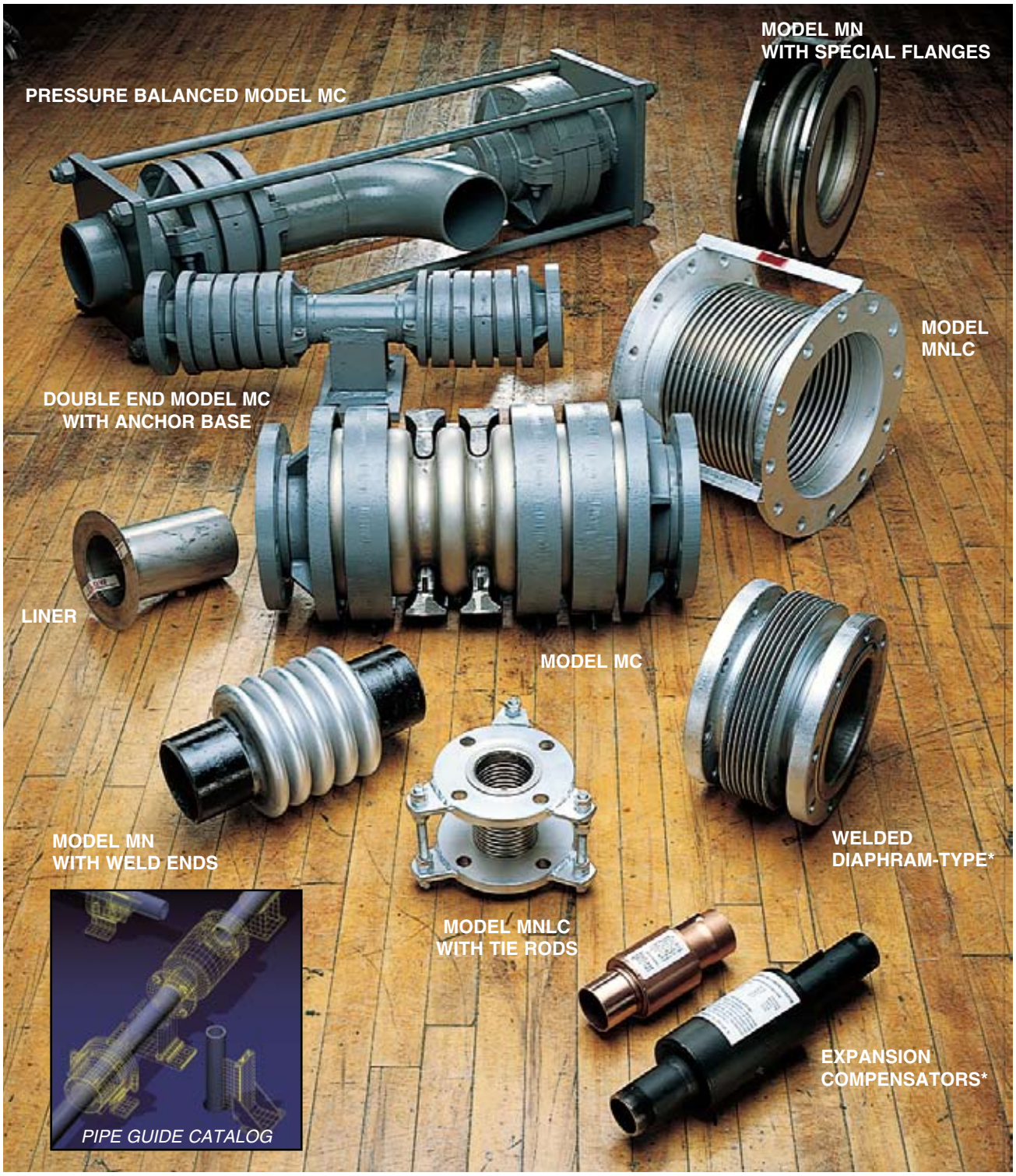
EXPANSION JOINT
DESIGN GUIDE



Metraflex®
for pipes in motion

2323 W. HUBBARD ST. • CHICAGO, IL 60612 • 312-738-3800 • FAX 312-738-0415 • http://www.metraflex.com

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The data on some of the expansion joints from Metraflex are presented first in this guide. For information on expansion joints not described, please contact the factory.

How to Order Metraflex Metal Expansion Joints

Certain basic information about the pipeline system is required in order to select and order expansion joints. Data required about the system includes:

1. **Maximum Working Pressure**
2. **Working Temperature**
3. **Axial, Lateral or Angular Movement**
4. **Cycles Required**
5. **Pipe Size**
6. **End Fittings -** Flange, Weld, Groove or Combination
7. **Bellows Material**
8. **Velocities**
9. **Accessories -** Liners, Covers, Tie Rods

Metal Bellows expansion joints offer a cost effective alternative to other expansion devices while optimizing the productive life of a piping system.

Our expansion joints are designed to last as long as the system. They are maintenance-free. Sealing problems and large space requirements of other expansion devices are eliminated with bellows expansion joints.

All units meet the Standards of the Expansion Joint Manufacturers Association (EJMA) and military specification MIL-E-17813. Consult factory for specific type and class.

Metraflex has been supplying industry with quality piping products for over 40 years. Our reputation for superior products and technical support sets us apart from our competition.

In addition to non-metallic expansion joints, **Metraflex** is a supplier of metallic expansion joints, braided hose, expansion loops, pulsation dampeners, and other specialty piping products using bellows technologies. For more information or to order,

Contact us at:

Metraflex®
for pipes in motion

(312) 738-3800 • (312) 738-0415 Fax

www.metraflex.com

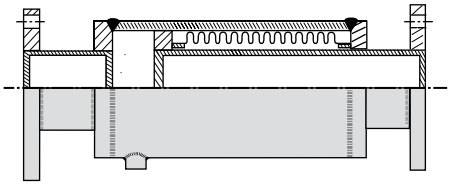
or contact the representative in your area - see back cover.

MODEL METRAGATOR EXPANSION JOINTS

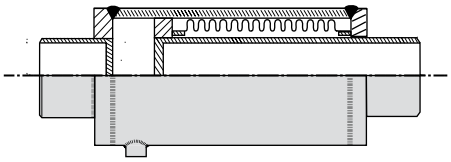
EXTERNALLY PRESSURIZED

*The **Metragator** solves the problem of long axial travel for expansion joints. It comes standard for movements of 4", 6" and 8". They are available in 150 and 300 psi models, and can be configured as doubles if required.*

Maximum Working Pressure . . . . . .150 or 300 psi
Working Temperature . . . . . .700 F
Test Pressure . . . . . .225/450 psi
Bellows . . . . . 2-Ply T304 S/S



FLANGED END



WELD END

SIZE	COM-PRES-SION	150PSI CLASS				300 PSI CLASS			
		FLANGED		WELD END		FLANGED		WELD END	
		OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
2"	4"	24-7/8	34	24-1/4	26	25-3/4	49	23-1/4	35
	6"	31-5/8	41	31	33	34-3/4	63	32	48
	8"	38-3/8	50	37-3/4	42	41-3/4	72	39-1/4	58
2-1/2"	4"	25-1/8	40	24-1/2	29	25-3/4	56	23-1/4	36
	6"	31-7/8	48	31-1/4	37	34-3/4	73	32	52
	8"	38-5/8	58	38	47	41-3/4	84	39-1/4	63
3"	4"	23-7/8	51	23-1/4	38	24-3/4	75	22-1/4	47
	6"	30-1/8	60	29-1/2	47	31-1/4	87	28-1/2	59
	8"	38-3/8	75	37-3/4	62	39-3/4	106	37-1/4	78
4"	4"	23-7/8	75	24-1/4	59	25-3/4	121	22-3/4	74
	6"	31-3/8	89	30-3/4	73	32-1/2	141	29-1/2	94
	8"	37-7/8	110	37-1/4	94	41-1/4	170	38-1/2	124
5"	4"	25	112	24-1/4	91	24-1/2	158	21-1/2	97
	6"	31-1/2	133	30-3/4	112	30-3/4	181	27-1/2	120
	8"	38-1/4	165	37-1/2	144	36-3/4	203	33-3/4	143
6"	4"	25-1/2	138	24-3/4	115	25-1/4	190	21-1/2	106
	6"	32-1/4	162	31-1/2	139	31-1/4	214	27-1/2	130
	8"	38-1/2	200	37-3/4	177	37-1/2	239	33-3/4	155
8"	4"	28-1/4	198	27-1/4	153	26-3/4	295	22-1/2	168
	6"	34-3/4	230	33-3/4	185	33-1/2	336	29	209
	8"	42	283	41	238	40	377	35-3/4	250
10"	4"	27	240	26	186	28-1/2	396	23-3/4	216
	6"	34	281	33	227	35-3/4	452	30-3/4	272
	8"	40-1/4	342	39-1/4	288	44-3/4	534	40	354
12"	4"	27	308	26	226	30-1/2	540	25	285
	6"	33-1/4	355	32-1/4	273	38-1/4	610	32-1/2	355
	8"	39-3/4	428	38-3/4	346	47-3/4	712	42-1/4	457
14"	4"	28-1/4	491	24-1/2	293	30-3/4	732	25	373
	6"	36	565	32	367	38-1/2	828	32-1/2	468
	8"	45-1/2	671	41-3/4	473	48	966	42-1/4	607
16"	4"	28-3/4	547	24-1/2	329	31-1/2	798	25	418
	6"	36-1/4	631	32	412	39-1/4	905	32-1/2	525
	8"	46	749	41-3/4	530	48-3/4	1060	42-1/4	680

ADDITIONAL BELLOWS DATA

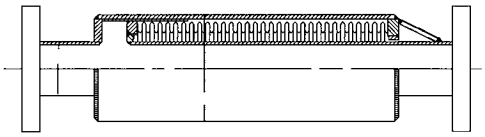
SIZE	BELLOWS EFFECTIVE AREA (Inches Squared)		BELLOWS SPRING CONSTANT (Lbs/Inch/Corrugation)					
	150# CLASS	300# CLASS	150# CLASS			300# CLASS		
			4"	6"	8"	4"	6"	8"
2"	13	12	183	115	92	388	260	194
2-1/2"	13	12	183	115	92	388	260	194
3"	21	16	343	235	172	504	380	252
4"	36	30	200	143	103	850	566	424
5"	47	42	235	166	120	1002	668	501
6"	59	53	269	189	138	1140	760	570
8"	89	83	332	235	166	2424	1616	1212
10"	125	135	400	280	200	3266	2177	1633
12"	167	182	463	326	235	3491	2327	1745
14"	212	212	1328	885	1053	2656	1770	1328
16"	276	276	1425	950	712	2850	1900	1424

COMPENSATORS

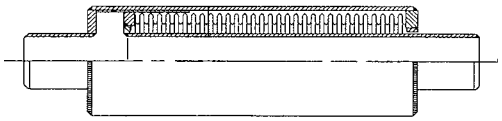
SMALL DIAMETER

Metraflex Compensators *are perfect for pipe diameters up to 4" when axial movement is required due to thermal expansion. They are stocked with both 2" and 3" compression ability in flanged, weld, thread, and sweat ends.*

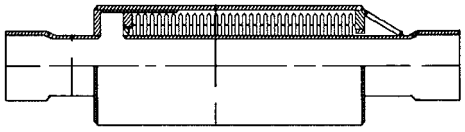
For greater movements and larger diameters, check our Metragator expansion joints.



FLANGED END



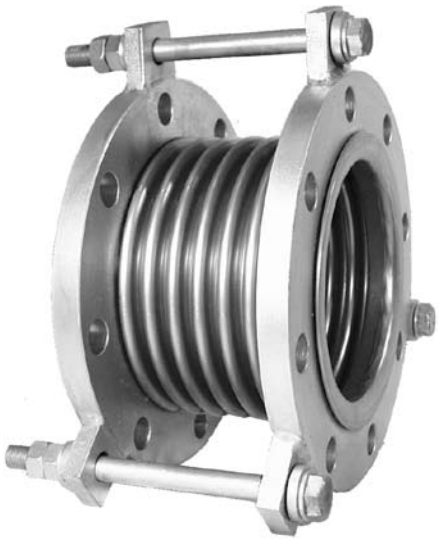
WELD/THREAD END



SWEAT END

Maximum Working Pressure . . . . . 175 psi
Working Temperature . . . . . .750 F
Test Pressure . . . . . 250 psi
Bellows . . . . . Multi-Ply T304 S/S

SIZE	COM-PRES-SION	END CONFIGURATION					
		FLANGED		WELD/THREAD END		SWEAT ENDS	
		OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
3/4"	2"	12-3/4	8	12-3/4	3	11	3/4
	3"	16-1/2	9	16-1/2	3	14-7/8	1
1"	2"	13-1/4	9	13-1/4	4	11-1/4	1
	3"	16-1/2	10	16-1/2	4	15-1/8	1-1/2
1-1/4"	2"	13-1/4	12	13-1/4	5	12-1/2	1-1/2
	3"	16-1/2	13	16-1/2	5	16-3/8	2
1-1/2"	2"	14-5/8	14	14-5/8	7	12-7/8	2
	3"	17-1/2	15	17-1/2	6	16-3/4	3
2"	2"	14-5/8	18	14-5/8	10	13	3
	3"	17-1/2	20	17-1/2	8	17	4
2-1/2"	2"	16	29	16	14	13-1/4	4
	3"	18-3/4	29	18-3/4	14	17	5
3"	2"	16	34	16	18	14	4-1/2
	3"	19-1/4	36	19-1/4	16	18	6
4"	2"	16-3/8	47	16-3/8	25	-	-
	3"	19-1/4	44	19-1/4	22	-	-

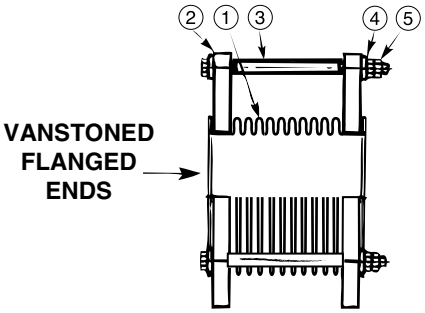


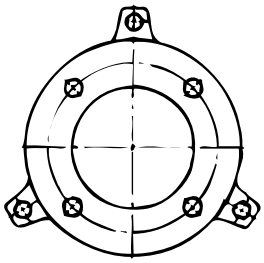
BELLOWS CONNECTORS

WITH TIE RODS

*The **Bellow Pump Connector,** which is kept stocked to 14" for fast delivery, is designed to meet a broad set of needs. It has a 2-ply construction and tie rods that allow it to work well, and economically, in many situations.*

150 F Maximum Working Pressure. . . . . 225 psi
212 F Maximum Working Pressure. . . . . 190 psi
480 F Maximum Working Pressure. . . . . 110 psi





SEE BELOW FOR
NUMBER OF RODS

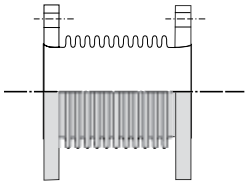
LIST OF MATERIALS		
ITEM	**PART**	**Material**
1	Bellows (2 ply)	T304 S.S.
2	ANSI 150# Flange	Carbon Steel
3	Tie Rods	AISI-1020
4	Grommett	Neoprene
5	Nuts	ANSI-1020

SIZE	OAL (in)	COMPRESSION (in)	EXTENSION (in)	LATERAL (in)	NO. TIE RODS	WEIGHT (lbs.)
2"	6	0.9	0.2	0.66	3	12
2-1/2"	6	0.9	0.2	0.53	3	16
3"	6	0.9	0.2	0.45	3	18
4"	6	1	0.2	0.39	3	28
5"	6	1	0.2	0.31	3	34
6"	6	1	0.2	0.26	3	43
8"	6	1	0.2	0.22	3	63
10"	8	1.4	0.2	0.33	3	93
12"	8	1.4	0.2	0.26	3	120
14"	8	1.4	0.2	0.33	3	145

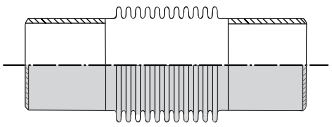
MODEL MNLC EXPANSION JOINTS

LOW CORRUGATION

*The **MNLC Expansion Joints** provide perfect balance between value and performance. With two standard lengths and three pressure ratings available, they can be delivered quickly. Non-standard designs are also easily available.*



FLANGED END



WELD END

Maximum Working Pressure . . . . . 50/150/300 psi
Working Temperature . . . . . .800 F
Test Pressure . . . . . 75/225/450 psi
End Fittings:
Flanges . . . . . .ANSI B16.5
Weld Ends . . . . . A 53 / A 106
Bellows . . . . . .T316 S/S

For other pressure ratings and materials, contact factory.

SIZE	SHORT/ LONG*	COMPRESSION*			FLANGED ENDS						WELD ENDS					
		50 psi (in)	150 psi (in)	300 psi (in)	50 psi		150 psi		300 psi		50 psi		150 psi		300 psi	
					OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
2”	S	1-1/8	1-1/8	3/4	6-1/2	11	6-1/2	11	6-1/2	12	9-7/8	3	9-7/8	3	9-7/8	3
	L	1-3/4	1-3/4	1-1/4	8-1/2	13	8-1/2	13	8-1/2	14	11-3/4	4	11-3/4	4	11-3/4	4
2-1/2”	S	1	1	3/4	7	14	7	14	7	16	9-7/8	3	9-7/8	3	9-7/8	3
	L	1-3/4	1-3/4	1-1/4	8-7/8	16	8-7/8	16	8-7/8	17	11-3/4	4	11-3/4	4	11-3/4	4
3”	S	1	1	3/4	7-3/8	17	7-3/8	20	7-3/8	21	10-1/2	5	10-1/2	5	10-1/2	5
	L	2	2	1-3/8	9	18	9	21	9	22	12	6	12	6	12	7
4”	S	1-1/4	1-1/4	7/8	7-1/2	27	7-1/2	35	7-1/2	37	10-5/8	8	10-5/8	8	10-5/8	9
	L	2-1/2	2-1/2	1-3/4	10-3/4	28	10-3/4	38	10-3/4	40	13-3/4	9	13-3/4	9	13-3/4	10
5”	S	1-1/4	1-1/4	3/4	7-5/8	33	7-5/8	45	7-5/8	47	10-5/8	13	10-5/8	13	10-5/8	14
	L	2-1/2	2-1/2	1-3/4	11-1/4	34	11-1/4	49	11-1/4	51	14-1/4	15	14-1/4	15	14-1/4	17
6”	S	1-1/4	1-1/4	3/4	8	43	8	85	8	89	11	18	11	18	11	20
	L	2-1/2	2-1/2	1-3/4	11-1/2	47	11-1/2	90	11-1/2	94	14-1/2	20	14-1/2	20	14-1/2	22
8”	S	1-1/2	1-1/2	1	9-1/4	64	9-1/4	120	9-1/4	126	12-1/8	22	12-1/8	22	12-1/8	24
	L	3	3	2	13-1/4	71	13-1/4	125	13-1/4	131	16-1/8	26	16-1/8	26	16-1/8	29
10”	S	1-1/2	1-1/2	1	9-3/8	45	9-3/8	160	9-3/8	168	12-1/8	25	12-1/8	25	12-1/8	27
	L	3-3/8	3-1/4	2-1/2	14-3/8	52	14-3/8	170	14-3/8	179	17-1/4	32	17-1/4	32	17-1/4	35
12”	S	1-1/2	1-1/2	1	9-3/4	70	9-3/4	200	9-3/4	210	12-1/2	35	12-1/2	35	12-1/2	39
	L	3-1/4	3-1/8	2-1/4	13-1/2	85	13-1/2	220	13-1/2	231	16-1/4	42	16-1/4	42	16-1/4	46

* For lateral movements, consult factory.
** Doubles come with anchor bases and without bases (universal style). Consult factory for doubles information.

SIZE	SHORT/ LONG*	COMPRESSION*			FLANGED ENDS						WELD ENDS					
		50 psi (in)	150 psi (in)	300 psi (in)	50 psi		150 psi		300 psi		50 psi		150 psi		300 psi	
					OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
14"	S	1-3/4	1-1/2	1	10-3/8	98	10-3/8	220	10-3/8	386	14-1/8	56	14-1/8	68	14-1/8	132
	L	3-1/2	3	2	15	112	15	240	15	414	18-3/4	70	18-3/4	88	18-3/4	160
16"	S	1-3/4	1-1/2	1-1/2	11-1/4	112	11-1/4	232	11-1/4	440	15	62	15	68	15	92
	L	3-1/2	3	3	16-3/4	127	16-3/4	250	16-3/4	470	20-1/2	77	20-1/2	86	20-1/2	122
18"	S	1-3/4	1-1/2	1-1/2	11-1/2	112	11-1/2	296	11-1/2	564	15	57	15	71	15	99
	L	3-1/2	3	3	17	123	17	314	17	598	20-1/2	68	20-1/2	89	20-1/2	131
20"	S	1-3/4	1-1/2	1-1/2	13-3/8	130	13-3/8	378	13-3/8	710	15	72	15	88	15	113
	L	3-1/2	3	3	18-7/8	146	18-7/8	402	18-7/8	750	20-1/2	88	20-1/2	112	20-1/2	173
22"	S	1-3/4	1-1/2	1-1/2	14	140	14	426	14	830	15	78	15	100	15	152
	L	3-1/2	3	3	19-1/2	157	19-1/2	454	19-1/2	875	20-1/2	95	20-1/2	128	20-1/2	202
24"	S	1-3/4	1-1/2	1-1/2	14-1/4	220	14-1/4	495	14-1/4	1030	15	88	15	116	15	180
	L	3-1/2	3	3	19-3/4	240	19-3/4	520	19-3/4	1070	20-1/2	108	20-1/2	150	20-1/2	220
30"	S	1-3/4	1-1/2	-	9	370	9	**	-	-	11-1/2	128	11-1/2	196	-	-
	L	3-1/2	3	-	14-1/2	405	14-1/2	**	-	-	17	162	17	264	-	-
36"	S	1-3/4	1-1/2	-	9	575	9	**	-	-	11-1/2	180	11-1/2	235	-	-
	L	3-1/2	3	-	14-1/2	625	14-1/2	**	-	-	17	230	17	315	-	-
42"	S	1-3/4	1-1/2	-	9	770	9	**	-	-	11-1/2	205	11-1/2	265	-	-
	L	3-1/2	3	-	14-1/2	830	14-1/2	**	-	-	17	355	17	355	-	-
48"	S	1-3/4	1-1/2	-	10-1/2	970	10-1/2	**	-	-	11-1/2	320	11-1/2	320	-	-
	L	3-1/2	3	-	16	1030	16	**	-	-	17	420	17	420	-	-

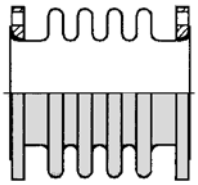
* This table only shows standard designs. For other movements, lengths, or sizes, contact factory.
** Customer to specify flanges.

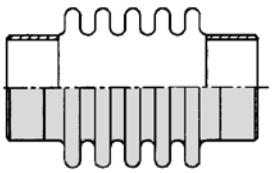
ADDITIONAL BELLOWS DATA

SIZE	EFF AREA (sq in)	BELLOWS SPRING CONSTANT (Lbs./Inch)					
		SHORT			LONG		
		50 psi	150 psi	300 psi	50 psi	150 psi	300 psi
2”	6	590	595	731	315	320	453
3”	12	345	349	1138	231	240	759
4”	19	800	803	1775	399	406	888
5”	29	985	987	2059	465	480	961
6”	40	1170	1181	2456	549	555	1146
8”	66	1220	1235	2791	609	620	1395
10”	104	1655	1669	2996	750	760	1226
12”	146	784	1815	4586	435	957	2293
14”	183	2200	3960	5120	1100	1990	2560

SIZE	EFF AREA (sq in)	BELLOWS SPRING CONSTANT (Lbs./Inch)					
		SHORT			LONG		
		50 psi	150 psi	300 psi	50 psi	150 psi	300 psi
16"	237	1720	3360	4240	860	1680	2120
18"	298	1640	5200	6500	820	2600	3240
20"	362	1960	5600	7130	980	2800	3600
22"	434	2040	5700	11800	1020	2850	5900
24"	512	2460	6100	12300	1230	3030	6200
30"	780	4940	10600	NA	2500	5300	NA
36"	1105	5930	12510	NA	3000	6300	NA
42"	1487	6920	13800	NA	3500	6900	NA
48"	1925	7390	15800	NA	4000	7900	NA

* For lateral movements, consult factory.
** Doubles come with anchor bases and without bases (universal style). Consult factory for doubles information.





FLANGED END **WELD END**

MODEL MN EXPANSION JOINTS

HIGH CORRUGATION

*The **Model MN** uses a hydroformed bellows for minimal residual stresses and minimal thinning at the convolution root and crown. It is an excellent choice for any application within the pressure ratings of the 150 and 50 psi classes.*

Maximum Working Pressure . . . . . 50 or 150 psi*
Working Temperature . . . . . .850 F
Test Pressure . . . . . .75/225 psi
End Fittings:
Flanges . . . . . .ANSI B16.5
Weld Ends . . . . . A 53 / A 105
Bellows . . . . . .Hydroformed T304 S/S

* Full vacuum rating.

SIZE	NO. CORR	50PSI CLASS, SINGLE*						150PSI CLASS, SINGLE*					
		MOVEMENT*		FLANGED		WELD ENDS		MOVEMENT*		FLANGED		WELD ENDS	
		COMP (in)	EXT (in)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	COMP (in)	EXT (in)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
2-1/2 & 3”	1	3/8	1/8	6-1/4	19	8-1/8	9	1/4	1/8	6-1/4	19	8-1/8	9
	2	3/4	3/8	7-1/2	20	9-3/8	10	1/2	1/4	7-1/2	20	9-3/8	10
	3	1-1/8	1/2	8-3/4	21	10-5/8	11	3/4	3/8	8-3/4	21	10-5/8	11
	4	1-1/2	3/4	10	22	11-7/8	12	1	1/2	10	22	11-7/8	12
	5	1-7/8	7/8	11-1/4	23	13-1/8	13	1-1/4	5/8	11-1/4	23	13-1/8	13
	6	2-1/4	1-1/8	12-1/2	24	14-3/8	14	1-1/2	3/4	12-1/2	24	14-3/8	14
	7	2-5/8	1-1/4	13-3/4	25	15-5/8	15	-	-	-	-	-	-
	8	3	1-1/2	15	26	16-7/8	16	-	-	-	-	-	-
4”	1	3/8	1/8	6-1/4	28	8-3/8	11	1/4	1/8	6-1/4	28	8-3/8	11
	2	3/4	3/8	7-1/2	29	9-5/8	12	1/2	1/4	7-1/2	29	9-5/8	12
	3	1-1/8	1/2	8-3/4	30	10-7/8	13	3/4	3/8	8-3/4	30	10-7/8	13
	4	1-1/2	3/4	10	31	12-1/8	14	1	1/2	10	31	12-1/8	14
	5	1-7/8	7/8	11-1/4	32	13-3/8	15	1-1/4	5/8	11-1/4	32	13-3/8	15
	6	2-1/4	1-1/8	12-1/2	33	14-5/8	16	1-1/2	3/4	12-1/2	33	14-5/8	16
	7	2-5/8	1-1/4	13-3/4	34	15-7/8	17	-	-	-	-	-	-
	8	3	1-1/2	15	35	17-1/8	18	-	-	-	-	-	-
5”	1	3/8	1/8	6-3/4	33	8-3/8	14	1/4	1/8	6-3/4	33	8-3/8	14
	2	3/4	3/8	8	35	9-5/8	16	1/2	1/4	8	35	9-5/8	16
	3	1-1/8	1/2	9-1/4	37	10-7/8	18	3/4	3/8	9-1/4	37	10-7/8	18
	4	1-1/2	3/4	10-1/2	39	12-1/8	20	1	1/2	10-1/2	39	12-1/8	20
	5	1-7/8	7/8	11-3/4	41	13-3/8	22	1-1/4	5/8	11-3/4	41	13-3/8	22
	6	2-1/4	1-1/8	13	43	14-5/8	24	1-1/2	3/4	13	43	14-5/8	24
	7	2-5/8	1-1/4	14-1/4	45	15-7/8	26	-	-	-	-	-	-
	8	3	1-1/2	15-1/2	47	17-1/8	28	-	-	-	-	-	-
	9	-	-	16-3/4	49	18-3/8	30	-	-	-	-	-	-
	10	-	-	18	51	19-5/8	32	-	-	-	-	-	-

*Consult factory for Double information and for lateral movements.

SIZE	NO. CORR	50PSI CLASS, SINGLE*						150PSI CLASS, SINGLE*					
		MOVEMENT*		FLANGED		WELD ENDS		MOVEMENT*		FLANGED		WELD ENDS	
		COMP (in)	EXT (in)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	COMP (in)	EXT (in)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
6"	1	1/2	1/4	6-1/4	43	7-5/8	20	3/8	1/8	6-1/4	43	7-5/8	20
	2	1	1/2	8	46	9-3/8	23	3/4	3/8	8	46	9-3/8	23
	3	1-1/2	3/4	9-3/4	49	11-1/8	26	1-1/8	1/2	9-3/4	49	11-1/8	26
	4	2	1	11-1/2	52	12-7/8	29	1-1/2	3/4	11-1/2	52	12-7/8	29
	5	2-1/2	1-1/4	13-1/4	55	14-5/8	32	1-7/8	7/8	13-1/4	55	14-5/8	32
	6	3	1-1/2	15	58	16-3/8	35	2-1/4	1-1/8	15	58	16-3/8	35
	7	3-1/2	1-3/4	16-3/4	61	18-1/8	38	-	-	-	-	-	-
	8	4	2	18-1/2	64	19-7/8	41	-	-	-	-	-	-
	9	4-1/2	2-1/4	20-1/4	67	21-5/8	44	-	-	-	-	-	-
	10	5	2-1/2	22	70	23-3/8	47	-	-	-	-	-	-
8"	1	1/2	1/4	6-1/2	58	9-5/8	28	3/8	1/8	6-1/2	64	9-5/8	28
	2	1	1/2	8-1/4	62	11-3/8	32	3/4	3/8	8-1/4	66	11-3/8	32
	3	1-1/2	3/4	10	66	13-1/8	36	1-1/8	1/2	10	68	13-1/8	36
	4	2	1	11-3/4	70	14-7/8	40	1-1/2	3/4	11-3/4	70	14-7/8	40
	5	2-1/2	1-1/4	13-1/2	74	16-5/8	44	1-7/8	7/8	13-1/2	74	16-5/8	44
	6	3	1-1/2	15-1/4	78	18-3/8	48	2-1/4	1-1/8	15-1/4	78	18-3/8	48
	7	3-1/2	1-3/4	17	82	20-1/8	52	2-5/8	1-1/4	17	82	20-1/8	52
	8	4	2	18-3/4	86	21-7/8	56	3	1-1/2	18-3/4	86	21-7/8	60
	9	4-1/2	2-1/4	20-1/2	90	23-5/8	60	-	-	-	-	-	-
	10	5	2-1/2	22-1/4	94	25-3/8	64	-	-	-	-	-	-
10"	1	1/2	1/4	6-7/8	76	9-3/4	31	3/8	1/8	6-7/8	89	9-3/4	31
	2	1	1/2	8-3/4	80	11-5/8	35	3/4	3/8	8-3/4	91	11-5/8	35
	3	1-1/2	3/4	10-5/8	84	13-1/2	39	1-1/8	1/2	10-5/8	93	13-1/2	39
	4	2	1	12-1/2	88	15-3/8	43	1-1/2	3/4	12-1/2	95	15-3/8	43
	5	2-1/2	1-1/4	14-3/8	92	17-1/4	47	1-7/8	7/8	14-3/8	97	17-1/4	47
	6	3	1-1/2	16-1/4	96	19-1/8	51	2-1/4	1-1/8	16-1/4	99	19-1/8	51
	7	3-1/2	1-3/4	18-1/8	100	21	55	2-5/8	1-1/4	18-1/8	102	21	55
	8	4	2	20	104	22-7/8	59	3	1-1/2	20	105	22-7/8	59
	9	4-1/2	2-1/4	21-7/8	108	24-3/4	63	-	-	-	-	-	-
	10	5	2-1/2	23-3/4	112	26-5/8	67	-	-	-	-	-	-
12"	1	1/2	1/4	7-7/8	118	10-3/8	33	3/8	1/8	7-7/8	135	10-3/8	33
	2	1	1/2	9-3/4	123	12-1/4	38	3/4	3/8	9-3/4	137	12-1/4	38
	3	1-1/2	3/4	11-5/8	128	14-1/8	43	1-1/8	1/2	11-5/8	141	14-1/8	43
	4	2	1	13-1/2	133	16	48	1-1/2	3/4	13-1/2	142	16	48
	5	2-1/2	1-1/4	15-3/8	138	17-7/8	53	1-7/8	7/8	15-3/8	144	17-7/8	53
	6	3	1-1/2	17-1/4	143	19-3/4	58	2-1/4	1-1/8	17-1/4	145	19-3/4	58
	7	3-1/2	1-3/4	19-1/8	148	21-5/8	63	2-5/8	1-1/4	19-1/8	147	21-5/8	63
	8	4	2	21	153	23-1/2	68	3	1-1/2	21	150	23-1/2	68
	9	4-1/2	2-1/4	22-7/8	158	25-3/8	73	-	-	-	-	-	-
	10	5	2-1/2	24-3/4	163	27-1/4	78	-	-	-	-	-	-
14"	1	5/8	1/4	8-3/8	160	10-3/8	70	3/8	1/8	8-3/8	177	10-3/8	70
	2	1-1/4	5/8	10-1/4	166	12-1/4	76	3/4	3/8	10-1/4	180	12-1/4	76
	3	1-7/8	7/8	12-1/8	172	14-1/8	82	1-1/8	1/2	12-1/8	184	14-1/8	82
	4	2-1/2	1-1/4	14	178	16	88	1-1/2	3/4	14	188	16	88
	5	3-1/8	1-1/2	15-7/8	184	17-7/8	94	1-7/8	7/8	15-7/8	192	17-7/8	94
	6	3-3/4	1-7/8	17-3/4	190	19-3/4	100	2-1/4	1-1/8	17-3/4	196	19-3/4	100
	7	4-3/8	2-1/8	19-5/8	196	21-5/8	106	2-5/8	1-1/4	19-5/8	200	21-5/8	106
	8	5	2-1/2	21-1/2	202	23-1/2	112	3	1-1/2	21-1/2	206	23-1/2	112
	9	5-5/8	2-3/4	23-3/8	208	25-3/8	118	-	-	23-3/8	212	25-3/8	118
	10	6-1/4	3-1/8	25-1/4	214	27-1/4	124	-	-	25-1/4	217	27-1/4	124
16"	1	5/8	1/4	8-3/8	177	10-3/8	80	3/8	1/8	8-3/8	197	10-3/8	80
	2	1-1/4	5/8	10-1/4	184	12-1/4	87	3/4	3/8	10-1/4	201	12-1/4	87
	3	1-7/8	7/8	12-1/8	191	14-1/8	94	1-1/8	1/2	12-1/8	205	14-1/8	94
	4	2-1/2	1-1/4	14	198	16	101	1-1/2	3/4	14	209	16	101
	5	3-1/8	1-1/2	15-7/8	205	17-7/8	108	1-7/8	7/8	15-7/8	213	17-7/8	108
	6	3-3/4	1-7/8	17-3/4	212	19-3/4	115	2-1/4	1-1/8	17-3/4	218	19-3/4	115
	7	4-3/8	2-1/8	19-5/8	219	21-5/8	122	2-5/8	1-1/4	19-5/8	223	21-5/8	122
	8	5	2-1/2	21-1/2	226	23-1/2	129	3	1-1/2	21-1/2	230	23-1/2	129
	9	5-5/8	2-3/4	23-3/8	233	25-3/8	136	3-3/8	1-5/8	23-3/8	236	25-3/8	136

* Consult factory for Double information and for lateral movements

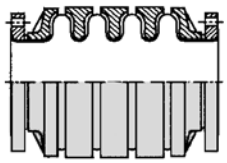
MODEL MC EXPANSION JOINTS

SELF EQUALIZING, RING CONTROLLED

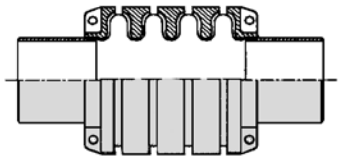
As in the Model MN expansion joints, the ***Model MC*** *utilizes a hydroformed bellows. It also provides the ultimate in control and safety with self equalizing control rings.*

Maximum Working Pressure . . . . . .300 psi*
Working Temperature . . . . . .500 F
Test Pressure . . . . . 450 psi
End Fittings:
Flanges . . . . . .ANSI B16.5
Weld Ends . . . . . A 53 / A 106
Bellows . . . . . .Hydroformed T304 S/S

* 300 psi is the bellows rating. Flange rating must also be considered. Full vacuum rating.



FLANGED END



WELD END

SIZE	# CORR	COM-PRES-SION* (in)	FLANGED ENDS				WELD ENDS			
			SINGLE		DOUBLE**		SINGLE		DOUBLE**	
			OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
2-1/2" & 3" Effective Area = 21 sq in	1	3/8	7-1/4	28	-	-	13-5/8	25	-	-
	2	3/4	8-3/4	35	21-1/8	90	15-1/4	30	27-1/2	85
	3	1-1/8	10-3/8	42	24-3/8	109	16-7/8	37	30-3/4	100
	4	1-1/2	12	49	27-5/8	125	18-1/2	45	34	115
	5	1-7/8	13-5/8	57	30-7/8	134	20-1/8	52	37-1/4	130
	6	2-1/4	15-1/4	64	34-1/8	149	21-3/4	60	40-1/2	145
	7	2-5/8	16-7/8	72	37-3/8	165	23-3/8	68	43-3/4	161
	8	3	18-1/2	80	40-5/8	175	25	70	47	177
	9	3-3/8	20-1/4	88	43-7/8	197	26-5/8	84	50-1/4	195
	10	3-3/4	21-3/4	95	47-1/8	211	28-1/4	91	53-1/2	207
	11	4-1/8	23-1/8	103	50-3/8	227	29-7/8	99	56-3/4	224
	12	4-1/2	24-3/4	110	53-5/8	235	31-1/2	100	60	241
	13	4-7/8	26-3/8	118	-	-	33-1/8	114	-	-
4" Effective Area = 29 sq in	1	3/8	7-1/4	40	-	-	13-5/8	30	-	-
	2	3/4	8-3/4	50	21-1/8	125	15-1/4	40	27-1/2	105
	3	1-1/8	10-3/8	60	24-3/8	135	16-7/8	49	30-3/4	123
	4	1-1/2	12	68	27-5/8	151	18-1/2	58	34	141
	5	1-7/8	13-5/8	77	30-7/8	169	20-1/8	67	37-1/4	139
	6	2-1/4	15-1/4	85	34-1/8	186	21-3/4	76	40-1/2	177
	7	2-5/8	16-7/8	90	37-3/8	200	23-3/8	85	43-3/4	195
	8	3	18-1/2	100	40-5/8	219	25	94	47	213
	9	3-3/8	20-1/4	110	43-7/8	238	26-5/8	103	50-1/4	231
	10	3-3/4	21-3/4	120	47-1/8	257	28-1/4	112	53-1/2	250
	11	4-1/8	23-1/8	127	50-3/8	284	29-7/8	122	56-3/4	269
	12	4-1/2	24-3/4	135	53-5/8	311	31-1/2	132	60	289
	13	4-7/8	26-3/8	143	-	-	33-1/8	143	-	-
5" Effective Area = 40 sq in	1	3/8	7-1/4	50	-	-	13-5/8	40	-	-
	2	3/4	8-3/8	60	21-1/8	135	15-1/4	50	27-1/2	125
	3	1-1/8	10-3/8	70	24-3/8	155	16-7/8	60	30-3/4	145
	4	1-1/2	12	80	27-5/8	177	18-1/2	72	34	170
	5	1-7/8	13-5/8	90	30-7/8	198	20-1/8	83	37-1/4	190
	6	2-1/4	15-1/4	100	34-1/8	220	21-3/4	95	40-1/2	215
	7	2-5/8	16-7/8	115	37-3/8	250	23-3/8	105	43-3/4	230
	8	3	18-1/2	125	40-5/8	266	25	116	47	257
	9	3-3/8	20-1/4	135	43-7/8	288	26-5/8	128	50-1/4	281
	10	3-3/4	21-3/4	145	47-1/8	310	28-1/4	140	53-1/2	305
	11	4-1/8	23-1/8	160	50-3/8	335	29-7/8	150	56-3/4	325
	12	4-1/2	24-3/4	170	53-5/8	355	31-1/2	160	60	345
	13	4-7/8	26-3/8	180	-	-	33-1/8	171	-	-

* For lateral movements, consult factory.
** Double end units come with anchor bases and without bases (universal style). Consult factory for doubles information.

SIZE	# CORR	COM-PRES-SION* (in)	FLANGED ENDS				WELD ENDS			
			SINGLE		DOUBLE**		SINGLE		DOUBLE**	
			OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
6" Effective Area = 62 sq in	1	3/4	9-1/2	95	-	-	19	90	-	-
	2	1-1/2	12-3/4	120	29-1/4	270	22-1/4	110	38-3/4	260
	3	2-1/4	16	145	35-3/4	320	25-1/2	135	45-1/4	310
	4	3	19-1/4	170	42-1/4	395	28-3/4	158	51-3/4	356
	5	3-3/4	22-1/2	205	48-3/4	425	32	180	58-1/4	400
	6	4-1/2	25-3/4	230	55-1/4	470	35-1/4	200	64-3/4	425
	7	5-1/4	29	255	61-3/4	520	38-1/2	225	71-1/4	475
	8	6	32-1/4	280	68-1/4	570	41-3/4	250	77-3/4	540
	9	6-3/4	35-1/2	305	74-3/4	625	45	280	84-1/4	600
	10	7-1/2	38-3/4	320	81-1/4	675	48-1/4	315	90-3/4	670
8" Effective Area = 92 sq in	1	3/4	9-1/2	135	-	-	19	125	-	-
	2	1-1/2	12-3/4	165	29-1/4	357	22-1/4	152	38-3/4	344
	3	2-1/4	16	190	35-3/4	410	25-1/2	180	45-1/4	400
	4	3	19-1/4	225	42-1/4	475	28-3/4	210	51-3/4	460
	5	3-3/4	22-1/2	250	48-3/4	490	32	240	58-1/4	520
	6	4-1/2	25-3/4	280	55-1/4	590	35-1/4	270	64-3/4	580
	7	5-1/4	29	310	61-3/4	650	38-1/2	300	71-1/4	640
	8	6	32-1/4	335	68-1/4	705	41-3/4	330	77-3/4	700
	9	6-3/4	35-1/2	375	74-3/4	775	45	360	84-1/4	760
	10	7-1/2	38-3/4	415	81-1/4	845	48-1/4	390	90-3/4	820
10" Effective Area = 135 sq in	1	3/4	10-1/2	165	-	-	19	150	-	-
	2	1-1/2	13-3/4	200	29-1/4	442	22-1/4	182	38-3/4	424
	3	2-1/4	17	240	35-3/4	515	25-1/2	215	45-1/4	490
	4	3	20-1/4	270	42-1/4	550	28-3/4	250	51-3/4	560
	5	3-3/4	23-1/2	300	48-3/4	640	32	280	58-1/4	620
	6	4-1/2	26-3/4	340	55-1/4	715	35-1/4	315	64-3/4	690
	7	5-1/4	30	375	61-3/4	785	38-1/2	350	71-1/4	760
	8	6	33-1/4	400	68-1/4	840	41-3/4	380	77-3/4	820
	9	6-3/4	36-1/2	440	74-3/4	915	45	415	84-1/4	890
	10	7-1/2	39-3/4	475	81-1/4	985	48-1/4	450	90-3/4	960
12" Effective Area = 175 sq in	1	3/4	11	280	-	-	19	175	-	-
	2	1-1/2	14-1/4	320	32-1/2	590	22-1/4	210	40-3/4	480
	3	2-1/4	17-1/2	365	39	675	25-1/2	250	47-1/4	560
	4	3	20-3/4	405	45-1/2	755	28-3/4	290	53-3/4	650
	5	3-3/4	24	445	52	835	32	330	60-1/4	720
	6	4-1/2	27-1/4	485	58-1/2	875	35-1/4	370	66-3/4	800
	7	5-1/4	30-1/2	525	65	995	38-1/2	410	73-3/4	880
	8	6	33-3/4	570	71-1/2	1075	41-3/4	445	79-3/4	950
	9	6-3/4	37	610	78	1160	45	490	86-1/4	1040
	10	7-1/2	40-1/4	650	84-1/2	1235	48-1/4	525	92-3/4	1110
14" Effective Area = 205 sq in	1	3/4	13-1/4	252	-	-	14-1/2	127	-	-
	2	1-1/2	15-1/4	286	33	597	16-1/2	161	35	472
	3	2-1/4	17-1/4	319	37	663	18-1/2	194	39	538
	4	3	19-1/4	351	41	727	20-1/2	226	43	602
	5	3-3/4	21-1/4	384	45	793	22-1/2	259	47	668
	6	4-1/2	23-1/4	417	49	859	24-1/2	292	51	734
	7	5-1/4	25-1/4	450	53	925	26-1/2	325	55	800
	8	6	27-1/4	483	57	991	28-1/2	358	59	866
	9	6-3/4	29-1/4	516	61	1057	30-1/2	391	63	932
	10	7-1/2	31-1/4	549	65	1123	32-1/2	424	67	998
16" Effective Area = 268 sq in	1	3/4	13-1/4	295	-	-	14-1/2	158	-	-
	2	1-1/2	15-1/4	330	33	673	16-1/2	193	35	536
	3	2-1/4	17-1/4	365	37	743	18-1/2	228	39	606
	4	3	19-1/4	400	41	813	20-1/2	263	43	676
	5	3-3/4	21-1/4	435	45	883	22-1/2	298	47	746
	6	4-1/2	23-1/4	472	49	957	24-1/2	335	51	820
	7	5-1/4	25-1/4	508	53	1029	26-1/2	371	55	892
	8	6	27-1/4	542	57	1097	28-1/2	405	59	960
	9	6-3/4	29-1/4	578	61	1169	30-1/2	441	63	1032
	10	7-1/2	31-1/4	614	65	1241	33-1/2	477	67	1104
18" Effective Area = 325 sq in	1	13/16	10-5/16	378	-	-	14-1/2	189	-	-
	2	1-5/8	12-3/8	416	30	800	16-9/16	227	35-1/8	610
	3	2-7/16	14-7/8	456	34-1/8	880	18-5/8	267	39-1/4	690
	4	3-1/4	16-1/2	494	38-1/4	955	20-11/16	305	43-3/8	766
	5	4-1/16	18-9/16	534	42-3/8	1035	22-3/4	345	47-1/2	846
	6	4-7/8	20-5/8	573	46-1/2	1113	24-13/16	384	51-5/8	925
	7	5-11/16	22-11/16	613	50-5/8	1195	26-7/8	424	55-3/4	1005
	8	6-1/2	24-3/4	651	54-3/4	1273	28-15/16	362	59-7/8	1080
	9	7-5/16	26-13/16	691	58-7/8	1350	31	502	64	160
	10	8-1/8	28-7/8	730	63	1430	33-1/16	541	68-1/8	1238

* For lateral movements, consult factory.

** Double end units come with anchor bases and without bases (universal style). Consult factory for doubles information.

SIZE	# CORR	COM-PRES-SION* (in)	FLANGED ENDS				WELD ENDS			
			SINGLE		DOUBLE**		SINGLE		DOUBLE**	
			OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)	OAL (in)	WT (lbs)
20" Effective Area = 392 sq in	1	13/16	11-13/16	460	-	-	14-1/2	210	-	-
	2	1-5/8	13-7/8	513	33-1/2	1076	16-9/16	263	37-1/8	826
	3	2-7/16	15-15/16	566	37-5/8	1182	18-5/8	316	40-1/4	932
	4	3-1/4	18	619	41-3/4	1288	20-11/16	369	45-3/8	1038
	5	4-1/16	20-1/16	672	45-1/8	1394	22-3/4	422	49-1/2	1144
	6	4-7/8	22-1/8	725	50	1500	24-13/16	475	53-5/8	1250
	7	5-11/16	24-3/16	778	55-1/8	1606	26-7/8	528	57-3/4	1356
	8	6-1/2	26-1/4	831	58-5/8	1702	28-15/16	581	61-7/8	2008
	9	7-5/16	28-5/16	884	62-1/8	1818	31	634	66	1298
	10	8-1/8	30-3/8	937	65-5/8	1924	33-1/16	687	70-1/8	1674
24" Effective Area = 540 sq in	1	13/16	12-13/16	539	-	-	14-1/2	240	-	-
	2	1-5/8	14-7/8	585	34-1/4	1180	16-9/16	294	38	888
	3	2-7/16	16-15/16	630	38-3/8	1275	18-5/8	345	40-1/4	990
	4	3-1/4	19	675	42-1/2	1373	20-11/16	398	45-3/8	1096
	5	4-1/16	21	720	45-7/8	1470	22-3/4	452	49-1/2	1204
	6	4-7/8	22-7/8	766	50-3/4	1576	24-13/16	510	53-5/8	1320
	7	5-11/16	25	811	55-7/8	1671	26-7/8	560	57-3/4	1420
	8	6-1/2	27	857	59-3/8	1767	28-15/16	610	61-7/8	1520
	9	7-5/16	29	903	62-7/8	1857	31	654	66	1603
	10	8-1/8	31-1/8	957	66-3/8	1974	33-1/16	717	70-1/8	1734

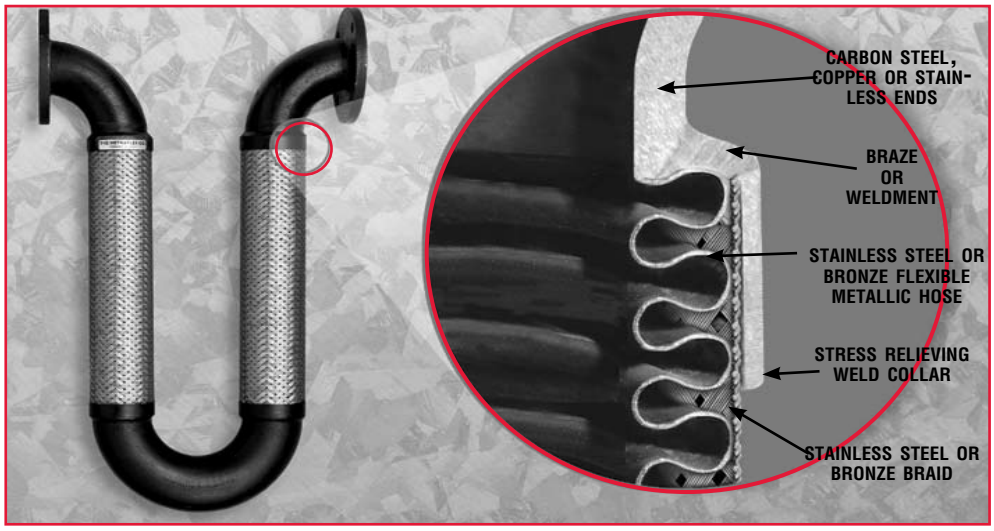
ADDITIONAL BELLOWS DATA

SIZE	BELLOWS EFFECTIVE AREA (Inches Squared)	BELLOWS SPRING CONSTANT (Lbs./Inch/Corrugation)
2-1/2”	21	2600
3”	21	2600
4”	29	2800
5”	40	3100
6”	62	3500
8”	92	3700
10”	135	4000
12”	175	4200
14”	205	4400
16”	268	4700
18”	325	5000
20”	392	5400
24”	540	6200

* For lateral movements, consult factory.
** Double end units come with anchor bases and without bases (universal style). Consult factory for doubles information.

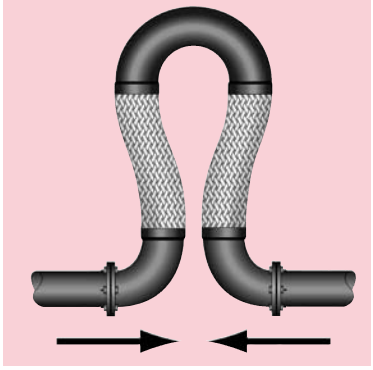
METRALOOP: Thermal and Seismic Expansion Joint

ALL METALLIC CONSTRUCTION

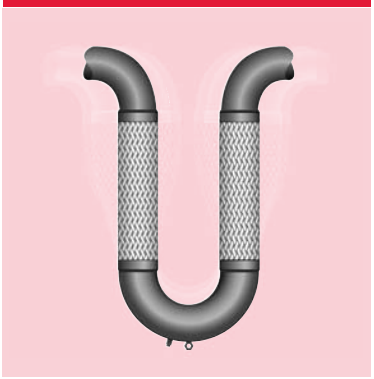


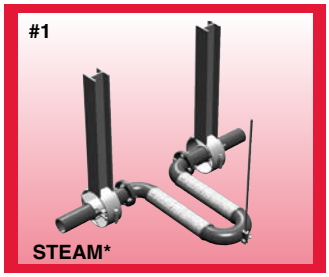
No Thrust Loads
Unlimited Movement
1/2" to 24" diameter

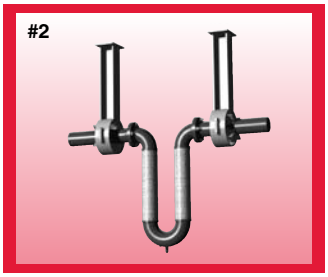
THERMAL EXPANSION: AXIAL MOVEMENT

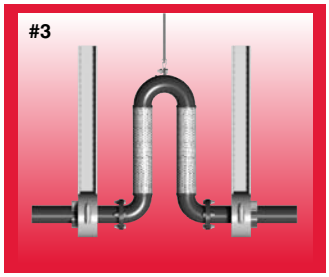


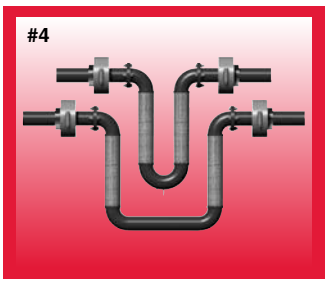
SEISMIC MOVEMENT: ALL DIRECTIONAL

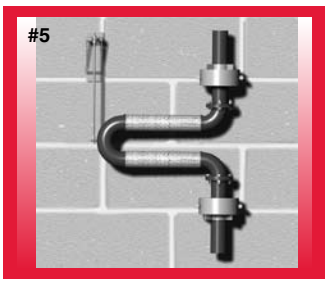


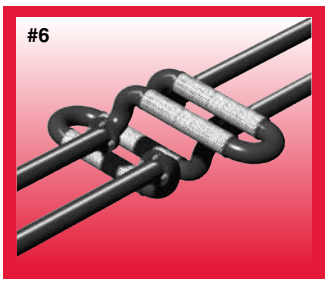


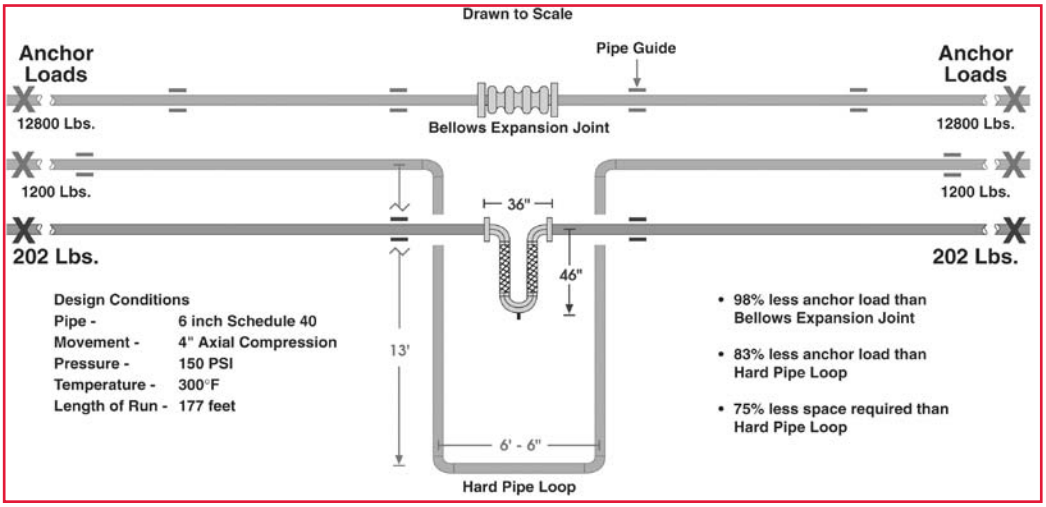








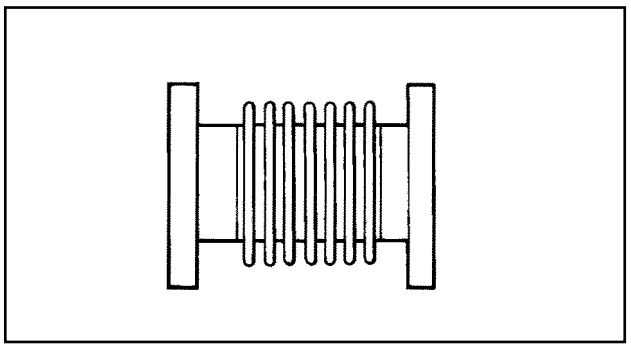




For complete details request the Metraloop Design Guide or go to www.metraflex.com

BELLOWS EXPANSION JOINT STYLES

Axial Joint

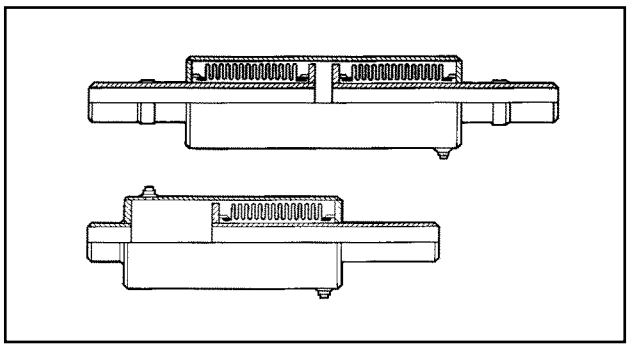


Axial bellows expansion joints are designed to accommodate compressive or extension movements along the bellows longitudinal axis. Movements available can be specified as amounts from a “neutral length”. The neutral length is the theoretical length before movement. From this neutral length, the unit will provide movement in either extension or compression. Therefore, to utilize all the movement available from the unit when it is known that the movement will be in one direction only, it is recommended that the units be installed with either pre-extension or pre-compression, depending upon the pipe movement.

Care is required during installation to ensure that the unit is installed at its correct length so that it will only work within its specified limit. Any deviation would have a detrimental affect upon bellows life. Axial units must also be adequately anchored and guided.

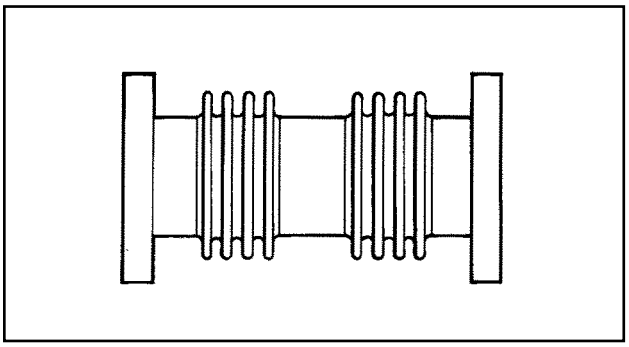
Axial bellows are supplied flanged, grooved, or with beveled ends suitable for welding into pipelines, or with a combination of both.

Externally Pressurized Axial Joint



Applications where long axial movements exist have resulted in the development of the externally pressurized unit. In these units, working pressure is transferred to the outside of the bellows via a gap between the internal flange and housing. Standards are available in 4”, 6” and 8” of movement. Compensators are also available in 3” models for 4” diameter and below.

Untied Universal Joint

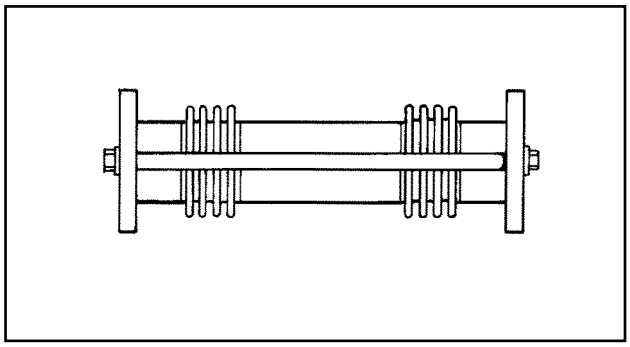


A universal/double expansion joint assembly is formed by connecting two bellows with a length of center pipe. This type of unit will cater to both axial and lateral movements. Although a conventional axial bellows will offer a limited amount of lateral movement, it is usually advisable for a universal unit to be used if the amount of lateral movement required is significant.

Anchor bases can be placed on the middle spool to make a double joint, with movement on both sides of the anchor.

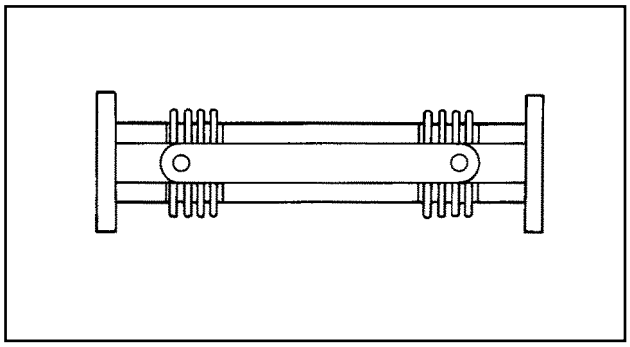
BELLOWS EXPANSION JOINT STYLES

Universal Joint



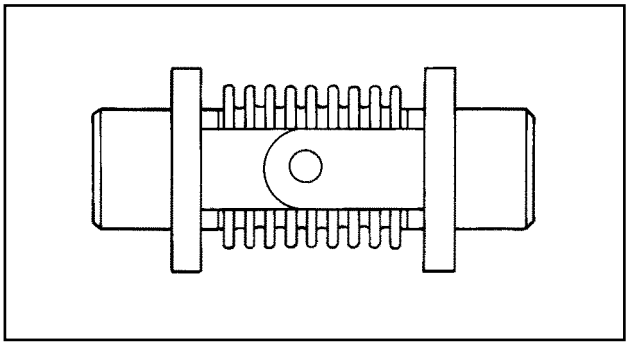
For higher pressure applications, where there is a limitation to the forces that the connecting pipe can accommodate, universal joints are restrained against the elongation effect due to pressure end load by the use of tie bars. These are designed to contain the pressure end load within the unit length, and do not transmit this load to the adjacent piping system.

Double Hinge Joint



Double Hinge Bellows are basically two Single Hinge Bellows combined into one unit with a common tie bar joining the two ends. Therefore, any expansion of the center pipe within the limits of the tie bar will simply compress the bellows, and will not exert movement on the adjoining pipe. This type of unit allows for lateral movement in one plane only.

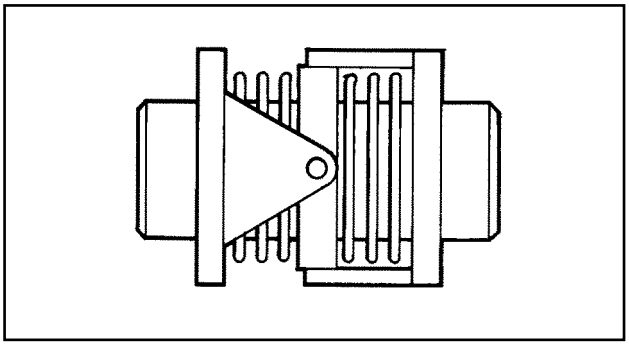
Single Hinge Joint



Hinge units offer movement in one plane only, and operate by angulating the bellows. The pressure end load is contained by the hinge parts; therefore, this type of assembly is ideal where it is not practical to install heavy guiding or strong anchors.

Single Hinge Bellows are usually used in pairs to give lateral movement in one plane.

Gimbal Joint



Gimbal Bellows are designed to allow angular rotation in any plane using two pairs of hinges fixed to a common floating gimbal ring. The gimbal ring and hinge parts are designed to restrain the end thrust of the expansion joint due to internal pressure and any external forces which are imposed on the joint.

As in the case of Single Hinge Bellows, Gimbal Bellows are usually used in pairs to give lateral movement in any plane.

INTERNAL LINERS

Internal liners are recommended where the following conditions exist in a piping system:

1. In steam lines where the velocity of flow would set up vibration within the bellows.

2. In compressed air pipes.

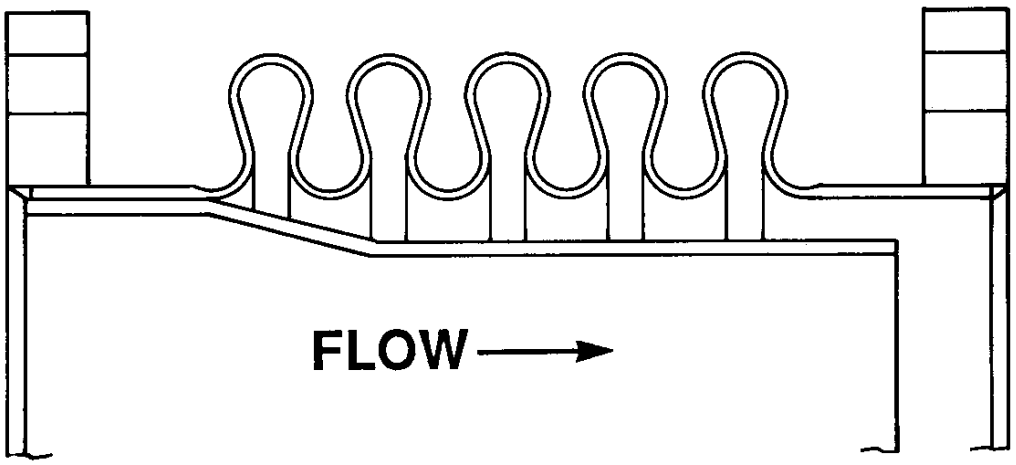
3. In ducts carrying exhaust gases.

4. Where the flowing media is abrasive; i.e., contains solid particles which could damage the inside of the bellows.

5. Where turbulent flow exists; for example, when bellows are positioned downstream of an elbow, valve or adjacent to recirculating pumps. In such a case, due to the possibility of vibration being set up within the bellows, it is often necessary to fit heavy liners.

6. If liners are required in systems which are subject to flow reversal when the flow is high velocity, it is often necessary to either fit thick carbon steel liners or strengthen the leading edge of the thin gauge stainless liners normally used. The effects of the flow would otherwise cause the leading edge of the sleeve to vibrate and shatter.

As a general rule, liners are necessary when the flow rate exceeds 10 ft./sec. They are available in slide-in “top hat” designs, or welded-in designs.



AXIAL BELLOWS APPLICATION PROCEDURE

When designing your axial bellows system, use the following procedure:

1. Calculate thermal expansion.
2. Establish position of bellows.
3. Establish position of guides.
4. Calculate forces acting on anchors.

Once these four tasks have been completed, you will have all the information you require to complete your design of an axial bellows system. By referring to the data sheets on axial bellows, you can select specific bellows to meet your requirements, or you can define your requirements in terms related to standard units.

CALCULATING THERMAL EXPANSION

Refer to the Engineering Data section of this publication. Page 20

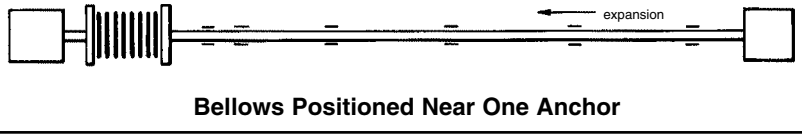
ESTABLISHING POSITION OF BELLOWS

In theory, bellows can be positioned anywhere between two anchors, but in practice, one of only two positions is used:

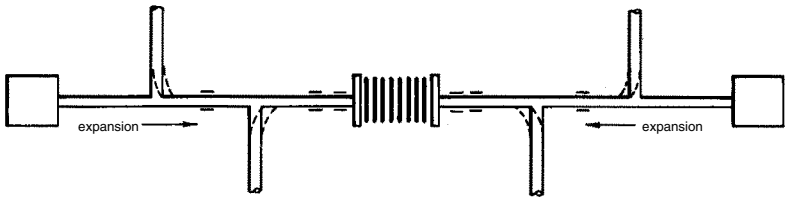
1. Near one anchor.
2. At the center of the pipe.

When an axial bellows unit is positioned near a main anchor, it is installed within four pipe diameters of the anchor to eliminate the necessity for a guide between the bellows unit and the anchor. However, it is normal to position guides between the bellows and the other anchor.

When an axial bellows unit is positioned near the center of the pipe between the anchors, guides must be positioned on both sides of the bellows unit to prevent bowing. By spreading the load equally on both sides of the bellows, deflection on small bore branch lines is kept to a minimum.



Bellows Positioned Near One Anchor



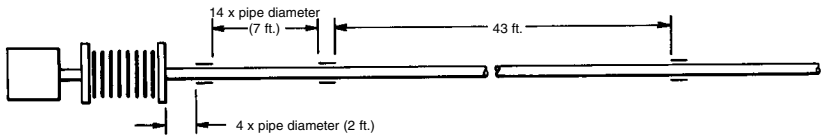
Bellows Positioned Centrally Between Anchors

ESTABLISHING POSITION OF GUIDES

Proper guiding of a pipe is essential if axial bellows units are to function correctly. Guides are necessary to ensure proper application of movement to the bellows and to prevent bowing or buckling of the pipeline.

When using axial bellows units, the first guide should be positioned within a distance of four pipe diameters from the bellows unit. The distance between the first guide and the second must not be more than fourteen pipe diameters. For more details, see the Metraflex Pipe Guide catalog.

Bellows Applications



Example of Guide Spacing

ESTABLISHING POSITION OF GUIDES

Position pipe guides per the recommendations of the Expansion Joint Manufacturer's Association.

For example, the guide spacing in a length of pipe containing an axial bellows unit with an operating pressure of 125 psig and a nominal bore of 6 in. would be:

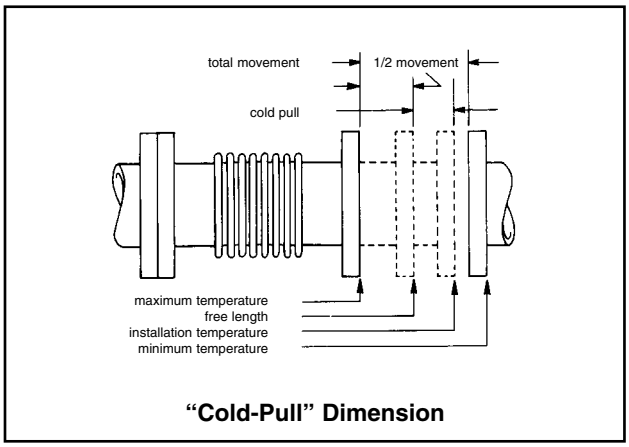
1st Guide: 4 x pipe dia. = 24" from the bellows unit

2nd Guide: 14 x pipe dia. = 7' from the 1st guide

Intermediate Guides: Every 40' thereafter

CALCULATING "COLD-PULL" DIMENSIONS

Bellows movement can be expressed as a ± figure based on the factory supplied length. This represents the movement in expansion and compression of which a bellows is capable. However, because it is more usual to find pipes carrying hot media than cold media (except, of course, in cryogenic applications), bellows are usually selected for their capacity to compensate for pipe expansion. In order to make maximum use of the total movement available in any one bellows, it is therefore necessary to install the unit "pre-stretched" into the pipe system to give it greater compression potential. This degree of "stretching" is termed its "cold-pull or sprung" dimension.



"Cold-Pull" Dimension

It is essential that a bellows is never over-compressed or over-extended. Knowing the anticipated maximum and minimum operating temperatures is vital in order to make suitable provision for thermal expansion at installation. If, for example, an axial unit stretched to its maximum extension is installed in a heat-wave, a hard frost six months later could over extend the bellows.

Given known maximum and minimum operating temperatures, total movement potential of the bellows unit, and the required movement calculated from the thermal expansion, it is a matter of simple arithmetic to calculate the necessary length at installation temperature to ensure safe operation throughout the temperature range specified.

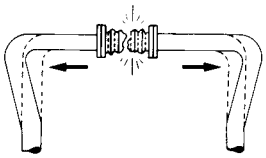
Anchoring and Guiding

Proper guiding and anchoring is essential to an installation of expansion joints or pipe loops. They will prevent the pipe from squirming or buckling and are required to ensure the manufacturer's warranty.

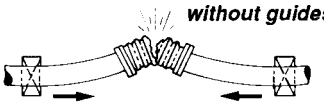
Anchors at each end of the pipe run must be stronger than the force needed to compress the joint. Depending upon system pressure, this force may be many thousands of pounds. See example installation on page 23.

Guides permit axial movement of the pipe while restraining both lateral and angular movement. The quantity and location of the guides is dependent upon the natural flexibility of the pipe and the pressure rating of the system. Guides should be installed per the following chart.

Effect of thrust from internal pressure without anchors.



Effect of thermal expansion without guides.



PROPER ALIGNMENT OF ANCHORS AND GUIDES.
(Illustration shows 2 guides on each side of the joint because joint is installed in the middle of the pipe run.)

CONCENTRIC PIPE GUIDE SPACING

* Data Per Expansion Joint Manufacturers Association

Pipe Size	Maximum Distance To 1st Guide	Approx. Distance Between 1st to 2nd Guide	Approximate Distance Between Additional Pipe Guides (In feet)			
			@ 50 PSI	@ 100 PSI	@ 150 PSI	@ 300 PSI
1"	4"	1'4"	21'	15'	12'	10'
1-1/4"	5"	1'5"	23	17	13	12
1-1/2"	6"	1'9"	28	20	17	13
2"	8"	2'4"	32	23	18	15
2-1/2"	10"	2'11"	35	28	22	20
3"	1'	3'6"	38	28	23	17
3-1/2"	1'2"	4'1"	45	35	27	19
4"	1'4"	4'8"	52	38	31	22
5"	1'8"	5'8"	63	45	38	25
6"	2'	7'	68	48	40	28
8"	2'8"	9'4"	87	62	45	38
10"	3'4"	11'8"	107	75	60	48
12"	4'	14'	118	85	70	50
14"	4'8"	16'4"	122	88	72	55
16"	5'4"	18'8"	137	96	80	60
18"	6'	21'	145	105	85	65
20"	6'8"	23'4"	160	118	90	70
24"	8'	28'	181	125	105	75

CALCULATING FORCES ACTING ON ANCHORS

To calculate the sum total of forces acting on any anchor in a pipe system incorporating axial bellows, you must calculate the following:

1. Deflection load.
2. Pressure thrust.
3. Frictional resistance.
4. Centrifugal force.

Each must be examined individually before arriving at the sum of the forces acting on an anchor point.

Before calculating the forces, the following points must be considered:

1. If the pipe changes direction at an anchor point, the resultant of the two forces acting on both sides should be calculated.

2. If there is a change of diameter in a long straight pipe, an intermediate anchor between bellows of different diameters will be subject to the differential thrust from each side.

3. If, due to the presence of a valve in the pipe run, some bellows are pressurized while other are not, the anchor between the valve and the bellows must be considered as a main anchor.

Deflection Load - Deflection load is due to the spring rate of the axial bellows, a force which is given in each individual data sheet. To calculate the deflection load on any anchor you apply the following formula:

Deflection force = Spring rate x movement*

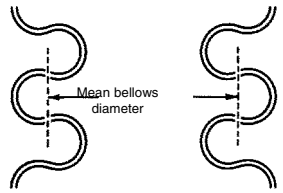
* For high corrugation joints where number of corrugations can vary, movement must be divided by the number of corrugations.

CALCULATING FORCES ACTING ON ANCHORS

Pressure Thrust - Pressure thrust is the force due to internal or external pressure trying to open out the bellows (as with a piston in a cylinder), and is calculated using the following formula:

Pressure thrust = Test Pressure x bellows effective area

As illustrated below, the effective cross-section of a bellows is the mean diameter of the bellows, taking the tip and the root of the convolutions as the extremes.



Bellows Effective Area

Values for effective area (and spring rate) are given for each unit in the data sheets.

Frictional Resistance - The frictional resistance of a pipe moving over its guides can be calculated using the following formula:

Frictional resistance = Coefficient of resistance of guide* x total weight of pipe†

* It is normal for guide manufacturers to give coefficient of friction values in their engineering specifications, but in the event of this not being available, the value 0.3 can be taken for the majority of installations.

† The total weight of the pipe between anchors is the sum of pipe weight, media weight in that section of pipe, insulation, and attached equipment, if any.

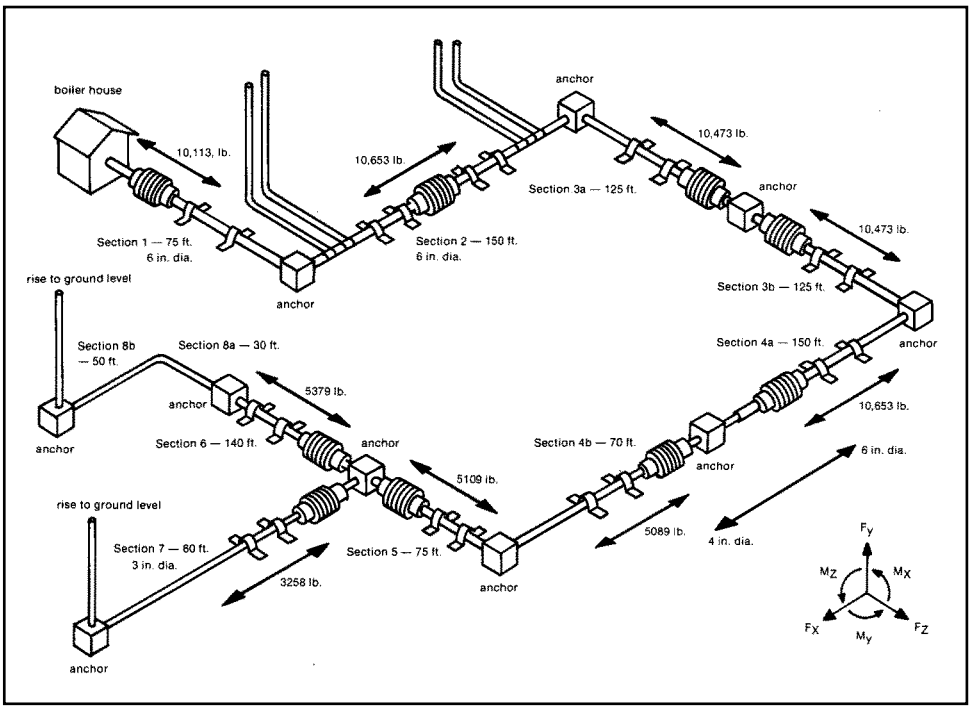
Centrifugal Thrust - In the case of anchors situated at a pipe elbow, with high velocities and large diameters the affect of centrifugal thrust due to flow of media within the pipe must be considered. This can be calculated using the following formula:

$$\text{Centrifugal thrust} = \frac{2Apv^2}{g} \times \text{Sin}\,\frac{\theta}{2}$$

Where: A = Internal area of pipe
p = Density of media
v = Velocity of flow
g = 32 ft./sec.^{2}
θ = Angle of pipe elbow

Force on Intermediate Anchors - There is a limit to the amount of movement you can get out of a single axial bellows, and when you are faced with an expansion problem in a straight run of pipe which requires more movement than you can get out of one bellows, you must install additional bellows, and with them, additional or intermediate anchors.

If the pipe is the same diameter throughout its length, and run is of equal length on each side of expansion joint the thrusts on intermediate anchors are balanced by the bellows on either side and, in theory, there is no force on the anchor once the full expansion has been taken up. It is recommended, however, that the load on intermediate anchors
be calculated on the assumption that the pipe
will warm up from one end. Hence the load on intermediate anchors would be equal to the sum of the deflection force and the friction force, calculated in the same way as for a main anchor. If expansion joint is not centered in the pipe run, calculate longer pipe run to determine required force for intermediate anchor.



COMPLEX AXIAL INSTALLATION EXAMPLE

The requirement is to select suitable axial units from the data sheets, calculate forces acting on anchor points, and establish the position of guides and anchors.

For the purpose of example, we have specified a pipe system of varying pipe sizes to carry steam at 140 psig and 360° F. The extremes of the line shown at the boiler house and where the line rises to ground level can be considered as anchors. The branches on the 150 ft. pipe run can be considered as flexible. Installation temperature is assumed to be 50°.

Step 1 - Calculate thermal expansions in each straight pipe section and position anchors so that expansion between anchors is within data sheet specified movements. For maximum economy in bellows systems, use natural flexibility of pipe where feasible (see Engineering Data section).

Take thermal expansion as 2.52 in./100 ft.

The following table lists details of bellows type and installed length for each pipe section.

Bellows Applications

Pipe Section	Leg Length (ft.)	Total Expn. (in.)	Bellows Model No.	Installed Length (in.)	Installation Notes
1	75	1.89	6" MODEL C, 3 corrugations with weld ends	28-3/4	Unit installed near anchor.
2	150	3.78	6" MODEL C, 6 corrugations with weld ends	25-1/4	Unit installed at center pipe section to reduce deflection of branches.
3a	125	3.15	6" MODEL C, 5 corrugations with weld ends	32	2 bellows used between anchors with intermediate anchor between bellows, because of branch line.
3b	125	3.15	6" MODEL C, 5 corrugations with weld ends	32	
4a	150	3.78	6" MODEL C, 6 corrugations with weld ends	35-1/4	2 bellows used between main anchors with additional main anchor at pipe reducer, because load would be differential pressure thrust.
4b	70	1.77	4" MODEL C, 5 corrugations with weld ends	20-1/8	
5	75	1.89	4" MODEL C, 5 corrugations with weld ends	20-1/8	Pipe anchored at intersection of 3 in branch, unit placed near anchor.
6	140	3.53	4' MODEL C, 10 corrugations with weld ends	28-1/4	Bellows installed near anchor.
7	60	1.51	3" MODEL C, 4 corrugations with weld ends	18-1/2	Bellows installed near anchor.
8a	30	.76	— —	— —	This section is flexible.
8b	50	1.26	— —	— —	No bellows required.

Step 2 - From the following chart for recommended guide spacings, establish guide spacing for each pipe diameter.

Pipe Diameter	1st Guide (4 D.)	2nd Guide (14 D.)	Intermediate Guides (Chart)
3 in.	1 ft.	3 ft. 6 in.	23 ft.
4 in.	1 ft. 4 in.	4 ft. 9 in.	32 ft.
6 in.	2 ft.	7 ft.	42 ft.

Step 3 - Establish the loads acting on anchor points.

1. Pipe Diameter - in.	3	4	6
2. Test Pressure - psig (P)	210	210	210
3. Axial Spring Rate - lbs./in./corr.	2600	2800	3500
4. Bellows Effective Area - in.² (A)*	21	29	62
5. Pipe Weight - lb./ft. (W)	7.57	10.79	18.97
6. Media Weight - lb./ft. (M)	0.02	0.04	0.07
7. Insulation Weight - lb./ft. (I)	2	3	5
8. Coefficient of Friction (μ)	0.3	0.3	0.3

*For this information, refer to the appropriate data sheet.

From the above information, the anchor loads due to the bellows in each pipe section can be calculated as follows:

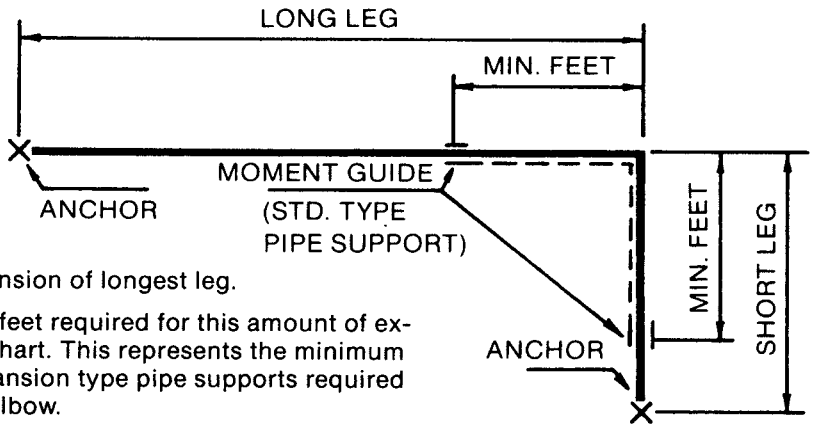
Pipe Section	1	2	3a	3b	4a	4b	5	6	7
Pressure Thrust - lb. (PxA)	13,020	13,020	13,020	13,020	13,020	6,090	6,090	6,090	4,410
Deflection Load - lb. $(S/R \times \frac{MOVEMENT}{\#\ of\ CORR})$	2,205	2,205	2,205	2,205	2,205	991	1,058	988	981
Friction Load -lb. μ(Total W+M+I)(Leg Length (ft.))	540	1,080	900	900	1,080	290	311	580	172
Total Thrust - lb.	15,765	16,305	16,125	16,125	16,305	7,371	7,392	7,658	5,573

The above information can now be entered onto the pipe system layout, and resultant loads on each anchor can be calculated.

Pipe Flexibility

Natural pipe flexibility should be examined prior to the use of other expansion devices. The following charts on "L" bends, "Z" bends, and loops can be used to determine the flexibility of the piping system.

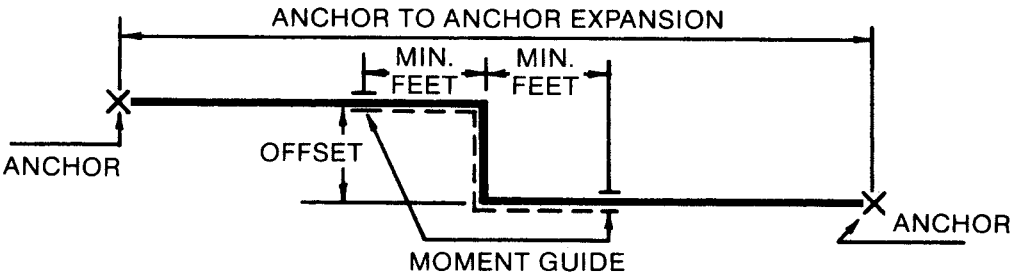
"L" Bends



1. Calculate expansion of longest leg.
2. Find minimum feet required for this amount of expansion from chart. This represents the minimum footage of expansion type pipe supports required EACH side of elbow.

Pipe Size	Expansion of Longest Leg								
	1"	1½"	2"	2½"	3"	3½"	4"	4½"	5"
2"	8'	11'	13'	15'	16'	17'	18'	19'	20'
2½"	9'	12'	14'	16'	17'	18'	19'	21'	22'
3"	10'	13'	15'	17'	18'	19'	20'	22'	23'
4"	11'	14'	16'	18'	19'	22'	22'	24'	25'
5"	12'	15'	17'	19'	21'	23'	25'	27'	28'
6"	13'	16'	19'	21'	23'	25'	27'	29'	31'
8"	18'	20'	22'	25'	27'	29'	31'	33'	35'
10"	20'	23'	26'	28'	30'	33'	35'	38'	40'
12"	22'	26'	29'	32'	34'	37'	40'	43'	45'
14"	22'	26'	29'	32'	34'	37'	40'	43'	47'
16"	22'	26'	29'	32'	35'	39'	41'	45'	50'
18"	22'	26'	29'	32'	36'	40'	42'	47'	52'
20"	22'	26'	29'	32'	37'	41'	44'	49'	53'
24"	22'	26'	29'	32'	38'	41'	44'	50'	54'

"Z" Bends

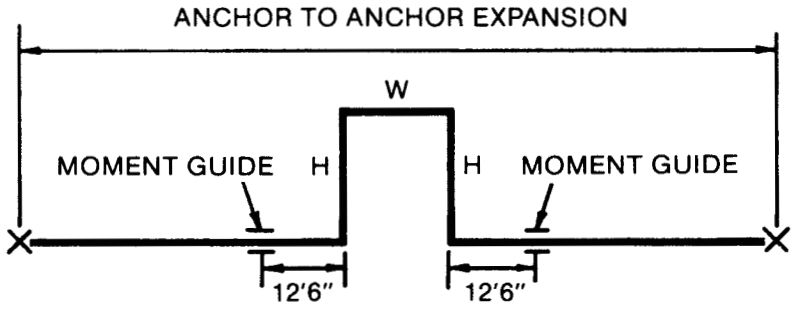


1. Calculate total expansion anchor to anchor.
2. Find minimum feet required for this amount of expansion from chart. This represents the minimum footage for offset and minimum footage of expansion type pipe supports required for EACH side of "Z" bend.

"Z" Bends (Continued)

Pipe Size	Anchor to Anchor Expansion								
	1"	1½"	2"	2½"	3"	3½"	4"	4½"	5"
2"	6'	7'	9'	10'	11'	12'	12'	13'	14'
2½"	6'	8'	9'	10'	11'	12'	13'	14'	15'
3"	7'	9'	10'	12'	13'	14'	15'	16'	17'
4"	8'	10'	11'	13'	14'	16'	17'	18'	19'
5"	8'	10'	12'	14'	16'	17'	19'	20'	21'
6"	9'	11'	13'	15'	17'	19'	20'	22'	23'
8"	9'	12'	14'	17'	19'	20'	22'	24'	25'
10"	10'	13'	16'	18'	20'	23'	25'	27'	28'
12"	11'	14'	17'	20'	22'	24'	26'	28'	30'
14"	11'	14'	17'	20'	22'	25'	27'	29'	32'
16"	11'	14'	17'	20'	22'	25'	27'	30'	33'
18"	11'	14'	17'	20'	25'	26'	28'	31'	34'
20"	12'	15'	18'	20'	25'	27'	29'	32'	35'
24"	13'	15'	18'	21'	26'	28'	30'	33'	36'

Loops



Pipe Size		Anchor to Anchor Expansion									
		1"	2"	3"	4"	5"	6"	7"	8"	9"	10"
2"	W	2'0"	2'6"	3'6"	4'0"	4'6"	5'0"	5'6"	6'0"	6'6"	7'0"
	H	4'0"	5'0"	7'0"	8'0"	9'0"	10'0"	11'0"	12'0"	13'0"	14'0"
2½"	W	2'0"	3'0"	3'6"	4'0"	4'6"	5'0"	5'6"	6'0"	6'6"	7'0"
	H	4'0"	6'0"	7'0"	8'0"	9'0"	10'0"	11'0"	12'0"	13'6"	14'0"
3"	W	2'0"	3'0"	4'0"	4'6"	5'6"	6'0"	6'6"	7'0"	7'6"	8'0"
	H	4'0"	6'0"	8'0"	9'0"	11'0"	12'0"	13'0"	14'0"	15'0"	16'0"
4"	W	2'6"	3'6"	4'6"	5'6"	6'0"	7'0"	7'6"	8'0"	9'0"	9'6"
	H	5'0"	7'0"	9'0"	11'0"	12'0"	14'0"	15'0"	16'0"	18'0"	19'0"
5"	W	2'6"	4'0"	5'0"	6'0"	7'0"	8'0"	8'6"	9'6"	10'0"	11'0"
	H	5'0"	8'0"	10'0"	12'0"	14'0"	16'0"	17'0"	19'0"	20'0"	22'0"
6"	W	2'6"	4'6"	5'6"	6'6"	7'6"	8'6"	9'6"	10'6"	11'0"	12'0"
	H	5'0"	9'0"	11'0"	13'0"	15'0"	17'0"	19'0"	21'0"	22'0"	24'0"
8"	W	3'0"	4'6"	6'0"	7'6"	8'6"	8'6"	10'6"	11'6"	12'6"	13'6"
	H	6'0"	9'0"	12'0"	15'0"	17'0"	19'0"	21'0"	23'0"	25'0"	27'0"
10"	W	3'0"	4'6"	6'6"	8'0"	9'6"	10'6"	11'6"	12'6"	13'6"	14'6"
	H	6'0"	9'0"	13'0"	16'0"	19'0"	21'0"	23'0"	25'0"	27'0"	29'0"
12"	W	3'0"	5'0"	6'6"	8'6"	10'0"	11'0"	12'6"	13'6"	14'6"	15'0"
	H	6'0"	10'0"	13'0"	17'0"	20'0"	22'0"	25'0"	27'0"	29'0"	31'0"

Thermal Expansion of Pipe in Inches per 100 Feet

Saturated Steam[1]	Temperature (° F.)	Cast Iron	Carbon and Carbon Molybdenum	Wrought Iron	4-6% Cr. Alloy Steel	12% Cr. Stainless Steel	18 Cr.-8 Ni. Stainless Steel	Copper	Monel
	-200	-1.058	-1.282	-1.289	-1.250	-1.170	-2.030	-1.955	-1.53
	-180	-0.982	-1.176	-1.183	-1.130	-1.070	-1.850	-1.782	-1.40
	-160	-0.891	-1.066	-1.073	-1.030	-0.970	-1.670	-1.612	-1.27
	-140	-0.797	-0.948	-0.955	-0.970	-0.870	-1.480	-1.428	-1.12
	-120	-0.697	-0.826	-0.833	-0.800	-0.750	-1.300	-1.235	-0.98
	-100	-0.593	-0.698	-0.705	-0.700	-0.630	-1.090	-1.040	-0.82
	-80	-0.481	-0.563	-0.570	-0.550	-0.520	-0.880	-0.835	-0.68
	-60	-0.368	-0.428	-0.435	-0.430	-0.400	-0.670	-0.630	-0.51
	-40	-0.248	-0.288	-0.295	-0.290	-0.270	-0.450	-0.421	-0.35
	-20	-0.127	-0.145	-0.152	-0.145	-0.130	-0.225	-0.210	-0.18
	0	0	0	0	0	0	0	0	0
	20	0.128	0.148	0.180	0.140	0.140	0.223	0.238	0.2
	32	0.209	0.230	0.280	0.234	0.234	0.356	0.366	0.3
	40	0.270	0.300	0.350	0.280	0.280	0.446	0.451	0.37
29.39	60	0.410	0.448	0.540	0.430	0.430	0.669	0.684	0.55
28.89	80	0.550	0.580	0.710	0.500	0.550	0.892	0.896	0.74
27.99	100	0.680	0.753	0.887	0.650	0.690	1.115	1.134	0.92
26.48	120	0.830	0.910	1.058	0.800	0.820	1.338	1.366	1.11
24.04	140	0.970	1.064	1.240	0.950	0.960	1.545	1.590	1.30
20.27	160	1.110	1.200	1.420	1.100	1.090	1.784	1.804	1.50
14.63	180	1.240	1.360	1.580	1.250	1.230	2.000	2.051	1.70
6.45	200	1.390	1.520	1.750	1.400	1.380	2.230	2.296	1.88
0	212	1.480	1.610	1.870	1.500	1.460	2.361	2.428	2.00
2.5	220	1.530	1.680	1.940	1.550	1.510	2.460	2.516	2.07
10.3	240	1.670	1.840	2.120	1.720	1.650	2.680	2.756	2.27
20.7	260	1.820	2.020	2.300	1.880	1.790	2.920	2.985	2.47
34.5	280	1.970	2.180	2.470	2.050	1.930	3.150	3.218	2.66
52.3	300	2.130	2.350	2.670	2.200	2.080	3.390	3.461	2.87
74.9	320	2.268	2.530	2.850	2.370	2.220	3.615	3.696	3.07
103.3	340	2.430	2.700	3.040	2.530	2.360	3.840	3.941	3.27
138.3	360	2.590	2.880	3.230	2.700	2.510	4.100	4.176	3.48
180.9	380	2.750	3.060	3.425	2.860	2.670	4.346	4.424	3.70
232.4	400	2.910	3.230	3.620	3.010	2.820	4.580	**4.666**	3.91
293.7	420	3.090	3.421	3.820	3.180	2.980	4.800	4.914	4.12
366.1	440	**3.250**	3.595	4.020	3.350	3.130	5.050	5.154	4.34
451.3	460	3.410	3.784	4.200	3.530	3.290	5.300	5.408	4.56
550.3	480	3.570	3.955	4.400	3.700	3.450	5.540	5.651	4.78
664.3	500	3.730	4.151	4.600	3.860	3.600	5.800	5.906	4.99
795.3	520	3.900	4.342	4.810	4.040	3.760	6.050	6.148	5.23
945.3	540	4.080	4.525	5.020	4.200	3.930	6.280	6.410	5.45
1115	560	4.250	4.730	5.220	4.400	4.090	6.520	6.646	5.69
1308	580	4.430	4.930	5.430	4.560	4.250	6.780	6.919	5.91
1525	600	4.600	5.130	5.620	4.750	4.420	7.020	7.184	6.12
1768	620	4.790	5.330	5.840	4.920	4.580	7.270	7.432	6.38
2041	640	4.970	5.530	**6.050**	5.100	4.750	7.520	7.689	6.61
2346	660	5.150	5.750	6.250	5.300	4.910	7.770	7.949	6.85
2705	680	5.330	5.950	6.470	5.480	5.080	8.020	8.196	7.07
3080	700	5.520	6.160	6.670	5.650	5.250	8.280	8.472	7.30
	720	5.710	6.360	6.880	5.850	5.430	8.520	8.708	7.65
	740	5.900	6.570	7.100	6.030	5.600	8.780	8.999	7.79
	760	6.090	6.790	7.320	6.220	5.770	9.050	9.256	8.02
	780	6.280	7.000	7.530	6.410	5.950	9.300	9.532	8.27
	800	6.470	7.230	7.730	6.610	6.120	9.580	9.788	8.51
	820	6.660	7.450	7.960	6.800	6.300	9.820	10.068	8.76
	840	6.850	7.660	8.180	7.000	6.480	10.100	10.308	9.02
	860	7.049	7.970	8.400	7.190	6.660	10.370	10.610	9.27
	880	7.248	8.100	8.630	7.380	6.840	10.630	10.971	9.52
	900	7.460	**8.340**	8.870	7.580	7.010	10.900	11.156	9.78
	920	7.668	8.540	9.070	7.770	7.200	11.180	11.421	10.01
	940	7.862	8.770	9.300	7.970	7.380	11.460	11.707	10.31
	960	8.073	8.990	9.520	8.170	7.560	11.730	11.970	10.57
	980	8.300	9.220	9.740	8.360	7.840	12.000	12.269	10.83
	1000	8.510	9.420	9.970	8.550	7.920	12.260	12.543	11.08
	1020		9.65		8.75	8.10	12.55		11.36
	1040		9.87		8.95	8.27	12.82		11.63
	1060		10.08		9.15	8.46	13.10		11.90
	1080		10.32		9.35	8.64	13.37		12.18
	1100		10.57		9.54	8.83	13.62		12.43
	1120		10.75		9.75	9.00	13.91		12.72
	1140		10.98		9.95	9.18	14.17		12.98
	1160		11.21		10.15	9.36	14.45		13.26
	1180		11.43		10.36	9.55	14.72		13.55
	1200		11.63		10.49	9.72	14.98		13.81
	1220		11.87		10.75	9.90	15.26		14.10
	1240		12.10		10.95	10.08	15.53		14.39
	1260		12.33		11.15	10.27	15.81		14.68
	1280		12.55		11.35	10.45	16.08		14.96
	1300		12.75		11.55	10.63	16.34		15.24
	1320		12.98		11.75	10.80	16.62		15.53
	1340		13.21		11.95	10.98	16.90		15.82
	1360		13.42		12.15	11.17	17.17		16.10
	1380		13.65		12.35	11.35	17.43		16.40
	1400		13.87		12.54	11.53	17.70		16.68
	1420						17.98		
	1440						18.25		
	1460						18.52		
	1480						18.80		
	1500						19.07		

[1]Vacuum in HG Below 212°F., Pressure in psig Above 212°F.

NOTE: Bold-face entries in each column indicate the maximum recommended temperature for each metal.

A Guide to Bellows Material Selection

Material	Manufacturing Feasibility & Availability
Gr. 304	Standard material for convolution manufacture. Bellows supplied in this grade are usually used on water or steam applications. For temperatures to 850°F.
Gr. 304L	Bellows can be supplied in this material when required, subject to availability of sheet of the required gauge. For Nitric Acid service, the use of 321 supplied to special compositional limits is an alternative frequently employed.
Gr. 316	Improved corrosion resistance as compared to 321, especially with regard to pitting corrosion. Specified where 321 is inadequate but where conditions are not sufficiently severe to require the use of more expensive materials, such as high Nickel alloys. Typical uses include high sulphur crude oils, brackish waters, flue gases, food processing and numerous applications in chemical and petrochemical processing.
Gr. 321	Adequate corrosion resistance and mechanical properties at ambient and elevated temperatures, 800°F to 1500°F.
Gr. 347	This grade is occasionally specified, and bellows can be manufactured subject to the availability of suitable material. In most applications, 321 is equal in service to 347, and it is our normal practice to offer this grade when 347 is requested.
Gr. 310	This grade is sometimes requested for special purposes. Because of difficulty in obtaining material suitable for bellows manufacture, it is our practice to offer Incoloy 800 as a superior alternative material where necessary.
Incoloy 800	Bellows can be supplied in this material when its good corrosion resistance and high temperature properties are required to meet service conditions. Incoloy 800 is preferred to Type 310 Stainless Steel for bellows manufacture.
Incoloy 825	A very useful high Nickel alloy having good corrosion resistance towards a variety of media, and excellent resistance to Chloride and Caustic stress corrosion. Applications include steam service when the highest degree of reliability is required, and cases where Type 316 stainless steel may be inadequate; for example, dewpoint condiitons in flue gas service, static or contaminated sea water, and Sulphuric and Phosphoric acids.
Inconel 600	Bellows can be manufactured from this material when required. The alloy combines good general corrosion resistance with virtual immunity to Chloride stress corrosion and also has good high temperature strength and oxidation resistance. For high temperature service where corrosion resistance is not a requirement, Nimonic 75 is often preferable because of its superior mechanical properties.
Inconel 625	One of the more recent Nickel-Chrome Molybdenum alloys combining good high temperature properties with good resistance to Chloride stress corrosion and a variety of corrosive environments.
Monel 400	This Nickel-Copper alloy finds limited use for bellows manufacture in some specialized applications such as Chlorine service. However, the manufacture of small diameter bellows would be uneconomic, and we advise that an alternative material should be used where the service conditions permit.
Nimonic 75	This high Nickel alloy is a standard material for the manufacture of bellows for high temperature service. It is virtually immune to Chloride stress corrosion and was extensively used where resistance to this form of failure was required before Incoloy 825 became available.
Nimonic 80A Nimonic C263	Bellows have been manufactured in these materials since 1960, and can be supplied where the service conditions warrant their use. Bellows can also be supplied in other Nimonic alloys which are available in sheet form.
Hastelloy B	This Nickel-Molybdenum alloy possesses outstanding resistance to Hydrochloric Acid, and is also resistant to Hydrogen Chloride gas, as well as Sulphuric and Phosphoric acids. Bellows can be supplied when required, subject to the availability of sheet material.
Hastelloy C 276	A Nickel-Chrome Molybdenum alloy having outstanding resistance to a wide variety of severely corrosive chemical process environments including: wet Chlorine, Hypochlorites, Chlorine Dioxide solutions, hot contaminated mineral acids and Acetic acid, sea water and brine. Bellows can be supplied when required, subject to the same limitations as for Hastelloy B.

EXPANSION JOINT INSTALLATION INSTRUCTIONS

1. The bellows element shall be protected from damage. Dents, scores, arc strikes, weld spatter, and other damage can cause the joint to fail. Damaged joints should not be used.

2. Align joint flange and pipe flange holes. Do not try to compensate for flange or pipe misalignment by putting any torsional, compressive, extension, or offset loads on the expansion joint. Good practice suggests that a mating flange in the piping system remain unwelded until the expansion joint has been bolted in position.

3. All anchors, guides, and supports must be installed according to engineering drawings and specifications.

4. Internally pressurized expansion joints are to be installed in the proper orientation with respect to direction of flow.

5. Unit lengths must not be altered during installation except for the application of cold pull.

6. Remove shipping restraints after installation, but before hydrotesting.

7. Test pressure should not exceed 1 1/2 times design pressure.

8. Water free of halogens should be used for hydrotesting.

9. If testing medium is significantly heavier than the product to be carried in the system, care must be taken to support the additional weight.

10. Paints containing low melting point metals or their compounds, particularly aluminum, lead or zinc, must not be allowed to come into contact with the bellows convolutions.

11. All installation procedures should conform to E.J.M.A. Safety Recommendation in Section B.

Terms and Conditions

1. All quotations are subject to approval, acceptance and correction at the home office. Any errors in quotations resulting in orders will be corrected and resubmitted to the customer for their acceptance or refusal.

No prices may be made up from information other than that shown in the tables.

2. All prices are F.O.B. factory, Chicago, Illinois, are are quoted exclusive of any taxes.

Shipments boxed for trans-ocean export, add 10% to total trade price.

Terms: Net 30 days from date of invoice.

3. Cancellation or alteration of an order or return of any product by Buyer may not be made without advance written consent of manufacturer and shall be subjected to a cancellation charge. Custom joints are not returnable.

A 35% minimum restocking charge shall be placed on any returned goods.

4. We will not be responsible for delays in shipping due to conditions beyond our control such as strikes, fires, or accidents.

5. Any claims for shortages or damaged products must be made in writing within 10 days after receipt of shipment.

6. Prices subject to change without notice.

Design and Dimensional Specifications

The products illustrated reflect the design characteristics at time of printing.

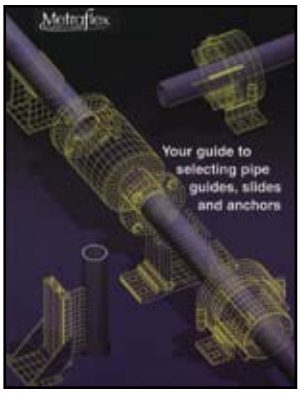
Metraflex reserves the right to change dimensions, materials, or methods of construction without notice. Please contact the factory for certified prints (exact dimensions) when necessary.

Limited Warranty

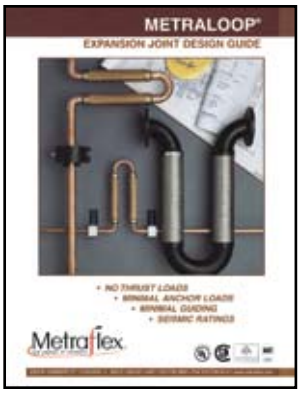
All products are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment, subject to the limitations below.

If the purchaser believes a product is defective the purchaser shall: (a) Notify the manufacturer, state the alleged defect and request permission to return the product. (b) If permission is given, return the product with transportation prepaid. If the product is accepted for return and found to be defective, the manufacturer will, at its discretion, either repair or replace the product F.O.B. factory, within 60 days of receipt, or refund the purchase price. Other than to repair, replace or refund as described above, purchaser agrees that manufacturer shall not be liable for any loss, costs, expenses or damages of any kind arising out of the product, its use, installation or replacement, labeling, instructions, information or technical data of any kind, description of product or use, samples or model, warnings or lack of any of the foregoing. NO OTHER WARRANTIES, WRITTEN OR ORAL, EXPRESS OR IMPLIED, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, ARE MADE OR AUTHORIZED. NO AFFIRMATION OF FACT, PROMISE, DESCRIPTION OF PRODUCT OR USE OR SAMPLE OR MODEL SHALL CREATE ANY WARRANTY FROM MANUFACTURER, UNLESS SIGNED BY THE PRESIDENT OF MANUFACTURER. These products are not manufactured, sold or intended for personal, family or household purposes.

• HOSE & BRAID



• GUIDES, SLIDES AND ANCHORS



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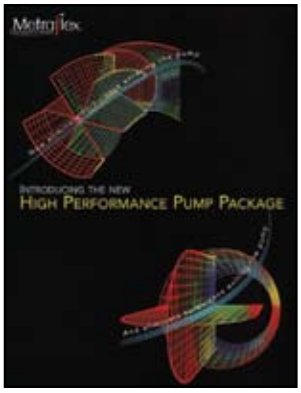
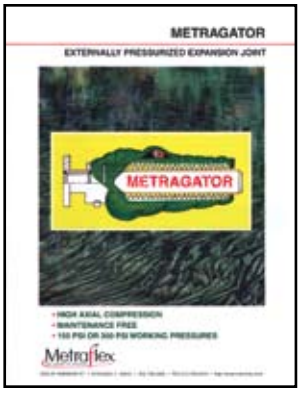


• HIGH PERFORMANCE

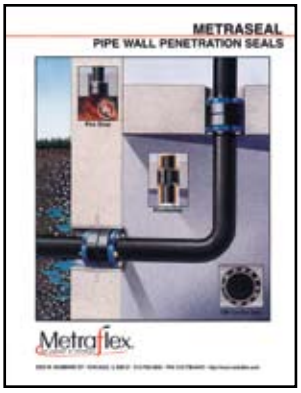
• SILENT CHECK VALVES



• METRAGATOR EXPANSION JOINTS

• CAST IRON STRAINERS

• RUBBER JOINTS



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