

## INNOVATIVE TECHNOLOGY TO MEET THE DEMANDS FOR OIL & GAS EXPLORATION

### ENGINEERED BELLOWS DEVICES



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## SENIOR METAL BELLOWS APPLICATIONS

Oil and gas exploration faces greater challenges employing new technologies for improving well production. Equipment operates in harsher environments and at higher pressures and temperatures, making operating conditions too much for many conventional technologies. Elastomers cannot stand up to the temperatures and conventional bellows cannot withstand the extreme pressures and corrosive environments in which they need to operate.

Senior Aerospace Metal Bellows has been serving the oil & gas industry for decades. Today, our R&D efforts are creating new technological solutions to meet the rigorous challenges faced by the oil and gas industry.

### High Pressure Bellows Seals work up to 15,000 psig for 100,000 cycles

- Patent pending High Pressure Bellows Seal for use in gas charged valves, such as gas lift or chemical injection valves
- These bellows seals are capable of operating in pressures up to 15,000 PSIG and 100,000 or more cycles



### Compensators for harsh environments

Welded metal bellows are ideal for use as pressure and temperature compensators.

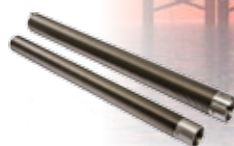
- Greatest amount of compensation in the smallest package size
- Corrosion resistant materials
- Operating temperatures up to 1200° F
- Superior frequency response vs. piston type devices

### Applications

- MWD/LWD
- Fluid filled junction boxes
- Subsea actuators
- Instruments
- Electric Submersible Pumps (ESP)

### LWD/MWD Compensators – Superior Responsiveness

- Provides pressure compensation
- Better frequency response as compared with piston technology



### Subsea Junction Box Compensators

- Junction box is used to connect subsea equipment to equipment on the surface
- Unit is filled with a dielectric fluid to draw heat away from cables
- Internal bellows compensator provides for volume compensation



### Subsea Actuator Pressure Compensator Exposed to Seawater

- Extreme pressures in subsea actuation
- Welded metal bellows provides pressure compensation between oil and seawater
- High nickel alloys are used and highly optimized bellows designs are employed to meet a 25 year operational life



### Instrument Compensator Bellows

- For use in downhole gyroscopes and accelerometers
- These instruments require precise, repeatable performance, while operating at high pressures and temperatures
- Senior's welded metal bellows provides for compensation on pressure or thermal effects on these devices



### Electric Submersible Pump Compensators

- When the system is filled with a dielectric fluid, it will change volumetrically due to thermal changes
- The compensator protects the system from pressure build up as the volume of the fluid expands



### High Temperature Automatic Thermal Actuators/Valves

- Provide precise movement for a specified temperature range
- All welded, stainless steel construction
- Suitable for operating temperature ranges to 600° F
- Cycle life to hundreds of thousands of cycles
- Superior performance and life compared with rubber diaphragm designs



### Zero Leakage Metal Bellows Accumulators

- Maintenance free, zero leakage operation
- Gas charge is hermetically sealed by all-welded metal construction
- Never requires re-charging
- No wearing seals
- Superior performance and life compared with piston or bladder accumulators



### Hermetic Vacuum Pumps/Compressors

- Zero leakage
- Minimum of 10,000 hours continuous operation
- Optional all metal wetted surfaces
- Suitable for high temperature operation
- Ideal for corrosive environments
- Infinite life bellows design



### WELDED METAL BELLOWS

- Axial, lateral and angular motion
- Absolute leak tightness
  - Leak rates up to  $1 \times 10^{-10}$  cc/sec - He are possible
- Operation in extreme environments
  - High temperatures
  - Corrosive media
  - High pressures
- Long stroke
- High cycle life
  - Hundreds of thousands, millions or billions of cycles
- Round or non-round shapes
- Range in size from 1/8" in diameter up to 23" or more.



As compared with typical elastomeric solutions, the welded metal bellows can withstand significantly higher temperatures and tolerate corrosive environments. Welded metal bellows may be used as flexible seals or may be designed into more complex devices to solve performance and reliability issues that affect more conventional solutions.

Senior applies its core welded metal bellows technology to design components and devices such as:

- Compensators
- Seals
- Actuators
- Thermal Valves
- Accumulators and Reservoirs

### A BREAKTHROUGH PROCESS

A welded metal bellows is manufactured from sheet stock. The material will be chosen to suit the application - stainless steel, high nickel alloys, titanium or other high performance alloys.

- Diaphragms are stamped out of sheet stock
- Two diaphragms are welded together at the ID to create a single convolution
- Convolution are stacked and welded at the OD to create a bellows capsule

