

CORROSION RESISTANT PTFE
EXPANSION JOINTS

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**GROUPE
CARBONE LORRAINE**

DESCRIPTION

Carbone of America ARMYLOR expansion joints are designed to compensate for misalignment, to absorb expansion and contraction and to isolate vibration and shocks in piping systems. Expansion joints are available in a wide variety of designs and materials, including metal and "plastic". Carbone specializes in state of the art PTFE expansion joints. The flexible PTFE section is selected for its superior corrosion resistance over alternate materials such as rubber, metal, and other polymers.

The convoluted fluoropolymer liners used for expansion joints are generally made by one of three processes.

Paste Extrusion — Carbone of America's ARMYLOR PTFE liners are made by this method. Paste extrusion uses the finest grained PTFE powders that are precisely extruded, sintered, cooled and then formed into their convoluted shapes. PTFE tubes manufactured by paste extrusion have proven superior mechanical properties including 300 - 500 % elongation and superior flex life (over 300,000 cycles).

Isostatic Molding — This method uses less expensive, coarse PTFE powders that are compression molded into either tubes or cylinders. PTFE liners formed by isostatic molding normally are thicker for comparable service ratings, have lower flex life, and less uniform mechanical properties.

Both paste extrusion and isostatic molding use PTFE fluoropolymer resins. PTFE fluoropolymer is not a true thermoplastic and therefore retains its mechanical properties and pressure rating for expansion joints over a wider temperature range.

Thermal Extrusion — This method normally uses PFA fluoropolymer resin which is a true thermoplastic. Thermoplastics are easier to process but lose their mechanical properties as temperatures increase. This can be a significant factor at higher process temperatures under varying pressure conditions.

Regardless of the manufacturing process used or the supplier of the product, it is critical to select an expansion joint that is designed to meet the temperature and pressure conditions of the specific application. Refer to Carbone's performance curves on following pages to assure proper selection.

ARMYLOR expansion joints are used extensively in the chemical processing industry. They are corrosion-proof, non-aging and exhibit extraordinary flex life with unmatched reliability. They often are priced at no more than those made of lesser materials. The flexible elements are formed over the full sealing face of the rotating (lap joint type) end flanges thus eliminating troublesome separate gaskets when connected to other PTFE piping.

Carbone offers 3 basic series of expansion joints with several options available for each.

Series A or G:

Standard for normal operating conditions



Series H:

Reinforced outer convolutes for intermediate pressures.



Series Z:

Armored for high pressure applications.



TYPICAL PROCESS APPLICATIONS:**GRAPHITE HEAT EXCHANGERS:**

Carbone expansion joints placed at or near the graphite nozzles eliminate failure caused by expansion and contraction of piping systems.

PUMP ISOLATION:

Carbone expansion joints on the suction and discharge sides of pumps absorb stresses of vibration and expansion and contractions due to rapid temperature changes. Mechanical seal maintenance, as a result, can be drastically reduced.

COLUMNS, REACTORS, AND PIPING SYSTEMS:

ARMYLOR expansion joints are excellent vibration dampeners and facilitate the installation of various process equipment and piping systems.

HEATING, VENTILATING & AIR CONDITIONING (HVAC) AND REFRIGERATION**PUMPS, COMPRESSORS, ROTATING EQUIPMENT:**

Carbone "PTFE" expansion joints installed on flanged piping connections are used to reduce "noise pollution" caused by vibration of rotating equipment used in the HVAC industry including pumps and compressors. They are also used in HVAC and refrigeration piping that

GLASS LINED REACTOR CONNECTIONS:

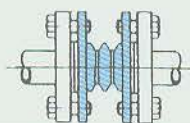
Vibration can be eliminated by using Carbone expansion joints on glass lined flanged connections. Bellows of "PTFE" absorb the vibration and movements of the pipe relative to the reactor and save thousands of dollars in reactor glass nozzle repairs.

CORROSION RESISTANCE PROCESS PIPING:

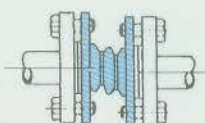
Carbone "PTFE" joints prevent unwanted stressing of piping caused by contraction and expansion of piping during thermal cycling. They can be used within their pressure/temperature boundaries for exotic alloy piping as well as all plastic piping (lined and unlined) including PVC, CPVC, ABS, PP (polypropylene), FRP, PVDF (Kynar®), PTFE (Teflon®), etc. Expansion joints are always recommended for long straight runs of pipe.

have inherent thermal cycling problems to compensate for expansion and contraction. "PTFE" bellows exhibit outstanding flex life and its life cycle cost has proven to be lower than other materials used for expansion joints.

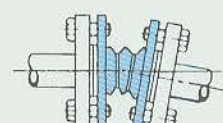
Pipe motion is absorbed by an expansion joint (limit bolts not shown)

**AXIAL TRAVEL**

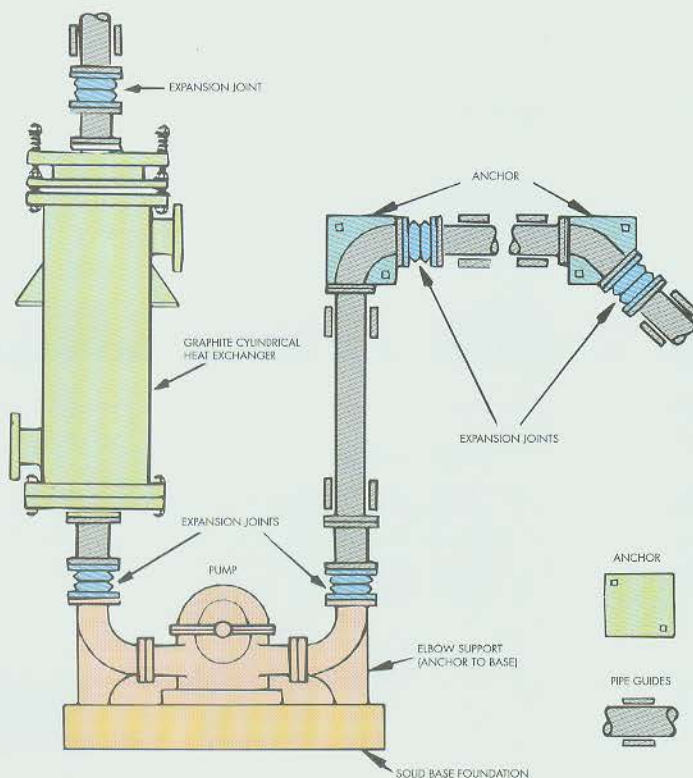
"Maximum Travel" (\pm) may be called longitudinal movement or axial compression and extension. It is based on installation with no misalignment or angular deflection.

**MISALIGNMENT**

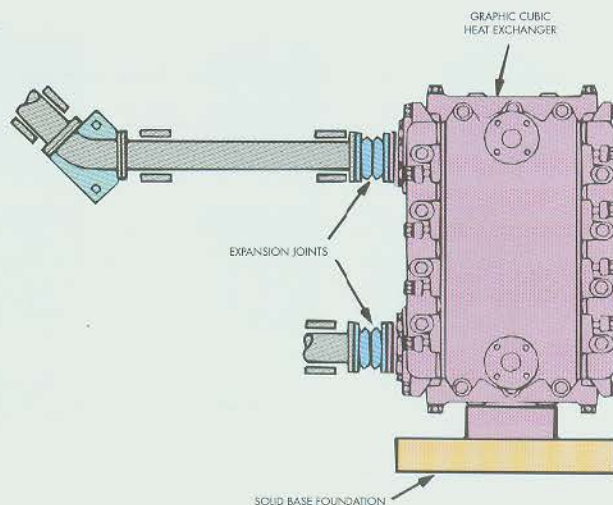
"Maximum Misalignment" may also be referred to as lateral offset or deflection. It is based on installation with no axial travel or angular deflection.

**ANGULAR DEFLECTION**

"Maximum Angular Deflection" may be called angular rotation. It is based on installation with no axial travel or lateral offset.



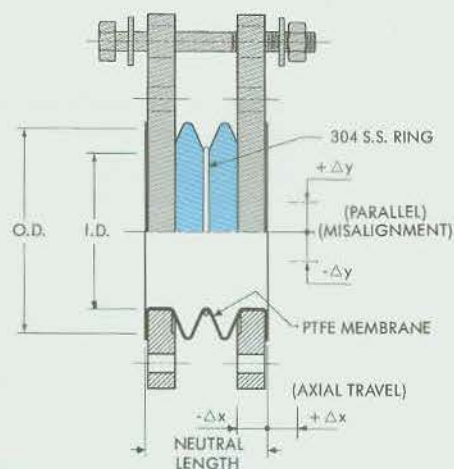
Typical piping, pump and heat exchanger layout utilizing expansion joints when equipment and piping are properly anchored.



WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Linersleeves must be used in abrasive service or where sharp-edged solids are or may be present (see page 10).

Series A & G

"A" & "G" SERIES
(2 CONVOLUTIONS SHOWN)



A & G REPRESENT
DIFFERENT NEUTRAL LENGTHS

Nominal size I.D.	Model	Number of Convolutions	Neutral length (in)	$\pm \Delta x$ Maximum axial travel ⁽¹⁾ (in)	$\pm \Delta y$ Maximum parallel misalignment ⁽¹⁾ (in)	Maximum angular deflection ⁽¹⁾ (degrees)	Nominal flare O.D. (in)	I.D. (in)	Spring Rate F_x ⁽²⁾ (lb/in)	Spring Rate F_y ⁽²⁾ (lb/in)	Weight (lbs)
1"	1A2	2	1-3/8	1/4	1/8	16	2-7/16	15/16	280	150	2
	1A3	3	1-3/4	1/2	1/4	24	2-7/16	15/16	260	110	2
	1G3	3	2	1/2	3/8	30	2-7/16	15/16	260	110	2
	1G5	5	3	3/4	9/16	39	2-7/16	15/16	230	90	2
1-1/2"	15A2	2	1-3/8	1/4	1/8	12	3-1/8	1-7/16	340	200	4
	15G3	3	2	1/2	1/4	20	3-1/8	1-7/16	290	160	4
	15A5	5	3-1/2	3/4	1/2	32	3-1/8	1-7/16	230	110	5
	15G5	5	3	3/4	1/2	36	3-1/8	1-7/16	230	110	5
2"	2A2	2	1-9/16	1/4	1/8	12	3-5/8	1-13/16	340	310	7
	2A3	3	2-3/4	3/4	3/8	17	3-5/8	1-13/16	290	260	8
	2G5	5	3-15/16	1	1/2	29	3-5/8	1-13/16	230	200	9
2-1/2"	25A2	2	2-1/4	5/16	1/8	11	4-5/16	2-3/8	260	340	10
	25G3	3	2-15/16	7/8	7/16	17	4-5/16	2-3/8	230	290	11
	25G5	5	3-15/16	1-3/8	9/16	25	4-5/16	2-3/8	200	230	12
3"	3A2	2	2-1/4	3/8	3/16	10	4-13/16	2-15/16	260	430	12
	3A3	3	3-5/8	1	1/2	15	4-13/16	2-15/16	230	340	13
	3G3	3	3-15/16	1	1/2	20	4-13/16	2-15/16	230	340	13
	3G5	5	4-15/16	1-9/16	9/16	25	4-13/16	2-15/16	200	260	14
4"	4A2	2	2-5/8	1/2	1/4	9	5-15/16	3-7/8	370	690	18
	4A3	3	3-5/8	1	1/2	14	5-15/16	3-7/8	290	510	19
	4G3	3	3-15/16	1	1/2	18	5-15/16	3-7/8	290	510	19
	4A5	5	5-1/4	1-1/4	5/8	21	5-15/16	3-7/8	200	340	20
	4G5	5	5-1/8	1-9/16	5/8	26	5-15/16	3-7/8	200	340	20
5"	5A2	2	3-1/4	1/2	1/4	8	6-7/8	4-3/4	490	830	24
	5A3	3	4	1	1/2	13	6-7/8	4-3/4	340	630	25
	5G5	5	6-7/8	1-3/4	1-1/4	19	6-7/8	4-3/4	230	460	26
6"	6A2	2	2-3/4	1/2	1/4	7	8-1/16	5-13/16	740	1030	29
	6A3	3	4	1-1/8	9/16	13	8-1/16	5-13/16	570	860	30
	6G3	3	5-7/8	1-1/8	9/16	18	8-1/16	5-13/16	570	860	30
	6A5	5	6	1-1/4	5/8	19	8-1/16	5-13/16	460	690	31
	6G5	5	8-7/8	1-3/4	7/8	25	8-1/16	5-13/16	460	690	31
8"	8A2	2	4	7/8	1/4	6	10-1/16	7-5/8	1200	1260	47
	8G3	3	5-7/8	1-1/8	9/16	12	10-1/16	7-5/8	860	1030	48
	8G5	5	8-7/8	1-3/4	1-1/2	18	10-1/16	7-5/8	570	860	50
10"	10A2	2	5-1/4	1/2	1/4	6	12-3/16	9-1/2	1260	1370	64
	10G3	3	5-7/8	1-1/8	3/8	10	12-3/16	9-1/2	860	1150	66
	10G5	5	8-7/8	1-3/4	5/8	15	12-3/16	9-1/2	570	970	68

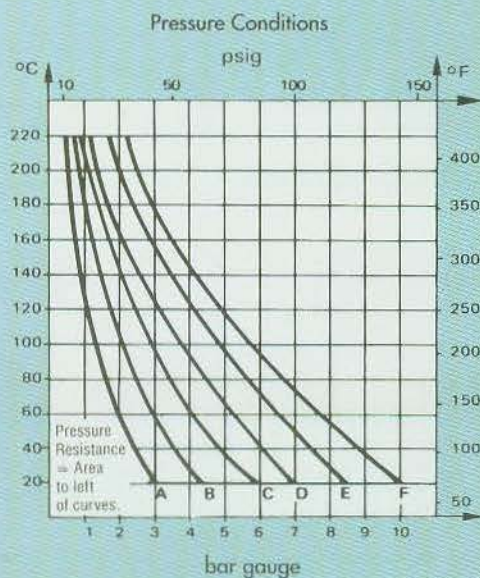
A & G dimensional data (continued)

Nominal size I.D.	Model	Number of Convolutions	Neutral length (in)	± Δx Maximum axial travel (in)	± Δy Maximum parallel misalignment (in)	Maximum angular deflection (degrees)	Nominal flare O.D. (in)	I.D. (in)	Spring Rate Fx (2) (lb/in)	Spring Rate Fy (2) (lb/in)	Weight (lbs)
12"	12G3	3	5-7/8	1-3/16	3/8	8	14-9/16	11-5/8	860	1140	105
	12G5	5	8-7/8	2	5/8	12	14-9/16	11-5/8	690	970	108
14"	14G3	3	5-7/8	1-3/16	3/8	8	16-1/8	12-9/16	1140	1540	125
	14G5	5	8-7/8	2	5/8	12	16-1/8	12-9/16	910	1310	130
16"	16G3	3	5-7/8	1-3/16	3/8	7	17-3/16	14-5/16	1140	1540	155
	16G5	5	8-7/8	2	5/8	11	17-3/16	14-5/16	910	1310	160
18"	18G3	3	5-7/8	1-3/16	3/8	7	20-1/2	16-9/16	1430	1660	175
	18G5	5	8-7/8	2	5/8	11	20-1/2	16-9/16	1140	1370	180
20"	20G3	3	5-7/8	1-3/16	3/8	6	22-7/16	18-5/16	1710	2000	185
	20G5	5	8-7/8	2	5/8	10	22-7/16	18-5/16	1430	1710	195
24"	24G3	3	6-7/8	1-3/16	3/8	6	26-5/16	22-7/16	1710	2000	270
	24G5	5	9-7/8	2	5/8	10	26-5/16	22-7/16	1430	1710	285
30"	30G3	3	7-1/4	1-3/16	3/8	6	32-1/2	28	2000	2280	420

Larger sizes available upon request.

- Notes: (1) $\frac{\text{Actual travel}}{\text{maximum travel}} + \frac{\text{actual parallel misalignment}}{\text{maximum parallel misalignment}} + \frac{\text{actual angular deflection}}{\text{maximum angular deflection}} < 1$
 (2) Springs rates given are for 70 deg. F. Spring rates decrease as temperature rises and over time when operated under pressure due to thermoplastic "creep". Consult Factory if more information is required.

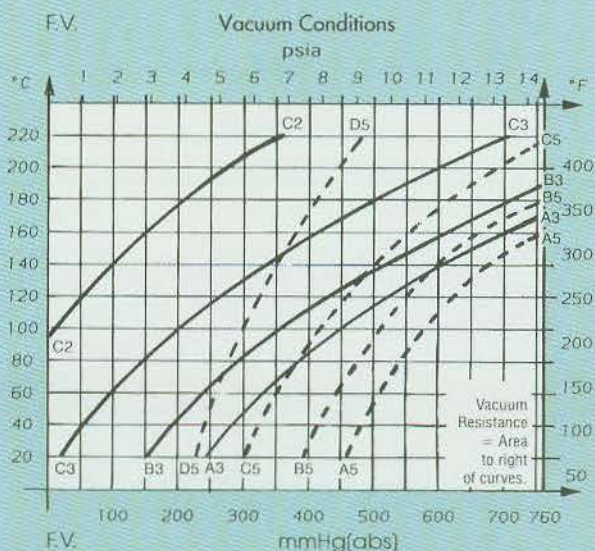
PERFORMANCE CURVES FOR SERIES A & G



Curve	SIZE (in)
A	20 & 24
B	16 & 18
C	12 & 14
D	8 & 10
E	4 - 6
F	1 - 3

For pressure conditions for 5 convolutions multiply values by 0.6 at temperature desired.

For pressure conditions for 2 convolutions multiply values by 2 at temperature desired.



Curve	SIZE (in)	No. of Conv.
A3	16 - 24	3
A5	16 - 24	5
B3	12 & 14	3
B5	12 & 14	5
C2	8 - 10	2
C3	3 - 10	3
C5	3 - 10	5
*	1 - 6	2
*	1 - 2-1/2	3
D5	1 - 2-1/2	5

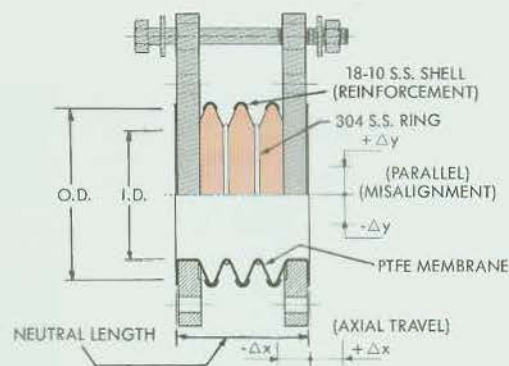
*Rated for full vacuum up to 350°F.

Note: Vacuum rings can be added to all models to increase vacuum ratings. See page 10.

WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Linersleeves must be used in abrasive service or where sharp-edged solids are or may be present (see page 10).

Series H

"H" SERIES — REINFORCED
OUTER CONVOLUTE
(3 CONVOLUTIONS SHOWN)

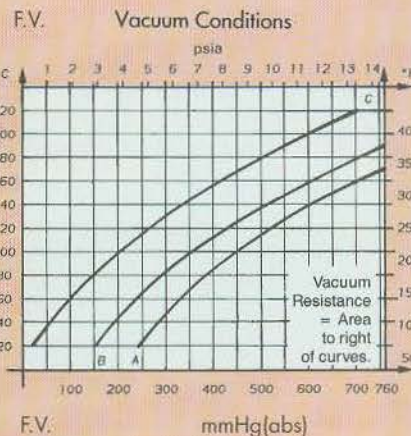
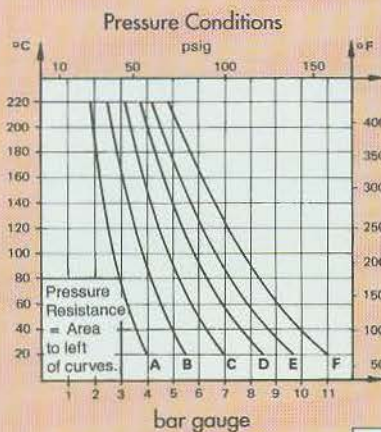


Nominal size I.D.	Model	Number of Convolutions	Neutral length (in)	$\pm \Delta x$ Maximum axial ⁽¹⁾ travel (in)	$\pm \Delta y$ Maximum parallel ⁽¹⁾ misalignment (in)	Maximum angular ⁽¹⁾ deflection (degrees)	Nominal flare O.D. (in)	I.D. (in)	Spring Rate F_x ⁽²⁾ (lb/in)	Spring Rate F_y ⁽²⁾ (lb/in)	Weight (lbs)
1"	1H2	2	2	9/32	1/8	10	2-7/16	15/16	260	110	5.5
1-1/2"	15H2	2	2	9/32	3/16	9	3-1/8	1-7/16	290	160	9
2"	2H3	3	2-15/16	5/16	3/16	15	3-5/8	1-13/16	290	260	14
2-1/2"	25H3	3	2-15/16	3/8	3/16	15	4-5/16	2-3/8	230	290	17
3"	3H3	3	3-15/16	9/16	5/16	14	4-13/16	2-15/16	230	340	19
4"	4H3	3	3-15/16	9/16	5/16	14	5-15/16	3-7/8	290	510	24
5"	5H3	3	4-15/16	3/4	3/8	14	6-7/8	4-3/4	340	630	29
6"	6H3	3	5-7/8	1-1/8	3/8	13	8-1/16	5-13/16	570	860	35
8"	8H3	3	5-7/8	1-1/8	3/8	12	10-1/16	7-5/8	860	1030	46
10"	10H3	3	5-7/8	1-1/8	3/8	10	12-3/16	9-1/2	860	1140	79
12"	12H3	3	5-7/8	1	3/8	8	14-9/16	11-5/8	860	1140	108
14"	14H3	3	5-7/8	1	1/4	8	16-1/8	12-9/16	1140	1540	128
16"	16H3	3	5-7/8	1	1/4	7	17-13/16	14-5/16	1140	1540	158
18"	18H3	3	5-7/8	1	1/4	7	20-1/2	16-9/16	1430	1660	176
20"	20H3	3	5-7/8	1	1/4	6	22-7/16	18-5/16	1710	2000	196
24"	24H3	3	6-7/8	1	1/4	6	26-5/16	22-7/16	1710	2000	286

Larger sizes and other number of convolutions available upon request.

(1), (2) see notes under Series A & G dimensional data chart on page 5.

Performance Curves for Series H



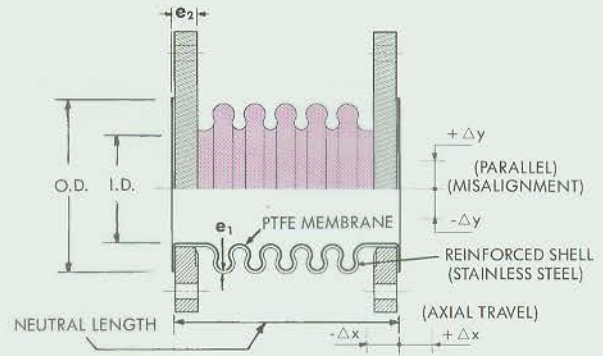
Curve	SIZE (in)
A	20 & 24
B	16 & 18
C	12 & 14
D	8 & 10
E	4 - 6
F	1 - 3

Curve	SIZE (in)
A	16 - 24
B	12 & 14
C	3 - 10
*	1 - 2-1/2

*Sizes 1 - 2-1/2" are rated full vacuum up to 350°F.

Series Z

"Z" SERIES — ARMORED (5 CONVOLUTIONS SHOWN)



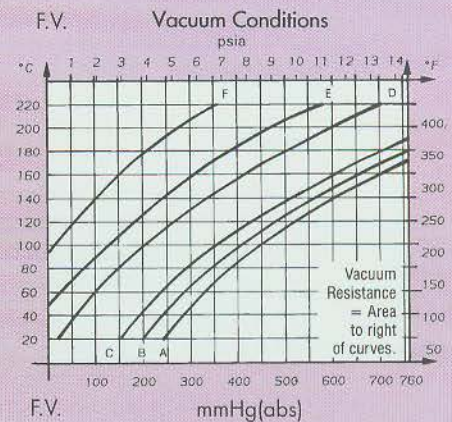
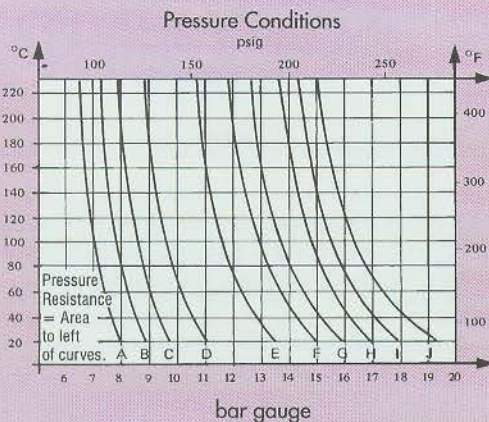
Nominal size I.D.	Model	Number of Convolutions	Neutral length (in)	$\pm \Delta x$ Maximum axial travel ⁽¹⁾ (in)	$\pm \Delta y$ Maximum parallel misalignment ⁽¹⁾ (in)	e_1 (in)	Nominal flare O.D. (in)	e_2 (in)	Spring Rate F_x ⁽²⁾ (lb/in)	Spring Rate F_y ⁽²⁾ (lb/in)	Weight (lbs)
2"	2Z7	7	5-7/8	9/32	3/32	0.014	3-7/8	7/8	1300	1400	12
2-1/2"	25Z7	7	5-7/8	5/16	3/32	0.02	4-5/8	7/8	1300	2500	14
3"	3Z5	5	5-7/8	5/16	3/32	0.02	5	7/8	2200	6300	17
4"	4Z5	5	5-7/8	3/8	3/32	0.03	6-1/4	7/8	1900	8000	19
5"	5Z5	5	5-7/8	3/8	3/32	0.04	7-7/16	15/16	4200	8000	24
6"	6Z6	6	7-11/16	13/16	5/32	0.04	8-3/8	15/16	2200	8000	29
8"	8Z7	7	9-5/8	1-1/8	7/32	0.05	10-9/16	1	2200	9700	44
10"	10Z7	7	9-5/8	1-3/8	1/4	0.05	12-5/8	1-13/16	2900	10800	60
12"	12Z12	12	15-3/4	1-7/8	1/2	0.05	14-9/16	1-13/16	2300	2100	90
14"	14Z12	12	15-3/4	3	3/4	0.05	16-15/16	1-13/16	1200	3000	121
16"	16Z12	12	15-3/4	3-5/16	11/16	0.05	18-7/8	1-13/16	1500	3000	165
18"	18Z11	11	15-3/4	3	9/16	0.05	20-15/16	1-13/16	1400	4600	176
20"	20Z11	11	15-3/4	3	9/16	0.05	23	1-1/4	1800	6300	220
24"	24Z11	11	15-3/4	3	7/16	0.05	27	1-7/16	2200	9100	264

Note: Standard units have "drilled" ANSI 150# clearance holes.

ANSI 300# clearance holes available upon request. Add suffix "F" to catalog number and state "ANSI 300# drilling".

(1), (2) see notes under Series A & G dimensional data chart on page 5.

Performance Curves for Series Z



Curve	SIZE (in)	Curve	SIZE (in)
A	24	F	8
B	20	G	6
C	18	H	4
D	12 & 16	I	3
E	10	J	2

Curve	SIZE (in)
A	20 & 24
B	16 & 18
C	12 & 14
D	8 & 10
E	4 - 6
F	2 - 3

WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Linersleeves must be used in abrasive service or where sharp-edged solids are or may be present (see page 10).

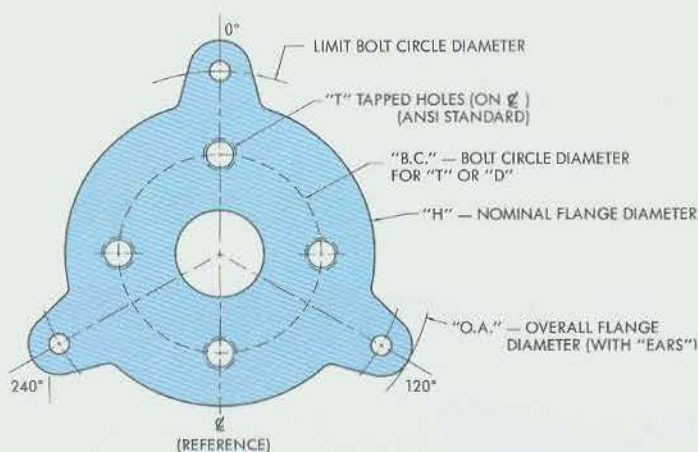
Expansion Joint Flange Drilling

Nominal size	# Holes	"T" Thread (in-UNC)	B.C. (in)	"R" Models only			L.B. Dia. (in)	L.B. B.C. (in)	Nominal flare Dia. "H" (in)	Flange Thickness (in)	"O.A." Dia. (in)
				# Holes	"E" Thread (in-UNC)	B.C. (in)					
1"	4	1/2-13	3-1/8	4	5/16-18	3-1/8	3/8	5-1/2	4-1/2	3/8	6-11/16
1-1/2"	4	1/2-13	3-7/8	4	5/16-18	3-7/8	3/8	7-1/8	6	1/2	8-1/4
2"	4	5/8-11	4-3/4	4	5/16-18	4-3/4	3/8	7-11/16	6-1/2	1/2	8-7/8
2-1/2"	4	5/8-11	5-1/2	—	—	—	3/8	8-1/2	7-1/4	5/8	9-11/16
3"	4	5/8-11	6	4	5/16-18	6	3/8	9-1/16	7-7/8	5/8	10-1/4
4"	8	5/8-11	7-1/2	8	5/16-18	7-1/2	3/8	10-1/4	9	5/8	11-5/8
5"	8	3/4-10	8-1/2	—	—	—	1/2	11-1/4	10	3/4	12-7/8
6"	8	3/4-10	9-1/2	8	3/8-16	9-1/2	1/2	12-3/8	11-1/4	3/4	14-1/16
8"	8	3/4-10	11-3/4	—	—	—	1/2	14-3/4	13-9/16	3/4	16-7/16
10"	12	7/8-9	14-1/4	—	—	—	1/2	17-5/16	16-1/8	1	19
12"	12	7/8-9	17	—	—	—	1/2	20-1/4	19-1/8	1	21-15/16
14"	12	1-8	18-3/4	—	—	—	1/2	22-1/4	21-1/16	1	23-7/8
16"	16	1-8	21-1/4	—	—	—	9/16	24-13/16	23-5/8	1	26-15/16
18"	16	1-1/8-7	22-3/4	—	—	—	9/16	26-3/16	25-3/16	1	28-5/16
20"	20	1-1/8-7	25	—	—	—	9/16	28-3/4	27-9/16	1	30-7/8
24"	20	1-1/4-7	29-1/2	—	—	—	5/8	33-1/4	32	1-1/4	35-13/16
30"	28	1-1/4-7	36	—	—	—	5/8	41-5/16	38-3/4	1-3/8	43-7/8

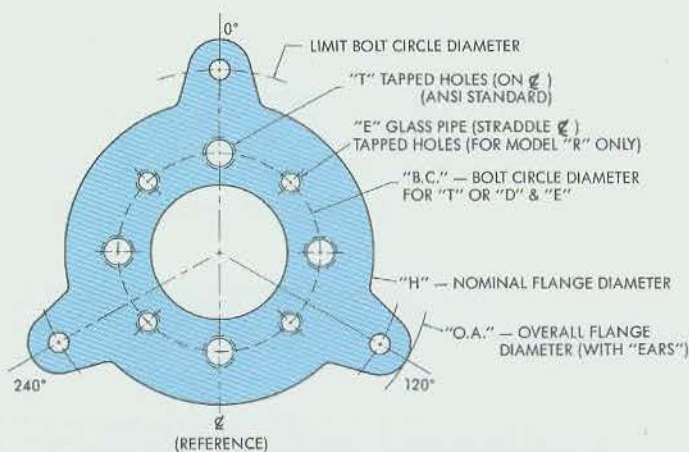
Note: "T" thread is for "T" tapped models;
for "D" drilled models, add 1/8" to "T" for hole size

L.B. = Limit Bolt
B.C. = Bolt Circle
O.A. = Overall

MODEL "T" SHOWN
(ANSI TAPPED)



MODEL "R" SHOWN
("DOUBLE DRILLING" — ANSI TAPPED + GLASS TAPPED HOLES.)



Other Design Notes

In addition to the expansion joints inherent spring rates, F_x and F_y , noted in the preceding charts, a pressure Force F_p , also known as the "depth effect", must also be considered for pipe support design calculations. This pressure Force is simply:

1) $F_p = P \cdot A$; where F_p is the pressure force (lb), P is the operating pressure (psig) in the pipe and A is the reaction force area (in²) of one convolute. The pressure force, F_p , will act in the axial direction and must be added to the axial spring force ($F_x \cdot x$) to give the total axial reaction force, R_x , as per below.

2) $R_x = F_p + (F_x \cdot x)$; where R_x is the pipe support reaction force (lb), F_p is the pressure Force (lb), F_x is the spring rate (lb/in) from charts, x is the expected or design axial movement (in.) of the expansion joint.

The table below gives the areas (A) required for this calculation for each size joint. The number of convolutions of the expansion joint does **not** affect this calculation.

Area (in ²)	Size	1"	1.5"	2"	2.5"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"
	Model A, G, H	1.4	3.9	6.0	8.5	14	21	30	46	71	104	146	167	217	279	326	480
	Model Z	—	—	6.7	9.6	14	23	31	48	79	121	163	202	271	326	388	550

INSTALLATION PROCEDURE FOR ARMYLOR EXPANSION JOINTS

Carbone expansion joints are precision products made to rigid standards. The safe operation of a Carbone expansion joint, like that of any piece of critical process equipment depends upon proper installation, good operating practice and regular inspection and maintenance. Do not exceed pressure/temperature rating shown in appropriate graphs in catalog. Premature failure and/or rupture could result. For maximum service and safety, please follow these instructions.

1. After inspection return the unit to its carton until time for installation. Always keep the protective wood covering tight on the expansion joint and remove only when ready to install unit because sealing surfaces may become warped or damaged.
2. During installation, protect the TFE faces from sharp edges, abrasion, paint, welding splatter, etc. Ensure that sealing faces are clean, smooth & parallel.
3. Gaskets may not be required when connecting expansion joints to PTFE lined pipe or fittings. When connecting joints to an unlined flange or porcelain, graphite, or glass lined equipment use a gasket thickness of 1/8" minimum. PTFE gaskets are available from Carbone upon request.
4. Leave limit bolts at the factory settings. Severe damage can result if the limit bolts and stop nuts are removed or altered.
5. When connecting expansion joints to types of piping materials other than PTFE, the lower of the flange bolt torque values recommended on the table below and the recommended bolt torque values of the other material should be applied. Never exceed the recommended values.

FIGURES BELOW REPRESENT TORQUE VALUES WHEN CONNECTING EXPANSION JOINTS TO LINED PIPE WITHOUT USING GASKETS.

Size ISP (")	Torque (Ft-lbs)	Size ISP (")	Torque (Ft-lbs)	Size ISP (")	Torque (Ft-lbs)	Size ISP (")	Torque (Ft-lbs)
1/2	5	2-1/2	30	10	50	24	90
3/4	5	3	40	12	60	28	90
1	10	4	30	14	70	30	100
1-1/4	10	5	40	16	65	32	120
1-1/2	15	6	45	18	90	36	120
2	25	8	60	20	85	42	100

Tighten the flange bolts with a torque wrench, using a "crisscross" pattern that alternately tightens the bolts located 180° apart. Using this pattern, tighten the bolts in 20% increments until 80% of final bolt torque has been achieved. For tightening to the final torque values, tighten the bolts sequentially clockwise around the flange. This will help ensure that the bolts are evenly stressed.

After the first thermal cycle, when the flanges have cooled to ambient temperature, all bolts should be re-torqued to original specifications, re-torqued 72 hours later, and then on an annual basis.

NOTE: If used to handle hot material, it is recommended that these units be installed at nearly extended length rather than neutral setting. If used in a line which will be chilled, install at nearly compressed length. In this way the full travel capabilities will be utilized.

6. To perform their function properly, expansion joints must not be rigid. When rigidity is required it should be provided by other means, usually by attaching the pipe or fittings to non-yielding structural members before and after each joint. In straight runs, Carbone expansion joints may be alternated with these anchor points, the spacing depending on expected motion and allowable expansion and contraction as shown in catalog. Generally, the system should be anchored wherever it changes direction or branches, such as at elbows, tees, or crosses. No more than one expansion joint should be placed between any two anchors.
7. Provide vertical support for piping at any point where weight might cause misalignment.
8. The life of any flexible coupling, expansion joint, or bellows depends largely on freedom from both angular and parallel misalignment; life increases as misalignment decreases. For maximum life keep misalignment minimum, and certainly within the limits shown in catalog.
9. **WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure.**

The technical data contained herein is by way of example and should not be relied on for any specific application. Carbone of America will be pleased to provide specific technical data or specifications with respect to any customer's particular applications. Use of the technical data or specifications contained herein without the express written approval of Carbone of America is at user's risk and Carbone of America expressly disclaims responsibility for such use and the situations which may result therefrom.

Carbone of America makes no warranty, express or implied, that utilization of the technology or products disclosed herein will not infringe any industrial or intellectual property rights of third parties.

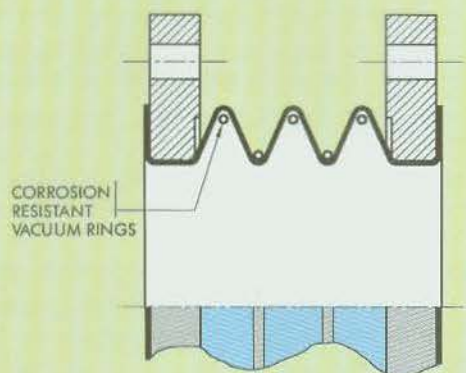
Carbone of America is constantly involved in engineering and development. Accordingly, Carbone of America reserves the right to modify, at any time, the technology and product specifications contained herein.

All technical data, specifications and other information contained herein is deemed to be the proprietary intellectual property of Carbone of America. No reproduction, copy or use thereof may be made without the express written consent of Carbone of America.

WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Linersleeves must be used in abrasive service or where sharp-edged solids are or may be present (see page 10).

Vacuum Rings

Carbone can increase vacuum ratings by adding reinforcement rings to the interior of the convolutions. These rings increase vacuum ratings to 29.8" Hg @ 360° F (2 mmHg abs @ 180° C) for joints up to 3 convolutions. Consult Carbone representative for vacuum limitations for 5 or more convolutions. Standard material for reinforcing rings is PFA coated stainless steel. Other materials such as monel, titanium, zirconium, tantalum, etc. are available upon request. Use suffix "V" when ordering vacuum rings, i.e. 2A3TV.

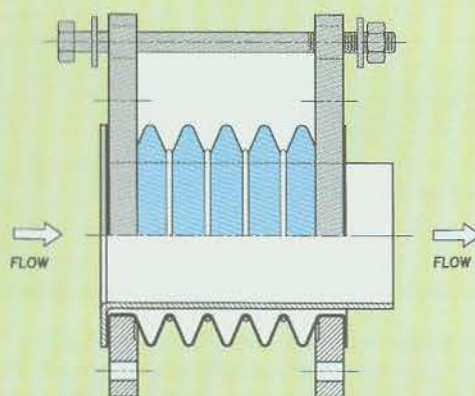


Liner Sleeves

We recommend and can supply PTFE flared liner sleeves for the following applications:

1. Abrasive fluids that can mechanically damage the internal surfaces of the expansion joint.
2. Slurries with high solids content which may settle between the convolutions.
3. High velocity applications.

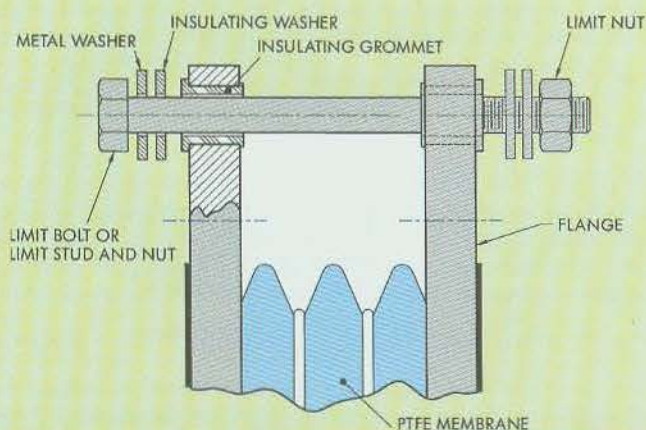
Use prefix "L" when ordering liner sleeves; i.e. L2A3T.



Insulated Limit Bolts

For applications such as piping for electrolytic cells and protection against galvanic corrosion, it is important to have electrical discontinuity between the flanges. This is accomplished by using an insulated limit bolt assembly.

Use suffix "I" when ordering insulated limit bolts; i.e. 2A3TI.

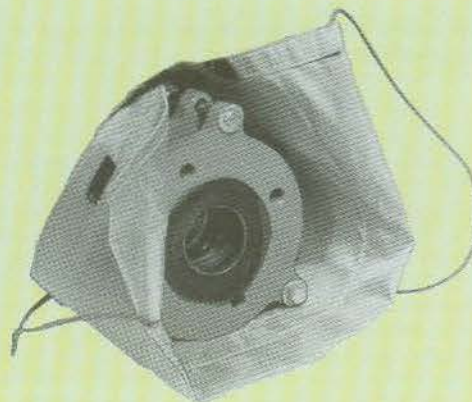


Safety Shields

Safety Shields are recommended for all expansion joint applications involving hazardous service in order to protect personnel from injury in the event of an expansion joint failure. Safety shields can be ordered separately from Carbone.

Safety shields are manufactured from Teflon® impregnated glass cloth with Teflon® draw strings. They are suitable for temperatures up to 430° F.

®Registered trademark of DuPont.



SELECTION OF APPROPRIATE EXPANSION JOINT SHOULD BE BASED UPON:

1. Pressure and temperature limitations as per performance curves.
2. Neutral length and maximum movements based upon dimensional data charts.
3. Operating conditions which may require optional features.

GENERAL SPECIFICATIONS AND ACCESSORIES INFORMATION

MOLDED PTFE

ARMYLOR PTFE CONFORMS TO ASTM D-1457 TYPE III.
Standard colors are BLACK in pipe sizes up to and including 16" and WHITE for 18" and above.
WHITE can be furnished in sizes 1" through 12" if desired. In this case add suffix "W" to the catalog number.

FLANGES

For series A, G, and H:
Ductile iron per ASTM A536, blue epoxy paint.
For series Z:
Steel, red oxide primer.
Other flange materials available upon request. Add suffix "F" when ordering and specify required material.

LIMIT BOLT ASSEMBLY

Limit bolts and washers Cadmium plated steel
Limit nuts Zinc-plated steel elastic stop nuts
Special materials such as stainless steel, monel, fiberglass, etc. are available upon request. Add suffix "B" when ordering.

REINFORCING RINGS AND SHELLS

T304 (18-8) Stainless steel

HOW TO ORDER

SIZE	+	SERIES	+	NUMBER OF CONVOLUTIONS	+	FLANGE DRILLING*	+	OPTIONS
1" to 30" (Note: 1 1/2"=15, 2 1/2"=25)		"standard" "reinforced" "armored"		See charts page 4-7		150# ANSI clearance holes = D 150# ANSI tapped holes = T Glass tapped & 150# ANSI tapped (2 sets) = R Special drilling (specify) = S *If two different flanges are desired, use letters above in combination		B = special bolt material, i.e. stainless steel, fiberglass, alloy, etc. specify I = limit bolt insulator assembly; insulates flange from limit bolts F = special flange materials; steel, stainless steel, alloy, etc.; specify W = white PTFE for sizes 1" thru 12" P = special paint; specify V = internal vacuum support rings; PFA encapsulated stainless steel standard; specify other materials if required.

EXAMPLE:

4-A-3-DT-BI

Explanation:
4" Type A expansion joint, 3 convolutions, 150# ANSI drilled clearance holes one flange, 150# ANSI tapped holes other flange, special bolt material (TS16SS), limit bolt insulators.

WARRANTY

Carbone of America Corp. warrants its products to be free of any defects in material or workmanship for a period of 12 months from date of installation or 18 months from shipment, whichever comes first.

However, Carbone of America Corp. shall have no liability whatsoever for units which fail due to mechanical damage, misuse or abuse. Except for this warranty, Carbone of America Corp. makes no warranty, expressed or implied, and expressly excludes any warranty of application or fitness for a particular service. Carbone's maximum liability hereunder shall be limited to the repair or replacement of any defective product, if appropriate. Carbone of America Corp. shall, under no circumstances, be liable for any incidental, consequential, or other damages, including, but not limited to, loss of business or profits, based on any alleged negligence, breach of warranty, strict liability or other theory, arising out of the use or handling of these products.

WARNING: Safety shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Linersleeves must be used in abrasive service or where sharp-edged solids are or may be present (see page 10).