# GAS TURBINE & COMBINED CYCLE PLANTS

## Providing Specialised Expansion Joint Technology

DEKOMTE
Expansion Joint Technology

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# Introduction

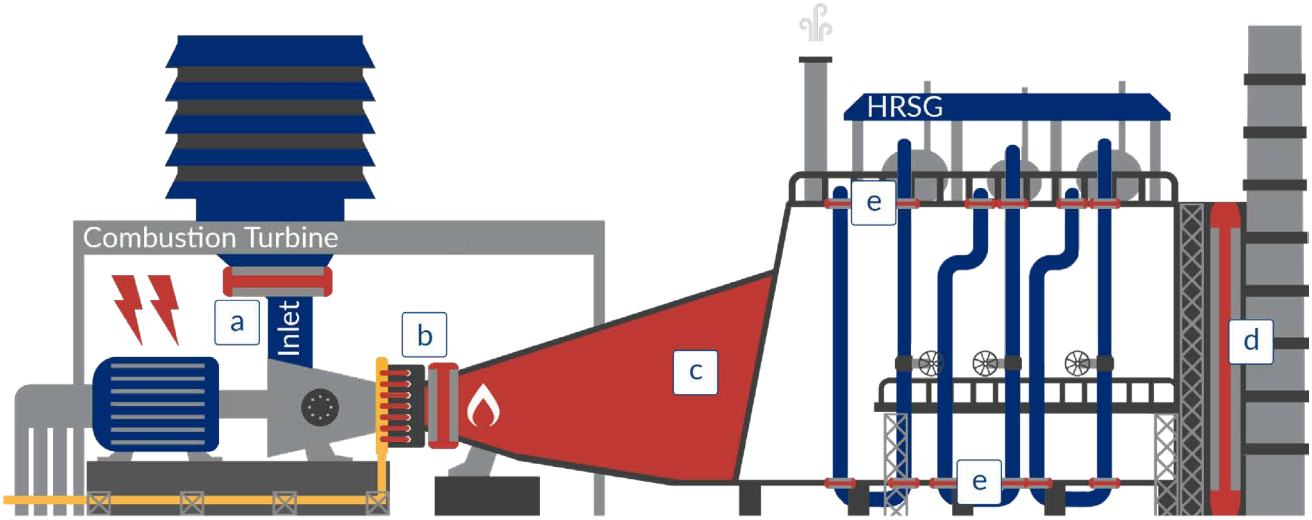
With a worldwide reputation for excellence, DE**KOM**TE manufactures fabric and stainless steel expansion joints for all applications within a gas turbine power station and offer varying technical standards to suit the technical requirements, maintenance cycles and budgets for each joint.

Gas turbine power stations subject the exhaust duct and HRSG casing to extreme stress and fatigue, with the expansion joint being the focus point and relief. In many power stations, the failure and replacement of these expansion joints is considered routine maintenance, with weld repairs to steel parts and duct cracking becoming common place during outages.

DE**KOM**TE has more than four decades of experience in designing two-shift, high-cycling expansion joint systems, as OEM equipment and as retrofitted systems. A complete solution, encompassing the whole scope of duct, frame, adjacent insulation and expansion joint, will provide a reliable, maintenance-free solution with a longer lifespan.

Depending on the operating conditions of the site, a DE**KOM**TE solution can offer lifespans of up to 25 years.

DE**KOM**TE is accredited to RAL GZ 719, the world-class quality standard for fabric expansion joints, ensuring that a detailed and thorough technical approach is maintained in all products offered, and the highest quality is guaranteed in the delivered solutions.




a GT Inlet  b GT Exhaust  c HRSG Inlet  d HRSG Outlet  e Penetration Seals

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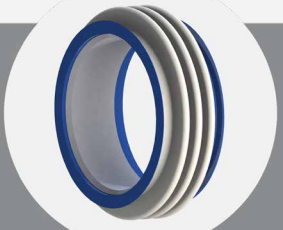
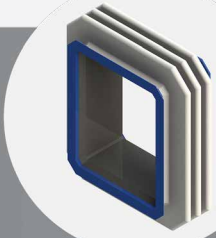
# Products

Fabric Expansion Joints

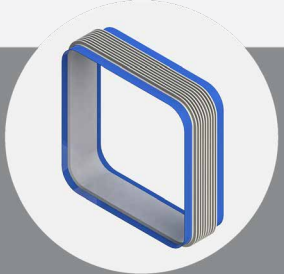


Single-layer. Round Metallic Expansion Joints



Single-layer. Rectangular Metallic Expansion Joints

Multi-layer, Round Metallic Expansion Joints



Multi-layer, Rectangular Metallic Expansion Joints

PTFE Expansion Joints

Rubber Expansion Joints

Flexible Hoses

# Scope of Supply - Design for Integration

DE**KOM**TE fabric expansion joints are available in any geometric shape (round, square, oval, multi-sided) and in any size.

The scope of design responsibility is a key aspect of DE**KOM**TE philosophy for an integrated solution to the adjacent duct; this ensures no weakness in the steel frame, liner plate or insulation system.

A metal frame, flow plate, liner system, backing bars, fixings and insulation all form part of the scope that creates a reliable expansion joint. DE**KOM**TE is able to consider the impacts of turbulent flow, pressure variations, vibration to the expansion joint and the surrounding environment.

External features such as heat convectors for a reliable fixing system, can be a key design aspect for the fabric and clamping area to function.

Adjacent jacketed insulation systems can be used to aid the interfaces to external ducting telemetry or insulation.

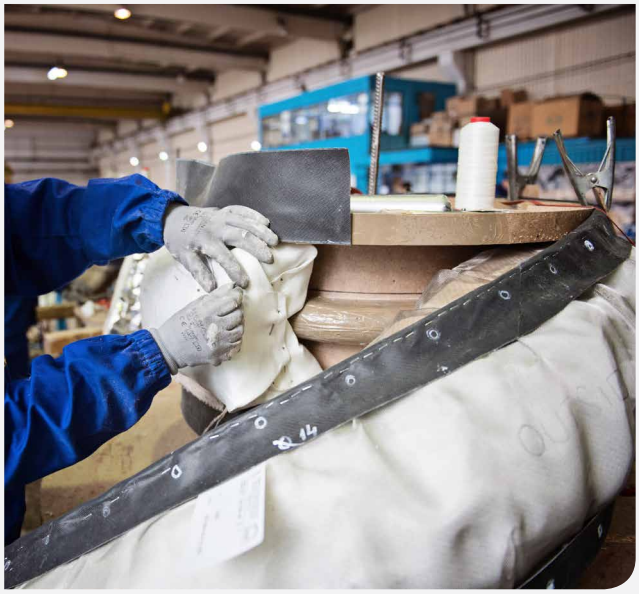
Personnel guards and external protection equipment can be integrated with the expansion joint to give a package of supply and make the installation as straight forward as possible.

# Formed Solutions

DE**KOM**TE manufacture bespoke tailor-made solutions, utilising moulds and forms that create an expansion joint to a desired shape. The purpose of a mould is to allow movements to take place without any creasing or folding of materials.

A smooth and formed joint maintains a constant and even surface temperature which reduces the thermal stress and any fatigue to the materials and important gas membrane.

Formed joints are essential in all high movement requirements, where creasing causes rapid material degradation and failure.



# Technical Services, Inspection & Installation

## Design Studies and Technical Support

Design comparison, investigation and modelling can be achieved using the extensive database of empirical knowledge at DE**KOM**TE. We offer objective technical support at short notice for critical problems.

## Engineering Services

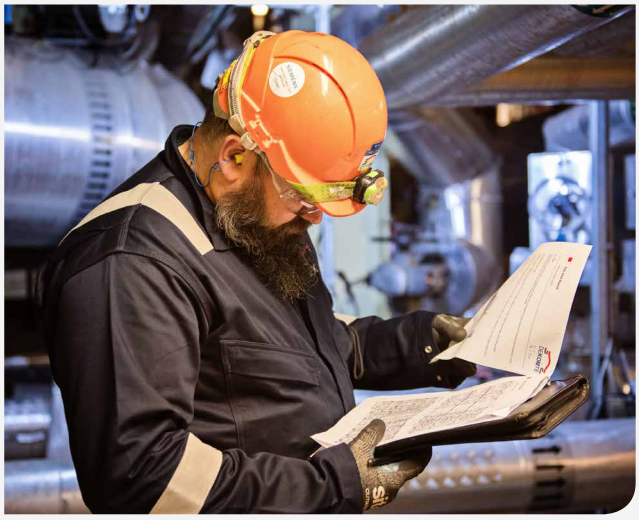
DE**KOM**TE pushes the boundaries of product development with the latest computer and industry best practice tools and procedures.

The discerning use of Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD), together with 2D and 3D design software, allows a correlation of on-site empirical experience and theoretical models. The formulation of specifications, tenders and design critique are also offered as an independent technical service.

## Inspection and Maintenance

DE**KOM**TE has experienced site engineers and designers who are able to review all expansion joints in a plant. We produce a technical report for maintenance planning and plant improvement, establishing a baseline of the sites expansion joints and helping to build a plan to reduce total costs. This includes:

- Visual and thermographic inspection
- Create a condition report on all existing joints on the plant:
  - » Evaluation of fixing system and gas tightness
  - » Review of adjacent elements for corrosion, cracking or distortion
  - » Internal review of expansion joint, including the flow plate and lining systems



## Turnkey Installation

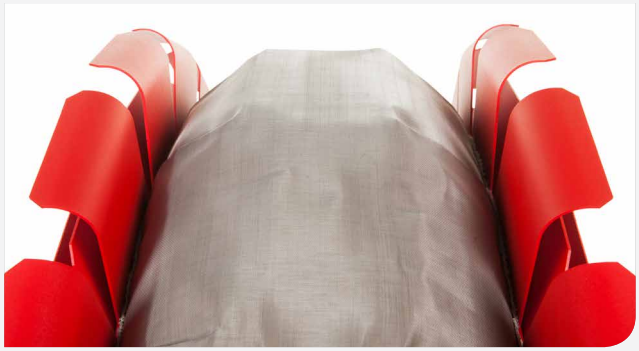
The use of skilled design engineers, technicians, and service engineers, together with qualified on-site skilled labour means DE**KOM**TE offers a complete turnkey contracting solution for duct problems.

# Hot Casing for GT Exhaust / HRSG Inlet

The most critical aspect of hot casing solutions is the steel frame design and its integration to a reliable expansion joint system.

The temperature gradient of the casing to the fabric clamping area can create high stresses, increasing fatigue and reducing life. Square ducts can have more serious problems with the corner regions due to high stresses.

DE**KOM**TE has many designs for hot casing exhaust systems. In order to establish a suitable design for the casing, support, stiffeners and expansion joint, the stress calculations and fatigue of materials must be considered. Most significant in the calculation process is the cycling and types of starts that a plant will run.



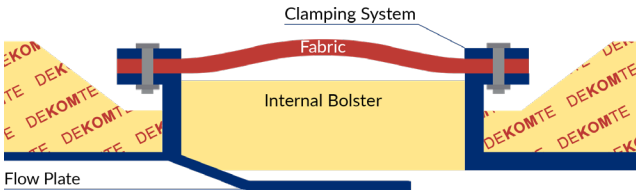
## Short-Term Solutions:

- Weld repairs to frame and duct
- Regular replacement of fabric
- External insulation

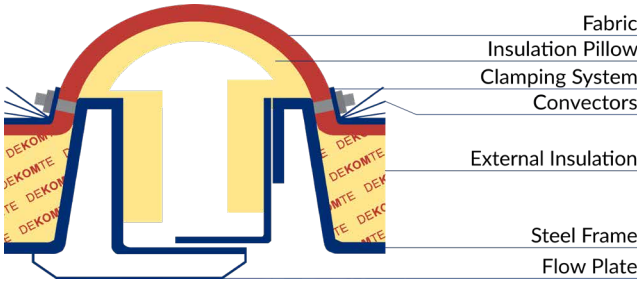
## Long-Term Solutions:

- New steel part arrangement
- Improved duct interface
- New external insulation
- New fabric and bolster design
- New fixing and convector design

## Base Load (hot to hot) Cross-Section:




## Cycling (hot to hot) Cross-Section:




Key elements of the design are:

### Duct Connection

Both welded and clamped flange systems are available, with consideration given to thermal fatigue, distortion and consistent gas-tightness.

### Steel Frame Design

The frame is the most critical part of hot casing solutions. The temperature gradient created on the frame during transient operating conditions of the gas turbine creates high fatigue stresses - resulting in cracking and gas leakage.

### Flow Plate

Smooth cross-section changes in the duct are essential to reduce turbulence and insulation degradation.

### Internal Bolster / Pillow

Fully encapsulated and formed insulation bolsters / pillows protect the joints from the inside. Segmented sections of insulation can reduce compression and damage caused by the movements.

### Fabric

Formed fabrics prevent creasing, crumpling and folding through all movements, essential for high cycling operations. Durable, multi-layer compositions with high temperature membranes and outer protection ensure gas-tightness and prevent stress and damage.

### Clamping System

A gas-tight seal is achieved with proper design of the bolting and clamping to meet the required site pressure.

### Convectors

Managing the temperature profile through the expansion joint, requires control of the radiated and outer surface. The use of convectors achieves this in the clamping area.

### External Insulation / Cladding

The expansion joint system is further protected from excess external radiated temperatures by intelligent integration of the external insulation.

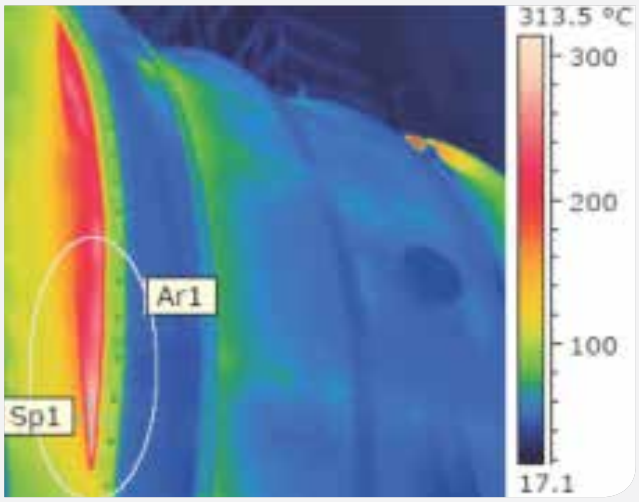
# Cold Casing for GT Exhaust / HRSG Inlet

Expansion joints that are installed within a section of duct with internal lining, known as cold casing duct arrangements, experience lower stresses than hot casing arrangements.

Due to the internal insulation, the steel frame isn't exposed to the same heat stress, however the liner and insulation interfaces across the expansion joint system are critical to ensuring a reliable solution.

Formed fabrics that prevent creasing and folding through all movements, are important for cycling and longer life.

DE**KOM**TE recommends a review of the connection and internal lining of the joints to ensure that no heat path develops to weaken the design.



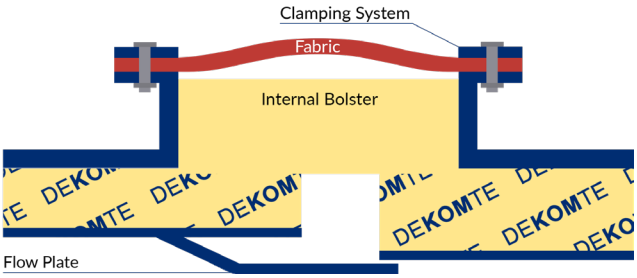

## Short-Term Solutions:

- Re-insulate missing pockets
- Plate gaps to duct flange
- Reconfigure bolsters
- Install flow plate
- Upgrade clamping system

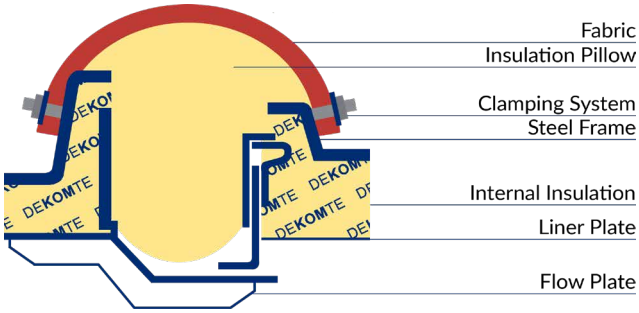
## Long-Term Solutions:

- Designed steel parts
- Improved duct interface
- New seamless internal insulation
- New fabric and bolster design

## Base Load (cold to cold) Cross-Section:




## Cycling (cold to cold) Cross-Section:




Key elements of the design are:

### Duct Connection

Both welded and clamped flange systems are available, with consideration given to thermal fatigue, distortion and consistent gas-tightness.

### Steel Frame Design

In a cold casing system, the steel frame design is not subjected to the same thermal stresses as long as the frame can remain cold.

### Flow Plate

Smooth cross-section changes in the duct are essential to reduce turbulence and insulation degradation.
The liner plate should cover the expansion joint space, allowing flexibility by floating / sliding sections. A liner that is seamless over the adjacent flange connections protects the casing and interface to the expansion joint frame.

### Internal Bolster / Pillow

Fully encapsulated and formed insulation bolsters / pillows protect the joints from the inside. Segmented sections of insulation can reduce compression and damage caused by the movements.

### Fabric

Formed fabrics prevent creasing, crumpling and folding through all movements, essential for high cycling operations. Durable, multi-layer compositions with high temperature membranes and outer protection ensure gas-tightness and prevent stress and damage.

### Clamping System

A gas-tight seal is achieved with proper design of the bolting and clamping to meet the required site pressure.

# HRSG Outlet

The HRSG outlet is a cool condition operating expansion joint, where the temperature conditions are typically a maximum temperature of 150°C - favourable to a simple material and thin-layered expansion joint.

Additionally, the movements are less significant due to the low temperature. The main function is isolating the structure of the duct, HRSG and stack to allow civil structural tolerances, vibration elimination and flexibility from dynamic weather loading.

DE**KOM**TE recommends the use of 6mm reinforced rubber expansion joints or multi-layer PTFE expansion joints with rubber sealing, as the best solutions to address these main issues:

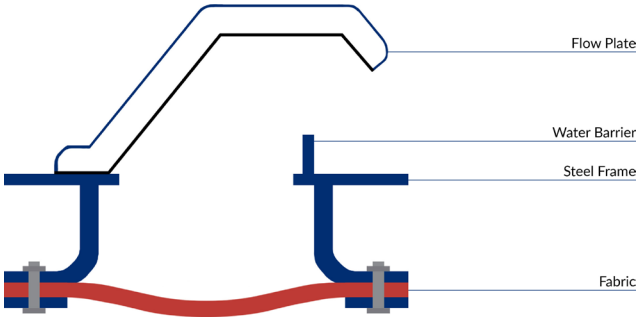
- Weather tightness
- Water sealing
- And environmental degradation

The effect of these issues includes heavy corrosion on the roof section caused by weather ingress into the duct through the joint flanges, and also on the bottom, caused by water leakage out through the flange from inside the unit.

DE**KOM**TE recommends the retrofit of additional water barriers, drains and integrated flow plate systems. These give the security of a cleaner, longer functioning expansion joint by eliminating the build-up of water, deposits and debris from inside the joint space.

Careful consideration of the material selection will help a joint at the stack connection reach an expected life of 20 years. Short-term cost savings can result in high maintenance costs on an expansion joint where the cost of access is prohibitive.

## HRSG Outlet Joint Cross-Section:




## Flow Plate and Water Barrier:

Key elements of the design are:

### Duct Connection

The integration to the duct is important to reduce weakness and risk in the design. A welded connection is best, with good overlap to insulation and duct cladding system.

### Steel Frame Design

The use of the correct material, coating and corner design are important to reach plant lifetime solution. Adding drains, barriers and flow plates are key to extending life and managing water build up for elimination of corrosion.

### Flow Plate

A protective flow plate and water barrier prevents condensation, water and debris from pooling in the joint space.

### Internal Bolster / Pillow

Noise attenuation is solved by using high density rubber based joints, or in some cases specially designed acoustic pillows.

### Fabric

Materials that are stable for the environmental an plant conditions will maximise the maintenance life cycle. Fabric compositions that include water sealing materials along with gas-tightness will extend the life of the joint.

### Clamping System

A correctly rated and designed bolting system is required to ensure an even distributed sealing pressure is applied to the joint. With particular emphasis on gas-tightness.

# Penetration Seals

Penetration seals can be some of the most challenging expansion joints due to their high movement requirements. Particularly on the front modules at GT exhaust temperatures, the floor and side wall seals have large movements in a small cross-section.

Leaking packing glands and mechanical seals require regular maintenance and have a detrimental impact on casings and adjacent equipment - making them an unreliable and expensive solution.

DE**KOM**TE solutions are gas-tight and ensure no loss of flue gas or heat to the environment.

DE**KOM**TE offers both metallic bellows and fabric expansion joints.

## Metallic Bellows

Metallic bellows offer the lowest initial cost and are therefore favoured for first time installations.

However, retrofitting metallic bellows is uncommon due to the necessity to either:

- Deliver the bellow in split halves, requiring welding the bellow on-site, or;
- Deliver completed bellows, requiring the steam pipe to be cut and welded.

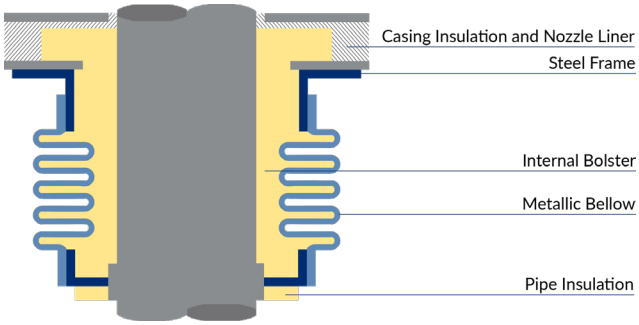
## Fabric Expansion Joints

Due to the problematic replacement of the metallic expansion joints, DE**KOM**TE has developed highly reliable fabric expansion joint solutions, both as:

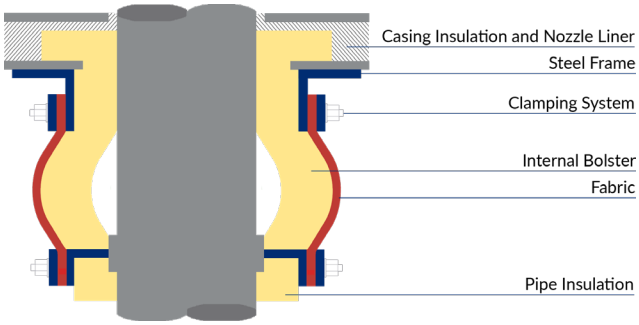
- An OEM installation - a product delivered as a fully assembled unit, where cost optimisation is the key function of the design.
- And as a retrofit solution - a product delivered in parts, where longevity, durability and reliability are main focus.

Fabric penetration seals boast the ability to patch, repair and replace in sections, thus minimising downtime or outage.

## Metallic Penetration Seal Cross-Section:




## Fabric Penetration Seal Cross-Section:




Key elements of the design are:

### Pipe Insulation

Intelligent integration of the insulation to the expansion joint pipe collar prevents damage from excess external radiated temperature.

### Steel Frame Design

Casing collars align the joints by resetting the pipe concentricity to the casing position.
Pipe collars manage temperatures in the seals and offer space for integration of piping insulation to protect the seal from the inside.

### Internal Bolster / Pillow

Fully encapsulated and formed insulation bolsters / pillows protect the joints from the inside. Segmented sections of insulation can reduce compression and damage caused by the movements.

### Fabric

Formed fabrics prevent creasing, crumpling and folding through all movements, essential for high cycling operations. Durable, multi-layer compositions with high temperature membranes and outer protection ensure gas-tightness and prevent stress and damage.

### Clamping System

A gas-tight seal is achieved with proper design of the bolting and clamping to meet the required site pressure. When possible to attach to the pipes, bolted flanges can eliminate the maintenance required of a circumferential clamp.

### Casing Insulation and Nozzle Liner

The insulation around a nozzle in the casing is subject to highly turbulent gas flow, which invariably pits and pulls the insulation into the gas stream. DE**KOM**TE avoid this by installing encapsulated casing bolsters and redesigned nozzle liner plate sections.
Ensuring casing temperature is maintained will ensure the further reliability of the penetration seal.

# Hotspot Repair Technology

Whilst regular insulation repairs and maintenance can be intrusive, laborious and time-consuming, pumpable insulation is an alternative solution that lowers cost and shortens downtime.

DE**KOM**TE can repair missing insulation pockets and hot areas by injecting liquid insulation from the outside while the unit is running.

## What is Pumpable Insulation?

Pumpable insulation consists of short bio-soluble fibres that have been blended with binders to form a paste-like consistency mastic that can be pumped into a cavity.

A pneumatically-driven pump consisting of a pneumatic motor, hopper, pressure regulator, gauge and a 20m delivery hose is used to inject the insulation material.

- Sockets are welded at 250mm intervals to form an array / matrix around the hot spot area. Using the array of sockets as a template, the outer casing is drilled to create a flow-path for the mastic insulation.
- The mastic delivery hose is connected to each socket in turn, and the mastic material is pumped into the cavity while simultaneously being monitored by a thermal imaging camera.
- Once the insulation has been successfully injected into the cavity, the sockets are capped off with a hexagon plug.

## Causes of Insulation Loss

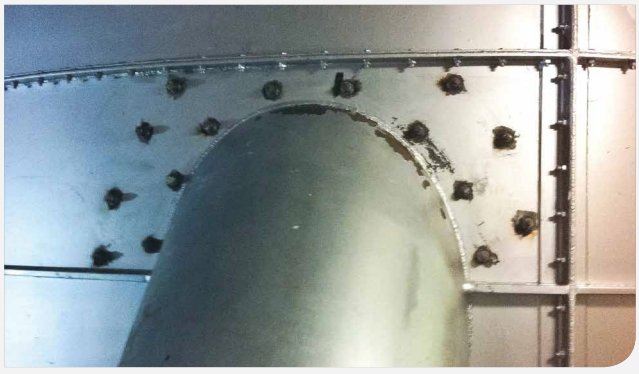
- No liner
- Liner plate damage
- Gas flow under liner (by distortion or gaps in the liner)
- Compacting of insulation
- Degradation of insulation (by moisture or vibration)

## Effects of Insulation Loss

- Casing cracks leading to gas leakage
- Temperature-induced material fatigue
- Decreased efficiency
- All effects cause adjacent safety and environmental concerns

## Applications

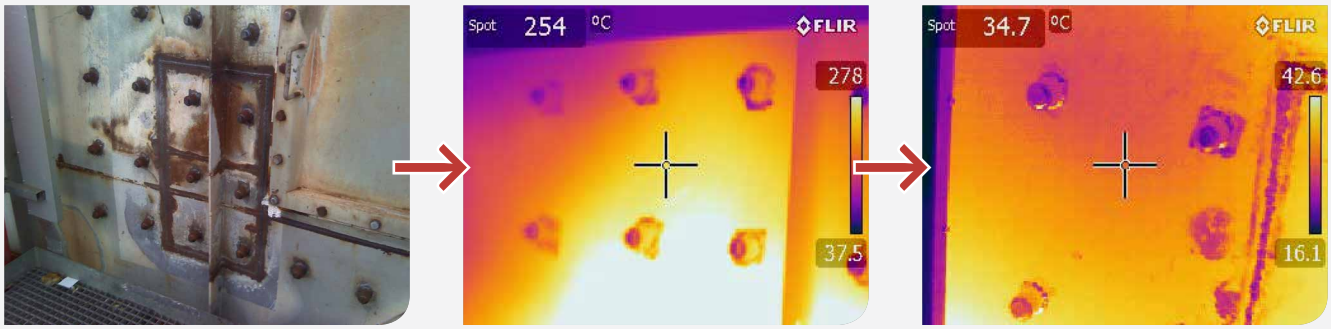
- GT casing
- GT Exhaust Diffuser
- Penetration Seals
- HRSG Casing



During an annual inspection, one of our customers discovered they had poor insulation in the internal liner plates of their GT Exhaust duct. The plant had repaired the liner plate issues and renewed the insulation, but the location was still showing hotspots.

The hot spot is created by movement or breakdown of the mineral wool and ceramic fibres that leaves a void in the insulation. Using a small team of site engineers and Unifrax Isofrax insulation material, this issue can be solved quickly and economically.

In the progression photos below, you can see the pumpable insulation has successfully reduced the external surface of the door casing. In the last sequence, the nozzle of the pump is still attached, demonstrating just how quickly pumpable insulation cools an area.





| Typical Casing Insulation |
| --- |
| Low thermal conductivity (600°C - 0.09 W/mK) |
| Use limit 1200°C / Melting point >1500°C |
| Dry density 96-128kg/m$^3$ |
| Resistant to flue gas velocities up to 20m/s |

| Pumpable Insulation |
| --- |
| Low thermal conductivity (600°C - 0.09 W/mK) |
| Use limit 1200°C / Melting point >1500°C |
| Wet density 1090kg/m$^3$ / Dry density 270kg/m$^3$ |
| Resistant to flue gas velocities up to 20m/s |

## Casing Repairs

DE**KOM**TE also offers casing repairs, liner modifications and new attachment solutions. These are aimed at maintaining casing temperatures for a longer life.

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