Expansion Joints for Gas Turbine Systems
EagleBurgmann

expansion joint solutions

Value engineering raised on global experience
Over 50 years of challenges in the expansion joint industry proves that EagleBurgmann KE 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 KE’s major focuses:
- Value engineering to decrease operational downtime
- Lean manufacturing to reduce costs
- 3D smart design to maximize overall service life

EagleBurgmann KE’s 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 KE is approved to:
- PED 97/23/EC
- ISO 3834-2
- ISO 9001
- ISO 14001
- OHSAS 18001
- ASME U Stamp
- ASME R Stamp
- Other approvals are available upon customer request

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

EagleBurgmann KE is a proud of the appreciation given from hundreds of customers around the world.

EagleBurgmann KE’s global manufacturing footprint:
- Europe
- Americas
- South East Asia
- India

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

www.eagleburgmann-ej.com
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Introduction

Turbine technology and design
are continuously being developed to meet the demands for greater efficiency, output and reliability in gas turbine power plants.

The commercial demands to minimize fuel costs and improve efficiency coupled with HSE commitments to reduce emissions and noise will continue to put pressure on turbine manufacturers to seek more advanced solutions in modern gas turbine technology.

The challenges
of gas turbine systems place special engineering demands on expansion joints, requiring particular attention to comprehensive design and fabrication. Expansion joints help to ensure the stability and reliability of the turbine system. Gas turbines produce high temperature exhaust gases with high flow velocity in varying pressure conditions. As a result, any connecting duct system is exposed to a combination of thermal stresses, turbulence and considerable vibration.

The trust and cooperation
EagleBurgmann KE has earned with the world’s leading 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, industrial expansion joint solutions for a wide range of gas turbine systems.
Gas Turbine Systems

In gas turbine systems 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 flow velocities, many start/stop cycles for peak load, back up etc.

With peaker plants more prevalent today, gas turbine units experience more thermal cycles per year with higher operating temperatures. End users are demanding improved warranties with longer intervals between maintenance outages.

One way to improve operational reliability and increased service life is to invest in expansion joints that are designed especially for extreme conditions, extending the life of your gas turbine exhaust unit.

The expansion joints are installed:
- in connection to the air inlet
- in connection to the exhaust outlet
- immediately after the diffuser
- on the outlet ducting itself
- in connection to the bypass stack
- within the HRSG boiler

The exact location of the expansion joint in a gas turbine system is a major factor in the design of each expansion joint; specifically with regard to the selection and composition of the materials from which the individual layers are fabricated.

Expansion joints for gas turbines are constructed using a combination of our high performance PTFE, high temperature fabrics and felt materials. Integration of our expansion joints with high quality bolster bags, durable frames and flow sleeve design, makes an industrial solution that withstands thermal expansions, vibrations and severe pressure fluctuations.

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.

Expansion joints in the gas turbine part of a combined cycle power plant.
Acoustic expansion joints are designed to reduce noise emission and dampen vibration on the air intake side of the gas turbine; between the filter and the gas turbine compressor.

Construct from a single layer of heavy non-reinforced rubber, Acoustic expansion joints compensate for movements in multiple directions simultaneously.

The Acoustic expansion joint provides the following advantages:
- Accommodates thermal expansion
- Absorbs movements in multiple directions and vibration
- Has proven sound reduction abilities
- Is a 100% gas tight solution without the use of gaskets due to the self-sealing property of the rubber
- Can be delivered pre-shaped at required dimensions
- Can be delivered with pre-punched holes for easy installation
- Needs no external insulation
- Is easy to transport and store

**Acoustic operating limits**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>-35 ... +150°C</td>
</tr>
<tr>
<td>Pressure range:</td>
<td>-0,1 ... 0,1 bar</td>
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<td>Maximal axial movements:</td>
<td>... 30 mm</td>
</tr>
<tr>
<td>Maximal lateral movements:</td>
<td>... 15 mm</td>
</tr>
</tbody>
</table>

Acoustic expansion joint for noise reduction and minimizing of vibration.

Air intake on gas turbine system.
Exhaust duct system - fabric solutions

Combine-X
are multi-layered fabric expansion joints specifically designed for gas turbine systems. They are primarily installed between the gas turbine and the diffuser.

EagleBurgmann KE has developed Combine-X, a fabric expansion joint customized to accommodate operating conditions to the system in question. Combine-X meets the most severe design requirements and are, among others, available in hot-to-hot, hot-to-cold, or cold-to-cold designs.

Combine-X expansion joints offer an extremely flexible solution to challenges encountered in turbine system pipework design to ensure reliable and economical plant operation.

Fluastal
fabric expansion joints are the optimal expansion joints for environments with high temperatures and high dust loads.

They are primarily installed in the:
- Diverter inlet
- Diverter outlet
- By-pass stack

Designed with stainless steel wire mesh and bands on the gas side, this multi-layer expansion joint provides high form stability and temperature resistance.

They are available in an easy-to-install option with either a silicone coated outer cover or the more temperature resistant PTFE based outer cover.

Expansion joint units
are fabric expansion joints pre-assembled on steel components that offer many advantages:
- Steel work can be designed and engineered by us as part of our scope
- All pre-assembly is completed 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 then welded on site for easier handling, shipping and installation
- When large movements need to be accommodated, the expansion joints can be supplied with scissor control guides for the installation of two or more expansion joints in line.

<table>
<thead>
<tr>
<th>Combine-X operating limits</th>
<th>Fluastal operating limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature:</td>
<td>Temperature:</td>
</tr>
<tr>
<td>–35 ... +650 °C</td>
<td>–35 ... +575 °C</td>
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<tr>
<td>Pressure range:</td>
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<tr>
<td>... 85 mm</td>
<td>... 85 mm</td>
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</table>
Special features can be applied depending on the gas turbine supplier and the operating conditions of the fabric expansion joint.

**Pre-bolster**
The heavy construction protects insulation from flow and turbulence while providing excellent and even temperature reduction. The CF technology ensures maximum life time. The pre-bolster is installed with studs and washers to ensure that it will follow the moving parts.

**Pulse Breaker**
Reduces the pressure pulse on insulating materials and limits the flow of hot gases. Though quite strong, the mesh retains maximum flexibility during thermal expansion and contraction.

**Pulse Barrier**
Reduces the pressure pulse on insulating materials.

**Sleeve Extension**
Welded steel frame extensions that minimizes the gap affected by pressure fluctuations. Increases the support of the pulse breaker and limits flow of hot gases. May be relevant when supplying soft parts for existing steel parts.

**Leaf Seal replacement**
The stock GE Frame 7 turbine exhaust Flex Seal has a tendency of losing its flexibility and function-

**Flange and frame insulation**
EagleBurgmann KE designs and manufactures custom-made flange and frame insulation for the specific expansion joint if needed. They are delivered as easily assembled parts.

Some of the special features illustrated. 1: Pre-bolster, 2: Pulse barrier, 3: Pulse breaker
Exhaust duct system
- metal solutions

MGTX
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 and are designed for frequent start/stop cycles.

Metal bellows typically see a similar temperature to the internal duct temperature; this reduces or eliminates the thermal stress. In addition to their ability to withstand extremely high temperatures, metal expansion joints can endure fast ramp rates without the thermal stress that causes yielding.

Liner thickness and design should be determined based on flow condition including turbulence correction factors. EagleBurgmann KE 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.

Material selection
When specifying metal gas turbine expansion joints, EagleBurgmann KE recommends using stainless steel 321 for the bellows membrane and stainless steel 321 or 347 for the connection hardware. Stainless steel 321 and 347 are stabilized with titanium and columbium respectively.

Customized solutions
- Two-ply redundant design option: each ply capable of performing the application requirement.
- Reinforced ply (root rings) available when the design requires it.
- Annealing may be performed depending on the specification.
- Bellows cover (standard)
- Weather cover
- Liners (standard)
- Liners may be supported by liner stiffeners.

Choice of fabric or metal expansion joint
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.

MGTX operating limits

| Temperature: | ... +675 °C |
| Pressure range: | ... 3 bar |
| Maximal axial movements: | ... 38 mm |
| Maximal lateral movements: | ... 6 mm |

Production of MGTX unit.

Onsite installation of MGTX.

MGTX shipped with internal stiffener (spider) to maintain roundness during site installation.
Test & Quality Inspection

Inhouse testing
Raw materials, semi-finished products and complete expansion joint constructions undergo both general and comprehensive tests and control procedures.

At a minimum, all expansion joint constructions can be tested with regard to:
- Flexibility rate of the expansion joint type
- Leakage rate of the expansion joint type
- Sound insulation properties of the expansion joint
- Temperature distribution (heat/energy loss) through the expansion joint
- FEA (Finite Element Analysis) of expansion joint and steel parts with regard to life and fatigue

In-house lifetime simulation can be performed on the expansion joint using EagleBurgmann KE developed test equipment by request. Our high cycle fatigue or low cycle fatigue movement simulator will test expansion joints in axial or lateral direction as well as test the material to a total of 100,000 cycles.

Based on our test and research results, we are able to document the operational reliability and lifetime of an expansion joint for a given application. We are also able to perform customer-specific tests.

Noise reduction in exhaust
With increasing focus on workplace and environmental safety, combined with larger and more powerful gas turbines, expansion joints must be designed to meet more requirements than ever. Noise inside ducts reach dangerous levels (sound power), and the demand for noise reduction outside the ducts (sound pressure) is becoming an increasingly important factor in system design.

In co-operation with a third party institute*, EagleBurgmann KE has tested the noise emission for a total of 11 Combine-X gas turbine expansion joint designs. This was done to confirm sound pressure emission levels outside gas turbine ducts at a certain distance.

Based on the sound pressure recordings and weighted logarithmic average, EagleBurgmann KE has developed a tool to determine the optimal expansion joint design for the maximum acceptable sound level at a pre-defined distance from the duct.

The tool accounts for site and environmental factors such as:
- Duct dimensions
- Sound pressure level inside duct
- Sound pressure level at distance from duct
- Maximum acceptable sound pressure level

Noise reduction in air intake
Acouseal expansion joints are specially designed and tested to meet requirements for optimum sound reduction. They have been tested by the independent third party Danish Technological Institute whose measurements, based on VDI 2571, show that these expansion joints offer extremely efficient sound insulation.* (See index below)

![Sound insulation index of Acouseal.](image)

* DELTA Danish Electronics, Light & Acoustics, Teknologisk Institut

* The test was carried out for a building length of 150 mm.
Analysis Tools

Finite element analysis (FEA) is a computerized method for estimating how a structure or assembly will react under real life operating conditions from forces caused by heat, vibration, mechanical stress, etc.

Gas turbine systems are often used during peak load periods (several start/stop cycles), which makes the calculation of the life expectancy of components a very important factor. FEA is widely used to verify the design of expansion joints and their structures used in gas turbine systems. The designs supplied are based on many years of experience and are often supported by FEA models.

A complete expansion joint unit can be analysed by means of FEA to ensure maximum 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.

Steel components analysis
EagleBurgmann KE has developed our own models for use in analyzing expansion joint construction, particularly in the critical area of the steel components for the 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 to troubleshoot existing installed units and recommend modifications to the design and quality of the steel frame. FEA can offer protection against unexpected failure and downtime.
Installation, Service & Preventive Maintenance

Servicing our customers is vital to us. Operational reliability and long service life of expansion joints is crucial. Unplanned shutdowns are not only troublesome, but expensive. The right installation can save hundreds of man-hours with proper and safe installation.

The key to long-term and reliable expansion joints is dependent on a professional installation team. EagleBurgmann KE’s service team has extensive installation experience and supervision on projects worldwide and can be available 7 days a week, within 24 to 48 hours.

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 services include:
- Evaluations and troubleshooting
- Initial dimensional measurements
- Installation & refurbishment
- Supervision and training
- Plant surveys
- Emergency services
- Final inspection by experienced service engineers

Emergency hotlines

<table>
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<tbody>
<tr>
<td>South East Asia</td>
<td>+65 9630 3420</td>
</tr>
<tr>
<td>India</td>
<td>+91 93805 80508</td>
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<tr>
<td>Middle East</td>
<td>+971 55 531 946</td>
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<tr>
<td>Europe</td>
<td>+45 21 24 66 32</td>
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<tr>
<td>USA</td>
<td>+1 (859) 653 8364 (fabric)</td>
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<tr>
<td></td>
<td>+1 (619) 562 6083 (metal)</td>
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</tbody>
</table>
Expansion Joint
Product Range

Design and engineering capabilities
With more than 50 years of experience as a solution provider, EagleBurgmann KE has developed capabilities in solving challenges associated with controlling thermal expansion of piping and ducting systems.

EagleBurgmann KE has a proven track record of capabilities both in engineering and product reliability, with installations in all continents and various market sectors.

Through continuous innovation, we provide our customers with the latest technologies and solutions within the expansion joint industry.

As a solution provider, EagleBurgmann KE offers a wide range of services in connection with optimization of conditions for expansion joints. They include:
- Consulting, evaluations and troubleshooting
- Initial dimensional measurements
- Installation and refurbishment
- Supervision and training
- Plant surveys
- Emergency service
- Final inspections

Fabric Expansion Joints
are able to compensate for movements in several directions simultaneously and have almost no reactive force. They require little space for installation and are easy to adapt to physical conditions.

Selection of the right fabric expansion joint depends on a variety of factors which vary from application to application.

By combining different materials and taking thermal, chemical and mechanical resistance into consideration, as well as the fatigue properties of the materials, our engineers develop optimal solutions that provide long-term reliability to customers in various industries.

Fabric expansion joint operating limits*
- Dimensions: According to customer specifications
- Temperature range: –35 ... +1,000 °C
  For higher temperature, please request
- Pressure range: –0,35 ... 0,35 bar

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

EagleBurgmann KE offer a full range of metal expansion joints from rectangular and round ducting joints to highly engineered designs for critical applications.

The company has a long history of welding and forming of special materials including a wide range of nickel alloys and stainless steels. EagleBurgmann KE offers complete documentation packages in accordance to current industry standards such as ASME, PED and EJMA.

Metal expansion joint operating limits*
- Dimensions: Circular: DN40 mm and up
  Rectangular: According to customer specifications
- Temperature range: –198 ... +1,371 °C
- Pressure range: Full vacuum up to 172 bar

*Operating limits depends on design, material selection, type of expansion joint and duct insulation.
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. Everyday more than 6000 EagleBurgmann 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