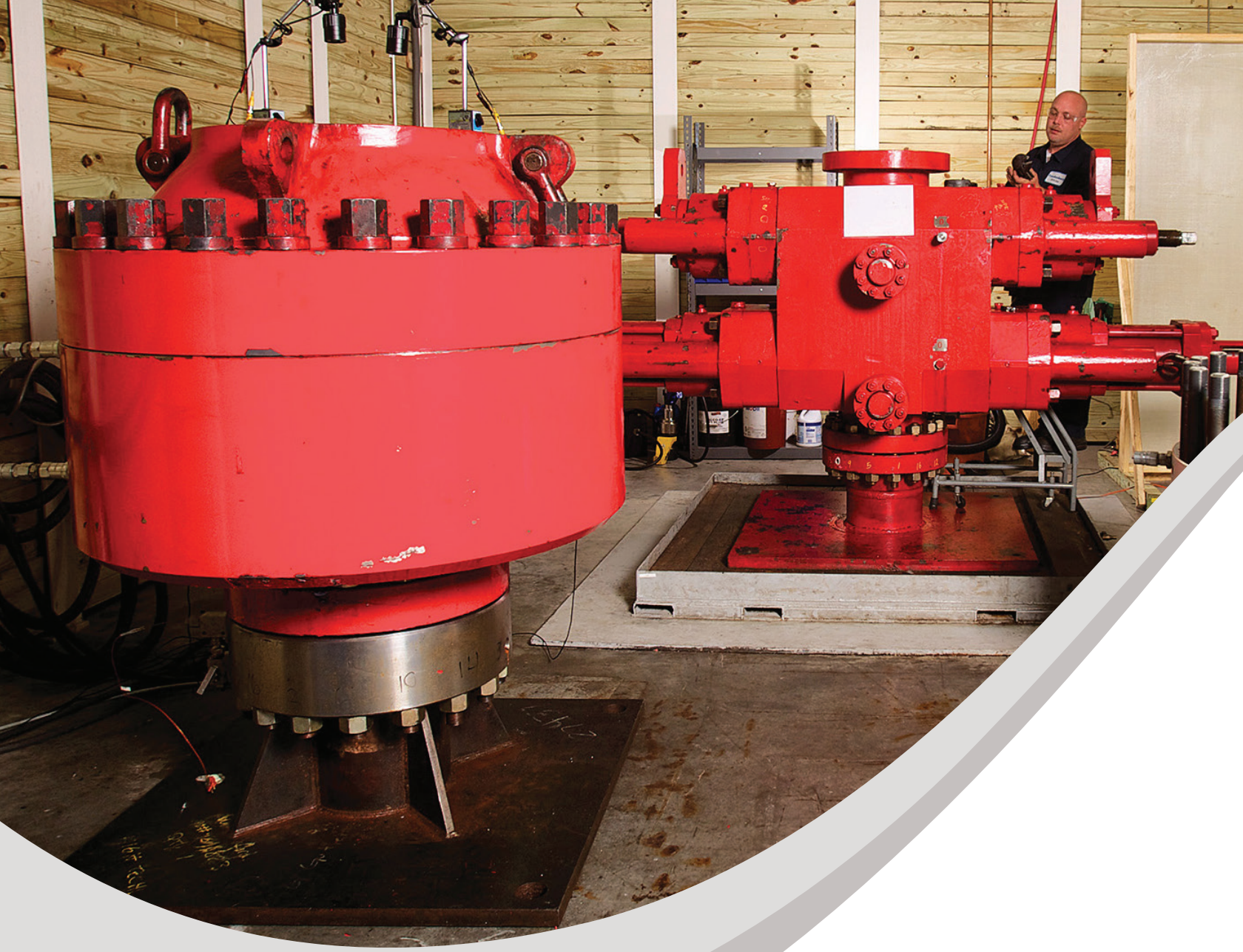

# MATERIALS DEVELOPMENT & PRODUCT TESTING LAB

FREUDENBERG
OIL & GAS TECHNOLOGIES

FREUDENBERG
INNOVATING TOGETHER

Welcome to our Materials Development and Product Testing Lab.

At Freudenberg Oil & Gas Technologies, we know that meeting the ever-changing demands of new applications in the upstream oil and gas industry requires sealing technologies to evolve as well.

We believe that providing the most innovative and comprehensive solutions for our customers requires an investment. Located in Houston, Texas, USA our 14,000 square foot facility is dedicated to providing material and test capabilities to address the latest challenges faced by operators, OEMs and engineering/service providers.

Freudenberg Oil & Gas Technologies is the first seal solution provider to have an internal facility that develops unique elastomers and has the capabilities to evaluate solution properties in a variety of conditions, including sour gas and HPHT.

We see this facility as instrumental in supporting our objective of being the global leader in providing innovative sealing solutions to the upstream oil and gas industry.

We welcome you to visit the lab and learn more about our capabilities.

Sincerely,

Richard T. Schmidt

President and CEO

# LEADING EDGE TEST FACILITY

Freudenberg Oil & Gas Technologies relentlessly pursues the highest levels of product expertise, technology improvements, quality systems and above all, customer service. Our commitment to delivering top-quality solutions to our customers has taken form through a 14,000 square foot facility with the ability to perform an unprecedented level of product verification testing and analysis in-house for our sealing solutions and proprietary customer projects. Our testing facility includes six labs capable of standard tests, as well as many customer-specific requests.

Facility capabilities include:

Thermal Cycling Lab

HPHT Lab (15,000 psi / 103 MPa at 430°F / 232°C)

Product Testing Lab

Product Test Lab

Sour Gas H2S / Customer Media Lab

Mixing Lab


Materials Development – Mixing Lab

## THERMAL CYCLING LAB

Our Thermal Test Lab is dedicated to product function testing for a variety of sealing solutions such as Spring Seals, T-Seals and FS Seals. This facility utilizes an environmental chamber, a gas booster and an accumulator vessel.

**Equipment**
Thermal chamber (48 x 48 x 48 inches, max load 2,500 lbs)
Gas booster + accumulator vessel

**Typical Tests Performed**
ISO 10423 pressure temperature cycling test
API 6A F 1.11
Customer-specified tests

**Temperature Range**
Typical temperature cycle:
-04°F to 250°F (-20°C to 121°C)
Chamber is capable of temperature range:
-100°F to 375°F (-73°C to 191°C)

**Pressure Range**
Standard test: atmospheric pressure to 15,000 psi (103 MPa)
Customer specific test: with new vessel design can get up to 20,000 psi (138 MPa)

**Gases / Fluids**
Standard gases: 100% N2
Other gas combinations to be evaluated upon request

Thermal Cycling Test

## HPHT TEST LAB

Our HPHT (High Pressure High Temperature) Test Lab uses Rapid Gas Decompression (RGD) Testing to assess material and function of products such as O-Rings, Spring Seals and T-Seals. The lab includes insulated, self-contained test vessels with band heaters between vessel and insulation.

The lab is also used for high pressure high temperature rubber compatibility studies with various fluids (drilling muds, produced water etc.) common in drilling and productions stages.

**Equipment**
Insulated self-contained test vessels, with band heaters between vessel and insulation

**Typical Tests Performed**
Norsok M-710 RGD
ISO 23936
NACE TM 0187
Shell DODEP
Total GS-PVV-142
Customer-specified tests

**Temperature Range**
Room temperature, to 430°F (220°C)

**Pressure Range**
Standard test: atmospheric pressure to 15,000 psi (103 MPa)
Customer specific test: new vessel design can get up to 20,000 psi (138 MPa)

**Gases / Fluids**
Standard gases:
5% CO2, 95% CH4
10% CO2, 90% CH4
100% N2 and 100% CO2
Other concentrations or gas combinations to be evaluated upon request

# MECHANICAL PROPERTIES LAB

The Material Properties Test Lab performs physical testing for O-Rings, Spring Seals and T-Seals, among other solutions. This facility is equipped to conduct a wide variety of tests on the mechanical properties of Elastomers and Plastics – Tensile Testing, Flexural Strength and Modulus, Compression Stress Relaxation Testing as well as conduct immersion testing with combustible and flammable fluids.

**Equipment**

Tensile Tester equipped with environmental chamber and video extensometer
Manual clicker press
Densimeter
Microscope
Hardness tester Shore A, D and IRHD
Heating oven
Compression stress relaxation fixtures

**Types of Tests Performed**

ISO 48
ISO 37
ISO 527
ISO 34-1
ISO 1817
ISO 11357-1+2
ISO 188
ISO 815
ISO 1183
ASTM D 429
ASTM D 412
ASTM D 638
ASTM D 395
ASTM D 790
ASTM D 2240
ASTM 3767
ASTM D 2000

**Example Tests Performed**

Mechanical Properties
Hardness
Compression set
Immersion testing (in flammable and combustible fluids)

# PRODUCT TEST AREA

Our Product Test Area was designed to perform function testing for products such as BOPs and ram packers. The facility has 3 high pressure rated bunkers and it is capable of running API 16A testing, as well as customer-specific tests. Typical tests cover water, control fluids, drilling muds and glycol. Other fluids will be evaluated upon request.

**Typical Tests Performed**

API 16A
Customer-specified tests

**Pressure Range**

Up to 15,000 psi (103 MPa)

**Gases / Fluids**

No gases
Fluid test: water, control fluids, drilling muds, glycol
Other fluids to be evaluated upon request

Product Test Bunker

## SOUR GAS TEST LAB

Our Sour Gas Lab tests a broad spectrum of gases and fluids, as well as customer-specific combinations as requested. Material and function tests include atmospheric pressure to 2,000 psi and immersion testing to 15,000 psi, as well as Norsok M-710 sour gas testing.

**Equipment**
3 test vessels with stands and insulation in the lab hood
Wet scrubber for air purification

**Typical Tests Performed**
Norsok M-710 sour gas
ISO 23936
ISO 10423 immersion test / API 6A F 1.13
ISO 10423 fixture test /API 6A F 1.13
Customer-specified tests

**Temperature range**
Room temperature to 430°F (220°C)

**Pressure Range**
Standard test: atmospheric pressure to 2,000 psi (13 MPa)
Customer-specific test immersion testing to 15,000 psi (103 MPa)

**Gases / Fluids**
Standard gases:
2% $H_2S$, 3% $CO_2$, 95% $CH_4$
10% $H_2S$, 5% $CO_2$, 85% $CH_4$
100% $N_2$
Other concentrations or gas combinations to be evaluated upon request

## MIXING LAB

Our capabilities include a mixing lab to cultivate new material recipes. Freudenberg Oil and Gas Technologies' elastomer research group is focused on developing new formulations targeted for solving the most stringent challenges encountered by materials used in the oil and gas industry, from extreme temperature and pressure conditions to exposure to harsh drilling and completion fluids.

The mixing lab has all the necessary equipment for compounding new material recipes for seals, BOPs, packers and other non-metallic based oilfield parts. Freudenberg Oil and Gas Technologies developed a full range of elastomers, from commercial NBR, HNBR, NR, and EPDM base polymers to high-performance FKM grades, including GAZGUARD® - our patented RGD-resistant compounds.

**Purpose**
Develop new elastomer material recipes

**Product Example**
O-Rings, Spring Seals & T-Seals

**Equipment**
3L Moriyama Mixer
8" x 16" Mill
Heaters for the mill and mixer
50 ton Panstone Hydraulic press
Rubber cutter
Oven
MDR Rheometer
DSC - Differencial scanning Calorimetry
- Tg (Glass transmission temperature)
- Heat capacity

# FREUDENBERG GROUP GUIDING PRINCIPLES

- Value for Customers
- Innovation
- Leadership
- People
- Responsibility
- Long Term Orientation

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