EFFOXFLEXTOR
DAMPERS AND EXPANSION JOINTS

DAMPERS & EXPANSION JOINTS

CECO ENVIRONMENTAL
www.cecoenviro.com

www.effoxflextor.com

INTRODUCTION

EFFOXFLEXTOR IS THE INTERNATIONAL LEADER IN THE DESIGN AND MANUFACTURE OF DAMPERS AND EXPANSION JOINTS FOR USE IN FLUE GAS AND PROCESS AIR HANDLING SYSTEMS. OUR TEAM INCLUDES A SKILLED STAFF OF ENGINEERS, DESIGNERS, FABRICATORS, AND FIELD SERVICE PERSONNEL TO ENSURE THE HIGHEST QUALITY ENGINEERED-TO-ORDER PRODUCT.

WHY TO WORK WITH **EFFOX**FLEXTOR:

Quality Products
+ Dampers and Expansion Joints
+ Complementary product lines
+ Engineered-to-Order products
+ High value for the total cost
+ Supplier of products for full system integration

Extensive Capacity
+ 100,000 Sq Ft. (9,300 Sq. m) captive shop in the USA
+ 200,000 Sq. Ft. (18,600 Sq. m) CECO captive shop in China
+ Experienced global fabrication partners

User Friendly
+ On time deliveries
+ Practical installation and maintenance manuals
+ Global start-up technicians
+ Spare parts and service support

Experienced Professionals
+ Specialized industry expertise
+ Reliable products
+ High customer satisfaction ratings
+ Knowledgeable Regional Sales Representatives

CAPABILITIES

AIR HEATER ISOLATION LOUVER

EXPANSION JOINT

FABRIC FILTER POPPET

FGD BYPASS LOUVER

Dampers

Expansion Joints

PULVERIZER CONTROL DAMPER

FD FAN INLET RADIAL VANE DAMPER

ID FAN INLET GATE

CAPABILITIES

DAMPERS

With over 35 years of experience, EFFOXFLEXTOR offers time tested robust dampers to achieve a 20+ year low maintenance design life. Constructed with carbon steel, stainless steel, alloy, and/or corrosion resistant materials our dampers are capable of withstanding temperatures up to 1800°F (982°C) and the most chemically punishing environments. Our engineering and design team is involved with every project to ensure the structural and dynamic integrity of our products.

Standard Design considerations:

+ 300% safety factor on drive sizing
+ Maximum of 60% of yield stress on all components
+ Modeling to minimize pressure drop, frame deflection and blade deflection
+ High quality components and trademarked material selection to minimize maintenance

EXPANSION JOINTS

EFFOXFLEXTOR is the recognized leader in providing non-metallic expansion joints to the utility and industrial markets around the world. With custom engineered designs for each application, EFFOXFLEXTOR has provided reliable flexible solutions for service from -40°F to 2100°F (-40°C to 1149°C). Our **EFLEX™** expansion joints reflect the highest engineering standards and professional workmanship in the power generation and heavy industrial market. The EFFOXFLEXTOR team provides customer service and technical support from project inception to completion.

+ Over 100 years of combined experience in the Expansion Joint Industry
+ DuPont Certified Supplier of VITON® Fluoroelastomer Expansion Joints
+ Long time contributing member of the FSA (over 25 years)

QUALITY AND CERTIFICATES

All EFFOXFLEXTOR fabrication is performed according to strict Quality Control procedures.

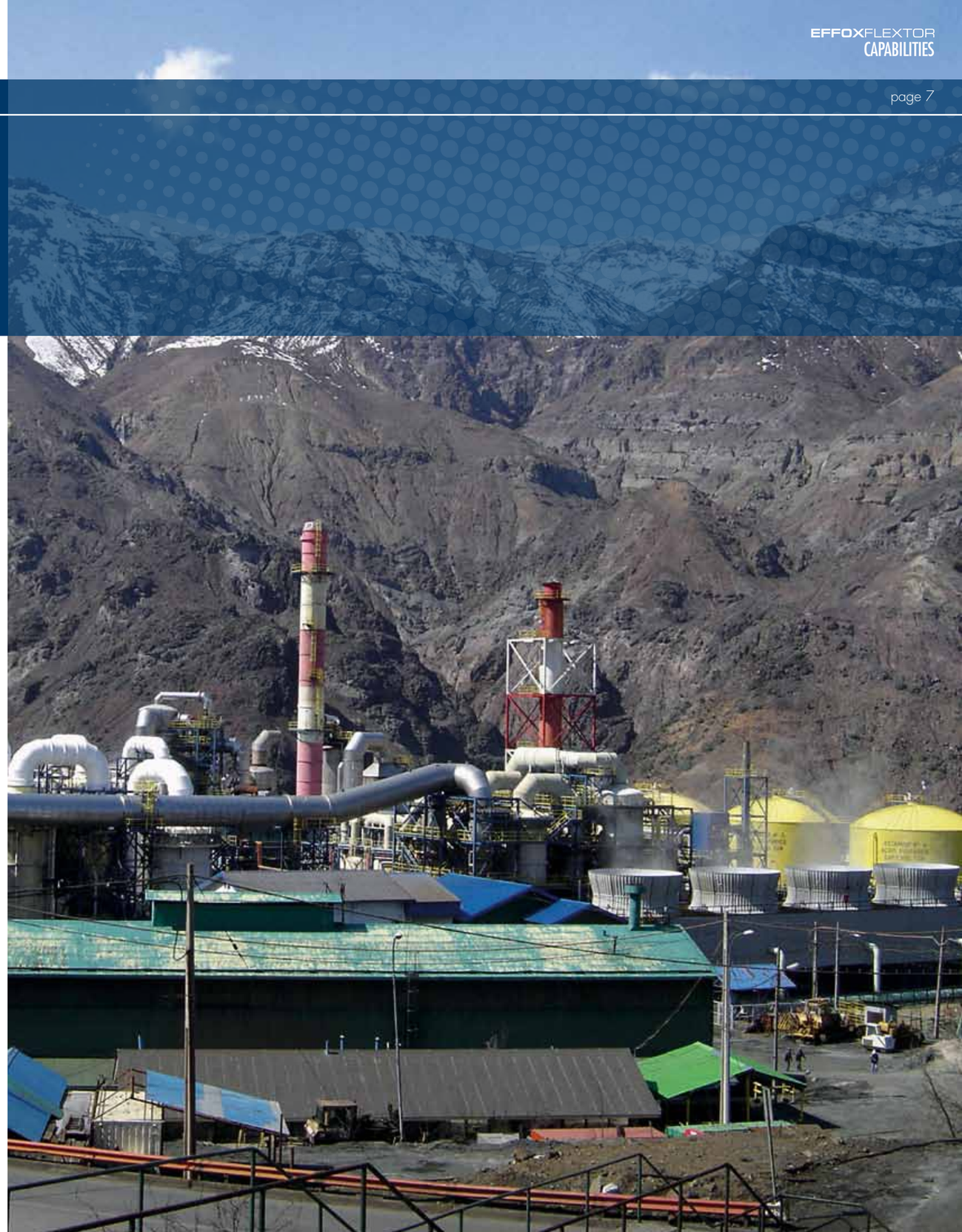
Our quality standards include:

+ AISC (American Institute of Steel Construction)
+ AWS (American Welding Society)
+ CWB (Canadian Welding Bureau)
+ ISO 9001:2008

We are also members of the following trade associations:

+ ASME (American Society of Mechanical Engineers)
+ FSA (Fluid Sealing Association)

EFFOXFLEXTOR offers in-house, non-destructive testing using approved and certified testing methodology. Our in-house quality control staff includes full-time certified welding inspectors (CWI).



DAMPERS

GUILLOTINE/SLIDE GATE DAMPERS

EFFOXFLEXTOR manufactures heavy duty low leak slide gate and zero leak slide gate dampers to provide isolation for flue gas and air systems. Slide gates, also referred to as guillotine dampers, are required to isolate systems for maintenance or for bypass purposes.

EFFOXFLEXTOR has supplied slide gate dampers in the largest ducting systems in the industry. We have supplied gates with duct openings of 25 feet (7.6 m) wide and 35 feet (10.7 m) tall. Our zero leak guillotine dampers are pressure and temperature tested to verify leakage at system design conditions. Our guillotine dampers can be found in some of the most demanding environments such as high dust loading zones in cement plants, highly corrosive environments in coal fired power plants and high temperature and high velocity gas turbine systems.

Zero Leak Design

+ Allows for complete isolation of the flue duct
+ Seal air fan provides 200% safety factor with a minimum of +3 inches w.g. (7.5 mbar) above system pressure

Low Leak Design

+ For use in negative pressure systems or where small flue gas pass through may be tolerated
+ Blade guides and angle seats provide an economical alternative for low leak applications

Optional designs and features include:

+ Drive system:
  - Chain and sprocket system with proprietary EFFOXFLEXTOR sprocket design
  - Rack and Pinion
  - Linear drive system
+ Electric, pneumatic, hydraulic, or manual actuation
+ Bottom chamber with clean out ports allows blade to cut through particulate obstructions in the duct
+ Mullion seals coupled with re-entry seals provide complete removal of blade from the gas stream
+ Metallic leaf seal and retainer design achieves tight shutoff and ease of maintenance

DAMPERS

LOUVER DAMPERS

Designed for flow control or isolation, **EFFOX**FLEXTOR offers several styles of louver dampers to meet your application and system specifications.

Our louver dampers are offered with a parallel blade or opposed blade design. Parallel louvers are primarily used for system isolation. **EFFOX**FLEXTOR parallel blade louvers are used around the world in applications for bypass capability and tight shut off for the process & utility industries.

The **EFFOX**FLEXTOR opposed blade louver offers the ability to accurately modulate and control flow over a design range. The opposed blade design helps to create a more uniform flow across the damper.

Louver Design features:

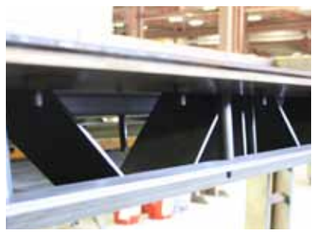
+ Bolted dual airfoil design to minimize deflection and warping of blades
+ Electric, pneumatic, hydraulic, or manual actuation
+ Outboard bearings to prevent flue gas exposure and allow for ambient cooling. Bearings are permanently sealed and lubricated to eliminate maintenance
+ Bolted packing assembly at damper shafts for ease of maintenance
+ Blade to blade, top & bottom, and jamb seals are available to minimize leakage to less than 1% of flow volume

Zero Leak Louver Designs

Along with our standard dual bolted airfoil design, **EFFOX**FLEXTOR offers two damper models with a zero leakage design.

Double Louvers

+ Two banks of blades. The area between the banks of blades is pressurized with seal air to achieve zero leakage
+ Options for in-sync actuation or independent actuation of banks of blades when control is needed
+ "Belt and Suspenders" approach



Tandem Louvers

+ One bank of blades with open space in-between blade assemblies. When in the closed position the open space between the blades is pressurized to achieve zero leakage
+ Offers a lower cost alternative and smaller footprint to the double louver

DAMPERS

DIVERTER DAMPERS

EFFOXFLEXTOR has extensive experience in the design and supply of toggle and pivot style diverter dampers for HRSG, waste heat recovery, gas turbine, and other systems that require diversion of the gas stream. We have designed and installed diverter dampers in systems ranging from small engine units to the largest turbines in the world such as the GE Frame 7 FA & 9 FA.

Additionally, **EFFOX**FLEXTOR can supply a variety of diverter arrangements including louvers, butterfly/wafers and guillotines. Leakage options range from low leak to zero leak, and man safe with the use of a blanking plate. We can engineer the best arrangement for your leakage, pressure drop, operational needs, and safety requirements.

EFFOXFLEXTOR can pair any of our diverter designs with stacks, silencers, expansion joints, structural supports, and/or ladders and platforms to supply a turn-key diverter solution custom designed for your application.

Our louver style diverter offers cost effective fine tuned flow control where higher pressure drop is acceptable.

STACK ISOLATION DAMPERS

EFFOXFLEXTOR offers a wide range of options for stack dampers. Whether the installation is for large diameter or rectangular stacks our, blade configurations are designed to meet the needs for your application.

+ Linkage and counterweight arrangements assist in preventing pressure from building in system
+ Integrated gutter design redirects precipitation to the outside of the stack in the closed position

DAMPERS

BUTTERFLY/WAFER DAMPERS

EFFOXFLEXTOR has installed butterfly dampers from 12 inches (304 mm) in diameter to greater than 120 inches (3048 mm) in diameter. Our butterfly dampers can be found in some of the harshest environments where abrasion, corrosion and dust loading are prevalent.

+ Seal options include tadpole seal, bar stop, or elastomeric seals
+ Electric, pneumatic, or hydraulic actuation.
+ Can be used for modulation or open/close applications
+ Internal refractory/ceramic wool linings available for high temperature applications

Butterfly dampers are not as precise as louver dampers for flow control but can be used for modulation when precision is not critical. For more precise flow control applications, opposed multi-blade circular louver dampers can be used.

HIGH PERFORMANCE METAL SEAT WAFER

EFFOXFLEXTOR manufactures high performance metal seat dampers for elevated temperature applications in thermal oxidizers and dirty abrasive environments such as pulverizer outlet dampers. Utilizing a sectioned adjustable metal seal and machined blade seating surface these dampers provide tight shutoff for critical applications.

Design features

+ Proven ¼% leakage at 24 inches w.g. (60 mbar) and 450°F (232°C)
+ Designed for reliable frequent operation such as cycling every 3 minutes, 365 days/year
+ 200,000+ cycle life, tested.

POPPET DAMPERS

Poppet Dampers are ideal for applications that require quick cycling time and tight shutoff. Poppet dampers are used for isolation capabilities for fabric filter applications and incineration systems. They are engineered to control the reverse gas flow, outlet flow, and bypass flow of gases, in turn enhancing filtration.

Poppet dampers are designed so that all the components can be maintained after the damper has been installed. This allows for easy and low cost maintenance and inspections.

+ Constructed in single and double blade arrangements, double blade arrangements are used when zero leakage is required.
+ Poppet seats are manufactured with thick gauge back-up bars and welded thin gauge metal seals to maximize strength while minimizing leakage

RADIAL VANE DAMPERS

Radial vane dampers are used primarily on the inlet of centrifugal fans to direct flow and assist in pre-spinning the flow into the wheel. Radial Vanes are commonly referred to as Variable Inlet Vanes (VIV). The use of a radial vane damper enhances the performance of the fan by:

+ Introducing swirl into the inlet of the fan in the direction of rotation
+ Changing the fan curve as the damper moves
+ Eliminating low-volume stalling of the fan

EXPANSION JOINTS

NON-METALLIC EXPANSION JOINTS

EFFOXFLEXTOR is the world leader in the design and supply of non-metallic expansion joints. We offer designs specifically engineered for every application and have supplied expansion joints in Boilers, Incinerators, Fans, Environmental Control Equipment such as SCRs, FGD and Fabric Filters. Our expansion joints can be found in Fossil Fired Power Plants, Refineries, Cement Plants, Steel Mills, Pulp & Paper Plants, and Gas Turbine Applications throughout the world.

The design parameters which influence the performance of any expansion joint and which must be defined for proper design analysis include:

+ Movements
+ Design/Operating Temperature
+ Design/Operating Pressure
+ Flue Gas Composition
+ Adjacent Ductwork Configuration & Metallurgy

Our **EFLEX™** non-metallic expansion joints incorporate the latest advancements in engineering and materials such as:

Elastomeric

Elastomeric expansion joints are used in flue ducts operating at or below 400°F (204°C) and provide vibration and acoustic dampening when connected to large fans. Material selection is based on maximum duct temperatures and flue gas composition.

+ Ethylene Propylene (EPDM) has very good chemical resistance and is rated for 300°F (149°C)
+ Fluoroelastomers (FKM) such as DuPont's Viton® were specifically engineered for the low temperature applications of fossil fired power plants and have excellent chemical and abrasion resistance and are rated for 400°F (204°C)
  - Meets FSA-DSJ-401-09 Specification for FKM Compound
  - Belt buildup per FSA-DSJ-402-09 recommendation

Fluoroplastic

Our **EFLEX™** Fluoroflex expansion joints can provide a flexible solution for applications operating at or below 600°F (316°C). These materials are designed for wet and/or corrosive services and provide outstanding resistance to chemicals and heat beyond that of elastomers. Fluoroflex belts are manufactured using a fluoropolymer (PTFE) coated fiberglass cloth with a secondary laminated corrosion barrier of cross-plied PTFE resulting in a superior chemical resistant product with ZERO porosity.

- Meets FSA-DSJ-403-07 guidelines

Composites

Composite expansion joints consist of layers of material bonded and sewn together along the outer edges starting with our Fluoroflex single layer belt as the outside cover and gas seal member. Each layer of a composite is designed to work in unison for the specific service conditions.

EFLEX™ FLUOROFLEX FLEXIBLE ELEMENTS DELIVER SUPERIOR CHEMICAL AND THERMAL RESISTANCE

THREE BOLT BACKUP BAR CORNERS WITH 6″ (150 MM) RADIUS REDUCE STRESS AND PROVIDE PROPER SEALING

EXPANSION JOINTS

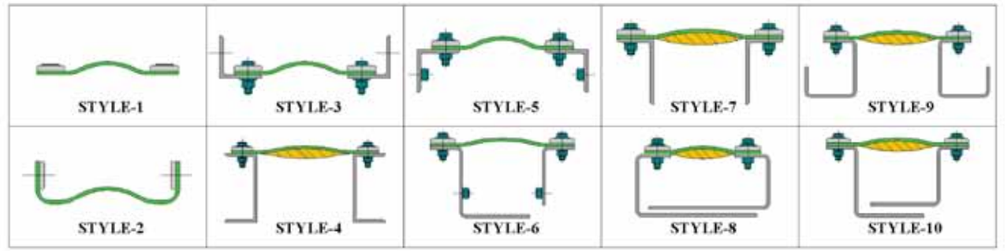
1. OUTSIDE LAYER/COVER
   Our **EFLEX™** Fluoroflex single layer belt beside with the highest temperature capability for a gas seal layer.
2. INSULATION LAYER
   Needled fiberglass insulation thermally bonded to the **EFLEX™** Fluoroflex substrate to protect from heat degradation. The bonding prevents separation and potential "Hot Spots".
3. TFE LAYER
   Additional vapor barrier can be provided for applications which may cycle thru dew point
4. REINFORCING LAYERS
   Vermiculite coated fiberglass fabric acts as an insulator and increases expansion joint strength and durability. Wire mesh layers may also be added for increased durability and abrasion resistance.
5. ADDITIONAL INSULATION LAYERS
   The presence and thickness of this layer is determined by the system temperature to ensure that the heat transfer from the flue gas is reduced to a point less than the maximum temperature of the vapor barrier and cover.
6. INSIDE LAYER/ENCASEMENT
   Close weave material binds the belt together, acts as an insulator and adds strength for handling & service. Note: A metal flow liner is required to protect against abrasion.

Integrally Flanged U-Belt Design

+ Belt is formed at right angles and incorporates flanges into the flexible element
+ Best for single layer belts and services less than 700°F (371°C)
+ Highly effective vibration and acoustical dampening with elastomers adjacent to Fans
+ Good design for applications where condensation is an issue as internal cavity is reduced

Flat Belt Design

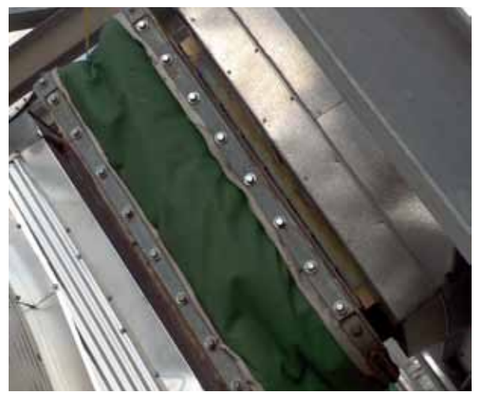
+ Mounted parallel to flow stream using adapter frames
+ Multiple design configurations engineered for specific service conditions
+ Best use for higher temperature applications



Design Configurations

EFLEX™ Non-metallic expansion joints can be provided in a myriad of profiles engineered for each location in your system. Every design has particular benefits and by incorporating additional accessories such as metal flow liners, cavity pillows and various frames styles can provide a flexible solution for any application.

The chart above represents only the basic expansion joint designs. Contact **EFFOX**FLEXTOR for the best solution to fit your needs.



MARKETS & SERVICES

DESIGN & ENGINEERING

EFFOXFLEXTOR has a dynamic team of designers and engineers who thrive on the technical challenges of Engineered-to-Order heavy duty industrial requirements. Our technical staff includes graduate and professional engineers highly experienced in the damper and expansion joint industries. Our staff has extensive global field experience.

PROJECT MANAGEMENT

Many of our key personnel have been with the company since the 1980's. Additional personnel have been added over the years who have damper and expansion joint experience. **EFFOX**FLEXTOR is the only damper and expansion joint manufacturer that has maintained this degree of continuity within its organization.

We follow a strict project management methodology using project scheduling and tracking software designed for the challenges of the Engineered-to-Order production environment.

INSTALLATION & START-UP

EFFOXFLEXTOR has experienced site personnel that offer high quality support of our equipment at your job site. We offer you the following services:

+ Routine inspections/surveys
+ Site supervision
+ Calibration and testing
+ Training for operations personnel
+ Belt vulcanizing/heat splicing

MAINTENANCE

Our staff is available promptly to be on your job site for maintenance, inspections, and troubleshooting. Our technicians are also available to train your personnel on the use, inspection, and maintenance of our equipment in order to prolong the service life of our components in your system.

AFTERMARKET SERVICES

EFFOXFLEXTOR offers a wide variety of aftermarket products and services including:

+ Spare Parts
+ Service
+ Repair/retrofit of any brand damper
+ Fabric Expansion Joint belt replacements

CECO ENVIRONMENTAL

ENERGY TECHNOLOGIES

CECO Environmental, through its Aarding, CECO China, **EFFOX**FLEXTOR and Zhongli Industrial Technology businesses, is the leading provider of custom engineered solutions which meet the most demanding needs of the power, petrochemical and heavy industries worldwide.

Our products and solutions include designing, engineering and manufacturing of exhaust systems, acoustical components, heavy duty dampers, and fabric expansion joints for use in gas turbine, fossil fuel combustion and other exhaust gas applications.

CECO ENVIRONMENTAL

CECO Environmental is a leading global industrial technology company focused on providing innovative solutions for the air pollution control, energy, and fluid handling/filtration industries. Through its well known brands, CECO provides a wide spectrum of products and services that play a vital role in helping companies achieve production standards, meet increasing plant needs and comply with stringent air quality control regulations.

CECO also offers you an advantage that's unavailable anywhere else. We are a single source provider that utilizes the combined knowledge and expertise gained from years of working together, to develop integrated products and solutions for a broad and diverse customer base.

Our multi-disciplined engineering and project management staff have a thorough understanding of industry codes and standards as well as extensive technical capabilities. This makes CECO the ideal partner in developing new products or helping you choose the best solution to each and every application.

CECO is driven by an unwavering commitment to provide high quality solutions and products for our customers, a challenging and innovative workplace for our employees, and long term sustainable growth for our shareholders.

EFFOXFLEXTOR PROJECTS

A FEW OF OUR MAJOR INSTALLATIONS

MORE THAN

5,000 *satisfied customers*
150,000 *installed dampers*
250,000 *installed expansion joints*
2,000 *coal power projects installed*
400 *HRSG projects installed*
35 *countries served*

NORTH AMERICA

+ **Prudhoe Bay, Alaska**
  Refinery - Petroleum
+ **Fort McMurray, Alberta, Canada**
  Refinery - Oil Sands
+ **LaCygne, Kansas**
  Coal Fired Boiler - Fabric Filter
+ **Belews Creek, North Carolina**
  Coal Fired Boiler - FGD
+ **Oak Grove, Texas**
  Coal Fired Boiler
+ **Chouteau, Oklahoma**
  Coal Fired Boiler - Fabric Filter
+ **Council Bluffs, Iowa**
  Coal Fired Boiler - Fabric Filter & FGD
+ **Cumberland City, Tennessee**
  Coal Fired Boiler - FGD
+ **Castle Dale, Utah**
  Coal Fired Boiler - FGD
+ **Dickerson, Maryland**
  Coal Fired Boiler - FGD
+ **Cedar Rapids, Iowa**
  Grain Processing
+ **Cliffside, North Carolina**
  Coal Fired Boiler - FGD
+ **Oak Creek, Wisconsin**
  Coal Fired Boiler - FGD
+ **Cameron Parish, Louisiana**
  Gas Turbine - LNG

LATIN & SOUTH AMERICA

+ **Lazaro Cardenas, Mexico**
  Gas Turbine - Power Generation
+ **Mazatlan, Mexico**
  Gas Turbine - Power Generation
+ **Puero Nare, Columbia**
  Gas Turbine - Power Generation
+ **Timbues, Argentina**
  Gas Turbine - Power Generation
+ **Iquique, Chile**
  Coal Fired Boiler - Fabric Filter

EUROPE

+ **Castejon, Spain**
  Gas Turbine - Power Generation
+ **Modugno, Italy**
  Gas Turbine - Power Generation
+ **Krakow, Poland**
  Coal Fired Boiler - FGD
+ **Smedervo, Serbia**
  Steel Mill

AFRICA

+ **Arzew, Algeria**
  Refinery - Petroleum
+ **Bonny Island, Nigeria**
  Gas Turbine - Refinery

MIDDLE EAST

+ **Jeddah, Saudi Arabia**
  Gas Turbine - Power Generation; Oil Fired Boiler, Seawater FGD & ESP
+ **Yanbu, Saudi Arabia**
  Oil Fired Boiler
+ **Ras Tanura, Saudi Arabia**
  Refinery - Fabric Filter
+ **Riyadh, Saudi Arabia**
  Gas Turbine - Power Generation
+ **Sohar Port, Oman**
  Gas Turbine - Refinery

ASIA

+ **Jingyuan, China**
  Coal Fired Boiler
+ **Thai Bihn, Vietnam**
  Coal Fired Boiler - FGD
+ **Ratchaburi, Thailand**
  Coal Fired Boiler - Wet FGD
+ **Yeosu-si, Korea**
  Gas Turbine - Refinery
+ **Dangjin, Korea**
  Coal Fired Boiler - Wet FGD
+ **Samalkot, India**
  Gas Turbine - Power Generation
+ **Jamshedpur, India**
  Steel Mill
+ **Manjung, Malaysia**
  Coal Fired Boiler
+ **Sual, Philippines**
  Coal Fired Boiler - Wet FGD
+ **Taichung, Taiwan**
  Coal Fired Boiler - Wet FGD
+ **East Java, Indonesia**
  Coal Fired Boiler - Wet FGD
+ **Grasberg, Indonesia**
  Mining

AUSTRALIA & NEW ZEALAND

+ **Wheatstone, Australia**
  Fired Heater - LNG
+ **South West Queensland, Australia**
  Coal Fired Boiler

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