1	21.1		
	2 1/2		0.7	1.8	2.5	3.5	4.2	5.3	7.0	8.8	10.5	12.3	14.0	15.8	17.5	21.0	24.5		
	3		0.9	2.2	3.1	4.4	5.2	6.5	8.7	10.9	13.1	15.3	17.4	19.6	21.8	26.2	30.5		
5	2		0.4	1.0	1.4	2.0	2.4	2.9	3.9	4.9	5.9	6.9	7.9	8.8	9.8	11.8	13.7	17.7	
	2		0.5	1.2	1.6	2.3	2.8	3.5	4.7	5.8	7.0	8.2	9.3	10.5	11.7	14.0	16.4	21.0	
	3		0.6	1.5	2.2	3.1	3.7	4.6	6.1	7.7	9.2	10.7	12.3	13.8	15.3	18.4	21.5	27.6	
	3 1/2		0.8	1.9	2.7	3.9	4.6	5.8	7.7	9.6	11.5	13.5	15.4	17.3	19.2	23.0	26.9	34.6	
6	2 1/2			0.7	1.0	1.4	1.6	2.0	2.7	3.4	4.1	4.8	5.5	6.1	6.8	8.2	9.5	12.3	13.6
	2 1/2			0.8	1.2	1.7	2.0	2.5	3.3	4.1	5.0	5.8	6.6	7.4	8.2	9.9	11.5	14.8	16.5
	3			0.9	1.3	1.8	2.2	2.7	3.6	4.5	5.5	6.4	7.3	8.2	9.1	10.9	12.7	16.4	18.2
	4			1.2	1.7	2.5	2.9	3.7	4.9	6.1	7.4	8.6	9.8	11.0	12.3	14.7	17.2	22.0	24.5
7	3			0.5	0.7	1.0	1.2	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	9.0	10.0
	3			0.6	0.9	1.2	1.5	1.8	2.5	3.1	3.7	4.3	4.9	5.5	6.1	7.4	8.6	11.0	12.3
	4			0.7	1.0	1.5	1.8	2.2	3.0	3.7	4.5	5.2	5.9	6.7	7.4	8.9	10.4	13.4	14.9
	5			1.0	1.4	2.0	2.5	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2	12.3	14.3	18.4	20.4
8	3 1/2				0.5	0.8	0.9	1.2	1.5	1.9	2.3	2.7	3.1	3.5	3.8	4.6	5.4	6.9	7.7
	3 1/2				0.7	1.0	1.1	1.4	1.9	2.4	2.8	3.3	3.8	4.3	4.7	5.7	6.6	8.5	9.5
	4				0.7	1.0	1.2	1.5	2.0	2.6	3.1	3.6	4.1	4.6	5.1	6.1	7.2	9.2	10.2
	5 1/2				1.0	1.5	1.7	2.2	2.9	3.6	4.4	5.1	5.8	6.5	7.3	8.7	10.2	13.1	14.5
10	5					0.5	0.6	0.7	1.0	1.2	1.5	1.7	2.0	2.2	2.5	2.9	3.4	4.4	4.9
	5					0.7	0.8	1.0	1.3	1.6	2.0	2.3	2.6	2.9	3.3	3.9	4.6	5.9	6.5
	6					0.8	0.9	1.2	1.5	1.9	2.3	2.7	3.0	3.5	3.8	4.6	5.4	6.9	7.7
	7					1.0	1.2	1.4	1.9	2.4	2.9	3.4	3.9	4.3	4.8	5.8	6.7	8.7	9.6

SAE J518C 4-Bolt Flange Specifications



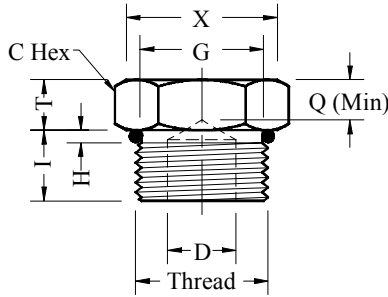
Code 61

Nom. Flange Size	A +0.00 -0.06	B +0.005 -0.000	C ±0.010	E ±0.005	H Dia Max	GG ±0.010	Q ±0.010	O	EE Min.	FF	Z Thread UNC	Z Thread Metric	Max Work. Pres.	Bolt Torque lb-in	N70 "O" Ring
1/2"	0.50	1.000	1.188	0.265	0.94	0.688	1.500	2.12	1.31	1.81	5/16-18	M8x1.25	5000 psi	175-225	2-210
3/4"	0.75	1.250	1.500	0.265	1.25	0.875	1.875	2.56	1.62	2.06	3/8-16	M10x1.50	5000 psi	250-350	2-214
1"	1.00	1.560	1.750	0.315	1.50	1.031	2.062	2.75	1.88	2.31	3/8-16	M10x1.50	5000 psi	325-425	2-219
1 1/4"	1.25	1.750	2.000	0.315	1.70	1.188	2.312	3.12	2.12	2.88	7/16-14	M10x1.50	4000 psi	425-550	2-222
1 1/2"	1.50	2.115	2.375	0.315	1.98	1.406	2.750	3.69	2.50	3.25	1/2-13	M12x1.75	3000 psi	550-700	2-225
2"	2.00	2.490	2.812	0.375	2.45	1.688	3.062	4.00	3.00	3.81	1/2-13	M12x1.75	3000 psi	650-800	2-228
2 1/2"	2.50	2.995	3.312	0.375	2.92	2.000	3.500	4.50	3.50	4.28	1/2-13	M12x1.75	2500 psi	950-1100	2-232
3"	3.00	3.615	4.000	0.375	3.55	2.438	4.188	5.31	4.19	5.16	5/8-11	M16x2.00	2000 psi	1650-1800	2-237
3 1/2"	3.50	4.095	4.500	0.442	4.00	2.750	4.750	6.00	4.69	5.50	5/8-11	M16x2.00	500 psi	1400-1600	2-241
4"	4.00	4.595	5.000	0.442	4.50	3.062	5.125	6.38	5.19	6.00	5/8-11	M16x2.00	500 psi	1400-1600	2-245
5"	5.00	5.595	6.000	0.442	5.50	3.625	6.000	7.25	6.19	7.12	5/8-11	M16x2.00	500 psi	1400-1600	2-253

Code 62

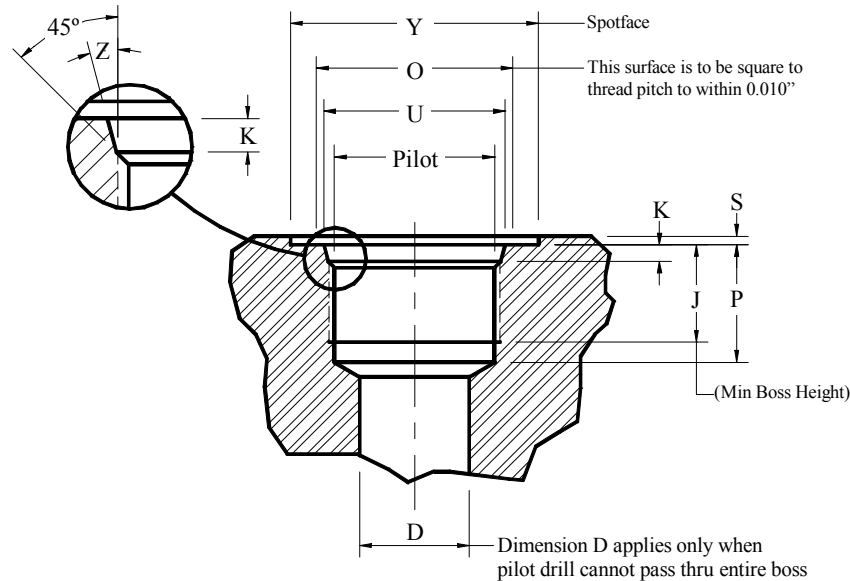
Nom. Flange Size	A +0.00 -0.06	B +0.005 -0.000	C ±0.010	E ±0.005	H Dia Max	GG ±0.010	Q ±0.010	O	EE Min.	FF	Z Thread UNC	Z Thread Metric	Max Work. Pres.	Bolt Torque lb-in	N70 "O" Ring
1/2"	0.50	1.000	1.250	0.305	0.94	0.718	1.574	2.22	1.50	1.88	5/16-18	M8x1.25	6000 psi	175-225	2-210
3/4"	0.75	1.250	1.625	0.345	1.25	0.937	2.000	2.81	1.88	2.38	3/8-16	M10x1.50	6000 psi	300-400	2-214
1"	1.00	1.560	1.875	0.375	1.50	1.093	2.250	3.19	2.12	2.75	7/16-14	M12x1.75	6000 psi	500-600	2-219
1 1/4"	1.25	1.750	2.125	0.405	1.72	1.250	2.625	3.75	2.38	3.06	1/2-13	M14x2.00	6000 psi	750-900	2-222
1 1/2"	1.50	2.115	2.500	0.495	2.00	1.437	3.125	4.44	2.75	3.75	5/8-11	M16x2.00	6000 psi	1400-1600	2-225
2"	2.00	2.490	3.125	0.495	2.62	1.750	3.812	5.25	3.38	4.50	3/4-10	M20x2.50	6000 psi	2400-2600	2-228

Male O'Ring Boss (ORB) Specifications



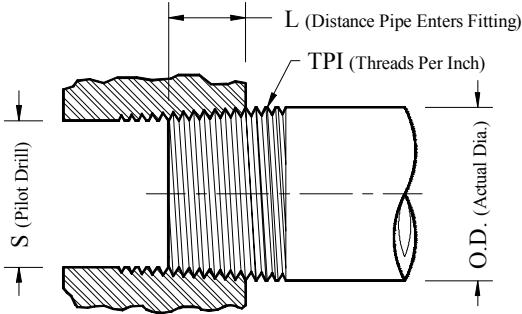
Nom. Size	Dash No.	UNF Thread	C Hex	D ^{+0.005} / _{-0.000}	G ^{+0.002} / _{-0.003}	H ^{+0.015} / _{-0.000}	I ± .005	T	Q	X	N70 O'Ring
1/8	-02	5/16"-24	7/16	0.093	0.250	0.063	0.297	0.125	0.06	0.438	2-902
3/16	-03	3/8"-24	1/2	0.125	0.313	0.063	0.297	0.125	0.08	0.500	2-903
1/4	-04	7/16"-20	9/16	0.203	0.364	0.075	0.360	0.156	0.10	0.563	2-904
5/16	-05	1/2"-20	5/8	0.234	0.427	0.075	0.360	0.156	0.12	0.625	2-905
3/8	-06	9/16"-18	11/16	0.297	0.482	0.083	0.391	0.188	0.16	0.688	2-906
1/2	-08	3/4"-16	7/8	0.422	0.660	0.094	0.438	0.188	0.22	0.875	2-908
5/8	-10	7/8"-14	1	0.500	0.773	0.107	0.500	0.250	0.25	1.000	2-910
3/4	-12	1-1/16"-12	1-1/4	0.656	0.945	0.125	0.594	0.313	0.25	1.250	2-912
7/8	-14	1-3/16"-12	1-3/8	0.718	1.07	0.125	0.594	0.313	0.25	1.375	2-914
1	-16	1-5/16"-12	1-1/2	0.875	1.195	0.125	0.594	0.375	0.25	1.500	2-916
1-1/4	-20	1-5/8"-12	1-7/8	1.093	1.507	0.125	0.594	0.375	0.25	1.875	2-920
1-1/2	-24	1-7/8"-12	2-1/8	1.344	1.756	0.125	0.594	0.375	0.25	2.125	2-924
2	-32	2-1/2"-12	2-3/4	1.813	2.381	0.125	0.594	0.375	0.30	2.750	2-932

Female O'Ring Boss (ORB) Specifications



Nom. Size	Dash No.	UNF Thread	Y	O	U ^{+0.005} / _{-0.000}	Pilot Drill	K ^{+0.015} / _{-0.000}	S	J	P	D	Z ± 1°
1/8	-02	5/16"-24	0.672	0.438	0.358	I	0.074	0.062	0.390	0.468	0.062	12
3/16	-03	3/8"-24	0.750	0.500	0.421	Q	0.074	0.062	0.390	0.468	0.125	12
1/4	-04	7/16"-20	0.828	0.563	0.487	25/64	0.093	0.062	0.454	0.547	0.172	12
5/16	-05	1/2"-20	0.906	0.625	0.550	29/64	0.093	0.062	0.454	0.547	0.234	12
3/8	-06	9/16"-18	0.969	0.688	0.616	33/64	0.097	0.062	0.500	0.609	0.297	12
1/2	-08	3/4"-16	1.188	0.875	0.811	11/16	0.10	0.094	0.562	0.688	0.391	15
5/8	-10	7/8"-14	1.344	1.000	0.942	13/16	0.100	0.094	0.656	0.781	0.484	15
3/4	-12	1-1/16"-12	1.625	1.250	1.148	63/64	0.130	0.094	0.750	0.906	0.609	15
7/8	-14	1-3/16"-12	1.765	1.375	1.273	1-3/32	0.130	0.094	0.750	0.906	0.719	15
1	-16	1-5/16"-12	1.910	1.500	1.398	1-15/64	0.130	0.125	0.750	0.906	0.844	15
1-1/4	-20	1-5/8"-12	2.270	1.875	1.713	1-17/32	0.132	0.125	0.750	0.906	1.078	15
1-1/2	-24	1-7/8"-12	2.560	2.125	1.962	1-51/64	0.132	0.125	0.750	0.906	1.312	15
2	-32	2-1/2"-12	3.480	2.750	2.587	2-27/64	0.132	0.125	0.750	0.906	1.781	15

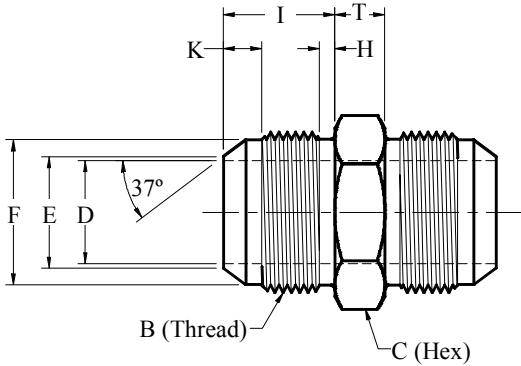
National Pipe Thread (NPT) Specifications



**Pipe size may be designated by giving a nominal pipe size and wall thickness or schedule. See chart on following page for schedules and physical dimensions.

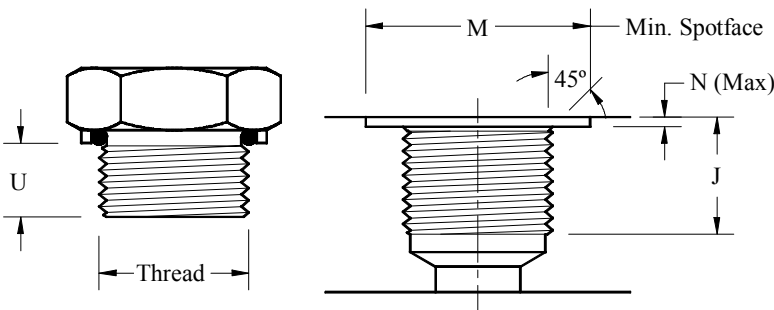
Nominal Pipe Size	TPI	OD	S	L	WALL THICKNESS**			
					Sch. 40	Sch. 80	Sch. 160	XXS
1/8	27	.405	11/32	3/16	.068	0.95	—	—
1/4	18	.540	7/16	9/32	0.88	.119	—	—
3/8	18	.675	37/64	19/64	0.91	.126	—	—
1/2	14	.840	23/32	3/8	.109	.147	.187	.294
3/4	14	1.050	59/64	13/32	.113	.154	.218	.308
1.00	11.50	1.315	1-5/32	1/2	.133	.179	.250	.358
1.25	11.50	1.660	1-1/2	35/64	.140	.191	.250	.382
1.50	11.50	1.900	1-47/64	9/16	.145	.200	.281	.400
2.00	11.50	2.375	2-7/32	37/64	.154	.218	.343	.436
2.50	8	2.875	2-5/8	7/8	.203	.276	.375	.552
3.00	8	3.50	3-1/4	15/16	.216	.300	.437	.600
3.50	8	4.00	3-3/4	1	.226	.318	—	—
4.00	8	4.50	4-1/4	1-1/16	.237	.337	.531	.674

JIC Specifications



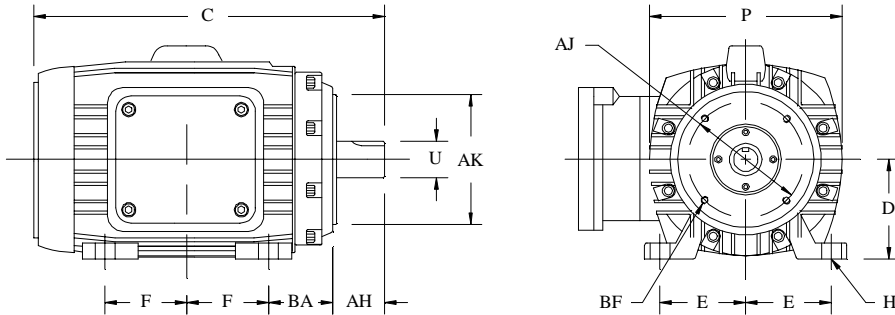
Nom. Size	Dash No.	B UNF Thread	C Hex	D	E±.003	F ^{+0.000} _{-0.005}	H ^{+0.015} _{-0.000}	I±.015	K ^{+0.015} _{-0.000}	T
1/8	-02	5/16"-24	7/16	.062	.083	.245	.063	.448	.177	.22
3/16	-03	3/8"-24	7/16	.125	.146	.307	.063	.479	.177	.22
1/4	-04	7/16"-20	1/2	.172	.193	.359	.075	.550	.193	.22
5/16	-05	1/2"-20	9/16	.234	.255	.421	.075	.550	.193	.22
3/8	-06	9/16"-18	5/8	.297	.318	.476	.083	.556	.198	.25
1/2	-08	3/4"-16	13/16	.391	.426	.654	.094	.657	.253	.25
5/8	-10	7/8"-14	15/16	.484	.539	.767	.107	.758	.266	.31
3/4	-12	1-1/16"-12	1-1/8	.609	.664	.938	.125	.864	.315	.38
7/8	-14	1-3/16"-12	1-1/4	.718	.788	1.063	.125	.890	.315	.38
1	-16	1-5/16"-12	1-3/8	.844	.913	1.188	.125	.911	.315	.38
1-1/4	-20	1-5/8"-12	1-11/16	1.078	1.147	1.501	.125	.958	.367	.46
1-1/2	-24	1-7/8"-12	2	1.312	1.381	1.750	.125	1.083	.378	.53
2	-32	2-1/2"-12	2-5/8	1.781	1.880	2.375	.125	1.333	.461	.68

British Standard Pipe Parallel (BSPP) Specifications



Dash Size	Whitworth Thread	Major Dia.	Minor Dia.	U	M	N	J
-04	1/4"-19	.52	.45	.37	.85	.059	.43
-06	3/8"-19	.66	.59	.37	1.00	.059	.43
-08	1/2"-14	.83	.74	.51	1.19	.059	.55
-12	3/4"-14	1.04	.95	.51	1.44	.059	.63
-16	1"-11	1.31	1.19	.63	1.81	.078	.75
-20	1-1/4"-11	1.65	1.54	.63	2.25	.078	.83
-24	1-1/2"-11	1.88	1.77	.63	2.50	.078	.83

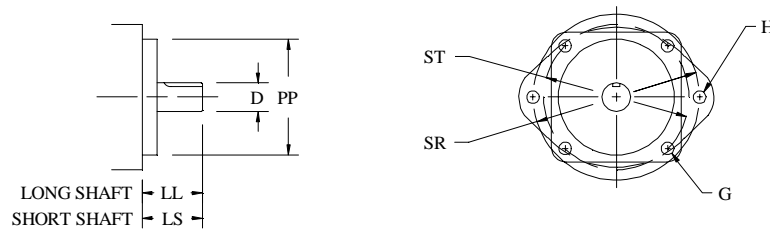
NEMA Motor & SAE Pump Specifications



**HP based on 1750 RPM and 440 volts.

NEMA Motor Specifications

HP	Frame Size	E	F	H	BA	C	D	P	U	AH	AJ	AK	BF (QTY.)
1	143 TC	2.75	2.00	0.34	2.25	12.25	3.50	7.72	0.88	2.13	5.87	4.50	3/8-16 (4)
2	145 TC		2.50			13.25							
3	182 TC	3.75	2.25	0.41	2.75	15.00	4.50	8.91	1.13	2.62	7.25	8.50	1/2-13 (4)
5	184 TC		2.75			15.63							
7.5	213 TC	4.25	2.75	0.41	3.50	18.00	5.25	11.19	1.38	3.12			
10	215 TC		3.50			19.50							
15	254 TC	5.00	4.13	0.53	4.25	24.00	6.25	12.75	1.63	3.75	9.00	10.50	1/2-13 (4)
20	256 TC		5.00			25.60							
25	284 TC	5.50	4.75	0.53	4.75	25.60	7.00	14.50	1.88	4.37	11.00	12.50	5/8-11 (4)
30	286 TC		5.50			27.09							
40	324 TC	6.25	5.25	0.66	5.25	30.87	8.00	15.50	2.13	5.00	11.00	12.50	5/8-11 (4)
50	326 TC		6.00			30.86							
60	364 TC	7.00	5.63	0.66	5.87	35.00	9.00	17.50	2.38	5.62			
75	365 TC		6.13			36.00							
100	405 TC	8.00	6.88	0.81	6.63	38.00	10.00	19.13	2.88	7.00	14.00	16.00	5/8-11 (8)
125	444 TC	9.00	7.25	0.81	7.50	43.00	11.00	22.06	3.38	8.25			
150	445 TC		8.25			46.00							



SAE Pump Specifications

Pump Size	PP (Pilot)	4-Bolt Mount		2-Bolt Mount		Straight Shaft		
		ST	G	SR	H	LL	LS	D
1.78	1.78	2.838	0.38	—	—	—	—	—
AA	2.00	—	—	3.250	0.41	—	1.06	0.50
A	3.25	4.125	0.44	4.188	0.44	2.31	1.25	0.63
B	4.00	5.000	0.56	5.750	0.56	2.81	1.63	0.88
C	5.00	6.375	0.56	7.125	0.69	3.31	2.19	1.25
D	6.00	9.000	0.81	9.000	0.81	3.94	2.94	1.75
E	6.50	12.500	0.81	12.500	0.81	3.94	2.94	1.75
F	7.00	13.780	1.06	13.780	1.06	—	—	—

A.S.A. Pipe Schedules

Pipe Size	Actual O.D.	Wall Thickness (I.D.)												
		10	20	30	40	Std.	60	80	XS	100	120	140	160	XXS
1/8	.405	.049 (.307)			.068 (.269)	.068 (.269)		.095 (.215)	.095 (.215)					
1/4	.540	.065 (.410)			.088 (.364)	.088 (.364)		.119 (.302)	.119 (.302)					
3/8	.675	.065 (.545)			.091 (.493)	.091 (.493)		.126 (.423)	.126 (.423)					
1/2	.840	.083 (.674)			.109 (.622)	.109 (.622)		.147 (.546)	.147 (.546)				.187 (.466)	.294 (.252)
3/4	1.050	.083 (.884)			.113 (.824)	.113 (.824)		.154 (.742)	.154 (.742)				.218 (.614)	.308 (.434)
1	1.315	.109 (1.097)	.100 (1.115)	.125 (1.065)	.133 (1.049)	.133 (1.049)		.179 (.957)	.179 (.957)				.250 (.815)	.358 (.599)
1 1/4	1.660	.109 (1.442)	.100 (1.460)	.125 (1.41)	.140 (1.38)	.140 (1.38)		.191 (1.218)	.191 (1.270)				.250 (1.16)	.382 (.896)
1 1/2	1.900	.109 (1.682)	.110 (1.680)	.125 (1.65)	.145 (1.61)	.145 (1.61)		.200 (1.50)	.200 (1.50)				.281 (1.338)	.400 (1.10)
2	2.375	.109 (2.157)	.125 (2.125)		.154 (2.067)	.154 (2.067)		.218 (1.939)	.218 (1.939)				.343 (1.689)	.436 (1.503)
2 1/2	2.875	.120 (2.635)			.203 (2.469)	.203 (2.469)		.276 (2.323)	.276 (2.323)				.375 (2.125)	.552 (1.771)
3	3.50	.120 (3.260)	.125 (3.25)	.188 (3.124)	.216 (3.068)	.216 (3.068)		.300 (2.90)	.300 (2.90)				.438 (2.624)	.600 (2.30)
3 1/2	4.00	.120 (3.760)			.226 (3.548)	.226 (3.548)		.318 (3.364)	.318 (3.364)					.636 (2.728)
4	4.50	.120 (4.260)			.237 (4.026)	.237 (4.026)	.281 (3.938)	.337 (3.826)	.337 (3.826)		.438 (3.624)		.531 (3.438)	.674 (3.152)
4 1/2	5.00					.247 (4.506)			.355 (4.29)					.710 (3.58)
5	5.563	.134 (5.295)			.258 (5.047)	.258 (5.047)		.375 (4.813)	.375 (4.813)		.500 (4.563)		.625 (4.313)	.750 (4.063)
6	6.625	.134 (6.357)			.280 (6.065)	.280 (6.065)		.432 (5.761)	.432 (5.761)		.562 (5.501)		.718 (5.189)	.864 (4.897)
7	7.625					.301 (7.023)			.500 (6.625)					.875 (5.875)
8	8.625	.148 (8.329)	.250 (8.125)	.277 (8.071)	.322 (7.981)	.322 (7.981)	.406 (7.813)	.500 (7.625)	.500 (7.625)	.593 (7.439)	.718 (7.189)	.812 (7.001)	.906 (6.813)	.875 (6.875)
9	9.625					.342 (8.941)			.500 (8.625)					
10	10.75	.165 (10.420)	.250 (10.25)	.307 (10.136)	.365 (10.02)	.365 (10.02)	.500 (9.75)	.593 (9.564)	.500 (9.75)	.718 (9.314)	.843 (9.064)	1.000 (8.75)	1.125 (8.50)	
11	11.75					.375 (11.00)			.500 (10.75)					
12	12.75	.180 (12.39)	.250 (12.25)	.330 (12.09)	.406 (11.938)	.375 (12.00)	.562 (11.626)	.687 (11.376)	.500 (11.75)	.843 (11.064)	1.000 (10.75)	1.125 (10.50)	1.312 (10.126)	
14	14.00	.250 (13.50)	.312 (13.376)	.375 (13.25)	.437 (13.126)	.375 (13.25)	.593 (12.814)	.750 (12.50)	.500 (13.00)	.937 (12.126)	1.093 (11.814)	1.250 (11.50)	1.406 (11.188)	
16	16.00	.250 (15.50)	.312 (15.376)	.375 (15.25)	.500 (15.00)	.375 (15.25)	.656 (14.688)	.843 (14.314)	.500 (15.00)	1.031 (13.938)	1.218 (13.564)	1.437 (13.126)	1.593 (12.814)	
18	18.00	.250 (17.50)	.312 (17.376)	.437 (17.176)	.562 (16.876)	.375 (17.25)	.750 (16.50)	.937 (16.126)	.500 (17.00)	1.156 (15.688)	1.375 (15.25)	1.562 (14.876)	1.781 (14.438)	
20	20.00	.250 (19.50)	.375 (19.25)	.500 (19.00)	.593 (18.814)	.375 (19.25)	.812 (18.376)	1.031 (17.938)	.500 (19.00)	1.280 (17.44)	1.500 (17.00)	1.750 (16.50)	1.968 (16.064)	
24	24.00	.250 (23.50)	.375 (23.25)	.562 (22.876)	.687 (22.626)	.375 (23.25)	.968 (22.064)	1.218 (21.564)	.500 (23.00)	1.531 (20.938)	1.812 (20.376)	2.062 (19.876)	2.343 (19.314)	

Pressure Losses In Pipe & Tubing

						Flow Rate (GPM) & Pressure Loss (PSI/FT) @ AVG. Velocity (FPS)									
Pipe				Pressure (PSI)		5 FPS		10 FPS		15 FPS		20 FPS		25 FPS	
Size	Sch.	O.D.	I.D.	Working	Burst	Loss	GPM	Loss	GPM	Loss	GPM	Loss	GPM	Loss	GPM
1/2	80	0.840	0.546	4,100	21,000	0.37	4	0.73	7	1.11	11	2.62	15	3.87	18
	40	0.840	0.622	2,300	15,600	0.28	5	0.57	10	1.35	14	2.23	19	3.29	24
3/4	80	1.050	0.742	3,500	17,600	0.20	7	0.40	14	1.08	20	1.79	27	2.64	34
	40	1.050	0.824	2,000	12,900	0.16	8	0.32	17	0.95	25	1.57	33	2.31	42
1	80	1.315	0.957	3,500	15,900	0.12	11	0.39	22	0.79	34	1.30	45	1.92	56
	40	1.315	1.049	2,100	12,100	0.10	14	0.34	27	0.70	40	1.16	54	1.71	67
1 1/4	80	1.660	1.278	3,000	13,900	0.07	20	0.27	40	0.55	60	0.91	80	1.34	100
	40	1.660	1.380	1,800	10,100	0.06	23	0.24	47	0.50	70	0.82	93	1.21	117
1 1/2	160	1.900	1.338	4,500	17,700	0.06	22	0.25	44	0.52	66	0.85	88	1.26	110
	80	1.900	1.500	2,800	12,600	0.05	28	0.22	55	0.45	83	0.74	110	1.09	138
	40	1.900	1.610	1,700	9,100	0.04	32	0.20	64	0.41	95	0.68	127	1.00	159
2	160	2.375	1.687	4,600	17,500	0.04	35	0.19	70	0.39	105	0.64	139	0.95	174
	80	2.375	1.939	2,500	11,000	0.05	46	0.16	92	0.33	138	0.54	184	0.79	230
	40	2.375	2.067	1,500	7,800	0.04	52	0.15	105	0.30	157	0.50	209	0.73	262
2 1/2	160	2.875	2.125	4,200	15,700	0.04	55	0.14	111	0.29	166	0.48	221	0.71	276
	80	2.875	2.323	2,800	11,500	0.04	66	0.13	132	0.26	198	0.43	264	0.63	330
	40	2.875	2.469	1,900	8,500	0.04	75	0.12	149	0.24	224	0.40	299	0.59	373
3	160	3.500	2.624	4,100	15,000	0.03	84	0.11	169	0.22	253	0.37	337	0.54	421
	80	3.500	2.900	2,600	10,300	0.03	103	0.10	206	0.20	309	0.33	412	0.48	515
	40	3.500	3.068	1,600	7,400	0.03	115	0.09	230	0.18	346	0.30	461	0.45	576

Pressure rating based on ASTM A53 grade B or A 103 grade B seamless
 Based on Barlows & 55,000 type ASAB93, 4-1966
 Medium hydraulic oil 220 SSU @ 120° F

						Flow Rate (GPM) & Pressure Loss (PSI/FT) @ AVG. Velocity (FPS)									
Tubing			Pressure (PSI)		5 FPS		10 FPS		15 FPS		20 FPS		25 FPS		
O.D.	I.D.	Wall	Working	Burst	Loss	GP	Loss	GPM	Loss	GPM	Loss	GPM	Loss	GPM	
1/4	0.180	0.035	3850	15,400	1.8	0.4	3.7	0.8	6.0	1.3	7.0	1.6	9.5	2.0	
3/8	0.305	0.035	2580	10,300	0.6	1.1	1.1	2.2	2.4	3.4	3.8	4.6	5.5	6.0	
	0.245	0.065	4750	19,100	0.8	0.7	1.9	1.5	2.4	2.1	4.5	2.9	6.5	3.5	
1/2	0.430	0.035	1930	7,700	0.4	2.4	1.1	4.9	2.0	7.5	4.0	9.7	5.0	12.0	
	0.370	0.065	3580	14,300	0.2	1.8	1.0	3.5	2.0	5.2	3.5	7.1	4.4	8.6	
3/4	0.652	0.049	1800	7,200	0.15	4.8	0.5	9.4	0.9	15.0	1.7	19.0	2.5	24.0	
	0.560	0.095	3400	13,950	0.2	4.0	0.6	8.0	1.6	12.5	2.4	16.5	4.3	20.0	
1	0.870	0.065	1790	7,150	0.1	9.2	0.3	19.0	0.7	28.0	1.2	39.0	1.7	48.0	
	0.760	0.120	3300	13,200	0.13	7.9	0.5	15.5	1.0	23.0	1.4	31.0	2.5	40.0	
1 1/4	1.060	0.095	2080	8,350	0.09	14.0	0.27	27.0	0.5	41.0	1.0	54.0	1.4	70.0	
	0.010	0.120	2650	10,600	0.43	12.0	0.15	24.0	0.3	37.0	0.5	50.0	0.8	62.0	
1 1/2	1.260	0.120	2200	8,800	0.07	21.0	0.25	42.0	0.45	62.0	0.75	82.0	1.4	110.0	
2	1.500	0.250	3480	13,750	0.05	28.0	0.15	54.0	0.32	82.0	0.55	108.0	0.8	140.0	

Unified and American Screw Threads

Size	UNC Coarse Thread Series		UNF Fine Thread Series	
	Threads Per Inch	Tap Drill	Threads Per Inch	Tap Drill
	1 (.073)	64	No. 53	72
2 (.086)	56	No. 50	64	No. 50
3 (.099)	48	No. 47	56	No. 45
4 (.112)	40	No. 43	48	No. 42
5 (.125)	40	No. 38	44	No. 37
6 (.138)	32	No. 36	40	No. 33
8 (.164)	32	No. 29	36	No. 29
10 (.190)	24	No. 25	32	No. 21
12 (.216)	24	No. 16	28	No. 14
1/4	20	No. 7	28	No. 3
5/16	18	F	24	I
3/8	16	5/16	24	Q
7/16	14	U	20	25/64
1/2	13	27/64	20	29/64
9/16	12	31/64	18	33/64
5/8	11	17/32	18	37/64
3/4	10	21/32	16	11/16
7/8	9	49/64	14	13/16
1	8	7/8	12	59/64
1 1/8	7	63/64	12	1 3/64
1 1/4	7	1 7/64	12	1 11/64
1 3/8	6	1 7/32	12	1 19/64
1 1/2	6	1 11/32	12	1 27/64
1 3/4	5	1 9/16		
2	4 1/2	1 25/32		
2 1/4	4 1/2	2 1/32		
2 1/2	4	2 1/4		
2 3/4	4	2 1/2		
3	4	2 3/4		

NUMBER & LETTER DRILL SIZES							
				Number Drill		Letter Drill	
No.	Size	No.	Size	No.	Size	Letter	Size
1	0.2280	28	0.1405	55	0.0520	A	0.2340
2	0.2210	29	0.1360	56	0.0465	B	0.2380
3	0.2130	30	0.1285	57	0.0430	C	0.2420
4	0.2090	31	0.1200	58	0.0420	D	0.2460
5	0.2055	32	0.1160	59	0.0410	E	0.2500
6	0.2040	33	0.1130	60	0.0400	F	0.2570
7	0.2010	34	0.1110	61	0.0390	G	0.2610
8	0.1990	35	0.1100	62	0.0380	H	0.2660
9	0.1996	36	0.1065	63	0.0370	I	0.2720
10	0.1935	37	0.1040	64	0.0360	J	0.2770
11	0.1910	38	0.1015	65	0.0350	K	0.2810
12	0.1890	39	0.0995	66	0.0330	L	0.2900
13	0.1850	40	0.0980	67	0.0320	M	0.2950
14	0.1820	41	0.0960	68	0.0310	N	0.3020
15	0.1800	42	0.0935	69	0.0292	O	0.3160
16	0.1770	43	0.0890	70	0.0280	P	0.3230
17	0.1730	44	0.0860	71	0.0260	Q	0.3320
18	0.1695	45	0.0820	72	0.0250	R	0.3390
19	0.1660	46	0.0810	73	0.0240	S	0.3480
20	0.1610	47	0.0785	74	0.0225	T	0.3580
21	0.1590	48	0.0760	75	0.0210	U	0.3680
22	0.1570	49	0.0730	76	0.0200	V	0.3770
23	0.1540	50	0.0700	77	0.0180	W	0.3860
24	0.1520	51	0.0670	78	0.0160	X	0.3970
25	0.1495	52	0.0635	79	0.0145	Y	0.4040
26	0.1470	53	0.0595	80	0.0135	Z	0.4130
27	0.1440	54	0.0550				

Thread Guide

Dash Size	NPT	ORB & JIC	BSPP	ORFS
-02	1/8"-27	5/16"-24	1/8"-28	—
-03	—	3/8"-24	—	—
-04	1/4"-18	7/16"-20	1/4"-19	9/16"-18
-05	—	1/2"-20	—	—
-06	3/8"-18	9/16"-18	3/8"-19	11/16"-16
-08	1/2"-14	3/4"-16	1/2"-14	13/16"-16
-10	—	7/8"-14	5/8"-14	1"-14
-12	3/4"-14	1-1/16"-12	3/4"-14	1-3/16"-12
-14	—	1-3/16"-12	—	—
-16	1"-11.5	1-5/16"-12	1"-11	1-7/16"-12
-20	1-1/4"-11.5	1-5/8"-12	1-1/4"-11	1-11/16"-12
-24	1-1/2"-11.5	1-7/8"-12	1-1/2"-11	2"-12
-32	2"-11.5	2-1/2"-12	2"-11	—

Fluid Powers Formulae & Useful Information

Fluid Power Formulae:
Torque and horsepower relations:

$$T = HP \times 5252 \div RPM$$

$$HP = T \times RPM \div 5252$$

$$RPM = HP \times 5252 \div T$$

Torque values are in foot pounds.

Hydraulic power flowing through pipe:

$$HP = PSI \times GPM \div 1714$$

HP = horsepower

PSI = gage pressure in lbs/sq. inch

GPM = flow in gallons per minute

Burst pressure of pipe and tube:

$$P = 2t \times S \div O$$

P = burst pressure in lbs/sq. inch

t = wall thickness of pipe or tube

S = tensile strength of pipe mat'l in lbs/sq. inch

O = outside diameter of pipe or tube in inches

Velocity of oil flow in hydraulic lines:

$$V = GPM \times 0.3208 \div A$$

V = velocity in feet per second

GPM = oil flow in gallons per minute

A = inside area of line in square inches

Rules of Thumb For Hydraulic Systems:

- a) Hydraulic Line Velocity: Suction 2 to 4 FPS
Return 6 to 10 FPS
Pressure 15 to 20 FPS

b) One H.P. is required for every one GPM @ 1500 PSI

c) Power required @ idle is approximately 5% of pump maximum rated pressure.

d) Heat generated in a system: BTU / Hour = 1.5 x PSI x GPM

e) Size of heat exchanger is 25% of input H.P.

f) Heat radiated from steel reservoir:

$$H.P. = .001 \times \Delta T \times A$$

Where A = area in square feet of tank surface

ΔT = difference between surface temperature and ambient temperature.

g) The size of a reservoir is 2-1/2 times the flow rate of the system.

h) Electric motors should not be run below 90% of name plate voltage.

Density

Common Metals (Pounds / Cubic Inch)	
Material	Weight
Aluminum	.0975
Brass: 80C.,20Z	.3105
Chromium	.2502
Copper	.3210
Gold	.6969
Iron, Cast	.254/.279
Iron, Wrought	.282/.285
Lead	.4096
Magnesium	.0628
Mercury (68° F)	.4892
Nickel	.3178
Silver	.376/.380
Steel, Carbon	.283/.284
Tin	.2633
Titanium	.1621
Tungsten	.672/.690
Vanadium	.2022
Zinc	.254/.259

Miscellaneous Substances (Pounds / Cubic Foot)	
Material	Weight
Asphaltum	87
Brick, Common	112
Brick, Fire	143
Brickwork, in mortar	100
Brickwork, in ce-	112
Charcoal	25
Coal, anthracite	94
Coal, bituminous	81
Concrete	137
Earth, loose	75
Earth, rammed	100
Granite	168
Gravel	109
Gypsum	150
Limestone	162
Masonry	150
Sandstone	143
Slate	175

American Woods (Pounds / Cubic Foot)		
Material	Green	Airdry
Alder, red	46	28
Birch	57	44
Birch, paper	50	38
Cedar, western red	27	23
Cedar, eastern red	37	33
Cedar, northern white	28	22
Douglas Fir, coast reg.	38	34
Douglas Fir, rocky mt. Reg.	35	30
Hemlock, eastern	50	28
Hemlock, western	41	29
Oak, red	64	44
Oak, white	63	47
Pine, western white	35	27
Poplar, yellow	38	28
Redwood	50	28
Spruce, eastern	34	28
Spruce, engelmann	39	23
Walnut, black	58	38

Conversion Factors

Equivalent Units		
1 Inch (in)	=	25.4 Millimeters (mm)
1 Kilogram (kg)	=	2.2064 Pounds (lb)
1 Liter (l)	=	61.026 Cubic inches
1 Gallon (U.S.)	=	3.79 Liters (l)
1 Pound (lb)	=	4.448 Newton
1 Horsepower (HP)	=	550 Foot Pounds per Second
1 Ton (metric)	=	1000 Kilograms (kg)
1 Foot (ft)	=	12 Inches (in)
1 Yard (yd)	=	3 Feet (ft)
1 Mile	=	1760 Yards (yd)
1 Mile	=	8 Furlong
1 league	=	3 Miles
1 fathom	=	6 Feet (ft)
1 rod	=	5.50 Yards (yd)
1 pint	=	4 Gills
1 quart	=	2 Pints
1 Gallon (British)	=	4 Quarts
1 are	=	100 Square Meters
1 Cubic Foot	=	12 Board Feet

Metric Prefixes

Prefix	Symbol	Multiplier
tera	T	1,000,000,000,000
giga	G	1,000,000,000
mega	M	1,000,000
kilo	k	1,000
hecto	h	100
deka	da	10
		1
deci	d	.1
centi	c	.01
milli	m	.001
micro	μ	.000001
nano	n	.000000001
pico	p	.000000000001

Conversion Factors						
Kilowatts	x	1.341	=	HP	x	.7457 = Kilowatts
Kilograms	x	2.205	=	Pounds	x	.4536 = Kilograms
Liters	x	.2642	=	Gallons (US)	x	3.785 = Liters
Pascals (Newton/M ²)	x	1.45x10 ⁻⁴	=	PSI	x	6897 = Pascals (Newton/M ²)
Dynes (Gram-CM/Sec ²)	x	2.248x10 ⁻⁶	=	Pounds	x	4.448x10 ⁵ = Dynes (Gram-CM/Sec ²)
Joules (Newton Meter)	x	.7376	=	Foot pounds	x	1.356 = Joules (Newton Meter)
Millimeter	x	.0394	=	Inches	x	25.4 = Millimeter
Newton (Kg M/Sec ²)	x	.2248	=	Pounds	x	4448 = Newton (Kg M/Sec ²)
Tons	x	2000	=	Pounds	x	5x10 ⁻⁴ = Tons
Tons-Long	x	2240	=	Pounds	x	4.464x10 ⁻⁴ = Tons-Long
Tons-Metric	x	2205	=	Pounds	x	4.535x10 ⁻⁴ = Tons-Metric
Atmosphers	x	14.7	=	PSI	x	.06804 = Atmosphers
Bars	x	14.5	=	PSI	x	.08695 = Bars
B.T.U.	x	778.2	=	Foot Pounds	x	.001285 = B.T.U.
Calories (Grams)	x	.003966	=	B.T.U.	x	252.2 = Calories (Grams)
Cubic Inch	x	.004329	=	Gallons	x	231 = Cubic Inch
Foot Pounds / Sec	x	.001818	=	H.P.	x	550 = Foot Pounds / Sec
BTU / Min	x	.02358	=	H.P.	x	42.41 = BTU / Min
Miles	x	1760	=	Yards	x	5.68x10 ⁻⁴ = Miles
Miles-Nautical	x	2027	=	Yards	x	4.933x10 ⁻⁴ = Miles-Nautical
Chains	x	22	=	Yards	x	.04545 = Chains
Cords	x	128	=	Cubic Foot	x	.007812 = Cords

Recommended Bolt Torque Values

For SAE Grade 2, Grade 5, Grade 8 cap screws & bolts.

Torques listed are approximate suggested values only on parts carrying residual oil of manufacture.




These values do not apply to plated or otherwise lubricated parts.

Torque-tension relationship is affected by lubrication, surface finish, thread fit, plating, lock washers, etc.

For plated cap screws and bolts, use only 75% of torque values listed.

Clamp load (lbs.) equals 75% of bolt proof load.

Bolt Size	SAE Grade 2		SAE Grade 5		SAE Grade 8	
	Load	Torque	Load	Torque	Load	Torque
1/4"-20	1320 lbs.	5 ft. lbs.	2020 lbs.	8 ft. lbs.	2860 lbs.	12 ft. lbs.
1/4"-28	1500 lbs.	6 ft. lbs.	2320 lbs.	10 ft. lbs.	3280 lbs.	14 ft. lbs.
5/16"-18	2160 lbs.	11 ft. lbs.	3340 lbs.	17 ft. lbs.	4720 lbs.	24 ft. lbs.
5/16"-24	2400 lbs.	13 ft. lbs.	3700 lbs.	19 ft. lbs.	5220 lbs.	27 ft. lbs.
3/8"-16	3200 lbs.	20 ft. lbs.	4940 lbs.	30 ft. lbs.	7000 lbs.	45 ft. lbs.
3/8"-24	3620 lbs.	22 ft. lbs.	5600 lbs.	35 ft. lbs.	7900 lbs.	50 ft. lbs.
7/16"-14	4380 lbs.	30 ft. lbs.	6800 lbs.	50 ft. lbs.	9550 lbs.	70 ft. lbs.
7/16"-20	4900 lbs.	35 ft. lbs.	7550 lbs.	55 ft. lbs.	10700 lbs.	78 ft. lbs.
1/2"-13	5840 lbs.	50 ft. lbs.	9050 lbs.	75 ft. lbs.	12750 lbs.	105 ft. lbs.
1/2"-20	6600 lbs.	55 ft. lbs.	10700 lbs.	90 ft. lbs.	14400 lbs.	120 ft. lbs.
5/8"-11	8800 lbs.	90 ft. lbs.	14400 lbs.	150 ft. lbs.	20350 lbs.	210 ft. lbs.
5/8"-18	10000 lbs.	105 ft. lbs.	16950 lbs.	180 ft. lbs.	23000 lbs.	240 ft. lbs.
3/4"-10	13000 lbs.	160 ft. lbs.	21300 lbs.	270 ft. lbs.	30100 lbs.	375 ft. lbs.
3/4"-16	14550 lbs.	180 ft. lbs.	23800 lbs.	300 ft. lbs.	33600 lbs.	420 ft. lbs.
7/8"-9	9700 lbs.	145 ft. lbs.	27000 lbs.	395 ft. lbs.	41600 lbs.	610 ft. lbs.
7/8"-14	10700 lbs.	155 ft. lbs.	29800 lbs.	435 ft. lbs.	45800 lbs.	675 ft. lbs.
1"-8	12700 lbs.	210 ft. lbs.	35500 lbs.	590 ft. lbs.	54500 lbs.	910 ft. lbs.
1"-12	13900 lbs.	230 ft. lbs.	38800 lbs.	650 ft. lbs.	59700 lbs.	1000 ft. lbs.
1"-14	14300 lbs.	240 ft. lbs.	39700 lbs.	655 ft. lbs.	61000 lbs.	1015 ft. lbs.

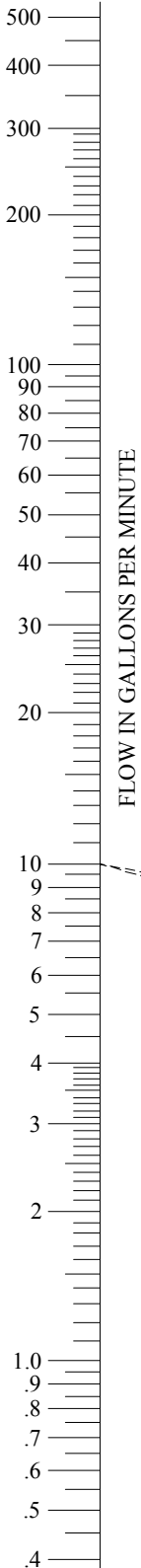
Grade	Markings	Material	Bolt & Screw Size	Proof Load (psi)	Tensile Strength
2		Low Carbon Steel	1/4" thru 3/4" Over 3/4" thru 1-1/2"	55,000 33,000	74,000 60,000
5		Medium Carbon Steel Quenched & Tempered	1/4" thru 1" Over 1" thru 1-1/2"	85,000 74,000	120,000 105,000
8		Medium Carbon Alloy Steel	1/4" thru 1-1/2"	120,000	150,000

Decimal Equivalents of Parts of an Inch in Imperial & Metric

<i>Fraction</i>	<i>Inches</i>	<i>Millimeters</i>
1/64	0.0156	0.3962
1/32	0.0313	0.7950
3/64	0.0469	1.1913
1/16	0.0625	1.5875
5/64	0.0781	1.9837
3/32	0.0938	2.3825
7/64	0.1094	2.7788
1/8	0.1250	3.1750
9/64	0.1406	3.5712
5/32	0.1563	3.9700
11/64	0.1719	4.3663
3/16	0.1875	4.7625
13/64	0.2031	5.1587
7/32	0.2188	5.5575
15/64	0.2344	5.9538
1/4	0.2500	6.3500
17/64	0.2656	6.7462
9/32	0.2813	7.1450
19/64	0.2969	7.5413
5/16	0.3125	7.9375
21/64	0.3281	8.3337
11/32	0.3438	8.7325
23/64	0.3594	9.1288
3/8	0.3750	9.5250
25/64	0.3906	9.9212
13/32	0.4063	10.3200
27/64	0.4219	10.7163
7/16	0.4375	11.1125
29/64	0.4531	11.5087
15/32	0.4688	11.9075
31/64	0.4844	12.3038
1/2	0.5000	12.7000

<i>Fraction</i>	<i>Inches</i>	<i>Millimeters</i>
33/64	0.5156	13.0962
17/32	0.5313	13.4950
35/64	0.5469	13.8913
9/16	0.5625	14.2875
37/64	0.5781	14.6837
19/32	0.5938	15.0825
39/64	0.6094	15.4788
5/8	0.6250	15.8750
41/64	0.6406	16.2712
21/32	0.6563	16.6700
43/64	0.6719	17.0663
11/16	0.6875	17.4625
45/64	0.7031	17.8587
23/32	0.7188	18.2575
47/64	0.7344	18.6538
3/4	0.7500	19.0500
49/64	0.7656	19.4462
25/32	0.7813	19.8450
51/64	0.7969	20.2413
13/16	0.8125	20.6375
53/64	0.8281	21.0337
27/32	0.8438	21.4325
55/64	0.8594	21.8288
7/8	0.8750	22.2250
57/64	0.8906	22.6212
29/32	0.9063	23.0200
59/64	0.9219	23.4163
15/16	0.9375	23.8125
61/64	0.9531	24.2087
31/32	0.9688	24.6075
63/64	0.9844	25.0038
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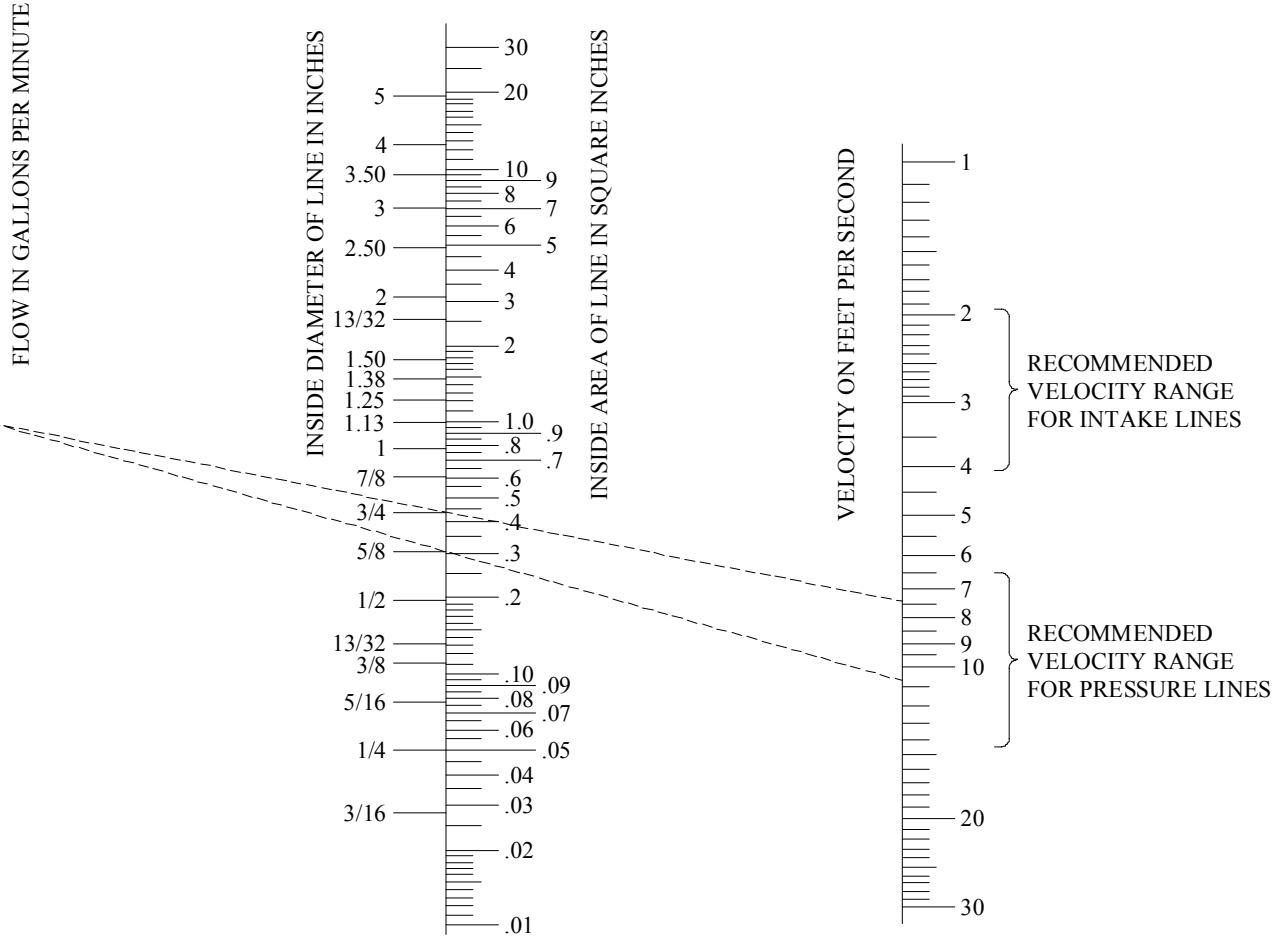
Flow Capacities of Hydraulic Lines at Recommended Velocities



This nomograph will aid you in selecting the correct line size when a straight edge is placed from the left column (GPM) to the recommended velocity in the right hand column. The example shows that with 10 gallons per minute a either a 5/8" or 3/4" I.D. line will give you a flow velocity within the recommended range for pressure lines.

$$\text{Area in Square Inches} = \frac{0.321 \times \text{Flow (G.P.M.)}}{\text{Velocity in Feet per Second}}$$

Recommendations are for hydraulic oils having a maximum viscosity of 315 S.S.U. at 100° F. And operating temperatures between 60° F and 155° F



Pressure Drop Through a Knife Edge Orifice

The following formula was used to calculate the pressure drop through a knife edge orifice.

Calculations are based on hydraulic oil having a viscosity of 155 SUS,
 a specific gravity of 0.895 and an orifice coefficient of 0.6.

$$P = S \left[\frac{Q}{29.81 \text{ Cd } d^2} \right]^2$$

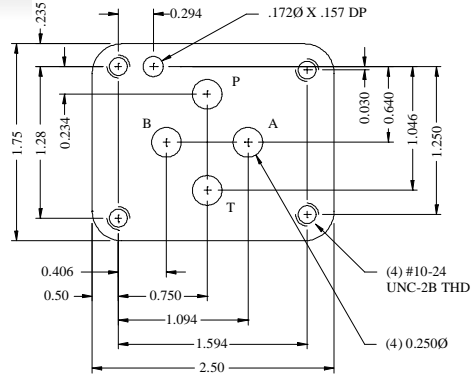
Where:

- Q = flow in GPM
- Cd = orifice coefficient
- d = orifice diameter
- P = pressure drop (PSI)
- S = specific gravity

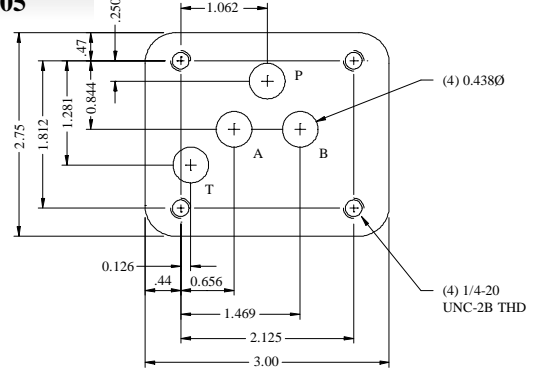
		Orifice Diameter - Inches																						
		1/64	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1					
Flow - GPM	0.1	469	29																					
	0.2	1877	117																					
	0.3	4224	264																					
	0.4		469																					
	0.5		733	46																				
	0.6		1056	66																				
	0.7		1437	90																				
	0.8		1877	117																				
	0.9		2376	149	29																			
	1.0		2934	183	36	11																		
	2.0			733	145	46	19																	
	3.0			1650	326	103	42	20																
	4.0			2934	579	183	75	36	20															
	5.0			4584	905	286	117	57	31	18														
	6.0				1304	413	169	81	44	26	11													
	7.0				1775	562	230	111	60	35	14	7												
	8.0				2318	733	300	145	78	46	19	9												
	9.0				2934	928	380	183	99	58	24	11	6											
	10.0				3622	1146	469	226	122	72	29	14	8											
	20.0					4584	1877	905	489	286	117	57	31	18	11									
30.0						4224	2037	1100	645	264	127	69	40	25	17									
40.0							3622	1955	1146	469	226	122	72	45	29	14								
50.0								5659	3055	1791	733	354	191	112	70	46	22	12	7					
60.0									4399	2578	1056	509	275	161	101	66	32	17	10					
70.0									5987	3509	1437	693	374	219	137	90	43	23	14					
80.0										4584	1877	905	489	286	179	117	57	31	18					
90.0											5801	2376	1146	619	363	226	149	72	39	23				
100.0												7162	2934	1415	764	448	279	183	88	48	28			
120.0													4224	2037	1100	645	402	264	127	69	40			
140.0														5750	2773	1497	877	548	359	173	94	55		
160.0															7510	3622	1955	1146	715	469	226	122	72	
180.0																4584	2474	1450	905	594	286	155	91	
200.0																	5659	3055	1791	1118	733	354	191	112

Valve Specifications

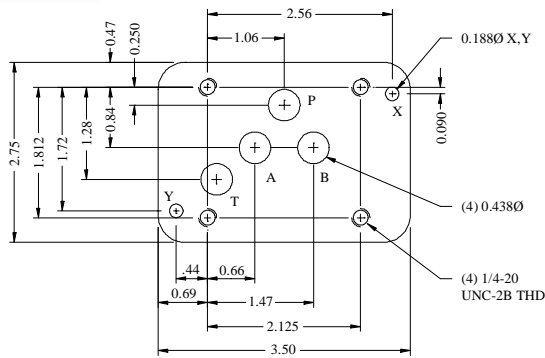
NFPA D03



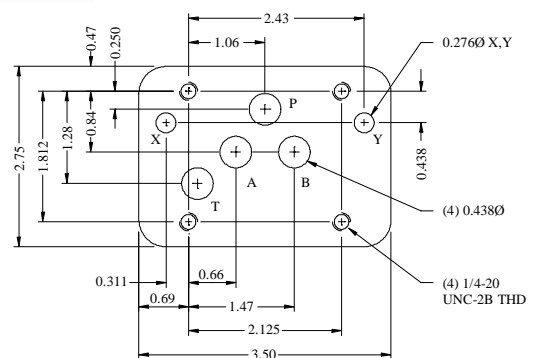
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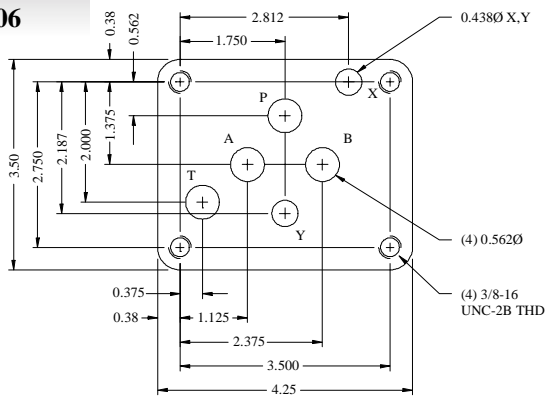
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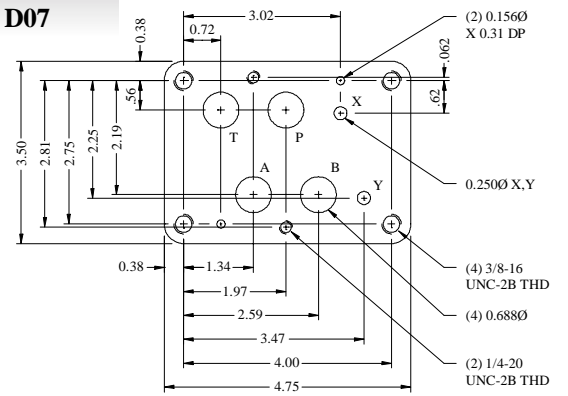
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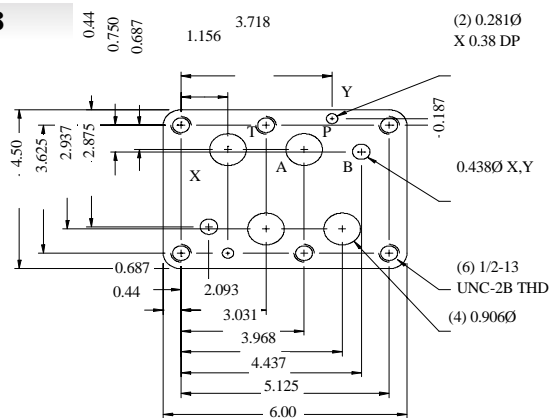
NFPA D06



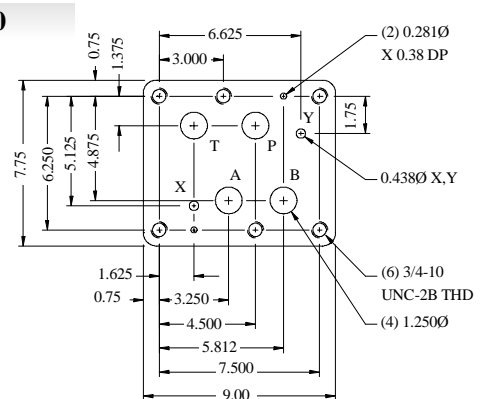
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NFPA D08

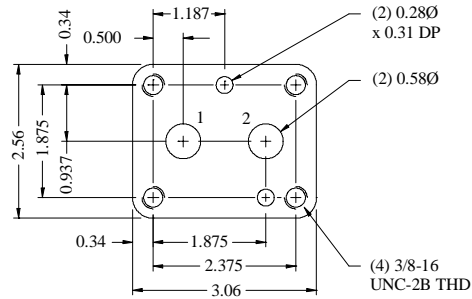


NFPA D10

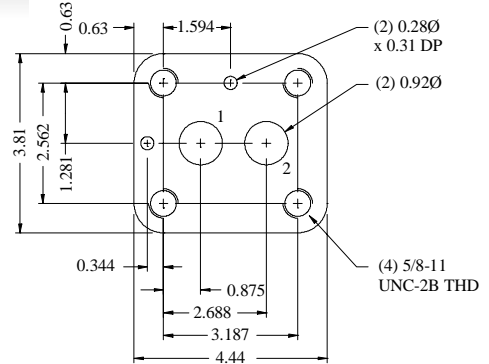


Valve Specifications

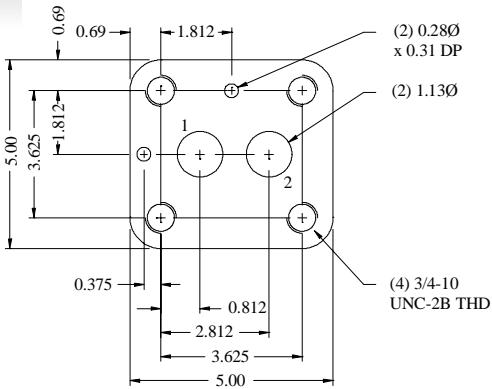
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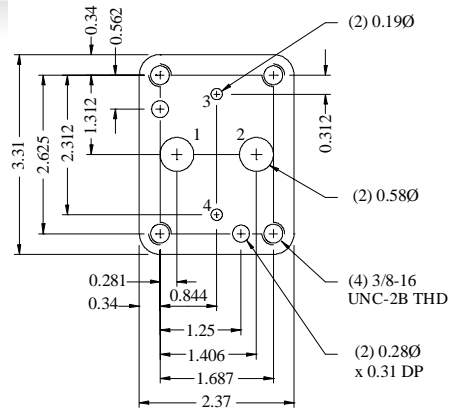
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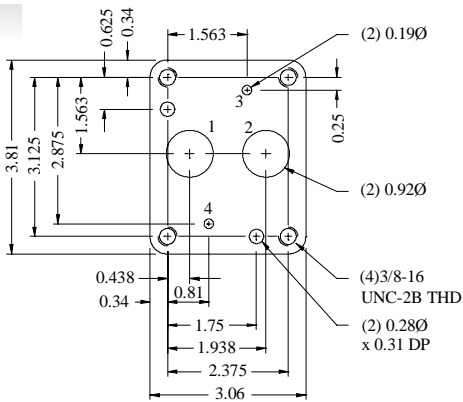
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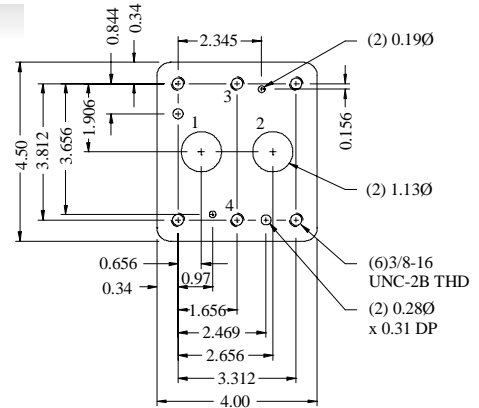
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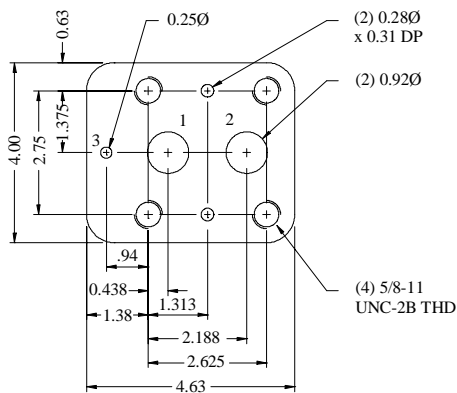
P08



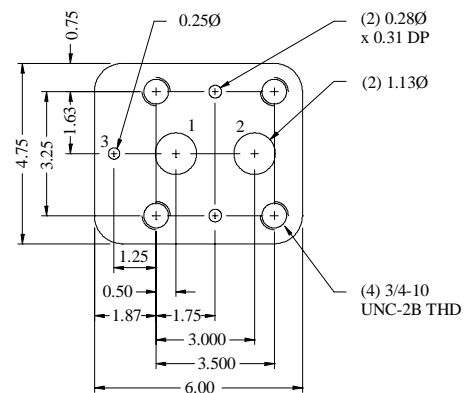
P10



R08

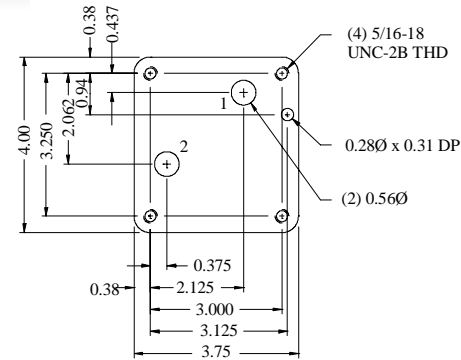


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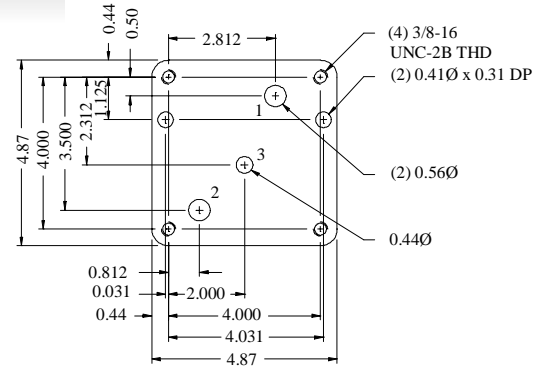


Valve Specifications

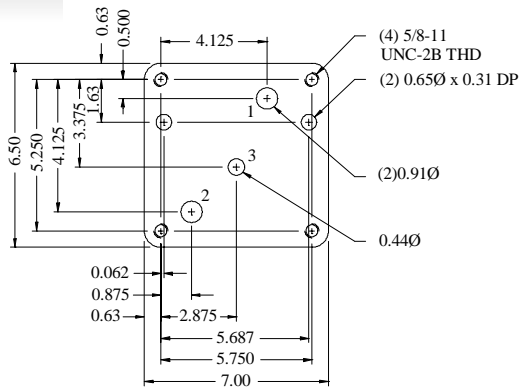
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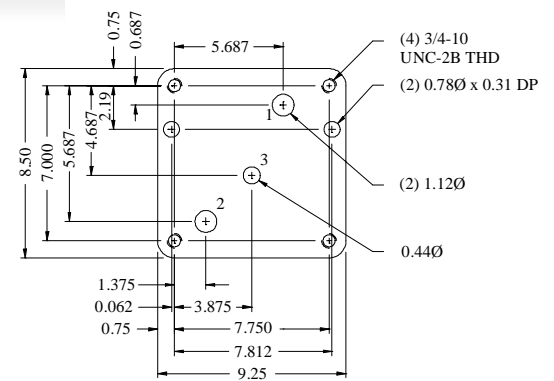
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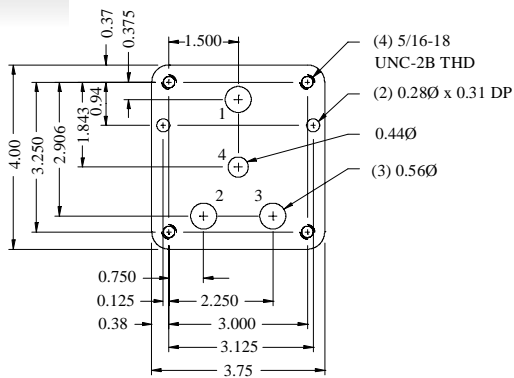
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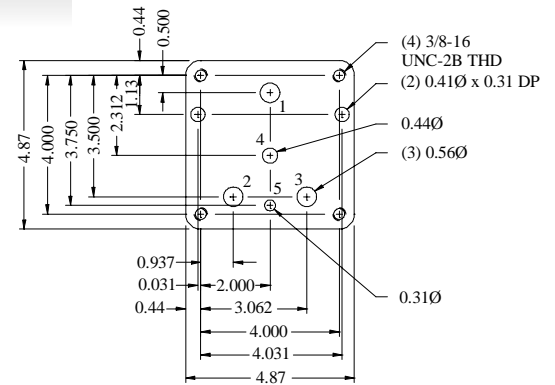
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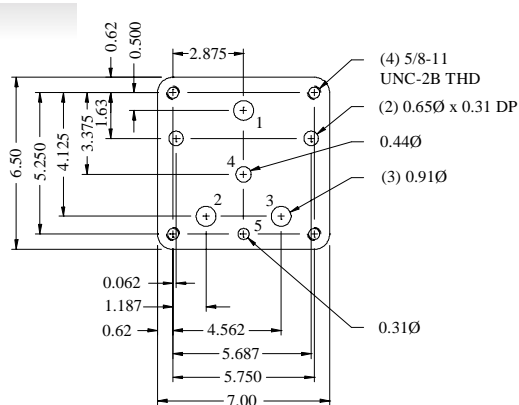
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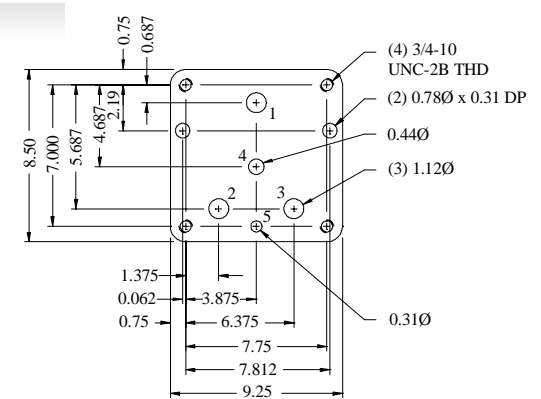
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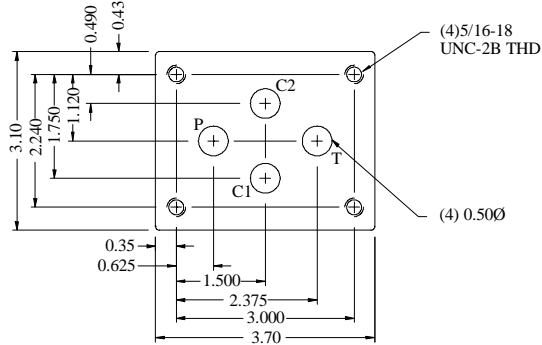


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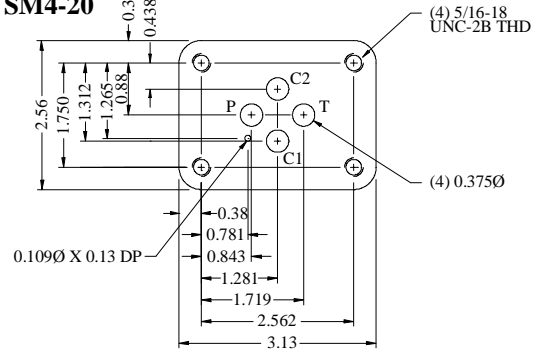


Valve Specifications

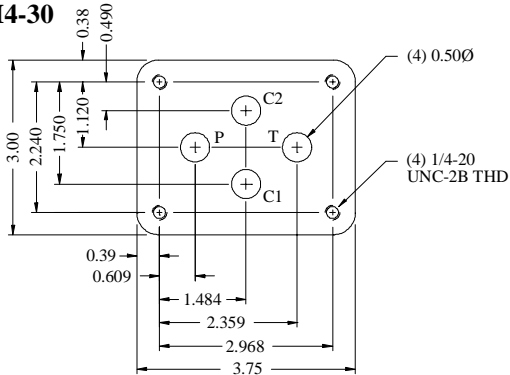
ATCHLEY CONTROLS 242



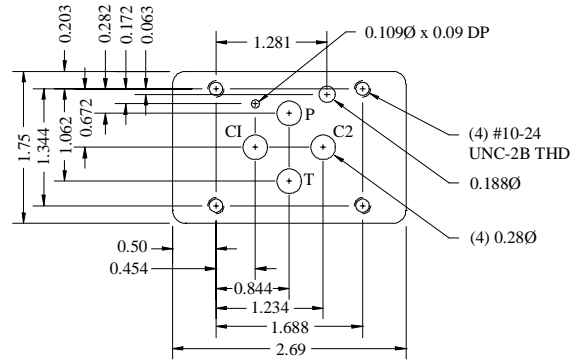
MOOG 62-100 SERIES / ATCHLEY CONTROLS 215A VICKERS SM4-20



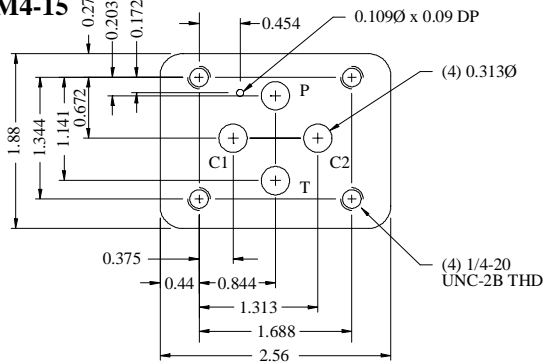
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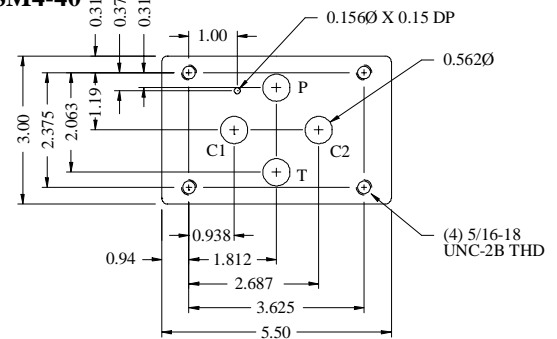
MOOG 772 / ATCHLEY CONTROLS 211A



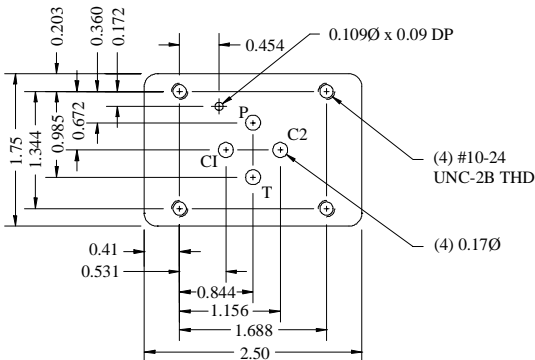
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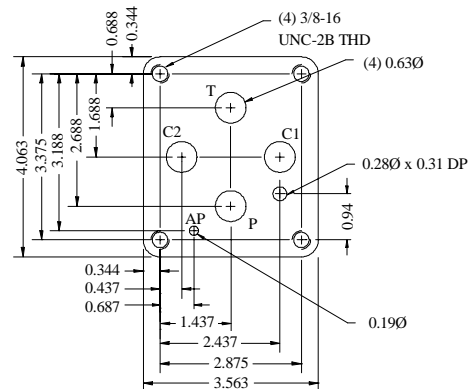
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MOOG 771 / ATCHLEY CONTROLS 206 / 208A VICKERS SM4-10

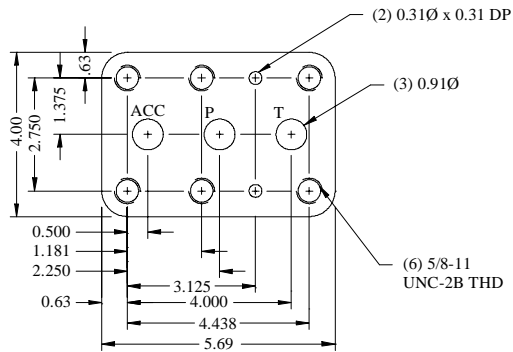


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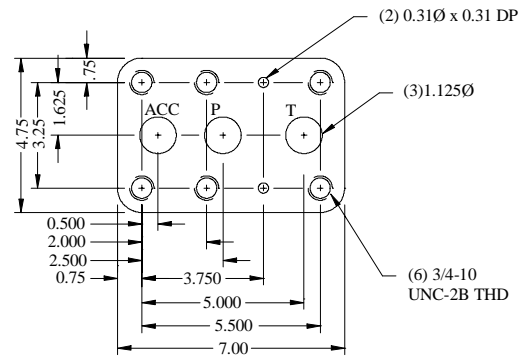


Valve Specifications

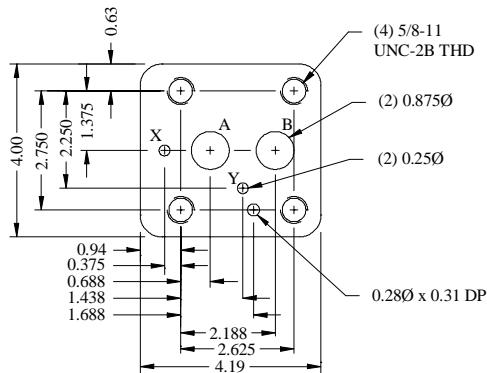
VICKERS URG06



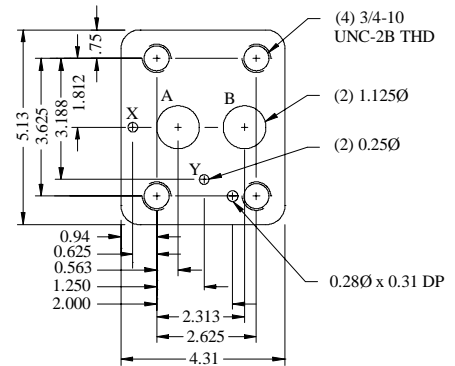
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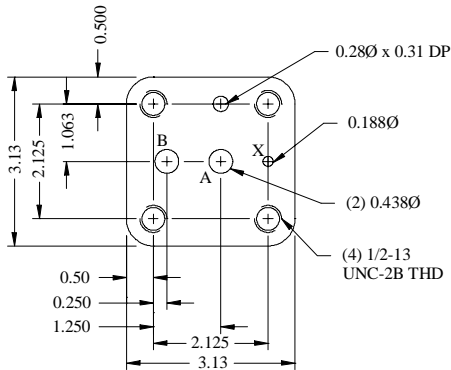
VICKERS CG06



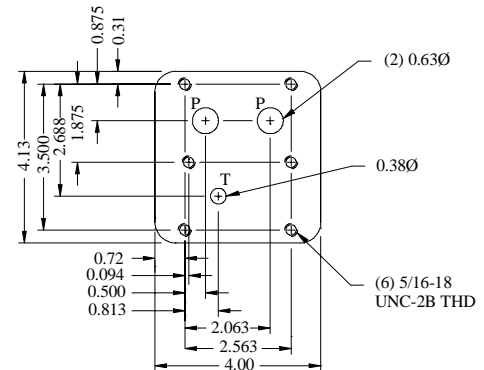
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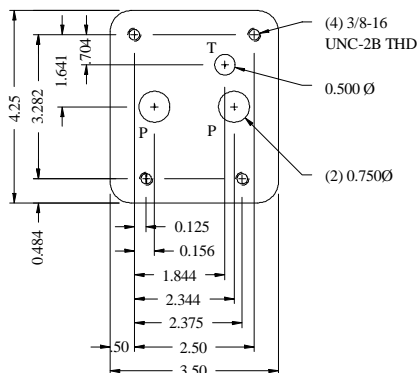
R06 / VICKERS CG03



SUNDSTRAND HOT OIL SHUTTLE 9510648



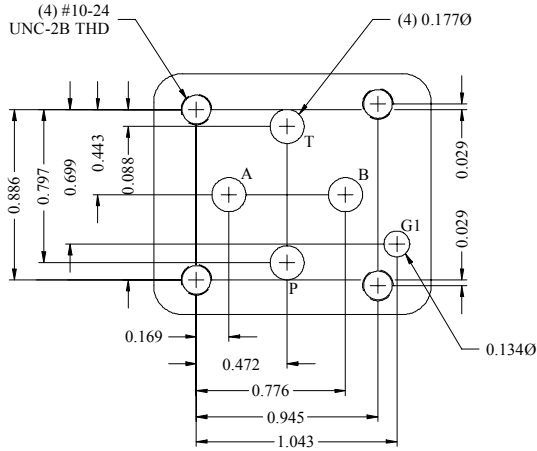
EATON HOT OIL SHUTTLE



Valve Specifications

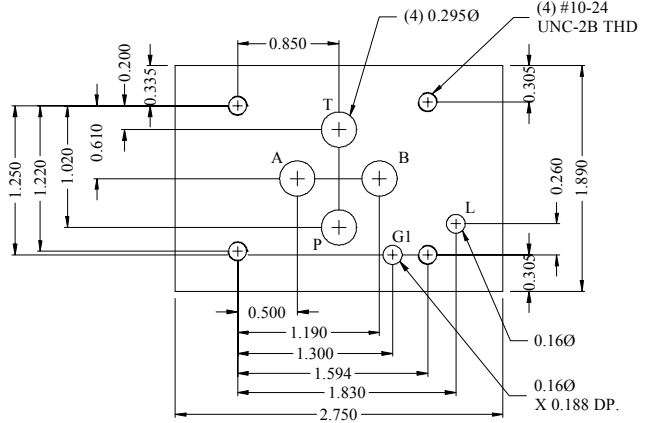
D02

ISO 4401-02-01-0-94
NFPA T3.5.1 R2 D02



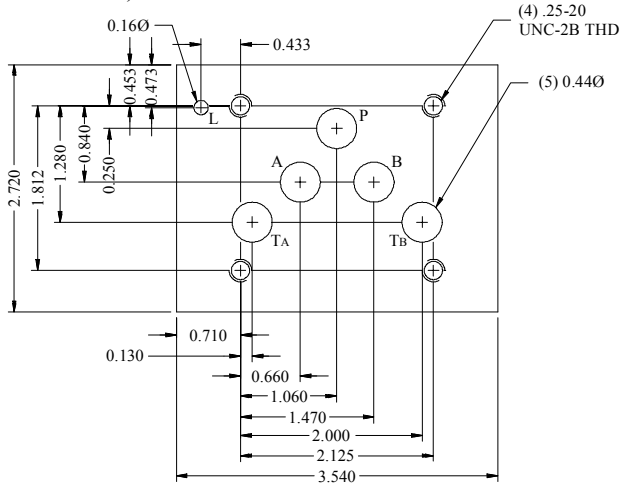
D03 with L

ISO 4401-03-02-0-94
NFPA T3.5.1 R2 D03



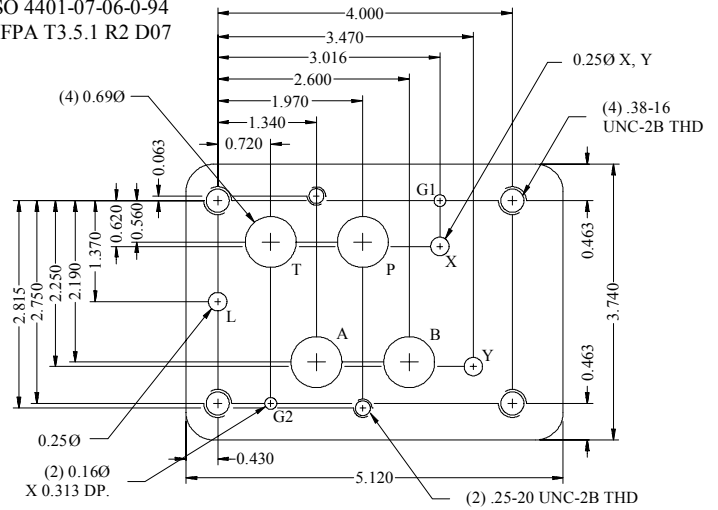
D05 with L

ISO 4401-05-04-0-94, NFPA T3.5.1 R2 D05



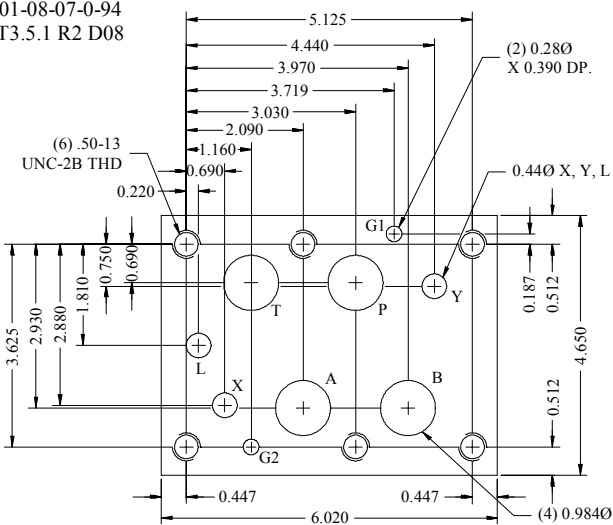
D07 with L

ISO 4401-07-06-0-94
NFPA T3.5.1 R2 D07



D08 with L

ISO 4401-08-07-0-94
NFPA T3.5.1 R2 D08



D10 with L

ISO 4401-10-08-0-94
NFPA T3.5.1 R2 D10

