

EXPANSION JOINT SELECTION

The successful installation of expansion joints in a pipe system requires the careful consideration of many variables.

The most important issue is to establish the direction in which the movements are acting and in which way the movements should be absorbed. Once this information is known, the solution incorporating the most suitable expansion joint type(s) can be determined.

The following pages give some ideas and suggestions for pipe system design, and how to implement expansion joints in the system in the best way.

Complex pipe systems must be subdivided into a number of less complex sections, to ensure the optimum movement absorption in several directions. Each section is

usually divided by a fix point (between each section).

Drawings

In the following pages examples of good practice in the use of expansion joints in different pipe systems are illustrated. The drawings are freely adapted from the applicable standards and are in accordance with the drawings available in the latest version of the standard prevailing at the time of this catalogues publication.

See animations

By using the WebLink located near each examples, you can see the online animations.

Questions & assistance

If you have any questions or would like any advice on the selection of expansion joints and their location in the pipe system, please contact us.

DEFINITIONS



FP = Fix point - on the straight pipe



FP = Fix point - placed in the corner



LFP = Light fix point



LFP = Light fix point - placed in the corner



G1 = Guide 1



G2 = Guide 2



Gn = Following guides (Guide 3 etc.)

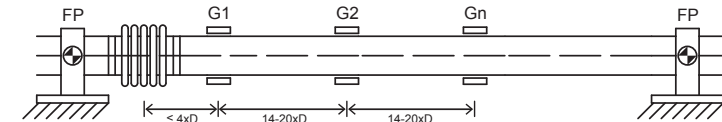
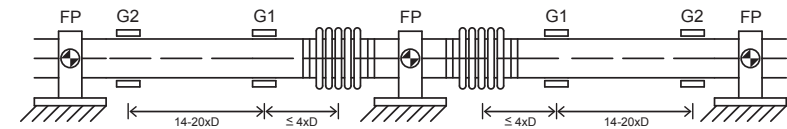
FIX POINTS, GUIDES ETC.

Fix points and guides for axial expansion joints

It is important that the fix point is placed as close to the axial expansion joint as possible. It is important to note that only one axial expansion joint can be installed between two fix

points. The distance between the expansion joint and the first guide should be a maximum of $4 \times$ diameter. The distance between the following guides should be $14-20 \times$ diameter. This is illustrated in the drawings below.

For other expansion joint types, the position of fix points and guides are dependent on the pipe system and the position of the expansion joint in the pipe system.

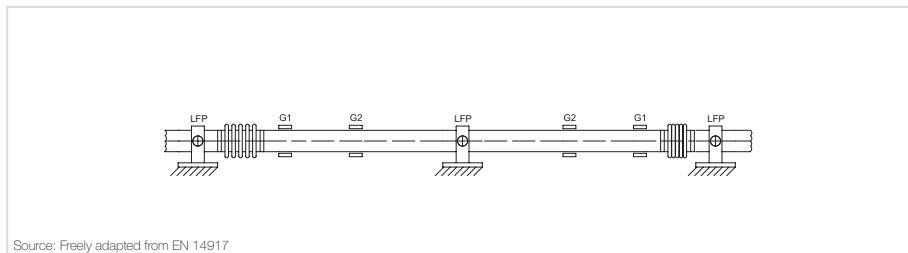


MORE INFORMATION

If you would like to learn more about how to install expansion joints, please visit our **installation instruction**, which is available online via this **WebLink: 13602**

Expansion joint selection

AXIAL

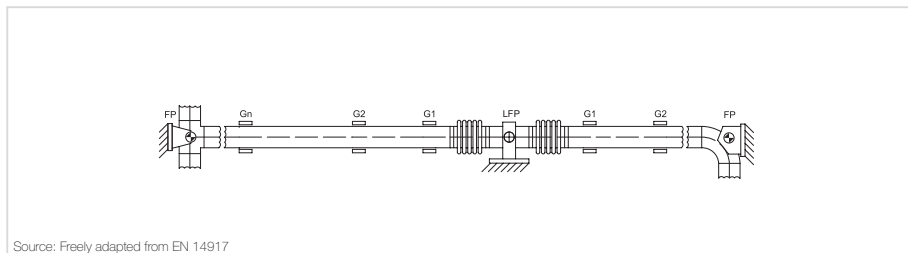


Straight piping section with axial expansion joints

This illustrates the importance in the use of the three fix points, as the use of two or more axial expansion joints in a piping section will create an undetermined arrangement.

The amount of movements imposed on each expansion joint is not controlled, as the pipe between the two bellows can move sideward freely in both directions depending on the

friction of the pipe supports and the differences in stiffness between the bellows. It is always important to have one axial expansion joint between two fix points.



Axial expansion joints not restraining the pressure thrust

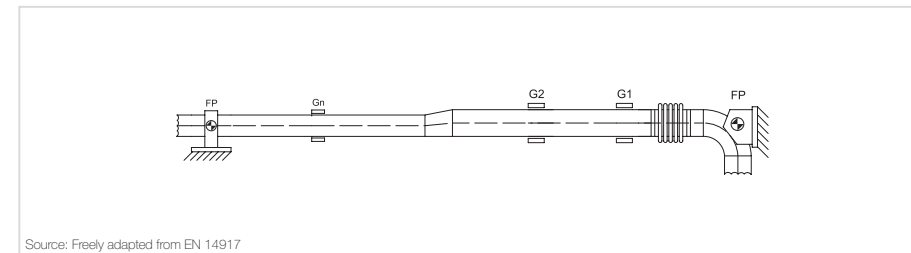
The piping system should be divided into sections by means of fix points, guides or restraining tie rods in order to have only one expansion joint

per section of straight pipe system. The fix points and other restraining devices should be designed for the full pressure thrust from the bellows

effective area plus the bellows displacement force. Additionally, the forces generated by the friction within the guides should also be considered.

Expansion joint selection

AXIAL

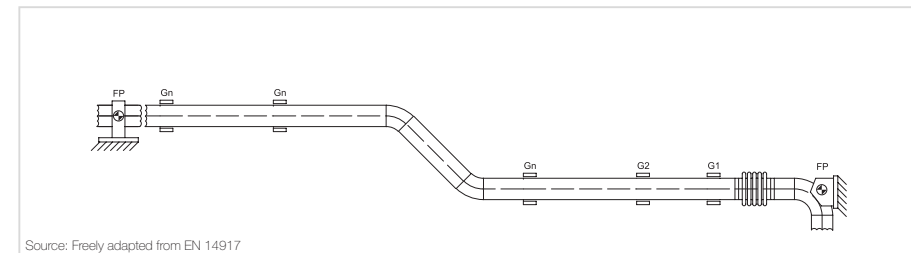


Single axial expansion joint located on the large diameter side of a reducer

When on the same straight pipe section, an axial expansion joint is located beside a reducer, the loads

on the small fix point should take into account the full pressure thrust of the expansion joint and, additionally, the

possible offset of the pressure thrust if the reducer is eccentric.



Straight piping with offset with axial expansion joint

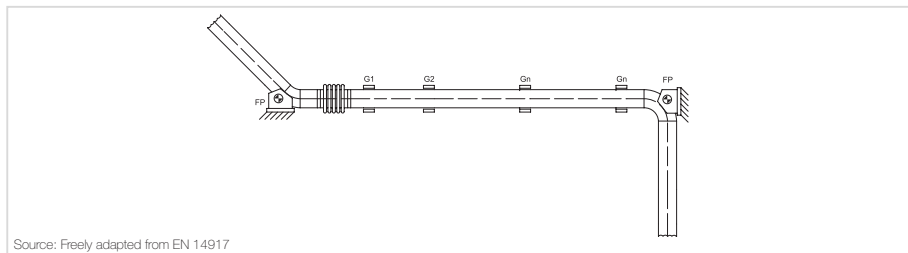
Shows the application of a single expansion joint in a pipe system containing an offset. It should be noted that applications of this type are not usually recommended and will only perform satisfactorily under certain conditions. As shown the pipe system is provided with fix points at each end to absorb the pressure, movement loading and guide friction. Where the line contains

an offset, this load must first be transmitted through the offset leg, resulting in a movement on the pipe system. Where the pipe system size is small, the offset appreciable, or where the pressure and movement forces are relatively high, this configuration may result in over-stressing, or distortion of the pipe system and guides. Note the proximity of the expansion joint to a fix point and the

distance between the first guide (G1). Further, the spacing between the first guide and the second guide (G2) and the spacing of guides (Gn) along the rest of the pipe system. Guides should be installed near both ends of the offset leg to minimise the effects of the bending movement on the system.

Expansion joint selection

AXIAL



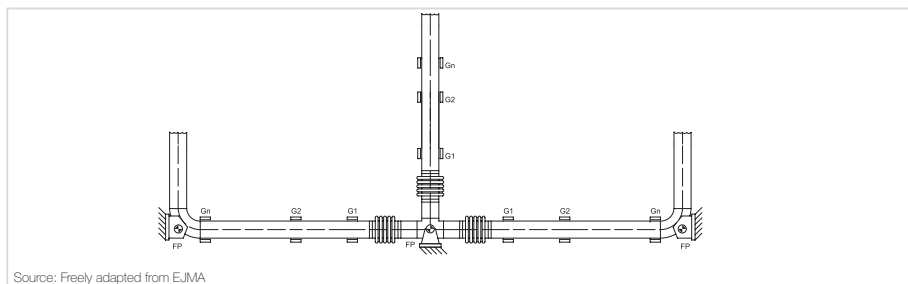
Source: Freely adapted from EN 14917

Straight piping with bend/offset with axial expansion joint

Typifies good practice in the use of a single expansion joint to absorb axial pipeline expansion.
Note the use of one expansion joint

between the two fix points, the distance between the expansion joint and a fix point, the proximity of the first guide (G1), the spacing between

the first guide and the second guide (G2), and the spacing of guides (Gn) along the remainder of the pipe system.



Source: Freely adapted from EJMA

Axial pipe system expansion in a pipe system with branch connection

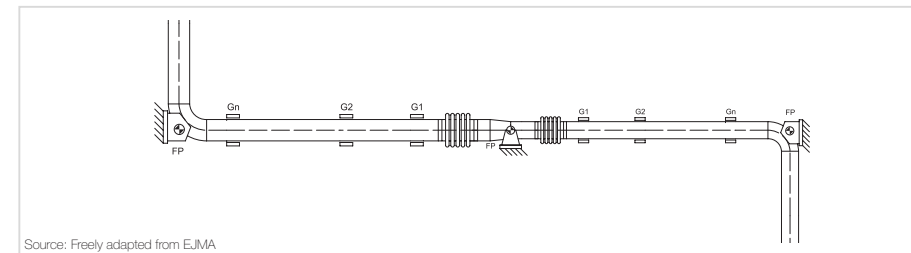
Typifies good practice in the use of expansion joints to absorb axial expansion in a pipe system with a branch connection. The fix point at the junction, which in this case is a

tee, is designed to absorb the thrust from the expansion joint in the branch line. Note the proximity of each expansion joint to a fix point, the closeness of each first guide (G1), the

spacing between the first guide (G1) and the second guide (G2) and the spacing of guides (Gn) along the remainder of each pipe section.

Expansion joint selection

AXIAL



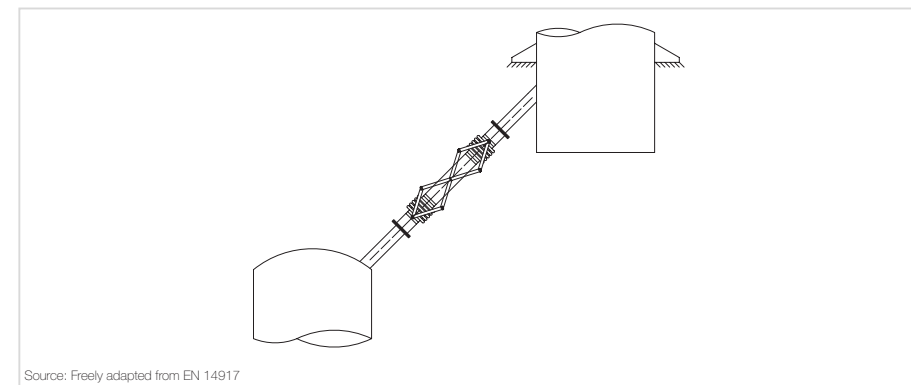
Source: Freely adapted from EJMA

Axial expansion joints in pipe system with reducer

Typifies good practice in the use of expansion joints to absorb axial expansion in a pipe system containing a reducer. The fix point at the reducer is designed to absorb the difference in

the expansion joints thrusts on each side of the reducer.
Note the proximity of each expansion joint to a fix point, the closeness of each first guide (G1), the spacing

between the first guide and the second guide (G2) and the spacing of guides (Gn) along the rest of each pipe section.



Source: Freely adapted from EN 14917

Straight piping section with two bends and axial expansion joints

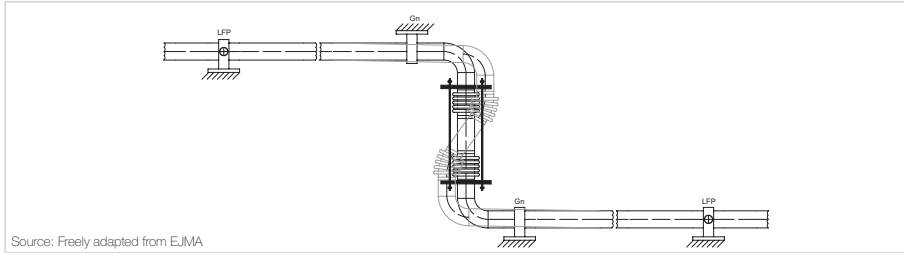
In cases where a universal expansion joint must absorb axial movement other than its own thermal growth, it cannot function as a tied expansion joint and must be used in combination with fix points to absorb pressure

loading. The relative expansion between the two vessels results in both axial and lateral movement on the expansion joint. Both vessels must be designed to absorb the load on the fix points. Control rods or

pantographic linkages may be used to distribute the movement equally between the bellows and control their movements.

Expansion joint selection

LATERAL



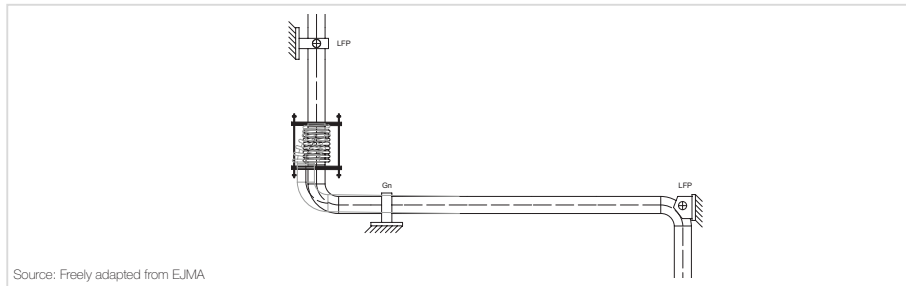
Source: Freely adapted from EJMA

Universal expansion joint to absorb lateral movement

Shows a tied universal expansion joint used to absorb lateral deflection in a single plane "Z" bend. Where dimensionally feasible, the expansion joint should be designed to fill the entire offset leg so that its expansion is absorbed within the tie rods as axial movement. The tie rod should be extended to the elbow centre line

when practical. The thermal movement of the horizontal lines is absorbed as lateral deflection by the expansion joint. Only directional guiding is required since the compressive loading on the pipe consists only of the force necessary to deflect the expansion joint. Any thermal expansion of the offset leg external to the tie rods, such

as that part of the elbows at either end, must be absorbed by bending of the horizontal pipe legs. Provisions should be made in the design of the guides to allow for both this deflection and the reduced length of the expansion joint in its deflected position.



Source: Freely adapted from EJMA

Tie rods to prevent axial movement

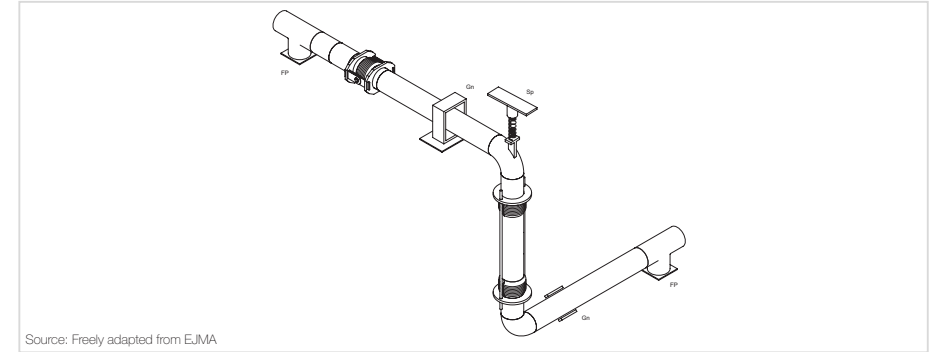
A piping configuration that permits the use of adapted tie rods to prevent axial movement frequently simplifies and reduces the cost of the installation. Due to the tie rods, the expansion joint is incapable of absorbing any

axial movement other than its own thermal expansion. The thermal expansion of the piping in the shorter leg is, as a result, imposed as deflection on the longer piping leg. Where the longer piping leg is not sufficiently flexible and where the

dimension of the shorter leg is suitable, tie rods may be installed spanning the entire short leg so that no deflection is imposed on the longer run from its source.

Expansion joint selection

LATERAL



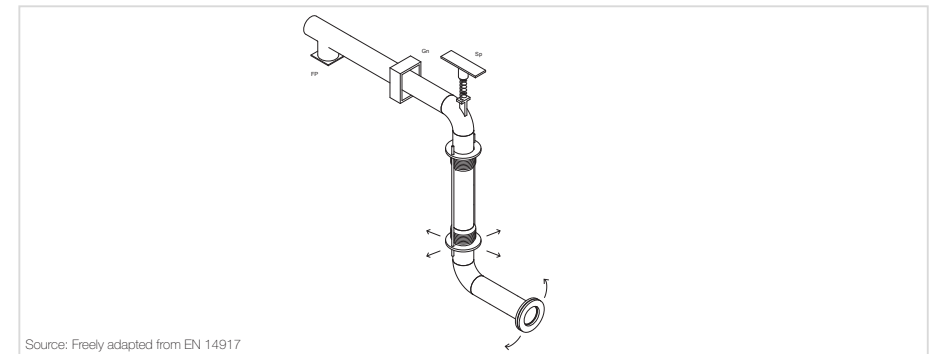
Source: Freely adapted from EJMA

Universal expansion joint in "Z" bend

Shows a typical application of a tied universal expansion joint in a three plane "Z" bend.

Since the universal expansion joint can absorb lateral deflection in any direction, the two horizontal piping

legs may lie at any angle in the horizontal plane.



Source: Freely adapted from EN 14917

Lateral expansion joint with two tie rods

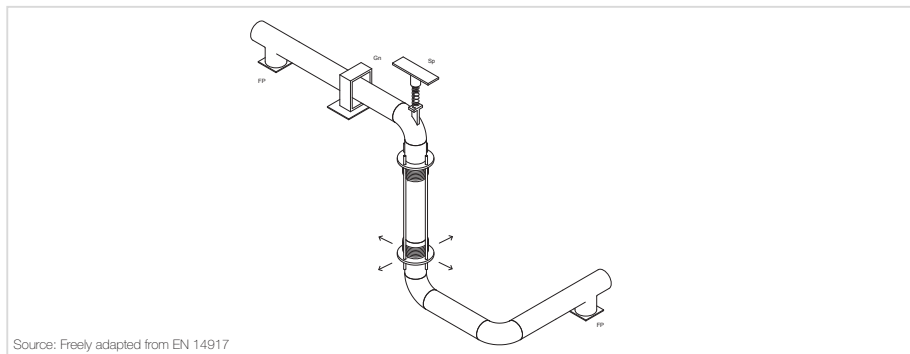
The drawing shows the possible movements.

The piping connected at the bottom should be guided in such a manner

that the expansion joint is not subject to torsion.

Expansion joint selection

LATERAL



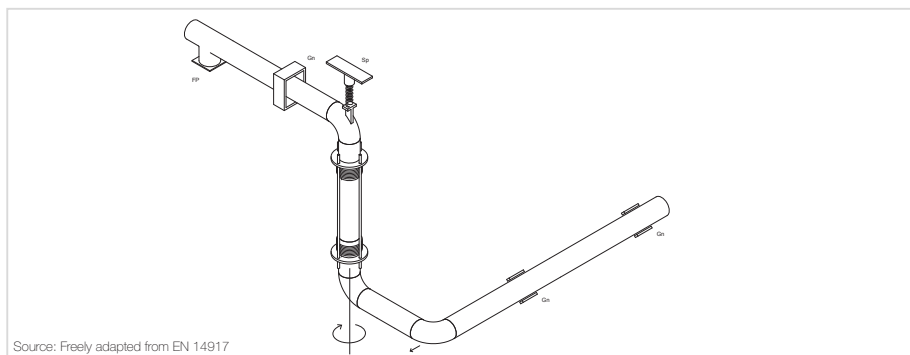
Lateral expansion joint with three or more tie rods

This kind of tied lateral expansion joint is used in a similar way to that of two gimbals.

The only difference is that the thermal

expansion between the restraining rods are compensated within the expansion joints. The relevant compression or extension has to be

included into the fatigue life calculation of the bellows.



Lateral expansion joint with three or more tie rods

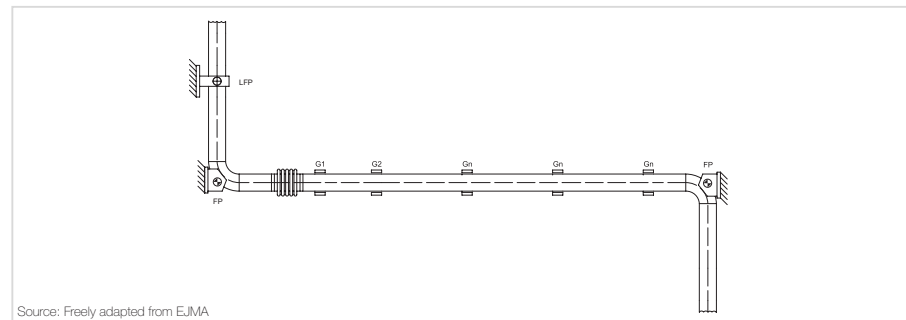
The use of lateral expansion joints with hinged tie rods in three-dimensional piping systems can, in certain

cases, be critical, as rotation around the longitudinal axis of the expansion joint is theoretically possible.

Rotation around the longitudinal axis of the bellow should be avoided.

Expansion joint selection

LATERAL

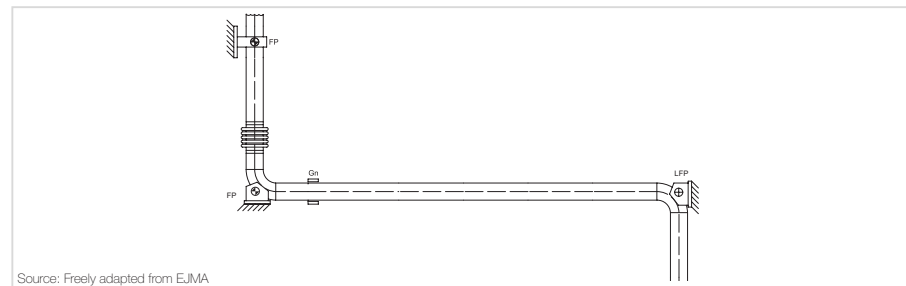


Single expansion joint for combined movements

As a single expansion joint is the least costly option, it is normally the first to be considered. This configuration shows a typical application of a single expansion joint absorbing combined axial movement and lateral deflection. The system closely resembles the arrangements shown for axial movement in the preceding section.

The expansion joint is located at one end of the long piping leg with fix points at each end. The guides are well spaced for both movement control and protection of the piping against buckling. The fix point (FP) at the left end of the pipe system absorbs the load on the fix point (FP) in the direction of the expansion joint

axis, while also permitting the thermal expansion of the short piping leg to act upon the expansion joint as lateral deflection. Due to the fix point, loading exists only in the piping segment containing the expansion joint.



Expansion joint installed in the short piping leg

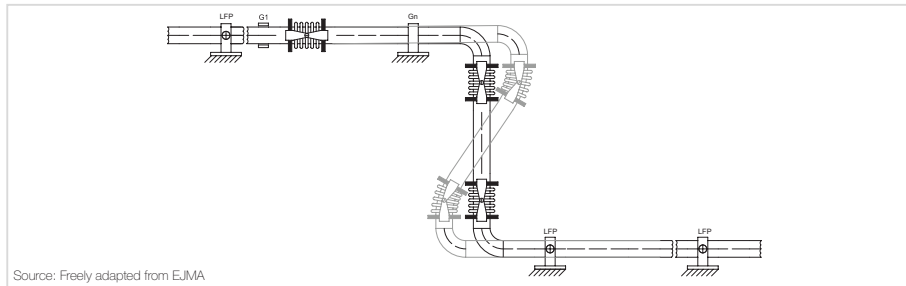
The configuration is an alternative arrangement in which the expansion joint is installed in the short piping leg

and the principal expansion is absorbed as lateral deflection. The longer piping leg is free of

compressive pressure loading and requires only fix points and a guide (Gn).

Expansion joint selection

HINGED

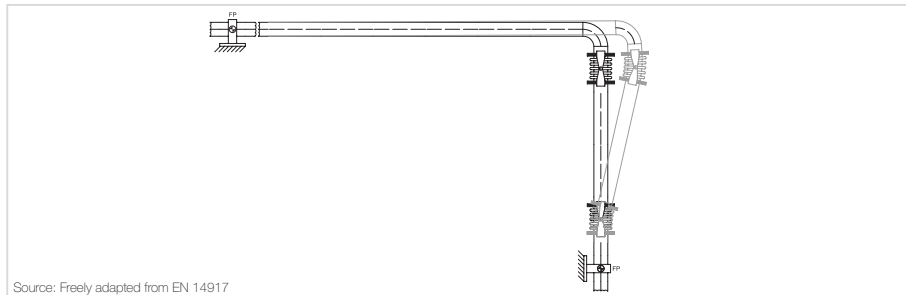


Hinges in a system

Hinged expansion joints can, in sets of two or three, be used for absorbing large lateral and axial movements.

In general, there should not be more than three angular expansion joints installed between two fix points, of

which a maximum of two can be gimbal expansion joints.



Two-hinge system

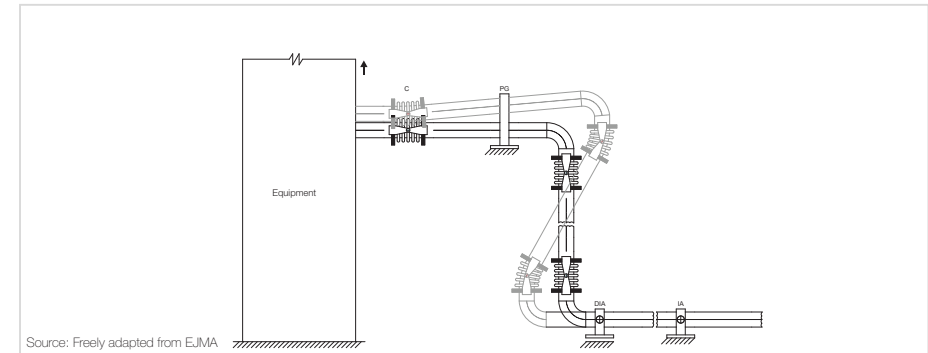
Illustrates the use of a two-hinge system to absorb the major thermal expansions in a single-plane "Z" bend. Since the pressure thrust is absorbed by the hinges on the expansion joints, only fix points are required at each end of the piping system. The thermal expansion of the offset section containing the expansion joints must be absorbed by the bending of the piping legs perpendicular to that segment, since the expansion joints are restricted to pure angular rotation by their hinges and

cannot extend or compress. The amount of bending deflection imposed on each of the two long piping legs may be controlled by the effective design of guides and supports. Where one long leg is sufficiently flexible to absorb the full thermal growth of the offset leg, the other long leg may be controlled to permit longitudinal movement only. The guides shown at the ends of the long pipe system near the elbows are intended to maintain the plane of the pipe system only and must allow for

the bending deflections of the long piping legs. When calculating guide clearances, consideration shall be given to the fact that the thermal expansion of the offset piping leg containing the expansion joints will be partially offset by the reduction in length resulting from the displacement of the centre pipe system. The latter effect may be ignored only where the distance between hinge pins is very large and the lateral displacement is small.

Expansion joint selection

HINGED



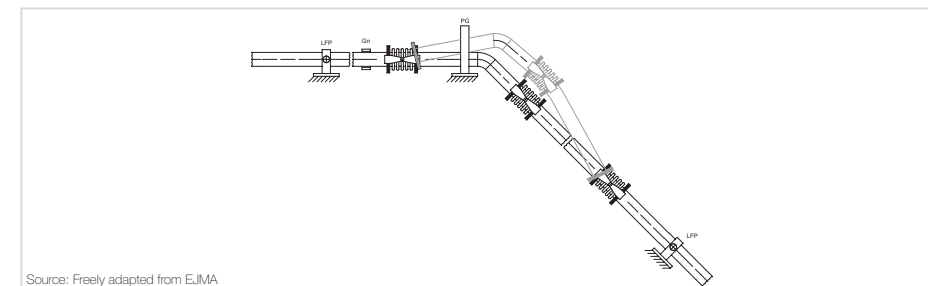
Three-hinged system

In this case, the entire deflection is absorbed by the expansion joints and negligible pipe bending loads will be imposed upon the fix points.

Where the distance between the fix point on the left and the first hinged expansion joint C is large, a pipe guide should be installed adjacent to the expansion joint, as shown. This pipe guide will minimise bending of

the pipe section between expansion joint C and the left hand fix point which might otherwise result from the movement required to rotate the expansion joint. One or more additional guides (Gn) may be used to maintain the plane of the piping system and relieve the hinges of bending forces which may be created by external loads.

Support for the piping system may be accomplished in various ways, utilising available supporting structures with greatest efficiency. It is essential that spring supports be used to permit the free movement of the piping between the expansion joints.



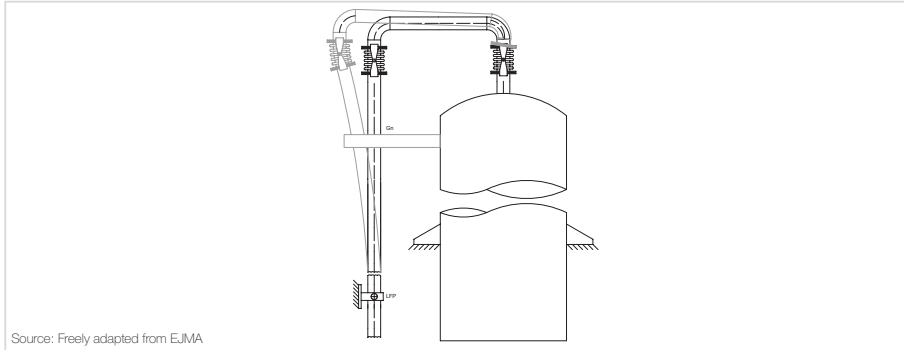
Hinge system in non 90° bend

The figure illustrates the principle that hinged expansion joint systems may also be used in other cases where

there are no 90° bends. Only fix points and guides are then required.

Expansion joint selection

HINGED



Two-hinged expansion joint system

In deploying hinged expansion joints for the most effective use, it should be noted that in order to function properly the hinges do not need to be colinear. The illustration shows a two-hinged expansion joint system. In this case, the expansion joints will absorb only the differential vertical growth between the vessel and pipe riser. Any horizontal movement due to piping expansion, vibration and wind loads will be absorbed by the bending

of the vertical pipe leg.

A planar guide may be installed near the top of the vessel to protect the hinged expansion joints from wind loads at right angles to the plane of the piping.

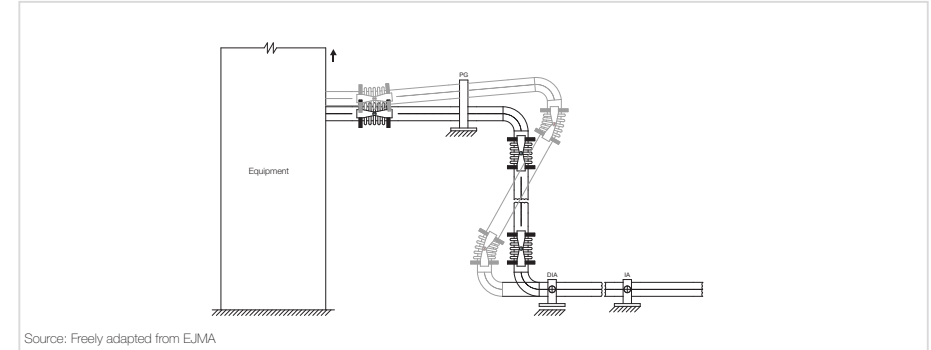
The fix point shown at the bottom of the riser is a fix point only, since the pressure load is absorbed by the expansion joint hinges.

This fix point must be capable of withstanding the forces created by

the bending of the riser. Depending on the dimensions and weight of the pipe system, sufficient support may be obtained from the process vessel and from the fix point. If additional supports are required, spring type supports should be used. The vertical piping may be cold pull to reduce bending stresses, utilising the hinges to withstand the cold spring force.

Expansion joint selection

HINGED



Hinged expansion joint system

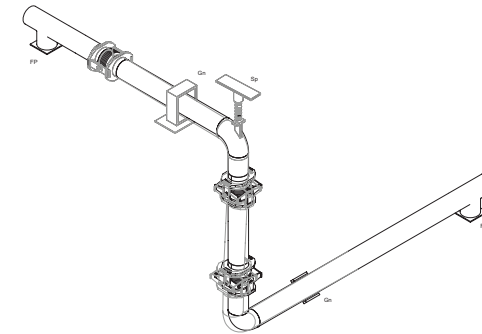
A hinged expansion joint system may be used effectively in applications involving movement other than the pure thermal growth of piping. The figure illustrates an application combining the thermal expansion of a piping system with the single plane movements of an item of connected equipment. As long as all movements are restricted to a single plane, the behaviour of the expansion joint system is quite similar to that of the system shown in the figure. A fix point is required at one end of the piping,

while the equipment serves as a fix point at the opposite end. The displacements of the equipment are added to those of the piping to evaluate the movements of the expansion joints. Planar guide clearances in the plane of the piping must be adequate to allow for the equipment movement as well as the piping rotations. The compact size and structural rigidity are the advantages of this expansion joint type. Through the use of these individual units, it is

frequently possible to compensate for the thermal expansion of irregular and complex piping configurations, which might preclude the use of other types of expansion joints. Due to the ability of the hinge structure to transmit loads, piping systems containing hinged expansion joints impose minimal forces on the fix points. Such systems can be supported at virtually any point, without interfering with the free movement of the system.

Expansion joint selection

GIMBAL



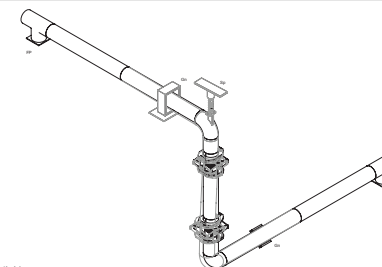
Source: Freely adapted from EN 14917

Two gimbals and one hinged expansion joint in a three-dimensional system

This often used system absorbs movements in any direction of the horizontal pipes through use of the

gimbals, while the hinged angular expansion joint takes the vertical movement resulting from the reduction

of the vertical distance between the gimbals.



Source: Freely adapted from EN 14917/EJMA

Two gimbals in a three-dimensional system

Just as hinged expansion joints offer great advantages in single plane applications, gimbal expansion joints are designed to deliver similar benefits in multi-plane systems. The gimbal expansion joints ability to absorb angular rotation in any plane is most frequently achieved by utilising two such units to absorb lateral deflection. An application of this type is shown in

the illustration. Since the pressure loading is absorbed by the gimbal structure, fix points only are provided. Guides are provided to restrict the movement of each piping leg. As in the case of hinged expansion joints, the location of pipe supports is simplified by the load carrying ability of the gimbal structure. Since, in a two gimbal system, the growth of the

vertical pipe leg will be absorbed by bending of the longer legs, spring supports (SP) may be required on either or both of these. Guides must be designed to allow for the thermal expansion of the leg containing the expansion joints and for the shortening of this leg due to deflection.

Expansion joint selection

U-PIPE

In some pipe systems, the operating conditions can be quite challenging, resulting in special considerations for the design of both the pipe system and for the expansion joints. Large movements can be absorbed in numerous ways, and with different expansion joint types. In many cases installing two or more expansion joints together at natural or contrived offsets in the pipe system can be a good solution to absorb large movement. The same pipe system design can also be used for the absorption of angular movements, which would not be possible in a straight pipe system.

Why U-bend/pipe loop?

The U-bend is a good solution for absorbing larger movements. The configuration of a pipe loop containing 3-angular (hinged) expansion joints can absorb, at a minimum, three times larger movements compared to a traditional pipe loop without angular expansion joints. The hinges on the expansion joints contain the pressure forces from the bellows and simultaneously ensure that movements are controlled, which helps to support the pipe system. The pipe system geometry is determined

by the amount of movement to be absorbed and the rotational capability of the expansion joints; the higher the movements the greater the distance required between the centre and end expansion joints.

The advantages of this U-pipe system design

- Large movements are absorbed
- The stress forces on the system fix points are much reduced compared to those from equivalent unrestrained expansion joints
- Costs for fix points are reduced
- Solutions using restrained expansion joints can prove to be very cost effective, especially when the pipe system is installed at heights. The need for the substantial fix points and guides in the pipe system that are routinely required with unrestrained expansion joints, becomes unnecessary due to the pressure thrust force from the bellows being contained by the hinge structure on the expansion joints

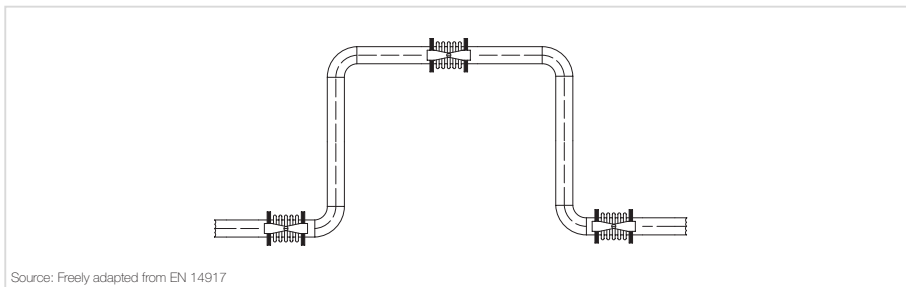
- As shown in the on the left, use of expansion joints in loops can reduce the number of loops required from 3 to 1

Tips!

- Venting or draining may be required if the loop is fitted vertically
- Expansion joints should be fitted as close to the elbows as possible
- Guides should be close to the outer expansion joints to direct the pipe growth onto the bend. The guides must allow free travel of the pipe system and expansion joints under all movement conditions
- The centre expansion joint in the U-bend should absorb the rotation equally to the rotation of the outer expansion joints
- It is advisable to cold pull the U-bend so that the expansion joints work equally from their neutral condition. This maximises the available travel from the bend, minimises the height of the bend and halves the total deflection force applied to the fix points

Expansion joint selection

U-PIPE

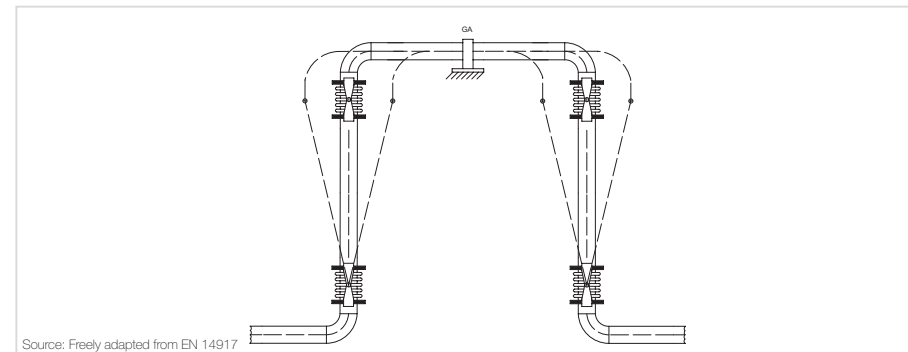


3 hinges in plane U-bend pipe system

With 3 hinges large movements can be absorbed.

Expansion joint selection

U-PIPE



4 hinged angular expansion joints in a U-bend pipe system

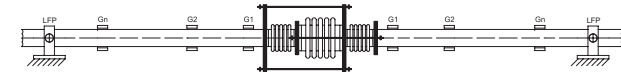
The U-shaped bend shown above is theoretically able to take an infinite number of positions due to the friction in the hinges and the difference in stiffness between the

expansion joints if no guide A (GA) is installed.

This problem can be solved by installing a lateral guide A (GA) at the top of the bend.

Expansion joint selection

PRESSURE BALANCED



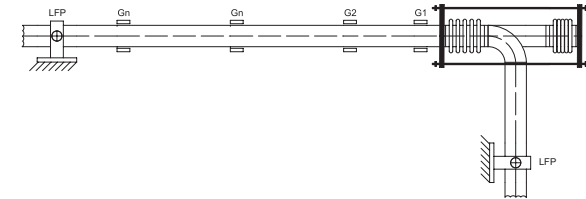
Source: Freely adapted from EN 14917/EJMA

In-line pressure balanced expansion joint

The above shows the use of an in-line pressure balanced expansion joint used to absorb axial movements in a long, straight pipe system. By utilising

this arrangement, the two fix points shown are relieved of pressure loading. Since the piping is relieved of compressive pressure loading, only a

minimum of guiding is required, primarily to direct the thermal expansion of the piping into the expansion joints in an axial direction.



Source: Freely adapted from EN 14917/EJMA

Pressure balanced expansion joint located at a change of direction

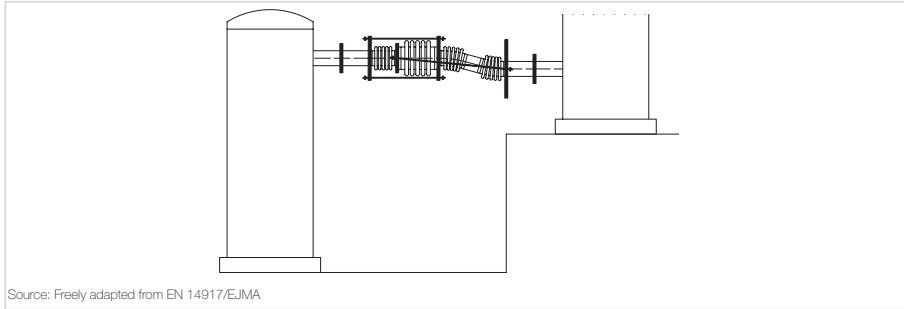
The above typifies good practice in the use of a pressure balanced expansion joint to absorb axial pipe system expansion. Note that the expansion joint is located at a change in the direction of the piping, with the elbow and the end of the pipe system

being secured by guides. Since the pressure thrust is absorbed by the expansion joint itself, and only the forces required to deflect the expansion joint are imposed on the piping, only a minimum of guiding is required. Directional guiding adjacent to the

expansion joint, as shown, may suffice in most cases. In long, small-diameter pipe systems, additional guiding may be necessary.

Expansion joint selection

PRESSURE BALANCED



Source: Freely adapted from EN 14917/EJMA

In-line pressure balanced expansion joint between two process vessels

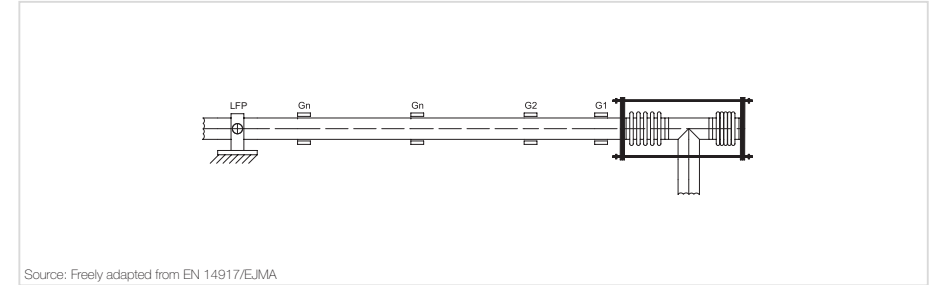
When two process vessels are to be connected, a pressure-balanced expansion joint will usually provide the best solution. This solution should include absorbing the growth of the interconnecting pipework, accepting movement due to any differential growth of the vessels and catering for the effects of any settlement. The design of process vessels will often prevent any significant loads from the pipework being applied to the vessel or nozzles. Through the utilisation of a pressure balanced expansion joint, all forces generated by internal pressure

acting on the expansion joint bellows are contained by the restraining structure on the unit. This leaves the spring rate forces created by the bellows movement to be contained, in most cases these forces are significantly less than those of the pressure forces and typically are easily resolved. The alternative to using a pressure balanced system would be to deploy simple unrestrained expansion joints. However, this would require the installation of a structure to enable fix points to be included. This could create significant costs,

particularly when the interconnecting pipework is at greater heights. In some applications, a simple in-line axial pressure balanced unit can be used. This style of expansion joint will accept mainly axial movement, but can be designed to additionally accept small lateral movements. In more complex arrangements, special expansion joints are required with a twin-bellows incorporated to accept greater lateral movements.

Expansion joint selection

PRESSURE BALANCED



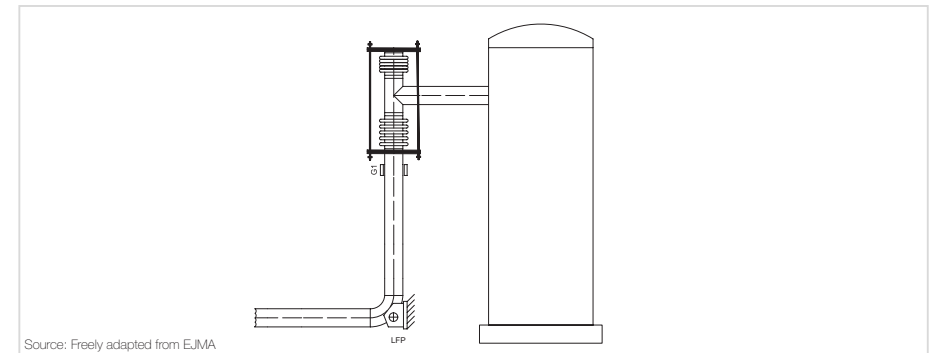
Source: Freely adapted from EN 14917/EJMA

Pressure balanced expansion joint located at a change of direction

If a change of direction existing in a pipe system, pressure balanced axial expansion joints (elbow or tee type) can be used to absorb the movement without charging the fix points or end

connections with high forces resulting from the pressure thrust. This is achieved by using an additional equalising bellow subjected to the line pressure and interconnecting devices

between the line bellows and equalising bellows. Each bellow should be designed to absorb full axial movement.



Source: Freely adapted from EJMA

Use of a pressure balanced expansion joint on a vessel

The above shows a common application for a pressure balanced expansion joint. Under various process conditions, the vessel and the vertical pipe may expand at different rates. By installing a pressure balanced expansion joint as shown, the differential vertical movement is absorbed as axial movement on the expansion joint and the thermal expansion from the centre line of the

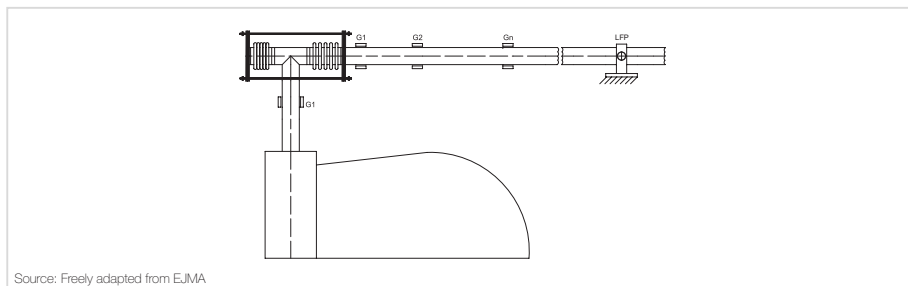
process vessel to the pipe system is absorbed as lateral deflection. The pipe system may then be secured by a fix point at the bottom and furnished with a guide adjacent to the expansion joint.

In many cases, no external structure is available at the upper elevation of the process vessel and the vessel must be connected to the vessel itself. Using this arrangement may

result in some bending load upon the pipe system, especially where the vessel is tall and is subject to wind loading deflection or similar effects. Where the guide is attached to a rigid external structure, the expansion joint must be designed to absorb wind loading deflection, and other similar loading, as lateral deflection.

Expansion joint selection

PRESSURE BALANCED



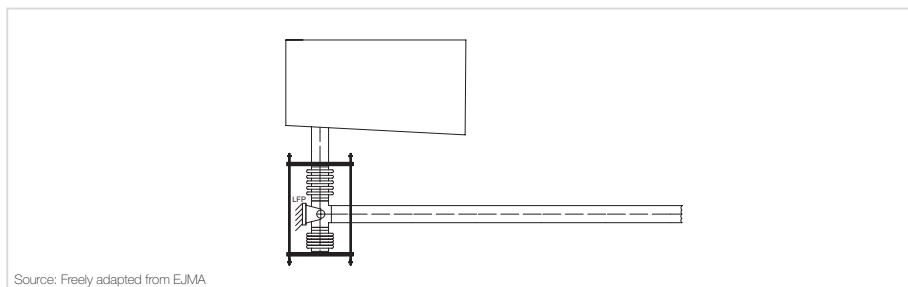
Source: Freely adapted from EJMA

Pressure balanced expansion joint on a turbine

The above shows a typical application of a pressure balanced expansion joint for combined axial movement and lateral deflection. Both the fix point at the end of the pipe system

and that on the turbine ensure that only guides are required. With an effective design, the guide can be made directly above the turbine to absorb the axial movement forces of

the expansion joint without imposing these on the turbine. The only force imposed on the turbine is that is required to deflect the expansion joint laterally.



Source: Freely adapted from EJMA

Pressure balanced expansion joint on a turbine

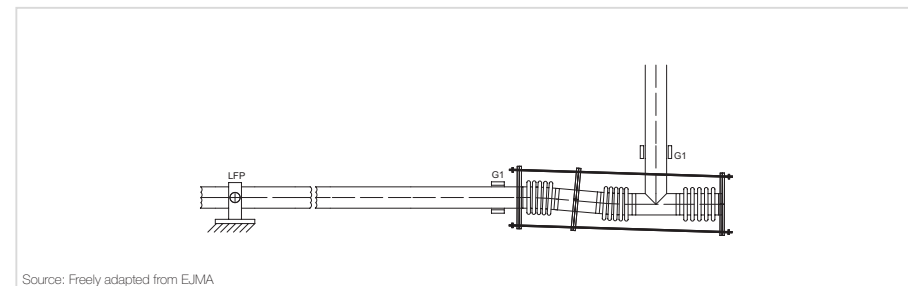
The above shows another turbine application but, in this case, the fix point of the turbine is located at some distance from the expansion joint.

The expansion of the turbine between its fix point and the expansion joint is absorbed as lateral deflection. A fix point is used at the centre fitting of the

expansion joint. Since the expansion joint is located close to the turbine, guiding is not required between the turbine and expansion joint.

Expansion joint selection

PRESSURE BALANCED



Source: Freely adapted from EJMA

Pressure balanced universal expansion joint

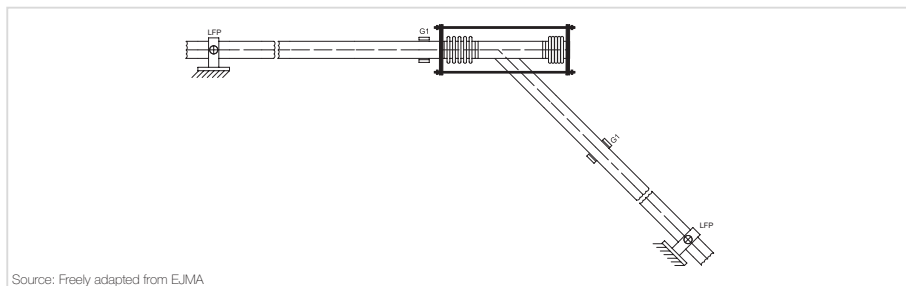
Where large amounts of lateral deflection are involved, a pressure balanced universal expansion joint must be used. In this design, two bellows are used in the flow end of the expansion joint and a single bellows in the balancing end. Normally as shown, the balancing bellows will be subjected only to axial movement if the tie rods are properly designed to rotate or pivot at their attachment points. In order for pressure balanced expansion joint to function properly, the pressure thrust, restrained by the tie rods, must exceed the axial

movement forces of the expansion joint. In a large diameter and low pressure application, it may be impossible to utilise the pressure balanced expansion joint to eliminate the pressure loading or at best, the effect may be uncertain. In such cases, another expansion joint design must be considered. Pressure balanced expansion joints are not recommended for use in services where the pressure equalising connection between the flow bellow and the balancing bellows may become plugged or blocked by the flow medium or by contaminants.

Where flow considerations permit, this problem may be overcome by the use of a tee as a center fitting of the expansion joint, rather than an elbow. In some cases, the pressure for the balancing end of the expansion joint has been introduced from a separate pressure source, but this is considered somewhat hazardous. A control failure or even a slow control response might result in partial or full pressure loading being imposed upon the piping or equipment, thus eliminating the initial reason for using the pressure balanced expansion joint.

Expansion joint selection

PRESSURE BALANCED



Pressure balanced expansion joint located at a change of direction

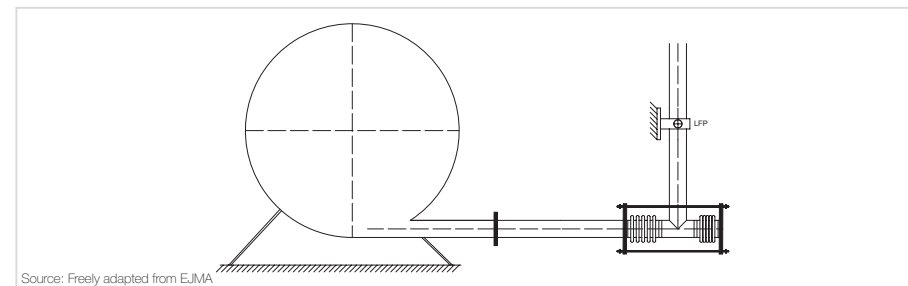
The above shows that a pressure balanced expansion joint can be used at the change in direction other than 90 degrees. In this case, the growth of the longer pipe system is absorbed as axial movement on the expansion

joint, while the thermal expansion of the offset pipe system introduces both axial and lateral components or deflection on the expansion joint. Only fix points are required at the ends of the lines and directional

guiding is used. The guide on the offset run may be used to absorb the axial movement forces of the expansion joint, if the piping is not sufficiently stiff to transmit this directly to the fix point.

Expansion joint selection

PRESSURE BALANCED



Pressure balanced expansion joint at equipment such as turbines etc.

The above typifies good practice in the use of a pressure balanced expansion joint to absorb the thermal expansion of equipment such as turbines, pumps and compressors. The primary function of the expansion joint is to minimise loading upon the

equipment casing. Note that only a fix point is required at the change of piping direction and, if the expansion joint is located immediately adjacent to the machine, no guiding is required. Care should be taken to provide sufficient flexibility in both the

flow bellows and the balancing bellows, so that the forces required to compress the expansion joint do not exceed loading limits for the equipment as established by the equipment manufacturer.