



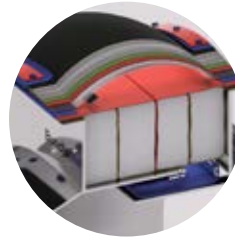
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FlexTec | *Technical Design Catalog*

FABRIC EXPANSION JOINTS

C A T A L O G U E



ABOUT US

Our company owes its roots to the esteemed founder, Armin Akbuęa. With his visionary approach and pioneering spirit in 1996, laid the foundation of our company. Although he departed from us in 2012, his legacy continues to shape our core values, directing us toward achievements.

Under its former brand name, Akmanlar, the company engaged in the import and manufacturing of high-temperature resistant thermal insulation products. Notably, in 1996, it introduced Turkey's first bolstered fabric expansion joint to Ekinciler Demir elik, contributing a significant innovation to our country's manufacturing sector.

As our company expanded under the BundleTec brand, in 2022, we proudly continued our innovative legacy by producing Turkey's first circumferential weldless Lens Metal expansion joint for Afşin-Elbistan B Thermal Power Plant. In 2023, we introduced Turkey's inaugural PTFE-layered Bellows Metal expansion joint for Erbil Thermal Power Plant, carrying our innovative vision's heritage into the future.

In addition to the Expansion Joint and Thermal Insulation divisions, through a strategic distribution agreement with Spanish Marina Textil, our company has inclusively embraced the Personal Protective Clothing group, greatly expanding its presence in the industry with a visionary spirit.

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BundleTec

INTRODUCTION

To reduce thermal stress in duct line systems, BundleTec fabric expansion joints absorb movement caused by duct misalignment and shock. BundleTec fabric expansion joints are made from a variety of non-metallic materials, including fluoroplastics, fluoroelastomers, synthetic elastomers, fabrics and insulation materials, depending on the application. It uses a variety of shapes and materials to solve problems arising due to thermal and mechanical stresses in complex systems. BundleTec fabric expansion joints adapt to all requirements of special specifications and different conditions. As one of the leading manufacturers of fabric expansion joints, BundleTec is compliant with the latest versions of ESA as well as engineering, design and manufacturing technologies.



APPLICATIONS

BundleTec is committed to being the global industry leader in the engineering and manufacturing of expansion joints for the following industries;

- Fossil Fuel Power Plant
- Gas Turbine and Heat Recovery Steam Gen.(HRSG)
- Circulating Fluidized Bed Boilers (CFB)
- Fire protection
- Energy and Environmental Technology
- Cogeneration Power Plant
- Nuclear power plant
- Oil refinery
- Chemical Refinery
- Iron & Steel Factories
- Pulp and Paper Industry
- Cement factory
- Heat/Dust Recovery
- Chemical Plants
- Marine Industry
- Food processing
- HVAC-Heating, Ventilation and Air Conditioning

ADVANTAGES

Fabric expansion joints are flexible connectors designed to provide stress relief and sealing in gaseous environments in duct systems. Depending on the design, they are manufactured from a wide variety of non-metallic materials, including synthetic elastomers, fabrics, insulation materials and fluoroplastics.

The advantages of fabric expansion joints are as follows;

• **Large movements in short distance;**

By requiring fewer expansion joints, it reduces the total number of units and provides additional economy.

• **Ability to easily absorb simultaneous movements in multiple planes;**

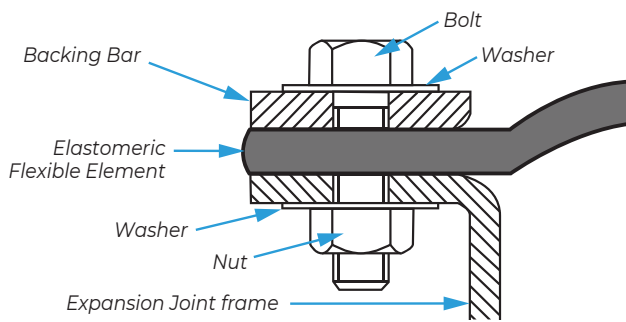
It allows the duct designer to absorb composite movements in fewer and simpler expansion joints.

• **Very low forces required to move;**

The low spring rate allows them to be used to isolate stresses on large, relatively lightweight equipment. A specific example is gas turbine exhaust, where minimizing forces resulting from duct expansion in the turbine frame is crucial.

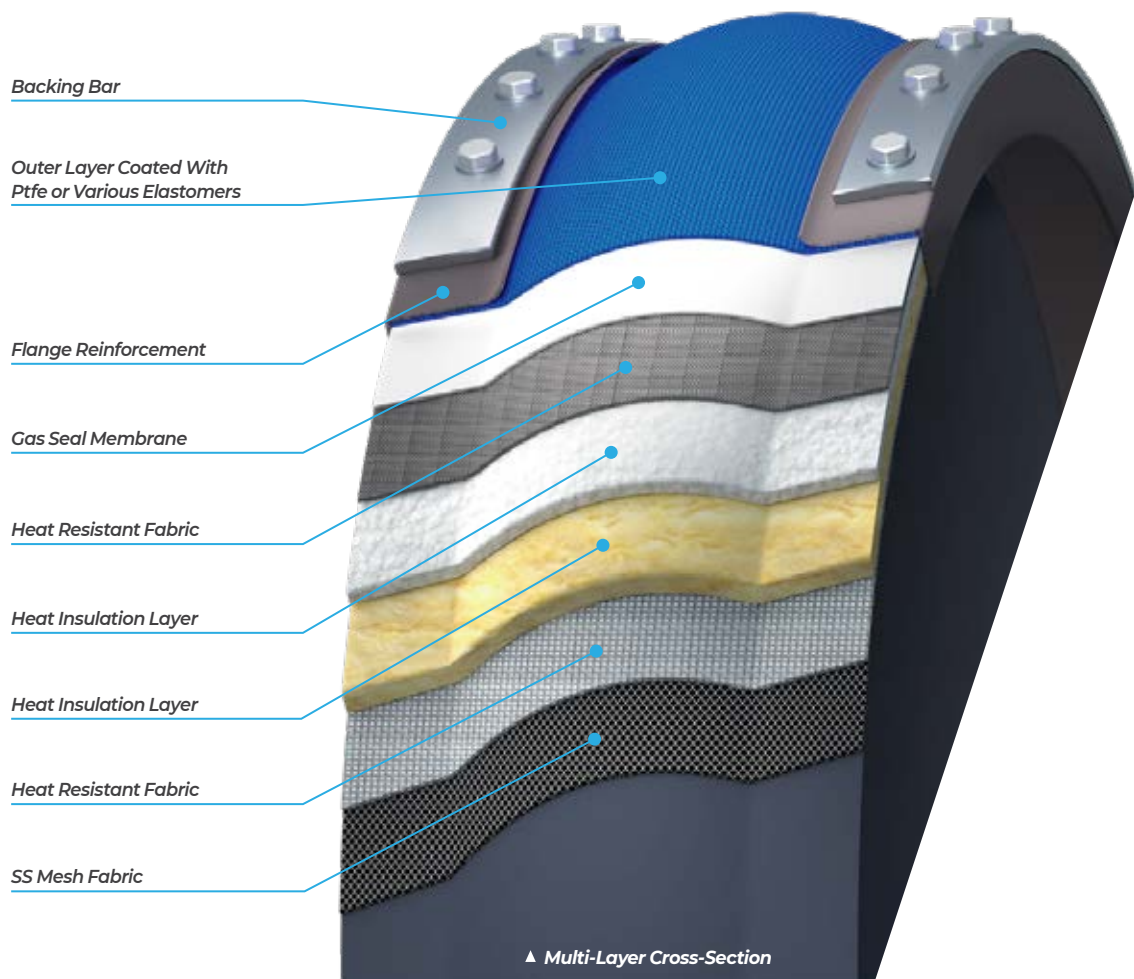
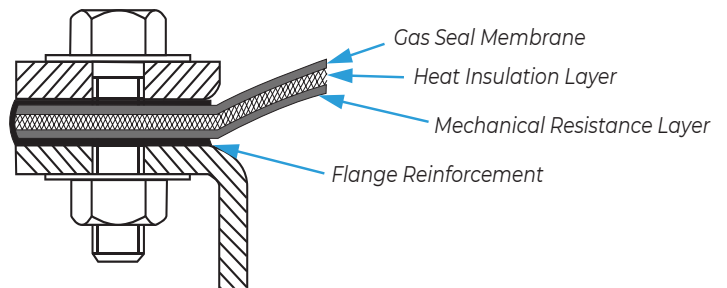
Single Layer Structure

Expansion joints, consisting of a bonded single layer, mostly made of elastomers and reinforcing materials or fluoroplastics and reinforcing materials.



Multi Layer Structure

Fabric expansion joints formed by combining different materials in various layers.



▲ Multi-Layer Cross-Section

MOVEMENT CAPABILITIES

Thermal expansion of the system is its expansion or contraction due to the difference between the operating temperature and the minimum ambient temperature during shutdown. The expansion joint engineer uses these movements and temperatures to select the appropriate material and design for each expansion joint.

BundleTec's fabric expansion joints can often accommodate combined axial, lateral, angular and torsional movements in a single assembly. Expansion joint positions can often be optimized to reduce the total number required.

Axial Compression/Extension

Dimensional shortening (compression) or lengthening of the face-to-face dimension parallel to the longitudinal axis of the expansion joint.

Lateral

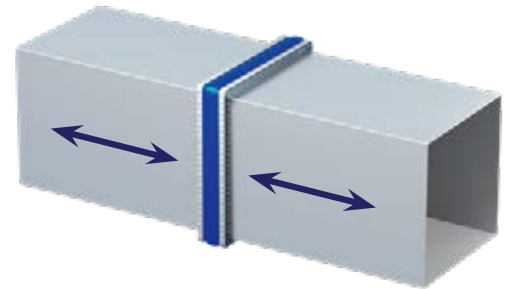
The amount of duct movement occurring in one or both of two planes perpendicular to the longitudinal axis of the duct that moves the expansion joint flanges out of alignment.

Torsion

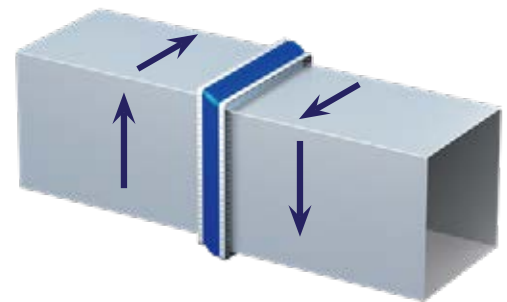
The amount of bending movement (in degrees) that occurs in planes perpendicular to the longitudinal axis of the duct system.

Angular

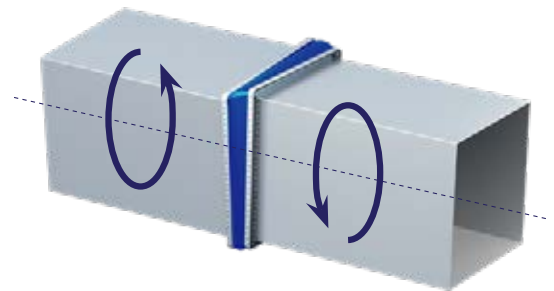
The amount of rotation (in degrees) of the duct system that flexes the expansion joint flanges outward from their parallel position.



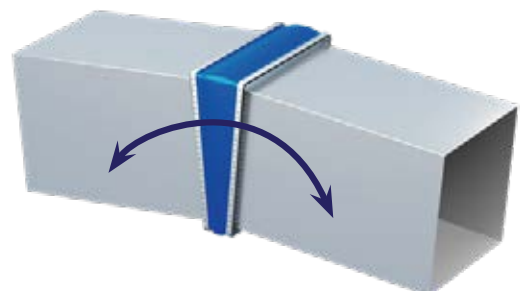
Axial Compression/Extension



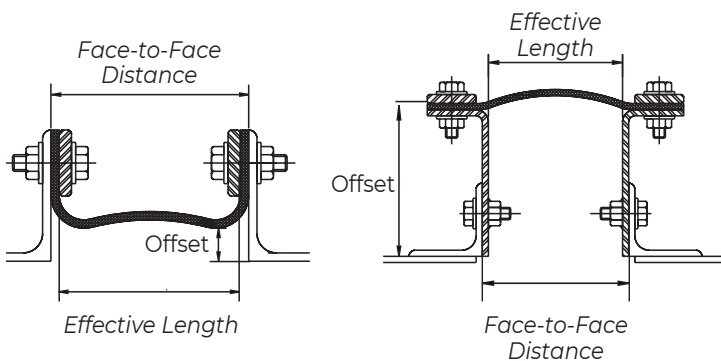
Lateral



Torsional



Angular



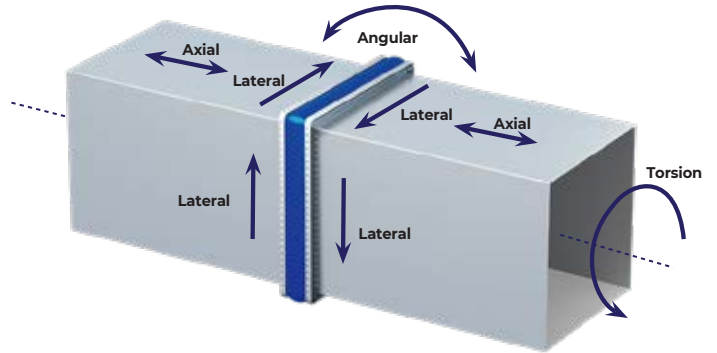
Movement Abilities

Once the supporting structural steel and duct system are in place, duct support points must be determined from which duct movements can be calculated. These calculations must be made at design and maximum operating temperatures, for mechanical and structural deflections, as well as for any earthquake and wind effects affecting the operation of the expansion joint assembly.

Expansion joints can handle axial, lateral, angular and torque movements combined in a single unit. Expansion Joint locations must be chosen carefully to keep the number of expansion joints within the system to a minimum and still be able to absorb all duct movements. If a expansion joint location involves very large axial and/or lateral movements, consult BundleTec on how these large movements can best be compensated.

Once all movements and expansion joint positions have been determined, the expansion joint geometry (type) must be selected for the application. The flange distance required at each location depends on the movement criteria and the geometry (style) selected.

The active length of the flexible element is an important design consideration. It may often be the case that larger movements can be accommodated by increasing the effective length of the expansion joint (see Table A).



The amount of "extra" material must be taken into account when calculating the "Expansion Joint life cycle". These movements are shown only as an example and do not reflect simultaneous movements.

Note:

1. BundleTec recommends that the effective length does not exceed 400 mm. For additional effective length, contact BundleTec.
2. When lateral movement exceeds 75 mm, the ductwork and/or expansion joint frame must be offset in advance by half the expected movement. Review offset requirements with BundleTec.

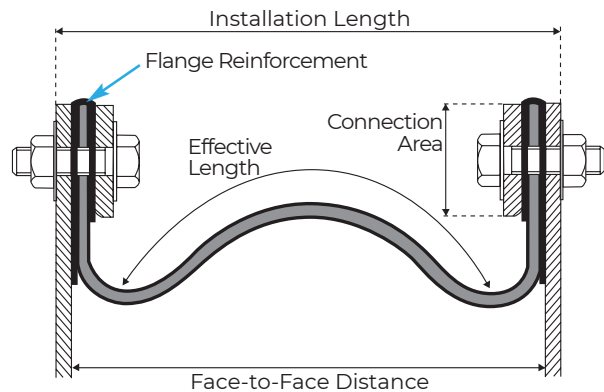


Table A: Typical Movement Chart

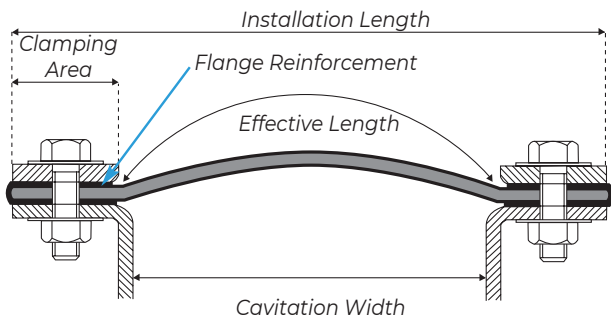
| TYPE | FACE-TO-FACE | | AXIAL COMPRESSION | | AXIAL ELONGATION | | LATERAL MOVEMENT | |
|---|--------------|---------|-------------------|---------|------------------|--------|------------------|--------|
| Single Layer Elastomeric or Fluoroplastic Flexible Element | 6" | (150mm) | 2" | (50mm) | 1/2" | (13mm) | +/- 1" | (25mm) |
| | 9" | (230mm) | 3" | (75mm) | 1/2" | (13mm) | +/- 1 1/2" | (38mm) |
| | 12" | (305mm) | 4" | (100mm) | 1" | (25mm) | +/- 2" | (50mm) |
| | 16" | (405mm) | 5" | (125mm) | 1" | (25mm) | +/- 2 1/2" | (63mm) |
| Composite (Multi-Layer) Flexible Element | 6" | (150mm) | 1" | (25mm) | 1/2" | (13mm) | +/- 1" | (13mm) |
| | 9" | (230mm) | 2" | (50mm) | 1/2" | (13mm) | +/- 1 1/2" | (25mm) |
| | 12" | (305mm) | 3" | (75mm) | 1" | (25mm) | +/- 2" | (38mm) |
| | 16" | (405mm) | 4" | (100mm) | 1" | (25mm) | +/- 2 1/2" | (50mm) |

*Effective Length is based on movement requirements and is longer than the face-to-face size shown above.

DESIGN ELEMENTS

Effective Length

Effective Length is the freely movable part of the flexible part of the expansion joint. The flexible element consists of a gas seal membrane with optional insulation and support layer(s) and flange reinforcement.



Gas Seal Layer

Gas membrane is a special layer in the expansion joint designed to prevent gas passage through the expansion joint body. The system must be designed to withstand internal stress and be resistant to chemical attack. The flexibility of the gas membrane is crucial to handle the movements of the duct system. In some cases, the gas membrane can be completed with a chemical barrier to increase chemical resistance.

Outer Layer

The Outer Layer is the layer that is exposed to the external environment and provides protection against the external environment. In some cases, the outer layer may be combined with the gas membrane or serve as a secondary membrane.

Insulation

Insulation (or insulation layers) provides a thermal barrier to ensure that the internal surface temperature of the gas membrane does not exceed the maximum service temperature. Insulation can also help reduce and/or eliminate condensation problems.

Support Layers

Support Layers hold the insulation in place and provide protection during transportation and system operation. Careful selection of appropriate materials (able to withstand system operating temperatures and chemical attack) is critical to successful design. Support layers can also be used to help create arched or curved expansion joint configurations where a specific shape is required.

Flange Reinforcement

Flange Reinforcement is an additional layer of fabric to protect the expansion joint clamping area from thermal and/or mechanical degradation.

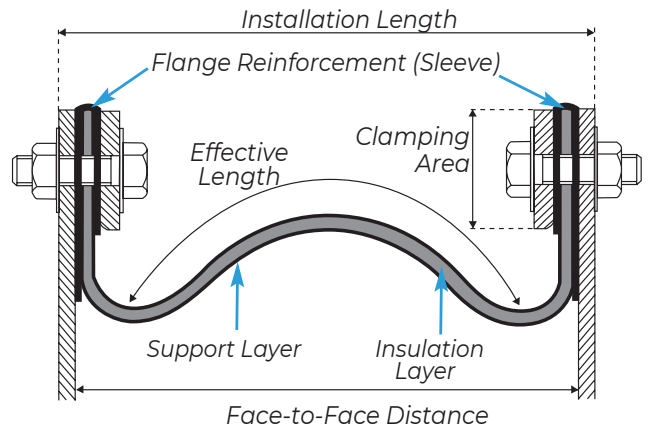
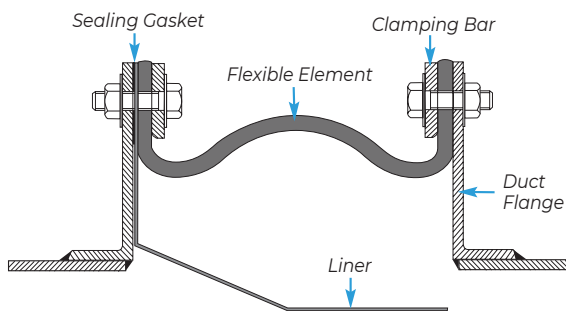
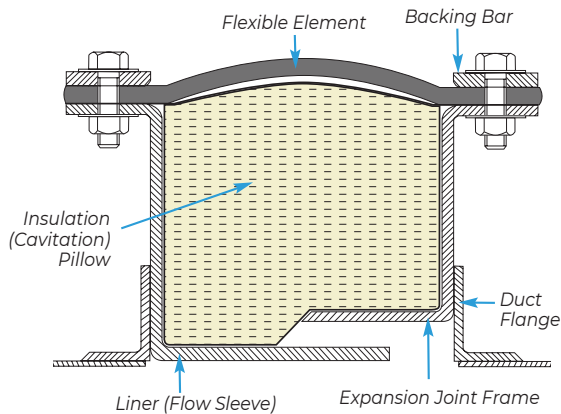


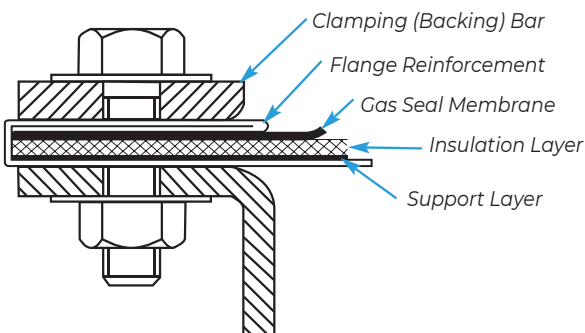
Table B: Bolting Guide

| Claming Bar Width | 50 | | 60 | | 70 | | 80 | |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Claming Bar Thickness | 8 | 10 | 10 | 12 | 10 | 12 | 12 | |
| Hole Spacing | 100 | | 100 | | 120 | | 120 | |
| Bolt Size | M12 | M16 | M16 | M20 | M16 | M20 | M16 | M20 |
| Recommended Torque (Nm): | | | | | | | | |
| For Fabric Expansion Joints | 60 | 80 | 100 | 120 | 115 | 140 | 130 | 160 |
| For Elastomeric Expansion Joints | 50 | 65 | 75 | 90 | 90 | 110 | 100 | 125 |

Anatomy of Fabric Expansion Joint



Function of Fabric Expansion Joint Elements



Flexible Element

Flexible Element is the part of the expansion joint that absorbs the vibration and thermal movements of the duct system. The flexible element shall consist of a gas-tight membrane with optional insulation layer(s), support layer(s), and flange gasket. In cases where the system temperature exceeds the temperature range of the gas insulation membrane, optional extra layers or insulation pillows are required.

Gas Seal Membrane

The Gas Tight Membrane must be designed to accommodate internal system pressure and resist chemical attack. The flexibility of the gas membrane is very important to accommodate the thermal movements of the duct system. Additional thermal protection may be required as existing gas seal membranes used in chimney duct applications have temperature limitations.

Insulation Layers

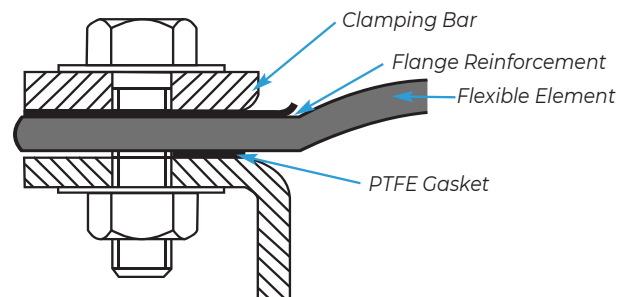
Insulation Layers provide a thermal barrier to ensure that the internal surface temperature of the gas membrane does not exceed the maximum service temperature. Insulation can also help reduce and/or eliminate condensation problems.

Support Layers

Also called insulation retainers, these layers hold the insulation layers in place and provide protection during transportation and system operation. Proper selection of appropriate materials that can withstand system temperatures and chemical attack is critical to a successful design.

Flange Reinforcement

Flange Reinforcement protects the gas seal membrane on a multi-layer flexible member from thermal degradation caused by hot metal flanges, support rods and bolting hardware. Flange Cushioning Gasket Due to the high density of fluoroplastics, a flexible gasket compatible with the flow medium is required between the metal connecting flange and the fluoroplastic gas membrane to ensure an adequate seal.



All sharp edges on the clamping bar that may come into contact with the flexible element must be chamfered smoothly to prevent damage to the flexible element.

Connection Tools

There are several methods of connecting expansion joints. Some of the most common are detailed below:

Connection Tools Comparison

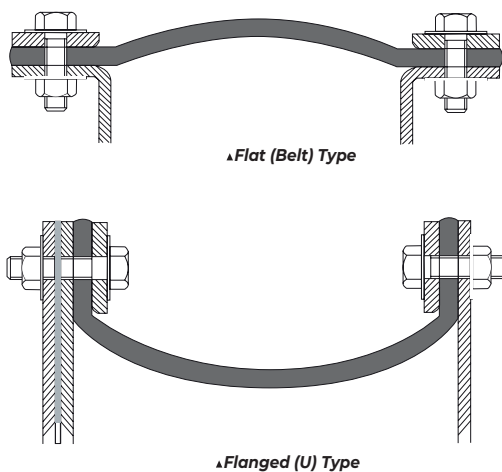
| EX-J Type | Connectin Tool | Duct Section | Duct Size | Working Pressure | Cost |
|------------------|--|---------------|---------------|------------------|--------|
| FLAT (BELT) | Screw Clamp | Round | Small | Low | Low |
| | Comment: Fast Installation | | | | |
| | T-Bolt Clamp | Round | Small / Large | Low | Low |
| | Comment: Quick installation. Use clamps in various segments to ensure equal clamping pressure on large diameters | | | | |
| FLANGED (U-TYPE) | Clamping Bar | Round / Rect. | Small / Large | Low / High | Medium |
| | Comment: Suitable for High Temperature Applications | | | | |
| FLANGED (U-TYPE) | Clamping Bar | Round / Rect. | Small / Large | Low / High | Medium |
| | Comment: Suitable for Medium Temperature Applications | | | | |

Worm Screw Clamp or Bolt Type (T-Bolt) Clamp Bands

It is used in small diameter round flat type expansion joint fabrics and is usually produced from stainless steel strip.

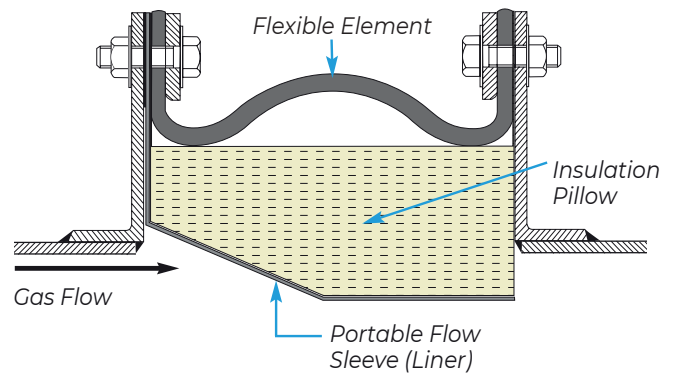
Clamping Bar

Metal bars used to connect the flexible element of the expansion joint to the duct system flanges or the expansion joint frame. Clamping bar selection depends on bolt spacing, bolt hole size and expansion joint flange

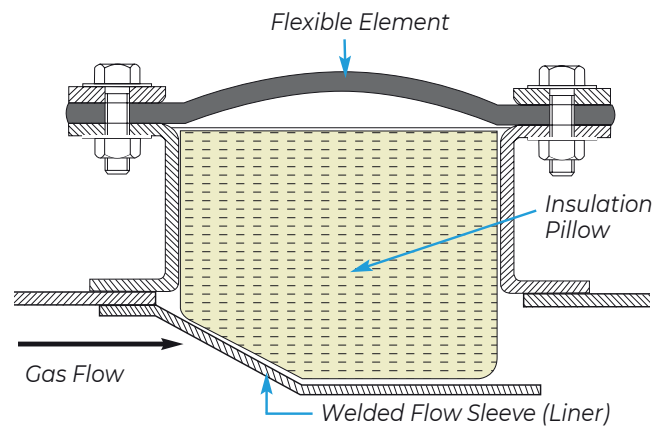


Insulation Pillow (Bolster)

Attached with tabs, flanges or pins, the Insulation Pillow fills the space between the flexible element and the baffle plate (flow liner) and helps prevent the buildup of particulate matter. The cushion minimizes the accumulation of unburned fuel, fly ash, or other solid particles in the expansion joint space in amounts that could damage the flexible element if they solidified to a cementitious state.



Additionally, some particles (fly ash) can create a severely corrosive (acidic) environment when exposed to cooling (below H_2SO_4 dew point) during a maintenance stop.



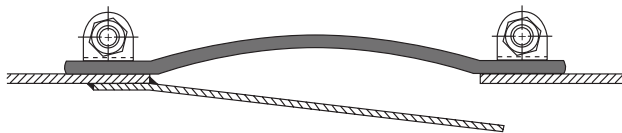
Frames

Effective sealing depends on the design of the frames to which the flexible element is attached. Many frame types are possible depending on the structure to which the expansion joint is attached, but there are some basic configurations that cover most applications.

Flat Type Expansion Joint Frames

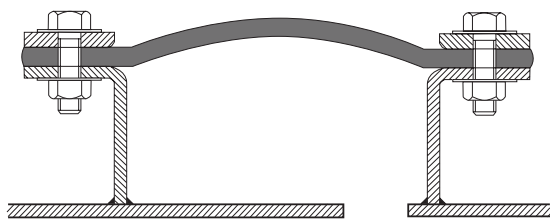
Basic Duct Connection

It can only be used effectively in circular ducts operating at low temperatures. For large diameters, several sections of clamping bands must be formed to ensure equal clamping pressure.



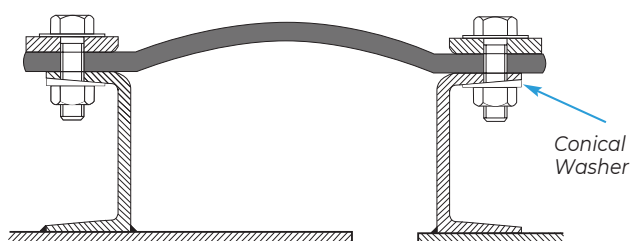
Angle Frame

A simple frame add-on for existing ductwork. For circular ducts, angles will be rounded outwards to appropriate lengths for welding. For rectangular ducts, a manufactured radius corner will be used to join straight lengths.

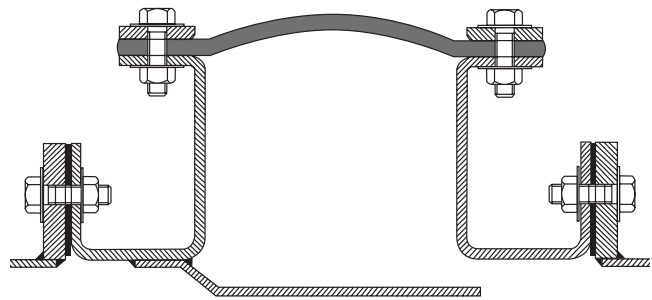


Profile Frame

When rolled steel (type C) ducts are used, tapered (wedged) washers should be used under the flange. Radius corners should be used in rectangular ducts.



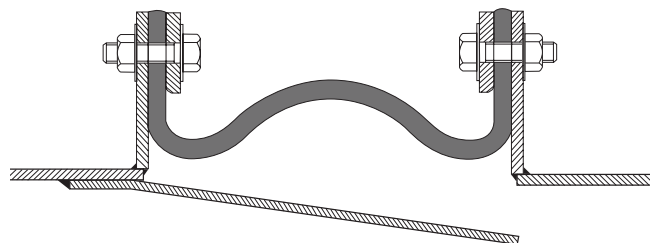
Pre-Fabricated Frame



Flanged Type Expansion Joint Frames

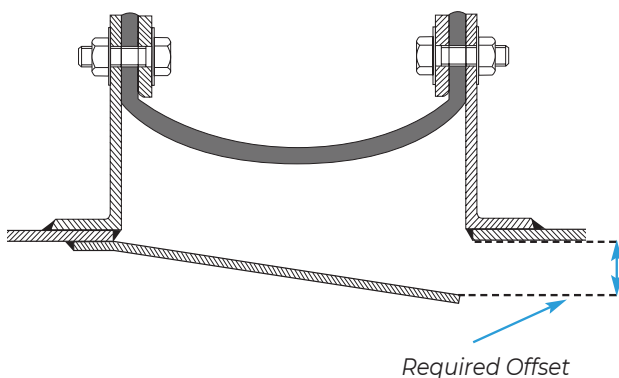
Basic Frame with Flat Bar

In cases where internal baffle plates are installed in this configuration, rectangular joints, especially at the corners, should be moved away from the flexible element.



Angle Frame

In cases where internal baffle plates are installed in this configuration, rectangular joints, especially at the corners, should be moved away from the flexible element.



EXP.-JOINT COMPONENTS

Insulation Pillow

Insulation pillow is a component formed by covering high temperature resistant blankets with high mechanical strength fabrics, mostly in the form of a closed pillow, which can be used to fill the gap between the flexible element and the flow liner.

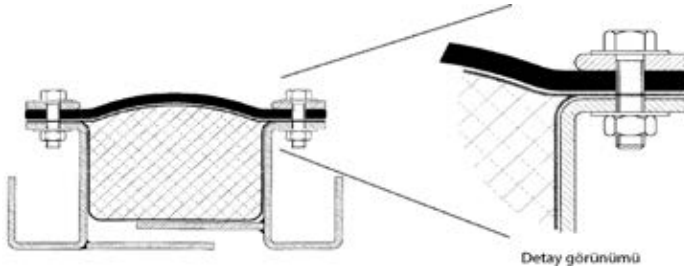
The main reasons for their inclusion in the design of expansion joints are:

- To provide additional thermal protection for the expansion joint fabric through the use of insulation materials with good thermal properties.
- To prevent solid particles from entering the expansion joint fabric space. There are two main challenges in systems where the environment may have heavy dust content. First, the potential for abrasive particles to cause damage and premature failure of the flexible element. Second, particles can accumulate in the space and become stuck, preventing compression movements in the system.
- Improving the acoustic performance of the expansion joint system by using bulk materials with good acoustic attenuation or absorption properties.
- To provide support to flexible elements and to minimize the effects of vibration or "flutter/knocking" by preventing these variations from being transmitted to the flexible elements.

Insulation Pillow Types

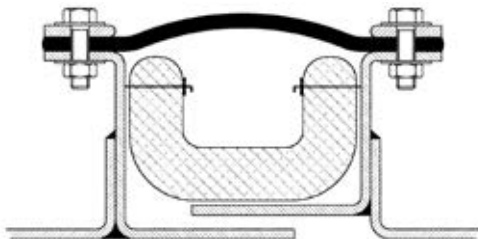
A. Flanged Type

This type maintains the position of the insulation pillow and ensures that the heat protection is maximized. In this system, the flanges of the insulation pillows are bolted between the expansion joint fabric and the clamping bars. In this way, the insulation pillow acts together with the flexible element and protects it against the corrosive effects of the fluid such as



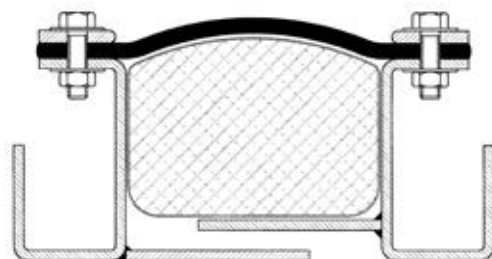
B. Pinned Type

In this system, the insulation pillow is fixed to the frame with the help of insulation pins so that it can move together with the flexible element. The fixing process can be done inside the frame edges or on the liner plates.



C. Block Type

Block type insulation pillows, which offer the most practical manufacturing and installation opportunities, are placed between the flexible element and the liner plates.



Liner (Flow Sleeve, Baffle Plate)

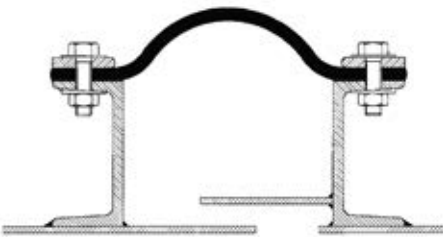
The design of the baffle plates is closely related to the frame design, and the baffle is usually formed by a portion of the frame itself. Many variations are possible, but a number of common types are described below. The shape of an liner is an important design criteria to ensure movement is not restricted. The main function is to keep high-velocity gases or particles away from the flexible element, thus preventing early erosion.

Other important points:

- Thickness of the material in proportion to the possibility of wear,
- The length of each section of the liner, taking into account expansion and deformation due to temperature,
- Need to protect the flexible element and insulation pillow,
- Welding form of the baffle plate

A. Double Liner

Easy to install in existing duct or angle flanged frames. The overlap allows the use of secondary dust seals when necessary.



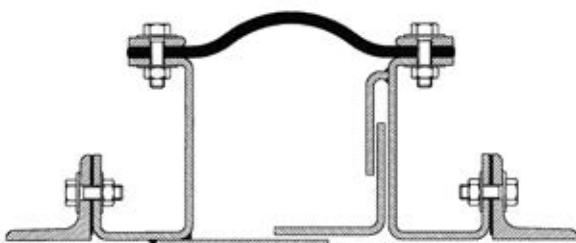
B. Removable Liner

It is necessary to pay attention to such liners to ensure that there is no mechanical interference with the flexible element. It is generally used only where movement is limited.



C. Floating Liner

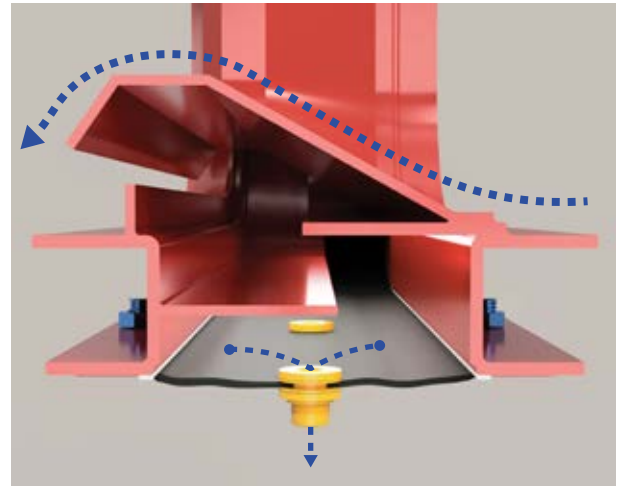
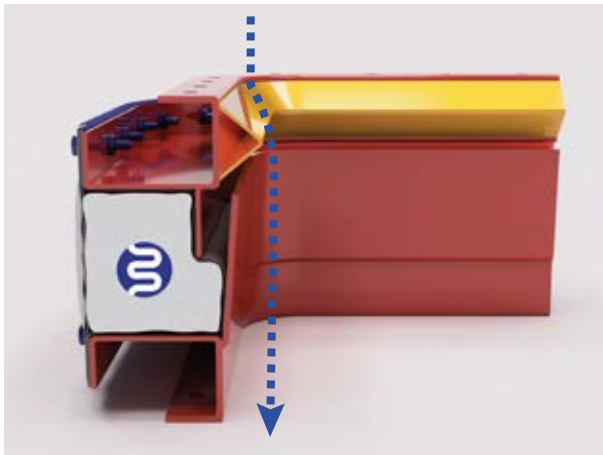
In this system with high lateral joint movements, the floating section is held at intervals by corner profiles or pins to allow free movement in the required plane.



EXP.-JOINT COMPONENTS

Particule Deflector (PD)

The Particule Deflector is an L-profile metal component located just above the baffle plate, used in the presence of updraft fluid with a very high solid particle content. It prevents particles falling down due to gravity or turbulent currents from entering the guide plate and accumulating.

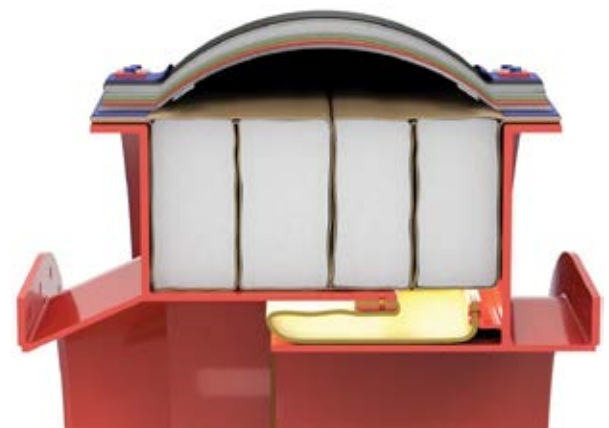


Drain Pipe and Barrier (DP & DB)

In order to discharge corrosive acidic condensation that may damage the expansion joint, a stainless steel or PTFE drain pipe is attached to the part of the expansion joint closest to the ground. However, the use of condensation barrier liner will largely prevent the condensation from filling into the expansion joint frame.

Single Axis Particle Barrier (SAPB)

Ceramic or Silicate fiber filled, flexible stainless steel braided packings are especially preferred for expansion joints in areas with high particle loads. These packings are fixed between the baffle plates to prevent particles from entering the cavity. This special accessory is used effectively together with the insulation pillows in cement factories.



Dual Axis Particle Barrier (DAPB)

Dual Axis Particle Barrier is a protection structure integrated into the frame in systems capable of lateral movement. This structure increases system performance and durability by keeping the entry of particles into the ex-j space to a minimum in environments with high solid particle content.

Particle Discharge Pipe (PDP)

Particle Discharge Pipe is a device used to automatically or manually discharge particles accumulated in the expansion joint space in systems with high solid particle content. With this method, long-term and trouble-free operation of the expansion joint is aimed.

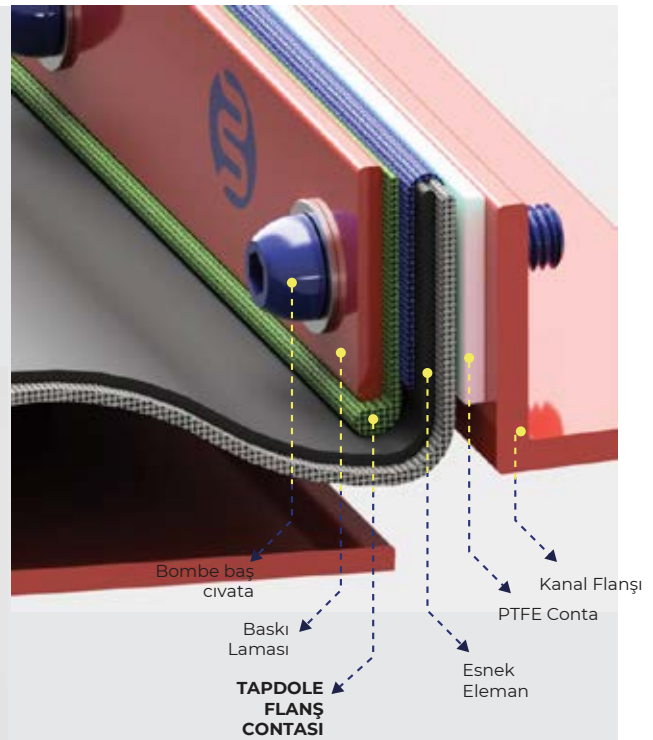
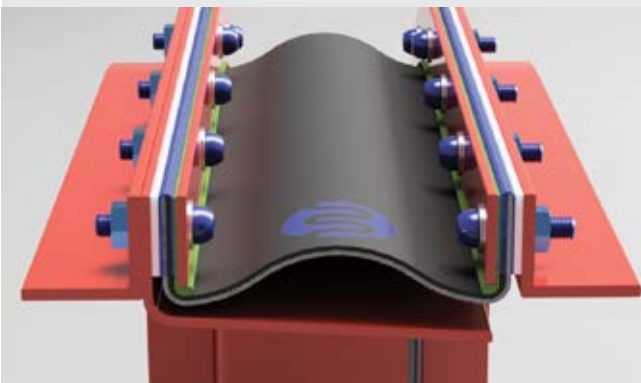


Flange Fins

Flange Fins are used to prevent the temperature in the metal body of the expansion joint from increasing in cases exposed to high fluid temperature. This increased temperature can lead to rapid deformation of the flexible elements of the expansion joint, especially the outer layer, which has the lowest heat resistance. In order to prevent this situation, flange fins made of copper material with a high heat conduction coefficient are used. These fins transfer the heat accumulated in the flange area from the expansion joint to the air via convective conduction. If it is not possible to use flange fins, gaskets made of materials with low heat conduction coefficient (such as Klingrit gasket) are used as an alternative. These gaskets prevent the heat accumulating on the flexible element by cutting the thermal bridge that may form between the pressure plate and the expansion joint body. With these methods, long-lasting and healthy operation of the flexible elements of the expansion joint is ensured.

Tadpole Flange Gasket (TG)

When using flanged type expansion joints in duct systems with positive pressure operating conditions, BundleTec recommends the use of the Tadpole gasket between the flexible element flange and the clamping plate (as shown). This protects the outer layer of the expansion joint from the bolt heads and clamping bar edges. In this system, it is important to choose countersunk or convex bolt heads.



DESIGN CRITERIA

Important criteria that will affect expansion joint selection and engineering design are as follows:

A. Environmental conditions

Ambient temperature

Fabric ex-j should not be located in an area with poor air circulation or exposed to high temperature radiation. Fabric ex-joints operating at high temperatures (above 250° C) are exposed to temperature gradients. This gradient is the difference between the higher internal temperature of the expansion joint (hot side) and the cooler external temperature (cold face). High ambient temperatures around the expansion joint will reduce this temperature gradient by reducing the rate at which heat dissipates from the outer surface of the expansion joint. This will lead to the deterioration of the primary layer, that is, the sealing membrane, and therefore the expansion joint. It is therefore important to ensure that adequate precautions are taken to keep ambient temperatures within the manufacturer's recommendations, for the same reason insulation of the expansion joint from the outside is generally not permitted. In places where cold outdoor conditions prevail, attention should be paid to the possibility of condensation forming inside. For such environments, countermeasures such as internal or external insulation can be applied.

Environment

Fabric expansion joints are generally used in power generation plants, chemical plants, cement factories, etc. It is found in harsh industrial locations such as In these places, the elastomer outer layer of the expansion joint may be exposed to contaminants that may contain higher than normal levels of aggressive agents. If the type and concentration of such contaminants are known at the design stage, it is possible to design a joint to resist this attack by selecting a suitable outer layer that is resistant to specific agents.

Location

Whether a expansion joint is located internally or externally within a building and exposed to the elements can also have an impact on the selection of the type of exterior layer. Expansion joints placed indoors may not necessarily require waterproof outer layers.

B. Dust Load and Velocity

The dust content in the environment may require a special design of the expansion joint frame. In general, the following should be avoided:

- Wear caused by dust particles
- Precipitation and compaction of sediment in the flexible element

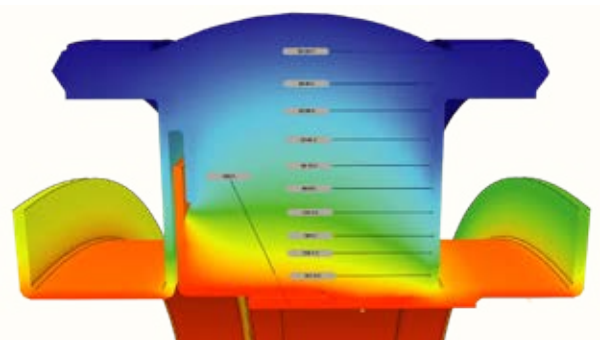
C. Finite Element Analysis

Finite Element Analysis determines how well a real-world structure or assembly resists forces, heat, vibration, mechanical stress. It is a computer-based calculation method to examine whether it will last or show the desired performance. This is called "analysis", but it's the method used in product design to predict what will happen when the product is used. The finite element method works by separating a real object into a large number of elements, and the behavior of each element is studied by a set of mathematical equations under the conditions in which it will operate. The computer program then sums up all the individual behaviors to predict the behavior of the entire object.

The Finite Element Method is used to predict the behavior of expansion joints according to the following physical phenomena:

- Heat transfer
- Mechanical stress
- Vibration

The method is widely used to verify the design of expansion joints and their structure used in gas turbine exhaust systems.



D. Sealing

Fabric expansion joints are designed to be leak-proof as well as reasonably practical. Although it is a relatively simple matter to demonstrate zero leakage or zero leakage under laboratory conditions, multilayer expansion joints operating at high temperatures should not be considered leakproof (or zero leakage) without verifying their field performance through extensive testing. Thanks to the careful selection and design of single-layer elastomeric expansion joints, with their inherent flexibility, it is much easier to achieve zero leakage systems, provided sufficient attention is paid to the quality and design of the adjacent metalwork.

The majority of fabric expansion joints (both single and multi-layer) can be considered sealed throughout the expansion joint body if appropriate materials are specified. However, particular attention should be paid to the overall metalwork condition and design, clamping areas and their surface finishes, fastening systems such as bolts or clamps, and flange reinforcements of expansion joints. These are the areas where the greatest potential for system losses exists. Where possible, new metal frame supplied with integrally mounted expansion joint fabric will always provide a much lower leakage rate than field joints of the fabric and installation of the fabric into the frame.

Using appropriate test methods¹, it is possible to demonstrate flue gas-tight² and nekal-tight³ systems under laboratory conditions.

To ensure tightness during operation, such tests should be carried out after installation on site.

¹ Test methods similar to DECHEMA Information Bulletin ZfPI, Annex 2 Clause 2.2 "Bubble method with foaming liquid".

² Test specifications RAL TI-002 Rev. 1- 06/98 Flue Gas Tight Fabric Expansion Joint sealing means "... no bubbles should form in the bellows area..." and "... but a limited number of foam bubbles are allowed to occur in the clamping area of the bellows and the cloth junction area."

³ Test specifications RAL TI-003 Rev. 1- 06/98 Nekal Proof Fabric Expansion Joints "... no bubbles should appear in the bellows area..." and "... this covers both the bellows area and the clamping area..."

E. Moisture content, Condensation, Washing

Moisture in the chimney duct system can have a serious, detrimental effect on the life of the fabric expansion joint and must therefore be carefully considered. At operating temperatures above the liquid's dew point, moisture content will only appear when the system cools. However, this moisture often appears as aggressive condensate and is an important factor if there are frequent thermal cycles. At operating temperatures below the dew point, the environment can be very corrosive and contain high humidity that can damage the expansion joint.

In places where cold environmental conditions prevail, attention should be paid to the use of fabric expansion joints as they may cause condensation problems. When the expansion joint is placed in a ductwork at a relatively low temperature, dewlap may occur, causing condensate to form which will attack from the inside. This can be met by providing external insulation (Note; internal insulation should be avoided). Expansion joints should be externally insulated only in applications where the internal duct temperature is below the maximum temperature capabilities of the expansion joint fabric.

More emphasis may be placed on the use of alternative materials that are less affected by acidic condensate.

In cases where duct or gas turbine flushing is required, to prevent moisture accumulation in the expansion joint material. A suitable drainage installed in the expansion joint material must be provided. To avoid accumulation in such places, the expansion joint should not be the lowest point of the system.

F. Movement

Fabric expansion joints are designed to absorb movements and misalignments in ducts and pipelines. The active length of the expansion joint fabric is the part that allows movement. The active length absorbs the vibration and thermal movements of the ductwork and may or may not be the same as the flexible length between flanges.

Movements normally occur by thermal expansion of the duct plate or pipe, but other types of movements are also possible, such as wind, snow load, duct misalignment, vibration, subsidence, and earthquakes.

Movement caused by vibration should not be confused with movement due to thermal cycling, which is slow and relatively infrequent. Fibrous materials are weak under high frequency and amplitude conditions. Consequently, vibrations must be considered separately from thermal movements to ensure correct material selection and provide appropriate design recommendations.

G. Noise and Sound

In-duct noise breakout may be an important design consideration under certain circumstances, and can be reduced by acoustic treatment of the duct. Fabric expansion joints may be the primary source of noise breakout in a duct system, and an internal acoustic bolster may be incorporated into the design to reduce such noise. The bolster would normally be manufactured from insulation material encased in a temperature resistant woven fabric or wire mesh (or both) and located between the joint and the internal flow sleeve. External acoustic treatment of fabric expansion joints is not usually permissible for reasons stated in Ambient temperature. The design of the internal flow sleeve(s) can also play an important part in the acoustic performance of a joint.

H. Pressure, Pulsation and Flutter

The operating pressure in a system is a crucial factor affecting the design of fabric expansion joints. The very flexible nature of the materials brings a number of design issues which must be addressed. Although maximum operating pressures in duct systems are low by comparison with pipeline systems, wide variations of pressure, such as a change from positive to negative, or short term peak pressures can occur. Such variations should be reflected in the design pressure specified, and the measure of gas tightness expected by the customer. Particular care in the choice and construction of materials must allow for:

- Containment of the stated design pressure under all conditions of movement and temperature, without over-stressing any of the expansion joint element
- Changes from positive to negative pressure which could entrap materials under compression, or cause them to be in contact with sharp or hot parts of a duct
- High positive pressure and compression allowing materials to abrade on bolt heads of clamp flanges
- Changes in pressure causing significant air spaces between layers of composite joint materials, which could allow circulation of hot gas
- Pressure surges occurring as a result of system operation

Pulsation

Pressure pulsation in a duct or pipeline can be detrimental to a fabric expansion joint, particularly those manufactured from plies of woven glass-cloth or ceramics. Rapid variation in pressure causes fatigue of the fibres, and can lead to premature failure of the expansion joint. Particular caution is required when designing expansion joints for combustion engine exhaust systems to ensure that the joint is not fitted too close to the engine. A sufficient distance is required to allow the pressure fluctuations to subside.

Flutter

Flutter can be induced by fans, particularly where the system is unbalanced, and the materials used for expansion joints adjoining fans must be selected with this in mind. To overcome flutter of the joint materials, which could lead to premature failure, the materials must be of sufficient thickness and density to damp out the oscillations. Reinforced elastomeric materials are commonly specified for expansion joints fitted to the fan inlet or outlet.

Flutter in expansion joint seals can be induced by high gas velocity, but is usually eliminated by careful design of a suitable flow liner attached to the duct or joint frame. The inclusion of a bolster can help to minimise flutter.

I. Temperature

Operating temperature

The operating temperature is the normal temperature of the media within the flue duct system under operation. Normally indicated in °C as design or maximum operating temperature.

Thermal cycles

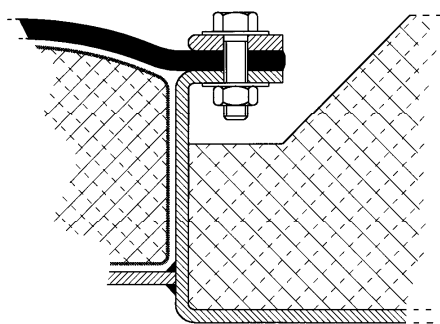
The definition of a thermal cycle is when the temperature in a flue duct system moves from ambient to full operating temperature and then returns to ambient. The number of thermal cycles is often used when calculating the life expectancy of steel frames for gas turbine exhaust systems or when considering the number of times moisture could appear in the system on cool down.

Excursion temperature

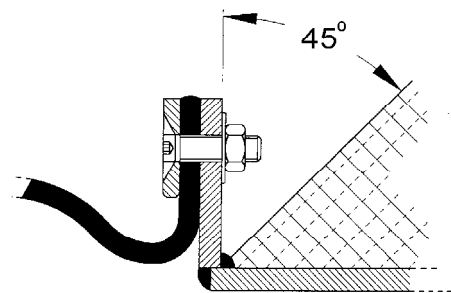
Occasionally, flue duct systems will have an upset condition or excursion. This is a situation when, for a short period of time, the temperature in the system increases above normal operating temperature. The expansion joint designer must consider this upset condition for duration and temperature when making material selection.

External insulation

External insulation should not cover a fabric expansion joint, except when it is part of the joint design to avoid condensation below dew point. The termination of duct insulation is critical to the airflow over the outer cover and in general should be chamfered back at an angle of not less than 45°. For very hot applications, the insulation termination must be carefully designed to minimise stress in metal frames and overheating in the clamping area.



External insulation installed on a belt type expansion joint



External insulation installed on a flanged expansion joint

MATERIALS OVERVIEW

The structural design of the layers of fabric expansion joints is largely determined by:

- Duct shape;
- Location;
- Installation conditions;
- Sealing requirements;
- Environment;
- External influences;
- Excessive pressure or vacuum;
- Heat;
- Degree of movement;
- Fluid velocity;
- Moisture formation;
- Solid components of the environment.

With timely planning, appropriate and efficient designs can be developed for practically all variables. We offer the best in consulting, backed by many years of practical experience and comprehensive testing procedures. The high quality of our fabric expansion joints is ensured by the selection of high-quality materials and their appropriate processing. Correct installation is another factor that determines the operational effectiveness of fabric expansion joints. We are happy to provide you with advice or expert installation engineers upon request.

We would be pleased.

Depending on operating conditions, welded or flanged internal baffle plates are recommended. Similarly, the mounting configuration of fabric expansion joints depends on the diameter, structural design, layer structure and sealing requirements.

BundleTec fabric expansion joints are produced principally without the use of asbestos. Today, insulation is provided by glass and silicate materials, which also serve as substrates for various coatings. In addition, sealing foils and fully vulcanized elastomers are also used. The suitability and durability of a expansion joint is determined by the correct composition of materials and proper processing, rather than the structure of a single layer. In this context, both practical experience and know-how of the expansion joint manufacturer are important.

The table below contains information on the compatibility of the most common materials used in the construction of fabric expansion joints with the most common chemicals, acids and alkalis. Additionally, the maximum temperature resistance (during operation) of each of these materials is shown in the second column.

| Material Type | Max. Temp. Resistance [°C] | Chemical Resistance | | Comments |
|----------------|----------------------------|---------------------|------|--|
| | | Acid | Soda | |
| Ceramic Fiber | 1250 °C | + | + | It can be used free or stitched in a expansion joint fabric or insulation pillow. |
| Mineral Wool | 750 °C | O | O | It can be used free or stitched in a expansion joint fabric or insulation pillow. |
| E-Glass Fibers | 550 °C | + | + | Glass Fiber Blanket is also suitable for use in some formed fabric expansion joints. |

| Material Type | Max. Temp. Resistance [°C] | Chemical Resistance | | Comments |
|--|----------------------------|---------------------|------|--|
| | | Acid | Soda | |
| INCONEL | 1250°C | + | + | INCONEL reinforced woven ceramic fibre. |
| Silmar V650 | 1100°C | + | + | Silicate fabric is extremely resistant to acids and temperature. |
| Marglass V1035 | 700 °C | + | + | Special glass fabric with high temperature resistant coating. |
| Marglass OX730IN | 600 °C | + | + | Woven glass fiber reinforced with stainless steel wire |
| Marglass 1000 | 550 °C | + | + | Glass fabric with high temperature resistance and good insulation effect |
| Marglass 800 | 500 °C | + | + | Glass fiber fabric, high tensile strength |
| Marglass 440 | 500 °C | + | + | Glass fiber fabric, high tensile strength |
| Aramid | 200 °C | + | + | High strength fabric for extreme mechanical loads. |
| Stainless steel 1.4301 & 1.4828 | 600-1000 °C | + | + | Fine wire mesh, material selection depends on requirements. |
| VITON-Marglass 1 VITON-Marglass 2 | 180 °C | + | + | Glass fiber fabric with VITON coating on single or double sides, excellent chemical resistance. |
| Fiberlam 501 Fiberlam 1001 Fiberlam 2001 | 310 °C | + | + | Glass fiber fabric, PTFE coated on one side, PTFE-Foil laminated composite material on the other side. |
| Fiberlam 1011 Fiberlam 2011 | 310 °C | + | + | Glass fiber fabric, double-sided PTFE-Foil laminated composite material. |
| Fibertex 1000 Fibertex 2000 | 310 °C | + | + | Glass fiber fabric, composite material with PTFE coated on both sides. |
| Marglass PTFE100 | 280 °C | + | + | PTFE coated glass fabric, 0.12 mm thickness |
| Marglass S510 Marglass S590 | 300 °C | - | O | Glass fabric with red, gray or black silicone coating on one/both sides. |
| Maramid S650 Maramid S880 | 300 °C | - | O | Aramid fabric, gray or black silicone coated on one/both sides. |

| Material Type | Max. Temp. Resistance [°C] | Chemical Resistance | | Comments |
|----------------------|----------------------------|---------------------|------|---|
| | | Acid | Soda | |
| Alufix 1 Alufix 2 | 400 °C | - | - | Glass fabric, one/both sides PU coated, gray, flame retardant, oil resistant. |
| Aluglas 430 | 200 °C | - | - | Glass fabric with aluminum foil lamination on one side. |
| Marglass SS | 400 °C | + | + | Glass fabric with stainless steel foil lamination on one side. |
| Hypalon 1000 | 120 °C | + | + | Polyester fabric, hypalon coated on both sides. |
| Polytex 900 | 70 °C | + | + | Polyester fabric, PVC coated on both sides. |

+ = Resistant; O = Conditionally Resistant; - = Not durable.

Insulation Notes

Normally fabric expansion joints must not be included in external piping insulation to allow the calculated and necessary heat transfer. If you would like to install an insulation, please contact us, such that we may choose a special design for your expansion joints.

The piping insulation must not contact the expansion joint flanges under all circumstances. Generally a distance of at least 80 mm has to be kept between piping insulation and expansion joint. The duct insulation at BundleTec fabric expansion joints has to be approved by our technical department. The installation of outer protection shields at the expansion joints has to be approved too.

“

"The Seal of Trust, The Heat of Innovation: BundleTec!"

”

Our company owes its roots to our esteemed founder Armin Akbuğa. He laid the foundation of our company with his visionary approach and pioneering spirit in 1996. Although he passed away in 2012, his legacy still shapes our company's core values and guides its success.

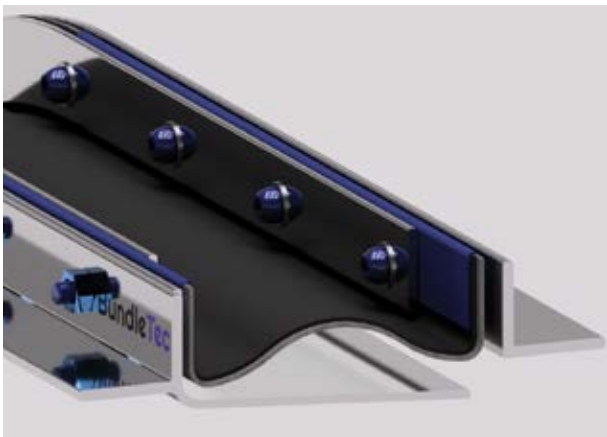
Akmanlar, with its brand name at the time it was founded, brought a great innovation to our country's manufacturing sector by producing Turkey's first self-cushioned fabric layer expansion joint for Ekinciler Demir Çelik in 1996.

Our company, growing with the BundleTec brand, proudly continues its legacy of innovative vision and carries it into the future.

BASIC STRUCTURES

BundleTec, with its deep-rooted experience in fabric expansion joints and special design capabilities, is a manufacturer that can offer excellent performance even in the most challenging working conditions by offering a wide range of high-quality material options. The fabric expansion joints we produce are specifically optimized for high-demand industrial applications and business requirements. This enables us to withstand variables such as temperature changes, pressure differences and vibration.

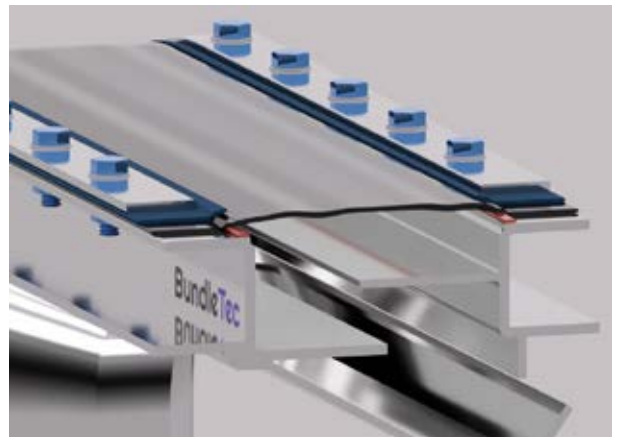
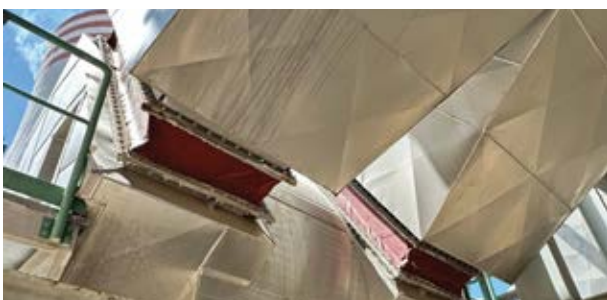
Our experienced engineers stand out for their expertise in customizing the design and features of expansion joints to meet the unique needs of our customers. In order to offer you the best performance, they will be pleased to guide you every step of the way with their rich knowledge of determining and applying the correct expansion joint structure.



FanTec Expansion Joints

FanTec expansion joints are products designed to effectively balance thermal expansion, vibration, and misalignment issues in pipe and duct systems within low temperature climate regions. These expansion joints are engineered to ensure smooth and efficient operation of systems by addressing these challenges.

- Single or multi layer structure
- Movements of many axes are damped at the same time
- Suitable for use in dry and wet environments
- Metal flange or clamp can be manufactured on request
- Operating temperature range: -35°C / $+250^{\circ}\text{C}$
- Working pressure range: $-0,25\text{ bar}$ / $+0,25\text{ bar}$

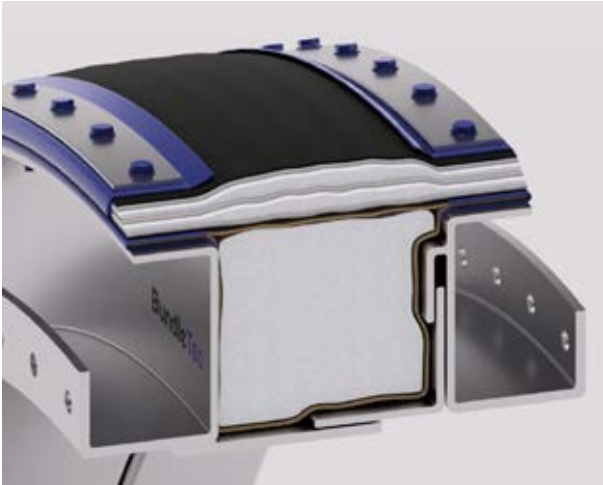


ChemTec Expansion Joints

ChemTec expansion joints provide effective solutions for thermal expansion, vibrations, and misalignments in pipe and duct systems located in chemically aggressive environments. These specialized expansion joints are designed to ensure the long-lasting and reliable operation of your systems.

- Single-layer structure
- Movements of many axes are damped at the same time
- Suitable for use in dry and wet environments
- Highly durable for acids
- Metal flange or clamp can be manufactured on request
- Operating temperature range: -35°C / $+315^{\circ}\text{C}$
- Working pressure range: $-0,35\text{ bar}$ / $+0,35\text{ bar}$

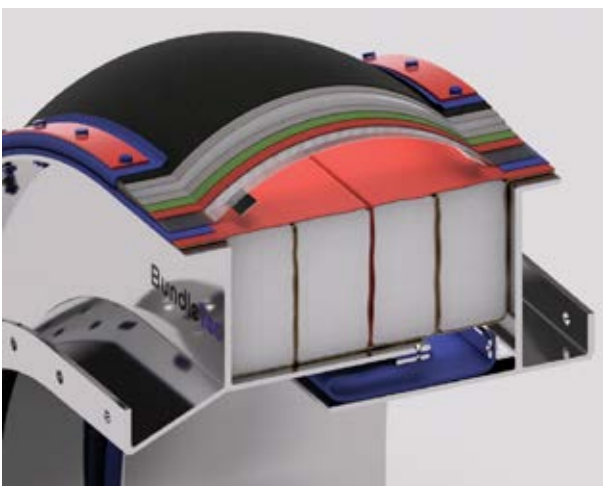
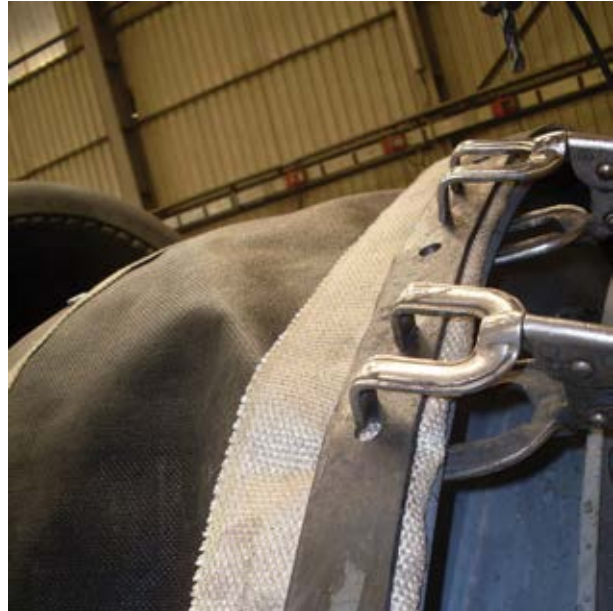




FlueTec Expansion Joints

FlueTec expansion joints effectively balance thermal expansion and displacement issues in pipe and duct systems in areas dominated by high temperatures and high flow rates.

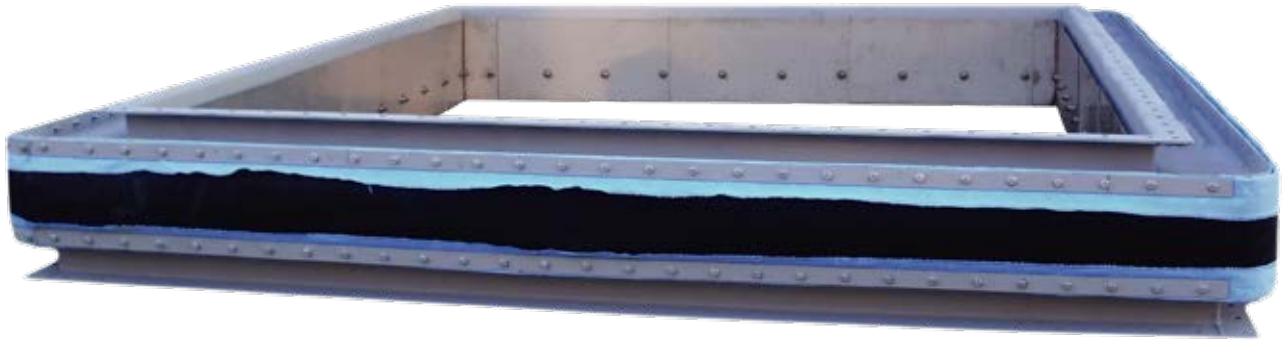
- Multi-layer structure
- Movements of many axes are damped at the same time
- Suitable for use in dry environments
- Medium level acid resistance
- Metal flange can be manufactured on request
- Operating temperature range: $-35^{\circ}\text{C} / +800^{\circ}\text{C}$
- Working pressure range: $-0,15\text{ bar} / +0,30\text{ bar}$



ArminTec Expansion Joints

ArminTec expansion joints safely absorb thermal expansion and misalignments of pipe and duct systems in dry, high temperature and high velocity area. The durable cambered knitted wire inside ensures that the fabric layers of expansion joint maintains its form while exposing axial compression/extension and lateral movement.

- Multi-layer structure
- Movements of many axes are damped at the same time
- Suitable for use in dry environments
- Specially designed for high axial extension
(Ex: Loopseal Expansion Joints)
- Medium level acid resistance
- Operating temperature range: $-35^{\circ}\text{C} / +950^{\circ}\text{C}$
- Working pressure range: $-0,10\text{ bar} / +0,30\text{ bar}$



GT-Tec Expansion Joints

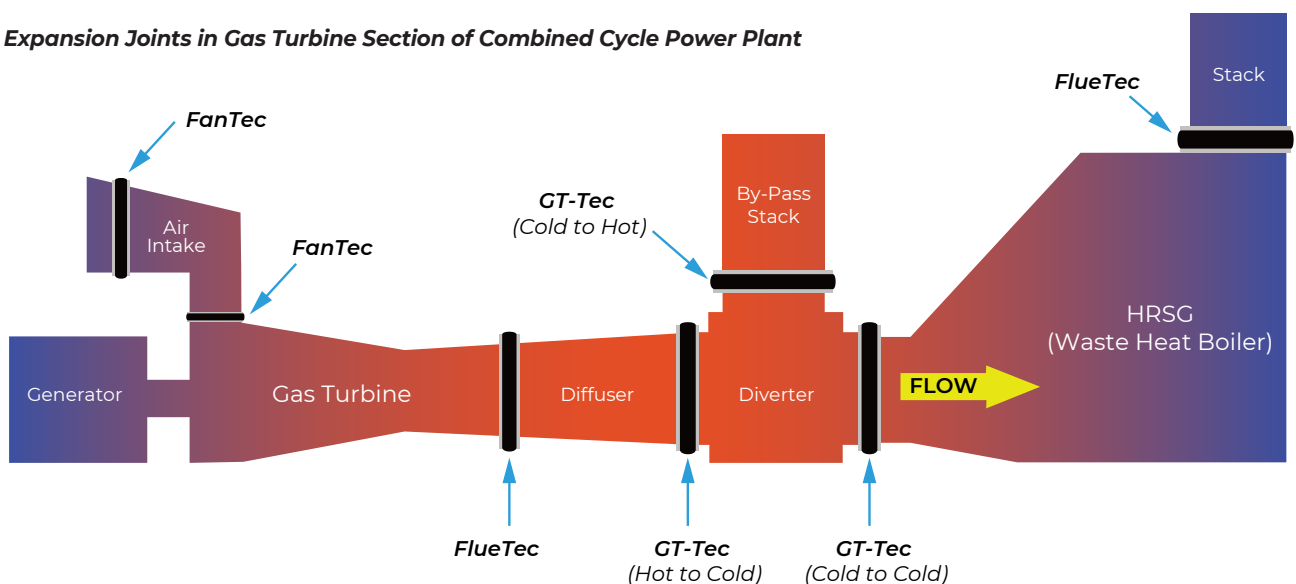
When designing an efficient and customized expansion joint for GT (Gas Turbine) application, it is necessary to consider a number of unique engineering challenges. If a GT Expansion Joint placed at the critical point between the turbine duct and the exhaust duct fails, the turbine must be shut down and this means the power plant becomes inoperable. Therefore, when BundleTec engineers are tasked with designing a custom expansion joint for a gas turbine exhaust system, they expect to encounter some challenges that are typically encountered in most gas turbine applications but are unique when compared to other industrial plants.

Heat stress is a major problem on gas turbines because the thermal state of a GT system fluctuates significantly during turbine operation—especially at the moment of turbine startup. The gas turbine rapidly transitions from a cold state to extremely high temperature, which subjects an expansion joint fitted to the exhaust outlet flanges to thermal shock. If the expansion joint is not adequately protected against these rapid thermal stress changes, the expansion joint will be adversely affected and may eventually lead to failure.

Beyond heat stress, vibrations and mechanical movements add significant stress to a working GT expansion joint. Motion and vibration levels in turbines and associated ducts increase proportionally as size, power and temperature increase.

The expansion joint design used in GT systems is divided into 3 basic categories: hot to hot, hot to cold and cold to cold. These design differences vary depending on the regions where the expansion joints will be placed.

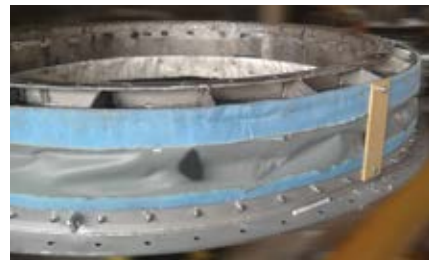
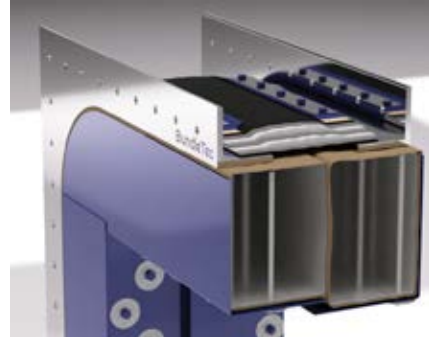
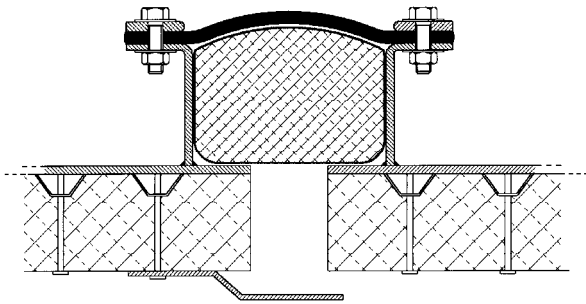
Expansion Joints in Gas Turbine Section of Combined Cycle Power Plant



Cold to Cold

gas turbine expansion joint configurations are used in areas where both connection flanges have internal insulation.

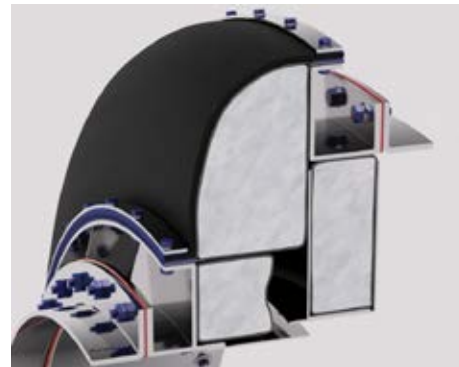
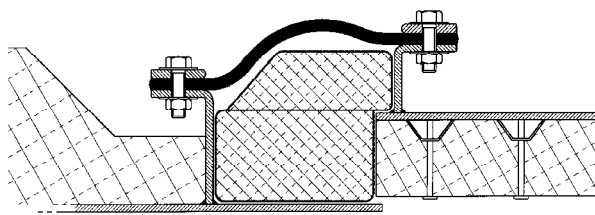
It uses studs welded to the connection flange for the assembly of slot hole guide plates, so that the hanging guide plates move freely in the direction and amount allowed by the slot holes as the temperature increases. In this model, no part of the expansion joint frame is directly exposed to the hot gas flow.



Hot to Cold

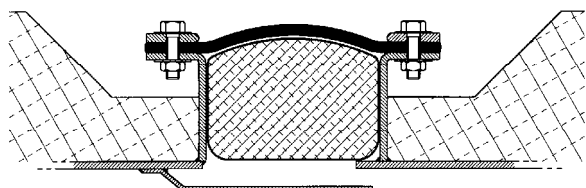
gas turbine expansion joint configurations are used in regions where one connection flange operates at exhaust gas temperature and the other connection flange has internal insulation.

The insulation pillow on the non-insulated flange side is fixed with pins and welded to the router body. On the insulated flange side, it uses rods welded to the connection flange for the installation of slot hole guide plates, so that the hanging guide plates move freely in the direction and amount allowed by the slot holes as the temperature increases.



Hot to Hot

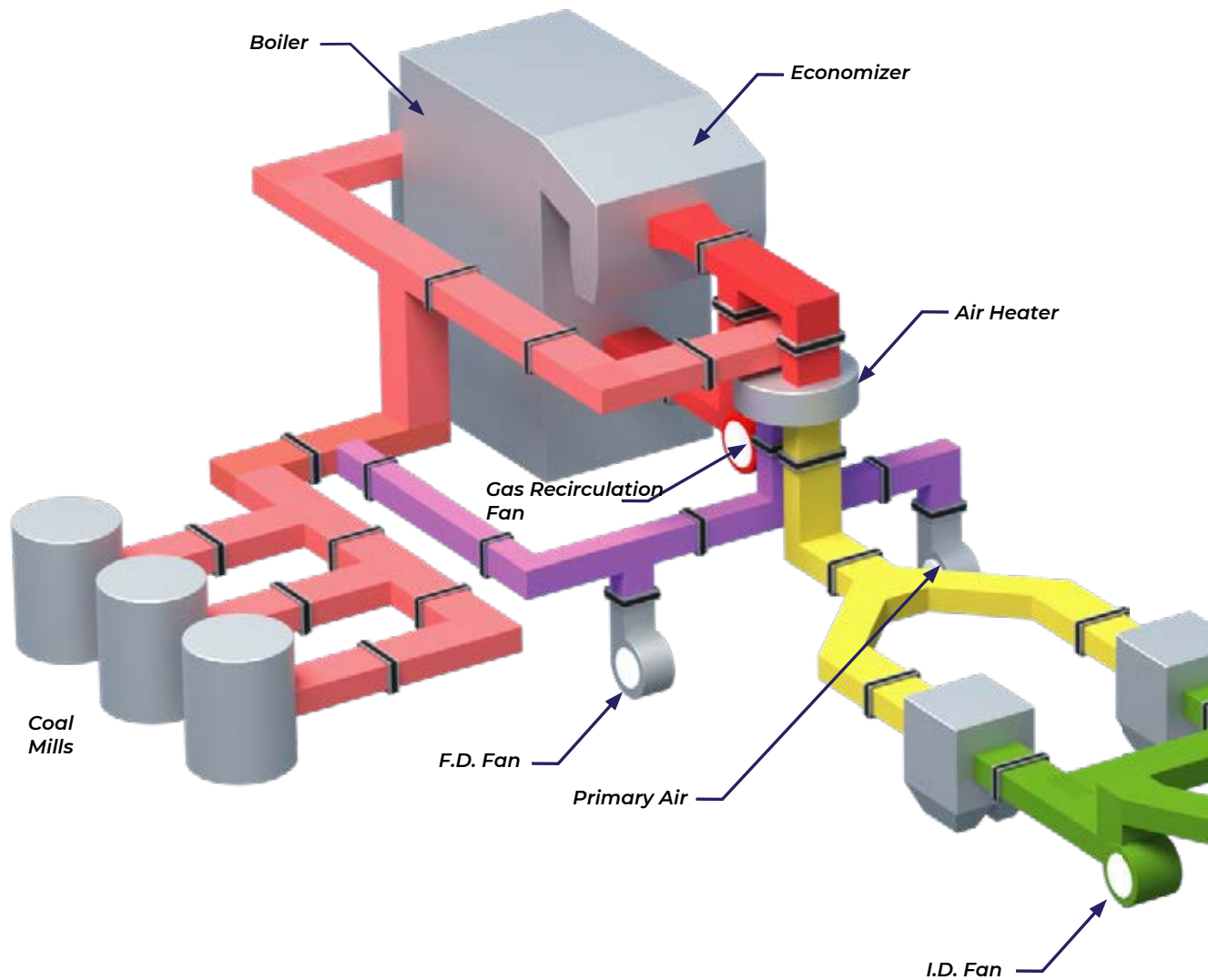
gas turbine expansion joint configurations are used in regions where both connection flanges operate at exhaust gas temperature. The special frame design allows for a very high number of cycles compared to traditional expansion joint frames.



Typical Boiler Duct Layout

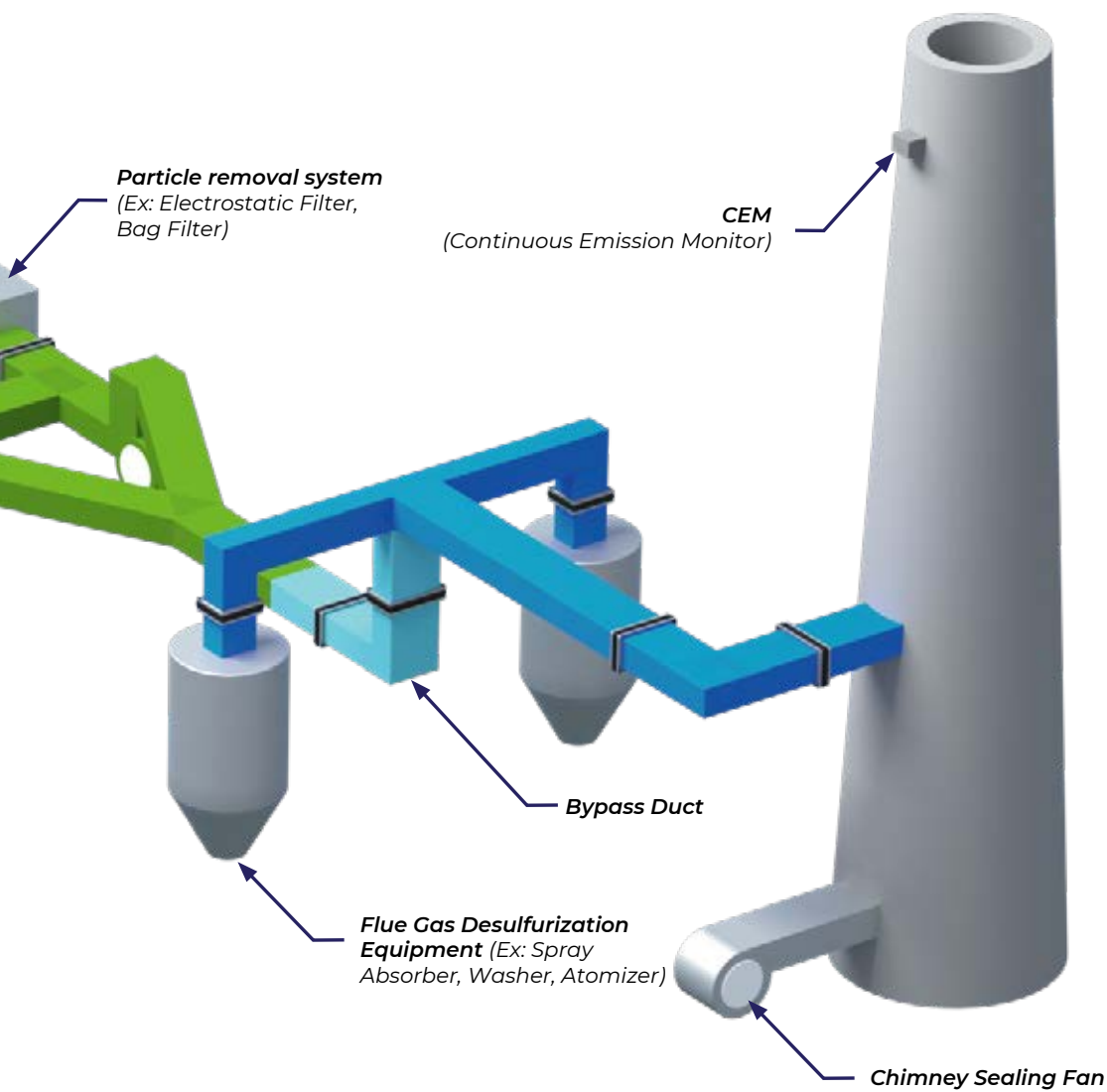
See the figure below for examples of fabric expansion joints used with ducts.

**Black components are Fabric Expansion Joints.



Field research technicians carefully examine the expansion joints and conduct a detailed analysis to create replacement plans suitable for current and projected life expectancies. This analysis is supported by written and photographic documents. Additionally, the infrared analysis method is used to detect leaks in expansion joints. This methodical approach accurately determines the scope and cost of outage work required, reducing or eliminating the possibility of unplanned forced outages.

| | |
|--|--|
| | 300-450°C Particulate laden flue gas <i>(Liner and insulation pillow recommended)</i> |
| | 300-400°C Clean air |
| | 150-200°C Particulate laden flue gas <i>(Liner and insulation pillow recommended)</i> |
| | 150-170°C Flue gas with minimum particles |
| | 150-170°C Acidic flue gas <i>(Corrosion resistant frame and fabric recommended)</i> |
| | 50-80°C Flue gas at acid dew point <i>(Corrosion resistant frame and fabric recommended)</i> |
| | Outdoor Clean air |



INSTALLATION INSTRUCTIONS

Storage

BundleTec fabric expansion joints are delivered well secured and sufficiently packed. Until the time of installation they must be stored dry and clean and be not subjected to solar radiation.

Assembly Preparations

The following steps should be taken before and during assembling BundleTec fabric expansion joints to ensure a proper installation:

- All packing materials should only be removed immediately before installation;
- Transportation devices should be removed as late as possible but before starting service;
- Verify that flange dimensions and bolt circles match at all connecting parts;
- Check all edges and surfaces of the system components for burrs and pollution;
- Components not supplied by BundleTec must not be sharp-edged. Edges which may contact the joint require a radius of at least 3 mm.

Expansion Joint Fabric Joining

We offer many different types of joinings in a wide variety of materials for a variety of applications. For this reason, the installation and especially the closure of open-ended expansion joints require many different techniques and methods. For combination of different layers or field supervision, please consult BundleTec.

Installation

- During installation, never walk on, or damage expansion joints.
- Organise the clamp bars to ensure correct match to duct flange. (See: Fig. 1)
- If appropriate, support the weight of the expansion joint during installation. For a vertical duct, support the joint on the upper flange with g-clamps.
- If appropriate, apply lubricant uniformly to all thread, nut and washer load-bearing surfaces.
- Compress the expansion joint slightly and slide between the gap in the duct. Orientate the joint to the ducting and locate the corners (if applicable), ensuring that the hot face is towards the inside of the duct. Pull the expansion joint over the duct flanges, spreading it equally to avoid any build up of excess material around the circumference of the duct. Secure with g-clamps.
- Starting from one corner, position the expansion joint flange and one corner section of clamp bar correctly, ensuring that the rounded edges face inwards and towards the flange they are clamping. (See: Fig. 2)
- Compress the expansion joint with a g-clamp either side of the middle hole of the corner clamp bar section, so that the clamp bar holes line up with those in the duct flange. (See: Fig. 3)

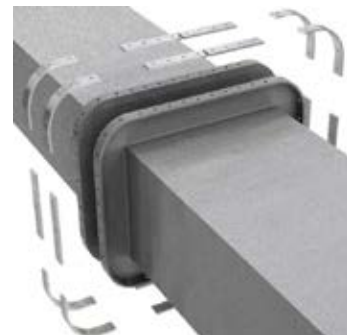


Fig. 1

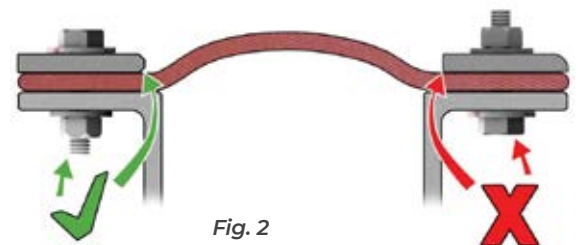


Fig. 2

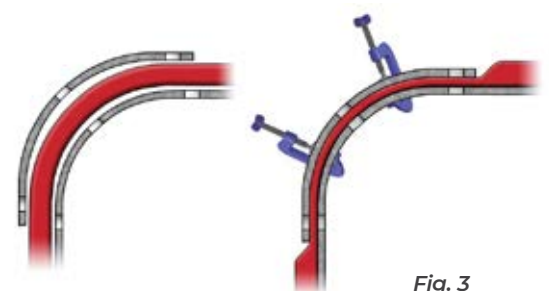


Fig. 3

- Starting at the middle hole of the corner clamp bar section, drill one hole through the expansion joint material, using the clamp bar and duct flange as templates. **It is very important** that the g-clamps (on both sides of the hole) hold the material securely otherwise the fabric may rotate with the drill, resulting in tearing (**See: Fig. 4**). Insert the bolt from the clamp bar side and tighten loosely. Working along the clamp bar, drill through the flange and clamp bar, inserting bolts from the clamp bar side and tightening the bolts loosely as you go, until all the bolts are in place in the first corner clamp bar section.
- In the same way, install the equivalent corner clamp bar section loosely on the opposite duct flange.
- Install all other corners in a similar manner on both flanges.
- Starting from the corners, use the same process to install all remaining clamp bar sections loosely, ensuring even distribution of excess expansion joint material (**See: Fig. 5**)
- Adjust positioning of the clamp bars to ensure best fit and maximum gap of 3mm or 1/8 inch between adjacent clamp bars. Avoid pinching the expansion joint fabric (**See: Fig. 6**)
- Tighten bolts on both flanges to ~80% of final loading.
- Using a torque wrench, tighten bolts to final loading.
- Make a second round of tightening to final loading.
- Report to your supervisor that installation is complete.

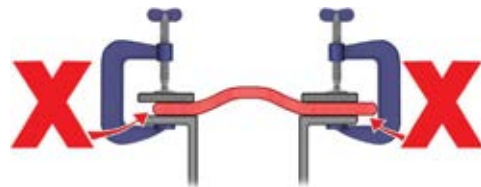


Fig. 4

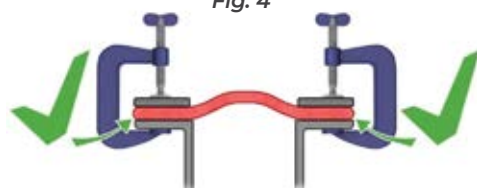


Fig. 5

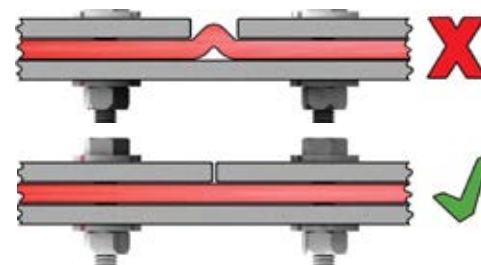


Fig. 6

Service and Maintenance

Compared to stiff piping systems, expansion joints are limited-life-time components. According to strains and operating conditions, but at least every 3 months, routine inspections should be done (i.e. visual check-up, screw fixings). Solvents may damage the surface coatings of fabric expansion joints. Therefore, do not paint the joint or use any caustic cleansing agents or those containing solvents.

Important Information

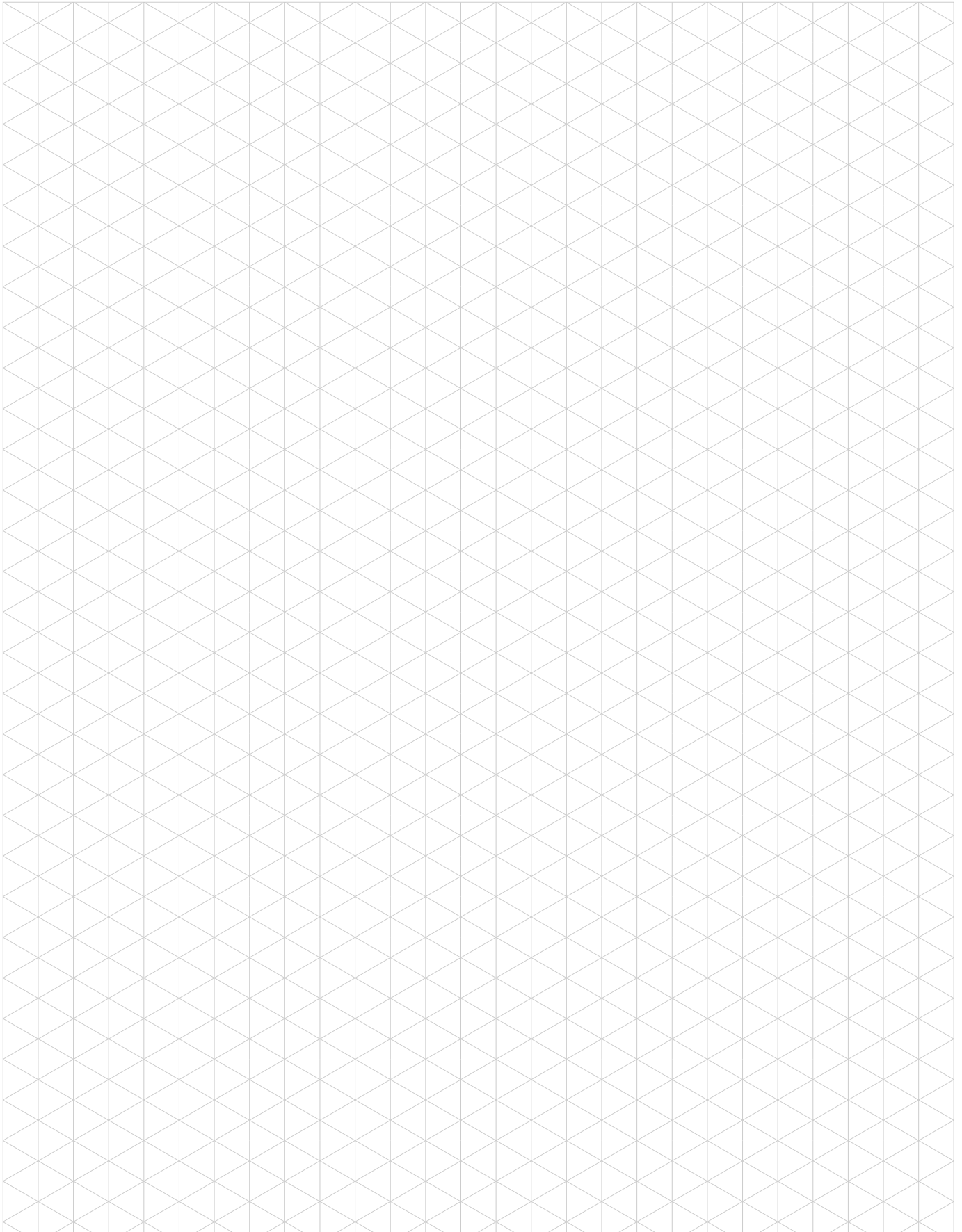
Fabric expansion joints are no supporting components of the piping system, therefore the correct positioning of guides and fixed-points is of utmost importance. Inside and outside of BundleTec fabric expansion joints are unmistakably marked. These marks must be observed in order to grant correct installation.

- Protect expansion joints against weld-sparks and sharp-edged objects whilst any work is carried out nearby;
- Lift pre-assembled joint kits only at marked transportation devices;
- Expansion joints have to be lifted with several spread loops or butt straps or have to be supported by plates;
- All dimensions and measures for installation must be strictly adhered to, otherwise no warranty can be given by manufacturer;
- PTFE-foils and coated fabrics tend to become brittle at low temperatures. Hence, fabric expansion joints made of these materials have to be handled with care at temperatures below +10 °C (50° F) and must not be installed at these temperatures;
- The allowable working temperature of the adhesives used during closing and mounting has to be sufficient to avoid burning!

Installation Service

Our experienced service team is available immediately on job-site at any time. All installation and assembly work will be executed promptly and competently by our skilled workers. We also may provide a foreman who may support your workers. Of course, our team will be at your service for measuring up your mounting situation and for disassembly too.

Please do not hesitate to contact our service department.



FABRIC EXPANSION JOINT QUESTIONNAIRE

Contact Name _____
 Fax _____
 Phone _____
 Address _____

 Project Name/No. _____
 Site Location _____
 Plant Type _____

Request No. _____
 Item/Tag No. _____
 Location of E.J. (inlet/outlet, etc.) _____
 Flow Direction (Up, Down, Horiz.) _____
 Flow Medium (air, flue gas, etc.) _____
 Type of Fuel (wet, dry, etc) _____
 New / Replacement _____

MOVEMENTS

inches mm

Axial Compression _____
 Axial Extension _____
 Lateral (parallel to short side) _____
 Lateral (parallel to long side) _____
 Angular(°) _____
 Torsion (°) _____

PRESSURE

inches W.C. mbar Pa

Design _____
 Operating _____

TEMPERATURE

°F °C

Operating Excursion _____
 Excursion (hrs) _____
 Ambient Maximum _____
 Ambient Minimum _____

FABRIC CONNECTION TYPE



CLAMPED



FLANGED (U-TYPE)

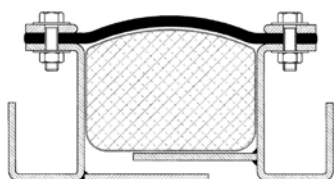


BELT (FLAT-TYPE)

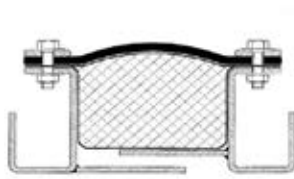


COMBI TYPE

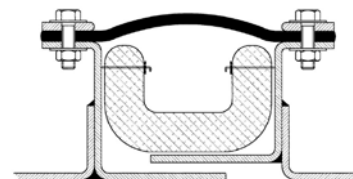
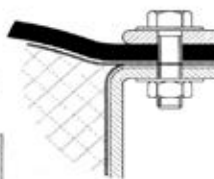
BOLSTER (INSULATION PILLOW) TYPE



BLOCK



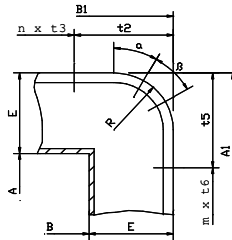
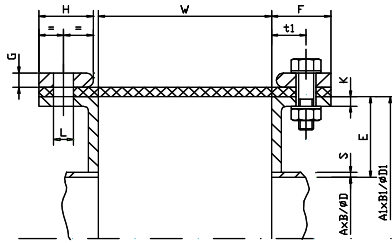
FLANGED



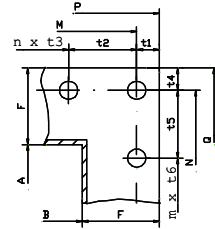
PINNED

FABRIC EXPANSION JOINT QUESTIONNAIRE

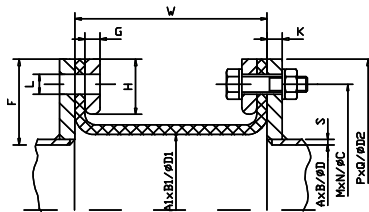
Belt type connection



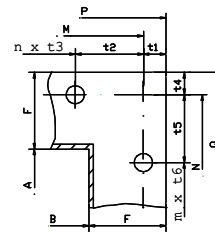
with hole in the edge edge



Flange connection



without hole in the edge



Rectangular

AxB inner duct dimension

A mm
B mm

A1xB1 inner dimension of the expansion joint

A1 mm
B1 mm

E set back

E mm

F flange height/width

F mm

G counter flange thickness

G mm

H counter flange width

H mm

K flange thickness

K mm

L bolt hole diameter

L mm

MxN hole line distance

M mm
N mm

PxQ outer dimension

P mm
Q mm

R radius

R mm

S duct wall thickness

S mm

W flange distance

W mm

t1 distance (round / rect.)

t1 mm

t2 distance (only rect.)

t2 mm

t3 distance (only rect.)

t3 mm

m number of holes

m

α angle

α °

Round

D inner duct diameter

D mm

D1 inner diameter of the expansion joint

D1 mm

E set back

E mm

F flange height/width

F mm

G counter flange thickness

G mm

H counter flange width

H mm

K flange thickness

K mm

L bolt hole diameter

L mm

C bolt pitch

C mm

N number of holes

N mm

D2 outer diameter

D2 mm

S duct wall thickness

S mm

W flange distance

W mm

t4 distance (only rect.)

t4 mm

t5 distance (only rect.)

t5 mm

t6 distance (only rect.)

t6 mm

n number of holes

n

β angle

β °



WORLD-CLASS QUALITY, EXTRAORDINARY ENGINEERING

BundleTec is a global multidisciplinary, industrial and technical solutions company. As a full-service company, our work ranges from product selection to customer specification. It includes everything from production to efficiency measurement and system optimization.

We offer services in many different regions and languages.

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