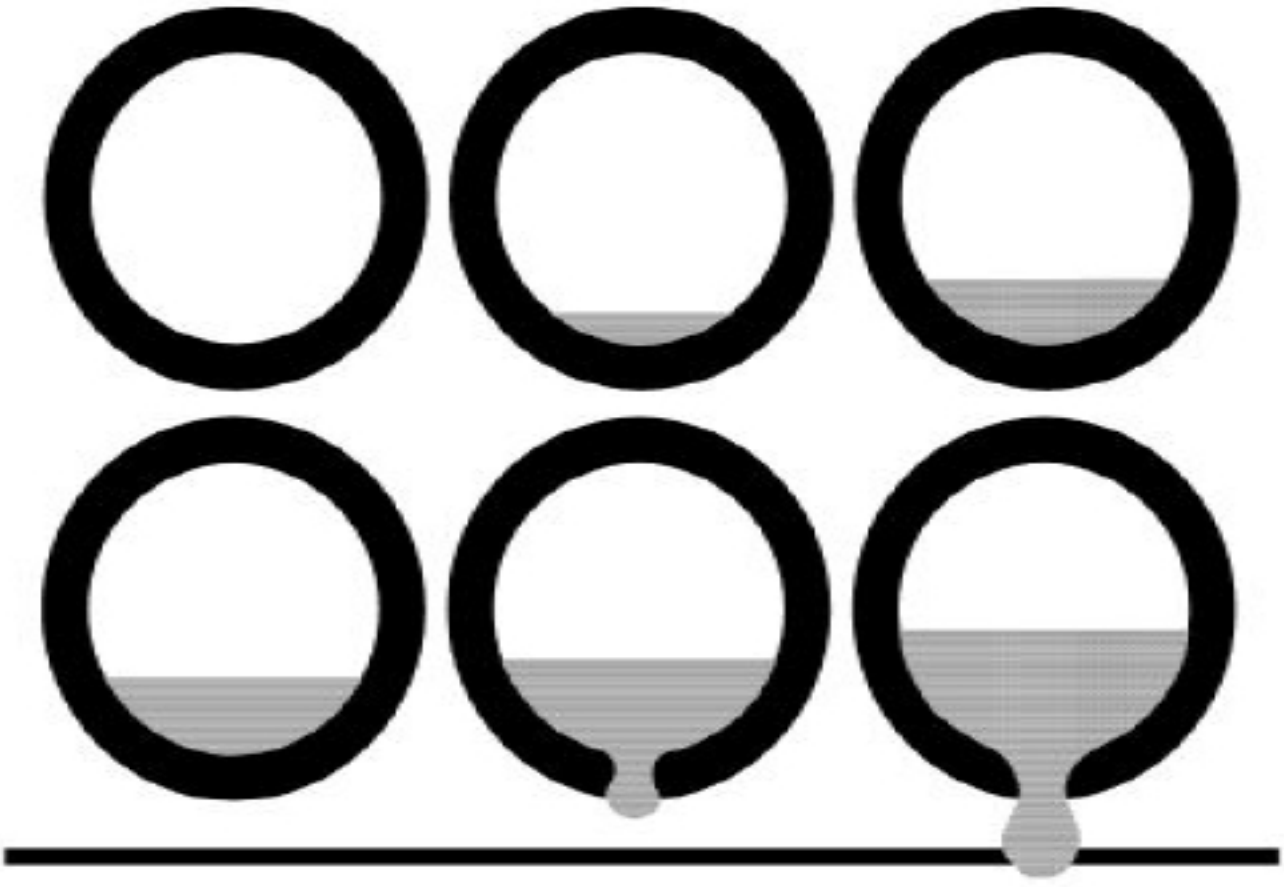
EATON | Hydraulics

HOW TO...

Identify and cure piping leaks



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Introduction

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Every industry has piping system leakage. This condition exists between the drawing board and the scrap dealer at all levels of industry including:

- The OEM level – The delivery of new units may be delayed because of fluid system leakage.
- The dealer level – Sales may be lost if oil drips from the unit onto the showroom floor.
- The user level – Leakage causes too much costly downtime.

In this booklet you will find a condensation of more than 60 years of Eaton's experience in working with the basic types of fitting configurations that contribute to piping system leakage. The causes of most leakage are identified and appropriate corrective measures are suggested.

The Basic Causes of Fluid System Leakage

1. Human error
2. Lack of quality control
3. Poor protection of components in handling
4. Difficult if not impossible to reach fitting connections
5. Lack of education
6. Poor selection of materials
7. Improper design of piping or routing

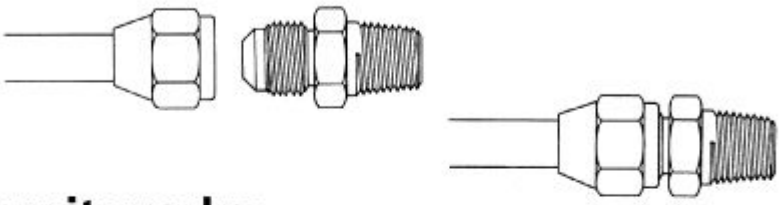
Find the Leak

1. Pinpoint the leak location. To make sure that the leak is not up higher and draining down:
   a) Wash down the leakage area.
   b) Watch for the leak to show.
   c) Place a paper towel above the connection; it will catch any fluid leaking from above.
2. Determine if the leak is at a valve spool, rod packing, motor or pump shaft, cracked casting, piping joint or hose or tube.

remember – Seepers or weepers can be hard to locate.

Leak Problem Areas

SAE 37° Flare Connection (SAE J514)



how it works:

This connection seals on the two mating 37° seats.

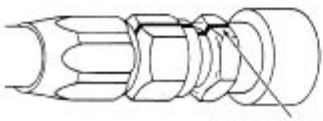
causes:

Most of the leaks on this connection are due to lack of tightening or human error. You can't tell if the nut has been tightened by just looking at the connection. If it is more than finger tight, you can't tell from observation how much. Torque wrenches are good only when they are used. You must rely on the user to be sure torque wrenches are used on all joints. The user must depend on his memory to know if he has tightened all of the joints.

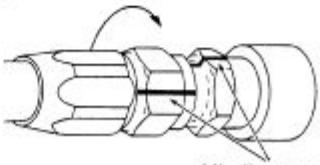
cure:

Here are steps for an excellent method of tightening. Anyone can tell if the joint was tightened and how much.

1. Tighten the nut by hand until it bottoms the seats.
2. Using a marker, draw a line lengthwise on the nut and extend it onto the adapter.
3. Using a wrench, rotate the nut to tighten. Turn the nut the amount shown in the chart on the next page.



Mark a line on the nut and adapter before torquing.



Misalignment of the mark shows the amount which the nut was tightened.

Line Size	Rotate No. of Hex Flats (For machined flares only)
-04	1 1/2 - 1 3/4
-05	1 - 1 1/2
-06	1 - 1 1/2
-08	1 1/4 - 1 3/4
-10	1 1/4 - 1 3/4
-12	1 - 1 1/2
-16	3/4 - 1
-20	1/2 - 3/4
-24	1/2 - 3/4
-32	3/4

Note: The misalignment of the marks will show how much the nut was tightened and, best of all, that it has been tightened.

What to do if the joint leaks after it has been tightened properly

Disconnect the line and check for:

1. Foreign particles in the joint .....Wash them off
2. Cracked seats .....Replace them
3. Seat mismatching or not concentric with the threads .....Replace the faulty part
4. Deep nicks in the seats .....Replace the faulty part
5. Excessive seat impression. This indicates excessive torque on the swivel nut or too soft a material for high pressures. Threads will stretch under high pressure .....Replace the faulty part
6. Chatter or tool mark – high and low spots on seats .....Replace the faulty part
7. SAE 45° nuts, when connected to an SAE 37° male flare fitting, will leak. The SAE 45° nut may be too long and can bottom on the adapter hex before the seats are tight .....Use all SAE 37° flare parts

remember – Many of the leakage problems on this type of connection won't show until the unit has been in service for a few hours.

Leak Problem Areas **(SAE J514)**

SAE Straight Thread O-Ring Seal

how it works:

This connection seals with an O-Ring on the male against a chamfer in the port. The use of straight thread O-Ring ports in place of pipe threads helps eliminate hydraulic leakage.

causes:

1. Elbows loosen up after short service
2. O-Ring seal leakage after short service
3. O-Ring seal leakage after long service
4. Instant leakage upon start up due to human error or faulty parts

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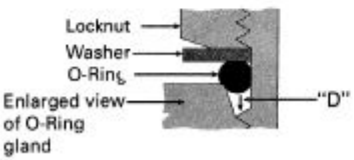
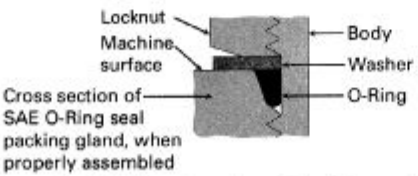
cures:

1. The locknut and washer must be to the top side of the thread relief. The washer must be snug to the thread relief. If not, reject the part.
2. Lubricate the O-Ring – this is very Important.
3. Thread the male O-Ring half into the port until the washer or solid hex bottoms onto the machined surface. Note: Make sure the spot face is large enough to accommodate the washer or hex of the adapter.
4. Position the elbow for desired alignment by backing it out of the port up to one full turn.
5. Tighten the locknut or solid hex.

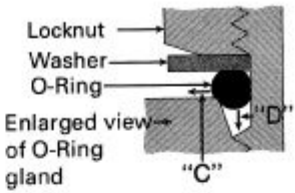
Why O-Ring lubrication is important:

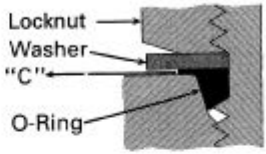




1. The fitting is engaged to the point where the O-Ring touches the face of the boss. Lubrication on the O-Ring permits it to move in direction "D."

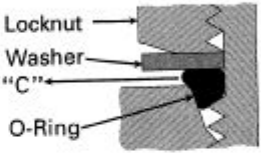
2. When the O-Ring and the boss are dry, the rotary motion of the assembly can cause friction and the O-Ring can move in direction "C."
3. The locknut and washer cannot bottom fully if the O-Ring is between the washer and the face of the boss. The compressed rubber between the washer and the boss will cold flow out from compression and the fitting will be loose and usually leak.

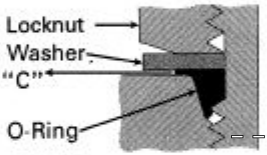


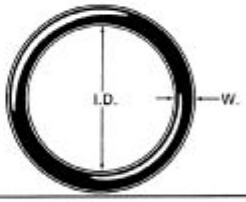


What happens when the locknut and washer are not backed up prior to assembly:

1. When the locknut and washer have not been backed up, there is not enough room for the O-Ring seal when the squeeze takes place.
2. The washer can't seat properly on the face of the boss. The compressed rubber between the washer and the boss face will cold flow out from compression, and the fitting will be loose and usually leak.





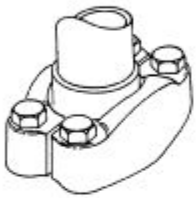


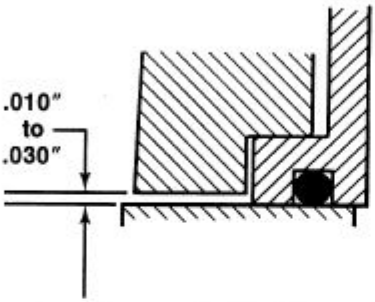
SAE J515 Straight Thread O-Ring			
Dash Size	Tubing O.D. Ref.	W, Width, Dia.	Inside Dia.
-2	1/8	.064±.003	.239±.005
-3	3/16	.064±.003	.301±.005
-4	1/4	.072±.003	.351±.005
-5	5/16	.072±.003	.414±.005
-6	3/8	.078±.003	.468±.005
-8	1/2	.087±.003	.644±.005
-10	5/8	.097±.003	.755±.005
-12	3/4	.116±.004	.924±.006
-14	7/8	.116±.004	1.048±.006
-16	1	.116±.004	1.171±.006
-20	1 1/4	.118±.004	1.475±.010
-24	1 1/2	.118±.004	1.720±.010
-32	2	.118±.004	2.337±.010

Recommended torque values for straight fittings or locknuts	
Dash Size	Foot - Pounds
-04	13 - 15
-05	14 - 15
-06	23 - 24
-08	40 - 43
-10	43 - 48
-12	68 - 75
-16	112 - 123
-20	146 - 161
-24	154 - 170
-32	218 - 240

Leak Problem Areas

SAE 4-Bolt Split Flange Connection (SAE J518 Codes 61 and 62)

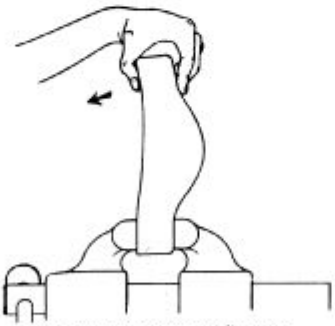




how it works:

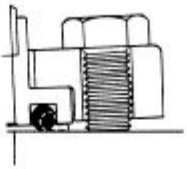
The SAE 4-bolt split flange connection is a face seal. The flanged head which contains an O-Ring seal must fit squarely against the mating surface and be held there with even tension on all bolts. The flanged head protrudes past the split flange clamps by .010 to .030 inch. This is to ensure that the flanged head will make contact with the mating accessory surface, compressing the O-Ring to form the seal.

Recommended Torque Values (Use Grade 5 bolts or better due to the high torque level required.)		
Connection Size	**Recommended Torque Inch-Pounds**	
	Code 61	Code 62
-08	175-225	175-225
-12	250-350	300-400
-16	325-425	500-600
-20	425-550	750-900
-24	550-700	1400-1600
-32	650-800	2400-2600
-40	950-1100	–
-48	1650-1800	–
Note: Air wrenches tend to cause flange tipping.		



Bending of bolts and flanges soaks up much of the torque values.

causes:



This connection is sensitive to installation errors and bolt torquing. Because of the flanged head protrusion and the flange clamp overhang, the flanges tend to tip up in a seesaw fashion when the bolts are tightened on one end. This pulls the opposite end of the flange away from the flanged head and, when hydraulic pressure is applied to the line, pushes the flanged head into a cocked position allowing seal extrusion.

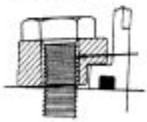
cure:

All bolts must be installed and torqued evenly. Finger tightening will help to get the flanges and shoulder started squarely. If lock washers are used, even more care must be taken.

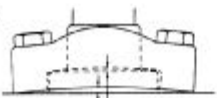
a second cause:

When excessive torque is applied to the bolts, the flanges often bend down until they bottom on the accessory. This also causes the bolts to bend outward.

Bending of the flanges and bolts tend to lift the flange off the shoulder in the center area between the long spacing of the bolts.

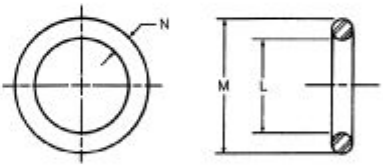


Bent flanges cause the bolts to bend.



Gaps up to .036 have been found on some leakers with bent flanges.

No hold down compression at center of shoulder.



Basic O-Ring dimensions are shown for reference only

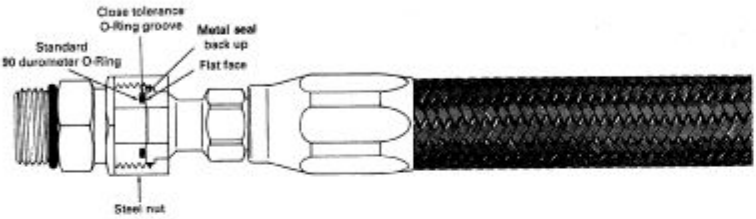
SAE J518 Codes 61 and 62 O-Ring Seal

Dash Size	L I.D. Ref. (in.)	M O.D. Ref. (in.)	N Dia. Ref. (in.)	SAE J120 O-Ring Size No.
-08	.734	1.012	.139	210
-12	.984	1.262	.139	214
-16	1.296	1.574	.139	219
-20	1.484	1.762	.139	222
-24	1.859	2.137	.139	225
-32	2.234	2.512	.139	228
-40	2.734	3.012	.139	232
-48	3.359	3.637	.139	237

ORS Connections
Run Rings Around Leaks™

Leak Problem Solution

O-Ring Face Seal Connection (SAE J1453)



Eaton's O-Ring Face Seal fittings and adapters are flat faced O-Ring seal connections that provide an excellent solution for leakage problems. These connections meet SAE J1453 performance requirements and are designed to handle working pressures up to 6000 psi. In order for this connection to virtually eliminate piping leaks, care must be taken to avoid the following problems, which may cause leakage.

causes:

1. Lack of proper tightening .....

cures:

Always use the following recommended torque values for maximum service life.

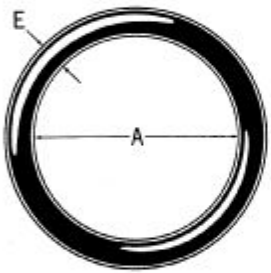
O-Ring Face Seal Connection Recommended Torque Values

Connection Dash Size	Swivel Nut Torque	
	(in.-lbs.)	(ft.-lbs.)
-04	120-144	10-12
-06	216-240	18-20
-08	384-420	32-35
-10	552-600	46-50

Connection Dash Size	Swivel Nut Torque	
	(in.-lbs.)	(ft.-lbs.)
-12	780-840	65-70
-16	1104-1200	92-100
-20	1500-1680	125-140
-24	1800-1980	150-165

2. No O-Ring in the groove . . . . . Make sure that the O-Ring does not fall out of the male end before the connection is made. Proper lubrication will help.

3. Improper O-Ring size . . . . . Although the O-ring Face Seal connection uses a standard size O-Ring, it is not the same size as those used on O-Ring boss or split flange fittings. It is critical that the correct O-Ring is used. The proper dash sizes and dimensions are listed on the chart below.



SAE J120 O-Ring Size Designation	Tube Size	A (inches)	E (inches)
-011	-4	.301	.07
-012	-6	.364	.07
-014	-8	.489	.07
-016	-10	.614	.07
-018	-12	.739	.07
-021	-16	.926	.07
-025	-20	1.176	.07
-029	-24	1.489	.07

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Torque values for SAE O-Ring boss ends, when used with O-Ring Face Seal connections,* per SAE J1453.			
Dash Size	Thread Size Inch	Straight Fitting or Locknut Torque	
		(in.-lbs.)	(ft.-lbs.)
-03	3/8-24	96-120	8-10
-04	7/16-20	168-192	14-16
-05	1/2-20	216-240	18-20
-06	9/16-18	288-312	24-26
-08	3/4-16	600-720	50-60
-10	7/8-14	864-960	72-80
-12	1 1/16-12	1500-1620	125-135
-14	1 3/16-12	1920-2160	160-180
-16	1 5/16-12	2400-2640	200-220
-20	1 5/8-12	2520-3360	210-280
-24	1 7/8-12	3240-4320	270-360
* Increased torque values are required for the increased pressure capabilities of O-Ring Face Seal connections.			

O-Ring Basics

For virtually all types of fluid connectors involving O-Rings, there are common guidelines that should always be followed:

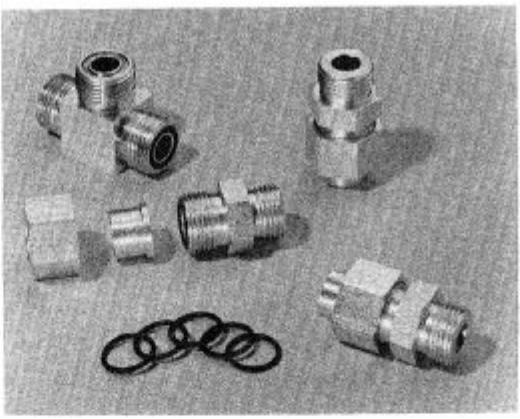
1. Care should be taken to ensure that the O-Ring is properly seated when the connection is made.

2. For maximum service life, use only O-Rings that are made of materials recommended by Eaton for the application. Maximum temperature ratings must not be exceeded for long lasting leak-proof connections.

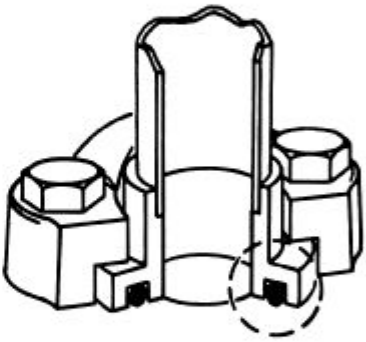
3. O-Rings should be lubricated using a compatible high shear oil. Lubricate as necessary to prevent rolling or cutting upon connection. For EPR O-Rings, use a vegetable-base lubricant or the system fluid.

4. Keep all connecting surfaces clean and grit free.

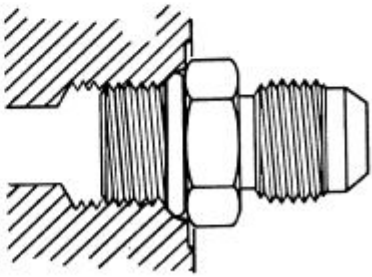
5. Used O-Rings should be replaced before re-installation to help prevent leakage problems.



Eaton O-Ring Face Seal connections



SAE 4-bolt split flange connection



SAE O-Ring boss connection

Leak Problem Areas

Pipe Threads (SAE J514)

Pipe threads are not recommended for high pressure applications, since they tend to leak more than any other style of connection.

Symbol . . .

NPT – National Pipe Taper

NPTF – National Pipe Taper Fuel (Dryseal)

NPT threads are likely to leak much more than Dryseal pipe threads. Either kind of pipe thread will leak if under tightened. There is not a general accepted standard for tightening either style of tapered threads. The tightening requirements change with each reuse and/or type of sealant used. Use a good pipe sealant on the male threads. Over tightening may crack the female port. Teflon tape is not normally recommended for hydraulic systems.

causes:	cures:
1. Connector is not tight	Tighten
2. Cracked port or connector	Replace defective parts
3. Oversized threads in port	Replace defective parts
4. Undersized threads on connector	Replace defective parts
5. Damaged threads, nicks, cuts, etc.	Replace defective parts
6. Threads are not Dryseal standard for hydraulics	Use "NPTF DRYSEAL" standard
7. Straight male pipe threads instead of tapered	Use "NPTF DRYSEAL" standard
8. Contaminated threads, dirt, chips, etc.	Clean and inspect
9. High vibration loosening connection	Retighten connector – reevaluate system design
10. Heat expansion of female threads	Retighten while hot
11. Too tight, causing thread distortion	Inspect and replace damaged parts

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Metric Pressure Conversion Tables

Bar to PSI **Multiply Bar by 14.5 = PSI**

Bar	0	1	2	3	4	5	6	7	8	9
	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI
0	–	14.5	29	43.5	58	72.5	87	101.5	116	130.5
10	145	159.5	174	188.5	203	217.5	232	246.5	261	275.5
20	290	304.5	319	333.5	348	362.5	377	391.5	406	420.5
30	435	449.5	464	478.5	493	507.5	522	536.5	551	565.5
40	580	594.5	609	623.5	638	652.5	667	681.5	696	710.5
50	725	739.5	754	768.5	783	797.5	812	826.5	841	855.5
60	870	884.5	899	913.5	928	942.5	957	971.5	986	1000.5
70	1015	1029.5	1044	1058.5	1073	1087.5	1102	1116.5	1131	1145.5
80	1160	1174.5	1189	1203.5	1218	1232.5	1247	1261.5	1276	1290.5
90	1305	1319.5	1334	1348.5	1363	1377.5	1392	1406.5	1421	1435.5
100	1450	1464.5	1479	1493.5	1508	1522.5	1537	1551.5	1566	1580.5

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Megapascal (MPa) to PSI **Multiply MPa by 145 = PSI**

MPa	0	1	2	3	4	5	6	7	8	9
	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI
0	–	145	290	435	580	725	870	1015	1160	1305
10	1450	1595	1740	1885	2030	2175	2320	2465	2610	2755
20	2900	3045	3190	3335	3480	3625	3770	3915	4060	4205
30	4350	4495	4640	4785	4930	5075	5220	5365	5510	5655
40	5800	5945	6090	6235	6380	6525	6670	6815	6960	7105
50	7250	7395	7540	7685	7830	7975	8120	8265	8410	8555
60	8700	8845	8990	9135	9280	9425	9570	9715	9860	10005
70	10150	10295	10440	10585	10730	10875	11020	11165	11310	11455
80	11600	11745	11890	12035	12180	12325	12470	12615	12760	12905
90	13050	13195	13340	13485	13630	13775	13920	14065	14210	14355
100	14500	14645	14790	14935	15080	15225	15370	15515	15660	15805

Kg/cm^2 to PSI

Multiply Kg/cm^2 by 14.22 = PSI

Kg/cm^2	0	1	2	3	4	5	6	7	8	9
	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI	PSI
0	–	14.22	28.44	42.66	56.88	71.1	85.32	99.54	113.76	127.98
10	142.2	156.42	170.64	184.86	199.08	213.3	227.52	241.74	255.96	270.18
20	284.4	298.62	312.84	327.06	341.28	355.5	369.72	383.94	398.16	412.38
30	426.6	440.82	455.04	469.26	483.48	497.7	511.92	526.14	540.36	554.58
40	568.8	583.02	597.24	611.46	625.68	639.9	654.12	668.34	682.56	696.78
50	711.0	725.22	739.44	753.66	767.88	782.1	796.32	810.54	824.76	838.98
60	853.2	867.42	881.64	895.86	910.08	924.3	938.52	952.74	966.96	981.18
70	995.4	1009.62	1023.84	1038.06	1052.28	1066.5	1080.72	1094.94	1109.16	1123.38
80	1137.6	1151.82	1166.04	1180.26	1194.48	1208.7	1222.92	1237.14	1251.36	1265.58
90	1279.8	1294.02	1308.24	1322.46	1336.68	1350.9	1365.12	1379.34	1393.56	1407.78
100	1422.0	1436.22	1450.44	1464.66	1478.88	1493.1	1507.32	1521.54	1535.76	1549.98

out
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