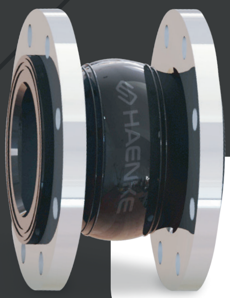
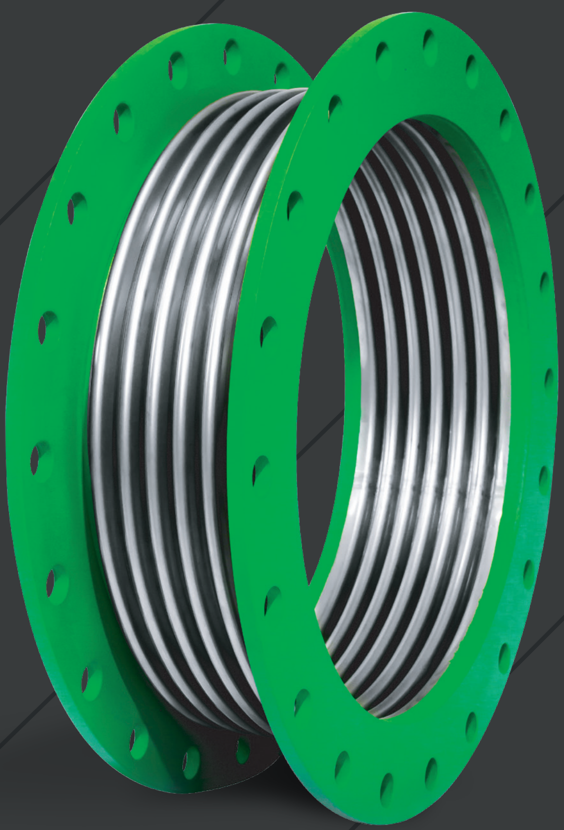
CERTIFIED ISO 9001:2015 COMPANY



EXPANSION JOINTS



IN-HOUSE
MANUFACTURING -
100% BRAZILIAN

HAENKE®

Haenke

Haenke is a **100% Brazilian company** that manufactures Flexible Metal Tubes and Expansion Joints. With over **35 years in the market and high credibility with customers**, it stands out for its quality, fair prices, and timely deliveries.

Aiming at improvement, it makes constant investments in the manufacturing area, acquiring machinery and equipment that allow for improving product quality, which is **ensured by the Quality Management System based on the ISO 9001:2015 series standard.**

We have exclusive engineering for the development of products and special expansion joint projects, serving various models of expansion joints with or without self-supporting structures.

Our products are designed, manufactured, and tested in accordance with applicable standards, meeting all their requirements.

Expansion joints are manufactured for the areas of power generation, sugar and alcohol plants, petrochemicals, oil, shipyards, food, pharmaceuticals, mining, steel, air conditioning, and pulp and paper ventilation, etc.

Summary

HAENKE®

AXIAL MOVEMENT

Axial movement is the change in the dimensional length of the bellows from its free length in a direction parallel to its longitudinal axis. Compression is always expressed as negative (-) and extension as positive (+).

LATERAL MOVEMENT

Lateral movement is the relative displacement of one end of the bellows to the other end, in a direction perpendicular to its longitudinal axis. Lateral movement can be imposed on a single bellows, but to a limited degree (figure 1). A better solution is to incorporate two bellows in a universal arrangement (figure 2). This results in greater compensation movements and much lower compensation forces.

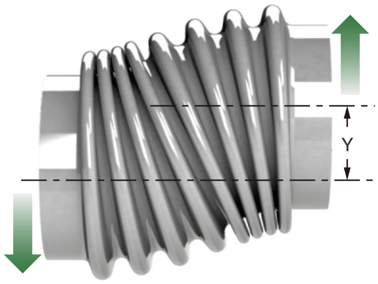
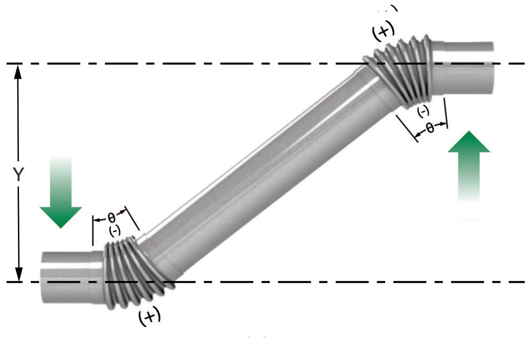
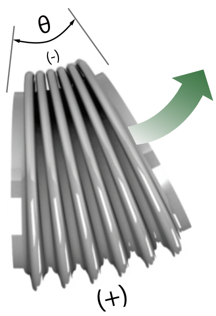


FIGURE 1



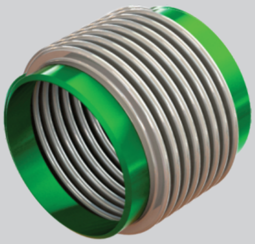
ANGULAR MOVEMENT

Angular movement is the rotational displacement of the bellows' longitudinal axis toward a point of rotation. The convolutions at the innermost point are in compression (-) while those further away are in extension (+). The angular capacity of a bellows is most often used with a second bellows.



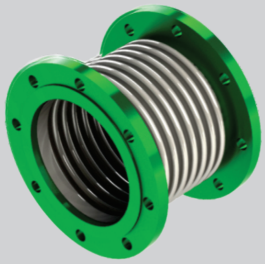
EXPANSION JOINT MODELS

H-AEJW



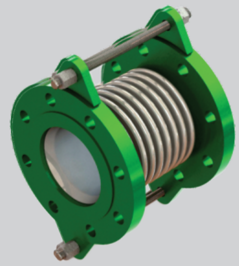
Axial Expansion Joint
with Weld Ends

H-AEJF



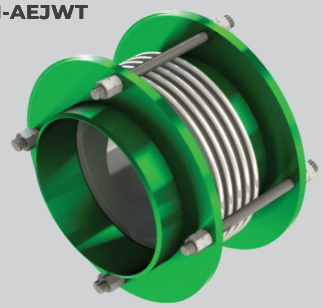
Axial Expansion Joint
with Flanges

H-AEJFT



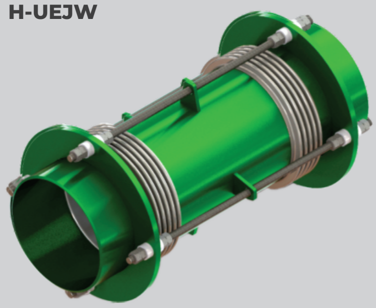
Axial Expansion Joint
Flanged with Tensioners

H-AEJWT



Axial Expansion Joint with
Weld Ends and Tensioners

H-UEJW

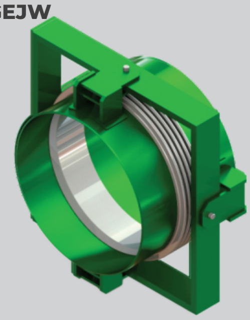


Universal Expansion Joint
with Weld Ends

H-UEJF

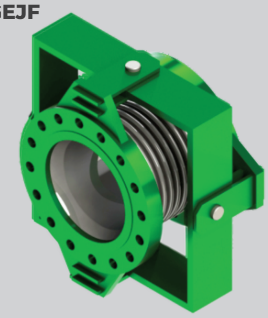
Universal Expansion Joint
with Flanges

H-GEJW



Gimbal Expansion Joint
with Welded Ends

H-GEJF

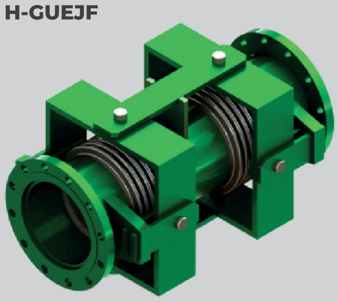


Gimbal Expansion Joint
with Flanges

H-HEJW

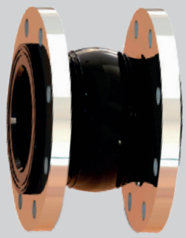
Hinge Expansion Joint
with Welded Ends

H-GUEJF



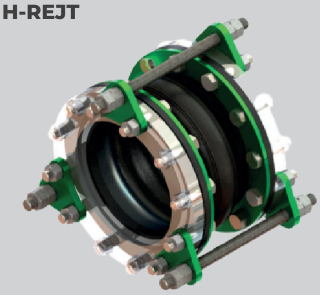
Gimbal Universal Expansion
Joint with Flanges

H-REJ



Rubber
Expansion Joint

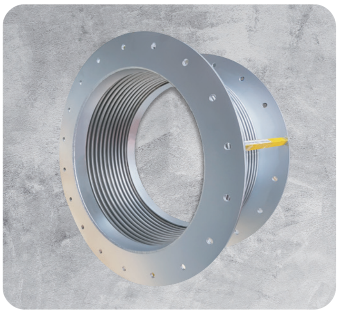
H-REJT

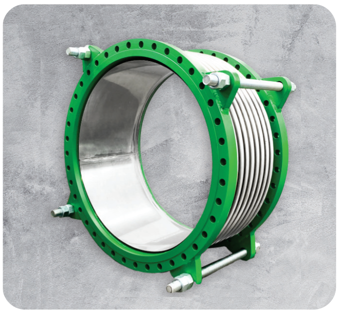


Rubber Expansion Joint
with Tensioners

AXIAL EXPANSION JOINTS AND VIBRATION DAMPERS

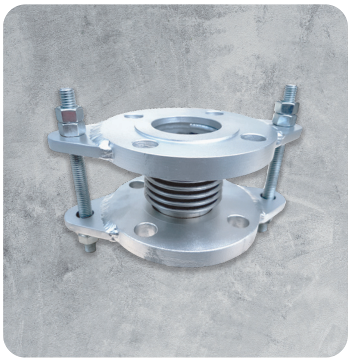
Designed to absorb axial compression or extension movements in straight sections of piping. This model must be installed between fixed points with unidirectional axial guides, containing the effects of reaction force due to joint pressure. Composed of stainless steel bellows (flexible element), stainless steel internal guide, and carbon or stainless steel terminals. Our standard line includes the H-JEAP models - Axial Expansion Joint (PPS - weld-end terminals) and H-JEAF - Axial Expansion Joint with Flanges, fixed or loose.





NOMINAL DIAMETER (in.)	Ø ext. (mm)	L1 (mm)	L2 (mm)	MOVEMENTS		SPRING CONSTANT		AMPLITUDE FOR H-AVEJ LINE	
				AXIAL	LATERAL	AXIAL	LATERAL		
				X (mm)	Y (mm)	(kgf/mm)	kgf/mm)	AXIAL (X) (mm)	LATERAL (Y) (mm)
2"	60,3	230	180	25	10	9	7	±1,5	±0,5
2.1/2"	73,0	230	180	38	18	13	11		
3"	88,9	260	205	38	13	9	7		
4"	114,3	340	255	50	22	14	9		
5"	141,3	340	280	50	20	16	14		
6"	168,3	345	270	50	17	17	30		
8"	219,1	350	290	50	14	28	62		
10"	273,0	370	300	50	11	33	119		
12"	323,8	370	315	50	11	39	161		
14"	355,6	330	260	50	11	40	318		
16'	406,4	330	265	50	7	46	461		
18"	457,0	330	270	50	7	51	644		
20"	508,0	330	275	50	6	73	57		
*OTHER DIAMETERS AND TECHNICAL CHARACTERISTICS AVAILABLE UPON REQUEST									

The Axial Expansion Joint can also be designed to absorb small-amplitude mechanical vibrations, reducing or eliminating mechanical and sound vibrations from equipment such as suction and discharge pumps, turbine inlets and outlets, fans, motors, compressors, etc. Our standard line includes the H-VDEJW model - Vibration Damping Expansion Joint (WET - Welded end Terminals) and H-VDEJF model - Vibration Damping Expansion Joint with Flanges, fixed or loose. The joints can also be supplied with a tensioning structure in galvanized carbon steel or stainless steel.

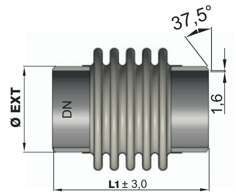


Haenke reference example:
H-VDEJW-304-3X300-WET-CS

- Carbon steel
- Welded end Terminals
- Overall length (WET)
- Nominal diameter
- Material alloy
- Model

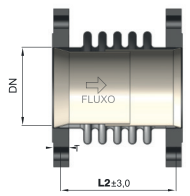
Design data (table):
Pressure: 10 kgf/cm²
Minimum service life at 25°C: 1000 cycles
Maximum axial movement (see table)
Maximum lateral movement (application without guide tube) (see table)

AXIAL EXPANSION JOINT WITH WELDED END TERMINALS



H-AEJW / H-VDEJW

AXIAL EXPANSION JOINT WITH FLANGES



H-AEJF / H-VDEJF

UNIVERSAL

Designed to absorb exclusively lateral and axial movements of the joint itself. Composed of two stainless steel bellows joined by an intermediate tube, internal stainless steel guide, and tensioning structure sized for low and medium working pressure, supporting the reaction effects of pressure released by the bellows. Universal Expansion Joints can be supplied with weld-on ends – H-UEJW or with flanges – H-UEJF.

***DIAMETERS AND TECHNICAL CHARACTERISTICS UPON REQUEST**

GIMBAL

Designed to absorb angular movements in space. Composed of a bellows and internal stainless steel guide and cardanic structure sized for low, medium, and high working pressures, withstanding the reaction effects of pressure released by the bellows. Gimbal Expansion Joints can be supplied with weld-on ends – H-GEJW or with flanges – H-GEJF.

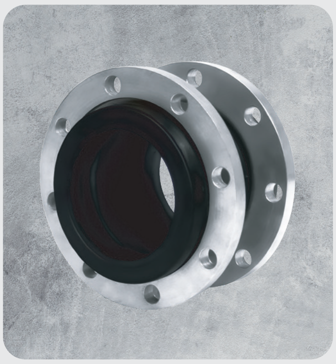
The Gimbal Expansion Joint must always be installed in pairs, or two plus one Hinged Expansion Joint (H-HEJ). Replacing the Universal Expansion Joint (H-UEJ), which cannot absorb large lateral spatial movements.

***DIAMETERS AND TECHNICAL CHARACTERISTICS UPON REQUEST**

HINGE

Designed to absorb coplanar angular movements. Composed of a bellows and internal stainless steel guide and hinge structure sized for low, medium, and high working pressures, withstanding the reaction effects of pressure released by the bellows. Hinged Expansion Joints can be supplied with weld-on ends – H-HEJW or with flanges – H-HEJF.

***DIAMETERS AND TECHNICAL CHARACTERISTICS UPON REQUEST**



RUBBER

Designed to absorb axial, lateral, angular movements and vibrations. Composed of an elastomer body and flanged ends in carbon steel or stainless steel. Rubber Expansion Joints are sized to withstand working pressures of up to 300 PSI (21 kgf/cm²) and temperatures of up to 100°C.

***DIAMETERS AND TECHNICAL CHARACTERISTICS UPON REQUEST**

DESIGN CONCEPTS

DIAMETERS AND TECHNICAL CHARACTERISTICS UPON REQUEST

When we heat a body, increasing its thermal energy, we increase the state of agitation of the molecules that compose it. These molecules need more space and end up moving away from each other, increasing the volume of the body. This phenomenon is known as thermal expansion.

Thermal Expansion of Pipes

In solid bodies, expansion occurs in all directions, but this expansion can be predominant in only one direction, and when this happens, we have linear thermal expansion or, simply, axial thermal expansion.

Here, we will address the effects of axial thermal expansion on the pipe shown in Figure 1:

To calculate axial thermal expansion, we use the following formula: **ΔL=L0. Δ T . K**

Where:
ΔL: Axial Thermal Expansion (mm)
L0: Initial pipe length (mm)
ΔT: Maximum temperature differential (°C)
K: Unit thermal expansion coefficient (mm/m.°C)

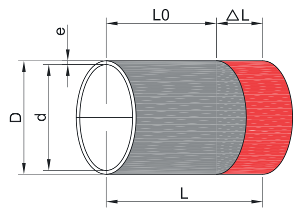


FIGURE 1

The following table shows the unit thermal expansion coefficients for carbon steel and 18 Cr 8Ni stainless steel materials and temperatures.

COEFFICIENTS OF LINEAR THERMAL EXPANSION K (mm/m·°C)						
MATERIAL	100	200	300	400	500	600
	° C					
CARBON STEEL	0,0120	0,0126	0,0131	0,0136	0,0141	0,0147
STAINLESS STEEL 18 Cr 8 Ni	0,0168	0,0175	0,0180	0,0184	0,0188	0,0191

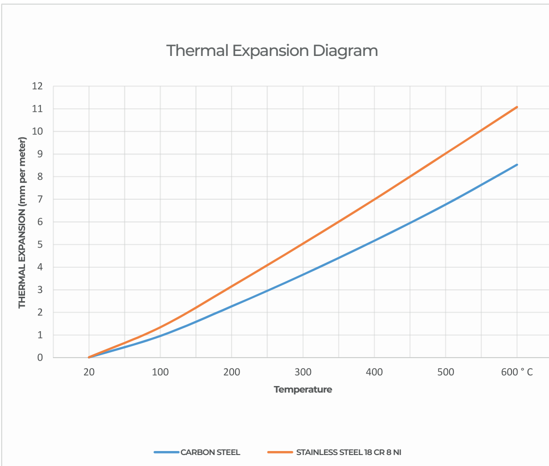
Example of axial thermal expansion calculation: **ΔL=L0. Δ T . K**

Consider a carbon steel pipe with an initial length of 30 m, installed at 20°C. What will be the thermal expansion of the pipe when the system operates at 200°C?

Applying the equation:
L0= 30m
ΔT= 200°C – 20 = 180°C
K= 0,0126 mm/m .°C (extracted from the table)
Replacing:
ΔL = 30 x 180 x 0,0126 = 0,06804m

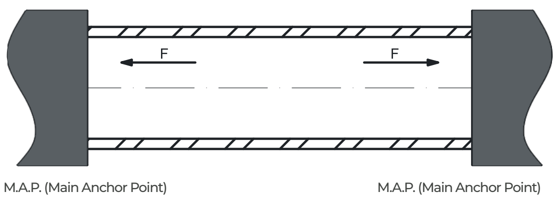
Therefore, at operating temperature, the pipe will measure 30.068 m.

The figure on the right shows a thermal expansion diagram, where we can graphically find the value of axial thermal expansion without using the equation.



FORCES CAUSED BY AXIAL THERMAL EXPANSION

Analyzing a straight pipe, fixed at both ends and subject to temperature variation, it will transmit a thrust force to the fixings due to its expansion.



As a consequence of Hooke's law, force F is equal to: F = A . E . K . ΔT / 1.000.000

Where:
F: Thrust force on fixed points (Ton)
A: Effective cross-sectional area of the pipe (cm^2)
E: Modulus of elasticity (Young's modulus) of the material at the temperature considered (kgf/cm^2)
Example:
Consider a DN 8" SCH80 carbon steel pipe fixed as shown in the previous figure and subjected to a temperature of 300°C.
For this case, we have the following values:
A: 82,35cm^2
F= 82,35 x 1.850.000 x 0,0131 x 280/ 1.000.000 = 558,8 tons

As we can see, this value is too high to be transmitted to any anchorage or equipment. Even if the points could be dimensioned to withstand such thrust force, extremely high internal stresses would arise in the pipe material.

If we calculate the resulting stress from the previous formula, we have:
$\delta = F/A$
$\delta = 558810{,}6\ kgf / 82{,}35\ cm^2 = 6785{,}789\ kgf/cm^2$

To avoid the transmission of these extremely high loads, and to protect the piping material from the equally high stresses generated by thermal expansion, it is essential to carefully analyze the pipeline design so that it complies with the required anchoring conditions and meets applicable regulatory stress standards.

Main efforts conveyed by the Expansion Boards

Pressure Reaction Force (PRF)

For the correct application of expansion joints, we must take into account the FRP (Reaction Force due to Pressure). This force is released by the expansion joints (Figure 2), which we can illustrate according to Pascal's principle, where pressure exerted on the seal of a liquid is transmitted with equal intensity in all directions. We can calculate this force using the formula:

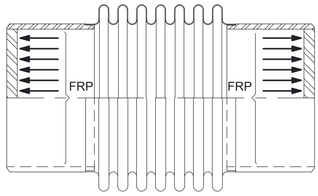


FIGURE 2

FRP= P x A
Where:
FRP: Reaction force due to pressure (kgf)
P: Internal pressure (kgf/cm^2)

For expansion joints, the reaction force per pressure released by the bellows (FRP) according to the equation (Figure 3):

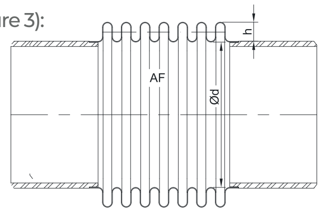


FIGURE 3

FRP= $P \times \Pi / 4 \times Øm^2 = P \times \Pi / 4 \times (Ød + h)^2$
We have:
FRP= Reaction force due to pressure (kgf)
P= Internal pressure (kgf/cm^2)
Øm= Average bellows diameter (cm)
Ød= Internal diameter of bellows (cm)
H= Bellows wave height (cm)

This force is released by joints that do not have a self-supporting external structure like the models H-AEJW, H-AEJF.

Therefore, for the correct installation of expansion joints in the dimensioning of fixed points and stresses when installed near equipment sensitive to this stress, there are several ways to avoid the transmission of reaction force by pressure:

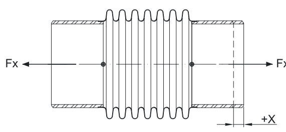
- Use expansion joints with a tensioning structure (universal, hinge, gimbal). In this case, the force is contained by the structure itself, freeing the fixed points and/or equipment from this considerable stress.
- Secure the ends of the pipe section where the joint is installed with fixed points capable of withstanding the reaction of this force.
- Use self-compensating expansion joints, whose construction system allows the effects of force to be compensated for by using a compensating bellows.

Spring constant (axial, lateral, angular)

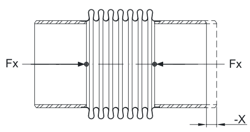
The spring constant is the force or moment required to compress, stretch, or deflect laterally or angularly the bellows of an expansion joint, serving as a key parameter in determining its flexibility and overall performance.
The spring constant is calculated based on the dimensional characteristics of the bellows and the elastic behavior of the materials used at different temperatures.
To obtain total axial and lateral spring constant values, multiply the spring constant by the total movement to be absorbed.

Axial movement
FX= Kx . X
We have:
FX= Total axial spring force (kgf)
KX= Axial spring constant (kgf/mm) – See table according to the product
X= Total axial movement (mm)

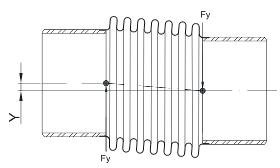
Sideways movement
FY= ky . Y
Where:
FY= Lateral spring force (kgf)
Ky= Lateral spring constant (kgf/mm) - See table according to the product
Y= Lateral movement (mm)



Axial Extension (+)



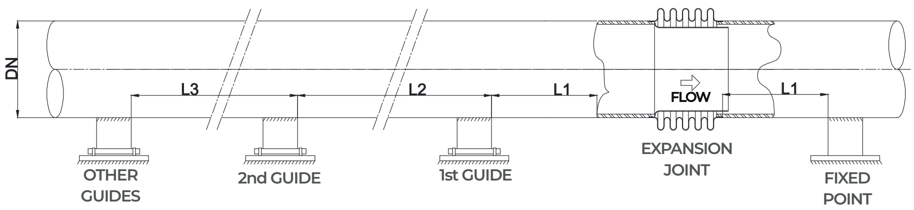
Axial Compression (-)



Lateral Movement

INSTALLATION RECOMMENDATIONS

- The installation site must be prepared for the installation of the Expansion Joint, following the specifications and design drawings.
- Changing the installation length of the Expansion Joint will result in additional movements, reducing its movement capacity during operation.
- Any axial, lateral, or angular pre-tension indicated in the drawing must be strictly observed when installing the expansion joint at the installation site.
- Do not use Expansion Joints to absorb movements greater than specified/designed.
- Install the expansion joints respecting the direction of flow, identified on the identification plate where applicable.
- Strictly observe the maximum permissible temperatures and pressures.
- Strictly follow all instructions contained in the corresponding drawings and specifications.
- Remove all shipping locks (when applicable) identified and painted yellow or red, only after complete installation of the Expansion Joint and before final testing of the line.
- The transport locks are designed to keep the expansion joint at the correct installation length, but they are not designed to withstand reaction forces due to internal pressure.
- Do not exceed the hydrostatic test pressure of 1.5 times the specified design pressure.
- To clean the system with steam, use the reel in the Expansion Joint position, replacing the joint after cleaning is complete. Follow this procedure if it is not specified at the time of specifying the Expansion Joint.
- Ensure that the fixed points of the piping where the Expansion Joints will be installed are properly sized.
- Next to the Expansion Joint, there should be axial guides according to the spacing indicated in the drawing and table below:

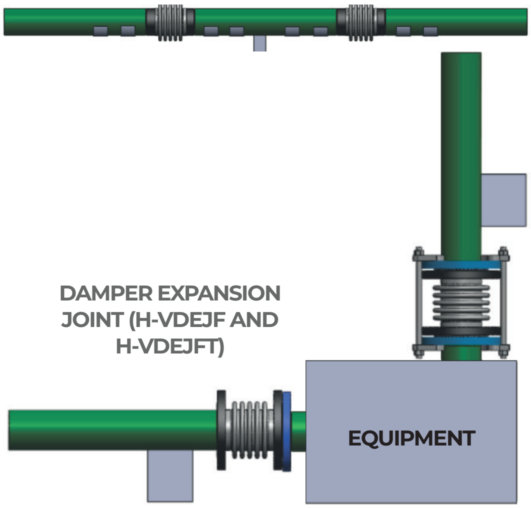


DN (In.)	Maximum Spaces - mm		Maximum Spaces - mm
	From Expansion Joint to 1st Guide	Between 1st Guide and 2nd Guide	From 2nd Guide onwards
1	100	350	3000
1 1/4	130	450	3400
1 1/2	160	600	4300
2	200	700	4900
2 1/2	250	900	6000
3	300	1200	6700
4	400	1500	9144
5	520	1800	7100
6	500	3000	12200
8	800	3000	15200
10	1000	3100	18900
12	1200	3100	20100
14	1400	4900	21300
16	1600	5500	23800
18	1850	6400	25900
20	2050	7000	28300
24	2450	8500	31100

*OTHER DIAMETERS AND TECHNICAL CHARACTERISTICS AVAILABLE UPON REQUEST

INSTALLATION EXAMPLES

AXIAL EXPANSION JOINTS (H-AEJW)



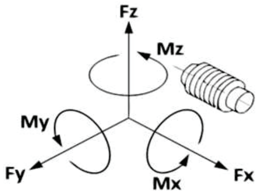
Install only one expansion joint between two fixed points. If several expansion joints must be installed in the same straight section of piping, distribute intermediate fixed points in the section, maintaining one joint between two fixed points.
For expansion joints with stroke limiters, when applicable, they must be locked in their final position, according to the dimensions specified in the design drawings in the last assembly stage prior to the hydrostatic testing of the line.
For connecting expansion joints for vibration, crimp the piping immediately after the expansion joint.
For the installation of Double and Anchored Expansion Joints (with self-supporting structures), strictly follow the pipe axes in accordance with the specified/designed movements of the Expansion Joint.

SPECIFICATION SHEET
FOR EXPANSION JOINTS

Specification No.:	Sheet:	Date:	Revision:

Identificação			
Client:			
Project/Drawing:	Item/Tag:	Revision:	
Type of Expansion Joint/Product:			
Nominal Diameter:	Installation Length:	Qty.:	
Application/Installation Location:			
Installation Position:	◯ Horizontal	◯ Vertical in flow direction	◯ Upward ◯ Downward

Project Data					Unit
Fluid:		Flow Velocity:			
Pressure		Design:			
		Operation:			
		Test:			
Temperature		Design:			
		Operation:			
Reference axes	Operating Movements	Axial X	Compression:		
			Extension:		
		Lateral Y			
		Lateral Z			
		Angular θ:			
	Claim/Installation Movements	Axial X	Compression:		
			Extension:		
		Lateral Y:			
		Lateral Z:			
		Angular θ:			
	Spring Constants	Axial X	Compression:		
			Extension:		
		Lateral Y:			
		Lateral Z:			
		Angular θ:			



Structural Materials			
	Bellow:		
	Flange:		Standard:
	Collar:		
	End Pipe:		
	Internal Guide Tube:		
	Protection Sleeve:		
	Gimbal/Links:		
	Tie Rods:		
	Others:		

General Notes

Responsible:	Contact:	Date:

To facilitate completion, request the electronic file by contacting us - **engenharia02@haenke.com.br**

Version - 1.0.0

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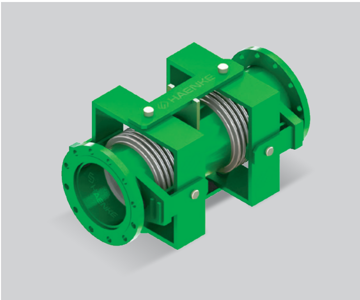

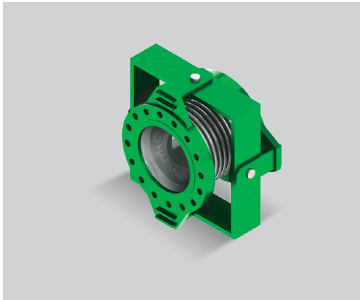

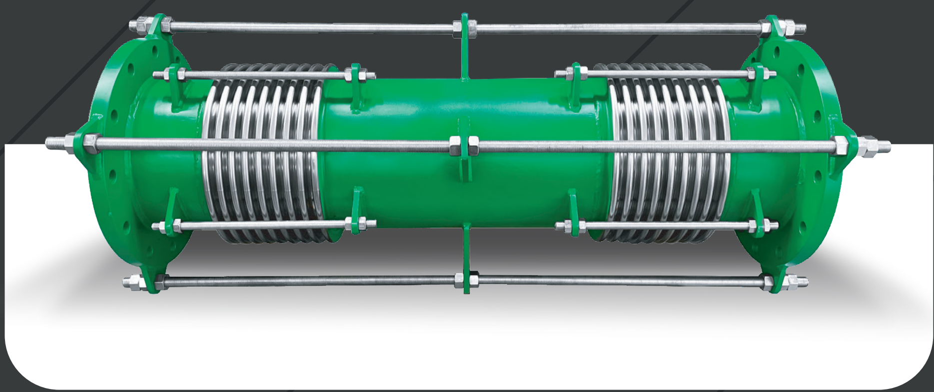

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