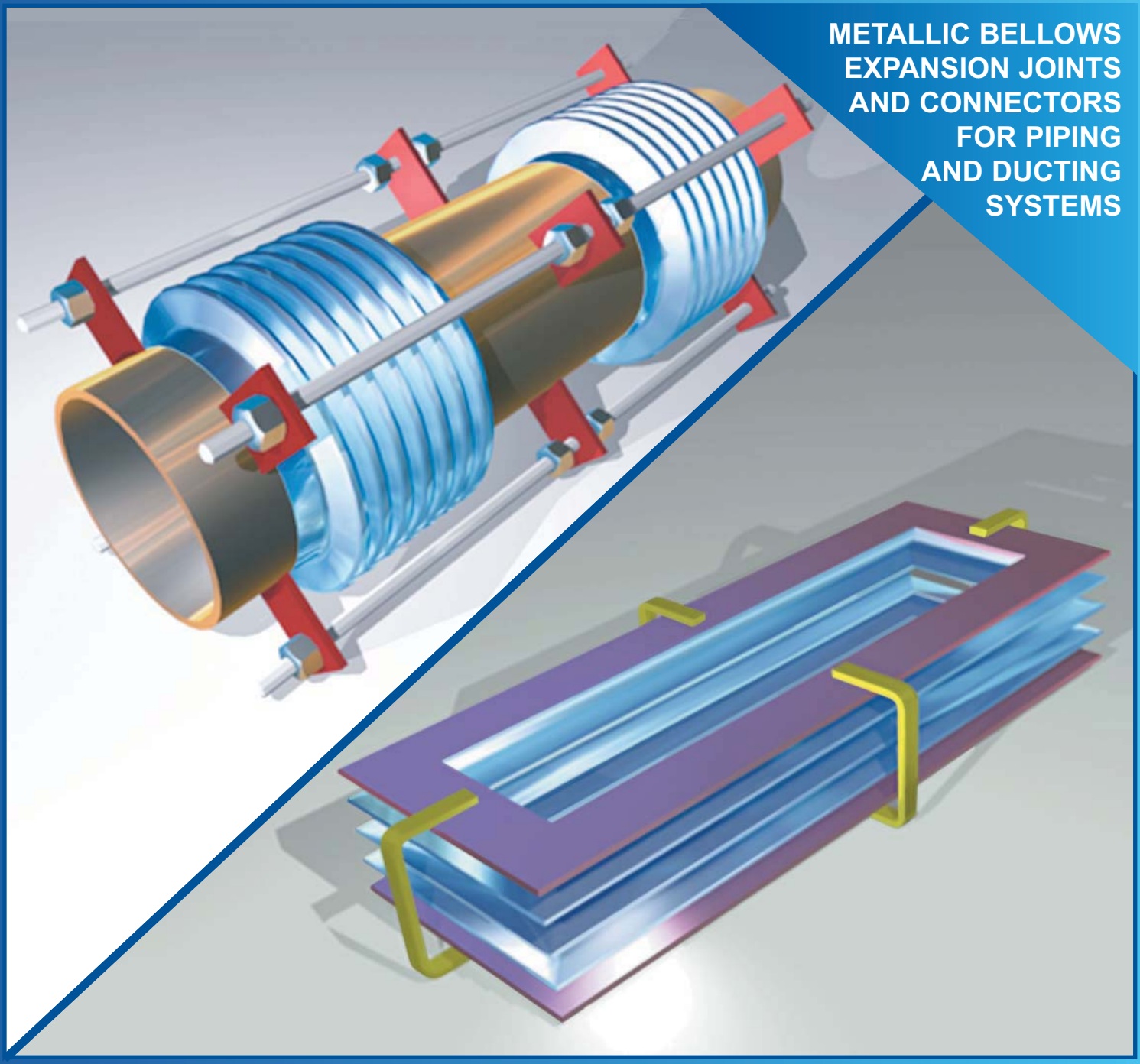
Thorburn Flex Inc

Flexible Piping Specialist



METALLIC BELLOWS EXPANSION JOINTS AND CONNECTORS FOR PIPING AND DUCTING SYSTEMS

- ✔ Single & Universal Unrestrained
- ✔ Tied Universal, Gimbal & Hinged
- ✔ Externally Pressurized
- ✔ Pressure Balanced
- ✔ Low Pressure Ducting
- ✔ Miniature Bellows Technology

Thorburn Flex Inc
Flexible Piping Specialist

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Thorburn Flex Inc

Flexible Piping Specialist

Thorburn is an innovative manufacturer of specialized engineered flexible piping systems (i.e. custom hose assemblies and expansion joints). Since 1960, Thorburn's corporate mission evolution and business philosophy have been customer driven and targeted to selected niche applications (in industries such as power generation, both fossel fuel and nuclear, pulp and paper, petrochemical, aluminium smelting, ship building, aerospace and pharmaceutical) where Thorburn can achieve clear positions of sustainable technological and market-share leadership.

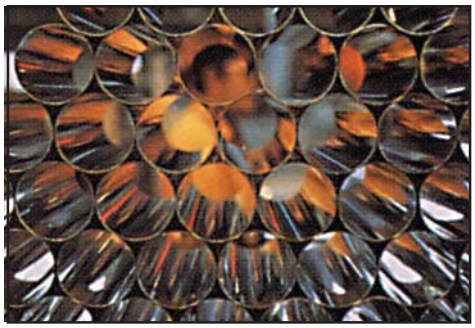
THORBURN'S EMPLOYMENT OF STATE-OF-THE-ART TECHNOLOGY

Thorburn's committment to development is reinforced through the use of CAD (Computer Aided Design) system technology and finite engineering analysis, which permits Thorburn to pinpoint potential critical areas and provide timely sound engineered solutions

FOUNDER, Jack Thorburn

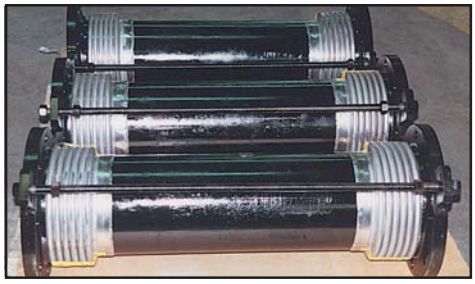
Shown is Jack Thorburn, who founded the company in 1954, enjoying one of his passions, cross-country skiing. Unfortunately Jack passed away on February 16th 1995. He will be sorely missed. The company's leadership passed to Jack's eldest son Robert in September 1994.

DESIGNING, BUILDING AND SUPPLYING THE WORLD'S FINEST EXPANSION JOINT AND CONNECTOR SYSTEMS

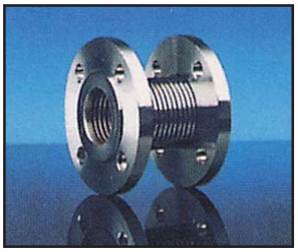


Bellows tubes prior to convolution forming

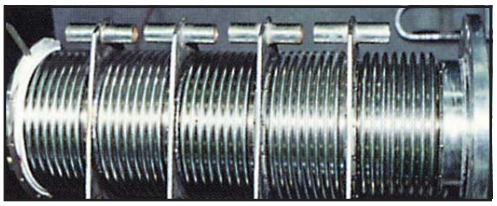
Thorburn's procedures and welders certified to ASME Sections III, VIII, IX using modern TIG welding technology



Thorburn's tied universal expansion joint system



Thorburn's Single-Flex unrestrained expansion joint system



Thorburn's multi-ply Inconel low stress high temperature/pressure custom bellows technology

EXPERIENCE YOU CAN DEPEND ON

Since 1960, Thorburn has devoted its expanding facilities and engineering expertise to the design, development and manufacture of flexible piping systems. Integrally associated with this product mix are Thorburn's metallic expansion joints and connectors for piping and ducting systems.

Large diameter roll forming of bellows

Our sincerest thanks to the many valued customers who have purchased Thorburn's flexible piping products over the years. We look forward to working together with you and meriting your continued support for many years to come.

Robert Thorburn
President

Thorburn's exclusive 24 hour field servicing and repairing by skilled craftsmen, technicians and engineers at your service.

Welding and Fabrication Certification

- Welders and welding procedures: ASME Section IX, VIII, III
- GTAW, FCAW, TIG, MIG, core wire
- Tube welding, tack welding, automated flame cutting, large turn tables, rolls and positioners
- Roll forming up to 180" single or multi-ply
- Hydro forming up to 56" single or multi-ply

Quality Assurance Certifications

- Commercial
  - CSA CAN3 Z299.1
  - ISO 9001
  - CSA B.51 (Category A&D)
  - ASME B31.1/B31.3/B31.5
- Nuclear
  - ASME CODE SECTION III subsection NCA 4000 (ASME-NQA-1)
  - CSA N-285.0
- Design and Materials
  - ASME code Sections I, II, III, VIII, IX, B31.1 and B31.3
  - EJMA 6th Edition

Testing, NDT/NDE Programs and Design Verification Tests

- ASME Section V
- Magnetic particle, ultrasonic, Eddy current and dye penetrant testing
- Mass spectrometer and helium leak detection, radiography
- Hydro testing
- Burst testing up to 150,000 psi
- Bellows fatigue testing
- Seismic and vibration analysis
- Spring rate, dead weight and hardness testing

Thorburn's state-of-the-art TIG welding technology for externally pressurized expansion joint assembly

Applications which employ Thorburn's metallic expansion joint technology

- Power generating both fossil fuel and nuclear
- Gas turbines, diesel exhaust
- Petroleum refining and chemical processing
- Hot metal industries
- Ship building and marine
- Cogeneration
- Aviation and aerospace duct work
- Pulp and paper processing
- Heat exchangers
- Industrial piping systems
- Gas separation
- Water treatment

THORBURN'S METALLIC BELLOWS EXPANSION JOINTS AND CONNECTORS FOR PIPING AND DUCTING SYSTEMS

METALLIC BRAIDED FLEX CONNECTORS

Pages 28 to 29

- Pipeline misalignment absorption
- Lateral deflection and vibration absorption
- Riser connections, pumps, compressors, cooling towers

SINGLE AND UNIVERSAL (Unrestrained)

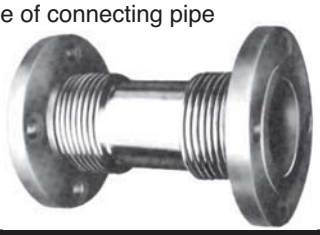
Pages 31 to 52

Single

- Thorburn's most economical expansion joint
- Will not absorb pressure thrust forces unless control rods are used
- Axial lateral offset limited and angular rotation
- Generally used where axial or lateral movement is required and where anchoring is not a problem

Universal

- Used when axial and/or lateral concurrent movement requirements exceed Thorburn's single bellows
- Lack of control devices demands careful anchoring and guidance of connecting pipe



HINGED ANGULAR ROTATION (Single plane)

Page 32

- Angular motion in only one plane
- Positive control over bellows movement
- Eliminates pressure thrust forces
- Transmits external loads
- Supports dead weight
- Prevents torsion on bellows
- No main anchors required
- Minimum guiding required
- Low forces on piping system
- Maximum bellows cycle life
- To be used in sets of two or three where piping changes direction. The hinge pins absorb internal pressure thrust, permitting the use of light anchors

GIMBAL ANGULAR ROTATION (All planes)

Page 33

- Angular motion in all planes
- Positive control over bellows movement
- Eliminates pressure thrust forces
- Transmits external loads
- Supports dead weight
- Prevents torsion on bellows
- No main anchors required
- Maximum bellows cycle life
- Used in sets of two or three to absorb motion in any plane

DOUBLE (In-line)

Page 45

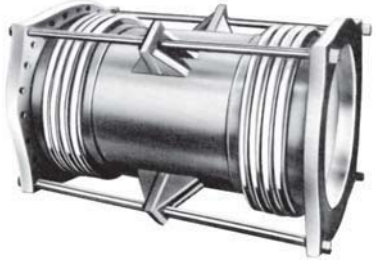
- Use in-line on long pipe runs of straight piping to absorb major axial movement up to 12"
- Joint is anchored in the center of the line, therefore two pipe guides must be placed on each side of the unit.

THORBURN'S METALLIC BELLOWS EXPANSION JOINTS AND CONNECTORS FOR PIPING AND DUCTING SYSTEMS

TIED UNIVERSAL

Pages 46 to 48

- Absorbs large amounts of lateral movement in any direction
- Eliminates pressure thrust loads
- Absorbs thermal growth of the piping between tie rod attachments
- Can support dead weight and centerspool
- Eliminates main anchors
- Minimum guiding
- Typically used in a change in direction of piping to absorb expansion in both ways



EXTERNALLY PRESSURIZED

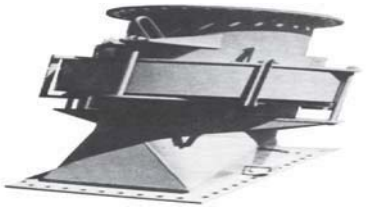
Pages 53 to 63

- Long axial movements
- High pressure/temperature capabilities
- Self-draining convolutions
- Integral cover and liner
- Leakproof/No packing

PRESSURE BALANCED (Elbow series)

Pages 67 to 68

- Absorbs axial and lateral movements while still restraining pressure thrust forces
- Eliminates main anchors
- Minimum guiding required

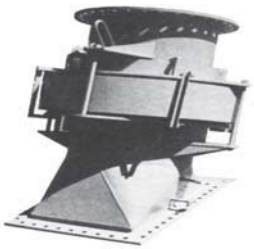


IN-LINE PRESSURE BALANCED

Page 69

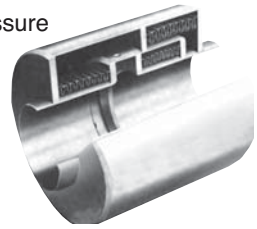
Universal series

- Eliminates pressure thrust forces
- Conserves space
- Eliminates main anchors
- Does not require a change in direction of the piping system
- Lower pressure axial movement



Externally pressurized series

- Eliminates main anchors
- Long axial movements at high pressure
- Self-draining convolutions
- Integral cover and liner
- Leakproof - Packless
- Maintenance free
- Eliminates pressure thrust forces

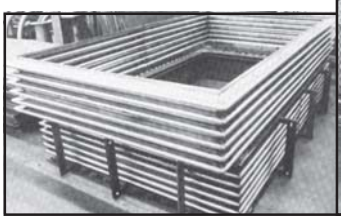


DUCTFLEX (Low pressure series)

Pages 70 to 79

(Axial and lateral offset limited and angular rotation)

- Typically used in low pressure high temperature ducting systems
- Also used in diesel exhaust systems where high temperature low pressures are in conflict
- Available in round and rectangular shapes
- Deep convolutions allow for large movement low spring rolls



MINIATURE NICKLE METAL BELLOWS SERIES

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TABLE OF CONTENTS

WHY USE THORBURN'S METAL BELLOWS TYPE EXPANSION JOINTS?

All piping or ducting systems are subjected to changes in their geometry due to various factors, some of which are:

a) Thermal:

i.e.
- Startup to operating temp.
- Variations in ambient temp.
- Emergency or fault conditions

b) Pressure:

i.e.
- Deformation, due to constant pressure
- Deformation, due to pulsating pressure
- Deformation, due to vibration

c) Mechanical:

i.e.
- Movement of other equipment
- Thermal growth in other equipment

Where the incorporation of sufficient natural flexibility in such a piping or ducting becomes a problem, three basic alternative solutions are open to the systems analyst.

1) The expansion loop
2) The slip type expansion joint
3) Thorburn bellows type expansion joint

1) EXPANSION LOOPS

The "loop" is the oldest method of dealing with pipe movement and probably the most expensive when one considers today's high costs of material and labour. In addition, pressure drops, heat loss, high anchor loading together with the large space requirement, can make this method economically unsound for the relatively small amount of movements that can be accommodated with the pipe loop.

2) SLIP TYPE EXPANSION JOINTS

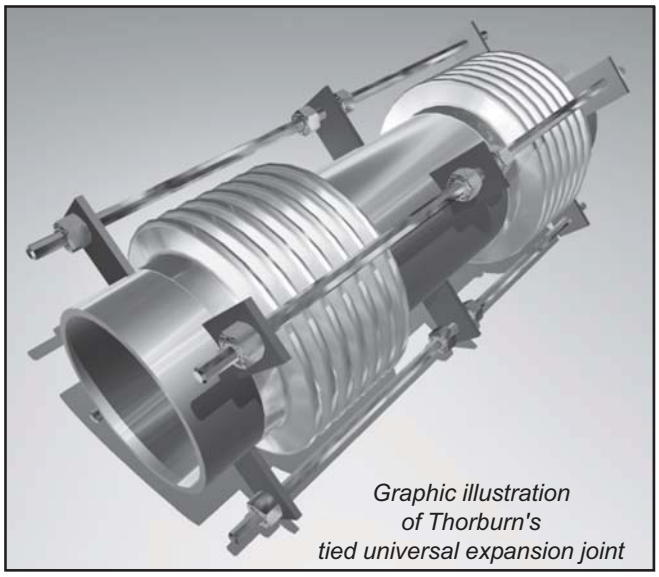
Derived from the "Stuffing Box", the slip type expansion joint is an improvement on the Expansion Loop but is somewhat limited in its applications, being suitable for axial motion only. Small amounts of lateral or angular displacement will cause binding and eventually premature leakage. The design of this product is such that a regular examination and maintenance program must be introduced so that if leakage occurs, packing is tightened or replaced.

In most cases the initial cost of the Slip type expansion joint greatly exceeds that of the Bellows expansion joint designed for the same application. Another factor to be considered is maintenance costs of Bellows type vs. the Slip type, as the bellows type requires no maintenance once correctly installed.

3) HOW A THORBURN METALLIC BELLOWS WORKS

Thorburn's metallic bellows is a flexible seal. The convoluted portion of an expansion joint is designed to flex when thermal movements occur in the piping system. The number of convolutions depends upon the amount of movement the bellows must accommodate or the force that must be used to accomplish this deflection.

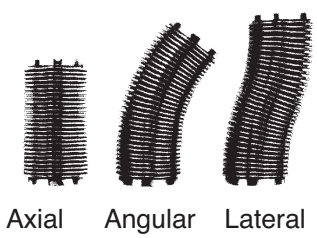
The convoluted element must be strong enough circumferentially to withstand the line pressure of the system, yet responsive enough longitudinally to flex. The longitudinal load (pressure thrust) must then be absorbed by some other type of device. These are usually anchors, tie rods, hinges, or Gimbal structures. Pressure thrust can be calculated by multiplying the effective area shown in the catalogue by the working pressure.



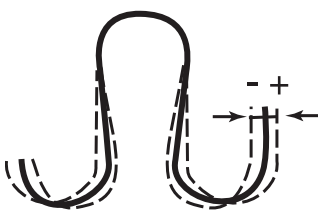
Graphic illustration of Thorburn's tied universal expansion joint

BELLOWS MOVEMENTS

Types of bellows movement

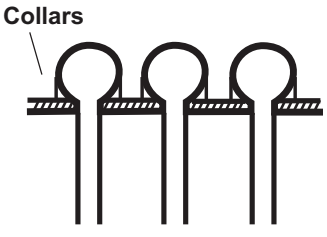


Principle for operation of a bellows corrugation

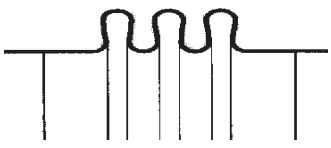


BELLOWS TYPICAL SHAPES

Toroidal shape, extremely pressure resistant

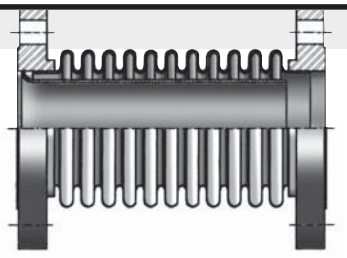


Lyre shape, pressure resistant and flexible



ACCESSORIES

LINERS



Typical Standard Expansion Joint

Liners or interval sleeves should be specified for expansion joints under the following conditions:

1. When pressure drop must be held to a minimum and smooth flow is desired.
2. When flow velocities are high and flow induced vibration could prove harmful to the bellows. Thorburn recommends the use of liners where the flow velocities exceed the following values:

   Air, steam and other gases:

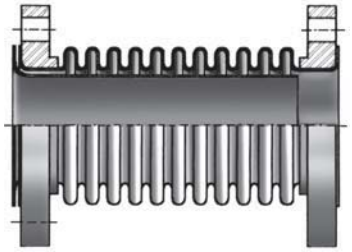
   a) Up to 6" diameter - 4 ft/sec. per inch of diameter.

   b) Over 6" diameter - 25 ft/sec.

   Water and other liquids:

   a) Up to 6" diameter - 1-2/3 ft/sec. per inch of diameter

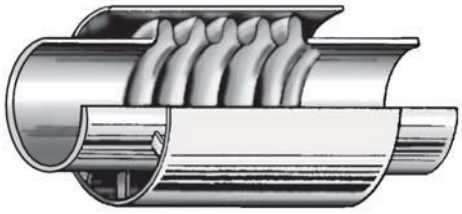
   b) Over 6" diameter - 10 ft/sec.
3. When turbulent flow is generated upstream of the expansion joint, heavy gauge liners are required.
4. When there is a possibility of erosion, such as in lines carrying catalyst or other abrasive materials, heavy gauge sleeves should be used.
5. When there is reverse flow, heavy gauge sleeves should be used and weep holes provided in the liner.
6. When extremely high temperatures are present. liners produce an air barrier which will decrease the operating temperature of the bellows.



Typical Vanstone Expansion Joint

COVERS

Thorburn's covers should be specified when the following conditions prevail:

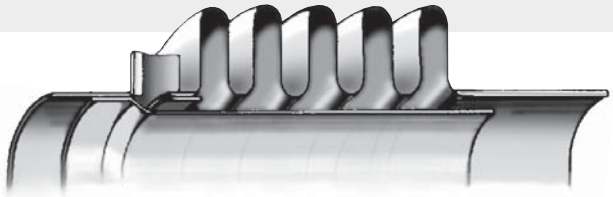


1. When there is a possibility of accidental damage to the bellows element during shipment, installation or while in service.
2. When welding is going to be done in the immediate vicinity of the bellows and there is a posibility of weld splatter or arc strikes hitting the bellows element.
3. When the expansion joint is going to be externally insulated. Note: one end of the cover must be left free to permit movement of the bellows, and the insulation used should be free from any substance which could prove harmful to the bellows material in the event of leaching.

In the case of Extra-Flex, the cover is provided as an integral part of the expansion joint and serves as a protection for personnel in the event of a bellows failure.

PURGE CONNECTIONS

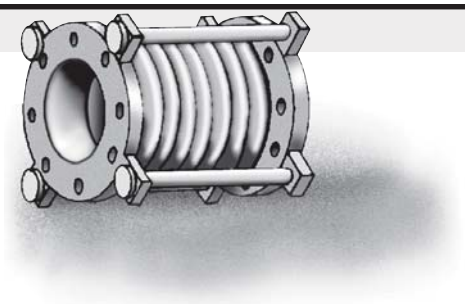
Purge connections are used in conjuction with internal liners to:



1. Prevent packing or collection of solids in the area between the liner and the bellows.
2. Introduce a cooling media, usually air or steam, between the bellows and the liner in high temperature service.

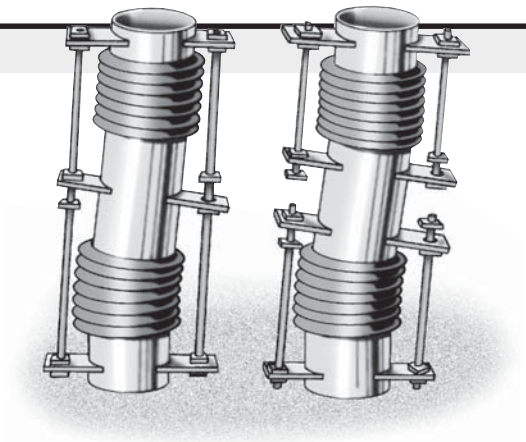
LIMIT RODS

Limit rods are used to limit over-compression and/or over-extension of the bellows element. Limit rods have no function under normal operating conditions. In the event of anchor failure the limit rod functions as a tie rod and contains the pressure thrust forces. This safety device prevents damage to piping, equipment and personnel.



ACCESSORIES

CONTROL RODS

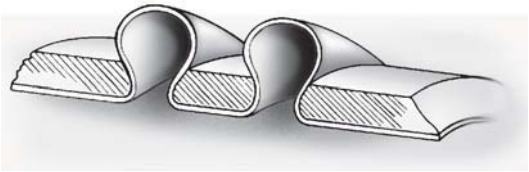


Control rods are utilized to prevent excessive displacement of the bellows in a universal expansion joint. These rods also control the relatively free centerspool between the two bellows. These rods are not designed to restrain pressure thrust forces.

TWO-PLY TESTABLE EXPANSION JOINT

The purpose of the 2-ply testable bellows is to provide a safety ply design. Each bellows ply is designed to withstand the system design pressure independently, so that in the event one ply fails for any reason, the remaining ply will enable the expansion joint to continue to function in a normal condition. The space between the bellows plies can be connected to a pressure gauge or a continuous monitoring system. It would register any change in pressure and thus trigger action to program replacement of the expansion joint on a routine basis.

TOROIDAL EXPANSION JOINT



Toroidal expansion joints are used in very high pressure systems. This type of construction transmits most of the hoop loading from the convolutions to the adjacent rings. This design allows relatively thin bellows to accept very high pressures.

MULTI-PLY BELLOWS

Multi-ply bellows construction is used when increased fatigue life and lower forces are required while still maintaining the same pressure capacity. The multiple plies act in unison as far as hoop pressure loading is concerned, but act individually when fatigue life and forces are calculated. Thorburn can also manufacture multi-ply bellows with varying materials. This is especially useful when the media dictates a material for corrosion protection, but one that is not strong enough to take the pressure loading. This type of construction allows Thorburn to supply the most economic bellows of optimum design for any individual application. Small holes are drilled into the outer ply cuffs of a multi-ply bellows to provide for expansion of entrapped air between the plies during high temperature operation.

HEAVY WALL BELLOWS

As a result of significantly improved fabrication capabilities, Thorburn now offers heavy wall single ply bellows to 3/16 of an inch (.187 inches, 4.76 mm) thickness and convolution heights ranging to 15 inches. These bellows possess reasonable spring forces as a result of the high convolution configuration.

Bellows of this thickness quite often enable maintenance personnel to make temporary weld repairs, in many cases without system shutdown. Such repairs might allow the system to continue to operate until a regularly scheduled shutdown occurs.

Heavy wall bellows are less susceptible to damage during installation and systems start-up. Multiple-ply bellows are available to a thickness of 1/4 inch (.250 inches – 6.35 mm).

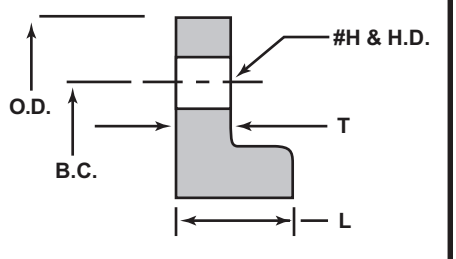
STANDARD FLANGE DATA

This abbreviated flange data summary is intended to help system designers in selecting the optimum pipe and duct flanges. The working pressure at temperature ratings were obtained from applicable flange specifications. Where elevated temperature data was not available, the rated working pressure at ambient was downrated in accordance with ASME Code strength versus temperature correction factors.

Slip-On Flanges	Nominal	Working Pressure Rating (psi) at Temperature (Deg. F)							
	I.D. (in.)	-20º to 100º	200º	300º	400º	500º	600º	700º	800º
Class 125 L.W. forged steel Mat'l A-105	6 - 12	175	152	134	116	98	80	62	46
AWWA 125 L.W. C207-54T Class D Mat'l A-105	14 - 96	150	131	115	99	83	67	51	38
150# forged steel ANSI B16.5 Mat'l A-105	1 - 24	275	260	230	200	170	140	110	80
Class 125 forged steel dimensions to B16.1 Mat'l A-105	26 - 96	275	240	210	180	150	130	110	80
Class 125 (Class A) cast steel B16.1 Mat'l 126A	1 - 12	175	165	140					
Class 125 (Class B)	1 - 12	200	190	165	140				
Cast steel B16.1	14 - 24	150	135	110					
Mat'l A-126B	30 - 48	150	115	50					
Class 300 forged steel ANSI B16.5 Mat'l A-105	1 - 24	740	675	655	635	600	550	535	410
Class 400 forged steel ANSI B16.5 Mat'l A-105	1 - 24	990	900	875	845	800	730	710	550

The dimensions data shown below have been consolidated from current standards for easy reference

Nom. Size (in.)	CLASS 125 L.W.							CLASS 150 B16.5							CLASS 300 B16.5						
	O.D.	T	L	BC	#H	HD	WT LBS	O.D.	T	L	BC	#H	HD	WT LBS	O.D.	T	L	BC	#H	HD	WT LBS
1.5								5.00	0.688	0.875	3.875	4	0.625	3	6.125	0.813	1.188	4.500	4	0.875	6
2.0								6.00	0.750	1.000	4.750	4	0.750	5	6.500	0.875	1.313	5.000	8	0.750	7
2.5								7.00	0.875	1.125	5.500	4	0.750	7	7.500	1.000	1.500	5.875	8	0.875	10
3.0								7.50	0.938	1.188	6.000	4	0.750	8	8.250	1.125	1.688	6.625	8	0.875	13
3.5								8.50	0.938	1.250	7.000	8	0.750	11	9.000	1.188	1.750	7.250	8	0.875	17
4.0								9.00	0.938	1.313	7.500	8	0.750	13	10.000	1.250	1.875	7.875	8	0.875	22
5.0								10.00	0.938	1.438	8.500	8	0.875	15	11.000	1.375	2.000	9.250	8	0.875	28
6.0	11	0.563	1.25	9.50	8	0.875	13	11.00	1.000	1.563	9.500	8	0.875	19	12.500	1.438	2.063	10.625	12	0.875	39
8.0	13.5	0.563	1.25	11.75	8	0.875	18	13.50	1.125	1.750	11.750	8	0.875	30	15.000	1.625	2.438	13.000	12	1.000	58
10.0	16	0.688	1.25	14.25	12	1	26	16.00	1.188	1.938	14.250	12	1.000	43	17.500	1.875	2.625	15.250	16	1.125	81
12.0	19	0.688	1.25	17.00	12	1	42	19.00	1.250	2.188	17.000	12	1.000	64	20.500	2.000	2.875	17.750	16	1.250	115
14.0	21	0.750	1.25	18.75	12	1.125	44	21.00	1.375	2.250	18.750	12	1.125	90	23.000	2.125	3.000	20.250	20	1.250	165
16.0	23.5	0.750	1.25	21.25	16	1.125	58	23.50	1.438	2.500	21.250	16	1.125	98	25.500	2.250	3.250	22.500	20	1.375	190
18.0	25	0.750	1.25	22.75	16	1.250	59	25.00	1.563	2.688	22.750	16	1.250	130	28.000	2.375	3.500	24.750	24	1.375	250
20.0	27.5	0.750	1.25	25.00	20	1.250	69	27.50	1.688	2.875	25.000	20	1.250	165	30.500	2.500	3.750	27.000	24	1.375	315
22.0	29.5	1.000	1.75	27.25	20	1.375	76	29.50	1.813	3.125	27.250	20	1.375	185	—	—	—	—	—		
24.0	32	1.000	1.75	29.50	20	1.375	115	32.00	1.875	3.250	29.500	20	1.375	220	36.000	2.750	4.188	32.000	24	1.625	475
26.0	34.25	1.000	1.75	31.75	24	1.375	125	CLASS 125 B16.1													
28.0	36.5	1.000	1.75	34.00	28	1.375	140	36.50	2.063	3.438	34.000	28	1.375	270							
30.0	38.75	1.000	1.75	36.00	28	1.375	150	38.75	2.125	3.500	36.000	28	1.375	305							
32.0	41.75	1.125	1.75	38.50	28	1.625	205														
34.0	43.75	1.125	1.75	40.50	32	1.625	215														
36.0	46	1.125	1.75	42.75	32	1.625	235	46.00	2.375	3.750	42.750	32	1.625	450							
40.0	50.75	1.125	1.75	47.25	36	1.625	280														
42.0	53	1.250	1.75	49.50	36	1.625	330	53.00	2.625	4.000	49.500	36	1.625	650							
48.0	59.5	1.375	2.50	56.00	44	1.625	425	59.50	2.750	4.125	56.000	44	1.625	800							
54.0	66.25	1.375	2.50	62.75	44	1.875	500	66.25	3.000	4.375	62.750	44	1.875	1025							
60.0	73	1.500	2.75	69.25	52	1.875	640	73.00	3.125	4.500	69.250	52	1.875	1250							
66.0	80	1.500	2.75	76.00	52	1.875	750	80.00	3.375	4.875	76.000	52	1.875	1775							
72.0	86.5	1.500	2.75	82.50	60	1.875	850	86.50	3.500	5.000	82.500	60	1.875	1925							
84.0	99.75	1.750	3.00	95.50	64	2.125	1000	99.75	3.875	5.375	95.500	64	2.125	2600							
96.0	113.25	2.000	3.25	108.50	68	2.375	1650	113.25	4.250	5.750	108.500	68	2.375	3275							



CORROSION RESISTANCE REFERENCE TABLE

Rating Code:

A - Suitable (normal conditions)
B - Limited Service
C - Unsuitable

Notes:

1 - Susceptible to intergranular corrosion
2 - May cause explosive reaction
3 - Susceptible to stress corrosion cracking
4 - Susceptible to pitting type corrosion
5 - Discolours
6 - Concentration over 50 % and/or temperature over 200ºF, contact Thorburn with application details

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Acetaldehyde	A	A	A	A	A
Acetanilide	B	B	B	B	B
Acetic acid	B	B	A	B1	A1
Acetic anhydride	B	B	A	B	B
Acetone	A	A	A	B	B
Acetophenone	A	A	A	B	B
Acetylene	C	A	A	A	A
Acrylates	B	B	B	B	B
Acrylic acid	B	B	A	B	B
Acrylonitrile	A	A	A	A	A
Alcohols	A	A	A	A	A
Alum	B	B	A	B	B
Alumina	A	A	A	A	A
Aluminium acetate	B	B	B	B	B
Aluminium chloride (Dry)	B	A	A	A	A
Aluminium chloride (Moist)	C	B	A	C3,4	C3
Aluminium fluoride	B	B	C	C	C
Aluminium hydroxide	A	B	B	B	B
Aluminium sulfate	B	B	B	B1,3	A3
Ammonia (Dry)	A	A	A	A	A
Ammonia (Moist)	C	C	B	A	A
Ammonium acetate	B	A	A	A	A
Ammonium bromide	C	B	B	C4	C4
Ammonium chloride (Dry)	C	A	A	A	A
Ammonium chloride (Moist)	C	B	B	C3,4	C3
Ammonium hydroxide	C	A	A	B	B
Ammonium nitrate	C	C2	B	B3	B3
Ammonium sulfate	C	B	C	C1	B
Amyl acetate	A	A	A	A	A
Amyl alcohol	A	A	A	A	A
Amyl chloride (Dry)	C	A	A	A	A
Amyl chloride (Moist)	C	B	C	C3,4	C3
Aniline	C	A	B	B	B
Aniline dyes	C	A	B	B	B
Asphalt	A	A	A	A	A
Atmosphere (Industrial)	A	A	A	B4	A4
Atmosphere (Marine)	A	A	A	B4	B4
Atmosphere (Rural)	A	A	A	A	A
Barium carbonate	A	B	B	B	B
Barium chloride (Dry)	B	A	A	A	A
Barium chloride (Moist)	C	B	C	C3,4	C3
Barium hydroxide	A	B	B	B	A
Barium sulfate	B	B	B	B	B
Barium sulfide	C	C	B	B	B
Beer	A	A	A	A	A
Beet sugar syrups	A	A	A	A	A
Benzaldehyde	A	B	B	B	B
Benzene (benzol)	A	A	A	A	A

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Benzoic acid	A	B	A	A	A
Benzylamine	C	B	B	B	B
Benzyl chloride (Dry)	A	A	A	A	A
Benzyl chloride (Moist)	B	B	B	C,3,4	C,3
Black liquor, sulfate process	C	A	B	B	B
Bleaching powder (Dry)	A	A	A	A	A
Bleaching powder (Moist)	B	B	B	C1,3,4	C3,4
Borax	A	A	A	A	A
Bordeaux mixture	A	A	A	A	A
Boric acid	A	B	A	A	A
Boron trichloride (Dry)	B	B	B	B	B
Boron trichloride (Moist)	B	B	C	C3,4	C3
Boron trifluoride (Dry)	A	B	A	B	B
Brines	A	B	B	C3,4	C3
Bromic acid	C	C	C	C	C
Bromine (Dry)	A	A	A	B	B
Bromine (Moist)	B	B	B	C	C
Butadiene	A	A	A	A	A
Butane	A	A	A	A	A
Butanol (butyl alcohol)	A	A	A	A	A
Butyl phenols	B	A	B	B	B
Butylamine	B	A	A	A	A
Butyric acid	A	B	A	B	B
Cadmium chloride (Moist)	B	B	B	C3,4	C3
Cadmium chloride (Dry)	A	A	A	A	A
Cadmium sulfate	A	A	A	A	A
Calcium bisulfite	B	B	B	B1	B
Calcium bromide	A	B	A	C3	C3
Calcium chloride (Moist)	A	B	A	C3,4	C3
Calcium chloride (Dry)	A	A	A	A	A
Calcium fluoride	B	B	B	C	C
Calcium hydroxide	A	B	A	B	B
Calcium hypochlorite (Moist)	B	B	B	C3,4	C3,4
Calcium hypochlorite (Dry)	A	A	A	A	A
Calcium nitrate	B	B	A	B1	B
Calcium oxide	A	A	A	A	A
Cane sugar syrups	A	A	A	A	A
Carbolic acid (Phenol)	B	B	B	B	B
Carbon dioxide (Dry)	A	A	A	A	A
Carbon dioxide (Moist)	B	A	A	A	A
Carbonated beverages	B	A	A	A	A
Carbonated water	B	A	A	A	A
Carbon disulfide	B	B	B	B	B
Carbon tetrachloride (Dry)	A	A	A	A	A
Carbon tetrachloride (Moist)	B	B	B	C3,4	C4
Castor oil	A	A	A	A	A
Chlorine (Dry)	A	A	A	A	A
Chlorine (Moist)	C	B	C	C3,4	C3

CORROSION RESISTANCE REFERENCE TABLE (cont'd)

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Chloroacetic acid	B	B	B	C3,4	C3
Chloric acid	C	C	C	C3	C3
Chlorine dioxide (Moist)	C	B	B	C3,4	C3
Chlorine dioxide (Dry)	B	A	A	A	A
Chloroform (Dry)	A	A	A	A	A
Chloroform (Moist)	B	B	B	C3,4	C3
Chromic acid	C	C	B	C1,4	C
Chromic fluoride	C	B	B	C	C
Chromic hydroxide	B	B	B	B	B
Chromium sulfate	B	B	B	B	B
Cider	A	A	A	A	A
Citric acid	A	B	A	B	B
Coffee	A	A	A	A	A
Copper chloride (Dry)	A	A	A	A	A
Copper chloride (Moist)	C	B	C	C3,4	C3
Copper nitrate	C	C	B	A	A
Copper sulfate	B	B	B	B1	B
Corn oil	A	A	A	A	A
Cottonseed oil	A	A	A	A	A
Creosote	A	A	A	A	A
Crude oil	B	A	A	C1	B
Cyclohexane	B	B	B	B	B
DDT	B	B4	B	B	B
Dichloroethane (Dry)	A	A	A	A	A
Dichloroethane (Wet)	B	B	B	C4	C4
Dichloroethylene (Dry)	A	A	A	A	A
Dichloroethylene (Moist)	B	B	B	C4	C4
Dichlorophenol	B	B	B	B3	B3
Disocyanate	A	A	A	A	A
Dimethyl sulfate	B	B	A	B	B
Epichlorohydrin (Dry)	A	A	A	A	A
Epichlorohydrin (Moist)	B	B	B	C3,4	C3
Ethane	A	A	A	A	A
Ethers	A	A	A	A	A
Ethyl acetate	A	B	A	B	B
Ethyl alcohol	A	A	A	A	A
Ethyl benzene	B	B	A	B3	B
Ethyl chloride (Moist)	B	B	B	C3,4	C3
Ethyl chloride (Dry)	A	A	A	A	A
Ethylene	A	A	A	A	A
Ethylene chlorohydrin (Dry)	A	A	A	A	A
Ethylene chlorohydrin (Moist)	B	B	B	C4	C4
Ethylene diamine	B	B	A	B	B
Ethylene glycol	A	A	A	A	A
Ethylene oxide	C	B	B	B	B
Fatty acids	B	B	B	B1,4	A
Ferric chloride (Moist)	C	B	B	C1,3,4	C3,4
Ferric chloride (Dry)	A	A	A	A	A
Ferric nitrate	C	C	B	B	B
Ferric sulfate	C	C	B	B1	A
Ferrous chloride (Moist)	C	B	B	C3,4	C3
Ferrous chloride (Dry)	A	A	A	A	A
Ferrous sulfate	B	A	B	B4	B
Fluorine (Dry)	A	A	A	A	A

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Fluorine (Moist)	C	B	C	C	C
Formaldehyde	A	A5	B	B	B
Formic acid	A	B	A	B1	A
Freon	A	A	A	A	A
Fruit juices	B	A	A	A	A
Fuel oil	A	A	A	A	A
Furfural	A	A	B	A	A
Gasoline	A	A	A	A	A
Gelatine	A	A	A	A	A
Glucose	A	A	A	A	A
Glue	A	A	A	A	A
Glutamic acid	B	B	A	B3,4	B3,4
Glycerin (glycerol)	A	A	A	A	A
Heptane	A	A	A	A	A
Hexachloroethane (Dry)	A	A	A	A	A
Hexachloroethane (Moist)	B	B	B	C4	C4
Hydrazine	C	C	A	A	A
Hydrobromic acid	C	C	B	C4	C
Hydrocarbons (Pure)	A	A	A	A	A
Hydrochloric acid	C	B	C	C4	C4
Hydrocyanic acid	C	B	B	B1	B
Hydrofluoric acid	C	B	B	C1,3	C
Hydrofluorsilicic acid	B	B	B	C	C
Hydrogen	A	A	A	A	A
Hydrogen chloride (Dry)	A	A	A	A	A
Hydrogen chloride (Wet)	C	B	C	C4	C4
Hydrogen peroxide	B	B	A	A	A
Hydrogen sulfide (Dry)	A	A	A	A	A
Hydrogen sulfide (Moist)	C	B	B	B4	A
Hydroquinone	B	B	B	B	B
Kerosine (Kerosene)	A	A	A	A	A
Lacquers	A	A	A	A	A
Lacquer solvents	A	A	A	A	A
Lactic acid	A	B	B	B1,4	B1
Lime	A	A	A	A	A
Lime (Sulfur)	C	B	B	B	B
Linseed oil	B	A	A	A	A
Lithium chloride (Moist)	C	B	B	C3,4	C3
Lithium chloride (Dry)	A	A	A	A	A
Lithium hydroxide	B	B	B	B	B
Magnesium chloride (Moist)	B	B	B	C3,4	C3
Magnesium chloride (Dry)	A	A	A	A	A
Magnesium hydroxide	A	A	A	A	A
Magnesium sulfate	A	A	A	B	A
Maleic acid	C	B	B	B1	B
Mercuric chloride (Moist)	C	B	A	C3,4	C3
Mercuric chloride (Dry)	C	A	A	A	A
Mercurous nitrate	C	B3	B	B	B
Mercury	C	B3	B	B	B
Methyl alcohol	A	A	A	A	A
Methane	A	A	A	A	A
Methyl chloride (Dry)	A	A	A	A	A
Methyl chloride (Moist)	B	B	B	C3,4	C3
Methyl ethyl ketone	A	B	A	B	B

CORROSION RESISTANCE REFERENCE TABLE (cont'd)

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Milk	A	A	A	A	A
Mine water	C	B	A	B	B
Naphthalene	B	B	A	A	A
Natural gas	A	A	A	A	A
Nickel chloride (Moist)	B	B	B	C3,4	C3
Nickel chloride (Dry)	A	A	A	A	A
Nitric acid	C	C	B	A	A
Nitrotoluene	B	B	B	B	B
Nitrogen	A	A	A	A	A
Oleic acid	B	A	B	B4	B
Oleum (Fuming H_2S0_4)	C	C	B	B	B
Oxalic acid	A	B	B	C1	B1
Oxygen	A	A	A	A	A
Palmitic acid	B	A	A	A	A
Parafin	A	A	A	A	A
Pentane	B	B	B	B	B
Phosphoric acid	B	B	B	C1	B1
Phthalic acid	B	B	B	B1	B
Picric acid	C	C	B	B	B
Potassium bromide	A	B	B	C	C
Potassium carbonate	A	A	A	A	A
Potassium chloride (Moist)	B	B	B	C3,4	C3
Potassium chloride (Dry)	A	A	A	A	A
Potassium chromate	A	B	A	B	B
Potassium cyanide	C	B	B	B	B
Potassium dichromate	C	A	A	A	A
Potassium fluoride	C	B	B	C	C
Potassium hydroxide	B	B3	A	B3	B3
Potassium nitrate	A	B	A	B	A
Potassium permanganate	B	B	B	B	B
Potassium sulfate	A	B	A	B	B
Propane	A	A	A	A	A
Propylene	A	A	A	A	A
Propylene dichloride (Dry)	A	A	A	A	A
Propylene dichloride (Moist)	B	B	B	C4	C4
Pyridine	B	B	B	B	B
Pyrrolidine	B	B	A	B	A
Quinine	B	B	A	B	B
Rosin	A	A	A	A	A
Sea water	A	B	A	C3,4	C3
Sewage	A	A	A	A	A
Silver salts	C	A	A	B	B
Silver nitrate	C	C	A	B	B
Soap solutions	A	A	A	A	A
Sodium	A	A	A	A	A
Sodium acetate	B	B	B	B4	B
Sodium bicarbonate	A	A	A	A	A
Sodium bisulfate	B	B	B	B1,4	B
Sodium bisulfite	B	B4	B	B	B
Sodium bromide	C	B	B	C	C
Sodium carbonate	A	A	A	A	A
Sodium chlorate (Moist)	B	B	B	C3,4	C3
Sodium chlorate (Dry)	A	A	A	A	A
Sodium chloride (Moist)	A	B	A	C3,4	C3
Sodium chloride (Dry)	A	A	A	A	A
Sodium chromate	B	B	B	B	B
Sodium citrate	B	B	B	B	B

MEDIA	CUPRO NICKEL 706	MONEL 400	INCONEL 625	321 STAINLESS	316 STAINLESS
Sodium cyanide	C	B	B	B	B
Sodium dichromate	C	B	B	B	B
Sodium fluoride	B	B	B	C4	C
Sodium hydroxide	B3	B3	A	B3	B3
Sodium hypochlorite (Moist)	C	B	B	C1,4	C4
Sodium hypochlorite (Dry)	A	A	A	A	A
Sodium metasilicate	A	A	A	A	A
Sodium nitrate	A	A	A	A	A
Sodium nitrite	B	B	B	B	B
Sodium peroxide	B	B	B	B	B
Sodium phosphate	A	A	B	B	B
Sodium silicate	A	A	A	A	A
Sodium sulfate	A	A	A	B3	B
Sodium sulfide	C	B	B	B4	B
Sodium sulfite	B	B	B	B	B
Sodium thiosulfate	C	B	B	B	B
Stannic chloride (Moist)	C	B	B	C3,4	C3
Stannic chloride (Dry)	A	A	A	A	A
Stannous chloride (Moist)	C	B	B	C3,4	C3
Stannous chloride (Dry)	A	A	A	A	A
Steam	A	A3	A	A	A
Stearic acid	B	B	B	B	B
Strontium nitrate	B	B	B	B	B
Sulfate black liquor	B	B	B	B	B
Sulfate green liquor	B	B	B	B3	B3
Sugar solutions	A	A	A	A	A
Sulfur (Dry)	B	A	A	A	A
Sulfur (Molten)	C	B	A	A	A
Sulfur chloride (Dry)	A	A	A	A	A
Sulfur chloride (Wet)	B	B	B	C3,4	C3
Sulfur dioxide (Dry)	B	B	B	C1	B
Sulfur dioxide (Moist)	C	C	C	C1	B
Sulfur trioxide (Dry)	A	A	A	A	A
Sulfuric acid, 95-100%	B	B	A	A	A
Sulfuric acid, 80-95%	B	B	B	B	B
Sulfuric acid, 40-80%	C	C	B	C1	C1
Sulfuric acid, 40%	B	C	B	C1	C1
Sulfurous acid	C	B	B	C1,4	C1,4
Tall oil	B	B	B	B	B
Tannic acid	B	B	B	B	B
Tar	A	A	A	A	A
Tartaric acid	B	B	B	B	B
Tetraphosphoric acid	C	C	B	B	B
Toluene	A	A	A	A	A
Trichloroacetic acid	B	B	B	C3,4	C4
Trichloroethane (Dry)	A	A	A	A	A
Trichloroethane (Moist)	B	B	B	C4	C4
Trichloroethylene (Dry)	A	A	A	A	A
Trichloroethylene (Moist)	B	B	B	C4	C4
Turpentine	A	A	A	A	A
Varnish	A	A	A	A	A
Vinegar	B	B	B	B	B
Water (potable)	A	A	A	A	A
Xylene	A	A	A	A	A
Zinc chloride (Moist)	C	B	B	C3,4	C3
Zinc chloride (Dry)	A	A	A	A	A
Zinc sulfate	B	B	B	B	A

BELLOWS MATERIAL DATA

Thorburn can supply bellows from most ductile materials which can be welded by the automatic TIG butt welding process and yield a homogeneous ductile weld structure.

Companies specifying and purchasing Thorburn bellows must give careful consideration to the selection of bellows material. When in doubt, consult Thorburn with your specific application.

MATERIAL CODES FOR BELLOWS (B), LINER (L), ENDS (E) AND SPOOL (S)

Thorburn Material Code					ASTM Material Designation	Material Type
Bellows (B)	Liner (L)	End (E)	Spool (S)	Accessories Tie rods, nuts, etc.		
B-0	L-0	E-0	S-0	A-0	A36/44W	Carbon steel
B-1	L-1	E-1	S-1	A-1	A-240	304
B-2	L-2	E-2	S-2	A-2	A-240	304L
B-3	L-3	E-3	S-3	A-3	A-240	316
B-4	L-4	E-4	S-4	A-4	A-240	316L
B-5	L-5	E-5	S-5	A-5	A-240	321
B-6	L-6	E-6	S-6	A-6	A-240	309
B-7	L-7	E-7	S-7	A-7	A-240	310
B-8	L-8	E-8	S-8	A-8	B-127	Monel 400
B-9	L-9	E-9	S-9	A-9	B-168	Inconel 600
B-10	E-10	E-10	E-10	A-10	B-443	Inconel 625
B-11	E-11	E-11	E-11	A-11	B-409	Incoloy 800
B-12	E-12	E-12	E-12	A-12	B-424	Incoloy 825
B-14	L-14	E-14	S-14	A-14	B-409	Incoloy 800HT
B-15	L-15	E-15	S-15	A-15	B-162	Nickel 201
B-16	L-16	E-16	S-16	A-16	B-575	Inco C276
B-17	L-17	E-17	S-17	A-17	B-364	Tantalum
B-18	L-18	E-18	S-18	A-18	—	Titanium Gr. 1
B-19	L-19	E-19	S-19	A-19	—	Zirconium Gr. 702
N/A	L-20	E-20	S-20	A-20	A-285	Carbon steel
N/A	L-21	E-21	S-21	A-21	A-570	Carbon steel
N/A	L-22	E-22	S-22	A-22	B-588	Carbon steel
N/A	L-23	E-23	S-23	A-23	A-606	Corten A
N/A	L-24	E-24	S-24	A-24	A-516	Carbon steel
B-X	L-X	E-X	S-X	A-X	—	Special - specify

Special notes

1) Use of these material codes as a suffix in the catalogue part number designate the bellows, liner, end connectors, spool and accessories material that will be supplied by Thorburn.
2) Special note for flanges and pipes: when forged flanges or scheduled pipe are used, the same nomenclature symbols are used (i.e.: E2 or S6).
3) ASME "SA" or "SB" materials are available upon request.
4) All bellows material purchased by Thorburn is "mill annealed" in accordance with "A", "SA" or "SB" specifications. Thorburn does not perform any other heat treating operations before welding, after welding, before forming convolutions or after forming convolutions unless specified by purchaser. Heat treatment of bellows after forming convolutions can lower bellows' spring rate, "squirm" pressure and cycle life. Thorburn will cooperate with purchasers requiring heat treatment after forming to arrive at what effect the heat treatment will have on published bellows data.

COMMON METALLURGICAL PROBLEMS

FAILURE MODE	CAUSE	FREQUENTLY USED SOLUTION
Chloride Stress Corrosion Cracking	Chlorides acting on austenitic stainless steel bellows (T-304, T-316, T-321)	Use a high nickel alloy like Inconel-600 or Inconel-625
Carbide Precipitation	Chromium carbides form in unstabilized stainless steels (T-304, T316) at high temperatures (over 700°F) causing loss of corrosion resistance	Use a stabilized stainless steel (T-321) or low carbon stainless steel (T-304L) or another high alloy material not affected by carbide precipitation
Pitting Corrosion	Galvanic action causing holes to form in a bellows, usually from acids	Use a bellows material containing molybdenum (T-316, I-825, I-625) or one of the specialty materials such as Zirconium, Titanium or Tantalum

HOW TO INTERPRET THORBURN'S BELLOWS DESIGN ANALYSIS DOCUMENTATION

All custom bellows designs should be documented to prove that the design has been analyzed to the proper code, the design is safe and mechanically stable, the cycle life is in accordance with the specification requirements and the important stress values have been satisfied. Thorburn bellows design analysis shows all the critical information in a summary format. This paper is offered to help a customer interpret the information that is shown on Thorburn's bellows design analysis so the information is more meaningful.

THORBURN REF: ABI-001-06/19/95 ITEM: 01 THORBURN EQUIPMENT INC.
CUSTOMER REF: LTD-401 SHEET __/__ OF __/__
JUNE 19, 1995 REV 08-06-92
PREPARED BY: LUCIAN BODOCAN APPROVED BY:KEN McCORMICK

THORBURN SINGLE BELLOWS DESIGN ANALYSIS

THIS EXPANSION JOINT DESIGN ANALYSIS WAS CALCULATED WITH THE DESIGN EQUATIONS STATED IN THE STANDARDS OF THE EXPANSION JOINT MANUFACTURER'S ASSOCIATION INC., SIXTH EDITION.

CODE REQUIREMENT:	ANSI B31.3
DESIGN PRESSURE:	256 PSI
DESIGN TEMPERATURE:	266 DEG. F
BELLOWS MATERIAL:	A240-T304
ALLOWABLE STRESS:	17,000 PSI
MODULUS OF ELASTICITY:	27,304,000 PSI
WELD JOINT EFFICIENCY	0.85

DESIGN MOVEMENT CONDITIONS

COND	AXIAL	LATERAL	ANGULAR	S5	S6	CYCLES	TYP
A.	0.25 0.13	0.10 0.20	1.00 2.00	2515	179315	4780	

INSIDE DIAMETER:	7.250 IN
OUTSIDE DIAMETER:	8.500 IN
NUMBER OF CONVOLUTIONS:	14 CONS
MATERIAL THICKNESS:	0.024 IN
NUMBER OF PLIES:	2 PLIES
FREE LENGTH OVER CONVOLUTIONS:	8.75 IN
S2 (CIRCONFERENTIAL MEMBRANE STRESS DUE TO PRESSURE):	9,206 PSI
S3 (MERIDIONAL MEMBRANE STRESS DUE TO PRESSURE):	1,598 PSI
S4 (MERIDIONAL BENDING STRESS DUE TO PRESSURE):	25,051 PSI
S5 (MERIDIONAL MEMBRANE STRESS DUE TO DEFLECTION):	SEE TABLE ABOVE
S6 (MERIDIONAL BENDING STRESS DUE TO DEFLECTION):	SEE TABLE ABOVE
S t (STRESS RANGE FOR PRIMARY DESIGN CONDITION):	200,485 PSI
DESIGN CYCLE LIFE FOR PRIMARY DESIGN CONDITIONS:	3,000 CYCLES
RATED CYCLE LIFE FOR PRIMARY DESIGN CONDITION:	4,780 CYCLES
MAXIMUM DESIGN PRESSURE BASED ON SQUIRM:	361 PSI
AXIAL SPRING RATE:	1,220 LBS/IN
LATERAL SPRING RATE:	1,500 LBS/IN
ANGULAR SPRING RATE:	167 IN LBS/DEG
TORSIONAL SPRING RATE:	74,457 IN LBS/DEG
BELLOWS EFFECTIVE AREA:	49.30 SQ/IN

This is the actual temperature that was used for the bellows design. For certain special applications such as refractory lined expansion joints, the bellows is designed for a lower temperature than the media.

This is the allowable stress for the bellows material at the bellows design temperature.

This is the modulus of elasticity of the bellows material at the design temperature which is used to calculate spring rate and column squirm pressure. The room temperature modulus of elasticity is used to calculate the deflection stresses (S5 & S6).

The weld joint efficiency is 1.0 if the bellows' longitudinal weld is 100% radiographically examined in accordance with the specified code.

The design movements create the deflection stresses that determine cycle life. One complete cycle is based upon moving the bellows from the neutral length to position 1, back through the neutral length to position 2 and then back to the neutral length.

Material thickness is generally stated as the standard sheet gauge thickness.

S2 (hoop stress) is an important membrane stress that runs circumferentially around the bellows. The value must be lower than the allowable stress for the bellows' material multiplied by the bellows' longitudinal weld joint efficiency.

S4 (pressure bending) is an important bending stress that is located in the side wall of the convolution running in the longitudinal direction. It is the stress that makes a "U" shaped convolution balloon out into an omega shape. The value of (S3 + S4) must be lower than the allowable stress of the bellows' material multiplied by material strength factor which is equal to 3.0 for bellows in the as formed condition (with cold work) and 1.5 bellows in the annealed condition (without cold work).

S6 (deflection bending) is the primary bending stress influencing fatigue life. This stress runs in the longitudinal direction and is most severe in the side wall of the convolution near the crest of root. There is no upper limit on this stress. It is calculated based on elastic theory, and the value of S6 is generally far in excess of the yield strength of the bellows material. That means that a typical expansion joint bellows undergoes plastic strain during each stroke.

This is the specified cycle life expectancy value as per EJMA, ANSI B31.3 Appendix X, ASME Section VIII or ASME Section III Equations.

The bellows' effective area is the area of the bellows that creates pressure thrust when acted upon by the operating pressure. The system anchors and/or the hardware on the expansion joint must be designed to withstand pressure thrust at the operating and test conditions.

Torsional spring rate is offered for those pipe stress analysts who are inputting bellows characteristics into a pipe stress program. Bellows are not generally designed for torsional movements. But, the torsional stiffness value can affect the output of a pipe stress analysis that includes a Thorburn expansion joint.

The proposed design has this calculated cycle life at the specified conditions.

There are two types of squirm or instability that can occur for internally pressurized bellows. One is called column squirm (similar to buckling of a column) and the other is called in-plane squirm (localized plastic deformation). Thorburn calculated the maximum design pressures based on the most conservative of the two methods. The value stated on the design analysis is the predicted squirm pressure with a safety factor of 2.25.

Thorburn's spring rate calculations are based on the elastic spring rate criteria from EJMA.

THORBURN'S METAL BELLOWS DESIGN ELEMENTS

1) PRESSURE THRUST

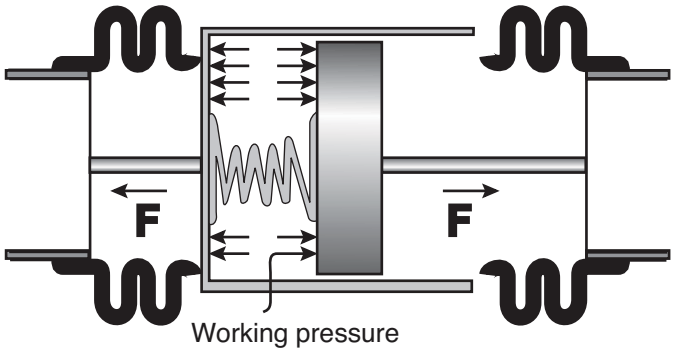
The spring represents the axial spring rate of the bellows. The hydraulic piston represents the effect of the pressure thrust which the expansion joint can exert on the piping anchors or pressure thrust restraints (hinges, Gimbals, tie rods) which may be part of the expansion joint assembly. The area of the hydraulic cylinder would be the effective area of the bellows.

Force on equipment or adjacent piping anchors "F" = (the effective area of the bellows) x (the working pressure) + (the spring rate of the bellows) x (the stroke of the bellows).

The pressure thrust force would equal (the working pressure) x (the bellows effective area).

The pressure thrust force is typically much higher than the spring force.

Expansion joints designed for lateral offset or for angular motion are more complicated to model accurately. However, the effect of pressure thrust is the same.

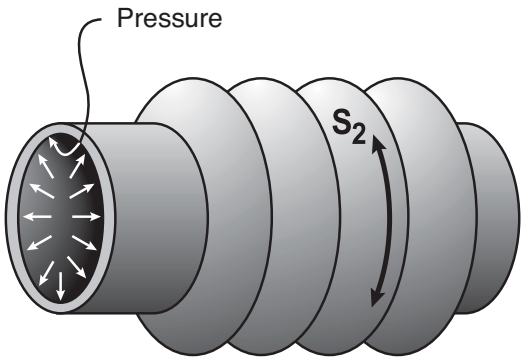


Working pressure acting on the effective area of the bellows

2) CIRCUMFERENTIAL MEMBRANE STRESS DUE TO PRESSURE S_2

The ability of a bellows to carry pressure is measured primarily by hoop stress or S_2 from the standards of the Expansion Joint Manufacturers Association (EJMA). S_2 is the stress which runs circumferentially around the bellows due to the pressure difference between the inside and the outside of the bellows.

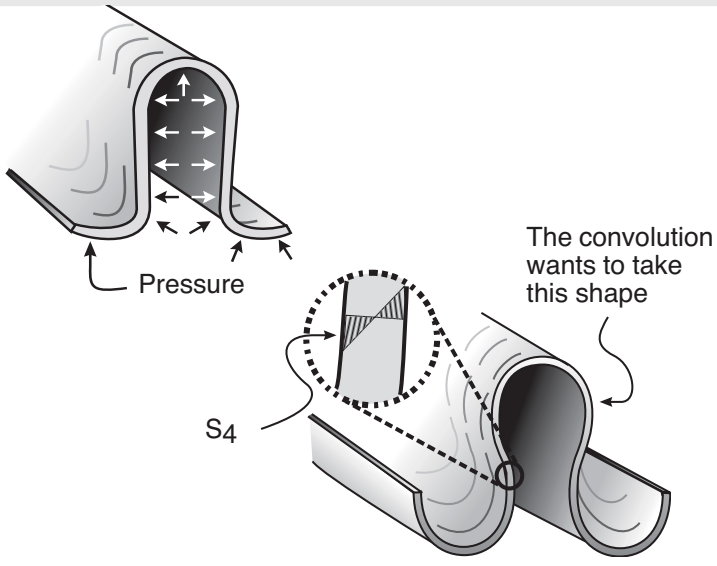
Hoop stress is what holds a bellows together like the hoops on a barrel. This stress must be held to a code stress level. The user should specify the code to be used.



3) MERIDIONAL MEMBRANE STRESS DUE TO PRESSURE S_4

The bellows ability to carry pressure is also limited by bulge stress or EJMA stress S_4. This is a stress which runs longitudinal to the bellows center line. More specifically, it is located in the bellows' side wall and it is a measure of the tendency of the bellows' convolutions to become less U-shaped and more spherical.

The value of (S3 + S4) must be lower than the allowable stress of the bellows' material multiplied by material strength factor which is equal to 3.0 for bellows in the as formed condition (with cold work) and 1.5 bellows in the annealed condition (without cold work). Accommodating a requirement for annealing will often result in the addition of reinforcing rings or a much heavier bellows material and more convolutions. It is Thorburn's standard to not anneal bellows after forming to take advantage of the added performance that is imparted to a bellows through cold work.

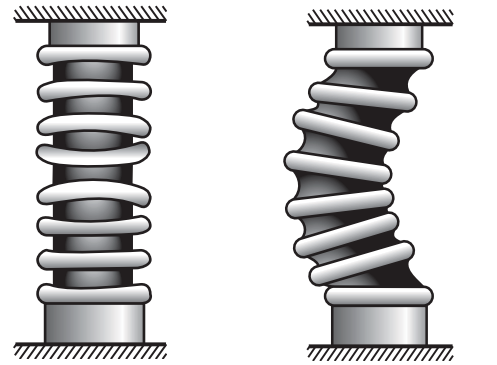


THORBURN'S METAL BELLOWS DESIGN ELEMENTS

4) BELLOWS STABILITY

Excessive internal pressure may cause a bellows to become unstable and squirm. Squirm is detrimental to bellows performance in that it can greatly reduce both fatigue life and pressure capacity. The two most common forms are column squirm and in-plane squirm. Column squirm is defined as a gross lateral shift of the center section of the bellows. It results in curvature of the bellows centerline. This condition is most associated with bellows which have a relatively large length-to-diameter ratio and is analogous to the buckling of a column under compressive load.

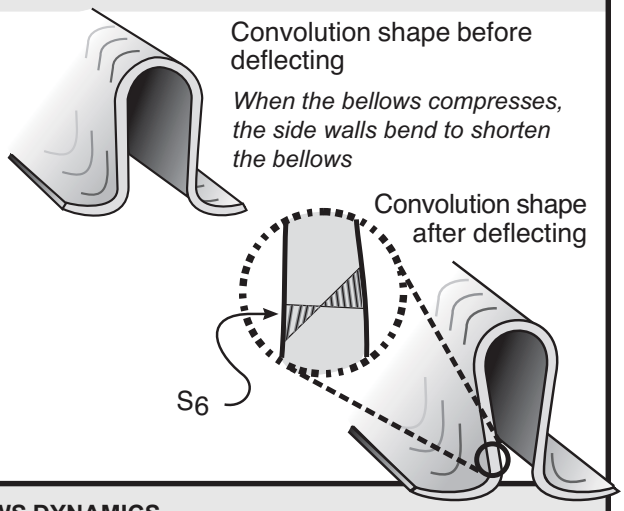
In-plane squirm is defined as a shift or rotation of the plane of one or more convolutions such that the plane of these convolutions is no longer perpendicular to the axis of the bellows. It is characterized by tilting or warping of one or more convolutions. This condition is predominantly associated with high meridional bending stress and the formation of plastic hinges at the root and crest of the convolutions. It is most common in bellows which have a relatively small length-to-diameter ratio.



5) MERIDIONAL BENDING STRESS DUE TO DEFLECTION S_6

When a bellows deflects, the motion is absorbed by deformation of the side walls of each convolution. The associated stress caused by this motion is the deflection stress or EJMA stress S_6. This stress runs longitudinal to the bellows' center line. The maximum value of S_6 is located in the side wall of each convolution near the crest or root.

Expansion joints are designed to operate with a value of S_6 which far exceeds the yield strength of the bellows material. This means that most expansion joints will take a permanent set at the rated axial or lateral motions. They are rarely designed to be elastic. This also means that the bellows will eventually fatigue after a finite number of movement cycles. It is important to specify a realistic cycle life as a design consideration when ordering an expansion joint. An overly conservative cycle life requirement can result in a bellows design that is so long and soft that it is subject to squirm failure.



DESIGN VARIABLES AS THEY AFFECT THORBURN METALLIC BELLOWS DYNAMICS

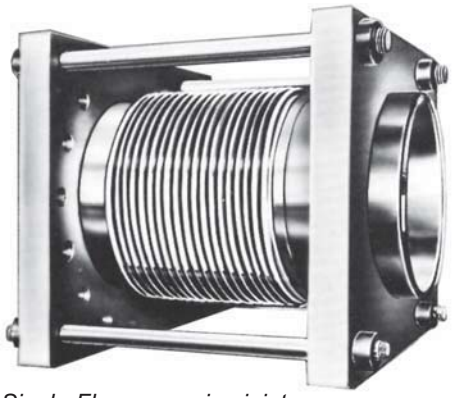
VARIATION	Stress EJMA S2	Stress EJMA S4	Deflection Stress EJMA S6	Column Squirm Pressure	In-Plane Squirm	Cycle life	Rated Axial	Rated Lateral	Rated Angular	Axial Spring Rate	Lateral Spring Rate	Angular Spring Rate	PressureThrust
Thicker Material	-(1)	-(2)	+(1)	+(3)	+(2)	-	-	-	-	+(3)	+(3)	+(3)	S
Thinner Material	+(1)	+(2)	-(1)	-(3)	-(2)	+	+	+	+	-(3)	-(3)	-(3)	S
Higher Convolute	-(1)	+(2)	-(2)	-(3)	-(2)	+	+	+	+	-(3)	-(3)	-(3)	+
Lower Convolute	-(1)	-(2)	+(2)	-(3)	+(2)	-	-	-	-	+(3)	+(3)	+(3)	-
Smaller Pitch	-(1)	+	-	-		+	+	+	+	-	-	-	S
Larger Pitch	+(1)	-	+	+		-	-	-	-	+	+	+	S
More Plies	-	-	S	+		S	S	S	S	+	+	+	S
Fewer Plies	+	+	S	-		S	S	S	S	-	-	-	S
Larger Diameter	+(1)	S	S	+		S	S	-	-	+	+	+	+
Smaller Diameter	+(1)	S	S	-		S	S	+	+	-	-	-	-
More Convolutions	S	S	-	-		+	+	+	+	-	-	-	S
Fewer Convolutions	S	S	+	+		-	-	-	-	+	+	+	S

Legend: +: Increase -: Decrease S: Same

(#) Indicates how steeply the variation affects the design variable, i.e., (1) means the change is linear; (2) means the design variable changes by the square of the variable; (3) means the design variable changes by the cube of the variable.

THORBURN EXPANSION JOINTS IN PIPING SYSTEMS

In selecting the proper Thorburn metal expansion joint to satisfy system requirements, it is essential that all the operating parameters be fully considered. The following section is presented as a guide for the piping system designer in evaluating the most significant operating requirements and how to apply them in selecting Thorburn metallic bellows expansion joints.



Typical tied Single-Flex expansion joint system with beveled ends

Typical Thorburn Metallic Expansion Joint Applications

Axial deflection applications

Figures 1 through 4 show typical applications of expansion joints to absorb axial pipeline expansion. Note the relative positions of the expansion joints, anchors and guides to achieve proper control of operating conditions.

Lateral deflection applications

Figure 5 shows a typical arrangement in which the expansion joint is installed so that the principal pipeline expansion is absorbed as lateral deflection. Figure 6 shows another typical arrangement in which the expansion joint is installed so that the principal pipeline expansion is absorbed as lateral deflection. Thorburn's thrust absorbing tie rods allow the use of intermediate anchors. Where possible, Thorburn's expansion joint should be designed to fill the entire offset leg so that its expansion is absorbed within the tie rods as axial deflection. Any expansion of the offset leg external to the tie rods must be imposed as deflection on the longer pipe legs (this displacement can be minimized by "cold springing" Thorburn's expansion joint). It should be noted that the two horizontal piping legs may lie in any angle in the horizontal plane since lateral deflection can be absorbed in any direction.

Rotational deflection applications

Figure 7 shows a typical arrangement in which Thorburn's hinged expansion joints are installed in a "Z" type plane so that the pipeline expansion is absorbed as rotational deflection. Note that the thrust absorbing hinges eliminate the need for main anchors and that Thorburn's expansion joint "B" must be capable of absorbing the sum of the rotation of expansion joints "A" and "C". Adequate guiding is necessary to maintain single plane deflection.

Just as Thorburn's hinged expansion joints may offer advantages in single plane applications, Thorburn's Gimbal expansion joints (not shown) are designed to offer similar advantages in multi-plane or "angled Z" plane systems. The Gimbal expansion joints are thrust absorbing and usually used in pairs with a Thorburn hinged expansion joint in an arrangement similar to Figure 6.

FIGURE 1

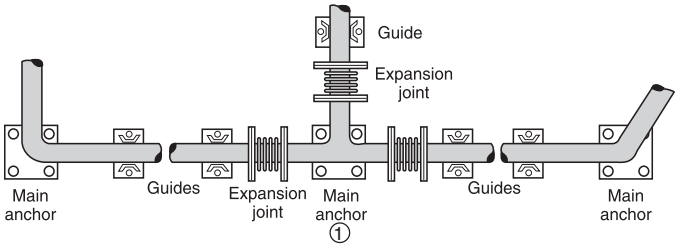


FIGURE 2

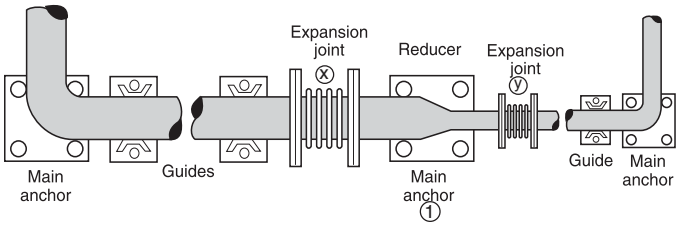


FIGURE 3

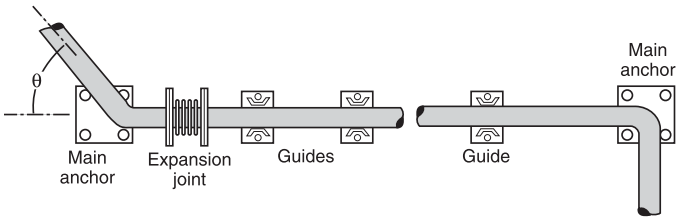
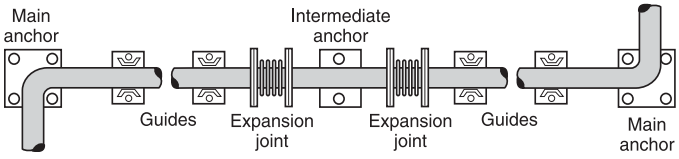


FIGURE 4



THORBURN EXPANSION JOINTS IN PIPING SYSTEMS

FIGURE 5

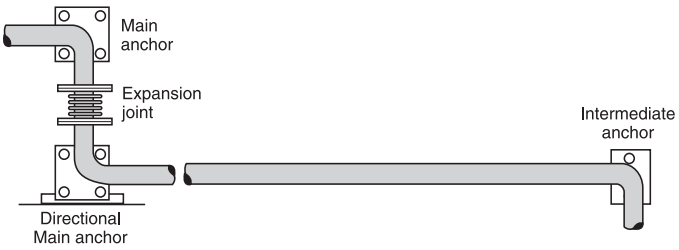


FIGURE 6

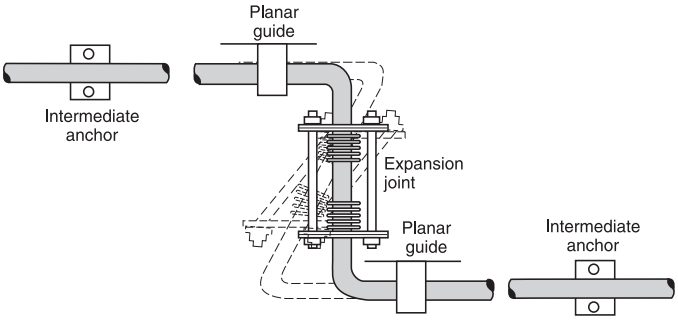
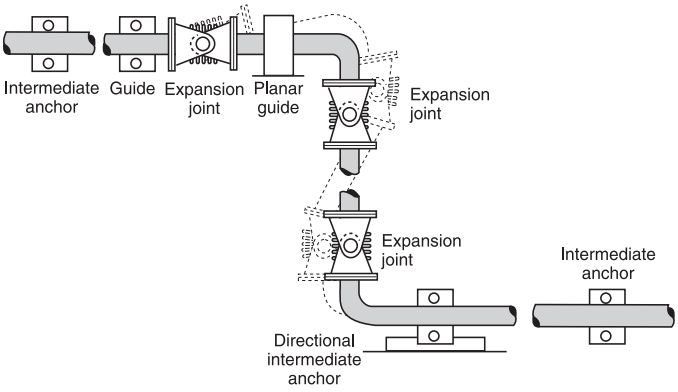


FIGURE 7



TYPICAL FORCES IN PIPING SYSTEMS

The following formulas are presented so that the significant forces created in piping sections containing Thorburn metallic expansion joints can be calculated and evaluated.

STRAIGHT PIPE SECTIONS (See Fig. 1)

$$F_{MA} = F_P + F_{EJ} + F_F$$

STRAIGHT PIPE SECTION WITH REDUCER (See Fig. 2)

$$F_{MA} = (F_{PX} - F_{PY}) + (F_{EJX} - F_{EJY}) + (F_{FX} - F_{FY})$$

CURVED PIPE SECTION (See Fig. 3)

In the case of anchors located at pipe bends or elbows, it is necessary to consider the forces imposed by the pipe sections on both sides of the anchor. These forces must be added vectorially. In addition, the effect of centrifugal force due to flow must be considered as follows:

$$F_{MA(FLOW)} = \frac{2A\rho V^2}{g} \sin\frac{\theta}{2}$$

FORCES ON INTERMEDIATE PIPE ANCHORS (See Fig. 4)

An intermediate anchor is designed to absorb forces due to expansion joint deflection and friction only. It is generally considered good practice to design the immediate anchor to resist the forces on the larger force side.

$$F_{IA} = F_{EJ} + F_F$$

LATERAL DEFLECTION (See Fig. 5 and 6)

For lateral deflection requirements it is necessary to consider, in addition to the other applicable forces, the lateral force and bending moment imposed on connecting pipe and/or equipment.

ROTATIONAL DEFLECTION (see Fig. 7)

For rotational deflection requirements it is necessary to consider, in addition to the other applicable forces, the bending moment imposed on the connecting pipe and/or equipment.

DEFINITIONS OF ACRONYMS

F_{MA}	=	force on main anchor (lbs)
F_{IA}	=	force on intermediate anchor (lbs)
F_P	=	force due to pressure (lbs) (bellows effective area x maximum pressure)
F_{EJ}	=	force due to expansion joint deflection (lbs) (axial spring rate x deflection)
F_F	=	force due to support and guide friction (lbs) (data available on request)
A	=	bellows effective area (in^2)
ρ	=	density of flowing media (lbs/in^3)
V	=	velocity of flowing media (in/sec)
g	=	acceleration due to gravity (386 in/sec^2)
θ	=	angle of pipe curve (degrees)

Note: Deflection forces, bending moments and effective areas are listed in the Expansion Joint Selection Chart (based on ANSI 321 stainless steel at +650ºF).

ANCHOR, GUIDE AND SUPPORT

GUIDELINES TO CONSIDER FOR THE INSTALLER OF THORBURN EXPANSION JOINTS

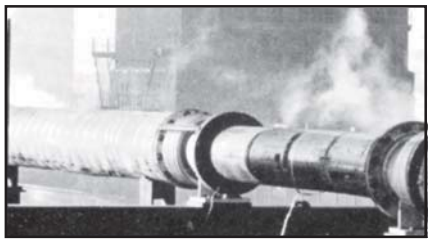
PIPE ANCHORS

Pipe anchors divide pipelines into individually expanding sections. The pipe anchors must be designed to withstand all the forces and movements imposed upon them. One Thorburn expansion joint system must be designed to provide adequate flexibility between these pipe sections' anchors.

Special note: Do not install more than one single Thorburn expansion joint between the same two anchors in any straight pipe section.

MAIN ANCHORS

A main pipe anchor must absorb the full line force due to internal pressure thrust, spring force to deflect Thorburn's bellows expansion joint, friction of pipe moving and the weight of piping acting on the anchor.



Main anchors must be installed:

a) at a change in direction of flow

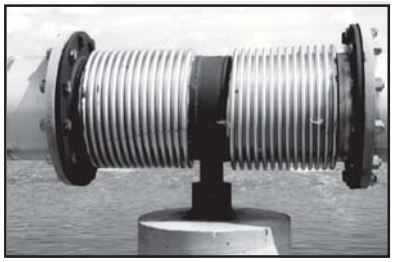
b) between two expansion joints of different sizes

c) at a side branch line containing an expansion joint

d) where shut-off valve or pressure relief valve is installed in a pipe run between two expansion joints

e) blind end of a pipe

INTERMEDIATE ANCHOR



Intermediate anchors must be designed to withstand forces and movements imposed upon them which include:

a) the force to deflect bellows

b) friction force of the piping due to guides and supports

Special note: The intermediate anchor is not intended to absorb pressure thrust as it is normally an anchor between a double bellows where the pressure thrust forces are balanced.

PIPE SUPPORTS

A pipe support permits free movement of the piping and supports only the weight of pipe and fluid. Pipe rings, U-bolts, spring hangers and rollers are examples of pipe supports but cannot be classified as pipe guides.

ANCHOR, GUIDE AND SUPPORT

GUIDELINES TO CONSIDER FOR THE INSTALLER OF THORBURN EXPANSION JOINTS

PIPE GUIDES AND GUIDING

Thorburn's bellows expansion joints are sections of flexible pipe that are specifically designed to absorb piping movement. Correct alignment of the adjoining pipe is of vital importance in the proper functioning of Thorburn's expansion joint system.

Although Thorburn expansion joints are designed and built for long and satisfactory life, maximum service will be obtained only when the pipeline has the recommended number of guides and is anchored and supported in accordance with good engineering practice.

Proper supporting of the pipeline is required not only to support the live and dead loads imposed on the line, but also to provide support for the expansion joint at each of its attachments. Pipe guides are necessary to insure proper application of movement to Thorburn's expansion joint and to prevent buckling of the line. Buckling may be caused by a combination of two things:

a) flexibility of Thorburn's expansion joint;

b) internal pressure loading on the pipe which causes it to act like a column loaded by the pressure thrust of Thorburn's expansion joint.

Typical alignment guides

PIPE ALIGNMENT GUIDE

Pipe alignment guides are primarily designed for applications involving only axial extension and compression and have a sleeve or other framework rigidly mounted to positively restrict pipeline movement to compression and extension only.

PLANAR GUIDE

Planar guides are used to restrict movement in one plane and permit movement in another plane. Such restraint is a criterion for stability of most single and universal tied joints when subject to internal pressure.

GUIDE DESIGNS

Proper design of both pipe alignment guides and planar pipe guides should allow sufficient clearance between the fixed and moving parts of the alignment guide to insure proper guiding without introducing excessive frictional forces.

Materials from which pipe alignment guides and planar pipe guides are made must provide strength and rigidity under design operating conditions and be sufficiently resistant to corrosion and wear to prevent eventual malfunction of the guide.

The first two alignment guides immediatly adjacent to each side of Thorburn's expansion joint should be circumferential to the pipe. Planar pipe guides must be designed with additional clearance in one direction to permit the intended lateral deflection and/or bending of the pipe to take place.

Typical insulated alignment guides

As in the case of pipe anchors, alignment guides can be subjected to lateral forces as high as 15% of the total axial force, and the system designer must assure himself that the guide, guide attachment and the structure to which it is attached are all designed to conservative stress levels. The design of the total guiding system must assure that no relative shifting of alignment guides and Thorburn expansion joint will occur from ground settlement or other environmental conditions.

PIPE GUIDE SPACING TABLE

Notes

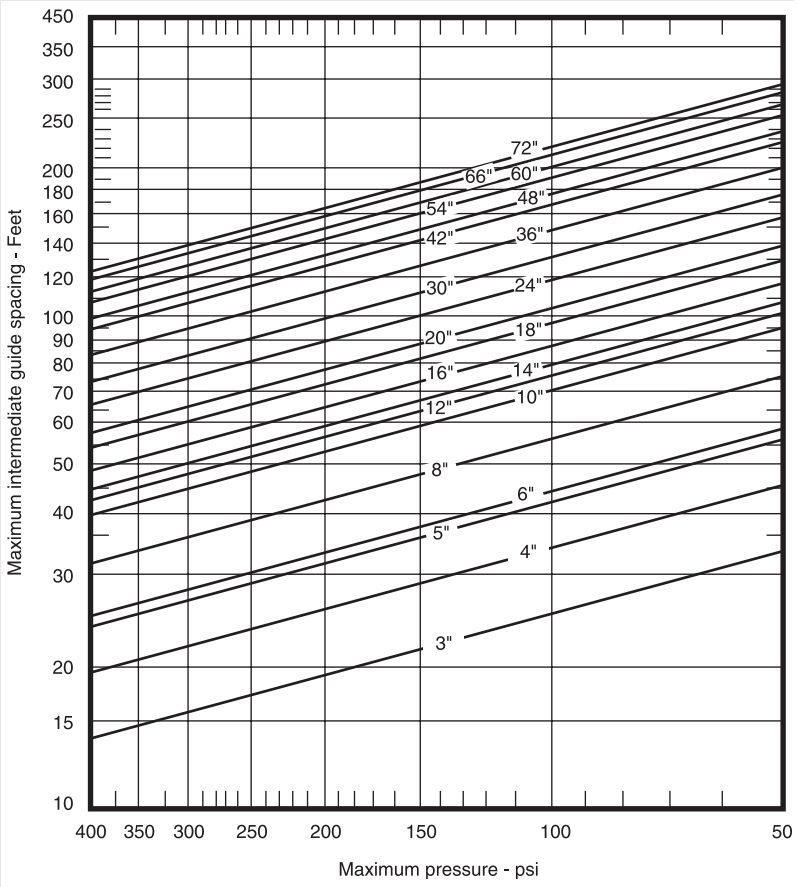
1: Thorburn recommends that for its single bellows expansion joints the first guide be located within four (4) pipe diameters from the expansion joint and the second guide be located within a distance of fourteen (14) pipe diameters from the first guide. The remaining guides are to be in accordance with the table on the right.

2: Maximum intermediate guide spacing for any pipe material or thickness may be calculated using the following formula:

$$L = 0.131 \sqrt{\frac{EI}{PA \pm \Delta R_a}}$$

Where L = Maximum intermediate guide spacing (feet)
E = Modulus of elasticity of pipe material (psi)
I = Moment of inertia of pipe (in^4)
P = Design pressure (psi)
A = Bellows effective area (in^2)
Δ = Axial stroke of expansion joint (in.)
R_a = Axial spring rate of bellows (lbs/in)

Notes:
1: When bellows is compressed in operation, use (+) ΔR_a; When extended, use (-) ΔR_a
2: Dead weight of the pipe should also be considered for guide spacing



EXPANSION JOINTS STANDARD SYMBOLS


Single


Single externally guided


Single internally guided


Single with tie rods (T) or limit rods (L)


Hinged


Gimbal

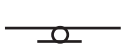

Single with intermediate anchor

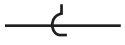

Single with main anchor


Intermediate anchor

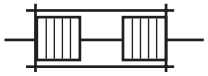

Main anchor

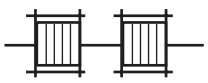

Alignment guide

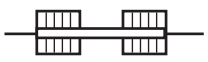

1- Roller supports

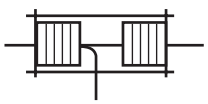

2- Spring hangers


Double


Universal


Universal with individual tie or limit rods


Swing


Pressure balanced

THERMAL EXPANSION OF PIPE DATA
(in inches per 100 feet of pipe)

Temp. Deg. F	Carbon Steel Carbon-Moly Low-Chrome (thru 3 Cr Mo)	5 Cr Mo thru 9 Cr Mo 18	Austenitic Stainless Steels Cr 8 Ni	12 Cr 17 Cr 27 Cr	25 Cr 20 Ni	Monel 67 Ni 30 Cr	3-1/2 Nickel	Aluminium	Gray Cast Iron	Bronze	Brass	Wrought Iron	70 Cu 30 Ni
-325	-2.37	-2.22	-3.85	-2.04	-3.00	-2.62	-2.22	-4.68		-3.98	-3.88	-2.70	-3.15
-300	-2.24	-2.10	-3.63	-1.92	-2.83	-2.50	-2.10	-4.46		-3.74	-3.64	-2.55	-2.87
-275	-2.11	-1.98	-3.41	-1.80	-2.66	-2.38	-1.98	-4.21		-3.50	-3.40	-2.40	-2.70
-250	-1.98	-1.86	-3.19	-1.68	-2.49	-2.26	-1.86	-3.97		-3.26	-3.16	-2.25	-2.53
-225	-1.85	-1.74	-2.96	-1.57	-2.32	-2.14	-1.74	-3.71		-3.02	-2.93	-2.10	-2.36
-200	-1.71	-1.62	-2.73	-1.46	-2.15	-2.02	-1.62	-3.44		-2.78	-2.70	-1.95	-2.19
-175	-1.58	-1.50	-2.50	-1.35	-1.98	-1.90	-1.50	-3.16		-2.54	-2.47	-1.81	-2.12
-150	-1.45	-1.37	-2.27	-1.24	-1.81	-1.79	-1.38	-2.88		-2.31	-2.24	-1.67	-1.95
-125	-1.30	-1.23	-2.01	-1.11	-1.60	-1.59	-1.23	-2.57		-2.06	-2.00	-1.49	-1.74
-100	-1.15	-1.08	-1.75	-0.98	-1.39	-1.38	-1.08	-2.27		-1.81	-1.76	-1.31	-1.53
-75	-1.00	-0.94	-1.50	-0.85	-1.18	-1.18	-0.93	-1.97		-1.56	-1.52	-1.13	-1.33
-50	-0.84	-0.79	-1.24	-0.72	-0.98	-0.98	-0.78	-1.67		-1.32	-1.29	-0.96	-1.13
-25	-0.68	-0.63	-0.98	-0.57	-0.78	-0.77	-0.62	-1.32		-1.25	-1.02	-0.76	-0.89
0	-0.49	-0.46	-0.72	-0.42	-0.57	-0.57	-0.46	-0.97		-0.77	-0.75	-0.56	-0.66
25	-0.32	-0.30	-0.46	-0.27	-0.37	-0.37	-0.30	-0.63		-0.49	-0.48	-0.36	-0.42
50	-0.14	-0.13	-0.21	-0.12	-0.16	-0.20	-0.14	-0.28		-0.22	-0.21	-0.16	-0.19
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	0.23	0.22	0.34	0.20	0.28	0.28	0.22	0.46	0.21	0.36	0.35	0.26	0.31
125	0.42	0.40	0.62	0.36	0.51	0.52	0.40	0.85	0.38	0.66	0.64	0.48	0.56
150	0.61	0.58	0.90	0.53	0.74	0.75	0.58	1.23	0.55	0.96	0.94	0.70	0.82
175	0.80	0.76	1.18	0.69	0.98	0.99	0.76	1.62	0.73	1.26	1.23	0.92	1.07
200	0.99	0.94	1.46	0.86	1.21	1.22	0.94	2.00	0.90	1.56	1.52	1.14	1.33
225	1.21	1.13	1.75	1.03	1.45	1.46	1.13	2.41	1.08	1.86	1.83	1.37	1.59
250	1.40	1.33	2.03	1.21	1.70	1.71	1.32	2.83	1.27	2.17	2.14	1.60	1.86
275	1.61	1.52	2.32	1.38	1.94	1.96	1.51	3.24	1.45	2.48	2.45	1.83	2.13
300	1.82	1.71	2.61	1.56	2.18	2.21	1.69	3.67	1.64	2.79	2.76	2.06	2.40
325	2.04	1.90	2.90	1.74	2.43	2.44	1.88	4.09	1.83	3.11	3.08	2.29	2.68
350	2.26	2.10	3.20	1.93	2.69	2.68	2.08	4.52	2.03	3.42	3.41	2.53	2.96
375	2.48	2.30	3.50	2.11	2.94	2.91	2.27	4.95	2.22	3.74	3.73	2.77	3.24
400	2.70	2.50	3.80	2.30	3.20	3.25	2.47	5.39	2.42	4.05	4.05	3.01	3.52
425	2.93	2.72	4.10	2.50	3.46	3.52	2.69	5.83	2.62	4.37	4.38	3.25	
450	3.16	2.93	4.41	2.69	3.72	3.79	2.91	6.28	2.83	4.69	4.72	3.50	
475	3.39	3.14	4.71	2.89	3.98	4.06	3.13	6.72	3.03	5.01	5.06	3.74	
500	3.62	3.35	5.01	3.08	4.24	4.33	3.34	7.17	3.24	5.33	5.40	3.99	
525	3.86	3.58	5.31	3.28	4.51	4.61	3.57	7.63	3.46	5.65	5.75	4.25	
550	4.11	3.80	5.62	3.49	4.79	4.90	3.80	8.10	3.67	5.98	6.10	4.50	
575	4.35	4.02	5.93	3.69	5.06	5.18	4.03	8.56	3.89	6.31	6.45	4.76	
600	4.60	4.24	6.24	3.90	5.33	5.46	4.27	9.03	4.11	6.64	6.80	5.01	
625	4.86	4.47	6.55	4.10	5.60	5.75	4.51		4.34	6.96	7.16	5.27	
650	5.11	4.69	6.87	4.31	5.88	6.05	4.75		4.57	7.29	7.53	5.53	
675	5.37	4.92	7.18	4.52	6.16	6.34	4.99		4.80	7.62	7.89	5.80	
700	5.63	5.14	7.50	4.73	6.44	6.64	5.24		5.03	7.95	8.26	6.06	
725	5.90	5.38	7.82	4.94	6.73	6.94	5.50		5.26	8.28	8.64	6.32	
750	6.16	5.62	8.15	5.16	7.02	7.25	5.76		5.50	8.62	9.02	6.59	
775	6.43	5.86	8.47	5.38	7.31	7.55	6.02		5.74	8.96	9.40	6.85	
800	6.70	6.10	8.80	5.60	7.60	7.85	6.27		5.98	9.30	9.78	7.12	
825	6.97	6.34	9.13	5.82	7.89	8.16	6.54		6.22	9.64	10.17	7.40	
850	7.25	6.59	9.46	6.05	8.19	8.48	6.81		6.47	9.99	10.57	7.69	
875	7.53	6.83	9.79	6.27	8.48	8.80	7.08		6.72	10.33	10.96	7.97	
900	7.81	7.07	10.12	6.49	8.78	9.12	7.35		6.97	10.68	11.35	8.26	
925	8.08	7.31	10.46	6.71	9.07	9.44	7.72		7.23	11.02	11.75	8.53	
950	8.35	7.56	10.80	6.94	9.37	9.77	8.09		7.50	11.37	12.16	8.81	
975	8.62	7.81	11.14	7.17	9.66	10.09	8.46		7.76	11.71	12.57	9.08	
1000	8.89	8.06	11.48	7.40	9.95	10.42	8.83		8.02	12.05	12.98	9.36	
1025	9.17	8.30	11.82	7.62	10.24	10.75	8.98			12.40	13.39		
1050	9.46	8.55	12.16	7.95	10.54	11.09	9.14			12.76	13.81		
1075	9.75	8.80	12.50	8.18	10.83	10.43	9.29			13.11	14.23		
1100	10.04	9.05	12.84	8.31	11.12	11.77	9.45			13.47	14.65		
1125	10.31	9.28	13.18	8.53	11.41	12.11	9.78						
1150	10.57	9.52	13.52	8.76	11.71	12.47	10.11						
1175	10.83	9.76	13.86	8.98	12.01	12.81	10.44						
1200	11.10	10.00	14.20	9.20	12.31	13.15	10.78						
1225	11.38	10.26	14.54	9.42	12.59	13.50							
1250	11.66	10.53	14.88	9.65	12.88	13.86							
1275	11.94	10.79	15.22	9.88	13.17	14.22							
1300	12.22	11.06	15.56	10.11	13.46	14.58							
1325	12.50	11.30	15.90	10.33	13.75	14.94							
1350	12.78	11.55	16.24	10.56	14.05	15.30							
1375	13.06	11.80	16.58	10.78	14.35	15.66							
1400	13.34	12.05	16.92	11.01	14.65	16.02							
1425			17.30										
1450			17.69										
1475			18.08										

This data is for information purposes only and does not imply that materials are suitable for all the temperatures shown.

TYPICAL DESIGN SPECIFICATIONS FOR THORBURN METALLIC BELLOWS TYPE EXPANSION JOINTS

INTRODUCTION

- To provide a sample specification for the fabrication, inspection and shipping of metallic bellows type expansion joints. Certain optional procedures are shown and will be followed when specified.

DATA REQUIRED

Size _____ Qty _____ Dimension limits _____

Axial Motion (Compression) _____ Extension _____

Lateral Motion _____

Angular Motion _____

Design Pressure (Internal) _____ (External) _____

Design Temperature _____ ºF or ºC

Cycle Life _____

BELLOWS ELEMENT

- Manufactured from large sheets producing longitudinal welds only. All welds planished to within 3% of parent metal thickness. Material thickness of sheet to be within commercial tolerances.

MATERIALS

- Bellows – T.321 stainless steel is standard. Readily available in T.316, T.304, Monel, Inconel, Incoloy, Hasteloy, etc. in thicknesses to .187". Materials shall be free from imperfections that would interfere with the purpose designed.
- All materials to meet ASM or ASME Code Section II if applicable.

DESIGN

- Expansion joints are designed to meet known requirements of EJMA, ASME B31.3 Appendix X or ASME Section VIII if applicable.
- The expansion joint shall be free of all control devices such as self-equalizing rings.

DRAWINGS

- The approval drawing shall show all principal dimensions including the number, size and thickness of bellows, location and type of welds (optional).
- The drawing shall list the movement, pressure and temperature rating, materials, test pressure, order number and project name (optional).

HEAT TREATMENT

- When specified, heat treatment will be performed.

WELDING

- Unless otherwise specified, the welding procedures and welders shall be qualified to Section IX of the ASME Boiler and Pressure Vessel Code for all pressure containing welds.
- Longitudinal welds in bellows and transition pieces shall conform to ASME Section VIII and Section IX (optional).
- Welding of bellows to transition pieces shall be to Code Case 1177.7 (optional).

TYPICAL DESIGN SPECIFICATIONS FOR THORBURN METALLIC BELLOWS TYPE EXPANSION JOINTS

INSPECTION

- The expansion joint is inspected to meet designated requirements.
- A partial data report shall be produced per ASME Section VIII and Code Case 1177.7 (optional).
- All pressure butt welds shall be subjected to a liquid penetrant examination by experienced operators in the presence of an authorized inspector (optional).
- All longitudinal seams of bellows and transition pieces shall be radiographed per ASME Section V (optional).
- Certificate of compliance will be forwarded on completion of project (optional).

TESTING

- All pressure welds shall be leak tested by either liquid penetrant examination to ASME Section V or internal pressure test.
- The expansion joint shall be hydrostatically tested to 1.5 times the operating pressure (or design pressure). Hydrostatic tests include the testing of the rods and attachments when they are an integral part of the expansion joint (optional).

REPORTS AND RECORDS

- Applicable records listed below will be kept available for examination by the purchaser's inspector.
  - Welding procedure specifications
  - Operators' welding qualification test results
  - Radiographic films (optional)
  - Certified mill test reports (optional)
  - A partial data report (optional)
- A clear indication of records, reports, inspection and tests required shall be stated at the time of placing purchase order.

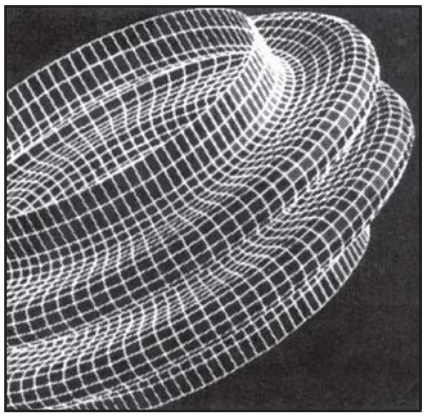
MARKING

- Each expansion joint will have attached to it the Thorburn stainless steel nameplate, showing our Company name and address, pressure rating and temperature rating.
- Expansion joints with flow liners will have a flow direction arrow painted visibly on the unit.
- Markings indicating P.O. number, project number, part number and customer coding if required must be specified (optional).

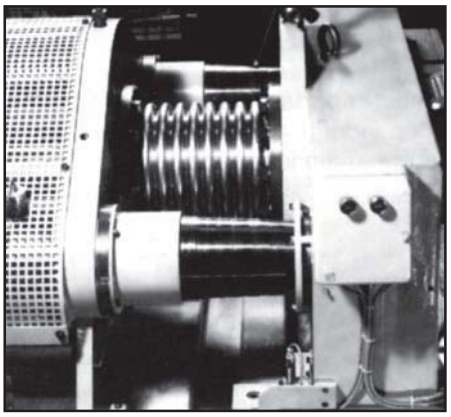
SHIPPING

- Expansion joints will be supplied with shipping bars and positioning devices for holding the joint in the required installation position during shipping and erection. These will be painted yellow and tagged with instructions for removal after installation.
- Standard protective paint will be applied to all surfaces unless otherwise specified. The bellows shall not be painted.
- Expansion joints will be supplied on skids, or loaded and blocked as deemed necessary for shipping.
- Protective coatings, coverings, end protection and special packaging may be provided as optional.
- The following "Installation Instruction Tag" will be on each expansion joint.

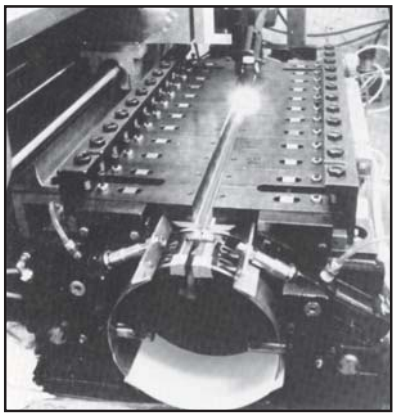
THORBURN'S METALLIC EXPANSION JOINTS SALIENT BUILDING PROCESS



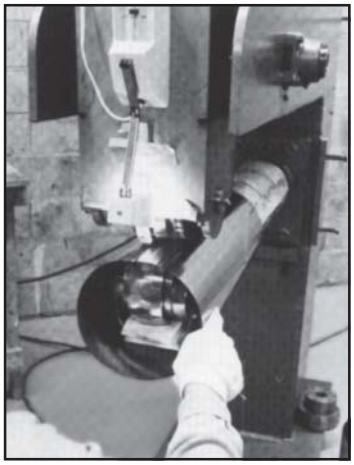
Developing designs using state-of-the-art finite engineering analysis



Verifying bellows designs through movement testing



Longitudinal seam welding after rolling tube



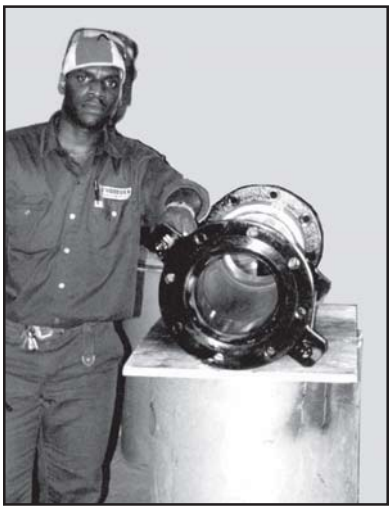
Planishing an Inconel welded tube for nuclear service

Thin-walled, cylindrical pipe, with longitudinal seam weld conforming to ASME Section II Materials and Section III Nuclear Design

Hydro forming bellows from a metallic tube for nuclear ASME Section III service

Thorburn's bellows designs conforming to EJMA 5th and 6th Edition and ASME Section III and VIII, Boiler and Pressure vessel requirements

Thorburn welders and welding procedures to ASME Section III, VIII and IX

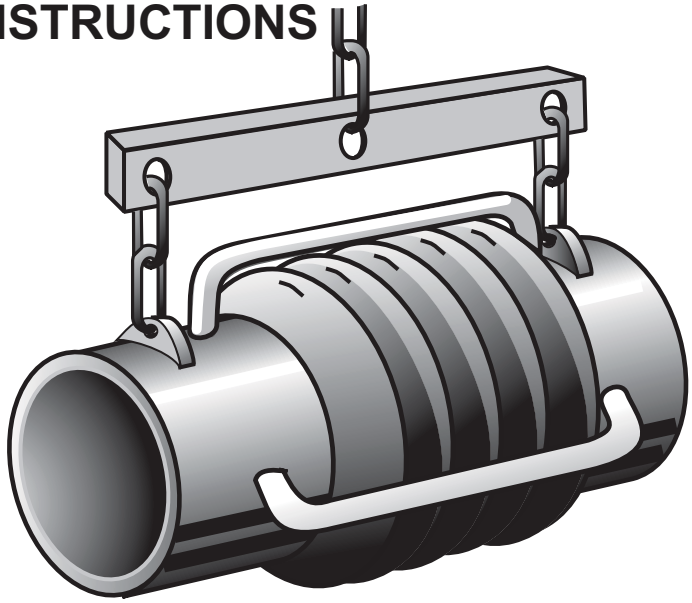


The finished product before packaging and assembling

SPECIFICATION DATA SHEET
THORBURN'S METAL BELLOWS EXPANSION JOINT

Customer Name				Date		Page	
Office Location				Inquiry/Job#			
Project Name				Location		Specification # or Applicable Code	
Prepared by Phone				Approved by		Phone	
DESIGN DATA		EJ# or Tag#		EJ# or Tag#		EJ# or Tag#	
Specification is in compliance with EJMA Safety Recommendations – yes or no							
QUANTITY REQUIRED							
NOMINAL DIAMETER (in.)							
Style of Expansion Joint e.g. Gimbal, Tied Universal, Single, etc.							
Type of Ends on Joint CC Collar WW Weld ends FF Flange ends VV Van stone flanges FW Flange weld ends VW Van stone weld ends	ENDS	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
	THICKNESS/FLANGE RATING						
	MATERIAL SPEC.						
WELD END PREPARATION Bevel/Angle or Square Cut							
Temperature Degrees Fahrenheit	System Design Temperature						
	Maximum Operating Temperature						
	Lowest Temperature Joint Will See						
	Installation Temperature						
Pressure psi	Design External or Internal						
	Operating						
	Maximum Test						
FLOW MEDIA/ENVIRONMENT							
BELLOWS MATERIAL							
CYCLING DATA MOVEMENT CONDITIONS AND ALLOWABLE BELLOWS SPRING FORCES Installation Misalignment 1 cycle	CYCLES	1		1		1	
	AXIAL MVMT	in.		in.		in.	
	LATERAL MVMT	in.		in.		in.	
	ANGULAR MVMT						
Total System Start-Up Cycles	CYCLES						
	AXIAL SPRING RATE	in./lbs.		in./lbs.		in./lbs.	
	LATERAL SPRING RATE	in./lbs.		in./lbs.		in./lbs.	
	ANGULAR SPRING RATE						
Operating Fluctuation Cycles	CYCLES						
	AXIAL MVMT	in.		in.		in.	
	LATERAL MVMT	in.		in.		in.	
	ANGULAR MVMT						
VIBRATION Frequency/Amplitude		F	A	F	A	F	A
FLOW VELOCITY (feet/sec.)							
INTERNAL FLOW LINER - Specify Material							
ENVELOPE Minimum I.D./Maximum O.D.		I.D.	O.D.	I.D.	O.D.	I.D.	O.D.
COVER - Specify Material							
OVERALL LENGTH Maximum or Required							
INSTALLATION POSITION Horizontal Vertical							

INSTALLATION INSTRUCTIONS



Thorburn expansion joints are fully inspected at the factory and are packaged to arrive at the job site in good condition. Please, immediately upon receipt at the job site, verify that there is no freight damage (i.e. dents, broken hardware, loose shipping bars, etc.).

Because the bellows expansion joint is required to absorb thermal and/or mechanical movements, the bellows element must be constructed of a relatively thin gauge material. This requires special installation precautions. The following steps should be taken prior to installation of the expansion joint into the pipeline or duct.

1. The opening into which the expansion joint will be installed should be examined to verify that the opening for which the expansion joint was designed does not exceed the installation tolerances designated by the designer and/or purchaser. If the opening exceeds the tolerance, notify Thorburn at once for a disposition.
2. The attachment edges of the pipe or duct should be smooth, clean and parallel to each other.
3. The area around the expansion joint should be cleared of any sharp objects or protusions. If not removable, they should be noted so they can be avoided.
4. Expansion joints provided with lifting lugs should be lifted only by the designated lifting lugs. ***Shipping bars (painted yellow) are not designed to be lifting devices. Never use a chain or any other handling devices directly on the bellows element or bellows cover.*** For expansion joints not provided with lifting lugs (i.e. less than 500 lbs.), the best lifting method should be evaluated at the time of installation.
5. The shipping bars are installed on an expansion joint to maintain shipping length and give the expansion joint stability during transit and installation. ***Do not remove the shipping bars until the installation is complete***.

INSTALLATION

The following precautions must be taken when installing an expansion joint.

1. Remove any protective covering from the ends of expansion joint. Plywood covers may have been used to protect flanges or weld ends. Check inside expansion joint for dessicant bags or any other material.
2. When a flow liner is installed in the expansion joint, orient the expansion joint with ***flow arrow pointing in direction of flow***.
3. Using lifting lugs, lift joint to desired location and position into pipeline or ducting.
4. Weld end expansion joints:
   a) ***Prior to welding, cover the bellows element with a chloride free fire retardant cloth***. This is to prevent arc strikes, weld splatter, etc. from damaging the bellows element.
   b) Using the proper electrode, weld the expansion joint to adjacent piping. ***Do not use bellows to correct for misalignment of piping unless this has been considered in the design of the expansion joint***.
5. Flanged end expansion joints:
   a) Orient expansion joint flanges so that the bolt holes are aligned with the mating flanges. ***Do not force the expansion joint to match the bolt holes of the mating flange***. This causes torsion on the bellows and will severely reduce the bellows capability during operation and may cause premature failure of the expansion joint. It is good practice to leave one pipe flange loose until the expansion joint is installed or to purchase an expansion joint with a flange that will rotate.
   b) Install gaskets and bolt to the required torque recommended by the flange manufacturer.

SAFETY AND DESIGN RECOMMENDATIONS

Thorburn expansion joints are employed in piping systems to absorb differential thermal expansion while containing the system pressure. They are being successfully utilized in refineries, chemical plants, fossil and nuclear power systems, heating and cooling systems, and cryogenic plants. Typical service conditions have ranged from pressures of 25 microns to 1000 psi and -420ºF to +2100ºF. Therefore, Thorburn expansion joints fall into the category of a highly engineered product. Thorburn expansion joints cannot and should not be purchased and used as commodity items if they are to perform their intended function safely and reliably. The system operating characteristics and Thorburn's expansion joints design, installation, test and operating procedures must all be considered.

Unlike most commonly used components, Thorburn's expansion joint bellows is constructed of relatively thin gauge material in order to provide the flexibility needed to absorb mechanical and thermal movements expected in service. This requires design, manufacturing quality, handling, installation and inspection procedures which recognize the unique nature of the product.

In general, the most reliable and safe bellows expansion joint installations have always involved a high degree of understanding between the user and Thorburn. With this basic concept in mind, this section was prepared in order to better inform the user of those factors which many years of experience have shown to be essential for the successful installation and performance of piping systems containing bellows expansion joints.

AFTER INSTALLATION BUT PRIOR TO HYDROSTATIC TEST

1. Inspect entire system to insure that anchors, guides and pipe supports are installed in strict accordance with piping system drawings. A pipe guide spacing chart is provided on page 20 to aid in this check.
2. ***Anchors must be designed for the test pressure thrust loads***. Expansion joints exert a force equal to the test pressure times the effective area of the bellows during hydrostatic test. Pressure thrust at design pressure may be found on the individual drawings.
3. If the system media is gaseous, check to determine if the piping and/or the expansion joint may require additional temporary supports due to the weight of water during testing.
4. ***Remove shipping bars (painted yellow) prior to hydrostatic testing***. Shipping bars are not designed for hydrostatic pressure thrust loads.
5. Hydrostatically test pipeline and expansion joint. ***Only chloride free water should be used for hydrostatic test*** (published reports indicate chloride attack as low as 3 ppm). Water should not be left standing in the bellows.

General Precautions

1. Cleaning agents, soaps and solvents may contain chlorides, caustics or sulfides and can cause stress corrosion which appears only after a bellows is put into service.
2. Wire brushes, steel wool and other abrasives should not be used on the bellows element.
3. Hydrostatic test pressure should not exceed 1 1/2 times the rated working pressure unless the expansion joint was specifically designed for this test pressure.
4. Some types of insulation leach chlorides when wet. Only chloride free insulation materials should be used for insulating an expansion joint.

THORBURN'S WARRANTY IS VOID UNLESS THE ABOVE INSTRUCTIONS ARE FOLLOWED

METALLIC BRAIDED FLEX CONNECTORS

PIPELINE MISALIGNMENT ABSORPTION, LATERAL DEFLECTION AND VIBRATION

Thorburn's braided Flex-Connectors are designed to provide isolation of the equipment from line stress and permit limited lateral offset which may be created by pipeline agitation or thermal induced movement.

Thorburn "PC" Pump Connectors

TYPICAL APPLICATIONS

■ Riser connections ■ Pumps ■ Compressors ■ Cooling towers

- Absorbs and isolates troublesome pipeline vibrations
- Smooths out force-pump system pulsations
- Tranquillizes jittering compressor pipelines
- Also absorbs pipeline expansion, compensates for misalignment, eliminates piping stresses
- Ends costly failure and downtime caused by pipeline vibration transmissions
- Customized to solve your vibration problem

Pressure/Temperature Factor Chart	
70°F/21°C	1.00
200°F/93°C	0.94
300°F/148°C	0.88
400°F/204°C	0.83

Note: For safe working pressures above 70°F/21°C, multiply pressure shown at 70°F/21°C times the correct factor of required temperature (see Pressure/Temperature Factor Chart).

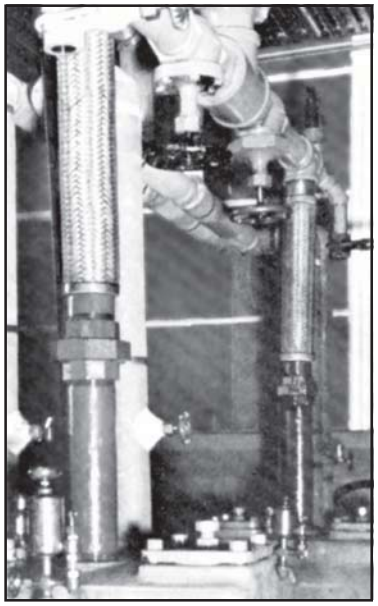
Higher pressure ranges, other end connections and different materials available. See Thorburn's Metal Hose Assembly catalogue or contact Thorburn for more details.

Model PC9614P

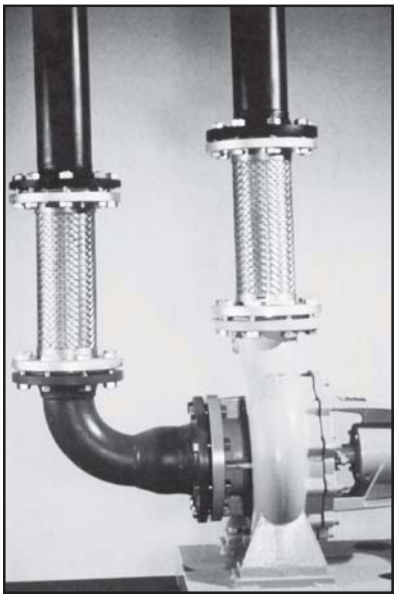
Plate Flanged #150

Model PC9601

Male NPT threaded



Typical threaded/welded in place connector



Typical flanged pump connector

Other typical end styles available

Female union

Van Stone swivel flange

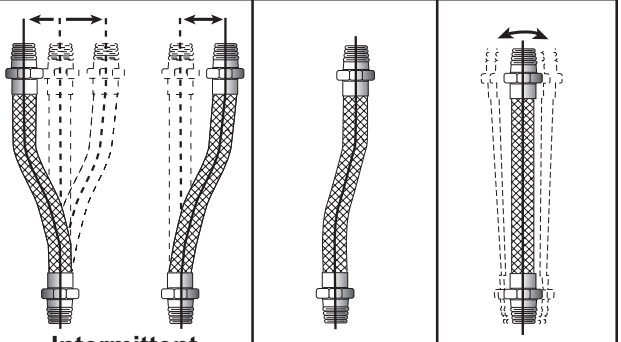
Weld neck or slip-on forged flanges

Model PC9614

Butt welded in place

Intermittent pipe travel
Refer to chart for maximum movement on each side of center line. For more than recommended maximum movement offset on the opposite side of the center line, install at right angle to movement or increase connector's length. Contact Thorburn for details.

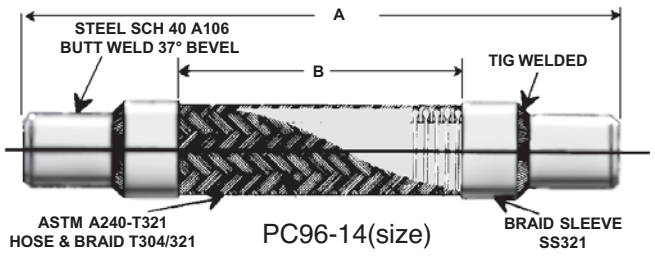
TYPES OF OFFSET MOTION FOR THORBURN CONNECTORS



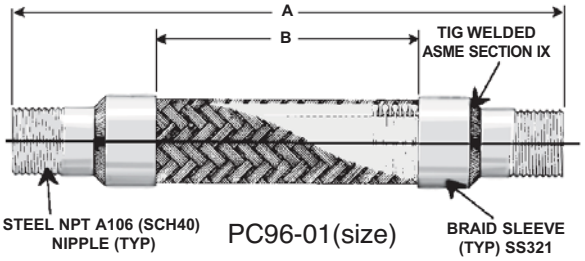
Intermittent Pipe Movement | **Misalignment** | **Vibration**

SPECIFICATIONS

THORBURN "PC" STAINLESS STEEL PUMP/ COMPRESSOR CONNECTOR NPT..0 WELDED



PC96-14(size)



PC96-01(size)

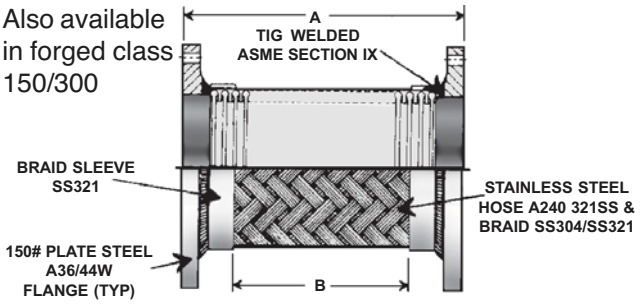
Thorburn number	Nominal Size I.D.		Length A		Length B		Pressure @ 70ºF/21ºC		Maximum offset		Approx. weight	
	in.	mm.	in.	mm.	in.	mm.	psi	kPa	in.	mm.	lbs.	kg.
PC96XX08	0.50	15	13.00	330	7.00	178	850	5860	0.50	12	0.50	0.20
PC96XX12	0.75	20	13.00	330	7.00	178	650	4481	0.50	12	0.75	0.30
PC96XX16	1.00	25	14.00	356	8.00	203	575	3964	0.50	12	1.00	0.40
PC96XX20	1.25	32	14.00	356	8.00	203	450	3102	0.50	12	1.50	0.60
PC96XX24	1.50	40	14.00	356	8.00	203	325	2241	0.50	12	2.00	0.90
PC96XX32	2.00	50	15.00	381	9.00	229	275	1896	0.50	12	2.50	1.10
PC96XX40	2.50	65	16.00	406	10.00	254	200	1379	0.50	12	3.50	1.50
PC96XX48	3.00	80	17.00	432	11.00	279	200	1379	0.50	12	5.00	2.20

XX= insert 01 for male NPT and 14 for weld ends

THORBURN "9617P" FLANGED PUMP CONNECTOR

Also available in ANSI B16.5 Class 150/300 plate and forged in carbon steel and stainless steel.
Part # forged 150: PC9617(size)
Part # forged 300: PC9617X(size) X=300lb
Part # 300# plate: PC9617PX X=300lb drilling
Higher pressure ratings.

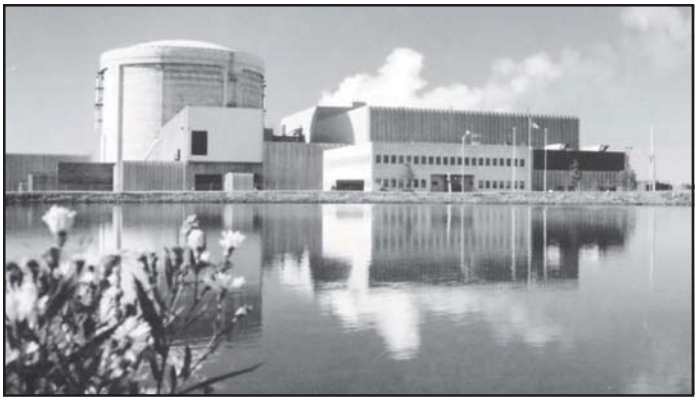
Also available in forged class 150/300



Thorburn number	Nominal Size I.D.		Length A		Length B		Pressure @ 70ºF/21ºC		Maximum offset		Approx. weight	
	in.	mm.	in.	mm.	in.	mm.	psi	kPa	in.	mm.	lbs.	kg.
PC9617P16	1.00	25	11.00	279	8.00	203	200	1379	0.50	12	8	3.60
PC9617P20	1.25	32	11.00	279	8.00	203	200	1379	0.50	12	10	4.50
PC9617P24	1.50	40	11.00	279	8.00	203	200	1379	0.50	12	14	6.40
PC9617P32	2.00	50	12.00	305	9.00	229	200	1379	0.50	12	16	7.27
PC9617P40	2.50	65	14.00	356	10.00	254	200	1379	0.50	12	19	8.60
PC9617P48	3.00	80	14.00	356	11.00	279	200	1379	0.50	12	22	10.00
PC9617P56	3.50	90	14.00	356	11.00	279	200	1379	0.50	12	25	11.30
PC9617P64	4.00	100	15.00	381	12.00	305	200	1379	0.50	12	29	13.10
PC9617P80	5.00	125	20.00	508	16.00	406	200	1379	0.50	12	38	17.30
PC9617P96	6.00	150	21.00	533	17.00	432	200	1379	0.25	6	42	19.00
PC9617P128	8.00	200	23.00	584	19.00	483	200	1379	0.25	6	74	33.60
PC9617P160	10.00	250	25.00	635	21.00	533	150	1034	0.25	6	90	40.90
PC9617P192	12.00	300	27.00	676	23.00	584	150	1034	0.25	6	100	45.50

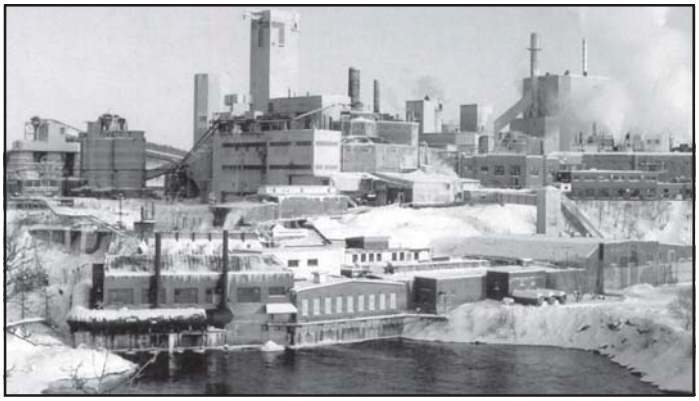
TYPICAL APPLICATIONS FOR THORBURN'S PIPING EXPANSION JOINT SYSTEMS

NUCLEAR



F/C annulus seal bellows, main steam-line, penetration seal bellows, CWC & RSW large diameter piping lines

PULP AND PAPER PROCESSING



White water lines, pump station lines, steam transfer lines

COGENERATION

Steam turbine supply lines, condenser and chilled water lines

MUNICIPAL/COMMERCIAL

Pump stations, high pressure steam heating systems, condenser and chilled water lines

MARINE / OFFSHORE

Steam piping, compression discharge lines, decompression chamber found in submarines

PETROCHEMICAL / HEAVY METAL PROCESSING

Hot shell refactory piping, LNG service, sulfuric acid production, nitric acid, heat exchange

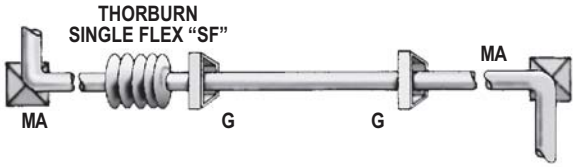
SINGLE-FLEX MODEL "SF"
SINGLE BELLOWS EXPANSION JOINT SYSTEM

Thorburn's Single-Flex metallic bellows are specifically designed for piping applications requiring limited absorbtion of axial and lateral movements. Where small thermal movements are involved and proper anchoring and guiding is feasable, Thorburn's Single-Flex "SF" series expansion joint system provides the most economical installation. Single-Flex is the base member of Thorburn metal expansion joint family, consisting of a bellows element and end fittings.

Shown Thorburn Single-Flex "SF" series unrestrained single metallic bellows expansion joint system.

TYPICAL APPLICATIONS

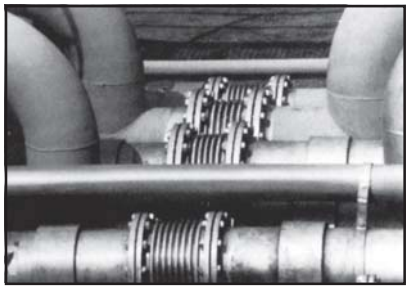
The most common application for Thorburn's Single-Flex expansion joint is to absorb axial movements of straight pipe between main anchors.



Shown typical installation for Thorburn's Single-Flex expansion joint system.

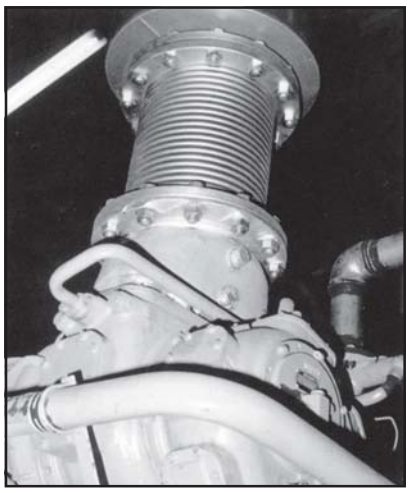
Single-Flex "SF" should be placed near one anchor and guides should be used to assume proper alignment and movement control. Each anchor must be designed to restrain the full pressure thrust of the expansion joint.

Typical pump station with a single bellows expansion joint system with control rods.



TEFLON LINED BELLOWS

Shown, special single bellows expansion joints with internal teflon liner (special design) for residue-free drainage of the filling pipes of a chemical tanker.

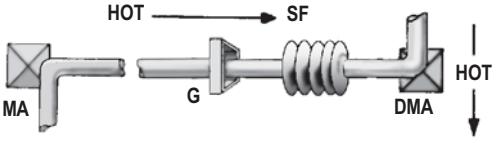


DIESEL EXHAUST

Typical application would be diesel power for oil rigs, work boats, auxiliary power, primary power and pleasure boats.

Thorburn Single-Flex expansion joint is located in the center of the piping run and each single bellows absorbs the axial movement of the section of piping in which it is located. Thorburn Single-Flex expansion joints are also used to absorb small amounts of lateral movement. A directional main anchor must be used to absorb the pressure thrust.

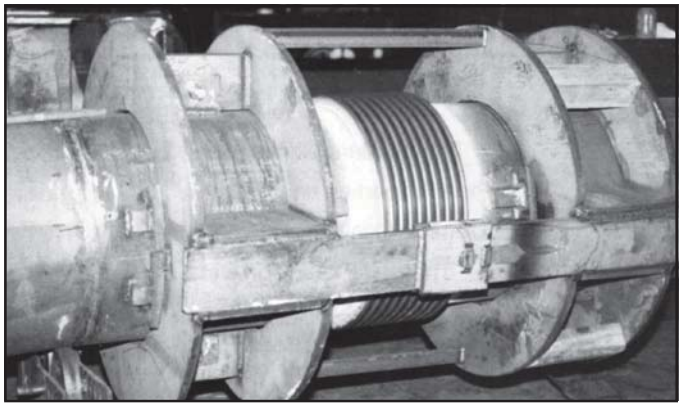
MA:	Main Anchor
DMA	Directional Main Anchor
PG:	Planar Guide
G:	Guide
SF	Single Expansion Joint



HING-FLEX SERIES "HF"
HINGED EXPANSION JOINT SYSTEM

Thorburn's Hing-Flex joints are typically used in sets of two or three, to absorb pipe movement in one or more directions in a single plane piping system. Each individual joint in the system is restricted to pure angular rotation by its hinges. However, each pair of hinged joints, separated by a section of piping, will act together to absorb lateral deflection in much the same manner as Thorburn's Dual-Flex universal expansion joint in a single plane application.

Thorburn's Hing-Flex hinges are designed to restrain the full pressure thrust of the expansion joint and may be designed to support the weight of piping and equipment, absorb thermal loads, wind loads and other external forces. Thorburn Hing-Flex system permits large movements to be absorbed with minimal anchor forces.

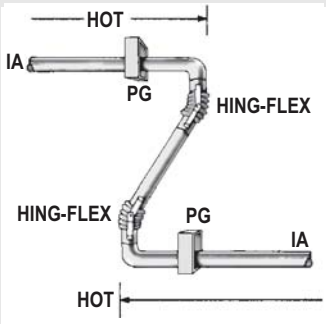


Thorburn Hing-Flex is a single expansion joint designed to permit angular rotation in one plane only by the use of a pair of pins through hinge plates attached to the expansion joint ends.

FEATURES

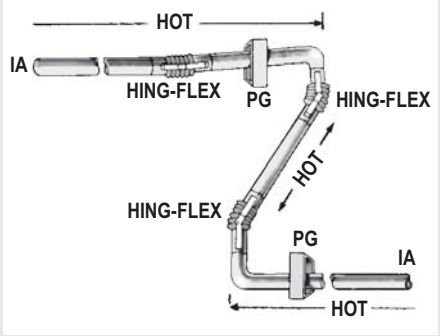
- Angular motion in one plane only
- Positive control over movement
- Eliminates pressure thrust forces
- Transmits external loads
- Supports dead weight
- Prevents torsion on bellows
- No main anchors required
- Minimum guiding required
- Low forces on piping system

Typical Thorburn Triple Hing-Flex system

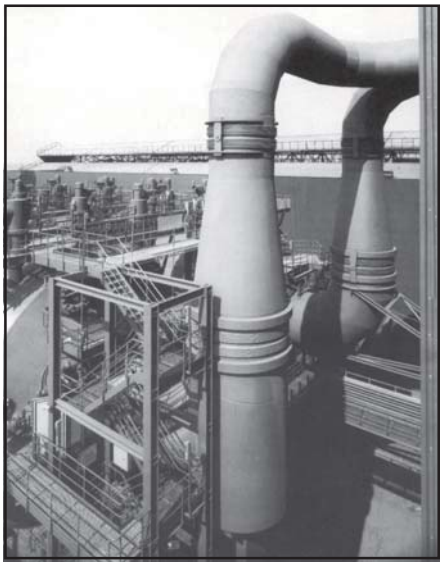


Thorburn's two hinge system will absorb thermal expansion in one plane as the expansion joints are restricted to angular rotation only and cannot extend or compress. This system relies on the bending deflections of the long horizontal piping legs to absorb the growth in the offset leg. Allow adequate clearance in the (PG) planar guides.

IA = Intermediate Anchor
G = Guide
PG = Planar Guide



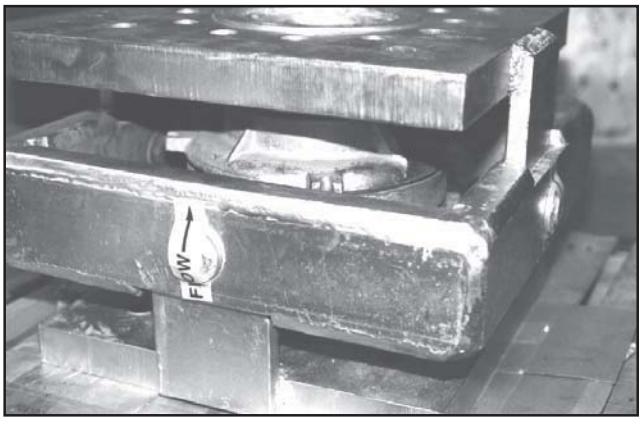
Thorburn's three hinge system is used where sufficient flexibility is not available in the long piping legs of a two hinge system. It is evident that the added hinge expansion will permit the necessary added angular rotation. Additional planar guides may be required to relieve the hinges of bending forces which may be created by external loads.



Thorburn's Hing-Flex expansion joints are designed for absorbation of thermal expansion and wind loads.

GIM-FLEX SERIES "GF"
GIMBAL EXPANSION JOINT SYSTEM

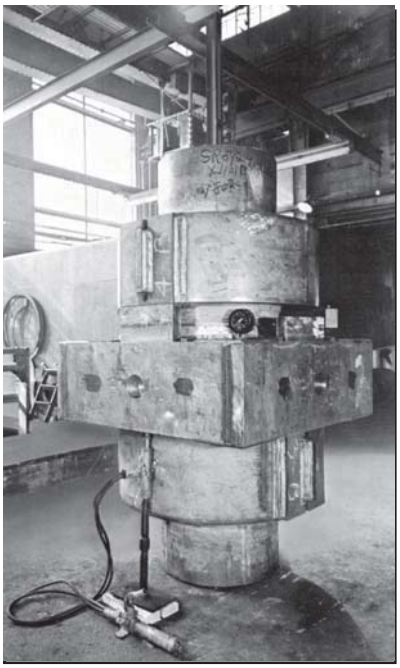
Thorburn's Gim-Flex joint is the most reliable expansion joint. It is capable of absorbing angular motion in all planes while retaining many advantages. The construction of a Thorburn Gim-Flex expansion joint incorporates a pair of hinges connected to a common floating Gimbal ring. This type of construction provides for close control of the movement imposed upon the bellows and at the same time can support the dead weight of the system. Wind loading and shear loads are also transmitted through the Gimbal structure. Other advantages include low forces and elimination of pressure thrust on adjacent equipment. Thorburn Gim-Flex expansion joints are either used in pairs or in combination with a Thorburn Hing-Flex expansion joint to absorb complex multi-plane motion in a piping system.



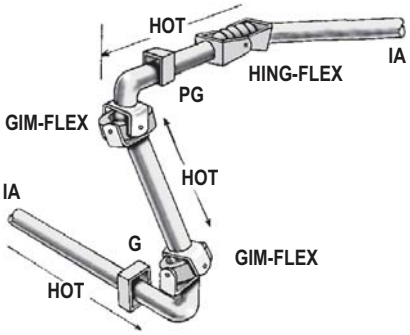
Thorburn's Gim-Flex finished assembly used in a high pressure steam piping system

FEATURES

- Angular motion in all planes
- Positive control over movement
- Eliminates pressure thrust forces
- Transmits external loads
- Supports dead weight
- Prevents torsion on bellows
- No main anchor required
- Minimum guiding required
- Low forces on piping system



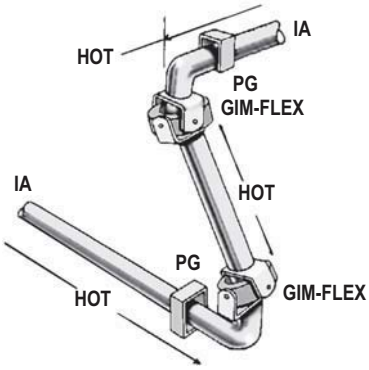
Final stages in the assembly of a large diameter high pressure/ temperature Gimbal expansion joint



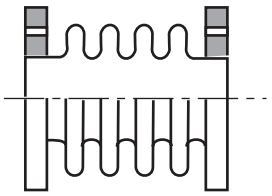
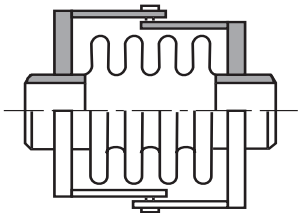
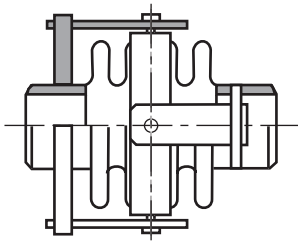
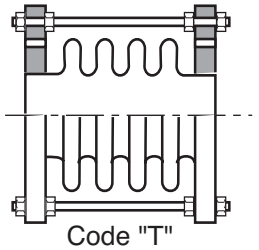
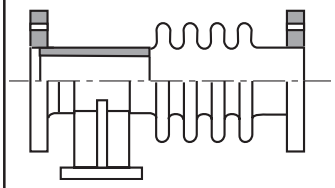
The use of Thorburn Gim-Flex expansion joints results in the best system possible to eliminate the effects of thermal growth and lowers both reaction forces and installation costs. Expensive main anchors are eliminated and only minimal guiding is required. To eliminate this, a Thorburn Hing-Flex expansion joint can be installed in the horizontal piping. This type of installation results in the lowest possible forces on the intermediate anchors.

IA = Intermediate Anchor
G = Guide
PG = Planar Guide

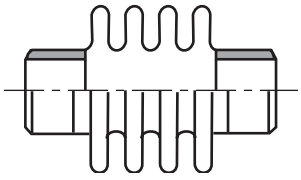
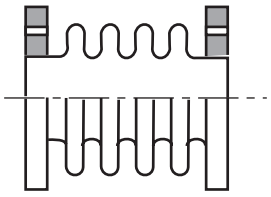
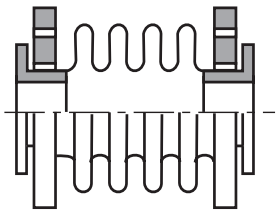
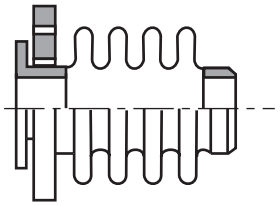
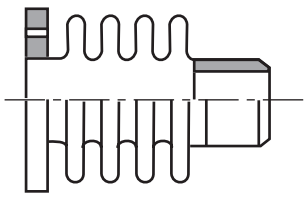
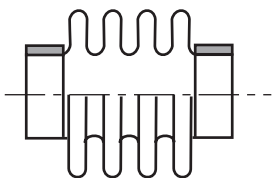
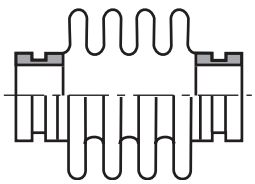
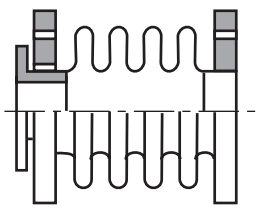
Thorburn's Gim-Flex joints are utilized in a pair to absorb the thermal expansion from the two horizontal piping legs. Note that the thermal growth of the vertical legs, however, must be absorbed by deflection of the horizontal piping.



SINGLE-FLEX MODEL "SF"
SINGLE BELLOWS EXPANSION JOINT SYSTEM

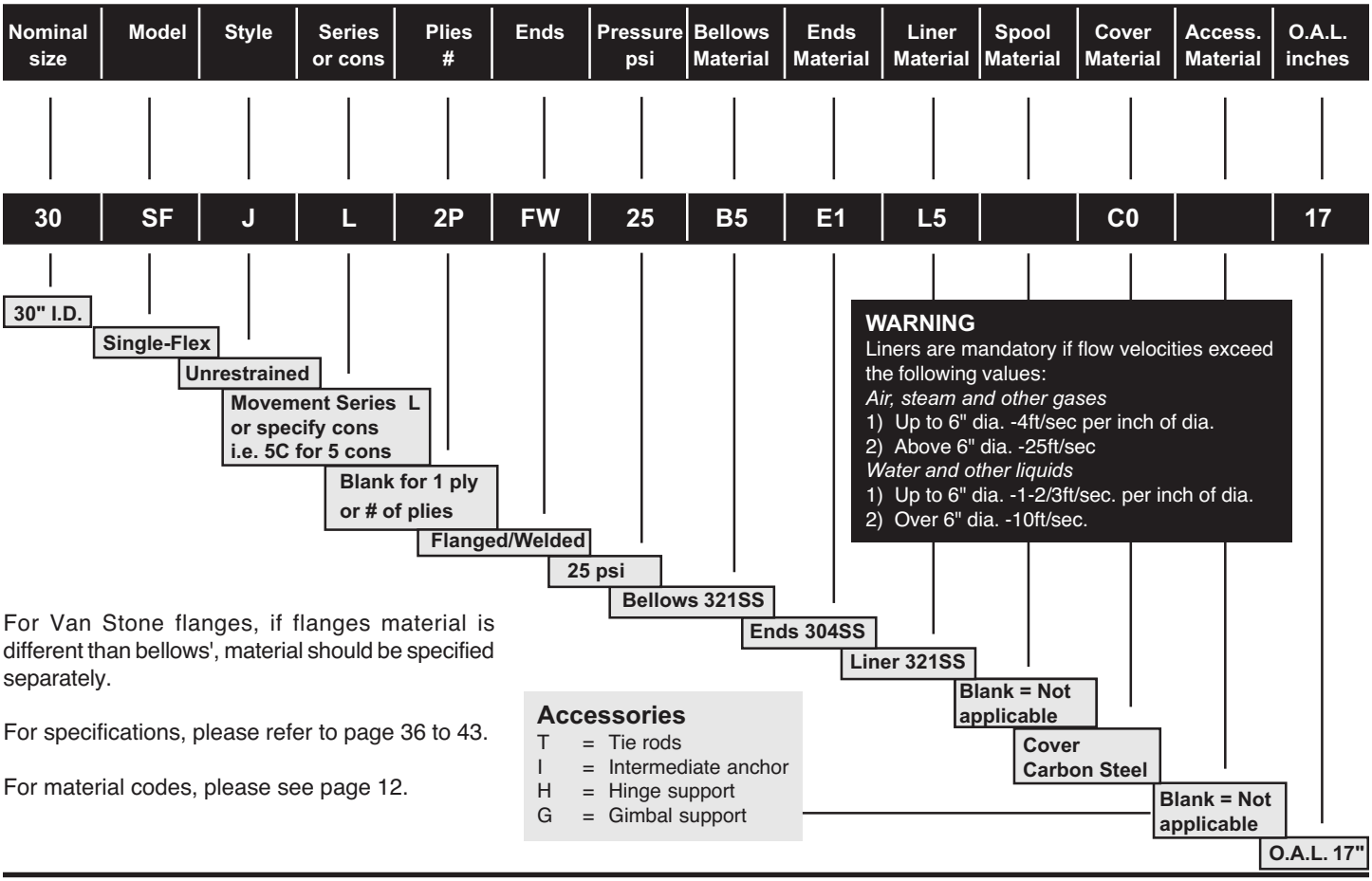
S T Y L E S		
Unrestrained	**Hinge**	**Gimbal**
 Code "J"	 Code "H"	 Code "G"
	Tie Rod	**Intermediate Anchor**
End fittings are available in a variety of combinations and materials	 Code "T"	 Code "P"

Thorburn's skilled welder certified to ASME Section IX using modern TIG welding for bellows flange attachment

E N D C O N N E C T O R S			
Weld End	**Flange**	**Van Stone Flange**	**Van Stone / Weld End**
 Code "WW"	 Code "FF"	 Code "VV"	 Code "VW"
Flange / Weld End	**Collar Bellows**	**Vitaulic Grooved End**	**Van Stone / Flange**
 Code "FW"	 Code "CC"	 Code "GG"	 Code "VF"

SINGLE-FLEX MODEL "SF"

HOW TO ORDER FROM THIS CATALOGUE



WARNING
Liners are mandatory if flow velocities exceed the following values:
Air, steam and other gases
1) Up to 6" dia. -4ft/sec per inch of dia.
2) Above 6" dia. -25ft/sec
Water and other liquids
1) Up to 6" dia. -1-2/3ft/sec. per inch of dia.
2) Over 6" dia. -10ft/sec.

For Van Stone flanges, if flanges material is different than bellows', material should be specified separately.

For specifications, please refer to page 36 to 43.

For material codes, please see page 12.

Accessories
T = Tie rods
I = Intermediate anchor
H = Hinge support
G = Gimbal support

STANDARD MATERIALS (Codes)

(unless specified otherwise)

Bellows:	ASTM A240T321 (B5)
Flanges:	Carbon steel A105 or Plate A36 or 44W (customer should specify actual flanges required, i.e. drilling, material, type) (E0)
Weld ends:	Carbon steel A53, A106, Plate A36 or 44WW (customer should specify actual weld ends required i.e. schedule, material) (E0)
Vitaulic ends:	Carbon steel A53, A106, A36, 44W (E0)
Collars:	Carbon steel A36/44W (E0)
Liners:	ASTM A240T321 (L5)
Covers:	Carbon steel A36/44W (C0)
Accessories:	Tie rods, Gimbal, hinges: Carbon steel (T0)

OPTIONS

Liner

To specify liners add **L** suffix to part number and advise of specific movements to properly size liner. On combination ends specify flow direction.

Cover

To specify covers add **C** suffix to part number

NOTES

1. Rated cycle life is 5000 cycles for any one movement tabulated minimum per EJMA.
2. To combine axial, lateral or angular movements the sum of each must not exceed 100%. Refer to pages 36 to 43.
3. To obtain greater movements or cycle life contact Thorburn.
4. Maximum axial extension movement is 50% of tabulated axial value.
5. Maximum test pressure: 1-1/2 x rated working pressure.
6. Catalogue pressure ratings are based upon a design temperature range of -20°F to 800°F. Actual operating temperature should always be specified.
7. For higher pressure temperature, movement and cycle ratings, contact Thorburn with your application details for fast action.

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	0.75	0.09	3	140	1472	4	6.00	1	4.00	5	5.00	3
	75	M	1.50	0.25	5	70	184	3	7.50	1	5.75	5	6.63	3
		L	1.88	0.38	12	56	138	2	8.50	2	6.50	6	7.50	4
		S	0.75	0.06	3	260	3072	12	6.00	1	4.00	6	5.00	3
1-1/2”	150	M	1.50	0.18	5	130	384	6	7.50	1	5.75	6	6.63	4
		L	1.88	0.25	10	104	288	4	8.50	2	6.50	7	7.50	4
		S	0.62	0.05	4	608	8650	22	6.00	1	4.50	11	5.25	6
4.0	300	M	1.25	0.18	6	304	1082	11	7.50	2	6.00	11	6.75	7
sq. in.		L	1.56	0.25	8	243	812	8	8.50	2	7.00	12	7.75	7
		S	0.75	0.08	6	144	1856	8	6.00	1	4.25	8	5.25	4
	75	M	1.50	0.20	10	72	232	4	8.00	1	6.00	8	7.00	4
		L	1.88	0.32	12	58	186	3	9.00	2	7.00	9	8.00	5
		S	0.75	0.06	5	286	3430	14	6.00	1	4.25	9	5.25	5
2”	150	M	1.50	0.18	10	143	430	7	8.00	1	6.00	9	7.00	5
		L	1.88	0.25	12	115	336	5	9.00	2	7.00	10	8.00	6
		S	0.62	0.05	4	768	5694	32	6.00	1	5.00	13	5.50	7
5.9	300	M	1.25	0.18	8	384	712	16	8.00	2	6.50	13	7.25	8
sq. in.		L	1.56	0.25	10	307	558	12	9.00	2	7.50	14	8.00	8
		S	0.75	0.07	6	630	2730	11	6.00	2	4.50	11	5.25	6
	75	M	1.50	0.29	12	315	340	6	8.00	2	6.50	11	7.25	7
		L	1.88	0.38	14	250	230	4	9.00	3	7.50	12	8.25	7
		S	0.75	0.06	5	630	4700	22	6.00	3	4.50	13	5.25	8
2-1/2”	150	M	1.50	0.25	10	315	590	11	8.00	3	6.50	13	7.25	8
		L	1.88	0.33	12	250	410	8	9.00	4	7.50	14	8.25	9
		S	0.62	0.04	4	1660	6830	48	6.00	3	5.00	20	5.50	11
8.3	300	M	1.25	0.16	8	830	850	24	8.00	4	7.00	21	7.50	12
sq. in.		L	1.55	0.25	10	660	590	16	9.00	4	8.00	21	8.50	13
		S	0.75	0.10	6	240	1768	12	7.25	4	5.00	10	6.00	7
	75	M	1.50	0.38	12	120	221	6	9.50	4	7.25	11	8.25	8
		L	1.88	0.48	15	96	144	5	10.50	5	8.25	11	9.25	8
		S	0.62	0.06	4	496	4210	20	7.25	5	5.00	16	6.00	10
3”	150	M	1.25	0.25	8	248	526	10	9.50	5	7.25	17	8.25	11
		L	1.56	0.32	12	198	342	9	10.50	6	8.25	17	9.25	12
		S	0.50	0.04	3	2464	17550	96	7.25	5	6.00	27	6.50	16
12.2	300	M	1.00	0.16	6	1234	2194	48	9.50	5	8.25	28	8.75	17
sq. in.		L	1.25	0.25	8	986	1426	43	10.50	6	9.50	29	10.00	18

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	0.80	0.10	6	598	2682	36	7.50	4	5.50	14	6.50	9
	75	M	1.60	0.40	12	299	335	18	10.25	5	8.00	15	9.00	10
		L	2.00	0.60	15	240	168	16	11.50	5	9.50	15	10.50	11
		S	0.62	0.07	4	988	6846	72	7.50	4	5.50	21	6.50	12
3-1/2”	150	M	1.25	0.28	9	494	856	36	10.25	5	8.00	22	9.00	13
		L	1.56	0.42	13	395	428	32	11.50	5	9.50	22	10.50	14
		S	0.50	0.05	3	1634	13834	138	7.50	5	6.50	36	7.00	20
16.3	300	M	1.00	0.20	6	817	1729	79	10.25	5	9.00	37	9.50	21
sq. in.		L	1.25	0.30	9	654	865	74	11.50	6	10.50	37	11.00	22
		S	0.80	0.12	7	480	2580	33	9.00	6	6.00	15	7.50	10
	75	M	1.60	0.48	14	240	323	17	12.00	7	9.00	15	10.50	11
		L	2.00	0.70	15	192	161	15	13.50	7	10.50	16	12.00	11
		S	0.62	0.08	5	968	6123	66	9.00	6	6.00	26	7.50	16
4”	150	M	1.25	0.32	10	484	765	33	12.00	7	9.00	27	10.50	17
		L	1.56	0.48	15	387	383	30	13.50	7	10.50	27	12.00	17
		S	0.50	0.06	4	1802	13180	128	9.00	7	7.00	45	8.00	26
20.1	300	M	1.00	0.24	8	901	1648	64	12.00	8	10.00	46	11.00	27
sq. in.		L	1.25	0.36	11	721	824	60	13.50	9	11.50	47	12.50	28
		S	1.20	0.12	5	688	4632	64	9.25	9	6.50	22	7.75	15
	75	M	2.40	0.48	10	344	579	32	12.50	10	9.75	23	11.00	16
		L	3.00	0.72	15	275	290	30	14.00	10	11.50	24	12.75	17
		S	1.00	0.09	5	1130	8774	120	9.25	10	6.50	33	7.75	21
5”	150	M	2.00	0.36	10	565	1097	60	12.50	10	9.75	34	11.00	22
		L	2.50	0.54	15	452	549	56	14.00	11	11.50	35	12.75	23
		S	0.75	0.06	3	1936	19090	228	9.25	11	7.50	60	8.25	35
30.7	300	M	1.50	0.24	6	968	2386	114	12.50	12	10.75	61	11.50	36
sq. in.		L	1.88	0.36	10	774	1193	106	14.00	13	12.50	63	13.25	38
		S	1.25	0.13	6	684	5106	102	9.75	12	7.25	26	8.50	19
	75	M	2.50	0.52	12	342	638	51	13.50	13	11.00	27	12.25	20
		L	3.00	0.75	15	274	213	34	15.25	14	13.00	27	14.00	21
		S	1.25	0.10	5	1260	10625	186	9.75	13	7.25	42	8.50	26
6”	150	M	2.50	0.40	10	630	1328	93	13.50	14	11.00	42	12.25	27
		L	3.00	0.62	13	504	443	62	15.25	15	13.00	43	14.00	28
		S	0.75	0.07	4	2340	19575	346	9.75	14	8.25	83	9.00	48
43.4	300	M	1.50	0.28	8	1170	2447	173	13.50	15	12.00	84	12.75	50
sq. in.		L	1.88	0.48	10	936	815	115	15.25	16	14.00	86	14.50	51

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
8” 72.5 sq. in.	25	S	1.50	0.18	8	952	10022	172	10.00	18	6.75	43	8.25	30
		M	3.00	0.72	13	476	1258	86	14.00	20	10.75	45	12.25	32
		L	4.00	0.95	15	381	417	57	16.00	21	12.75	46	14.25	33
	75	S	1.43	0.16	7	1206	12075	296	10.00	19	8.00	44	9.00	32
		M	2.86	0.64	12	603	1509	148	14.00	21	12.00	46	13.00	33
		L	3.50	0.90	15	482	503	98	16.00	22	14.00	47	15.00	34
	150	S	1.25	0.09	5	1962	24300	486	10.00	22	8.00	68	9.00	45
		M	2.50	0.36	9	981	3038	243	14.00	24	12.00	70	13.00	47
		L	3.00	0.70	12	785	1013	162	16.00	26	14.00	72	15.00	49
	300	S	0.75	0.06	4	5760	83520	1436	10.00	26	9.25	128	9.50	77
		M	1.50	0.25	7	2880	10406	718	14.00	29	13.25	131	13.50	80
		L	1.88	0.50	9	2304	3469	478	16.00	32	15.25	134	15.50	83
10” 111 sq. in.	25	S	1.50	0.17	6	748	12138	212	10.75	26	7.75	62	9.25	44
		M	3.00	0.68	12	374	1517	106	15.50	27	12.50	63	14.00	45
		L	4.00	0.99	15	299	505	70	18.00	29	15.00	65	16.50	47
	75	S	1.50	0.15	6	922	14625	360	10.75	27	9.00	63	9.75	45
		M	3.00	0.60	12	486	1828	180	15.50	28	13.75	64	14.50	46
		L	3.75	0.97	15	389	609	120	18.00	30	16.25	66	17.00	47
	150	S	1.25	0.12	4	1790	32025	656	10.75	30	9.00	96	9.75	63
		M	2.50	0.48	9	895	4003	328	15.50	32	13.75	98	14.50	65
		L	3.00	0.96	11	716	1334	219	18.00	35	16.25	101	17.00	68
	300	S	0.75	0.06	3	5220	104250	1890	10.75	35	10.50	177	10.50	106
		M	1.50	0.25	7	2610	13031	945	15.50	39	15.25	181	15.25	110
		L	2.00	0.50	8	2088	4344	630	18.00	43	17.75	185	17.75	114
12” 154 sq. in.	25	S	1.25	0.08	2	870	65410	363	10.50	37	5.50	62	8.00	50
		M	2.00	0.24	9	522	9540	218	12.25	39	7.25	65	9.75	52
		L	4.00	0.96	15	261	1170	109	16.50	44	11.50	70	14.00	57
	75	S	1.00	0.06	2	3030	210400	1287	10.50	41	6.00	75	8.25	58
		M	1.62	0.18	6	1818	38430	772	12.25	45	7.75	80	10.00	63
		L	3.25	0.72	11	909	4770	386	16.50	53	12.00	89	14.25	71
	150	S	0.82	0.05	2	5250	532336	2223	10.50	43	7.25	141	8.75	92
		M	1.38	0.15	4	3150	78120	1334	12.25	48	9.00	147	10.50	98
		L	2.75	0.40	7	1575	9810	667	16.50	58	13.25	158	14.75	108
	300	S	0.62	0.04	1	8790	1057380	3750	10.50	45	8.50	245	9.50	146
		M	1.00	0.12	3	5274	155700	2250	12.25	52	10.25	254	11.25	153
		L	2.00	0.36	6	2637	19440	1125	16.50	64	14.50	268	15.50	166

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	1.25	0.08	2	1020	88433	512	10.75	42	6.25	71	8.50	57
	25	M	2.00	0.23	8	612	12510	307	12.50	45	8.00	74	10.25	60
		L	4.00	0.92	15	306	1530	154	17.00	49	12.50	80	14.75	65
		S	1.00	0.05	2	3600	404428	1750	10.75	46	6.25	97	8.50	72
	75	M	1.62	0.15	5	2160	53460	1050	12.50	50	8.00	103	10.25	77
14”		L	3.25	0.60	10	1080	6670	525	17.00	59	12.50	113	14.75	86
		S	0.82	0.04	2	6150	664320	3000	10.75	48	7.75	194	9.25	121
	150	M	1.38	0.12	4	3690	99810	1800	12.50	54	9.50	201	11.00	127
		L	2.75	0.48	8	1845	13400	900	17.00	65	14.00	213	15.50	139
		S	0.62	0.03	2	7200	779072	3563	10.75	54	9.25	352	10.00	203
183	300	M	1.00	0.09	4	4320	107100	2135	12.50	63	11.00	363	11.75	213
sq. in.		L	2.00	0.36	8	2160	13410	1069	17.00	81	15.50	383	16.25	232
		S	1.25	0.08	2	867	63170	563	11.00	47	6.50	88	8.75	68
	25	M	2.00	0.25	7	520	9630	338	13.00	51	8.50	92	10.75	72
		L	4.00	0.98	15	260	1204	169	18.00	56	13.50	98	15.75	77
		S	1.00	0.07	2	3033	273728	2000	11.00	52	6.50	121	8.75	87
	75	M	1.75	0.14	5	1820	38340	1200	13.00	57	8.50	127	10.75	92
16”		L	3.50	0.56	10	910	4793	600	18.00	67	13.50	138	15.75	103
		S	0.75	0.06	2	5250	631680	3375	11.00	54	8.50	212	9.75	133
	150	M	1.50	0.11	4	3150	76680	2025	13.00	61	10.50	220	11.75	141
		L	3.00	0.44	8	1575	9585	1013	18.00	74	15.50	234	16.75	154
		S	0.75	0.03	2	6133	736960	3875	11.00	61	10.00	405	10.50	233
237	300	M	1.50	0.10	4	3680	87120	2325	13.00	72	12.00	418	12.50	245
sq. in.		L	3.00	0.40	8	1840	10890	1162	18.00	92	17.00	440	17.50	266
		S	1.25	0.08	2	1560	168458	1250	11.00	55	6.50	101	8.75	78
	25	M	2.00	0.21	7	936	23580	750	13.00	60	8.50	106	10.75	83
		L	4.00	0.82	14	468	2948	375	18.00	67	13.50	115	15.75	91
		S	1.00	0.05	2	2880	379008	2375	11.00	58	7.00	165	9.00	112
	75	M	1.75	0.10	4	1728	52380	1425	13.00	65	9.00	172	11.00	118
18”		L	3.00	0.50	8	864	6548	716	18.00	76	14.00	185	16.00	130
		S	0.75	0.04	2	8400	1247568	6750	11.00	64	8.75	282	9.75	173
	150	M	1.50	0.10	4	5040	174600	4050	13.00	74	10.75	293	11.75	184
		L	3.00	0.42	8	2520	21825	2025	18.00	91	15.75	313	16.75	203
		S	0.75	0.03	2	10080	1416000	8086	11.00	74	10.50	536	10.75	305
299	300	M	1.50	0.09	4	6048	192600	4852	13.00	90	12.50	553	12.75	322
sq. in.		L	3.00	0.36	8	3024	24057	2426	18.00	119	17.50	585	17.75	352

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	1.25	0.09	2	1773	231620	1750	11.50	62	7.50	127	9.50	95
	25	M	2.00	0.20	6	1064	32040	1050	13.50	66	9.50	132	11.50	99
		L	4.00	0.78	12	532	4005	525	19.00	75	15.00	142	17.00	109
		S	1.00	0.07	2	3273	505344	3125	11.50	65	8.00	216	9.75	140
	75	M	1.75	0.14	4	1964	70830	1875	13.50	72	10.00	224	11.75	148
20”		L	3.50	0.56	8	982	8854	938	19.00	85	15.50	238	17.25	162
		S	0.75	0.05	1	9300	1668688	9000	11.50	71	9.75	344	10.50	208
	150	M	1.50	0.12	3	5580	231300	5400	13.50	82	11.75	356	12.50	219
		L	3.00	0.48	6	2790	28913	2700	19.00	102	17.25	377	18.00	240
		S	0.75	0.03	1	11220	1842400	10800	11.50	88	11.50	653	12.00	364
363	300	M	1.50	0.10	4	6732	256500	6480	13.50	105	13.50	672	14.00	383
sq. in.		L	3.00	0.38	6	3366	32063	3240	19.00	158	19.00	705	19.50	416
		S	1.25	0.08	2	1830	273728	2123	11.50	65	7.50	184	9.50	125
	25	M	2.00	0.18	6	1098	39240	1274	13.50	72	9.50	190	11.50	131
		L	4.00	0.70	12	549	4905	637	19.00	82	15.00	201	17.00	141
		S	1.00	0.06	2	3420	636994	3875	11.50	70	7.50	214	9.50	142
	75	M	1.75	0.12	4	2052	87570	2325	13.50	76	9.50	220	11.50	149
22”		L	3.50	0.46	7	1026	10946	1163	19.00	95	15.00	239	17.00	168
		S	0.75	0.05	1	9510	2036980	10875	11.50	83	10.00	395	11.00	239
	150	M	1.50	0.11	3	5706	279900	6525	13.50	95	12.00	407	13.00	251
		L	3.00	0.44	6	2853	34988	3263	19.00	133	17.50	445	18.50	289
		S	0.75	0.03	1	19050	3628800	21623	11.50	90	12.00	772	12.00	431
434	300	M	1.50	0.09	3	11430	514800	12974	13.50	106	14.00	788	14.00	447
sq. in.		L	3.00	0.36	6	5715	64350	6487	19.00	154	19.50	836	19.50	495
		S	1.25	0.07	2	1893	347950	2497	11.50	70	7.50	217	9.50	143
	25	M	2.00	0.18	5	1136	50040	1498	13.50	74	9.50	221	11.50	147
		L	4.00	0.72	11	568	6255	749	19.00	85	15.00	232	17.00	158
		S	1.00	0.06	2	3540	763280	4750	11.50	77	7.50	224	9.50	150
	75	M	1.75	0.12	3	2124	105300	2850	13.50	84	9.50	231	11.50	157
24”		L	3.50	0.48	7	1062	13163	1425	19.00	105	15.00	252	17.00	178
		S	0.75	0.05	2	9750	2447760	12875	11.50	91	10.50	468	11.00	279
	150	M	1.50	0.11	3	5850	333900	7725	13.50	105	12.50	482	13.00	293
		L	3.00	0.44	5	2925	41738	3863	19.00	144	18.00	524	18.50	335
		S	0.75	0.04	1	19500	4895520	25872	11.50	98	12.00	985	12.00	541
511	300	M	1.50	0.08	3	11700	668700	15525	13.50	115	14.00	1002	14.00	558
sq. in.		L	3.00	0.32	5	5850	83588	7763	19.00	168	19.50	1055	19.50	611

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	1.25	0.07	2	2066	355320	2800	11.50	76	7.50	235	9.50	155
	25	M	2.00	0.18	3	1240	51200	1680	13.50	82	9.50	248	11.50	165
		L	4.00	0.72	11	620	6400	840	19.00	93	14.50	276	17.00	185
		S	1.00	0.06	2	7140	802120	10500	11.50	83	7.50	286	9.50	187
26”	75	M	1.75	0.12	3	4284	110670	6300	13.50	90	9.50	298	11.50	194
		L	3.50	0.48	7	2142	13834	3150	19.00	113	14.50	320	17.00	217
		S	0.75	0.05	2	10500	2521190	13175	11.50	98	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
594	150	M	1.50	0.11	3	6300	347580	7905	13.50	113				
sq. in.		L	3.00	0.44	5	3150	43448	3953	19.00	158				
		S	1.25	0.06	2	2280	361220	3013	11.50	83	7.50	289	9.50	185
	25	M	2.00	0.17	4	1368	52800	1808	13.50	87	9.50	293	11.50	189
		L	4.00	0.68	9	684	6600	904	19.00	101	14.50	307	17.00	203
		S	1.00	0.05	2	7710	835006	11445	11.50	90	7.50	296	9.50	192
28”	75	M	1.75	0.11	3	4626	14600	6867	13.50	98	9.50	304	11.50	200
		L	3.50	0.44	6	2313	1825	3434	19.00	122	14.50	328	17.00	224
		S	0.75	0.04	1	11250	2622037	14228	11.50	107	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
683	150	M	1.50	0.10	3	6750	391000	8537	13.50	123				
sq. in.		L	3.00	0.40	5	3375	48875	4269	19.00	173				
		S	1.25	0.06	2	2550	368480	4997	11.50	89	7.50	314	9.50	201
	25	M	2.00	0.17	4	1530	52920	2998	13.50	94	9.50	335	11.50	214
		L	4.00	0.68	9	765	6615	1499	19.00	108	14.50	369	17.00	238
		S	1.00	0.04	2	8250	1473920	16373	11.50	99	7.50	357	9.50	226
30”	75	M	1.75	0.11	3	4950	207000	9824	13.50	105	9.50	366	11.50	235
		L	3.50	0.44	6	2475	25875	4912	19.00	131	14.50	392	17.00	261
		S	0.75	0.03	1	16560	2947840	32750	11.50	114	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
779	150	M	1.50	0.10	3	9936	414000	19650	13.50	131				
sq. in.		L	3.00	0.38	5	4968	51750	9825	19.00	184				
		S	1.25	0.07	2	3000	379534	6246	11.50	99	7.50	335	9.50	217
	25	M	2.00	0.16	4	1800	54614	3748	13.50	111	9.50	351	11.50	231
		L	4.00	0.64	9	900	6827	1874	19.00	129	14.50	386	17.00	257
		S	1.00	0.06	2	8790	1510768	18926	11.50	102	7.50	428	9.50	265
32”	75	M	1.75	0.12	4	5274	212796	11356	13.50	112	9.50	466	11.50	275
		L	3.50	0.48	6	2637	26600	5678	19.00	140	14.50	485	17.00	303
		S	0.75	0.04	1	17580	3018588	34715	11.50	159	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
881	150	M	1.50	0.09	3	10548	426420	20829	13.50	196				
sq. in.		L	3.00	0.36	5	5274	53303	10415	19.00	235				

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	1.25	0.06	2	3187	1089366	7183	11.50	116	7.50	395	9.50	255
	25	M	2.00	0.15	4	1912	154820	4310	13.50	123	9.50	410	11.50	266
		L	4.00	0.60	7	956	19353	2155	19.00	154	14.50	433	17.00	294
		S	1.00	0.05	1	9360	2109744	21765	11.50	123	7.50	450	9.50	286
	75	M	1.75	0.10	2	5616	327375	13060	13.50	132	9.50	460	11.50	296
34"		L	3.50	0.40	3	2808	40922	6530	19.00	154	14.50	490	17.00	322
		S	0.75	0.04	1	18720	4548096	39922	11.50	156	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
989	150	M	1.50	0.09	2	11232	65475	23953	13.50	180				
sq. in.		L	3.00	0.36	4	5616	8184	11976	19.00	250				
		S	1.25	0.06	2	5700	1149120	15750	11.50	124	7.50	455	9.50	289
	25	M	2.00	0.15	4	3420	164700	9450	13.50	136	9.50	480	11.50	308
		L	4.00	0.60	7	1710	20588	4725	19.00	163	14.50	502	17.00	332
		S	1.00	0.05	1	9630	2318400	26625	11.50	131	7.50	550	9.50	340
	75	M	1.75	0.10	2	5780	337500	15975	13.50	139	9.50	560	11.50	349
36"		L	3.50	0.40	5	2890	42188	7988	19.00	180	14.50	592	17.00	386
		S	0.75	0.04	1	19260	4737600	53250	11.50	160	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1104	150	M	1.50	0.09	2	11556	675000	31950	13.50	180				
sq. in.		L	3.00	0.36	4	5788	84375	15975	19.00	266				
		S	1.25	0.06	2	6013	1183593	18040	11.50	132	7.50	547	9.50	339
	25	M	2.00	0.15	4	3608	169960	10824	13.50	138	9.50	556	11.50	347
		L	4.00	0.60	7	1804	21245	5412	19.00	174	14.50	582	17.00	378
		S	1.00	0.05	1	10167	2376360	30500	11.50	135	7.50	552	9.50	345
	75	M	1.75	0.10	2	6100	347625	18300	13.50	147	9.50	563	11.50	355
38"		L	3.50	0.40	5	3050	43453	9150	19.00	191	14.50	596	17.00	393
		S	0.75	0.04	1	20340	4837090	67122	11.50	176	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1225	150	M	1.50	0.09	2	12204	690525	40273	13.50	190				
sq. in.		L	3.00	0.36	4	6102	86316	20134	19.00	278				
		S	1.25	0.05	2	6333	1254600	21970	11.50	140	7.50	578	9.50	359
	25	M	2.00	0.14	3	3800	233145	13182	13.50	145	9.50	588	11.50	366
		L	4.00	0.55	6	1900	29143	6591	19.00	183	14.50	616	17.00	398
		S	1.00	0.04	1	10710	2518940	37370	11.50	147	7.50	583	9.50	365
	75	M	1.75	0.09	2	6426	486486	22422	13.50	155	9.50	595	11.50	375
40"		L	3.50	0.36	4	3213	60810	11212	19.00	202	14.50	712	17.00	457
		S	0.75	0.03	1	21420	5788400	73116	11.50	186	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1352	150	M	1.50	0.08	2	12852	1080135	43870	13.50	200				
sq. in.		L	3.00	0.32	4	6426	135017	21935	19.00	296				

SINGLE-FLEX MODEL "SF" SPECIFICATIONS

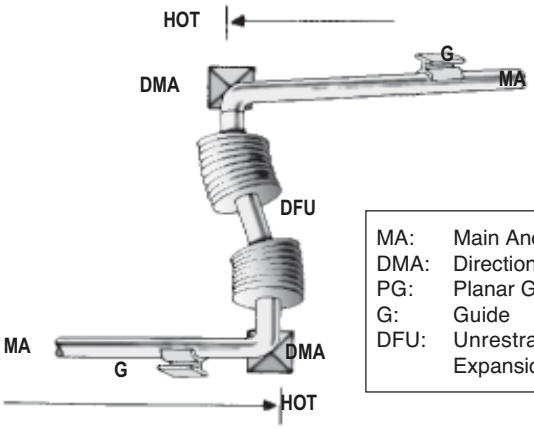
SINGLE BELLOWS EXPANSION JOINT SYSTEM

DESIGN DETAILS			NON-CONCURRENT MOVEMENT			SPRING RATE			OVERALL LENGTH AND WEIGHT					
									STYLE					
									WW		FF VV FV		FW VW	
SIZE	PRESSURE	SERIES	AXIAL	LATERAL	ANGULAR	AXIAL	LATERAL	ANGULAR	OAL	WT.	OAL	WT.	OAL	WT.
	psi		inch	inch	degree	lbs./ inch	lbs./ inch	in. lbs degree	inch	lbs.	inch	lbs.	inch	lbs.
		S	1.25	0.05	2	6420	1618400	23625	11.50	145	7.50	608	9.50	376
	25	M	2.00	0.14	5	3852	247500	14175	13.50	151	9.50	614	11.50	383
		L	4.00	0.55	10	1926	30938	7086	19.00	188	14.50	650	17.00	419
		S	1.00	0.04	2	10713	3278294	40620	11.50	148	7.50	684	9.50	416
42”	75	M	1.75	0.09	4	6428	514800	24372	13.50	167	9.50	697	11.50	432
		L	3.50	0.36	8	3214	64359	12186	19.00	212	14.50	734	17.00	473
		S	0.75	0.03	1	22050	666400	81240	11.50	191	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1486	150	M	1.50	0.08	2	13230	1028700	48744	13.50	210				
sq. in.		L	3.00	0.32	4	6615	128588	24372	19.00	309				
		S	1.25	0.05	2	6720	2086207	24528	11.50	152	7.50	628	9.00	436
	25	M	2.00	0.24	5	4032	328988	14717	13.50	160	9.50	636	11.00	398
		L	4.00	0.55	10	2016	41124	7359	19.00	200	14.50	676	16.50	438
		S	1.00	0.04	2	11550	4528556	42425	11.50	160	8.00	725	9.50	442
44”	75	M	1.75	0.09	4	6930	680462	25455	13.50	168	10.00	733	12.00	450
		L	3.50	0.36	8	3465	85058	12728	19.00	216	15.50	780	17.00	498
		S	0.75	0.03	1	23100	8093000	82410	11.50	184	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1625	150	M	1.50	0.08	2	13860	1377000	49446	13.50	220				
sq. in.		L	3.00	0.32	4	6930	172125	24723	19.00	324				
		S	1.25	0.05	2	7056	2243234	26318	11.50	164	7.50	658	9.00	410
	25	M	2.00	0.14	5	4234	351820	15791	13.50	713	9.50	667	11.00	420
		L	4.00	0.56	10	2167	43978	7896	19.00	209	14.50	702	16.50	456
		S	1.00	0.04	2	12075	4817613	45040	11.50	187	8.00	723	9.50	455
46”	75	M	1.75	0.09	4	7425	731680	27024	13.50	196	10.00	742	12.00	469
		L	3.50	0.36	8	3623	91460	1351	19.00	228	15.50	796	17.00	512
		S	1.00	0.04	1	23794	8992256	83279	11.50	198	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1772	150	M	1.75	0.08	2	14276	146894	49967	13.50	230				
sq. in.		L	3.00	0.32	4	7138	183112	24984	19.00	338				
		S	1.25	0.04	2	7320	2386420	34620	11.50	192	7.50	682	9.00	431
	25	M	2.00	0.13	5	4392	362700	20772	13.50	198	9.50	688	11.00	443
		L	4.00	0.50	10	2196	45337	10386	19.00	228	14.50	718	16.50	473
		S	1.00	0.03	2	12600	5125120	59625	11.50	198	8.50	884	10.00	540
48”	75	M	1.75	0.07	4	7560	755100	35775	13.50	207	10.50	914	12.50	560
		L	3.00	0.28	8	3780	94388	17880	19.00	242	16.00	958	17.50	600
		S	0.75	0.02	1	25200	9318400	94000	11.50	218	CUSTOMER TO SPECIFY FLANGE CONFIGURATION			
1924	150	M	1.50	0.05	2	15120	1510200	56400	13.50	255				
sq. in.		L	3.00	0.20	4	7560	188775	28200	19.00	380				

DUAL-FLEX DFU

UNRESTRAINED UNIVERSAL EXPANSION JOINT SYSTEM

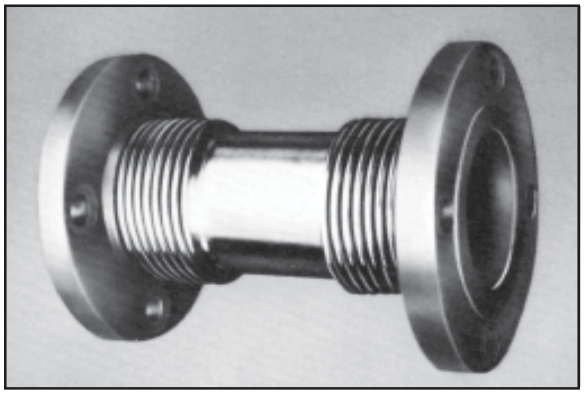
Thorburn's Dual-Flex Model DFU consists of two bellows joined by a common connector called a "pipe spool". However, unlike Thorburn's double joint Model DFP, this connector is not anchored to the structure. This permits Thorburn's unrestrained universal expansion joint Model DFU to absorb any combination of three basic movements: axial, lateral and angular. Model DFU is used where these combinations or single direction movements are too great to be handled by Thorburn's Single-Flex single joint.



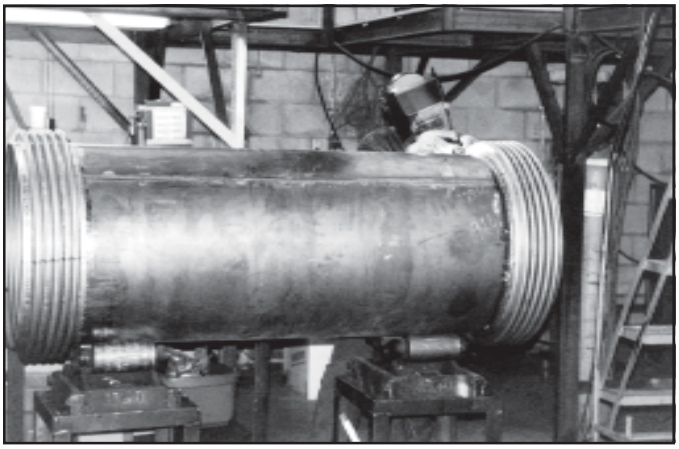
MA: Main Anchor
DMA: Directional Main Anchor
PG: Planar Guide
G: Guide
DFU: Unrestrained Universal Expansion Joint

WARNING

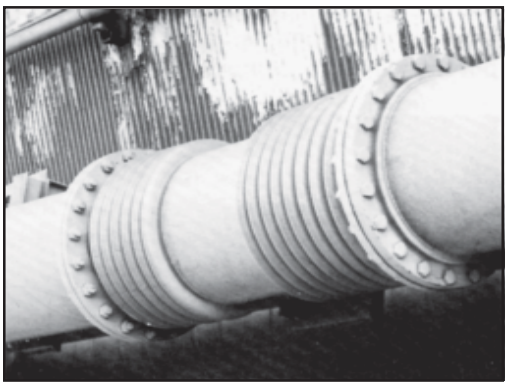
Without properly designed directional main anchors, Thorburn's Dual-Flex DFU is not recommended and Thorburn's Dual-Flex tied universal Model DFT should be used.



When large amounts of lateral movement are required, Thorburn's untied universal expansion joint Model DFU is used. This type of expansion joint will also result in lower forces on the anchors.



Thorburn welder, highly trained, certified to ASME Section IX, welding a 24" Dual-Flex DFU unrestrained expansion joint system.



Typical Thorburn Dual-Flex DFU unrestrained universal expansion joint system designed to accomodate up to 10" axial movement

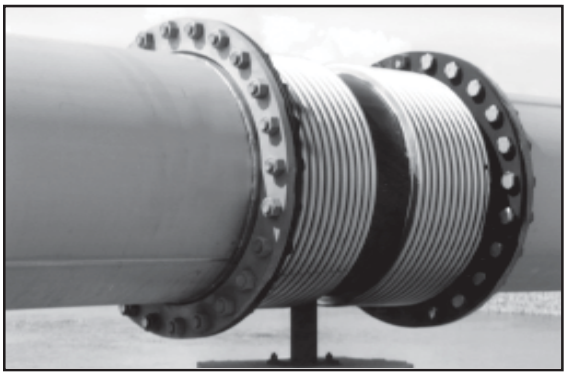
Additional points that must be considered before specifying Thorburns Dual-Flex DFU

1. For a very long expansion joint, the center spool may have to be supported. In vertical installations, the bellows or related hardware support the mass of the center spool. In horizontal installations, the bellows or related hardware are required to support the center spool mass as well as the weight of the fluid in the center spool. Therefore, it is important to specify the orientation of the universal assembly and the media when specifying Thorburn Dual-Flex DFU.
2. Specify the direction of flow for expansion joints requiring liners if the end fittings are not identical before specifying Thorburn Dual-Flex DFU.
3. Pressure thrust is a very important design consideration. For Thorburn Dual-Flex DFU, the pressure thrust force will be equal to the "Bellows Area" times the "Operating Pressure".

DUAL-FLEX DFP

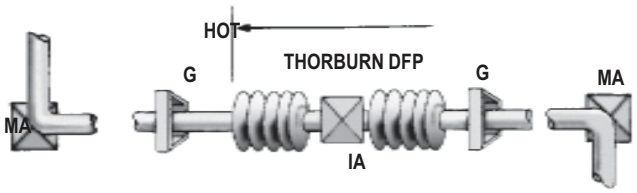
IN-LINE DOUBLE RESTRAINED EXPANSION JOINT SYSTEM WITH INTERMEDIATE ANCHORS

Thorburn's in-line double expansion joint system is specified when the axial movement of the piping run exceeds the capability of Thorburn's Sing-Flex (Single bellows) expansion joint. Model DFP consists of two single joints joined by a common spool which is anchored to a support base (intermediate anchor) directly to the structure.



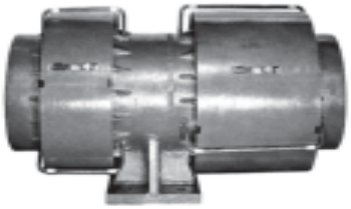
Thorburn's double expansion joint, with support foot, intermediate anchor system

Shown is one of over 20 Thorburn Dual-Flex double expansion joints installed at the Ste-Marthe du Cap-de-la-Madeleine, Quebec, project in 1991



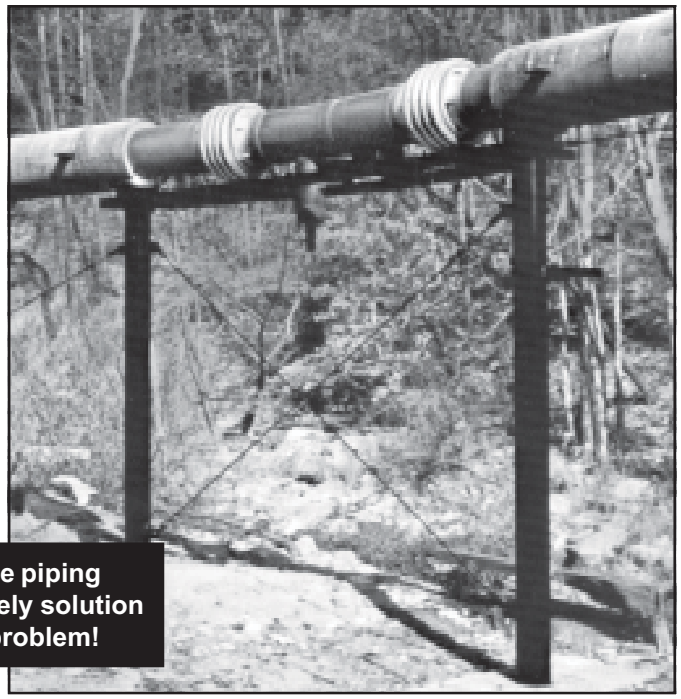
Thorburn Model DFP expansion joint is located in the center of the piping run and each single bellows absorbs the axial movement of the section of piping in which it is located.

Thorburn Dual-Flex Model DFP being prepared for shipment



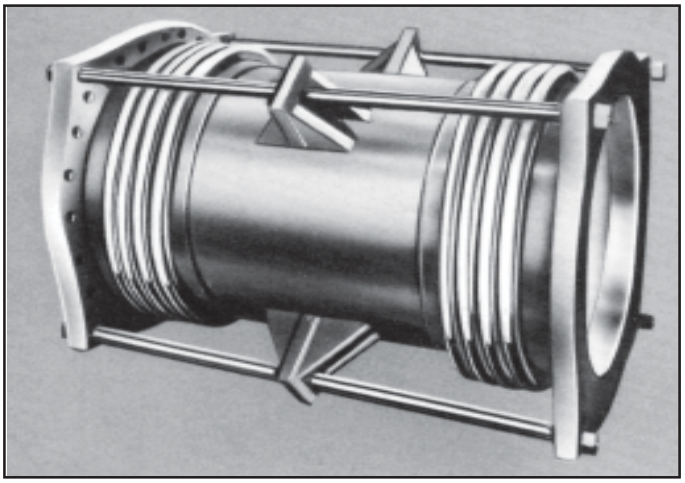
Double expansion joint with support base and protective covers

Let Thorburn's flexible piping specialists provide a timely solution to your pipe motion problem!



Double expansion joints are typically specified on long pipe runs. Shown above is one of four installed in a steam distribution line at a paper mill.

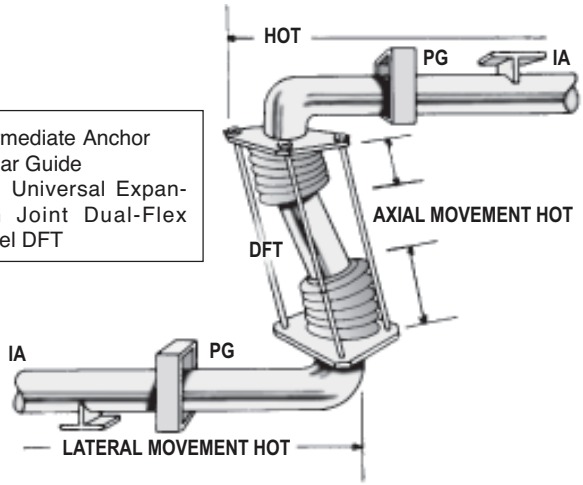
DUAL-FLEX DFT
TIED UNIVERSAL EXPANSION JOINT SYSTEM



Typical Thorburn tied universal Dual-Flex expansion joint Model DFT

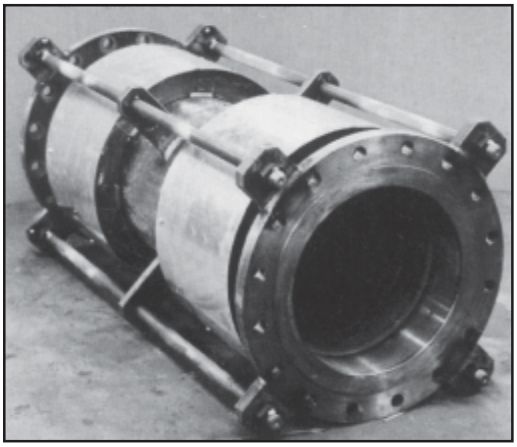
Thorburn's Dual-Flex Model DFT expansion joint is made up from two single expansion joints connected by a piece of pipe called the center spool. Tie rods are then attached on the outer ends to span both the bellows and the center spool. This type of construction allows the bellows to absorb the thermal growth of the piping between the tie rod attachments and still eliminates the pressure thrust on the system.

IA: Intermediate Anchor
PG: Planar Guide
DFT: Tied Universal Expansion Joint Dual-Flex Model DFT

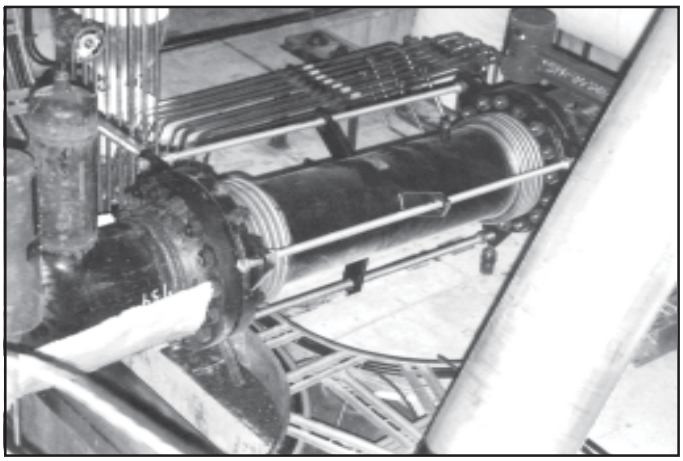


Thorburn flexible piping specialist verifying bellows' integrity

The most common application for Thorburn's Dual-Flex Model DFT tied universal expansion joint system is the "Z" shape piping system. In this case, the expansion joint absorbs the thermal growth of the horizontal piping as lateral deflection.



Typical Thorburn Dual-Flex Model DFT with protective bellows covers



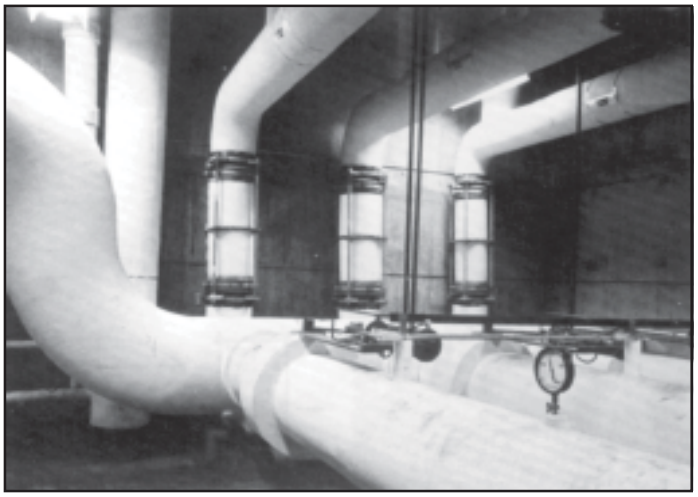
Thorburn's tied universal bellows Dual-Flex Model DFT steam transfer piping system at the Ottawa Hospital, Ontario. This is one of over 30 expansion joints installed in this TransAlta design co-generation system.

DUAL-FLEX DFT
TIED UNIVERSAL EXPANSION JOINT SYSTEM

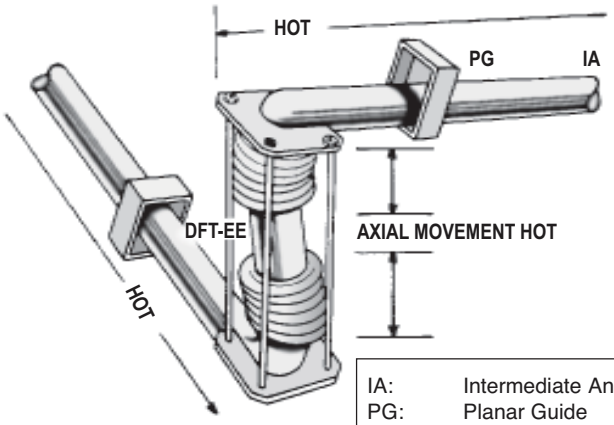
One important advantage found in Thorburn's Dual-Flex Model DFT is that the piping system does not have to be in one plane. The two horizontal legs may lie at any angle in the horizontal plane.

Where dimensionally feasable, Thorburn's Dual-Flex Model DFT should be designed to fill the extra offset leg so that its expansion is absorbed within the tie rods as axial movement. If this is not possible, the growth of the vertical piping leg outside the tied rods must be absorbed by bending in the horizontal legs. To eliminate this deflection, Thorburn can supply its tied universal expansion joints with two 90° elbows.

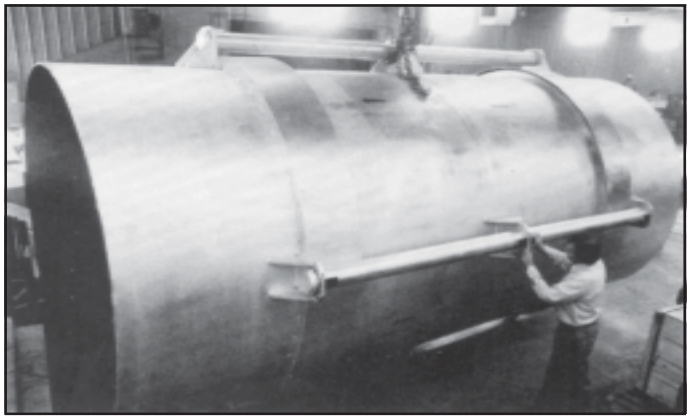
The tie rod attachments are then located at the centerline of each elbow, therefore the bellows can now absorb the total amount of thermal growth in the vertical leg of the piping system. Please refer to the sketch below for demonstration.



Due to the fact that the tie rods on Thorburn Dual-Flex Model DFT absorbs all pressure loads, the piping system only needs intermediate anchors. Directional guiding is all that is necessary.



IA:	Intermediate Anchor
PG:	Planar Guide
DFT-EE:	Tied Universal Expansion Joint with 90° elbows



108" diameter universal expansion joint

Thorburn Model DFT-EE is a tied universal expansion joint with elbow end connections designed to fill the entire offset leg so that its expansion is absorbed within the tie rods as axial movement. The movements in the horizontal lines are absorbed as lateral deflectors by Thorburn's Dual-Flex DFT-EE expansion joint system.

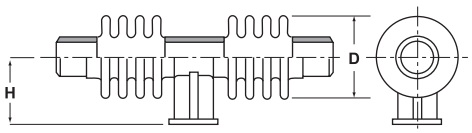
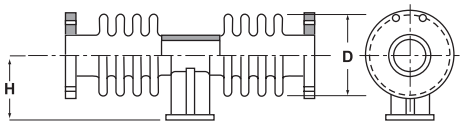
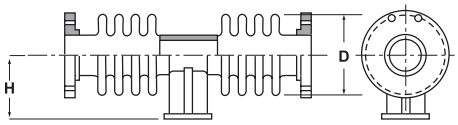
Though Thorburn catalogue shows only sizes up to 48", Thorburn can supply and manufacture joints up to 144" inches.

Typical tied universal expansion joint designed for large amounts of lateral movement from the two horizontal lines

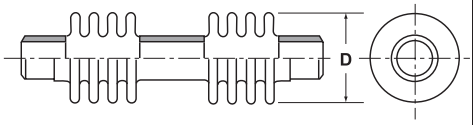
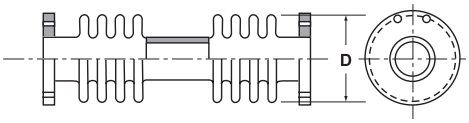
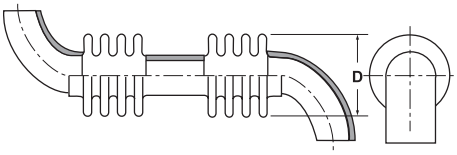
DUAL-FLEX MODEL DF

DOUBLE AND UNIVERSAL BELLOWS EXPANSION JOINT SYSTEM

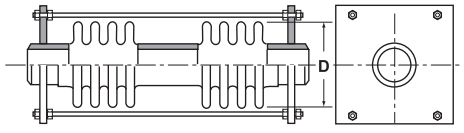
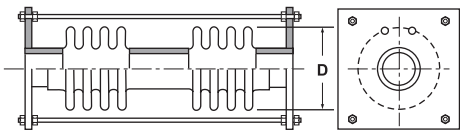
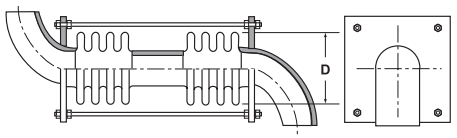
DUAL-FLEX DF STYLE "P"
IN-LINE DOUBLE EXPANSION JOINT SYSTEM

WELD END	VAN STONE FLANGE	FLANGE
		
End Code WW	End Code VV	End Code FF

DUAL-FLEX DF STYLE "U"
UNRESTRAINED UNIVERSAL EXPANSION JOINT SYSTEM

WELD END	FLANGE / VAN STONE FLANGE	ELBOW
		
End Code WW	End Code FF / End Code VV	End Code EE

DUAL-FLEX DF STYLE "T"
TIED UNIVERSAL-RESTRAINED EXPANSION JOINT SYSTEM

WELD END	FLANGE	ELBOW
		
End Code WW	End Code FF	End Code EE

DUAL-FLEX

HOW TO ORDER FROM THIS CATALOGUE

Nominal size	Model	Style	Series or cons	Plies #	Ends	Pressure psi	Bellows Material	Ends Material	Liner Material	Spool Material	Cover Material	Access. Material	O.A.L. inches
24	DF	T	A	2P	FF	150	B5	E1	L5	S0	C0	T0	34.5

- 24" I.D.
- Dual-Flex
- Tied-restrained
- Movement Series A or specify cons i.e. 5C5C for 5 cons x 5 cons
- Blank for 1 ply or # of plies
- Flanged/Flanged
- 150 psi
- Bellows 321SS
- Ends 304SS
- Liner 321SS
- Spool Carbon Steel
- Cover Carbon Steel
- Accessories i.e. Tie rod plates Carbon Steel
- O.A.L. 34.5

WARNING
Liners are mandatory if flow velocities exceed the following values:
Air, steam and other gases
1) Up to 6" dia. -4 ft/sec per inch of dia.
2) Above 6" dia. -25 ft/sec
Water and other liquids
1) Up to 6" dia. -1-2/3 ft/sec. per inch of dia.
2) Over 6" dia. -10 ft/sec.

Accessories
T = Tie rods
I = Intermediate anchor
H = Hinge support
G = Gimbal support

Please refer to pages 50 to 52 for specifications

For material codes, please see page 12

For movement specifications for Model DFP, please see Single-Flex pages 36 to 43

STANDARD MATERIALS

(unless specified otherwise)

Bellows:	ASTM A240T321 (B5)
Flanges:	Carbon steel A105 or Plate A36 or 44W (customer should specify actual flanges required, i.e. drilling, material, type) (E0)
Weld ends:	Carbon steel A53, A106, Plate A36 or 44W (customer should specify actual weld ends required i.e. schedule, material, thickness, etc.) (E0)
Vitaulic ends:	Carbon steel A53, A106, A36, 44W (E0)
Collars:	Carbon steel A36/44W (E0)
Liners:	ASTM A240T321 (L5)
Covers:	Carbon steel A36/44W (C0)
Accessories:	Tie rods, Gimbal, hinges: Carbon steel (T0)

OPTIONS

Liner

To specify liners add **L** as shown to part number and advise of specific movements to properly size liner. On combination ends specify flow direction.

Cover

To specify covers add **C** as shown to part number

NOTES

1. Rated cycle life for a standard Dual-Flex joint is 5000 cycles per EJMA 6th ed. for any one movement tabulated minimum.
2. To combine axial and lateral movements, the sum % of each must not exceed 100%. Refer to pages 50 to 52.
3. To obtain greater movements or cycle life contact Thorburn.
4. Maximum axial extension movement is 50% of tabulated axial value.
5. Maximum test pressure: 1-1/2 x rated working pressure.
6. Catalogue pressure ratings are based upon a design temperature range of -20°F to 800°F. Actual operating temperature should always be specified.
7. For higher pressure temperature, movement and cycle ratings with your application, contact Thorburn.

DUAL-FLEX SPECIFICATIONS

DESIGN DETAILS			NON-CONCURRENT MOVEMENT		SPRING RATE		OVERALL LENGTH			APPROX. WEIGHT*		
SIZE	PRESSURE psi	SERIES	AXIAL inch	LATERAL inch	AXIAL lbs./inch	LATERAL lbs./inch	FF inch	WW inch	EE inch	FF lbs.	WW lbs.	ADDED LATERAL MOVEMENT INCHES PER ADDI-TIONAL INCH OF SPOOL
1-1/2"	75	A	1.50	3.60	70	5	15.50	19.50	20.00	11.00	5.00	0.294
4.0	150	A	1.50	2.70	130	9	15.50	19.50	20.00	11.00	5.00	0.224
sq. in.	300	A	1.24	1.80	304	24	15.50	19.50	20.00	18.00	7.00	0.148
2"	75	A	1.50	3.00	72	8	15.50	19.50	20.00	15.00	6.00	0.247
5.9	150	A	1.50	2.30	143	15	15.50	19.50	20.00	15.00	6.00	0.188
sq. in.	300	A	1.24	1.50	384	42	16.00	19.50		18.00	8.00	0.126
2-1/2"	75	A	1.50	2.60	315	10	16.00	20.00	20.50	22.00	8.50	0.200
8.3	150	A	1.50	2.00	315	21	16.00	20.00	20.50	22.00	8.50	0.157
sq. in.	300	A	1.24	1.50	830	56	17.00	20.00	20.50	26.00	8.50	0.108
3"	75	A	1.50	3.50	120	8	20.00	23.50	24.00	27.50	13.00	0.251
12.2	150	A	1.24	2.10	248	15	20.00	23.50	24.00	27.50	13.00	0.152
sq. in.	300	A	1.00	1.40	1232	75	20.00	23.00	23.50	36.00	14.00	0.101
3-1/2"	75	A	1.60	3.50	299	37	21.00	24.00	26.00	30.50	16.00	0.200
16.3	150	A	1.24	2.10	494	46	21.00	24.00	26.00	30.50	16.00	0.157
sq. in.	300	A	1.00	1.40	817	110	21.50	24.00	26.00	39.00	17.00	0.157
4"	75	A	1.60	4.00	220	17	22.00	24.00	26.00	39.00	19.00	0.272
20.1	150	A	1.24	2.20	484	40	22.00	24.00	26.00	42.00	20.00	0.151
sq. in.	300	A	1.00	1.80	901	75	23.00	25.00	26.00	63.00	22.00	0.121
5"	75	A	2.40	3.70	344	38	23.00	26.00	29.00	49.00	26.00	0.242
30.7	150	A	2.00	2.70	565	70	23.00	26.00	29.00	51.00	28.00	0.182
sq. in.	300	A	1.50	1.70	968	135	24.00	27.00	30.00	79.00	28.00	0.112
6"	75	A	2.50	3.10	342	50	24.50	27.00	30.00	61.00	35.00	0.202
43.4	150	A	2.50	2.40	630	95	24.50	27.00	30.00	62.00	37.00	0.152
sq. in.	300	A	1.50	1.90	1170	185	25.00	27.00	30.00	102.00	39.00	0.122
8"	25	A	3.00	3.75	476	125	25.50	30.00	36.00	99.00	62.00	0.212
	75	A	2.86	3.40	603	145	25.50	30.00	36.00	99.00	62.00	0.212
72.5	150	A	2.50	2.10	981	250	25.00	29.00	35.00	103.00	66.00	0.138
sq. in.	300	A	1.50	1.70	2880	755	26.00	28.50	35.00	167.00	74.00	0.113
10"	25	A	3.00	3.00	374	145	25.00	28.00	37.00	139.00	86.00	0.195
	75	A	3.00	3.00	461	175	25.00	27.50	37.00	139.00	86.00	0.189
111	150	A	2.50	2.00	895	335	24.00	27.50	37.00	146.00	92.00	0.128
sq. in.	300	A	1.50	1.60	2610	1005	25.00	27.00	37.00	231.00	104.00	0.100
12"	25	A	2.50	5.00	435	100	28.00	31.00	41.00	160.00	110.00	0.266
	75	A	2.00	3.00	1515	350	28.00	30.50	41.00	203.00	120.00	0.163
154	150	A	1.64	2.00	2625	620	27.50	30.00	41.00	215.00	126.00	0.110
sq. in.	300	A	1.64	1.70	4395	1085	28.00	29.50	41.00	327.00	134.00	0.099

* Support foot and tie rods weights extra

DUAL-FLEX SPECIFICATIONS

DESIGN DETAILS			NON-CONCURRENT MOVEMENT		SPRING RATE		OVERALL LENGTH			APPROX. WEIGHT*		
SIZE	PRESSURE psi	SERIES	AXIAL inch	LATERAL inch	AXIAL lbs./inch	LATERAL lbs./inch	FF inch	WW inch	EE inch	FF lbs.	WW lbs.	ADDED LATERAL MOVEMENT INCHES PER ADDI-TIONAL INCH OF SPOOL
14"	25	A	2.50	4.60	510	135	28.00	31.50	45.00	172.00	121.00	0.246
	75	A	2.00	2.70	1800	480	28.00	30.50	45.00	261.00	133.00	0.150
183	150	A	1.64	1.80	3075	850	27.00	30.00	45.00	269.00	139.00	0.102
sq. in.	300	A	1.24	2.40	3600	960	29.00	30.50	45.00	467.00	185.00	0.133
16"	25	A	2.50	4.70	434	110	36.00	35.00	51.00	220.00	147.00	0.217
	75	A	2.00	2.70	1517	400	31.50	34.00	51.00	330.00	160.00	0.132
237	150	A	1.50	1.80	2625	710	31.00	33.00	51.00	340.00	170.00	0.090
sq. in.	300	A	1.50	2.90	1840	805	33.00	33.50	51.00	600.00	220.00	0.141
18"	25	A	2.50	4.10	780	250	31.00	35.00	55.00	245.00	175.00	0.194
	75	A	2.00	2.70	1440	480	32.00	34.00	55.00	350.00	180.00	0.128
299	150	A	1.50	2.00	4200	1425	31.50	33.00	55.00	365.00	200.00	0.100
sq. in.	300	A	1.50	2.50	5040	1685	33.00	34.00	55.00	730.00	275.00	0.119
20"	25	A	2.50	4.20	887	285	33.00	36.50	58.00	295.00	210.00	0.180
	75	A	2.00	2.70	1637	570	34.00	36.00	58.00	400.00	215.00	0.119
363	150	A	1.50	2.10	4650	1560	34.00	35.00	58.00	485.00	240.00	0.092
sq. in.	300	A	1.50	1.70	5610	1885	36.00	36.00	58.00	880.00	320.00	0.075
22"	25	A	2.50	3.90	915	375	34.00	36.00	60.00	320.00	225.00	0.165
	75	A	2.00	2.50	1710	670	35.00	36.00	60.00	530.00	255.00	0.109
434	150	A	1.50	1.90	4755	1915	34.00	35.00	60.00	550.00	265.00	0.085
sq. in.	300	A	1.50	1.90	9525	3865	36.00	35.00	60.00	1005.00	355.00	0.085
24"	25	A	2.50	3.50	947	425	34.00	37.00	61.00	410.00	250.00	0.153
	75	A	2.00	2.30	1770	810	35.00	36.00	61.00	605.00	260.00	0.101
511	150	A	1.50	1.80	4875	2290	34.50	35.00	61.00	635.00	290.00	0.079
sq. in.	300	A	1.50	1.80	9750	4615	36.50	35.00	61.00	1305.00	385.00	0.078
26"	25	A	2.50	4.00	1033	600	45.00	50.00	77.00	491.00	300.00	0.142
594	75	A	2.00	2.50	3570	2350	44.50	49.00	77.00	506.00	316.00	0.094
sq. in.	150	A	1.50	2.00	5250	2750	43.00	46.00	77.00	746.00	386.00	0.073
28"	25	A	2.50	4.00	1140	645	45.00	50.00	82.00	518.00	303.00	0.139
683	75	A	2.00	2.50	3855	2650	44.50	49.00	82.00	534.00	326.00	0.092
sq. in.	150	A	1.50	2.00	5625	2919	46.50	49.00	82.00	811.00	426.00	0.076
30"	25	A	2.50	3.90	1275	475	44.00	46.00	78.00	595.00	370.00	0.125
779	75	A	2.00	2.50	4125	1590	45.00	45.00	78.00	930.00	400.00	0.083
sq. in.	150	A	1.50	2.20	8280	3180	45.00	45.00	78.00	1030.00	495.00	0.073
32"	25	A	2.50	3.90	1500	795	44.00	46.00	86.00	820.00	440.00	0.116
881	75	A	2.00	2.50	4395	1521	45.00	45.00	86.00	1160.00	460.00	0.076
sq. in.	150	A	1.50	2.20	8790	3263	45.00	45.00	86.00	1215.00	565.00	0.068

* Support foot and tie rods weights extra

DUAL-FLEX SPECIFICATIONS

DESIGN DETAILS			NON-CONCURRENT MOVEMENT		SPRING RATE		OVERALL LENGTH			APPROX. WEIGHT*		
SIZE	PRESSURE psi	SERIES	AXIAL inch	LATERAL inch	AXIAL lbs./inch	LATERAL lbs./inch	FF inch	WW inch	EE inch	FF lbs.	WW lbs.	ADDED LATERAL MOVEMENT INCHES PER ADDITIONAL INCH OF SPOOL
34"	25	A	2.50	3.30	1594	750	44.00	46.00	86.00	825.00	475.00	0.111
989	75	A	2.00	2.10	4680	1437	45.00	45.00	86.00	1220.00	490.00	0.073
sq. in.	150	A	1.50	1.90	9360	3081	45.00	49.00	89.00	1307.00	600.00	0.065
36"	25	A	2.50	3.30	2850	1480	44.00	46.00	89.00	830.00	505.00	0.106
1104	75	A	2.00	2.10	4815	2590	45.00	45.00	89.00	1200.00	520.00	0.070
sq. in.	150	A	1.50	1.90	9630	5185	45.00	49.00	92.00	1400.00	635.00	0.062
38"	25	A	2.50	3.50	3007	1500	46.00	50.00	95.00	860.00	508.00	0.100
1225	75	A	2.00	2.20	5084	2675	48.00	49.00	95.00	1290.00	610.00	0.071
sq. in.	150	A	1.50	2.00	10170	5518	47.50	49.00	95.00	1620.00	713.00	0.060
40"	25	A	2.50	3.50	3167	1520	46.00	50.00	98.00	890.00	510.00	0.096
1352	75	A	2.00	2.20	5355	2760	45.00	49.00	98.00	1300.00	700.00	0.068
sq. in.	150	A	1.50	2.00	10710	5850	47.50	49.00	98.00	1840.00	790.00	0.058
42"	25	A	2.50	3.20	3210	1845	46.50	49.00	100.00	1120.00	630.00	0.093
1486	75	A	2.00	2.00	5357	3295	49.00	48.00	100.00	1985.00	650.00	0.061
sq. in.	150	A	1.50	1.80	110025	7000	49.00	52.00	103.00	1920.00	780.00	0.054
44"	25	A	2.50	3.10	3360	2095	50.00	52.00	110.00	1273.00	698.00	0.089
1625	75	A	2.00	2.00	5775	3678	52.00	51.00	110.00	2095.00	723.00	0.059
sq. in.	150	A	1.50	1.80	11550	7640	52.00	55.00	113.00	2143.00	863.00	0.052
46"	25	A	2.50	3.10	3528	2220	50.00	52.00	113.00	1349.00	732.00	0.086
1772	75	A	2.00	2.00	6038	3869	52.00	51.00	113.00	2150.00	759.00	0.056
sq. in.	150	A	1.50	1.80	11897	7960	52.00	55.00	116.00	2254.00	852.00	0.050
48"	25	A	2.50	3.10	3569	2345	50.00	52.00	116.00	1425.00	765.00	0.083
1924	75	A	2.00	2.00	6300	4060	52.00	51.00	116.00	2205.00	795.00	0.055
sq. in.	150	A	1.50	1.80	12600	8280	52.00	55.00	119.00	2365.00	945.00	0.049

* Support foot and tie rods weights extra

ASME Section IX Welding

One of Thorburn's certified ASME Section IX welders in action

Sizes available up to 144" I.D.

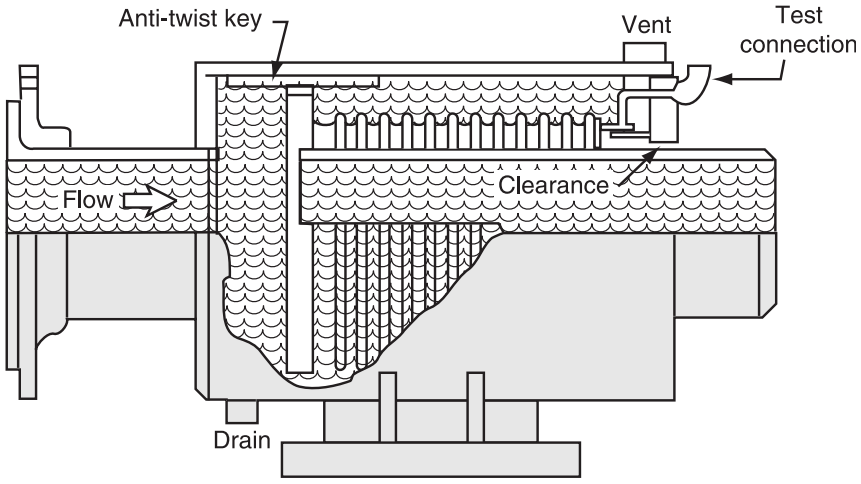
120" diameter tied universal expansion joint system

EXTRA-FLEX MODEL "EFS/EFD"
EXTERNALLY PRESSURIZED EXPANSION JOINTS

COMPARE THESE ADVANTAGES

- Up to 16" axial movement
- Leak-proof and no packing
- Maintenance free
- Design pressures up to 1000 psi
- Temperatures up to 1500ºF

Fully assembled Thorburn Extra-Flex Model EFS



Typical schematic of Thorburn Extra-Flex externally pressurized axial expansion joint system. Shown is Thorburn Model EFS single bellows design.

Cross-sectional view of Extra-Flex EFS expansion joint system

APPLICATIONS

- Replaces costly equalizing expansion joint system
- Replaces space confining pipe loop
- Replaces maintenance required slip joints
- Ideal for long pipe run steam lining that require high pressure/ temperature containment with lots of axial movement

What is Thorburn Extra-Flex expansion joint system?

Thorburn Extra-Flex expansion joint system is designed so that the pressure is external to the convolutions. This unique construction eliminates squirm, thus long axial movements are made possible even at higher pressures and temperatures.

THORBURN EXTRA-FLEX ADVANTAGES

Full thickness cover

Extra-Flex cover contains the full line pressure of the system, thus if bellows failure were to occur, the media could not escape radially outward and harm personnel in the area.

Self draining

Extra-Flex convolutions make it impossible for media collection in the bellows to cause any corrosive attack on the bellows element. The sediment or residue collects at the bottom of the casing for easy venting.

Purge and drain connector

Extra-Flex vent to assure fluid filled line and allow draining of any sediment.

Reduce installation costs

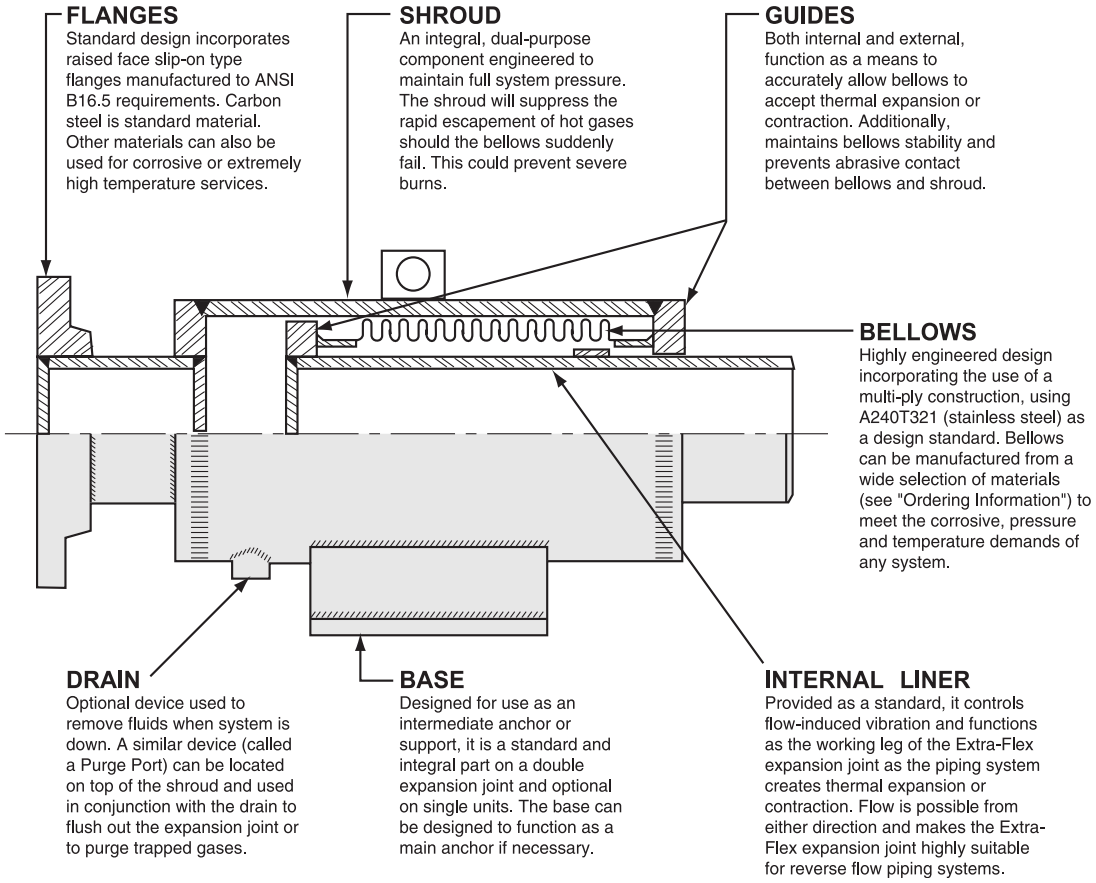
Extra-Flex bellows element is completly enclosed and there are no critical surfaces that require special precautions when handling the expansion joint during installation.

None of the slip joint disadvantages

Thorburn's Extra-Flex does not require maintenance or need lubrication or repacking, therefore making it ideal in areas where accessibility is limited.

EXTRA-FLEX MODEL "EFS/EFD"

SINGLE AND DOUBLE EXTERNALLY PRESSURIZED EXPANSION JOINT SYSTEM



EXTRA-FLEX VS EQUALIZING EXPANSION JOINTS

Costly equalizing rings, usually made from gray cast iron, are an integral part of the design requirement used by some manufacturers to achieve pressures exceeding 50 psi. Thorburn Extra-Flex state-of-the-art computer-aided technology has eliminated these rings by creating a bellows which achieves high pressures without the problems associated with equalizing rings, metal erosion from ring-to-bellows vibration and ring failure due to thermal shock; these and other potentially dangerous and costly situations are avoided when Extra-Flex is applied.

EXTRA-FLEX VS SLIP JOINTS

The vocabulary of slip joint users invariably includes the following terms: packing, leakage, periodic inspections, continual maintenance, large vaults, etc. Thorburn Extra-Flex expansion joint has eliminated these troublesome words from the expansion joint manufacturer's dictionary and replaced them with more agreeable terms: packless, all-welded construction, sealed system, leak-free and direct-burial-without-access vault. Most agreeable is the cost; substantially less than an equivalent slip joint.

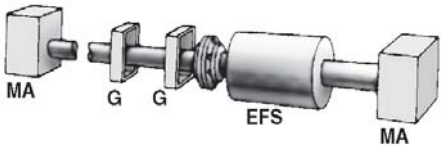
EXTRA-FLEX MODEL "EFS/EFD"
QUALITY YOU CAN DEPEND ON

Thorburn's certified welder finishing up the end plate weld on Extra-Flex EFS joint

AVAILABLE WITH A FIVE YEAR EXTENDED WARRANTY CALL THORBURN FOR DETAILS

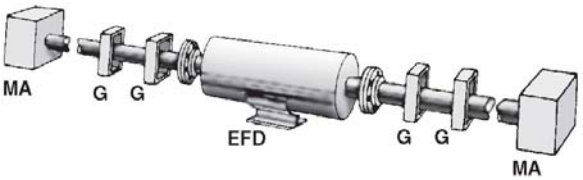
Thorburn's Extra-Flex EFS single expansion joint is normally located near an anchor at one end of a long piping run. Model EFS expansion joint should be placed with the fixed end adjacent to the anchor. Thorburn Extra-Flex double bellows "EFD" may be considered as two single "EFS" expansion joints mounted back-to-back and connected by a common casing. Thorburn Model EFD is installed in the center of a long piping run and is supplied with a support foot which acts as an intermediate anchor.

SINGLE EXTRA-FLEX MODEL EFS

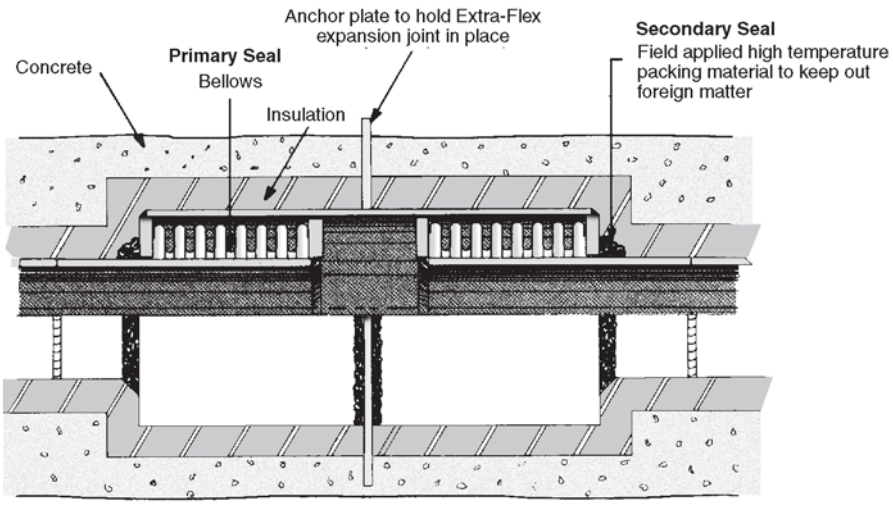


MA: Main Anchor
G: Guide
EFS: Extra-Flex Single
EFD: Extra-Flex Double

DOUBLE EXTRA-FLEX MODEL EFD



DIRECT BURIED EXTRA-FLEX



Shown typical Thorburn Model EFD

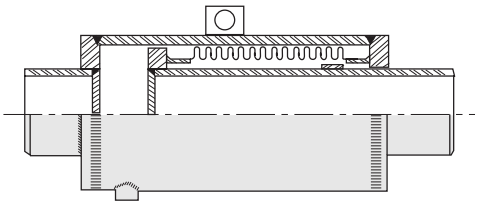
Thorburn Extra-Flex expansion joints can be directly buried in steam and condensated service. This eliminates the need for maintenance manways which are inconvenient to locate and expensive to build. Years of dependable maintenance-free buried service have proven that manways are not always required nor are they cost effective. Choose Extra-Flex money-saving approach when comparing the total installed cost of slip joints versus Thorburn Extra-Flex.

EXTRA-FLEX

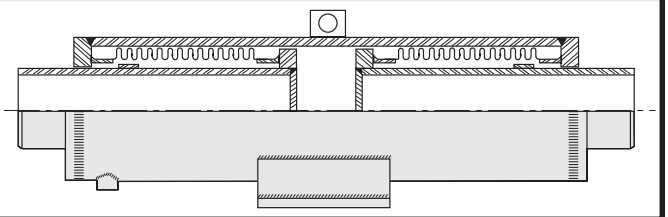
SINGLE AND DOUBLE EXTERNALLY PRESSURIZED

STYLE

EFS Single (WW shown)

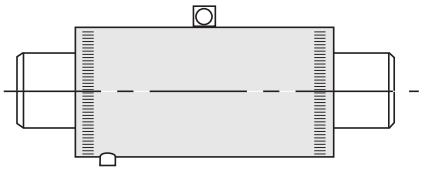


EFD Double (WW shown)

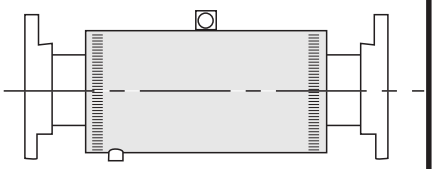


ENDS

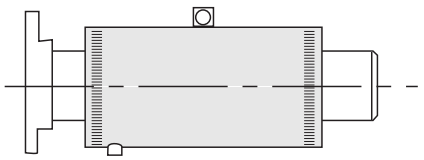
WW Weld end / Weld end



FF Flange / Flange



FW Flange / Weld end



Extra-Flex 2" single 300 psiexpansion joint c/w WW ends design for 4" axial movementc/w drain and purge connector

Bellows 321SS
Ends 304SS

Anchor 304SS
Spool 304SS

HOW TO ORDER FROM THIS CATALOGUE

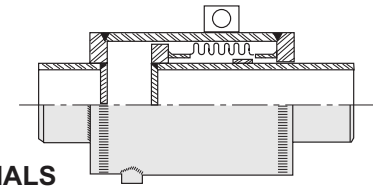
THORBURN PART NUMBER EXAMPLE									
Diameter	**Style**	**Ends**	**Pressure**	**Axial Movement**	**Optional Features**	**Bellows Material**	**End Material**	**Spool Material**	**Anchor Material**
2	**EFS**	**WW**	**300**	**4**	**DP**	**B5**	**E1**	**S1**	**A1**

OPTIONAL FEATURES

D **DRAIN CONNECTION 1/2" NPT COUPLING**

P **PURGE CONNECTION 1/2" NPT COUPLING**

A **SINGLE EXTRA-FLEX ANCHOR FOOT**



NOTES

1. Rated cycle life is 5000 for full rated movement shown on pages 57 to 63.
2. Maximum test pressure is 1-1/2 times the rated pressure.
3. Maximum installation misalignment is ± 1/4 axial and 1/16 lateral.
4. Flanges are 150 lb/300 lb RFSO per ANSI B16.5 unless specified otherwise.
5. For special components, please specify and call Thorburn with the details

STANDARD MATERIALS

Bellows: ASTM A240 T321 (B5)

Shroud: ASTM A53/A106/A570/A36/44W

Pipe: ASTM A53/A106/A570/A36/44W

Rings: ASTM A285C/A570/A36/44W

Flanges: ASTM A105/ANSI B16.5 RFSO/ A570/A36/44W

Drilling: 150# standard

300# option (Other drillings available upon request)

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
2" 12.2 sq. in.	EFS	150	S	4	0.50	170	24.00	36	26.00	46	25.00	42	5.56	4.5
			M	6	0.75	114	32.00	49	35.00	59	34.00	54		
			L	8	1.00	85	40.00	62	42.00	72	41.00	67		
		300	S	4	0.50	340	24.00	38	26.00	52	25.00	45		
			M	6	0.75	227	32.00	52	35.00	66	34.00	59		
			L	8	1.00	170	40.00	64	42.00	78	41.00	71		
	EFD	150	S	8	1.00	170	40.00	64	43.00	74	42.00	69		
			M	12	1.50	114	58.00	92	61.00	102	60.00	97		
			L	16	2.00	85	72.00	108	75.00	118	74.00	113		
		300	S	8	1.00	340	40.00	70	44.00	84	42.00	77		
			M	12	1.50	227	58.00	96	62.00	110	60.00	103		
			L	16	2.00	170	72.00	118	76.00	132	74.00	125		
2-1/2" 12.2 sq. in.	EFS	150	S	4	0.50	170	24.00	41	26.00	55	25.00	48	5.56	4.5
			M	6	0.75	114	32.00	54	35.00	68	34.00	61		
			L	8	1.00	85	40.00	62	42.00	76	41.00	69		
		300	S	4	0.50	340	24.00	42	26.00	62	25.00	62		
			M	6	0.75	228	32.00	56	35.00	76	34.00	66		
			L	8	1.00	170	40.00	65	42.00	85	41.00	75		
	EFD	150	S	8	1.00	170	40.00	71	43.00	85	42.00	78		
			M	12	1.50	114	58.00	103	61.00	117	60.00	110		
			L	16	2.00	85	72.00	126	75.00	140	74.00	133		
		300	S	8	1.00	340	40.00	73	43.00	93	42.00	83		
			M	12	1.50	227	58.00	105	61.00	125	60.00	115		
			L	16	2.00	170	72.00	128	75.00	148	74.00	138		
3" 16.3 sq. in.	EFS	150	S	4	0.50	220	24.00	52	26.00	68	25.00	60	6.63	5.0
			M	6	0.75	148	32.00	63	35.00	81	34.00	72		
			L	8	1.00	110	40.00	84	42.00	100	41.00	92		
		300	S	4	0.50	386	24.00	53	26.00	79	25.00	66		
			M	6	0.75	257	32.00	64	32.00	90	34.00	77		
			L	8	1.00	193	40.00	85	42.00	110	41.00	98		
	EFD	150	S	8	1.00	220	40.00	86	42.00	102	41.00	94		
			M	12	1.50	148	53.00	106	55.00	122	54.00	114		
			L	16	2.00	110	70.00	140	72.00	156	71.00	148		
		300	S	8	1.00	386	40.00	87	43.00	113	42.00	100		
			M	12	1.50	257	53.00	108	56.00	134	55.00	121		
			L	16	2.00	193	70.00	148	73.00	174	72.00	161		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
4" 30.7 sq. in.	EFS	150	S	4	0.50	364	24.00	86	27.00	112	26.00	98	8.63	6.0
			M	6	0.75	243	32.00	102	35.00	128	34.00	115		
			L	8	1.00	182	40.00	120	43.00	146	42.00	133		
		300	S	4	0.50	490	24.00	88	28.00	132	26.00	110		
			M	6	0.75	327	32.00	105	36.00	149	34.00	127		
			L	8	1.00	245	40.00	128	44.00	172	42.00	150		
	EFD	150	S	8	1.00	364	40.00	129	44.00	155	42.00	142		
			M	12	1.50	243	53.00	168	56.00	194	55.00	181		
			L	16	2.00	182	70.00	218	73.00	244	72.00	231		
		300	S	8	1.00	490	40.00	132	44.00	176	43.00	154		
			M	12	1.50	327	53.00	172	51.00	216	56.00	194		
			L	16	2.00	245	70.00	223	74.00	267	72.00	245		
5" 43.4 sq. in.	EFS	150	S	4	0.50	408	24.00	106	27.00	136	26.00	121	10.75	7.5
			M	6	0.75	272	30.00	126	33.00	156	32.00	141		
			L	8	1.00	204	36.00	150	39.00	180	38.00	165		
		300	S	4	0.50	532	24.00	110	28.00	166	26.00	138		
			M	6	0.75	355	30.00	130	34.00	186	32.00	158		
			L	8	1.00	266	36.00	154	40.00	210	38.00	182		
	EFD	150	S	8	1.00	408	38.00	186	41.00	216	39.00	201		
			M	12	1.50	272	50.00	225	53.00	255	51.00	240		
			L	16	2.00	204	62.00	263	65.00	293	63.00	278		
		300	S	8	1.00	532	38.00	190	42.00	246	40.00	218		
			M	12	1.50	355	50.00	230	54.00	286	52.00	258		
			L	16	2.00	266	62.00	278	66.00	334	64.00	306		
6" 54 sq. in.	EFS	150	S	4	0.50	460	24.00	124	27.00	162	26.00	143	10.75	7.5
			M	6	0.75	307	30.00	143	33.00	181	31.00	162		
			L	8	1.00	240	36.00	162	39.00	200	37.00	180		
		300	S	4	0.50	520	24.00	127	28.00	197	26.00	162		
			M	6	0.75	347	30.00	148	34.00	218	32.00	183		
			L	8	1.00	260	36.00	168	40.00	238	38.00	203		
	EFD	150	S	8	1.00	460	38.00	218	41.00	256	39.00	237		
			M	12	1.50	307	50.00	251	53.00	289	51.00	270		
			L	16	2.00	240	62.00	284	65.00	322	63.00	303		
		300	S	8	1.00	520	38.00	230	42.00	300	40.00	265		
			M	12	1.50	347	50.00	278	54.00	348	52.00	313		
			L	16	2.00	260	62.00	326	66.00	396	64.00	360		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
8" 84 sq. in.	EFS	150	S	4	0.50	756	25.00	168	28.00	228	26.00	198	12.75	8.5
			M	6	0.75	504	32.00	209	35.00	269	33.00	239		
			L	8	1.00	378	39.00	249	42.00	309	40.00	279		
		300	S	4	0.50	945	25.00	176	30.00	292	27.00	234		
			M	6	0.75	630	32.00	220	37.00	336	34.00	278		
			L	8	1.00	473	39.00	262	44.00	378	41.00	320		
	EFD	150	S	8	1.00	756	40.00	268	43.00	328	41.00	285		
			M	12	1.50	504	53.00	348	56.00	408	54.00	365		
			L	16	2.00	378	67.00	428	70.00	488	68.00	442		
		300	S	8	1.00	945	40.00	292	45.00	408	42.00	350		
			M	12	1.50	630	53.00	376	58.00	492	55.00	434		
			L	16	2.00	473	67.00	460	72.00	576	69.00	518		
10" 136 sq. in.	EFS	150	S	4	1.00	1044	26.00	248	30.00	334	28.00	284	16.00	10.5
			M	6	1.50	696	33.00	296	37.00	383	35.00	330		
			L	8	2.00	522	43.00	385	47.00	470	45.00	420		
		300	S	4	1.00	1642	26.00	260	31.00	420	28.00	340		
			M	6	1.50	1097	33.00	312	38.00	472	35.00	392		
			L	8	2.00	821	43.00	402	48.00	562	45.00	482		
	EFD	150	S	8	2.00	1044	43.00	380	47.00	466	45.00	416		
			M	12	3.00	696	58.00	480	62.00	564	60.00	515		
			L	16	4.00	522	76.00	588	80.00	670	78.00	620		
		300	S	8	2.00	1642	43.00	412	48.00	572	45.00	492		
			M	12	3.00	1097	58.00	493	63.00	650	60.00	572		
			L	16	4.00	820	76.00	662	81.00	820	78.00	740		
12" 183 sq. in.	EFS	150	S	4	1.00	1160	28.00	312	32.00	440	30.00	372	18.00	11.5
			M	6	1.50	773	35.00	426	39.00	554	37.00	486		
			L	8	2.00	580	45.00	560	49.00	686	47.00	618		
		300	S	4	1.00	2240	28.00	343	34.00	573	31.00	458		
			M	6	1.50	1493	35.00	432	41.00	552	38.00	492		
			L	8	2.00	1120	45.00	592	51.00	720	48.00	656		
	EFD	150	S	8	2.00	1160	44.00	520	48.00	648	46.00	580		
			M	12	3.00	773	59.00	652	63.00	780	61.00	712		
			L	16	4.00	580	79.00	828	83.00	956	81.00	886		
		300	S	8	2.00	2240	44.00	590	50.00	820	47.00	705		
			M	12	3.00	1493	59.00	727	65.00	855	62.00	790		
			L	16	4.00	1120	79.00	902	85.00	1032	82.00	967		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
14" 214 sq. in.	EFS	150	S	4	1.00	1128	28.00	364	32.00	540	30.00	448	20.00	12.50
			M	6	1.50	750	35.00	489	39.00	660	37.00	570		
			L	8	2.00	564	45.00	610	49.00	790	47.00	692		
		300	S	4	1.00	2362	28.00	406	34.00	736	31.00	570		
			M	6	1.50	1575	35.00	532	41.00	862	38.00	697		
			L	8	2.00	1181	45.00	648	51.00	972	48.00	810		
	EFD	150	S	8	2.00	1128	44.00	614	48.00	792	46.00	682		
			M	12	3.00	752	59.00	756	63.00	934	61.00	838		
			L	16	4.00	564	79.00	975	83.00	1143	81.00	1042		
		300	S	8	2.00	2362	45.00	682	51.00	1012	48.00	847		
			M	12	3.00	1575	60.00	850	66.00	1180	63.00	1015		
			L	16	4.00	1181	80.00	998	86.00	1347	83.00	1173		
16" 277 sq. in.	EFS	150	S	4	1.00	1328	28.00	334	33.00	530	30.00	432	22.00	13.50
			M	6	1.50	920	35.00	416	40.00	612	37.00	514		
			L	8	2.00	690	45.00	530	50.00	726	47.00	628		
		300	S	4	1.00	2216	29.00	408	35.00	788	32.00	597		
			M	6	1.50	1478	36.00	506	42.00	886	39.00	696		
			L	8	2.00	1108	46.00	658	52.00	1038	49.00	848		
	EFD	150	S	8	2.00	1328	44.00	568	49.00	764	46.00	665		
			M	12	3.00	920	59.00	726	64.00	922	61.00	824		
			L	16	4.00	690	79.00	962	84.00	1158	81.00	1060		
		300	S	8	2.00	2216	45.00	718	51.00	1098	48.00	908		
			M	12	3.00	1478	60.00	920	66.00	1300	63.00	1110		
			L	16	4.00	1108	80.00	1210	86.00	1590	83.00	1400		
18" 336 sq. in	EFS	150	S	4	1.00	1480	28.00	384	33.00	644	30.00	514	24.00	14.75
			M	6	1.50	987	35.00	452	40.00	712	37.00	582		
			L	8	2.00	740	45.00	564	50.00	824	47.00	694		
		300	S	4	1.00	2468	29.00	474	36.00	1074	32.00	759		
			M	6	1.50	1645	36.00	546	43.00	1194	39.00	879		
			L	8	2.00	1234	46.00	758	53.00	1388	49.00	1073		
	EFD	150	S	8	2.00	1480	44.00	664	49.00	924	46.00	894		
			M	12	3.00	987	59.00	822	64.00	1082	61.00	952		
			L	16	4.00	740	79.00	1026	84.00	1286	81.00	1156		
		300	S	8	2.00	2468	45.00	812	52.00	1442	48.00	1127		
			M	12	3.00	1645	60.00	1014	67.00	1644	63.00	1329		
			L	16	4.00	1234	80.00	1388	87.00	2018	83.00	1703		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
20" 403 sq. in.	EFS	150	S	4	1.00	1612	28.00	432	34.00	762	31.00	597	26.00	16.00
			M	6	1.50	1075	35.00	556	41.00	886	38.00	721		
			L	8	2.00	806	45.00	686	51.00	1016	48.00	850		
		300	S	4	1.00	3240	29.00	530	36.00	1160	32.00	845		
			M	6	1.50	2160	36.00	645	43.00	1284	39.00	969		
			L	8	2.00	1620	46.00	848	53.00	1478	49.00	1163		
	EFD	150	S	8	2.00	1612	44.00	732	50.00	1062	47.00	897		
			M	12	2.00	1075	59.00	910	65.00	1240	62.00	1075		
			L	16	4.00	806	79.00	1194	85.00	1524	82.00	1359		
		300	S	8	2.00	3240	45.00	934	52.00	1564	48.00	1249		
			M	12	3.00	2160	60.00	1232	67.00	1862	63.00	1547		
			L	16	4.00	1620	80.00	1610	87.00	2240	83.00	1925		
22" 480 sq. in.	EFS	150	S	4	1.00	1848	28.00	496	34.00	866	31.00	680	28.00	17.25
			M	6	1.50	1232	35.00	646	41.00	1016	38.00	830		
			L	8	2.00	924	45.00	835	51.00	1205	48.00	1020		
		300	S	4	1.00	3438	29.00	632	37.00	1372	33.00	1022		
			M	6	1.50	2292	36.00	774	44.00	1514	40.00	1144		
			L	8	2.00	1719	46.00	968	54.00	1708	50.00	1338		
	EFD	150	S	8	2.00	1848	44.00	816	50.00	1186	47.00	1000		
			M	12	3.00	1232	59.00	1014	65.00	1144	62.00	1079		
			L	16	4.00	924	79.00	1316	85.00	1338	82.00	1327		
		300	S	8	2.00	3438	45.00	1051	53.00	1791	49.00	1420		
			M	12	3.00	2292	60.00	1390	68.00	2130	64.00	1760		
			L	16	4.00	1719	80.00	1730	88.00	2470	84.00	2100		
24" 560 sq. in.	EFS	150	S	4	1.00	1988	28.00	612	35.00	1052	31.00	832	30.00	18.75
			M	6	1.50	1325	35.00	748	42.00	1188	38.00	968		
			L	8	2.00	994	45.00	936	52.00	1376	48.00	1156		
		300	S	4	1.00	3738	29.00	688	37.00	1638	33.00	1163		
			M	6	1.50	2492	36.00	867	42.00	1817	39.00	1342		
			L	8	2.00	1869	46.00	1042	52.00	1992	49.00	1517		
	EFD	150	S	8	2.00	1988	44.00	1004	51.00	1444	47.00	1224		
			M	12	3.00	1325	59.00	1229	66.00	1669	62.00	1449		
			L	16	4.00	994	79.00	1558	86.00	1998	82.00	1778		
		300	S	8	2.00	3738	45.00	1170	53.00	2120	49.00	1645		
			M	12	3.00	2492	60.00	1498	68.00	2448	64.00	1937		
			L	16	4.00	1869	80.00	1920	88.00	2870	84.00	2395		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

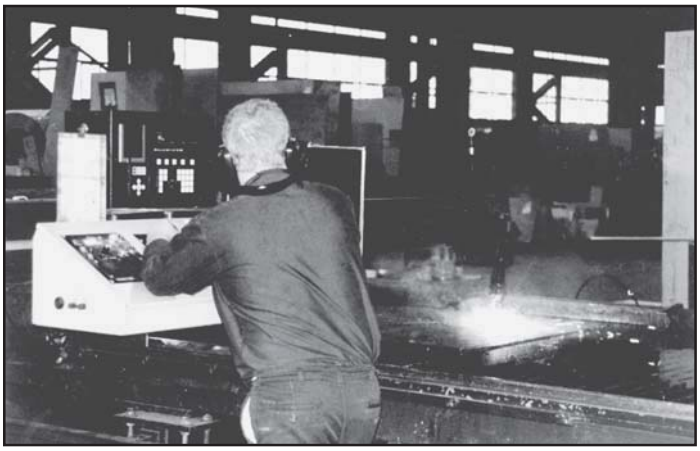
EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
26" 635 sq. in.	EFS	150	S	4	1.00	2255	24.50	507	30.50	1064	26.75	996	32.00	19.50
			M	6	1.50	1503	32.00	634	38.25	1192	34.25	884		
			L	8	2.00	1128	41.75	818	47.75	1374	44.00	1068		
		300	S	4	1.00	4510	25.00	642	34.25	1872	29.00	1212		
			M	6	1.50	3006	32.50	805	42.00	2036	36.50	1375		
			L	8	2.00	2255	42.25	1044	51.50	2274	46.25	1614		
	EFD	150	S	8	2.00	2255	42.25	915	49.75	1415	46.00	1165		
			M	12	3.00	1503	57.25	1169	65.00	1669	62.00	1419		
			L	16	4.00	1128	76.75	1537	84.25	2037	81.00	1787		
		300	S	8	2.00	4510	42.75	1156	63.50	2296	54.00	1726		
			M	12	3.00	3006	57.75	1482	68.75	2622	64.00	2052		
			L	16	4.00	2255	77.25	1960	88.00	3100	83.00	2530		
28" 730 sq. in.	EFS	150	S	4	1.00	2425	24.50	543	30.50	1173	26.75	828	34.00	21.00
			M	6	1.50	1616	32.00	679	38.00	1310	34.25	961		
			L	8	2.00	1212	41.75	875	47.75	1505	44.00	1160		
		300	S	4	1.00	4850	25.00	687	34.75	2230	29.25	1407		
			M	6	1.50	3232	32.50	862	42.50	2406	36.75	1582		
			L	8	2.00	2424	42.25	1117	52.00	2660	46.50	1837		
	EFD	150	S	8	2.00	2425	42.25	980	49.75	1556	46.00	1268		
			M	12	3.00	1616	57.25	1252	65.00	1822	62.00	1537		
			L	16	4.00	1212	76.75	1644	84.25	2214	81.00	1929		
		300	S	8	2.00	4850	42.75	1239	64.00	2679	54.00	1959		
			M	12	3.00	3232	57.75	1589	69.25	3029	64.00	2309		
			L	16	4.00	2424	77.25	2099	88.50	3519	83.00	2809		
30" 804 sq. in.	EFS	150	S	4	1.00	3925	24.50	583	30.75	1282	27.00	898	36.00	22.00
			M	6	1.50	2616	32.00	731	38.50	1431	34.50	1046		
			L	8	2.00	1962	41.75	945	48.00	1643	44.25	1260		
		300	S	4	1.00	7850	25.00	742	35.75	2484	29.75	1552		
			M	6	1.50	5233	32.50	932	43.50	2676	37.25	1742		
			L	8	2.00	3925	42.25	1214	53.00	2956	47.00	2024		
	EFD	150	S	8	2.00	3925	42.25	1052	50.00	1682	47.00	1367		
			M	12	3.00	2616	57.25	1348	67.25	1978	64.00	1663		
			L	16	4.00	1962	76.75	1776	84.50	2406	81.00	2184		
		300	S	8	2.00	7850	42.75	1339	55.00	2959	49.00	2149		
			M	12	3.00	5233	57.75	1719	70.25	3339	64.00	2529		
			L	16	4.00	3925	77.25	2283	89.50	3903	84.00	3093		

EXTRA-FLEX MODEL "EFS/EFD" SPECIFICATIONS

EXTERNALLY PRESSURIZED EXPANSION JOINTS

DESIGN DETAILS				AXIAL MOVEMENT			OVERALL LENGTH AND WEIGHT							
							STYLE							
							WW		FF		FW			
SIZE	TYPE	PRESSURE psi	SERIES	COMPRESS inch	EXTENDED inch	SPRING Rate lbs./ inch	OAL inch	WT. lbs.	OAL inch	WT. lbs.	OAL inch	WT. lbs.	SHELL O.D. inch	BASE "H" Dim. inch
32" 934 sq. in.	EFS	150	S	4	1.00	4182	24.50	619	31.50	1492	27.25	1093	38.00	23.00
			M	6	1.50	2788	32.00	776	39.25	1650	34.75	1252		
			L	8	2.00	2091	41.75	1003	48.75	1875	44.50	1477		
		300	S	4	1.00	8364	25.00	787	36.25	2705	30.00	1798		
			M	6	1.50	5576	32.50	990	44.00	2909	37.50	2001		
			L	8	2.00	4182	42.25	1288	53.50	3206	47.25	2299		
	EFD	150	S	8	2.00	4182	42.25	1158	50.75	1948	47.00	1553		
			M	12	3.00	2788	57.25	1472	70.00	2262	64.00	1867		
			L	16	4.00	2091	76.75	1926	87.50	2716	81.00	2321		
		300	S	8	2.00	8364	42.75	1494	55.50	3274	49.00	2384		
			M	12	3.00	5576	57.75	1900	70.75	3680	64.00	2790		
			L	16	4.00	4182	77.25	2496	90.00	4276	84.00	3386		
36" 1164 sq. in.	EFS	150	S	4	1.00	5398	24.50	703	31.75	1760	27.50	1276	42.00	25.25
			M	6	1.50	3600	32.00	884	39.50	1942	35.00	1459		
			L	8	2.00	2699	41.75	1148	49.00	2205	44.75	1720		
		300	S	4	1.00	10796	25.00	902	37.25	3471	30.50	2102		
			M	6	1.50	7198	32.50	1139	45.00	3710	38.00	2339		
			L	8	2.00	5398	42.25	1494	54.50	4063	47.75	2694		
	EFD	150	S	8	2.00	5398	42.25	1406	51.00	1844	47.00	1625		
			M	12	3.00	3600	57.25	1634	70.25	2594	64.00	2114		
			L	16	4.00	2699	76.75	2162	87.50	3122	81.00	2672		
		300	S	8	2.00	10796	42.75	1633	56.50	4033	49.00	2833		
			M	12	3.00	7198	57.75	2107	71.75	4507	64.00	3307		
			L	16	4.00	5398	77.25	2817	91.00	5217	84.00	4017		



STATE-OF-THE-ART PLASMA CUTTING

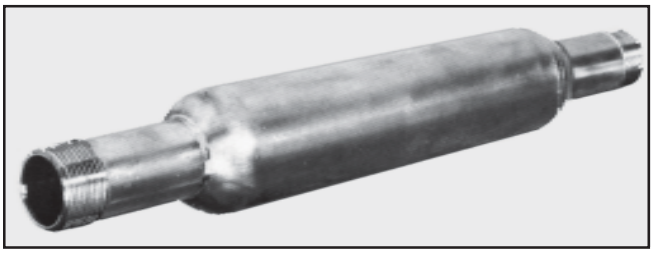
Let Thorburn's flexible piping team provide you with a timely economical pipe motion solution to your piping challenge. Shown is Thorburn's use of state-of-the-art plasma cutting highly corrosive resistant "6MO" plate.

COMP-FLEX DURABLE EXPANSION COMPENSATORS

PACKLESS GUIDED CONSTRUCTION
SIZES 3/4" TO 4"

Just what is Thorburn's Comp-Flex compensator and what does it do?

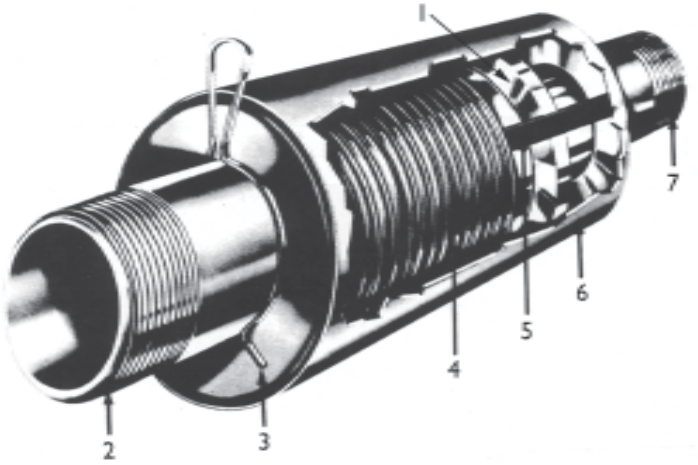
Thorburn's Comp-Flex compensators are small diameter multi-convoluted bellows. They are fully shrouded and specifically designed to absorb expansion and dimensional changes in anchored small diameter straight pipe runs.



Thorburn Model HPC-503

Also available with flanged and welded connections

Operating temperatures up to 750ºF
Operating pressures up to 175 psi



1 Internal guide ring maintains alignment of inner pipe and housing and prevents contact of the bellows and housing
2 Traveling pipe or tube isolates belows from internal flow
3 Installation clip
4 2-ply bellows for longer cycle life
5 Anti-torque device on threaded models
6 Shroud provides external protection for bellows
7 Fixed pipe or tube end

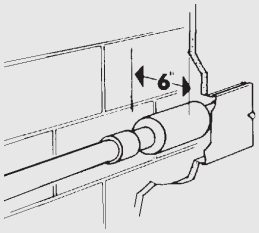
APPLICATIONS

- Heating and air conditioning piping systems
- Steam, hot water and chilled water piping systems
- Replacement of pipe-loops-slip joints

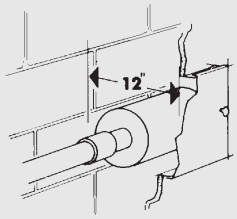
THORBURN COMP-FLEX ADVANTAGES
QUALITY • SAFETY • EXPERIENCE

- **Ends pipe expansion noise** - Uncontrolled expansion in piping systems causes unpleasant noises. Thorburn's Comp-Flex compensators eliminate this problem.
- **Minimize pressure drop** - Straight line Thorburn Comp-Flex compensators minimize pressure drop by eliminating multiple bends to absorb pipe motion.
- **Prevents pipe buckling** - When the pipeline is properly aligned, guided and anchored, all pipe movement is absorbed in the Thorburn Comp-Flex compensator.
- **Durable and maintenance-free** - Thorburn's Comp-Flex's lifetime design permits the unit to outlast most piping systems, maintenance-free.
- **Broad range sizes, end connections and material** - Thorburn Comp-Flex are available in standard sizes from 3/4" to 4" for copper tube, steel and stainless steel pipe; available connections are threaded, welded or flanged.

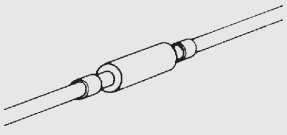
C O M P A R E



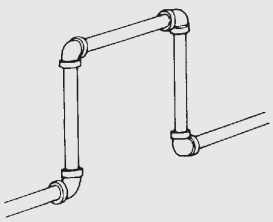
Narrow-wall construction the Thorburn Comp-Flex compensator way



Thick-wall construction the old-fashioned way



Extra piping eliminated the Thorburn Comp-Flex compensator way



Pipe-loop method the old-fashioned way

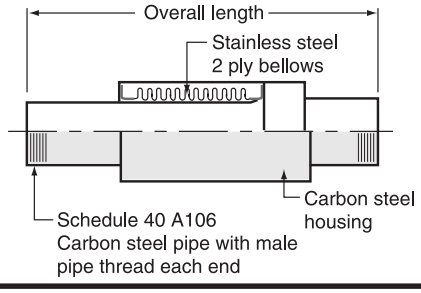
COMP-FLEX HPC SERIES

HIGH PRESSURE EXPANSION COMPENSATORS STEEL PIPE ENDS

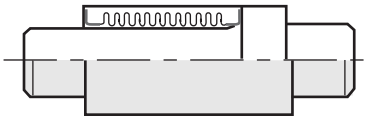
DESIGN DETAILS

Pipe expansion:	2"	Test pressure:	250 psi
Pipe contraction:	0.5"	Temperature range:	-40ºF to +750ºF
Working pressure:	175 psi	Cycle life:	10,000 full stroke cycles

HPC-503 MALE PIPE THREADS

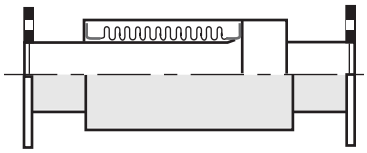


HPC-504 BEVELED FOR WELDING



Schedule 40 A106
Beveled 37.5º per ANSI B16.25

HPC-505 FIXED FLANGE



Flat face carbon steel plate flange
A36/44W per ANSI B16.5 150 lb.

Size Code HPC-503 HPC-504 HPC-505	Nominal Size (NPS)	Maximum Outside Dia. (in.)	Overall Length (in.)	Weight HPC-503 HPC-504 (lbs)	Weight HPC-505 (lbs)
12	0.75	2.375	12.750	2	6
16	1.00	2.500	13.250	3	7
20	1.25	3.000	13.250	4	10
24	1.50	3.500	14.625	5	11
32	2.00	4.000	14.625	7	17
40	2.50	5.000	16.000	11	25
48	3.00	5.563	16.000	14	30
56	3.50	6.000	16.125	18	40
64	4.00	6.625	16.375	22	48

Optional Construction

All models are available with all stainless steel materials.

HOW TO ORDER COMP-FLEX SERIES HPC

Part Number	Size Code	Option
HPC-505	32	S6

= Thorburn Comp-Flex Series HPC c/w 316SS housing and flanges 2" nominal

Size Code HPC-503 HPC-504 HPC-505	Nominal Size (NPS)	Spring Rate (lb/in)	Eff. Area ($in.^2$)	50 psi	Tabulated Force (pounds) for Individual Pressure					
					75 psi	100 psi	125 psi	150 psi	175 psi	250 psi
12	0.75	111	1.5	76	114	152	190	228	265	379
16	1.00	95	2.0	103	155	207	258	310	317	517
20	1.25	91	3.3	165	248	330	413	495	578	825
24	1.50	89	4.3	215	323	430	538	645	753	1075
32	2.00	70	6.0	313	470	627	783	940	1097	1567
40	2.50	150	8.8	438	658	877	1096	1315	1535	2192
48	3.00	150	13.1	653	979	1306	1632	1959	2285	3265
56	3.50	213	16.5	823	1234	1645	2056	2467	2879	4112
64	4.00	255	20.8	1039	1558	2077	2597	3116	3635	5194

Notes: 1) Higher pressure rating with greater movements available.
2) Available with copper tube ends Model CTC(M)(F) M = Male copper end F = Socket Female copper tube end.

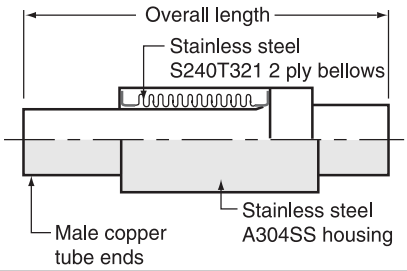
COMP-FLEX HPC SERIES

HIGH PRESSURE EXPANSION COMPENSATORS WITH COPPER TUBE ENDS

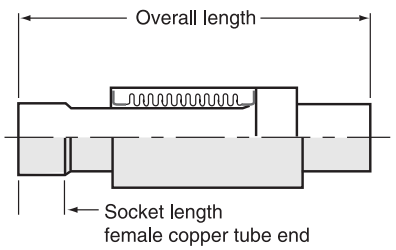
DESIGN DETAILS

Pipe expansion:	2"
Pipe contraction:	0.5"
Working pressure:	175 psi
Test pressure	250 psi
Temperature range:	-320ºF to +400ºF
Cycle life:	10,000 full stroke cycles

CTC-509 MALE COPPER TUBE ENDS



CTC-510 MALE/FEMALE COPPER TUBE ENDS



Size Code CTC-509 CTC-510	Copper Tube Size (in.)	Actual Tube O.D. (in.)	Overall Length (in.)	Outside Diameter (in.)	Socket Length (in.)	Weight (lbs)
12	0.75	0.875	11.000	1.500	0.750	0.7
16	1.00	1.125	11.250	2.375	0.875	1.0
20	1.25	1.375	12.500	2.500	1.000	1.5
24	1.50	1.625	12.875	2.500	1.188	2.0
32	2.00	2.125	13.188	3.000	1.375	2.4
40	2.50	2.625	13.500	4.000	1.500	3.6
48	3.00	3.125	14.000	4.500	1.750	4.0
56	3.50	3.625	14.500	5.000	2.000	4.5
64	4.00	4.125	14.500	5.563	2.000	6.0

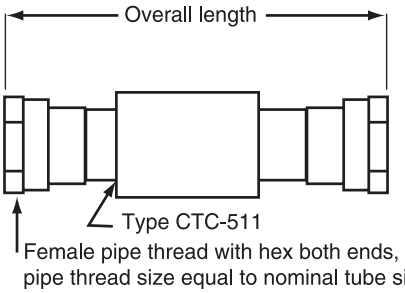
HOW TO ORDER COMP-FLEX SERIES CTC

Part Number	Size Code
CTC-509	16

= Thorburn Comp-Flex Series CTC 1" nominal c/w male copper tube ends

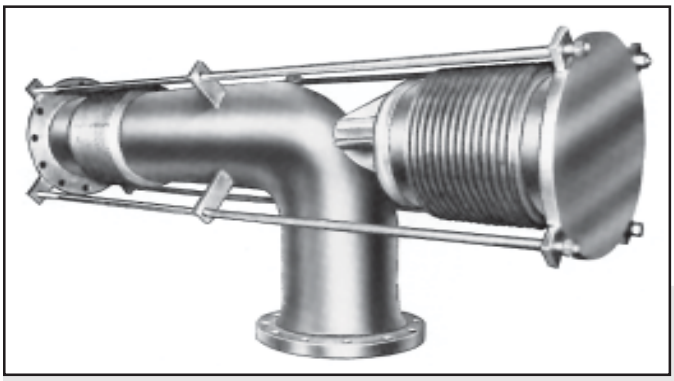
Size Code CTC-509 CTC-510	Copper Tube Size (in.)	Axial Spring Rate (lb./in.)	Eff. Area ($in.^2$)	Tabulated Force (Pounds) for Individual Pressure						
				50 psi	75 psi	100 psi	125 psi	150 psi	175 psi	250 psi
12	0.75	118	1.1	55	82	109	137	164	191	274
16	1.00	101	1.7	86	129	172	215	258	301	430
20	1.25	95	2.4	121	181	242	302	363	428	605
24	1.50	90	3.2	162	243	324	405	485	566	809
32	2.00	140	5.1	256	385	513	641	769	897	1282
40	2.50	128	7.6	378	568	757	947	1136	1325	1893
48	3.00	158	10.6	528	791	1055	1319	1583	1846	2638
56	3.50	186	16.9	845	1268	1690	2114	2536	2959	4227
64	4.00	373	17.9	897	1347	1795	2243	2692	3140	4486

Size Code	Copper Tube Size	Overall Length (in.)	Weight (lbs.)
CTC511-12	0.75	12.625	1.00
CTC511-16	1.00	13.313	1.40
CTC511-20	1.25	25.750	2.10
CTC511-24	1.50	15.250	3.80
CTC511-32	2.00	15.688	4.80



PRESSURE BALANCED EXPANSION JOINTS

ELBOW OR TEE SING-FLEX SERIES "PBES" AND UNIVERSAL SERIES "PBEU"



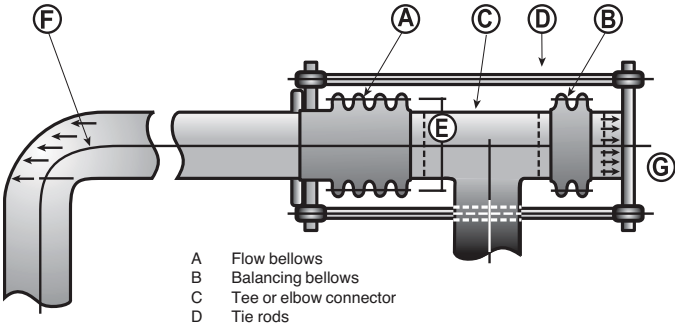
Typical Thorburn Model PBES pressure balanced elbow. These units are custom to suit specialized application requirements.

FEATURES

- Absorbs axial and lateral movements while still restraining pressure thrust
- Eliminates main anchors
- Minimum guiding required

Thorburn's Series PBES Sing-Flex and PBEU Universal are custom designed pressure balanced elbow or tee expansion joint systems. These joints are specifically designed to overcome the reaction load, due to internal pressure acting against turbine casings, pumps, structures and other equipment. They are used at a change in direction of piping where a main anchor cannot be installed, to absorb axial and lateral motion while restraining pressure thrust.

Thorburn's pressure balanced expansion joint design uses flow and balancing bellows that are inter-connected by the use of tie rods. The balancing bellows is subjected to the same line pressure as the flow bellows. As the flow bellows compresses, the tie rods make the balancing bellows extend an equal amount. Since there is no change in the volume of the system, the pressure forces remain in balance. It should be noted that when the flow bellows deflect laterally, there is no volume change and therefore the balancing bellows need only contain the proper number of convolutions required to absorb the axial movements of the system. The axial force, however, is the total of the force required to move the line bellows and balancing bellows.



A Flow bellows
B Balancing bellows
C Tee or elbow connector
D Tie rods
E Mean diameter of corrugations
F Pressure thrust of the line
G Reaction pressure thrust on the balancing end

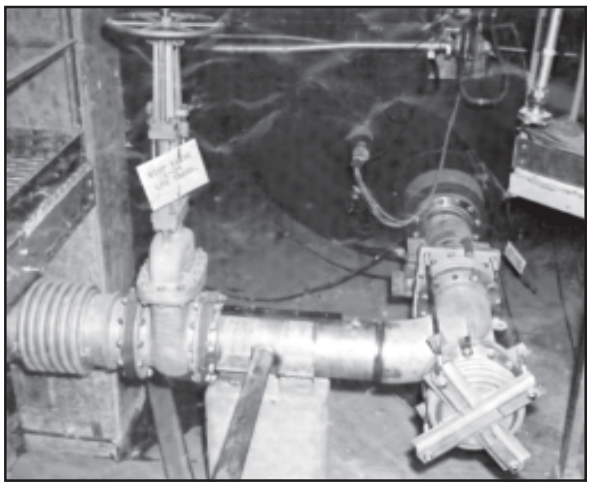
A schematic illustration showing the principle behind Thorburn pressure balance flexible piping technology.

How does Thorburn's axial pressure balance work?

Internal pressure causes a pressure thrust on flow bellows (A) and against the side outlet (elbow or tee) (C). This thrust is balanced by the identical internal pressure thrust (G) pushing on balancing bellows (B) that is transmitted back through the tie rods (D) counteracting the line pressure thrust (F). The force remaining is the axial spring force required to compress line bellows (A) and extend balancing bellows (B), plus whatever friction load is generated by the piping moving through the alignment guides.

TYPICAL APPLICATIONS

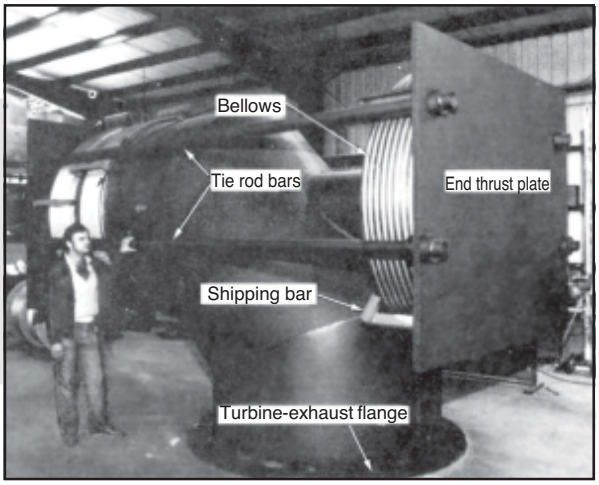
Thorburn's pressure balanced expansion joints are used where there is a change in the direction of the pipe line. The most common applications for Thorburn's pressure balanced elbow is adjacent to a piece of equipment such as a turbine, pump or valve where allowable nozzle loads necessitate the elimination of pressure thrust.

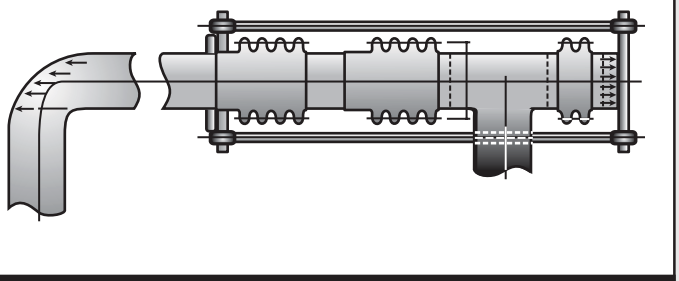


Shown is a typical pressure balanced elbow used where there is a change in the direction of the piping.

PRESSURE BALANCED EXPANSION JOINTS
ELBOW OR TEE DUAL-FLEX AND UNIVERSAL SERIES "PBEU"

Thorburn's pressure balanced elbow Model PBEU functions on the same principle as Thorburn Model PBES, except it has a universal flow bellows design. It is used when large amounts of lateral movement are required or when the lateral force must be held to a minimum. In this design, two bellows are used in the flow end of the expansion joint and single bellows in the balancing end.





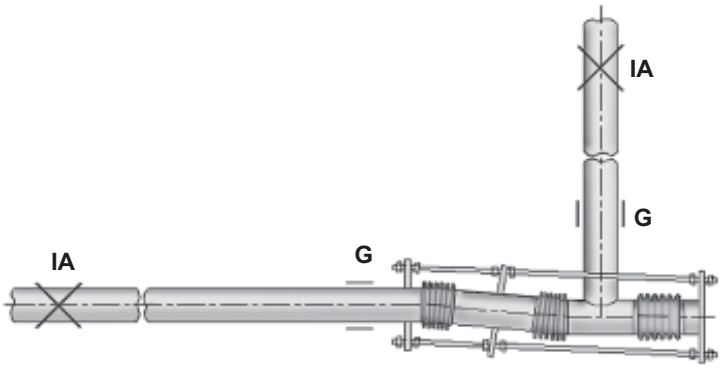
Pressure balanced joint has lateral pipe connection that can move easily between two bellows.

The use of the connecting pipe from the elbow/tee for the balancing bellows must be large enough to assure rapid equalitation of the pressure from balanced bellows with the pressure of the universal flow belows.

Where a pressure line connects to a component that is subject to a large amount of lateral deflection, Thorburn's Series PBEU is used to absorb this external lateral movement without impairing pressure loading on the system.

Thorburn's PBEU accomplishes this through a universal bellows at the flow end with a single bellows in the balancing end, joined together by four (4) tie rods. These tie rods pivot at their attachment joints. The lateral movement is taken by the flow bellows in the same manner as a tied universal expansion joint.

The sketch on the right shows a typical application of a pressure balanced expansion joint for combined axial movement and lateral deflection. The anchor on the piping run and that on the turbine are intermediate anchors and only directional guiding is required. By proper design, the guide directly above the turbine can be made to absorb the axial movement forces of the expansion joint without transmitting these to the turbine. The only force imposed on the turbine is that which is required to deflect the expansion joint laterally.

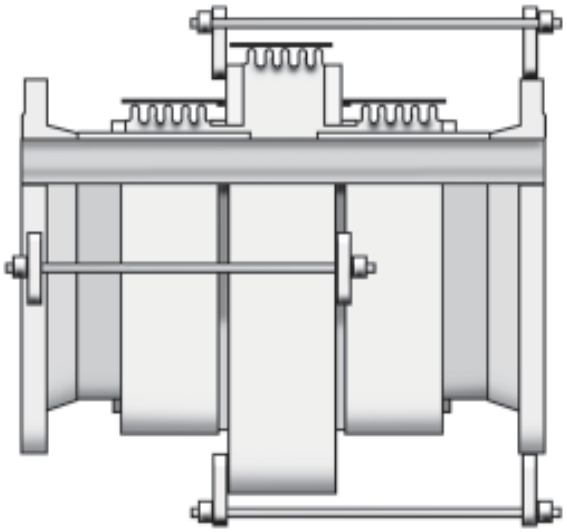


Guiding and anchoring construction in a Thorburn PBEU universal pressure balanced expansion joint system

IN-LINE PRESSURE BALANCED UNIVERSAL

FEATURES

- Eliminates pressure thrust
- Conserves space
- Eliminates main anchors
- Does not require a change in direction of the piping system



Thorburn Model IPBU universal series expansion joints are used where the location of the expansion joint prohibits or makes it very costly to install main anchors.

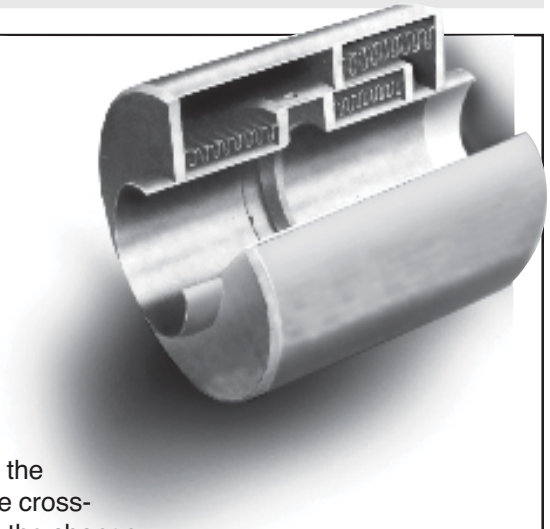
UNIVERSAL SERIES

Thorburn Model IPBU in-line pressure balanced expansion joint will absorb thermal motion while eliminating the pressure thrust loads on a piping system without a change in direction of the piping.

The unique design of this in-line pressure balanced joint consists of a constant volume device which is created by the addition of two balancing bellows whose difference in cross-sectional area is exactly twice the cross-sectional area of the line bellows. By proper cross-linking, the change in volume of the line bellows, due to a change in length (i.e. compression and/or extension) can be made to cause an equal but opposite change in volume of the balancing bellows. Thus, since the volume changes are of an equal value, the pressure forces that are normally present in a piping system containing bellows expansion joints are eliminated.

EXTERNALLY PRESSURIZED IN-LINE PRESSURE BALANCED EXPANSION JOINT SERIES IPBE

Thorburn's IPBE expansion joint is an in-line, externally pressurized pressure balanced expansion joint. This type of expansion joint is capable of long axial movements at high pressures and at the same time eliminates pressure thrust forces on the system. Main anchors are no longer required.



In-line externally pressure balanced Model IPBE absorbs large axial motion.

In order to accomplish this balancing, a constant volume device is used by the addition of a balancing bellows with a cross-sectional area equal to twice the cross-sectional area of the line or pipe size bellows. Through proper cross-linking, the change in volume of the line bellows, due to an axial change in lentgh, i.e. expansion or contraction, can be made to cause an equal but opposite change in volume of the balancing bellows. Therefore, if a contraction of the pipe occurs, an equal expansion can be made to occur in the balancing bellows. Using the principles of mechanics and hydraulics, if no volume change occurs, then all pressure forces remain constant and there are no forces out of balance. Thus the pressure thrust that would normally be present in a piping system containing an expansion joint is eliminated.

This unique design incorporates integral guide rings, a full thickness cover, self-draining convolutions and insensitivity to flow. It is easy to insulate and easy to handle during installation.

Similar to the standard Thorburn Extra-Flex expansion joint, it can be supplied either as a single or double. Either type can be supplied with a support foot which would act as an intermediate anchor.

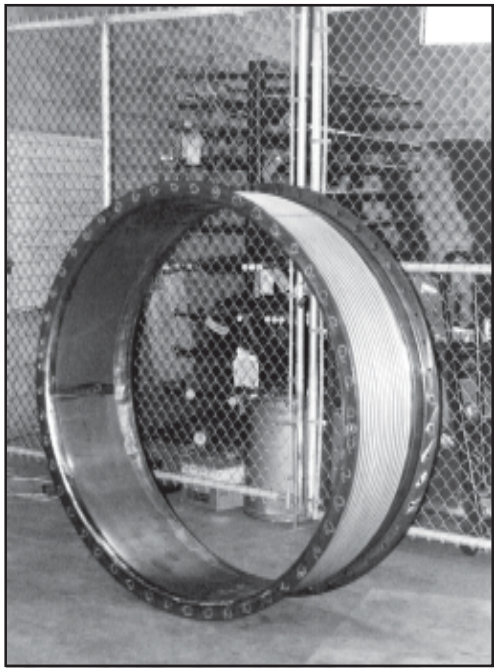
If high pressure thrust loads are causing the design of main anchors to be prohibitively costly and/or difficult, eliminate them by using Thorburn IPBE expansion joints.

DUCTFLEX SERIES SDF

ROUND METALLIC DUCTING EXPANSION JOINT TECHNOLOGY

DESIGN

Thorburn round Ductflex expansion joints are designed in accordance with the Fifth and Sixth Editions of the Standards of the Expansion Joint Manufacturers Association (E.J.M.A.) for use in dust collection and fume extraction duct systems. The pressure ranges are ±5 psi temperatures to 1800ºF (982ºC) depending on materials.



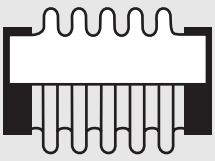
BELLOWS

Thorburn round Ductflex bellows are precision formed from cylinders of deep draw quality annealed sheets conforming to ASTM/ASME specifications. Bellows have a minimum of longitudinal seams, the same thickness as parent material, to insure uniform stress distribution and long service life.

TYPES/SIZES

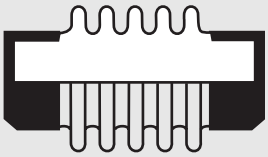
Thorburn round Ductflex expansion joints are available in sizes from 12" I.D. to 18 feet and can be supplied with lining purge nipples protective/insulating covers and special thermical packing for dust application.

COLLAR ENDS Code "CC"



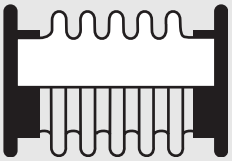
1/4" thick X 1-1/2 wide collars are designed to slip over duct and connect with a fillet weld. Carbon steel is standard. Other alloys furnished if specified.

WELD ENDS Code "WW"



1/4" thick and 3" wide with beveled ends designed to be butt welded to duct. Carbon steel is standard. Other alloys furnished if specified.

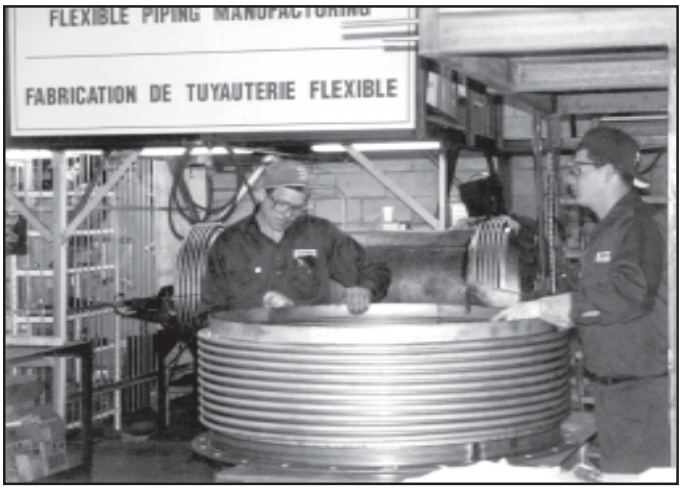
FLANGED ENDS Code "AF"



Standard carbon steel angle flanged ends are dimensioned on page 75. Companion flanges will be furnished when specified. Other alloys and sizes available upon request.

All Thorburn welders and procedures are qualified as ASME Section IX

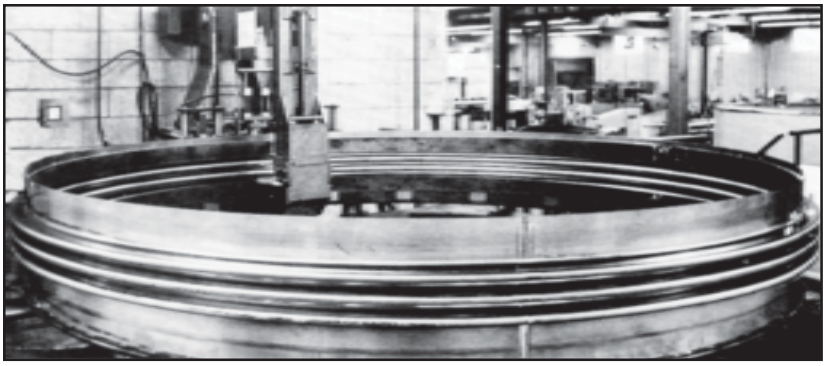
Thorburn professionals provide consistant quality you can always count on!



Thorburn expansion joint team of skilled craftsmen preparing a Thorburn Ductflex expansion joint for angle flange placement.

DUCTFLEX

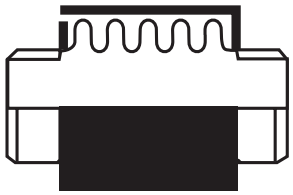
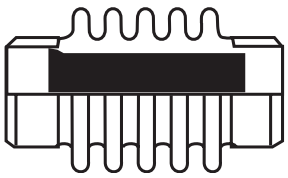
ROUND METALLIC DUCTING EXPANSION JOINTS
ENVIRONMENTAL PROTECTION TECHNOLOGY

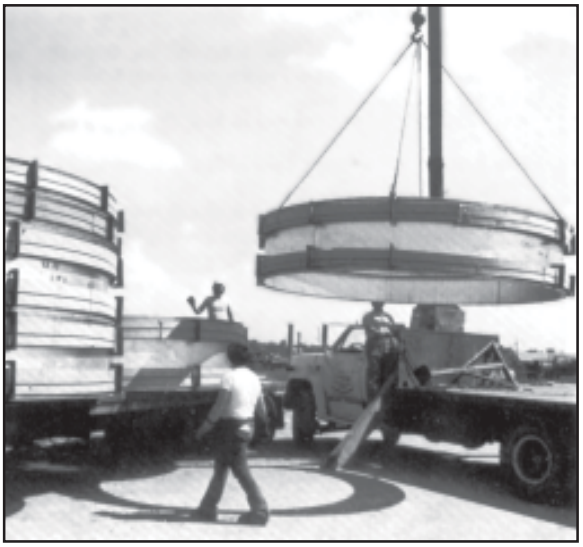


Thorburn Ductflex round expansion joints are made from welded tubes, then roll formed on special forming machines. In sizes 1" up to 16' I.D.

ALSO AVAILABLE IN DUAL BELLOWS AND RECTANGULAR DESIGNS

THORBURN DUCTFLEX OPTIONS

COVERS	LINERS
	
External covers should be specified to protect the bellows from mechanical damage or where the expansion joint will be insulated. Thorburn standard material is carbon steel.	Thorburn internal liners should be specified when flow velocity exceeds 25 FPS or where abrasive particles in the gas stream could cause erosion of the bellows.



16' round environmental ducting expansion joints being shiped to an iron ore smelter application. Shown with protective covers.

HOW TO ORDER THORBURN ROUND DUCTFLEX SERIES SDF DUCTING EXPANSION JOINTS

EXPLANATION

Size Duct (inches)	O.A.L. (inches)	Series	End Type	Style or Convo-lutions	Temp. ºF	Design Pressure Positive/ Negative (in. H_2O)	Bellows Material	Ends Material	Liner Material	Cover Material
							(For material codes, see page 12)			

PART NUMBER EXAMPLE

48	15	SDF	FF	C	800	75/50	B5	E3	L5	C0

for 48" I.D. by 15" O.A.L. single Ductflex belows expansion joint with flange ends "C" style with 800ºF with design pressure 75 to 50 psi, 321SS. Ends in 316SS and 321 carbon steel cover.

Note 1: Series DDF = Universal bellows.
Note 2: For all material codes please see page 12.

DUCTFLEX SINGLE BELLOWS SERIES "SDF"

ROUND METALLIC DUCTING EXPANSION JOINT SPECIFICATIONS

		NON-CONCURRENT MOVEMENTS			SPRING RATE			CC		WW		AF		ANGLE FLANGE DATA		
SIZE	STYLE	AXIAL inch	LATERAL inch	ANGULAR degree	AXIAL lbs/in	LATERAL lbs/in	ANGULAR lbs/deg	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	BOLT CIRCLE inch	HOLE DIA. inch	NO OF HOLES
12" 151 sq. in.	A	1.20	0.079	9.80	780	29500	330	5.750	11	8.750	19	5.750	15	**14.563**	**.406**	**12**
	B	2.00	0.220	16.00	470	6380	200	7.625	13	10.625	21	7.625	17			
	C	4.00	0.880	20.00	235	800	100	12.250	17	15.250	25	12.250	21			
	D	6.00	1.990	20.00	155	235	65	16.875	21	19.875	29	16.875	25			
14" 185 sq. in.	A	1.20	0.072	9.00	745	33700	375	5.750	13	8.750	21	5.750	17	**15.813**	**.406**	**12**
	B	2.00	0.200	15.00	445	7280	225	7.625	14	10.625	23	7.625	19			
	C	4.00	0.810	20.00	225	910	115	12.250	19	15.250	28	12.250	24			
	D	6.00	1.810	20.00	150	270	75	16.875	24	19.875	33	16.875	29			
16" 237 sq. in.	A	1.20	0.075	7.90	635	26500	420	6.250	15	9.250	25	6.750	23	**18.125**	**.406**	**16**
	B	2.00	0.210	13.00	380	5720	250	8.500	17	11.500	27	9.000	25			
	C	4.00	0.840	20.00	190	715	126	14.000	23	17.000	33	14.500	31			
	D	6.00	1.900	20.00	125	210	85	19.500	28	22.500	38	20.000	36			
18" 298 sq. in.	A	1.20	0.068	7.00	1185	62000	980	6.250	18	9.250	30	6.750	27	**20.125**	**.406**	**16**
	B	2.00	0.190	11.00	710	13400	590	8.500	22	11.500	34	9.000	31			
	C	4.00	0.750	20.00	355	1675	295	14.000	31	17.000	43	14.500	40			
	D	6.00	1.690	20.00	235	500	195	19.500	40	22.500	52	20.000	49			
20" 362 sq. in.	A	1.20	0.061	6.40	1320	84000	1330	6.250	20	9.250	33	6.750	29	**22.125**	**.406**	**20**
	B	2.00	0.170	10.00	790	18100	800	8.500	23	11.500	37	9.000	33			
	C	4.00	0.680	20.00	395	2270	400	14.000	34	17.000	48	14.500	44			
	D	6.00	1.530	20.00	265	670	265	19.500	44	22.500	58	20.000	54			
22" 434 sq. in.	A	1.20	0.056	5.80	1450	110600	1750	6.250	22	9.250	36	6.750	32	**24.125**	**.563**	**20**
	B	2.00	0.160	9.70	873	23900	1050	8.500	27	11.500	41	9.000	37			
	C	4.00	0.620	19.00	435	2990	525	14.000	38	17.000	52	14.500	48			
	D	6.00	1.400	20.00	290	885	350	19.500	49	22.500	63	20.000	59			
24" 512 sq. in.	A	1.20	0.520	5.40	1590	142000	2255	6.250	24	9.250	40	6.750	36	**26.125**	**.563**	**20**
	B	2.00	0.140	8.90	950	30800	1350	8.500	29	11.500	45	9.000	41			
	C	4.00	0.570	18.00	475	3845	675	14.000	41	17.000	57	14.500	53			
	D	6.00	1.290	20.00	320	1140	450	19.500	53	22.500	69	20.000	65			
26" 594 sq. in.	A	1.20	0.480	5.00	1640	171000	2700	6.250	26	9.250	43	7.250	43	**28.5**	**.563**	**24**
	B	2.00	0.130	8.30	985	36900	1625	8.500	30	11.500	48	9.500	48			
	C	4.00	0.530	16.00	492	4600	810	14.000	44	17.000	62	15.000	62			
	D	6.00	1.200	20.00	330	1370	540	19.500	57	22.500	75	20.500	75			
28" 683 sq. in.	A	1.20	0.450	4.70	1770	212000	3360	6.250	28	9.250	47	7.250	46	**30.5**	**.563**	**24**
	B	2.00	0.120	7.70	1060	45800	2020	8.500	34	11.500	53	9.500	52			
	C	4.00	0.500	15.00	530	5730	1010	14.000	48	17.000	67	15.000	66			
	D	6.00	1.110	20.00	355	1700	670	19.500	62	22.500	81	20.500	80			
30" 779 sq. in.	A	1.20	0.420	4.30	1900	260000	4110	6.250	30	9.250	50	7.250	50	**32.5**	**.563**	**28**
	B	2.00	0.110	7.30	1140	56000	2470	8.500	36	11.500	56	9.500	56			
	C	4.00	0.460	14.00	570	7010	1235	14.000	51	17.000	71	15.000	71			
	D	6.00	1.050	20.00	380	2075	820	19.500	67	22.500	87	20.500	87			
32" 881 sq. in.	A	1.20	0.040	4.10	2030	314000	4965	6.250	31	9.250	52	7.250	52	**34.5**	**.563**	**28**
	B	2.00	0.110	6.80	1215	67700	2980	8.500	38	11.500	59	9.500	59			
	C	4.00	0.440	13.00	610	8470	54	17.000	75	15.000	75	15.000	75			
	D	6.00	0.980	20.00	405	2510	995	19.500	71	22.500	92	20.500	92			

DUCTFLEX SINGLE BELLOWS SERIES "SDF"

ROUND METALLIC DUCTING EXPANSION JOINT SPECIFICATIONS

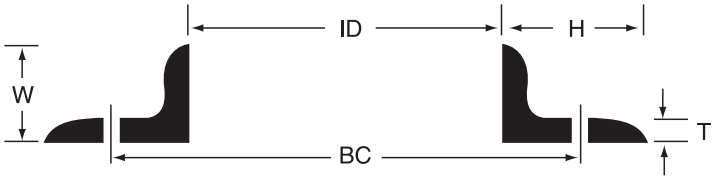
		NON-CONCURRENT MOVEMENTS			SPRING RATE			CC		WW		AF		ANGLE FLANGE DATA		
SIZE	STYLE	AXIAL inch	LATERAL inch	ANGULAR degree	AXIAL lbs/in	LATERAL lbs/in	ANGULAR lbs/deg	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	BOLT CIRCLE inch	HOLE DIA. inch	NO OF HOLES
34" 989 sq. in.	A	1.20	0.037	3.80	2156	374000	5930	6.250	33	9.250	56	7.250	56	**36.5**	**.563**	**32**
	B	2.00	0.100	6.40	1295	80900	3560	8.500	40	11.500	63	9.500	63			
	C	4.00	0.410	13.00	645	10100	1780	14.000	57	17.000	80	15.000	80			
	D	6.00	0.930	19.00	430	2995	1185	19.500	75	22.500	98	20.500	98			
36" 1104 sq. in.	A	1.20	0.035	3.60	3770	730000	11500	6.250	38	9.250	62	7.250	62	**38.5**	**.563**	**32**
	B	2.00	0.100	6.10	2260	158000	6940	8.500	47	11.500	71	9.500	71			
	C	4.00	0.390	12.00	1130	19700	3470	14.000	69	17.000	93	15.000	93			
	D	6.00	0.880	18.00	750	5840	2310	19.500	92	22.500	116	20.500	116			
38" 1225 sq. in.	A	1.20	0.033	3.50	3980	856000	13500	6.250	39	9.250	64	7.250	63	**40.5**	**.563**	**36**
	B	2.00	0.093	5.80	2390	185000	8135	8.500	49	11.500	74	9.500	73			
	C	4.00	0.370	11.00	1195	23100	4070	14.000	72	17.000	97	15.000	96			
	D	6.00	0.840	17.00	795	6850	2710	19.500	96	22.500	121	20.500	120			
40" 1352 sq. in.	A	1.20	0.032	3.30	4195	995000	15760	6.250	41	9.250	67	7.250	67	**42.5**	**.563**	**36**
	B	2.00	0.088	5.50	2520	215000	9460	8.500	51	11.500	76	9.500	76			
	C	4.00	0.350	11.00	1260	26800	4730	14.000	76	17.000	102	15.000	102			
	D	6.00	0.800	16.00	840	7960	3150	19.500	101	22.500	127	20.500	127			
42" 1485 sq. in.	A	1.20	0.030	3.10	4410	1149000	18200	6.250	44	9.250	72	7.250	71	**44.5**	**.563**	**40**
	B	2.00	0.084	5.30	2645	248000	10900	8.500	54	11.500	82	9.500	81			
	C	4.00	0.340	10.00	1325	31000	5460	14.000	80	17.000	108	15.000	107			
	D	6.00	0.760	15.00	880	9195	3640	19.500	106	22.500	134	20.500	133			
44" 1625 sq. in.	A	1.20	0.029	3.00	4620	131800	20870	6.250	46	9.250	75	7.250	75	**46.5**	**.563**	**40**
	B	2.00	0.081	5.00	2775	285000	12500	8.500	56	11.500	85	9.500	85			
	C	4.00	0.320	10.00	1385	35600	6260	14.000	84	17.000	113	15.000	113			
	D	6.00	0.730	15.00	925	10500	4175	19.500	111	22.500	140	20.500	140			
46" 1771 sq. in.	A	1.20	0.280	2.90	4835	1503000	23800	6.250	48	9.250	79	7.250	79	**48.5**	**.563**	**44**
	B	2.00	0.077	4.80	2900	325000	14300	8.500	60	11.500	91	9.500	91			
	C	4.00	0.310	9.60	1450	40600	7140	14.000	88	17.000	119	15.000	119			
	D	6.00	0.690	14.00	965	12000	4760	19.500	117	22.500	148	20.500	148			
48" 1923 sq. in.	A	1.20	0.027	2.80	5050	1704000	27000	6.250	50	9.250	82	7.250	82	**50.5**	**.563**	**44**
	B	2.00	0.074	4.60	3030	368000	16200	8.500	62	11.500	94	9.500	94			
	C	4.00	0.290	9.30	1515	46000	8095	14.000	92	17.000	124	15.000	124			
	D	6.00	0.670	14.00	1010	13600	5395	19.500	122	22.500	154	20.500	154			
50" 2123 sq. in.	A	1.10	0.022	2.50	7175	3233000	42300	6.000	56	9.000	89	9.000	131	**53.5**	**.688**	**48**
	B	2.30	0.087	5.00	3585	404000	21100	9.000	78	12.000	111	12.000	153			
	C	4.50	0.350	10.00	1795	50500	10600	15.000	123	18.000	156	18.000	198			
	D	6.80	0.780	15.00	1195	14900	7050	21.000	168	24.000	201	24.000	243			
52" 2289 sq. in.	A	1.10	0.021	2.40	7465	362800	47500	6.000	59	9.000	94	9.000	138	**55.5**	**.688**	**48**
	B	2.30	0.084	4.80	3730	454000	23700	9.000	82	12.000	127	12.000	161			
	C	4.50	0.330	9.60	1865	56700	11900	15.000	129	18.000	164	18.000	208			
	D	6.80	0.750	14.00	1244	16800	7900	21.000	176	24.000	211	24.000	255			
54" 2462 sq. in.	A	1.10	0.020	2.30	7750	4054000	53000	6.000	61	9.000	97	9.000	145	**57.5**	**.688**	**52**
	B	2.30	0.081	4.60	3880	507000	26500	9.000	85	12.000	121	12.000	169			
	C	4.50	0.320	9.20	1940	63300	13300	15.000	134	18.000	170	18.000	218			
	D	6.80	0.730	14.00	1290	18800	8845	21.000	183	24.000	219	24.000	267			

DUCTFLEX SINGLE BELLOWS SERIES "SDF"

ROUND METALLIC DUCTING EXPANSION JOINT SPECIFICATIONS

		NON-CONCURRENT MOVEMENTS			SPRING RATE			CC		WW		AF		ANGLE FLANGE DATA		
SIZE	STYLE	AXIAL inch	LATERAL inch	ANGULAR degree	AXIAL lbs/in	LATERAL lbs/in	ANGULAR lbs/deg	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	O.A.L. inch	WEIGHT lbs	BOLT CIRCLE inch	HOLE DIA. inch	NO OF HOLES
60" 3017 sq. in.	A	1.10	0.018	2.10	8630	5530000	724000	6.000	67	9.000	107	9.000	163	**63.5**	**.688**	**56**
	B	2.30	0.073	4.20	4315	691000	362000	9.000	94	12.000	134	12.000	190			
	C	4.50	0.290	8.40	2160	86400	18100	15.000	149	18.000	189	18.000	245			
	D	6.80	0.660	13.00	1440	25600	12100	21.000	203	24.000	243	24.000	299			
66" 3630 sq. in.	A	1.10	0.017	1.90	9510	7327000	95900	6.000	74	9.000	118	9.000	184	**69.5**	**.688**	**60**
	B	2.30	0.066	3.80	4755	916000	47900	9.000	104	12.000	148	12.000	214			
	C	4.50	0.270	7.60	2375	1115000	24000	15.000	163	18.000	207	18.000	273			
	D	6.80	0.600	11.00	1585	35700	16000	21.000	223	24.000	267	24.000	333			
72" 4299 sq. in.	A	1.10	0.015	1.70	10400	9476000	124000	6.000	81	9.000	139	9.000	273	**75.5**	**.688**	**68**
	B	2.30	0.061	3.50	5190	1185000	62000	9.000	113	12.000	161	12.000	305			
	C	4.50	0.240	7.00	2595	148000	31000	15.000	178	18.000	226	18.000	370			
	D	6.80	0.550	10.00	1730	43900	20600	21.000	237	24.000	285	24.000	435			
78" 5024 sq. in.	A	1.10	0.014	1.60	11260	12010000	157000	6.000	87	9.000	139	9.000	295	**81.5**	**.688**	**72**
	B	2.30	0.056	3.20	5630	1501000	78600	9.000	123	12.000	175	12.000	331			
	C	4.50	0.200	5.70	2815	187000	39300	15.000	193	18.000	245	18.000	401			
	D	6.80	0.450	8.60	1875	55600	26200	21.000	264	24.000	316	24.000	472			
84" 5806 sq. in.	A	1.10	0.013	1.50	12100	14958000	195800	6.000	94	9.000	150	9.000	321	**87.5**	**.813**	**76**
	B	2.30	0.053	3.00	6070	1870000	98000	9.000	132	12.000	188	12.000	359			
	C	4.50	0.210	6.00	3035	234000	48900	15.000	208	18.000	264	18.000	435			
	D	6.80	0.470	9.00	2025	69200	32600	21.000	284	24.000	340	24.000	511			
90" 6644 sq. in.	A	1.10	0.012	1.40	13000	18355000	240000	6.000	101	9.000	161	9.000	344	**93.5**	**.813**	**80**
	B	2.30	0.049	2.80	6500	2294000	121000	9.000	142	12.000	202	12.000	385			
	C	4.50	0.200	5.60	3250	287000	60000	15.000	223	18.000	283	18.000	466			
	D	6.80	0.440	8.40	2170	85000	40000	21.000	303	24.000	363	24.000	546			
96" 7539 sq. in.	A	1.10	0.011	1.30	13900	22229000	291000	6.000	108	9.000	172	9.000	374	**99.5**	**.813**	**88**
	B	2.30	0.046	2.60	6945	2778000	145500	9.000	151	12.000	215	12.000	417			
	C	4.50	0.180	5.30	3475	347000	72700	15.000	238	18.000	302	18.000	504			
	D	6.80	0.420	7.90	2315	103000	48500	21.000	324	24.000	388	24.000	590			
108" 9499 sq. in.	A	1.10	0.010	1.20	14900	30145000	395000	6.000	121	9.000	193	9.000	423	**111.5**	**.813**	**100**
	B	2.30	0.041	2.30	7475	3767000	197000	9.000	170	12.000	242	12.000	472			
	C	4.50	0.160	4.70	3735	471000	98600	15.000	267	18.000	339	18.000	569			
	D	6.80	0.370	7.00	2490	140000	65800	21.000	365	24.000	437	24.000	667			
120" 11684 sq. in.	A	1.10	0.009	1.10	16600	41238000	540000	6.000	134	9.000	214	9.000	474	**123.5**	**.813**	**108**
	B	2.30	0.037	2.10	8310	5154000	270000	9.000	189	12.000	269	12.000	529			
	C	4.50	0.150	4.20	4155	644000	135000	15.000	297	18.000	377	18.000	637			
	D	6.80	0.330	6.40	2770	191000	90000	21.000	405	24.000	485	24.000	745			
132" 14095 sq. in.	A	1.10	0.008	1.00	18300	54764000	717000	6.000	148	9.000	236	9.000	525	**135.5**	**.813**	**120**
	B	2.30	0.033	1.90	9150	6845000	358000	9.000	208	12.000	296	12.000	585			
	C	4.50	0.130	3.90	4575	856000	179000	15.000	327	18.000	415	18.000	704			
	D	6.80	0.300	5.80	3045	254000	119000	21.000	446	24.000	534	24.000	823			
144" 16733 sq. in.	A	1.10	0.008	0.89	20000	70996000	915000	6.000	162	9.000	258	9.000	576	**147.5**	**.813**	**132**
	B	2.30	0.031	1.80	10000	8870000	464000	9.000	227	12.000	323	12.000	641			
	C	4.50	0.120	3.50	5000	1109000	232000	15.000	356	18.000	452	18.000	770			
	D	6.80	0.280	5.30	3300	328000	155000	21.000	487	24.000	583	24.000	901			

MATING ANGLE FLANGES FOR DUCTFLEX EXPANSION JOINTS



- **ECONOMICAL FLANGES FOR LOW PRESSURE SERVICE**
- **CAN BE ADDED TO DUCTFLEX SINGLE AND DUAL DUCTFLEX EXPANSION JOINTS**

Thorburn Part Number	Nominal Diameter (inch)	Actual I.D. (inch)	Angle Thickness "T" (inch)	"H"	"W"	Revised Ductflex "CC" OAL	Weight (approx) Lbs	BOLT HOLES		
								Bolt Circle (inch)	Hose Size (inch)	Number of Holes
MAF14*	14	14.188	0.188	1.50	1.50	+ .5	7.00	15.813	0.406	12
MAF16*	16	16.250	0.188	1.75	1.75	+ 1	9.50	18.125	0.406	16
MAF18*	18	18.250	0.188	1.75	1.75	+ 1	10.50	20.125	0.406	16
MAF20*	20	20.250	0.188	1.75	1.75	+ 1	11.60	22.125	0.406	20
MAF22*	22	22.250	0.188	1.75	1.75	+ 1	12.80	24.125	0.563	20
MAF24*	24	24.250	0.188	1.75	1.75	+ 1	14.00	26.125	0.563	20
MAF26*	26	26.250	0.188	2.00	2.00	+ 1.50	17.30	28.500	0.563	24
MAF28*	28	28.250	0.188	2.00	2.00	+ 1.50	18.50	30.500	0.563	24
MAF28*	30	30.250	0.188	2.00	2.00	+ 1.50	20.00	32.500	0.563	28
MAF32*	32	32.250	0.188	2.00	2.00	+ 1.50	21.30	34.500	0.563	28
MAF34*	34	34.250	0.188	2.00	2.00	+ 1.50	22.50	36.500	0.563	32
MAF36*	36	36.250	0.188	2.00	2.00	+ 1.50	23.80	38.500	0.563	32
MAF38*	38	38.250	0.188	2.00	2.00	+ 1.50	24.60	40.500	0.563	36
MAF40*	40	40.250	0.188	2.00	2.00	+ 1.50	26.20	42.500	0.563	36
MAF42*	42	42.250	0.188	2.00	2.00	+ 1.50	27.50	44.500	0.563	40
MAF44*	44	44.250	0.188	2.00	2.00	+ 1.50	28.80	46.500	0.563	40
MAF46*	46	46.250	0.188	2.00	2.00	+ 1.50	30.00	48.500	0.563	44
MAF48*	48	48.250	0.188	2.00	2.00	+ 1.50	31.50	50.500	0.563	44
MAF50*	50	50.250	0.250	3.00	3.00	+ 3.50	54.00	53.500	0.688	48
MAF52*	52	52.250	0.250	3.00	3.00	+ 3.50	57.00	55.500	0.688	48
MAF54*	54	54.250	0.250	3.00	3.00	+ 3.50	59.70	57.500	0.688	52
MAF60*	60	60.250	0.250	3.00	3.00	+ 3.50	68.20	63.500	0.688	56
MAF66*	66	66.250	0.250	3.00	3.00	+ 3.50	76.70	69.500	0.688	60
MAF72*	72	72.313	0.375	3.00	3.00	+ 3.50	119.30	75.500	0.688	68
MAF84*	84	84.313	0.375	3.00	3.00	+ 3.50	141.90	87.500	0.813	76
MAF96*	96	96.313	0.375	3.00	3.00	+ 3.50	164.50	99.500	0.813	88
MAF108*	108	108.375	0.375	3.00	3.00	+ 3.50	187.30	111.500	0.813	100
MAF120*	120	120.375	0.375	3.00	3.00	+ 3.50	209.90	123.500	0.813	108
MAF132*	132	132.375	0.375	3.00	3.00	+ 3.50	232.50	135.500	0.813	120
MAF144*	144	144.375	0.375	3.00	3.00	+ 3.50	255.10	147.500	0.813	132

* = Material code (see codes page 12)

For other mating flange styles, call Thorburn for details.

DUCTFLEX
RECTANGULAR METAL DUCTING EXPANSION JOINTS

Thorburn Ductflex rectangular expansion joints are designed in accordance with the Sixth (6th) edition of the standards of the Expansion Joint Manufacturers Association (E.J.M.A.). Thorburn Met-Ductflex expansion joints are specifically designed to isolate, absorb or compensate for duct motion problems found in ducting systems (i.e. thermal growth, vibration, agitation).

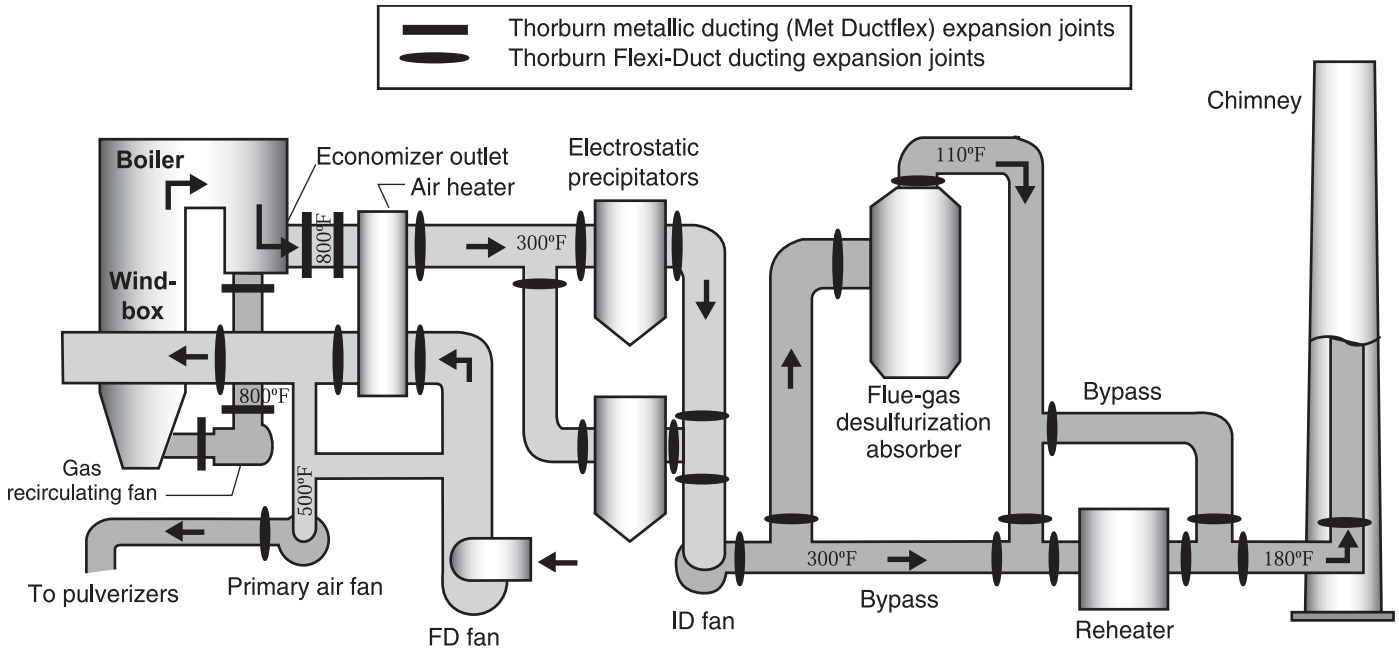
Welding of a typical Thorburn round radius corner rectangular expansion joint Series FRU

APPLICATIONS

- Dust collection and fume extraction ductwork systems
- Turbine condenser ducting
- Ducting systems to scrubbers, precipitators, condensers, boiler breaching and other gas or large "off-gas" systems

FOR AIR POLLUTION CONTROL EQUIPMENT IN TYPICAL UTILITY OR INDUSTRIAL POWER PLANT LAYOUT

The diagram below also shows position of other Thorburn expansion joint products, including fabric belted and fluoro elastomer expansion joint.



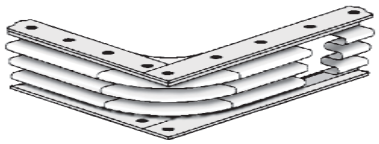
THORBURN DUCTING EXPANSION JOINT SELECTION

DUCTFLEX RECTANGULAR EXPANSION JOINTS
ROUND OR MITER CORNER DESIGNS

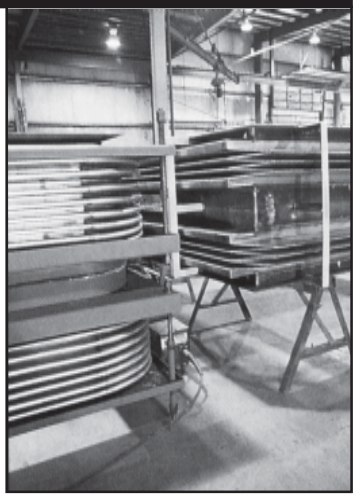
ROUND CORNER SERIES SFRU - 2 1/2" HIGH CONVOLUTIONS

The round corner for high cycle life and pressures when lateral motion is involved.

Standard bellows profile 2 1/2" high X 2" pitch



Outside view of round corner construction



Thorburn round radius corner metallic expansion joint profiled with on the right a camera corner expansion joint

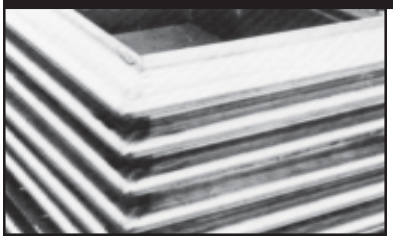
BENEFITS

- Can be made with 12" inside radius round corner to eliminate stress risers that exist in the corners of mitered or camera corner rectangular expansion joints.
- Best design for gas turbine applications because bellows will heat up at a uniform rate to minimize thermal shock.
- The best design for vacuum service (condenser necks). Lower stress due to pressure.
- Bellows will be close to the flue gas temperature at all times, providing that the bellows is insulated externally. Will minimize condensate and sulfur base acids forming in the convolutions.
- Highest pressure capacity.

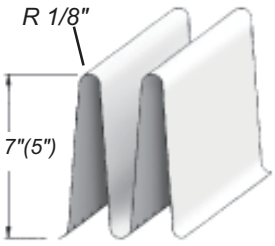
LIMITATIONS

- Limitation highest spring rate and cost per given movement.
- Low movement per convolution.

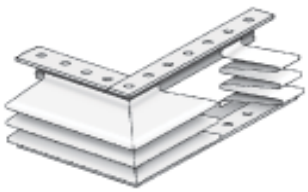
SINGLE MITERED CORNER SERIES SFRV3 - 5" & 7" HIGH CONVOLUTIONS



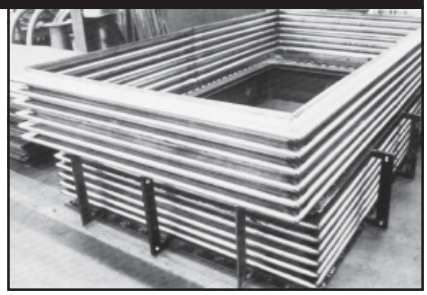
Miter corners are the most common corner design



Standard nominal 7" (5") high x 2.5" (2") pitch



Outside view of miter corner construction



Typical shipment of Thorburn's Series SFRV, single mitered corner

BENEFITS

- Lowest spring rate.
- Lowest cost for given amount of movement.
- Can be used for gas turbine service if thoroughly insulated internally and externally.
- Can be used for vacuum service (condenser necks) where cost is the primary consideration.

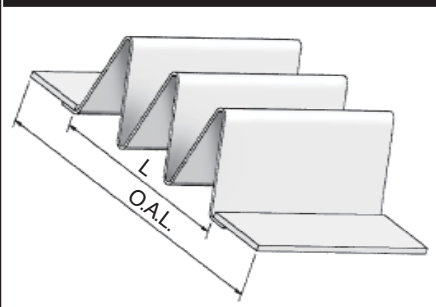
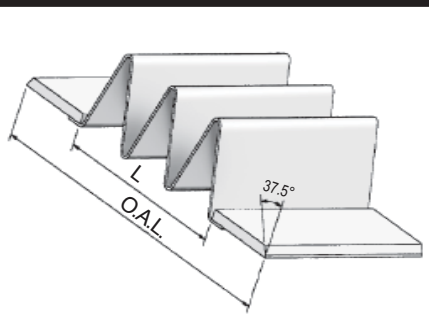
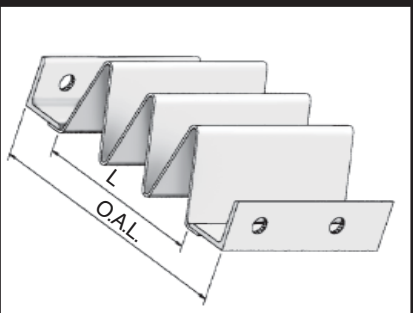
LIMITATIONS

- The deep convolution acts like a radiator if not thoroughly insulated externally. In flue gas service with ash and sulfur present, this cooling can result in the formation of condensate at the crest of the convolutions, causing pitting corrosion of the bellows.

DUCTFLEX

SINGLE RECTANGULAR METALLIC BELLOWS EXPANSION JOINT PRODUCT SPECIFICATIONS

ENDS

CC - COLLAR BELLOWS	WW - WELD ENDS	FF - FLANGED ENDS
		

Series Convolutions Pressure	Number of Cons.	Axial Movement inches	Spring Rate lbs/in/in Perimeter	Bellows Length (L) inches	Overall Length (in.) CC	Overall Length (in.) WW	Overall Length (in.) FF	Appr. Weight (lbs/Perimeter ft) CC	Appr. Weight (lbs/Perimeter ft) WW	Appr. Weight (lbs/Perimeter ft) FF
SFRU "U" Shape 2-1/2" high x 2" pitch ± 400" H_2O	1	0.75	35	2.0	6.0	8.0	8.0	4.5	6.5	15.5
	2	1.50	18	4.0	8.0	10.0	10.0	5.5	7.5	16.5
	3	2.25	12	6.0	10.0	12.0	12.0	6.5	8.5	17.5
	4	3.00	9	7.0	12.0	14.0	14.0	7.5	9.5	18.5
	5	3.75	7	10.0	14.0	16.0	16.0	8.5	10.5	19.5
SFRV2 "V" Shape 5" high x 2" pitch ± 100" H_2O	1	1.25	8.0	2.0	6.0	8.0	8.0	5.0	7.0	16.0
	2	2.50	4.0	4.0	8.0	10.0	10.0	6.5	8.5	17.5
	3	3.75	2.6	6.0	10.0	12.0	12.0	8.0	10.0	19.0
	4	5.00	2.0	8.0	12.0	14.0	14.0	9.5	11.5	20.5
	5	6.25	1.6	10.0	14.0	16.0	16.0	11.0	13.0	22.0
SFRV3 "V" Shape 7" high x 2.5" pitch ± 100" H_2O	1	1.75	3.5	2.5	6.5	8.5	8.5	5.5	7.5	16.5
	2	3.50	1.8	5.0	9.0	11.0	11.0	7.5	9.5	18.5
	3	5.25	1.2	7.5	10.5	13.5	13.5	9.5	11.5	20.5
	4	7.00	0.9	10.0	14.0	16.0	16.0	11.5	13.5	22.5
	5	8.75	0.7	12.5	16.5	18.5	18.5	13.5	15.5	24.5

HOW TO ORDER THORBURN METAL RECTANGULAR DUCTFLEX EXPANSION JOINT SYSTEMS SINGLE FLEX AND DUAL-FLEX SERIES

EXPLANATION

Inside Duct in. dim.	Series DFRV SFRU	Ends CC WW FF	Temp. ºF	Design Pressure Positive/ Negative (in. H_2O)	Con. Height	Number of cons.	Installed position H=Horiz. V=Vertic.	Material Bellows	Material Liner	Material Cover	Material End	Overall Length inches F/F

PART NUMBER EXAMPLES

60 x 96	DFRV	FF	900	15/30	6	3+3	H	B5	L5	C5	E0	22
36 x 48	SFRU	WW	800	80/10	3	4	V	B5	L5	C5	E0	14

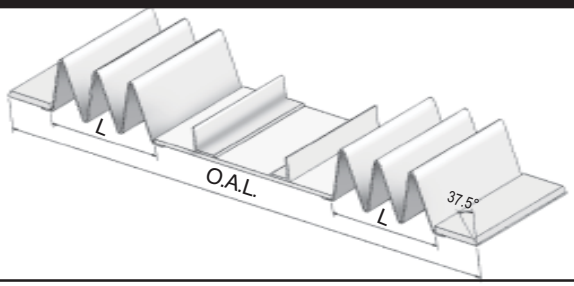
Note: 1) For metric dimensions, insert suffix metric code where applicable (i.e. MM = millimeters, C = degrees Celcius).
2) For material codes, please see page 12 for details

DUCTFLEX SERIES DFRU AND DFRV

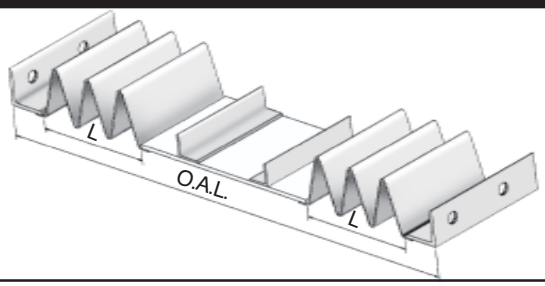
UNIVERSAL DUAL-FLEX RECTANGULAR METALLIC EXPANSION JOINTS

ENDS

WW - WELD ENDS



FF - FLANGED ENDS



Series Convolutions Pressure	Number of Cons.	Axial Movement inches	Spring Rate lbs/in/in Perimeter	Bellows Length (L) inches	Minimum (LL) inches	Overall Length (inches)		Approx. Weight (pounds/Perimeter ft)	
						WW	FF	WW	FF
DFRU "U" Shape 2 1/2" high x 2" pitch ± 400" H_2O at 800ºF	1 + 1	1.50	18.0	2	8	14	14	17	35
	2 + 2	3.00	9.0	4	12	18	18	19	37
	3 + 3	4.50	6.0	6	16	22	22	21	39
	4 + 4	6.00	4.5	8	20	26	26	23	41
	5 + 5	7.50	3.5	10	24	30	30	25	43
	6 + 6	9.00	3.0	12	28	36	36	27	45
	7 + 7	10.50	2.5	14	32	38	38	29	47
	8 + 8	12.00	2.375	16	36	42	42	31	49
DFRVZ "U" Shape 5" high x 2" pitch ± 100" H_2O at 800ºF	1 + 1	2.50	4.0	2	9	15	15	18	36
	2 + 2	5.00	2.0	4	13	19	19	22	40
	3 + 3	7.50	1.3	6	17	23	23	26	44
	4 + 4	10.00	1.0	8	21	27	27	30	48
	5 + 5	12.50	0.8	10	25	31	31	34	52
DFRV "V" Shape 7" high x 2.5" pitch ± 100" H_2O at 800ºF	1 + 1	3.50	1.5	2.5	10	16	16	18	37
	2 + 2	7.00	0.8	5.0	15	21	21	23	41
	3 + 3	10.50	0.5	7.5	20	26	26	27	45
	4 + 4	14.00	0.4	10.0	25	31	31	31	49
	5 + 5	17.50	0.3	12.5	30	36	36	35	53

FOR ORDER INFORMATION, PLEASE SEE PAGE 78

TECHNICAL NOTES TO CONSIDER WHEN SPECIFYING THORBURN DUCTFLEX

LINER

To specify liners, add **L** to part number and advise Thorburn of specific movements to properly size liner. On combination ends specify flow direction. Liners must be specified by client when flow velocity exceeds 25 FPS or where abrasive particles in the gas stream could cause erosion of the bellows.

COVER

To specify covers, add **C** to part number.

MATERIALS

Bellows: Cover, liner and end material must be stated in part number.

SEE PAGE 12 FOR CODE DETAILS

Bands: 1/4" THK X 2" wide, A36/44W
Weld ends: 1/4" THK X 3" wide, A36/44W
Flanges: 3 X 3 X 3/8, A36/44W
Liners: 1/8" THK, A36/44W
Covers: 11 gauge, A36/44W

SEE NOTE 7

NOTES

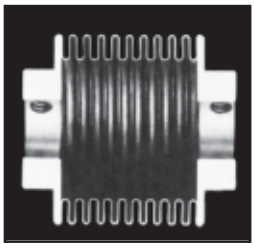
1. Pressure range shown is the maximum and minimum pressures for which these catalogue expansion joints are rated. In order to provide the proper reinforcement for your pressures, the maximum and minimum design pressures in inches of water (H_2O) MUST be specified in the catalogue part number as shown on page 78.
2. The convolution height shown is nominal.
3. Installation position MUST be specified in the catalogue part number to provide proper center duct support for Dualflex Series.
4. Max extension = 50% max compression.
5. Temperature rating is -20ºF to 800ºF for carbon steel duct components. Actual temperature should be specified.
6. Ends, bellows and liner material must be compatible with application media and temperature and pressure.
7. For temperatures exceeding 800ºF, MCOT A36 material is not recommended. For higher temperature, compatible materials should be used.

MINIATURE NICKLE METAL BELLOWS SERIES TMB

BELLOWS I.D. .08" (2MM) TO 1.5" (38 MM) MINIMUM WALL THICKNESS .0008" (.02 MM)

Thorburn's TMB miniature bellows compared to a safety match stick

- Metallic hermetic seals
- Volume compensators
- Pressure and temperature sensors
- Valve seals
- Flexible connector
- Vibration dampeners



Typical bellows profile

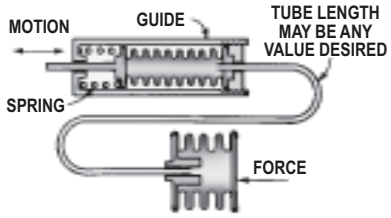
TYPICAL SERIES TMB BELLOWS PROFILE

- Material nickle (.02% sulfur max)
- Max. temp. 392ºF (200ºC)
- Each bellows leak tested 10^{-9} c.c./sec helium
- Seamless non porous, no moisture, dirt or dust
- Thin wall bellows sensitive ideal for very accurate instruments

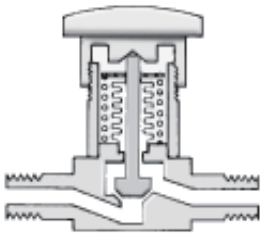
APPLICATIONS

- Metallic seals for motion into a hermetically sealed housing
- Pressure response devices, pressure switches, gauges, actuators
- Flexible shaft coupling
- Linear potentiometer bellows assembly

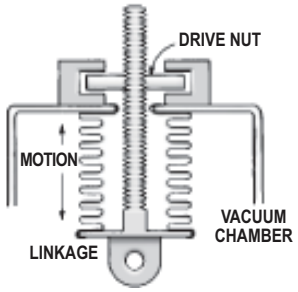
HYDRAULIC MULTIPLIER AND/OR REMOTE TRANSMISSION



VALVING

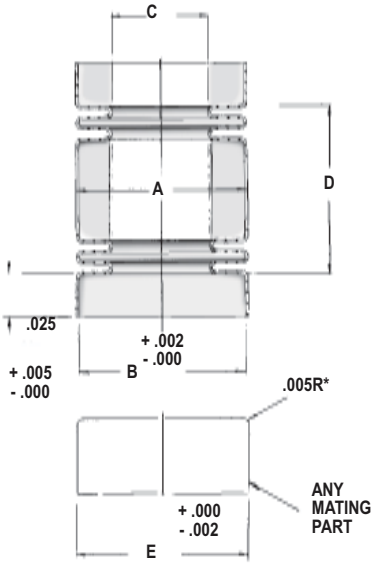


MANIPULATORS



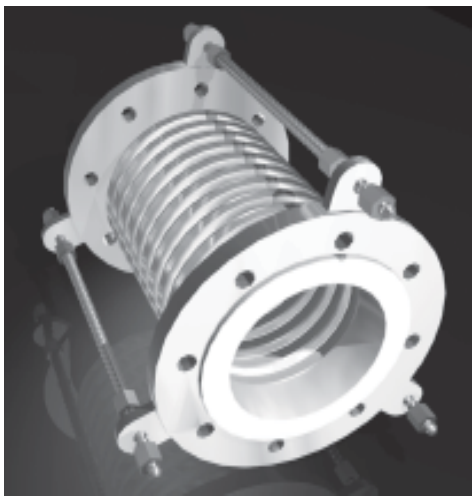
STANDARD MINIATURE BELLOWS TECHNICAL DATA

Thorburn Part #	Bellows O.D. "A"	Cuff I.D. "B"	Bellows I.D. "C"	Free Length "D"	Bellows Wall Nom.	Sp. rate Lb/In Nom.	Conv. Stroke (in.)	No. of Conv.	Mating Part O.D. "E"	Eff. Area	Max. Pres. for 1/2 Stroke
TMB-1	0.250	0.248	0.150	0.740	0.0015	5.90	0.149	24	0.246		
TMB-2	0.250	0.248	0.150	0.370	0.0015	11.82	0.070	12	0.246	0.0292	290
TMB-3	0.250	0.248	0.150	0.245	0.0015	17.73	0.045	8	0.246		
TMB-4	0.250	0.248	0.150	0.185	0.0015	23.63	0.032	6	0.246		
TMB-5	0.375	0.372	0.250	0.740	0.0018	8.15	0.194	24	0.370		
TMB-6	0.375	0.372	0.250	0.550	0.0018	10.87	0.142	18	0.370	0.0723	265
TMB-7	0.375	0.372	0.250	0.370	0.0018	16.31	0.092	12	0.370		
TMB-8	0.375	0.372	0.250	0.305	0.0018	19.57	0.075	10	0.370		
TMB-9	0.500	0.495	0.360	0.740	0.0025	21.62	0.172	24	0.493		
TMB-10	0.500	0.495	0.360	0.490	0.0025	32.44	0.112	16	0.493	0.1382	410
TMB-11	0.500	0.495	0.360	0.370	0.0025	43.25	0.082	12	0.493		
TMB-12	0.750	0.744	0.570	0.980	0.0030	30.73	0.208	21	0.741		
TMB-13	0.750	0.744	0.570	0.730	0.0030	40.33	0.156	16	0.741	0.328	355
TMB-14	0.750	0.744	0.570	0.540	0.0030	53.78	0.114	12	0.741		
TMB-15	1.000	0.994	0.740	1.230	0.0035	24.66	0.320	18	0.990		
TMB-16	1.000	0.994	0.740	0.730	0.0035	44.70	0.169	10	0.990	0.5678	230



HOT-FLEX "HF"

HEAVY DUTY TEFLON LINED METAL EXPANSION JOINT SYSTEM



Thorburn Hot-Flex expansion joint system combines the properties of metal and teflon into the most advanced and versatile expansion joint available in the world today

Thorburn's Hot-Flex expansion joint system is an engineered product that was specifically designed to provide high pressure/temperature transfer containment of highly corrosive medias that could not be safely handled by conventional metallic, elastomeric or teflon expansion joints.

Thorburn's Hot-Flex combines the high pressure rating of a metallic expansion joint with the high temperature corrosion resistance of teflon, creating a product that will outperform them both.

Engineering data shown is just a sample of Thorburn's Hot-Flex capabilities. Each Hot-Flex expansion joint can be custom engineered to your specific application: pressure/temperature rating, spring rate movement (axial, lateral and angular), metallic carcass (stainless steel, monel, inconel, hasteloy, etc.), various lengths.

Typical Design Movements and Force Specifications - Shown to 24" - Available up to120"

Thorburn Part Number	Diameter	Neutral Length	Net Weight (lbs)	Non-Concurrent Movement				Spring Rate		
				Axial Compression	Axial Extension	Lateral (±)	Angular (deg.)	Axial (lbs. per 1/8 in.)	Lateral (lbs. per 1/8 in.)	Angular (ft.•lbs. per deg.)
HF1.5-#C-FM-XX	1.5	7.00	18	0.69	0.44	0.25	14	38	60	0.60
HF2-#C-FM-XX	2	8.00	20	0.69	0.44	0.25	14	42	65	0.54
HF3-#C-FM-XX	3	9.00	27	0.87	0.56	0.25	10	43	79	1.08
HF4-#C-FM-XX	4	10.00	36	0.87	0.56	0.31	10	62	71	3.28
HF6-#C-FM-XX	6	12.00	51	1.75	1.12	0.62	12	66	100	6.25
HF8-#C-FM-XX	8	12.00	73	1.94	1.25	0.56	10	99	78	18.00
HF10-#C-FM-XX	10	14.00	96	2.12	1.31	0.62	10	82	368	22.00
HF12-#C-FM-XX	12	16.00	138	2.12	1.31	0.56	10	195	953	55.00
HF14-#C-FM-XX	14	16.00	165	2.12	1.31	0.56	10	209	562	79.00
HF16-#C-FM-XX	16	16.00	239	2.12	1.31	0.69	10	154	912	78.00
HF18-#C-FM-XX	18	16.00	280	2.25	1.44	0.75	10	222	1082	135.00
HF20-#C-FM-XX	20	16.00	343	2.25	1.44	0.62	10	309	1537	191.00
HF24-#C-FM-XX	24	16.00	390	2.25	1.44	0.50	8	326	1888	281.00

Notes: 1) #C = number of convolutions, i.e. 10C (Thorburn to specify)
2) FM = Flange type and material i.e. V = vanstone; F = fixed

Flange material codes: C = Plated carbon steel, S4 = Plated SS304 S6 = Plated SS316 Other: specify XX =

Standard drilling #150

HOW TO ORDER

Model	Size (in.)	OAL (in.)	Convolutions	Flange Type/Material	Accessories Rod & Flange Material	XX=Specify design pressure psi & temp. F.
HF	12	16	10C	FC	AC	50/212

Note 1 Available in different lengths for increased movement capabilities.
Note 2 Rods and flanges also available in stainless 304SS, 316SS, inconel, hasteloy, monel. Also teflon coated for special externally corrosive applications. Call Thorburn for details.
Note 3 Also available with other drilling patterns: 300, DIN, JIS, British standard, etc. Please specify requirement.
Note 4 Always specify required design pressure and temperature requirements.
Note 5 Available in sizes up to 48".

HOT-FLEX "HF" CONSTRUCTION DETAILS

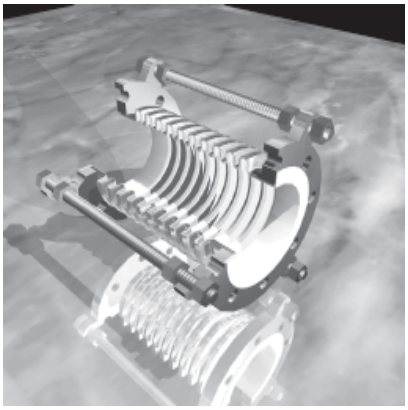
Hot-Flex PTFE or FEP teflon tube formed into a stainless steel, inconel, monel or hasteloy corrugated tube.

Flanges: Floating type (150#, 300# or metric). Available in carbon steel, stainless steel or teflon coated to meet your specific requirements.

Options: Gimbal-hinged-dual-externally pressurized-pressure balanced.

Working temperatures: from -300ºF to +400ºF.

Working pressures: 50 - 150 - 300 psi available (please specify).



- Absorbs pipe movements and stress
- Isolates mechanical vibration
- Reduces system noise
- Protects against surge forces

Note: For environmentally corrosive applications, laminated elastomeric or teflon covers available

DANGER: Thor-Shields must be used at all times in hazardous service to protect against serious personal injury in the event of expansion joint failure. Thorburn internal liners must be used in abrasive service or where sharp-edge solids are or may be present.

HOT-FLEX REQUIRED SPECIFICATION DESIGN DETAILS

1. SAFETY

Is fluid hazardous? Yes ❑ No ❑

Are abrasive solids present? Yes ❑ No ❑

(If yes to any of those questions, a Thor-Shield must be used)

2. FLUID PROPERTIES

Medium _____

Velocity _____

3. MATERIALS OF CONSTRUCTION

Metallic carcass _____

Flanges _____

Internal liner (if required) _____

4. EXPANSION JOINT FEATURES

Size in. nominal diameter

Internal liner Yes ❑ No ❑

Safety shield Yes ❑ No ❑

Installation position

Horizontal _____ Flow

Vertical _____

Up ❑

Down ❑

Installed length _____ in.

Flange drilling _____ lb.

5. MARKING: CONDITIONS NOT TO BE EXCEEDED

Pressure test _____ psig. @ _____ ºF

Operating pressure _____ psig @ _____ ºF

Axial movement _____ in.

Lateral movement _____ in.

Angular movement _____ in.

Angular movement _____ degrees

Are limit bolts to be factory set to eliminate pressure thrust?

Yes ❑ No ❑

6. SPRING RATE REQUIREMENTS IF APPLICABLE

Axial _____ lbs./in.

Lateral _____ lbs./in.

Angular _____ ft.-lbs./degree

7. DESIGN PARAMETERS

Condition	Pressure (psig)	Vacuum (in., Hg.)	Temp. (ºF)	Axial (in.)	MOVEMENTS* Lateral (in.)	Angular (deg.)
Testing						
Installation Tolerance						
Normal Operation						
Cold Weather Shutdown						
Design						

QUALITY, INNOVATION, SERVICE

Thorburn Equipment Inc. is committed to a policy of continuous development and research to provide flexible piping products that set the industry standards for quality, safety, environmental protection, durability and ease of handling. Therefore, the company reserves the right to alter and modify designs without notice.

WARNING

Since performance depends largely upon local conditions and proper care in use, which are outside Thorburn Equipment's control, Thorburn Equipment Inc. can accept no liability for any defect, damage, injury or loss arising from the products and information contained in this catalogue. Readers and customers are encouraged to conduct their own tests before using any product.

The Heart & Soul of the Company

Our people have turned Thorburn into a lean manufacturing company. We're nimble, ready to respond instantly to your needs with products and services unique in our industry. Through our combined efforts, we have designed systems for administration, engineering and manufacturing, based on what we know and learn about each customer and application.

Our company may be known by its products but Thorburn knows that our products are the result of people who emphasize core competences, work for excellence and keep the customer satisfied.

THORBURN'S WARRANTY

Thorburn warrants its expansion joints and connectors to be free from any defects of workmanship and material. Thorburn's warranty shall only cover the components of such assemblies manufactured by Thorburn. Should any such defects be discovered within three (3) months from the date of purchase by the end user, the questionable part should be returned to Thorburn. If, upon inspection, the part proves to be defective, Thorburn will furnish a replacement or, at its option, repair the part.

This warranty shall not apply to any part or parts of expansion joint or connector products if it has been installed, altered, repaired or misused, through negligence or otherwise, in a way that in the opinion of Thorburn affects the reliability of, or detracts from, the performance of the product. Nor does this warranty cover replacements or repairs necessitated by loss or damage resulting from any cause beyond the control of Thorburn, including but not limited to acts of God, acts of government, floods and fires.

The obligation of Thorburn under this warranty is limited to making a replacement part available or the repair of the defective part, and does not include the furnishing of any labour involved or connected therewith, such as that required to diagnose trouble or to remove or install any such product, nor does it include responsibility for any transportation expenses or any damages or losses incurred in transportation in connection therewith.

The foregoing is in lieu of any other warranties, expressed, implied or statutory, and Thorburn neither assumes nor authorizes any person to assume for Thorburn any other obligation or liability in connection with the sale of its products.

ACKNOWLEDGEMENTS

Design and preparation:	Robert Thorburn	Proof reading:	Marie Valin
Typesetting and layout:	Viviane Katz	Printing:	Québecor

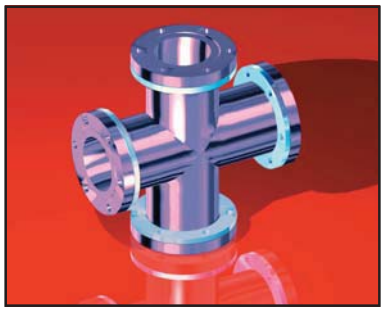
N O T E S

THORBURN'S NON-METALLIC EXPANSION JOINTS AND CONNECTORS FOR PIPING AND DUCTING SYSTEMS

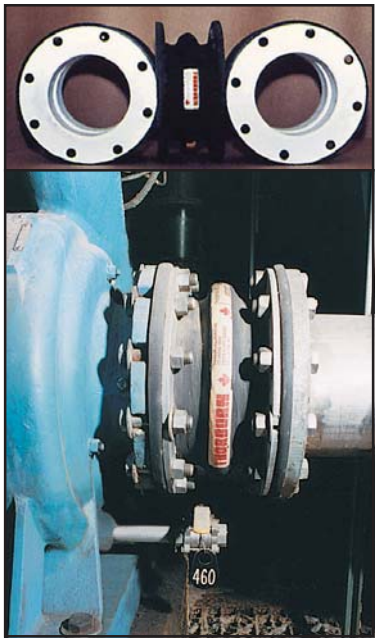
SPECIFICATIONS

- High pressure large diameter expansion joints sizes to 144", to 300 psi
- Round and rectangular expansion joints
- Special purpose moulded teflon expansion joints
- Elbow, fittings and transition joint connectors
- High temperature (1800ºF) ducting expansion joint systems
- Moulded spherical single, twin and universal

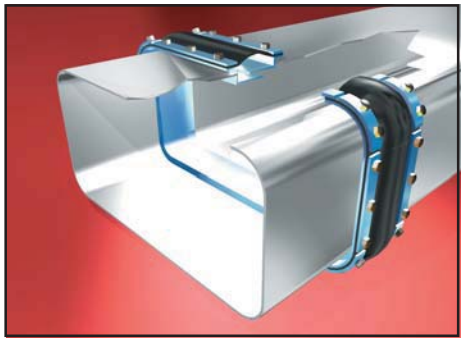
N.B. Power inspecting one of Thorburn's 20 expansion joints at the Belledune New Brunswick Canada power generating station. Size range 1" to 144"" I.D.



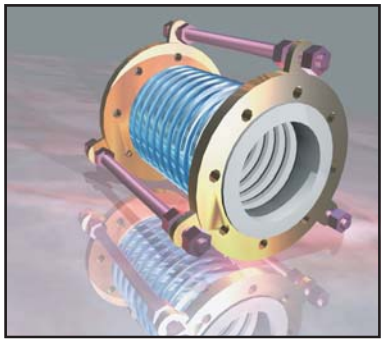
Thorburn custom elbows, connectors, fittings and even transition joints to handle specific pipe motion problems. Size range 1" to 30" I.D.



Thorburn's teflon lined rubber expansion joints installed to transfer white water at Bowater, Mersey, Nova Scotia. Size range 2" to 96" I.D.



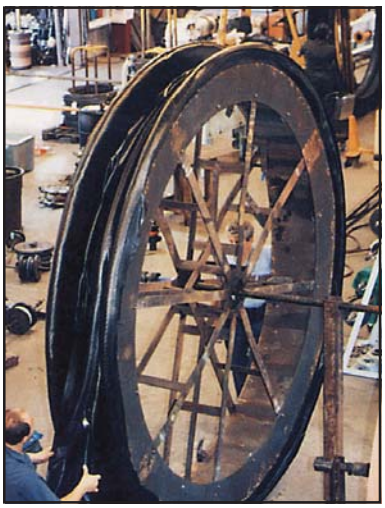
Thorburn non-metallic elastomeric and composite ducting expansion joints. Either round or rectangular. Temperatures ambient to 1800ºF.



Thorburn teflon lined metallic expansion joints for extreamely corrosive high temperature/pressure applications. Size 2" to 48" I.D.

Thorburn is leading supplier of molded teflon expansion joints to the petrochemical and pharmaceutical industries. Sizes 1-1/2" to 42" I.D.

Thorburn is the first company in the world to manufacture externally pressurized rubber expansion joints for deap sea water service

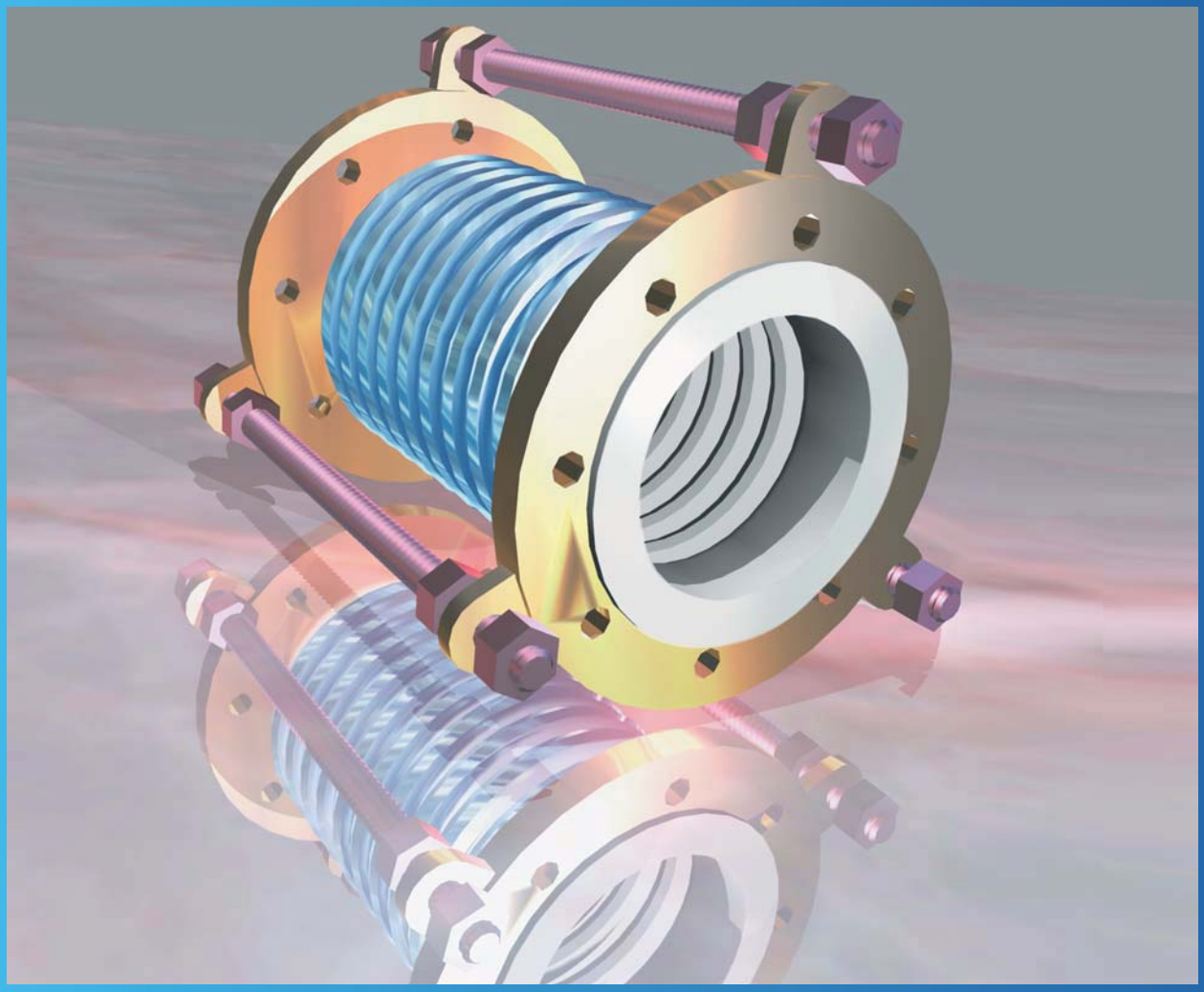


Thorburn employs traditional hand built as well as state-of-the-art CNC technology in the designing and manufacture of its expansion joints and connectors

Thorburn Flex Inc

Flexible Piping Specialist

BELLOWS TECHNOLOGY



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