EagleBurgmann expansion joint solutions

Value Engineering raised on global experience

Over 50 years of challenges in the expansion joint industry proves that EagleBurgmann Expansion Joint Solutions is one of the world’s most experienced and innovative expansion joint manufacturers.

Experience is sourced from all continents and various market sectors to provide our customers with the latest technologies and solutions.

Metal and fabric expansion joints are flexible connections, installed in piping and ducting systems to accommodate expansion and vibration caused by changes in temperature, pressure and media comprise.

EagleBurgmann Expansion Joint Solutions major focuses:
- Value engineering to decrease operational downtime
- Lean manufacturing to reduce costs
- 3D smart design to maximize overall service life

EagleBurgmann Expansion Joint Solutions comprehensive service:
- Evaluations and troubleshooting
- Initial dimensional measurements
- Installation and refurbishment
- Supervision and training
- Plant surveys
- Emergency services
- Final inspection by experienced Service Engineers

EagleBurgmann Expansion Joint Solutions is approved to:
- European Pressure Equipment Directive (PED) 97/23/EC
- ISO 3834-2
- ISO 9001
- ISO 14001
- OHSAS 18001
- ASME U Stamp
- ASME R Stamp
- Other approvals is available upon customer request

EagleBurgmann Expansion Joint Solutions is a respected member of:
- The European Sealing Association (ESA)
- Fluid Sealing Association (FSA)
- Expansion Joint Manufacturers Association (EJMA)
- Euro-Qualiflex

EagleBurgmann Expansion Joint Solutions is proud of the appreciation given from hundreds of customers around the world.

EagleBurgmann Expansion Joint Solutions has global production in:
- Europe
- Americas
- Asia Pacific

We have a worldwide sales network supported by EagleBurgmann and Freudenberg offices.

www.eagleburgmann-ej.com
P4. An Industry on the Move
P5. Combine-X Fabric Expansion Joints
P6. Combine-X Unit
P7. KE-Acouseal
P10. Engineering Gas Turbine Fabric Expansion Joints
P11. Clamping Arrangement & Leak Tightness
P12. Refurbishment of Steel Frames
P13. Metal Expansion Joints for Gas Turbine Exhaust
P14. Finite Element Analysis (FEA)
P15. Installation, Service & Preventative Maintenance
An Industry on the Move

The gas turbine industry is constantly on the move. New and improved types are continuously being developed to meet the demands and requirements for greater efficiency and output in gas turbine and combined cycle systems. The commercial demands to minimize fuel costs and improve efficiency coupled with environmental obligations to reduce emissions and noise will continue the development of more innovative solutions in modern gas turbine technology.

Expansion joints help to ensure the stability and reliability of any given gas turbine system. Turbines in such systems produce exhaust gases with high output temperatures and high gas speeds in varying pressure conditions. As a result, any connecting duct system is exposed to a combination of thermal stresses, turbulence and considerable vibration – an environment ideal for fabric expansion joints designed to compensate for these conditions.

In keeping up with industry advancements, EagleBurgmann Expansion Joint Solutions is continuously developing new types of fabric expansion joints specifically designed to suit the needs of modern gas turbine systems.

The trust and cooperation we have earned with the world’s major gas turbine manufacturers has provided us the opportunity to test our expansion joint designs under actual working conditions. This enables us to provide a range of thoroughly tested, high-tech expansion joint solutions for both small and large gas turbines.

Gas Turbine Systems - In Principle

In a single or simple cycle system, the hot exhaust gas is not recycled but is lead away through a (bypass) stack. Gas turbines used for single cycle systems are normally small turbines (not larger than frame 6) with exhaust temperatures up to 930°F. For these applications, fabric expansion joints are located on both the inlet and outlet sides of the gas turbine, on the ducting, and before the stack.

In a combined cycle system, the basic principle of the single cycle system is used but the exhaust gases are directed from the gas turbine to a waste heat recovery boiler (WHRB) or a heat recovery steam generator (HRSG). The steam from the HRSG is then directed to a steam turbo-generator for additional electric power production. Using the exhaust heat from the gas turbine in this way improves the overall thermal efficiency of the system. Generally applicable to larger gas turbines (frame 6 and upwards), combined cycle systems involve exhaust gas temperatures up to 1,250°F.

In large gas turbines with high exhaust temperatures and increased efficiency output special attention must be given to the components installed in the gas turbine environment. These components are exposed to extensive thermal stress, high gas velocities, water-washing of the turbine blading, many start/stop cycles for peak load and back up, etc.

In such systems fabric expansion joints are installed before the gas turbine (air inlet) and after the gas turbine (exhaust outlet), immediately after the diffuser, on the outlet ducting itself, in connection to the bypass stack, and with the boiler or generator.

In cogeneration, or CHP (Combined Heat and Power), designs, electric power is produced, using the same principle and set-up as in combined cycle systems. Combined with either a conventional boiler or an HRSG, all excess thermal energy from the exhaust gases will be recovered and used for producing process heat, i.e.; simultaneous production of electric power and process heat or steam.
The Combine-X fabric expansion joint is specifically designed for gas turbine applications. They are installed in a variety of locations; primarily in diffusers, exhaust plenum, damper inlets, damper outlets, by-pass stacks and boilers.

The location of the expansion joint in a gas turbine system is an important factor to consider when designing each expansion joint; particularly with material selection and composition of the individual layers. The expansion joint design must be customized to accommodate the operating conditions applicable to the system. EagleBurgmann Expansion Joint Solutions has developed Combine-X - a state-of-the-art, multi-layer fabric expansion joint designed to meet the most severe design requirements.

**Flexibility**
Great flexibility and standard movement accommodates up to 50% axial compression and ±20% lateral offset (depending on temperature and type).

**Gas sealing barrier**
A gas sealing barrier can be integrated into the outer cover, or installed separately as a new and improved high-temperature resistant layer.

**Design**
The expansion joint design is customized to various locations in the GT system. Hot-to-hot, hot-to-cold, or cold-to-cold designs among others that are available.

**Operating temperatures**
New designs allow for operating temperatures of up to 1,300°F, with minimal temperature differential (t = 400°F) on the flange.

**Pressure range**
From -56” WC / +30” WC – 140

**Temperature range**
Operable in ambient temperatures of up to 300°F.

**Lifetime**
The expansion joint construction including steel components can be analyzed using FEA/FEM, which includes calculations of fatigue life based on the start-up and shut-down cycles of the gas turbine. By incorporating new and improved materials in our expansion joint designs, the stress on steel components caused by elevated operating temperatures is minimized. This is an important feature that enables the expansion joint to perform to maximum efficiency even under conditions that are outside the design parameters.

Combine-X expansion joints offer an extremely flexible solution to problems that exist in turbine system pipework to help ensure reliable and economical plant operation. Our field service team can supply a turn-key packaged solution combining our specially designed expansion joints including all necessary measurements, analysis, supervision, installation and final inspection.
The use of expansion joint units, such as a Combine-X fabric expansion joint pre-assembled on steel components, offer many advantages:

- Steel work can be designed and engineered by us for delivery under our scope
- All pre-assembly is carried out in our workshop
- Installation into the duct is simple and quick
- Transport brackets hold the unit securely in place during transport and installation
- Large units are transported in sections and welded on site for easier handling, shipping and installation
- Can be supplied with scissor control guides for the installation of two or more expansion joints in line, when large movements need to be accommodated.

A complete expansion joint unit can be analyzed by means of FEM/FEA to ensure optimum service life. The analysis includes the temperature distribution in the steel components and the insulation, the gradient of both pressure and stress in steel components, and the heat loss in the complete expansion joint.

Incorporating FEM/FEA into your packaged solution makes it possible to calculate the expected service life, to optimize the design and to choose the most suitable steel quality.
The KE-Acouseal is designed to insulate sound and damp vibration. They are installed in the air intake side of the gas turbine, between the filter and the gas turbine compressor.

Increased awareness of the environmental impact of industrial plants and installations is imposing additional demands on their designs and the necessity for sound insulation of turbines is becoming more apparent. In anticipation of these requirements, EagleBurgmann Expansion Joint Solutions has designed the KE-Acouseal sound and vibration damper.

KE-Acouseal expansion joints are specially designed and tested to meet requirements for:

- Optimum sound insulation – they are tested and documented according to VDI 2571
- Vibration insulation in ducts – mechanical stress is minimized by the application of FEM/FEA calculations
- Accommodates thermal expansion
- Installation tolerances (±10 mm axial and lateral are standard) ensure easy and speedy installation
- No external insulation

KE-Acouseal expansion joints have been tested by the independent Danish Technological Institute whose measurements, based on VDI 2571, show that these rubber expansion joints offer extremely efficient sound insulation. (Refer to sound insulation index, ref. no. 260 2 4004 DTI.)

Corner sections of KE-Acouseal rubber expansion joints are designed using FEM/FEA to ensure optimum geometric precision, thereby minimizing mechanical stress at corners.

### Sound Insulator

- **Vibration Damper**
- **Improved Service Life**

### Sound reduction index R (dB)

<table>
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<th>31</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
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<td>30.0</td>
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<td>30.0</td>
<td>35.7</td>
<td>37.1</td>
<td>43.6</td>
</tr>
</tbody>
</table>

### KE-Acouseal installed on air intake.

![KE-Acouseal on air intake](image-url)
We can take the heat and the pressure from major water distribution pipelines spanning the high desert to specially designed pressure balanced units in cooling systems. EagleBurgmann Expansion Joint Solutions are installed in thousands of applications worldwide. Whether it is air, gas, petrochemicals or water, our expansion joints are designed to provide maximum reliability and safety. Our technical expertise and progressive manufacturing capabilities enable us to offer our customers solutions that increase overall service life, reduce costs and decrease operational downtime.

EagleBurgmann Expansion Joint Solutions – making business sense!

Innovative expansion joints solutions to meet the world’s pipe expansion needs
Flanges and flange heights
The correlation between flange temperature (temperature on the expansion joint) and stress in the steel frames determines the flange height. The steel quality should be taken into consideration when designing the expansion joint construction. A relatively high flange design or a flange design with a cooling effect is necessary when using steel qualities with high thermal conductivity – and vice versa.

Likewise, the duct insulation has great influence on the heat conductivity of the flange; full duct insulation will increase the temperature of the flange, whereas only half duct insulation will increase the flange temperature to a lesser extent.

Material selection
Steel qualities can be grouped into two categories: low-alloy ferritic steel (with relatively high heat conductivity) and stainless austenitic steel (with relatively low heat conductivity). It is very important to know the characteristics of the chosen steel quality. EagleBurgmann Expansion Joint Solutions has extensive experience in working with all types of steel, particularly in relation to:

- Welding procedures, spot welding, seam welding, etc.
- Calculating the steel behavioral pattern
- Working with steel qualities such as 3Cr12, 10CrMo910, AISI 316, AISI 321, AISI 410, AISI 347, etc.

Frame design, flange height, material selection, gas sealing, heat transmission, convection, bolster, duct insulation, clamping arrangements, duct washing, turbine cycles, etc. - are just some of the important parameters to consider when specifying the optimal expansion joint construction for a gas turbine or combined cycle system.

Measurement and calculation of gas sealing and heat transmission rates.

Combine-X sample.

Steel parts for fabric expansion joints.
Fabric expansion joints are designed to be as leak tight as is reasonably possible. The vast majority of expansion joints (both single and multi-layer designs) can be considered leak tight through the body of the expansion joint. However, special attention should be given to steel design, clamping areas, bolts or clamps and the flange reinforcement. It is in these areas that the greatest potential for leakage and system losses occurs.

There are several methods of clamping fabric expansion joints. The two most commonly used clamping methods are clamping bands and clamping bars. The requirement for leak tightness plays an important role in determining the clamping arrangement.

**Clamping bars** are ideal for both low and high temperatures. They ensure good leak tightness in both belt type and flanged type expansion joints.

EagleBurgmann Expansion Joint Solutions has designed a special low-leakage fabric expansion joint for critical applications. In this design we use a high-temperature gas barrier to ensure zero leakage in the flange area.

Effective sealing in the flange area also depends on the design of the frames to which the expansion joint is attached. The use of pre-assembled expansion joints will almost invariably ensure a much lower rate of leakage than on site assembly and installation.

**Insulation - external and internal**

In gas turbine systems, and other high temperature applications, expansion joints are often located at the point where the duct insulation changes from internal to external or vice versa. In most cases, the change in duct size and duct material can be made over the length of the expansion joint. This however, requires careful design and may require the expansion joint to be conical in order to keep the steel frame design within stress limits to accommodate the combinations: hot to hot/hot to cold/cold to hot/cold to cold steel frames.

External insulation should not cover a fabric expansion joint, except when it is part of the original expansion joint design. This avoids the possibility of condensation if the temperature should fall below the dew point. For very hot applications, i.e; gas turbine, the termination of the duct insulation must be carefully designed to minimize stress in steel frames and overheating in the clamping area.
Influences on the Expansion Joint  
Quality of Steel Frames

Refurbishment of Steel Frames

Influence of moisture, condensation and washing
Moisture within a gas turbine duct system can have a detrimental effect on the life of a fabric expansion joint, and should therefore be minimized or eliminated.

Where duct or gas turbine washing is necessary in order to remove impurities from the turbine blading, provisions should be made for a suitable drain to be located next to the expansion joint in order to prevent the accumulation of moisture on the expansion joint material. Such condensates and the gases dissolved in them are often highly corrosive and should be avoided. The drains are important features in systems that involve frequent thermal cycles. For instance, in special applications where aggressive fuels such as crude oil are used in combination with frequent start-stop cycles, condensation in the flange area can create sulphuric acid.

Refurbishment of existing steel frames
Poor steel design, the incorrect steel quality or incorrect insulation of steel parts can significantly increase the thermally induced stress on the steel frame. The results of this will quickly manifest themselves in the form of fatigue cracks in the steel, particularly in the corner sections, as these are the most exposed part of the unit.

EagleBurgmann can refurbish expansion joint construction including new steel frame design, without requiring any changes to the original layout of the ducting. We use FEM/FEA to calculate the best frame design and steel quality for the location in your plant.

The above are just some of the areas that need to be considered when designing the most reliable expansion joint solution for a gas turbine system. Please contact our experienced engineers for the optimal solution for your system.
Metal expansion joints for gas turbine applications are predominantly used as a pressure vessel. The expansion joint can withstand very high pressures while still absorbing thermal growth.

Whether to install a fabric or metal expansion joint in your gas turbine system depends on your specific application and system configuration. When in doubt, an expansion joint specialist can assist you in selecting the best type for your application.

Metal bellows typically see a similar temperature to the internal duct temperature; this reduces or eliminates the thermal stress. Metal expansion joints are able to withstand extremely high temperatures and fast ramp rates without the thermal stress that causes yielding. If lateral movement is present and a rectangular shape is required, a fabric expansion joint should be considered. For round units, with little or no lateral movements, a metal expansion joint functions well. If lateral movement is a requirement on a round application, a metal joint will require more length to accommodate the lateral deflection.

**Material selection**
When specifying metal gas turbine expansion joints, EagleBurgmann Expansion Joint Solutions recommends using stainless steel 321 for the bellows membrane and stainless steel 321 or 347 for the connection hardware. Continually heating and cooling stainless steel 304 through its sensitization range can lead to intergranular corrosion. Stainless steel 321 and 347 are stabilized with titanium and columbium respectively.

Liner thickness and design should be determined based on flow condition including turbulence correction factors. EagleBurgmann Expansion Joint Solutions uses liner stiffeners welded to the liner and internal ducting. Experience has shown that the liner welds are susceptible to thermal shock and turbulence stress.
Finite element analysis is a computerized method for predicting how a structure or assembly will react in real life operating conditions to forces caused by heat, vibration, mechanical stress, etc.

FEA/FEM enables our engineers to calculate failure, premature deterioration or optimal performance of a design. During the analysis, the product or assembly is broken down into a number of elements. The behavior of each element in the conditions in which it will operate is examined by a set of mathematical equations. The individual behaviors are then added up to predict the behavior of the complete object, i.e. the life expectancy of the complete expansion joint assembly.

Gas turbine systems are often used in peak load periods (several start/stop cycles), which makes the calculation of the life expectancy of components a very important factor. FEA/FEM is widely used to verify the design of expansion joints and their structures used in gas turbine exhaust systems. Based on the ANSYS finite element method (FEM), as well as our many years of experience, we have developed our own models to analyze expansion joint construction.

**Combine-X steel components**

EagleBurgmann Expansion Joint Solutions has developed our own models for use in analyzing expansion joint construction, and particularly in the critical area of the steel components for the Combine-X fabric expansion joint. Our analyses focus on:

- Temperature distribution in steel components and insulating material
- Stress/strain (both static and transient) arising in steel components
- Heat loss throughout the expansion joint unit

As a result of these analyses we are able to:

- Calculate the life expectancy of expansion joint units based on the start-up/shut-down cycles of the gas turbine.
- Optimize steel design
- Recommend the best material

Designers and engineers can also use FEA/FEM to troubleshoot existing installed units and recommend modifications to the design and quality of the steel frame. Finite element analysis can offer protection against unexpected failure and downtime.
Servicing our customers is vital
Operational reliability and long service life of expansion joints is crucial. Unplanned shut downs are not only troublesome, but expensive. The right installation can save hundreds of manhours with a proper and safe installation. EagleBurgmann Expansion Joint Solutions offers field service 7 days a week, within 24 to 48 hours.

The key to long-term and reliable expansion joints is dependent on a professional installation team. EagleBurgmann Expansion Joint Solutions’ service team has extensive installation experience and supervision on projects worldwide.

Safety is the highest priority
- Not only for our production and field service personnel, but for our customers and users of our products. The safety of all employees and personnel working on your plant or refinery is our greatest concern.

Our service teams complete routine safety training and certification to ensure each member observes current industry safety practices as well as site specific policies and procedures.

Our Comprehensive Service includes:
- Evaluations and troubleshooting
- Initial dimensional measurements
- Installation & refurbishment
- Supervision and training
- Plant surveys
- Emergency services
- Final inspection and experienced service engineers.

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EagleBurgmann Expansion Joint Solutions is a leading global organization in the development of expansion joint technology; working to meet the challenges of today’s ever-changing environmental, quality and productivity demands. Our flexible products are installed in thousands of plants, refineries and on equipment worldwide where reliability and safety are key factors for operating success. As part of the international organization EagleBurgmann Group, more than 5000 employees contribute their ideas, solutions and commitment to ensure our customers worldwide can rely on our products and services.

For more information – visit eagleburgmann-ej.com and eagleburgmann.com.