BOA Group

Your Flexible Solutions Partner

Expansion Joint Presentation

American BOA-Industrial Division

Mailing Address:

P.O. Box 1301, Cumming, GA 30028

Phone: 770.889.9400

Fax: 770.781.3968

Website: www.americanboa.com

E-mail: sales@boa-us.com

American BOA Heritage Timeline

- **Patent issued for first metallic bellows to IWKA: 1898**
- **American BOA Incoporates: 1957**
- **American BOA Relocates to Cumming, GA: 1982**

Industrial Manufacturing Facility

- Production Space: 85,000 sq. Ft.
- Employees: 120+
- Shifts: 3+
- Marketplace: Global

Key Product Portfolio

Industrial Products:

Metal Hoses

Expansion Joints

Metal Bellows

Capabilities

Expansion Joints

Product specifications	
Diameter:	3/8” to 240”
Wall thickness:	0.002” to .4”
Pressure rate:	~0 to 3480 PSI
Temperature:	-75° to 1,740° F
Frequencies:	0 – 7 KHz
Lifetime:	10^8 – 10^9 Cycles
Medium:	Gases/Liquids/Steam/ Chemicals

Bellows

Hoses

QUALITY

- •ASME Section VIII Code “U” and “R” Stamps
- •AS9000
- •ASME Section IX
- •ISO 9001:2000 Registration No. 0014154-800514
- •ISO/TS 16949:2002 Registration No. 0022306
- •ISO 14001:2004 Registration No. 0021787
- •CE Marking to PED 97/23/EC
- •AD Merkblatt - HPO

Contents of the Presentation

1. ABI Expansion Joints Advantages
2. Engineering
3. Manufacturing
4. Testing
5. Product Offering
6. ABI product applications
7. Benefits of program to you

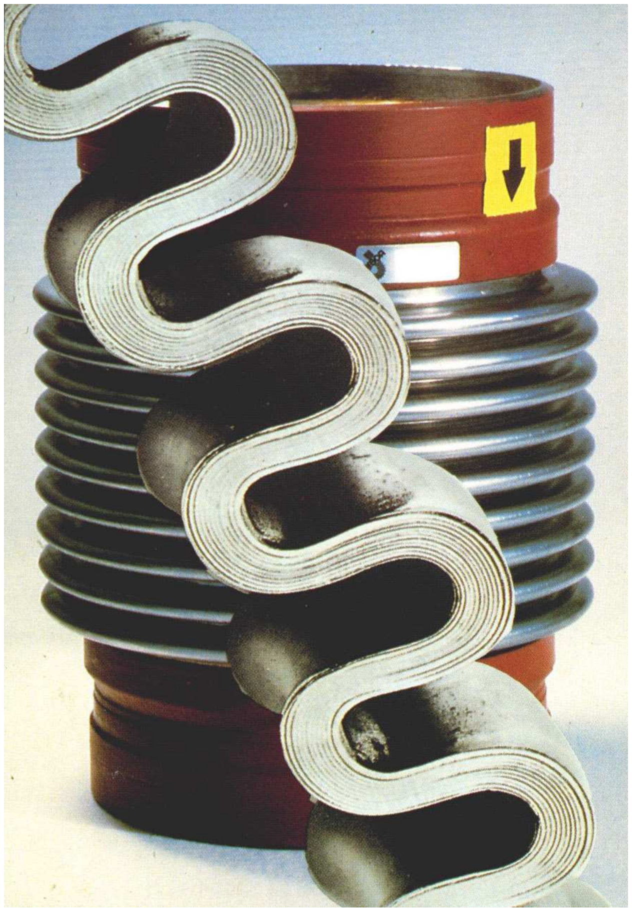
Competitive Priorities and Advantages of American BOA Expansion Joints

- American BOA's main competitive priorities for the expansion joint market are **service**, **quality**, and **reliability**. The customers for these products generally use the products on very expensive processes that can ill afford to be down (ie. military vessels, oil and gas refineries, etc..). Most customers are sophisticated to realize that a more reliable and well designed product will last longer, cause fewer problems and result in a lower total cost of ownership.
  - A competitive priority that complements the above, American BOA has focused on **reducing cycle times** to fulfill orders. When the expensive processes mentioned above are down, the company that is able to deliver the product in the shortest time period will win the order at a premium price.
- American BOA's competitive advantages are:
  - The **high level of sophisticated engineering** resources and tools to provide problem solving and design services
  - The **unique product features** of American BOA multi-ply designs
  - The **unique design geometry** that lessens the impact of vibration and lengthens durability
  - The **American BOA name** that has become synonymous with high quality and durability.

General Comments

- American BOA is unique in that "customers" are treated more like clients than just customers. Our clients look at us as the experts, and trust us to address issues that they are not aware exists.
  - A major defense contractor refuses to meet with competition.
- American BOA is unique in that we "sell the invisible" to our clients and they realize the "value added" service that comes with the product Others sell the product to fill a gap or fit an application; ABI works before and well after the sell to enable the client to be successful.
  - Chief Engineer at a major ship builder, told young engineers that he uses ABI products because of the service that goes on before and after the sale, not just for the superior quality of the products.
- American BOA exhaust expansion joints are unique and superior to our competitors American BOA looks at ship exhaust as two issues--thermal growth and vibration--with vibration as the key problem; competitors look at ship exhaust as thermal growth with vibration being a lesser, secondary problem.
  - At the Fish Expo Show in Seattle, the competitor stated that BOA's approach to engine exhaust with 4-ply and 5-ply bellows was "ridiculous." However, there were extensive testimonials that the BOA bellows solved all problems and was the most reliable of all products. The representative was not even conscious off the clients key application issues.

AMERICAN BOA MULTI-PLY EXPANSION JOINTS



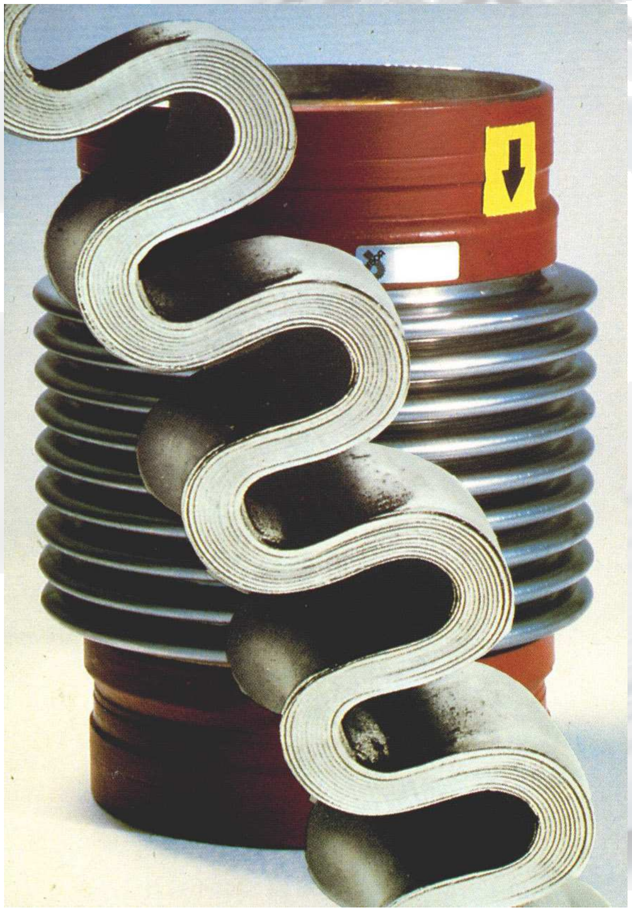
BOA alone provides multi-ply designs with more than 3 plies.

Technical Features and Benefits

(continued)

Advantages of BOA's Multi-Ply Bellows

- Cycle Life – The contour of the thin gauge multi-ply convolution is designed to keep pressure and induced deflection stresses at a minimum. As a result of the low stress level that the bellows experiences during operation, cycle endurance is substantially improved.
- Maximum Travel – Maximum axial, lateral, and angular movements are optimized considering the lowest possible spring rates and the shortest overall length.
- Safety – A catastrophic failure is virtually impossible. The multi-ply inner core would prevent this. Should a crack occur for any reason, - stress, corrosion, mechanical,- the plies, acting as a labyrinth gland would constrain the pressure and medium and hold the entire joint intact. A small blister would occur in the outer ply. However, the joint would still perform satisfactorily for many thousand cycles.



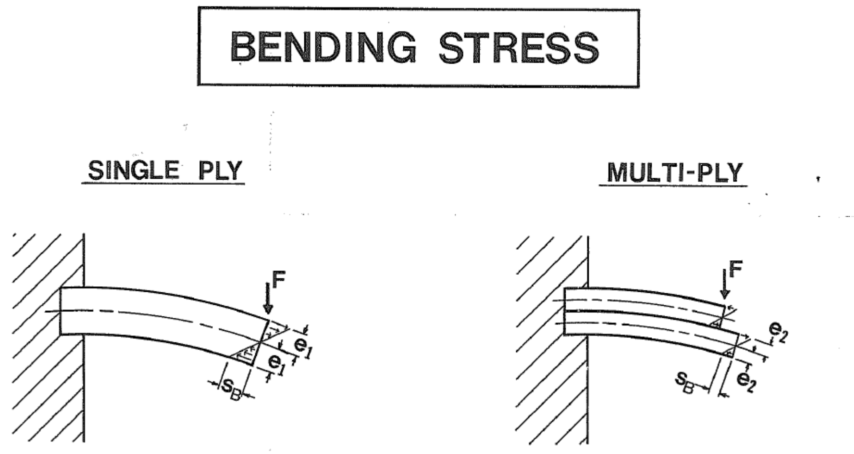
Technical Features and Benefits

Multi-Ply Bellows

BOA pioneered the development of the unique Multi-Ply bellows design which proved to be exceptionally effective in absorbing thermal expansion and vibration.

Advantages of BOA's Multi-Ply Bellows

- Flexibility – Thin gauge material is used in the manufacture of multi-ply bellows increasing flexibility and reducing deflection forces.
- Higher Pressures and Lower Thrust Forces – Greater pressure ratings can be attained with our Multi-Ply construction by increasing the number and/or gauge of the plies without changing the corrugation contour. With conventional joints, the wall thickness and corrugation height must be increased. Additionally, our shallow profile results in lower reaction forces because of a smaller mean diameter.



BENDING STRESS S_B IS PROPORTIONAL TO e. I.E., THE BENDING STRESS IN THE OUTER FIBER OF A SINGLE PLY BELLOWS IS 5 TIMES GREATER THAN S_B OF A 5-PLY BELLOWS.

Single Ply versus Multiply Bellows

For Reference Only

American BOA, Inc.
Expansion Joint Division

Quotation#:	I-0
Customer:	0
Date:	1/14/2009
Prepared By:	PV
Exp. Jt. Item #:	0

BELLOWS DESIGN CALCULATION

Author: M. Lanz — rev. 68, 6/27/02

Design Basis: The Expansion Joint Manufacturer's Association Standard, 7th Edition, 2000 Addenda
Allowable Stress Basis: ASME Sect. VIII, Division 1, 2001 Edition

			Actual	Allow.
	Bellows Element Geometry			
	Bellows Material:		SA240-T321	
	Collar Material:		SA240-T304	
	Bellows Inside Diameter (in.)			10.75
	Bellows Outside Diameter (in.)	H= 0.825		12.52
	Number of Convolutions			7
	Individual Ply thickness (in.)			0.012
	Number of Plies			5
	Bellows Element Length (in.)	2r= 0.310		5.00
	Bellows Effective Area (in.^2)			106.3
	Design Information			
	Condition Type (i.e design, upset)			Design
	Design Pressure (Psig)			100
	Design Temperature (deg. F)			600
	Axial Compression (in.)			1.000
	Axial Extension (in.)			0.000
	Lateral (+) (in.)			0.000
	Lateral (-) (in.)			0.000
	Angular (+) (deg.)			0.00
	Angular (-) (deg.)			0.00
	Bellows Stress Analysis			
			Actual Stress	Allow. Stress
S1	Tangent Circumferential Membrane Stress Due to Pressure, psi		4,983	18,300
S'1	Collar Circumferential Membrane Stress Due to Pressure, psi		5,094	16,600
S2	Circumferential Membrane Stress Due to Pressure, psi		3,602	18,300
S'2	Reinforcing Ring Membrane Stress Due to Pressure, psi	**	N/A**	N/A**
S3	Meridional Membrane Stress Due to Pressure, psi		715	N/A
S4	Meridional Bending Stress Due to Pressure, psi		51,157	N/A
S3+S4	Meridional Mem. + Bending Stress Due to Pressure, psi		51,872	54,900
S5	Meridional Membrane Stress Due to Deflection, psi		368	N/A
S6	Meridional Bending Stress Due to Deflection, psi		63,785	N/A
	Maximum Design Pressure Based Upon Squirm, psig		150	
	Fatigue Characteristics			
	Total Stress Range for All Movements (St), psi			100,463
	Fatigue Life (cycles to failure)	EJMA		280,654
	Expansion Joint Spring Rates			
	Axial Spring Rate (lbs./in.)			583
	Lateral Spring Rate (lbs./in.)			4,196
	Angular Spring Rate (in.-lbs./deg.)			173
	Torsional Spring Rate (in.-lbs./deg.)			774,702
	(Maximum Allowed Torsion = 0.064 deg.)			
	Pressure Thrust at Design Pressure (lbs.)			10,632

** Un-reinforced bellows, reinforcing rings not utilized

For Reference Only

American BOA, Inc.
Expansion Joint Division

Quotation#:	I-0
Customer:	0
Date:	9/12/2002
Prepared By:	PV
Exp. Jt. Item #:	0

BELLOWS DESIGN CALCULATION

Author: M. Lanz — rev. 68, 6/27/02

Design Basis: The Expansion Joint Manufacturer's Association Standard, 7th Edition, 2000 Addenda
Allowable Stress Basis: ASME Sect. VIII, Division 1, 2001 Edition

			Actual	Allow.
	Bellows Element Geometry			
	Bellows Material:		SA240-T321	
	Collar Material:		SA240-T304	
	Bellows Inside Diameter (in.)			10.75
	Bellows Outside Diameter (in.)	H= 0.825		12.52
	Number of Convolutions			7
	Individual Ply thickness (in.)			0.060
	Number of Plies			1
	Bellows Element Length (in.)	2r= 0.310		5.00
	Bellows Effective Area (in.^2)			106.3
	Design Information			
	Condition Type (i.e design, upset)			Design
	Design Pressure (Psig)			100
	Design Temperature (deg. F)			600
	Axial Compression (in.)			1.000
	Axial Extension (in.)			0.000
	Lateral (+) (in.)			0.000
	Lateral (-) (in.)			0.000
	Angular (+) (deg.)			0.00
	Angular (-) (deg.)			0.00
	Bellows Stress Analysis			
			Actual Stress	Allow. Stress
S1	Tangent Circumferential Membrane Stress Due to Pressure, psi		4,721	18,300
S'1	Collar Circumferential Membrane Stress Due to Pressure, psi		4,826	16,600
S2	Circumferential Membrane Stress Due to Pressure, psi		3,602	18,300
S'2	Reinforcing Ring Membrane Stress Due to Pressure, psi	**	N/A**	N/A**
S3	Meridional Membrane Stress Due to Pressure, psi		715	N/A
S4	Meridional Bending Stress Due to Pressure, psi		7,067	N/A
S3+S4	Meridional Mem. + Bending Stress Due to Pressure, psi		7,783	54,900
S5	Meridional Membrane Stress Due to Deflection, psi		7,302	N/A
S6	Meridional Bending Stress Due to Deflection, psi		349,416	N/A
	Maximum Design Pressure Based Upon Squirm, psig		492	
	Fatigue Characteristics			
	Total Stress Range for All Movements (St), psi			362,166
	Fatigue Life (cycles to failure)	EJMA		451
	Expansion Joint Spring Rates			
	Axial Spring Rate (lbs./in.)			14,282
	Lateral Spring Rate (lbs./in.)			102,858
	Angular Spring Rate (in.-lbs./deg.)			4,238
	Torsional Spring Rate (in.-lbs./deg.)			774,702
	(Maximum Allowed Torsion = 0.064 deg.)			
	Pressure Thrust at Design Pressure (lbs.)			10,632

** Un-reinforced bellows, reinforcing rings not utilized

Engineering:

Bellows Design Analysis:

American BOA is a member of the Expansion Joint Manufacturer's Association (EJMA) and manufacturers expansion joints in accordance with the latest EJMA Addendum. Bellows design analysis is performed in accordance with various design codes including:

- •EJMA, 9th Edition
- •ASME B31.1
- •ASME B31.3
- •ASME Section VIII Div 1 Appx 26
- •European Union Pressure Equipment Directive

Compliance with additional codes may be accommodated upon request.

Certification of EJMA Membership

This certificate is a declaration that

American BOA, Inc.

is an active member of the
Expansion Joint Manufacturers Association

Richard Byrne
EJMA Secretary

Date: 12/1/02

American BOA has conducted numerous fatigue, squirm, and burst tests as well as spring rate measurements for qualifying our Bellows Design analysis software.

Engineering:

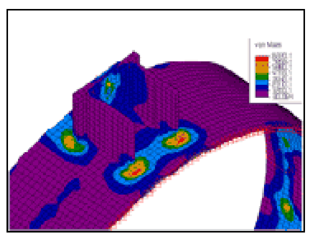
Hose Manufacturing:

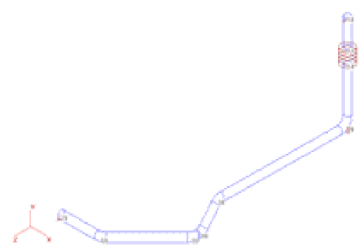
American BOA is a member of National Association for Hose and Accessory Distribution (NAHAD). Hose manufacturing is performed in accordance with ISO10380. In addition assemblies are certified to AD 2000-Merkblatt HPO as required for specific clients.

Engineering Tools:

To ensure safe and reliable products, American BOA's engineering staff utilizes additional software

- Algor-linear static analysis, heat transfer, and fluid flow
- Cosmos- linear static analysis and heat transfer
- AutoCAD-design & drafting
- Solidworks-design & drafting
- Caesar II-pipe stress analysis





CAESAR II
Job: P:\CAESAR FILES
Licensed To: AMERICAN BOA, INC.

DISPLACEMENT REPORT, Nodal Movements
CASE 3 (EXP) L3=L1-L2

	Translations(in.)			Rotations(deg.)		
NODE	DX	DY	DZ	RX	RY	RZ
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0013	-0.1188	-0.0057	0.0203	0.0218	0.0048
14	0.1643	0.2678	-0.6609	0.3740	0.0218	0.1739
19	0.3002	0.0313	-0.9228	0.2236	0.0617	0.1505

Manufacturing Equipment:

American BOA's Industrial Division specializes in flexible metal forming technologies and joining technologies (welding, brazing, etc.). Assets include:

•Mechanical bellows forming equipment capable of forming 2"ND to 240"ND bellows.

•Hydroforming bellows forming equipment capable of forming 3/8"I.D. to 10"ND bellows.

•Tube mills.

•Plasma table capable of burning up to 1 ¼" thick plate.

•In house machine shop services including milling equipment, lathes, CNC machines, drill presses, etc.

•Pipe rolls.

•Plate and sheet shears.

•Welding equipment set up for brazing and welding processes (MIG & TIG).

Testing Capabilities:

•American BOA manufactures products to the highest quality standards. To ensure products are free from defect the following testing processes are utilized:

•CWI Weld Inspection (Certified by American Welding Society)

•Finished product pressure testing including pneumatic, hydrostatic, and soap/bubble.

•Helium leak testing (positive pressure and full vacuum).

•Non destructive testing capabilities include dye penetrant examination, radiographic examination, and magnetic particle examination.

•Positive material identification (PMI).

•Fatigue testing.

•Spring rate testing.

•Real Motion Simulation (RMS)
6 degrees of freedom.

Flexible Component Design Variables:

- Bellows materials of construction.
- Material specification of other components.
- Nominal diameter.
- Overall length requirement (if required).
- End types (i.e. flanges, weld ends, etc.).
- Design Pressure.
- Test Pressure (if other than standard design code requirements).
- Design temperature.
- Design Movements (specified in concurrent, non-concurrent, misalignment, etc.).
- Force loading requirements.
- Media velocity and/or media abrasiveness.
- Options required (i.e. liners, shrouds, rods, hinges, gimbals, purge ports, etc.)

Expansion Joint Components

Primary component:

- Bellows

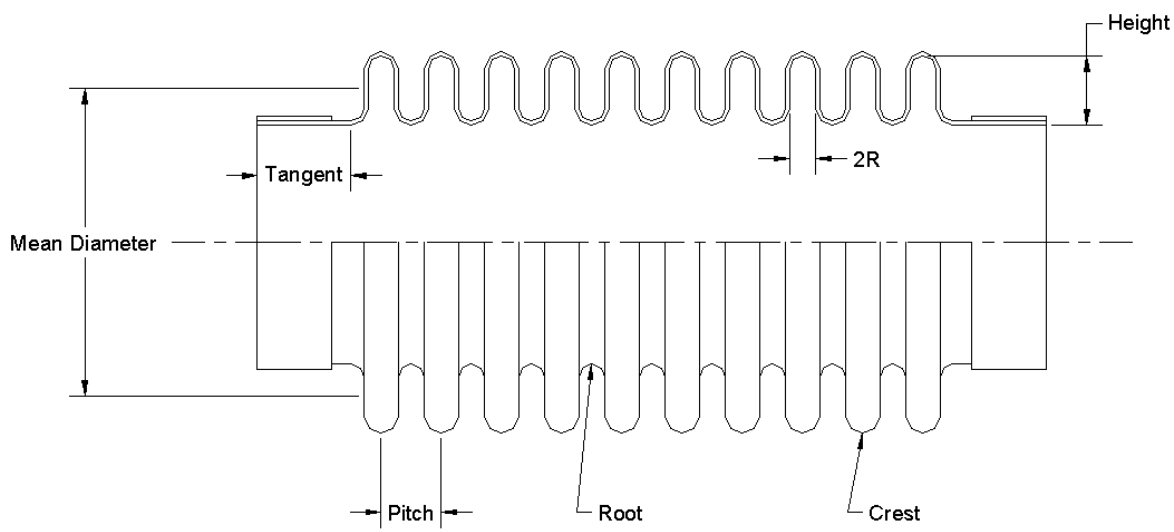
Secondary Components:

- Unions
- Liners
- Shrouds
- Restraints
- Other optional Equipment

Expansion Joint Definition:

An expansion joint is a device containing one or more bellows used to absorb dimensional changes caused by thermal growths or contractions. Expansion joints may also be used for vibration damping.

Bellows Terminology



Expansion Joint Movements Defined:

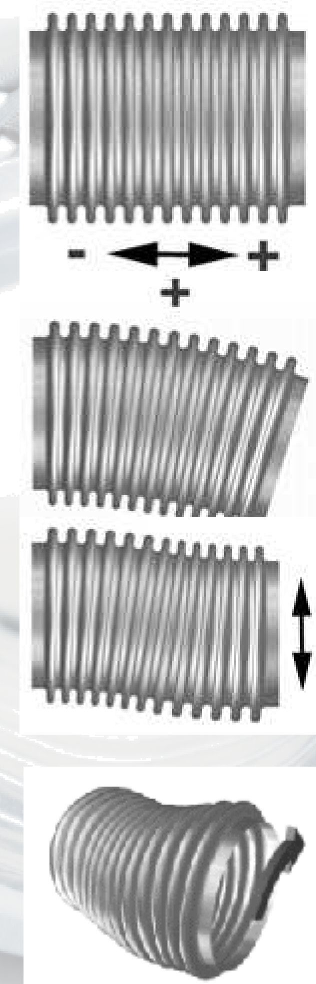
There are four basic movements that can be applied to a bellows. These are Axial, Lateral, Angular and Torsion as illustrated below. Bellows behave like springs in a piping system. When they are compressed, they resist the movement the same as a spring would. The spring rate of a bellows is entirely dependent on bellows geometry and material properties.

Axial movement is the change in dimensional length of the bellows from its free length in a direction parallel to its longitudinal axis.

Angular movement is the rotational displacement of the longitudinal axis of the bellows toward a point of rotation.

Lateral movement is the relative displacement of one end of the bellows to the other end in a direction perpendicular to its longitudinal axis (shear).

Torsion movement is the rotation about the axis through the center of a bellows. American Boa does not recommend torsional rotation of metal bellows expansion joints. Torsion destabilizes an expansion joint reducing its ability to contain pressure and absorb movement.



Expansion Joint Reactive Forces:

Spring Force:

The force required to deflect an expansion joint within a specific plane. A force equal to the spring force is exerted upon the systems anchors. The magnitude of the spring force is equal to the expansion joints planar spring rate multiplied by the amount traveled within that plane.

Example:

Axial Spring Rate = 300 #/inch, Design Movement = 3” axial compression,

Axial Spring Force = 300 #/inch * 3” = 900 #

Pressure Thrust:

The result of placing a “spring” within a rigid piping system. An expansion joint is a flexible unit, which will naturally extend (internal pressure) or compress (external pressure/vacuum). Pressure thrust typically exceeds the total spring force of the bellows and must be considered when designing a piping system’s main anchor. Pressure thrust is equal to the bellows cross sectional area multiplied by the design pressure.

Example (10” ND Single Bellows Expansion Joint):

Cross Sectional Area = 106.30 inches^2, Design Pressure = 350 PSIG,

Pressure Thrust = 37,205 #

Expansion Joint Anchoring & Guiding:

Anchoring:

Expansion joints must have anchors on either side. These anchors must be able able to withstand the total force the expansion joint and other system components exert. Expansion joints will exert a cumulative spring force and a pressure thrust. Additional forces include frictional forces from guides. Further forces may apply depending on piping configuration.

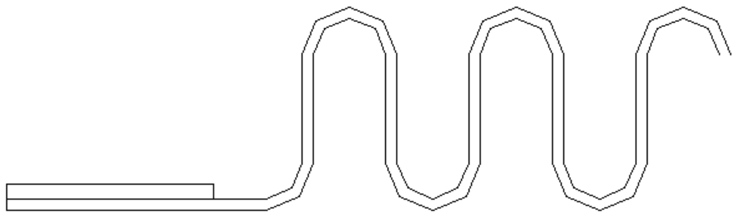
Guiding:

The expansion joint should be placed as close to a main anchor as possible. Guides should be applied within 4 pipe ND, 14 pipe ND, then every distance as calculated per the following equation. The maximum distance between pipe guides is equal to:

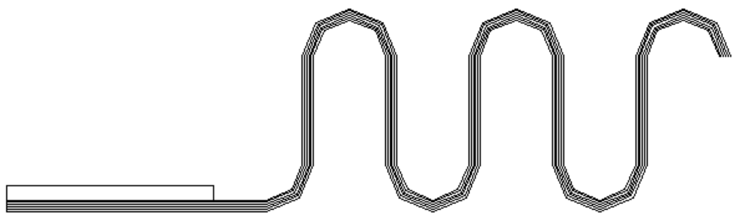
$$L_{max} = 0.131*[(E_p*I_p)/((P_d*A_e) \pm (f_i*e_x))]^{1/2}$$

where E_p = Pipe's Modulus of elasticity, I_p = Moment of inertia of the pipe's cross sectional area, P_d = Design pressure, A_e = Bellows effective area, f_i = Bellows theoretical initial elastic spring rate per convolution, and e_x = axial movement per bellows convolution.

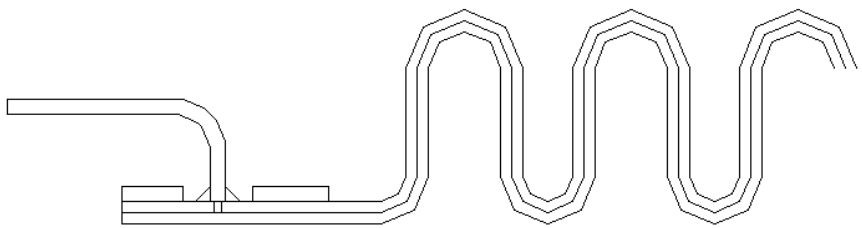
Types of Bellows



Single Ply Bellows

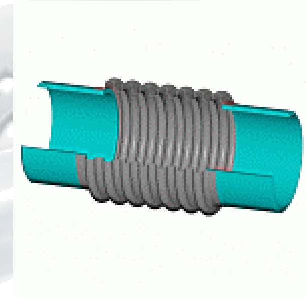


MultiPly Bellows (up to 5 plies)

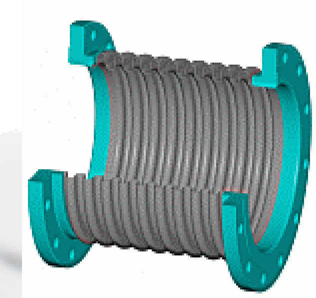


Two Ply Testable Bellows

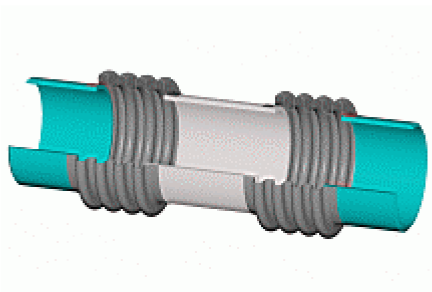
Types of Expansion Joints:

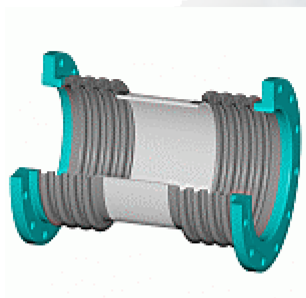


Single Expansion Joint:
The simplest type of expansion joint consists of a single bellows element welded to end fittings, normally flange or pipe ends. The single bellows can absorb small amounts of axial, lateral and angular movement with ease, but adequate anchors and guides must be provided.

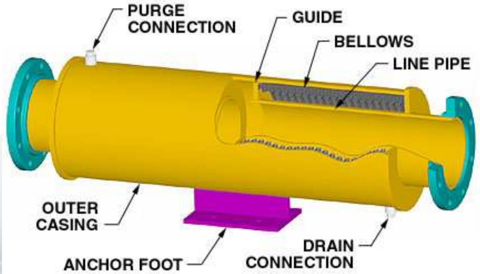


Universal Expansion Joint:
This assembly consists of two bellows connected by a center spool piece with flange or pipe ends. The universal arrangement allows greater axial, lateral and angular movements than a Single Bellows Assembly. Increasing the center spool length produces increased movement capability. Like the single, adequate anchors and guides must be provided.





Types of Expansion Joints:



Externally Pressurized Expansion Joint:
There are certain expansion joint applications that call for large axial movements. These are frequently encountered in steam distribution systems found in hospital, schools, or military installations. Internally pressurized assemblies become unstable even at low pressures when the number of convolutions reaches a certain limit; therefore, the problems created by these requirements cannot be solved using a Single Bellows Assembly. (Under increasing pressure, an internally pressurized bellows will act as an unstable column in compression, and squirm.) In cases like these, an Externally Pressurized Assembly provides the most viable solution. When pressure is applied externally to the bellows, as shown in the figure 1, the bellows are placed in tension. In this condition squirm is not a factor. A greater number of convolutions can be added to the bellows even at higher pressures, resulting in increased movement capability. This style joint has the added benefit of self-draining convolutions. All the trapped liquid media can be purged from the outer casing eliminating the possibility of liquid "flashing" to vapor. An anchor foot can be added to the Single Externally Pressurized Style allowing it to act as an intermediate anchor. The anchor foot is designed to withstand any loads produced by the deflection of the bellows. Dual Style Externally Pressurized designs are equipped with an anchor foot as a standard. The internal and external rings on both styles act as a pipe guide so the first guide (G1) is not necessary.

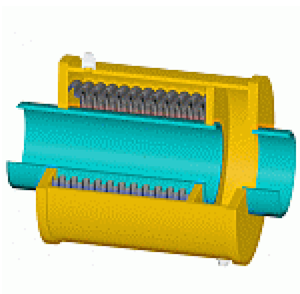
Types of Expansion Joints:

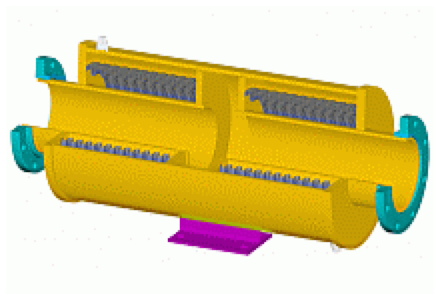
Externally Pressurized Expansion Joint (continued):

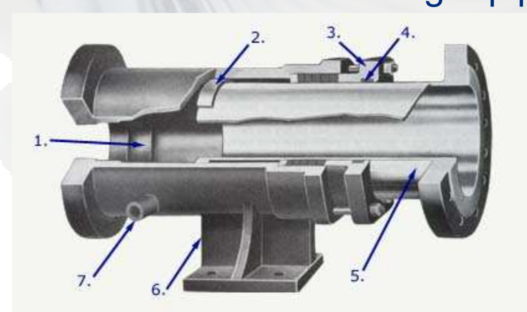
- <u>Design Features</u>:
- Bellows protection
- Smooth flow
- Oversize bellows
- Drain connection
- Purge connection
- Fail-safe design
- Self-draining convolutions
- Joint acts as first guide

Externally Pressurized Expansion Joint compared to Slip Type Joints:

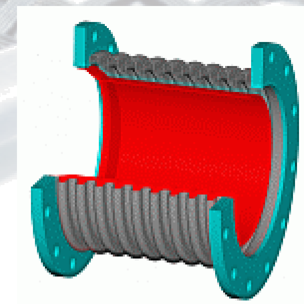
- Externally pressurized expansion joints are maintenance free after installation.
- Slip type joints require periodic repacking of the sleeve to prevent leaking.
- Slip type joints generate large frictional forces as a result of movement (generated by the metal mating surfaces).
- Externally pressurized expansion joints are much more cost effective in larger pipe sizes.







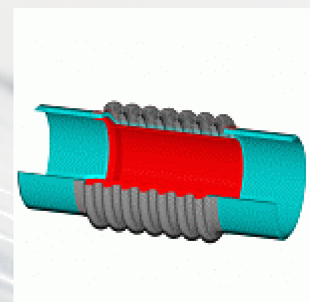
Expansion Joint Options:



Liners:

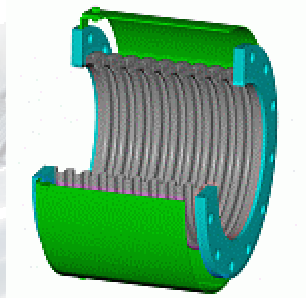
Liners or sleeves are available for all expansion joints and should be used when any of the following conditions exist:

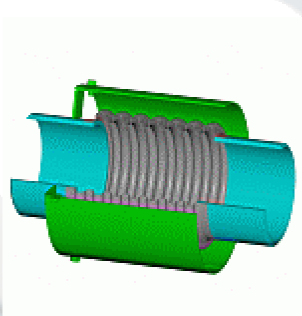
- When pressure drop must be minimized and smooth flow is essential.
- When turbulent flow is generated upstream of the expansion joint by changes in flow direction.
- When it is necessary to protect the bellows from media carrying abrasive materials such as catalyst or slurry.
- In high temperature applications to reduce the temperature of the bellows. The liner is a barrier between the media and the bellows.
- For Air, Steam and other Gases
  Up to 6 in. diameter - 4 ft/sec/in. of diameter
  Over 6 in. diameter - 25 ft/sec.
- For Water and other Liquids
  Up to 6 in. diameter - 2 ft/sec/in. of diameter
  Over 6 in. diameter - 10 ft/sec.



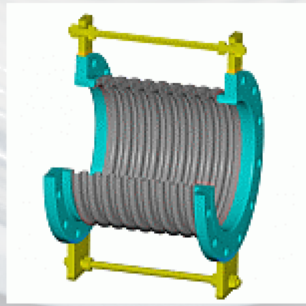
Note that flow liners can trap liquid if the expansion joint is installed with the flow vertical up. All standard parts are provided with drain holes to prevent liquid build between the liner and the bellows.

Expansion Joint Options:





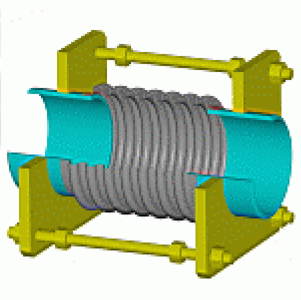
Covers (Shrouds):
Shrouds can be provided either fixed or removable. Fixed types are used where high velocity external steam conditions exist such as in condenser heater connections. The removable type of cover is the standard and permits periodic in service inspection. Covers are also used to prevent damage during installation and operation or when welding is going to be performed in the immediate vicinity. If the expansion joint is going to be externally insulated, a cover should be considered. American Boa always recommends covers for any expansion joint. The small cost increase is just economical insurance when compared to a complete joint replacement.



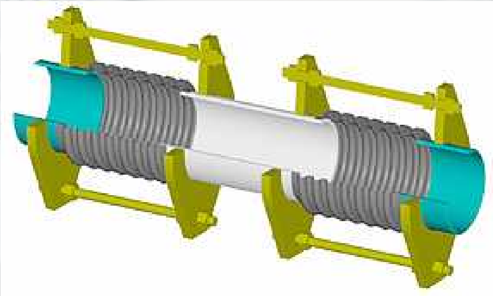
Tie Rods:
Ties rods are devices, usually in the form of bars or rods, attached to the expansion joint assembly and are designed to absorb pressure thrust loads and other extraneous forces (i.e. dead weight). When used on a Single or Universal Style Expansion Joint, the ability to absorb axial movement is lost. Only two rods may be used if the expansion joint is subjected to angulation.

Expansion Joint Options:

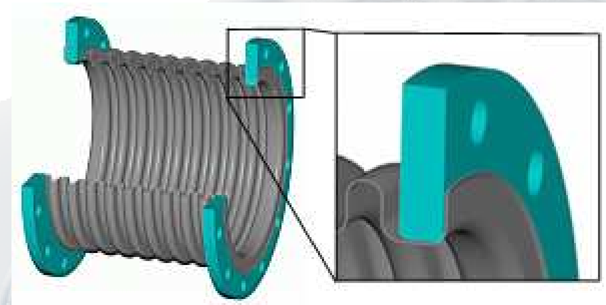
Limit Rods:
Limit rods are used to protect the bellows from movements in excess of design that occasionally occurs due to plant malfunction or the failure of an anchor. LIMIT RODS DO NOT CONTAIN THE PRESSURE THRUST DURING NORMAL OPERATION. Limit rods are designed to prevent bellows over-extension or over-compression while restraining the full pressure loading and dynamic forces generated by an anchor failure. During normal operation the rods have no function.



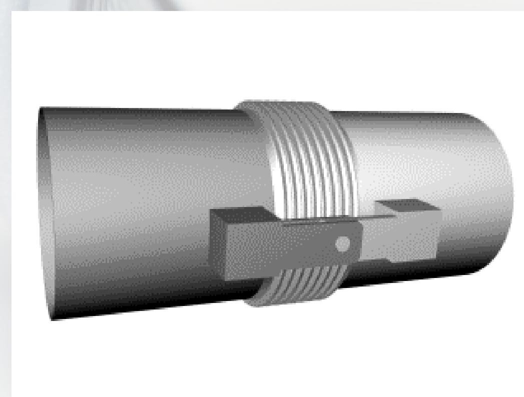
Control Rods:
Control rods are devices attached to the expansion joint assembly whose primary function is to distribute the movement between the two bellows of a universal expansion joint. CONTROL RODS ARE NOT DESIGNED TO RESTRAIN BELLOWS PRESSURE THRUST.



Expansion Joint Options:

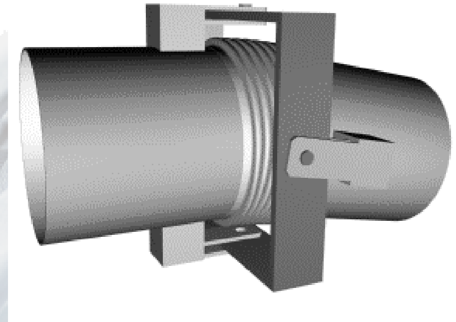


Van Stone Bellows:
Vanstone ends wrap the bellows neck around the flange face, which allows the flange to rotate. Van Stone type bellows are an economical solution compared to the use of stub ends (particularly in expensive alloys). Additionally the flange surface is no longer subjected to the flow, which allows for the use of cheaper alloy flanges.



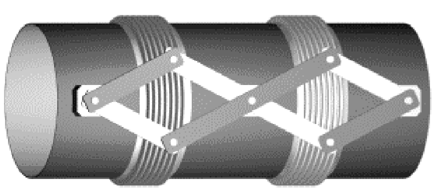
Hinged Expansion Joint:
When a Hinged Expansion Joint is used, movement is limited to angulation in one plane. Hinged Assemblies are normally used in sets of two or three to absorb large amounts of expansion in high pressure piping systems. Only low spring forces are transmitted to the equipment. The hinge hardware is designed to carry the pressure thrust of the system, and often times, used to combat torsional movement in a piping system. Slotted Hinged Expansion Joints are a variant of the standard Hinged Expansion Joints that allow axial and angular movement. Once a Slotted Hinge is introduced, torsion in the piping system is still resisted but the hinge no longer carries pressure thrust.

Expansion Joint Options:



Gimbal Expansion Joint:
The gimbal restraint is designed to absorb system pressure thrust and torsional twist while allowing angulation in any plane. Gimbal Assemblies, when used in pairs or with a Single Hinged unit, have the advantage of absorbing movements in multi-planer piping systems. The gimbal works the same as an automobile's universal drive shaft.

Pantograph Linkage:
Pantographic linkages are devices used to equally distribute movement between the two bellows of a universal style expansion joint. The devices work like scissors and do not contain pressure thrust.



Best Practices

- Always allow for adequate space to place an expansion joint.
- Always adequately guide the piping the expansion joint is placed in.
- Always account for pressure thrust when anchoring lines.
- Never subject a joint to conditions it is not rated for.
- Never subject a joint to torsion.
- Never put a damaged joint into service.

Installation and Operation Guidelines

Installation:

- Install expansion joint with shipping bars in place.
- Remove shipping bars before pressure testing system.:
- Do not damage bellows element (grinding, denting, weld splatter)

Operation:

- Periodically examine bellows for damage or wear.
- Ensure no solids are between convolutions during operation.
- Keep exterior free of corrosive elements.

THANK YOU FOR YOUR TIME!

American BOA-Industrial Division

Mailing Address:

P.O. Box 1301, Cumming, GA 30028

Phone: (770) 889-9400

Fax: (770) 781-3968

Website: www.americanboa.com

E-mail: sales@boa-us.com