

Metal Bellows Used for NASA Imaging Missions Help Scientists Research Solar Wind

The Customer

A US-based company that specializes in aerospace and defense technology reached out to BellowsTech for a solution for a space application. For over one hundred years, they have designed and built superior aircraft and spacecraft, advancing humanity's capacity for travel, exploration, and safety.

This company proudly stands at the forefront of space technology, building and testing lunar and deep space exploration capabilities. Some examples include NASA's Orion spacecraft, weather and climate surveillance satellites like the GOES-R series, and others.

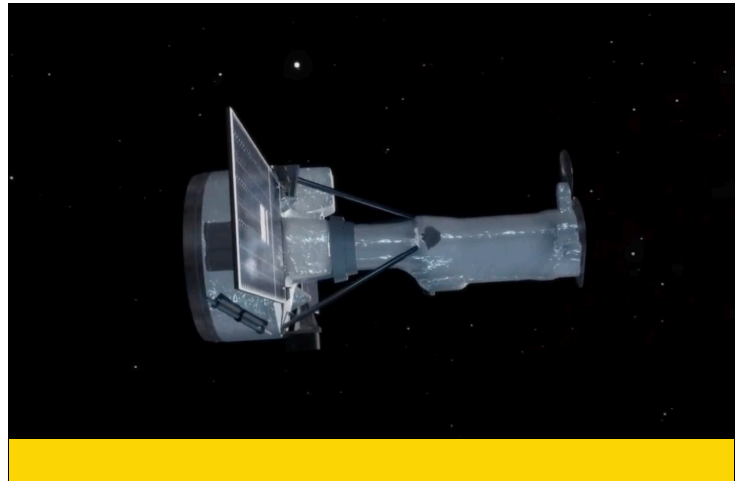
The Challenge

As a leader in space innovation, this customer frequently works with NASA to develop space exploration technology and instrumentation, including instrumentation used to monitor and catalog certain space activities. One such example includes the spacecraft and instrument for the Interface Region Imaging Spectrograph, or IRIS mission. IRIS was designed and built at Lockheed Martin's Palo Alto facility and operated by Lockheed Martin with support from the Norwegian Space Agency. The mission's goal is to further our understanding of the Sun-Earth connection by tracking the flow of plasma and energy into the corona and heliosphere, which previously had been quite challenging to view or study. IRIS allows the teams to obtain high-resolution UV spectra and images of the sun's chromosphere, particularly with relation to solar wind or space weather. Since its launch in 2013, IRIS has completed approximately 50,000 successful orbits around Earth, gathering many useful images.



Solar Flare

For the IRIS mission, the customer worked with MW Components' BellowsTech facility to develop custom metal bellows intended as contamination barriers between a ball screw mechanism and optics used for imaging. Due to their flexibility and leak-tight construction, metal bellows are often used to create a flexible seal between neighboring components. In this case, the metal bellows were used to isolate the optical telescope from molecular and particulate contaminants which could impact optical performance. Since the IRIS instrumentation was planned to be in orbit around the sun for many years, the metal bellows assembly also needed to be able to reliably cycle millions of times without failure.



To learn more about the imaging technology used in the IRIS mission, watch this video from NASA's Goddard Space Flight Center.
<https://youtu.be/gmU6XSlgbnA?si=yam8n5xG8KR1jRjs>

Almost ten years after successfully launching IRIS, similar instrumentation is now in production for NASA's Multi-slit Solar Exploration (MUSE) mission, set to launch in 2027. The intent of this mission is to help scientists understand what produces heat in the Sun's corona (the outermost layer) which leads to eruptions on the Sun. Those eruptions are what we think of as "space weather."

Since BellowsTech had previously worked to develop metal bellows used in imaging assemblies for the IRIS mission and the bellows had already performed beautifully for over a decade, standing up to the space environment, being highly responsive, and offering superior flexibility and leak-tight sealing, it stands to reason that BellowsTech would develop similar components for the new MUSE mission.

The Solution

The metal bellows assembly originally developed for IRIS was a custom edge-welded metal bellows with 300 series CRES flange and a stroke of +/- 0.04" in the compressed position. These bellows assemblies were produced to withstand up to fifty million stroke cycles with a target spring rate of 30 lb/in. For the MUSE mission, BellowsTech plans to produce the same part with the exact specifications as before along with two additional sizes with similar capabilities. The three sizes are used in three different mechanisms within the instrument.



Why BellowsTech?

You might be wondering why companies in highly technical industries rely on BellowsTech edge-welded bellows in their complex assemblies. It comes down to a combination of superior products, outstanding service, and knowledgeable support.

Better Manufacturing Means Better Products

Since the beginning, BellowsTech products have been produced with precision and repeatability in mind. BellowsTech's founder had previously worked for another bellows company. While there, he gained valuable experience in bellows design, research, development, and testing. This experience led to the understanding of the most common bellows failure mode. He discovered that edge-welded metal bellows failures typically occurred due to low-quality diaphragms. They were often not round, flat, or concentric enough to one another. This can cause misalignment and other issues that become apparent when welded together. So, he set out to manufacture the perfect diaphragm.

In metal bellows production, thin metal strip is cut into multiple pieces of formed shapes using a metal stamping process. These parts are called diaphragms. After production, diaphragms are attached to one another, most often using a precision welding technique called tungsten inert gas welding or TIG welding, which is ideal for welding thin metal materials. The two welded diaphragms, called convolutions, are then welded in succession to create the bellows.

The quality of the bellow diaphragms is determined by several factors, including the quality of the material selected, the preciseness of the stamping process, and the weld quality when attaching diaphragms. It is standard practice in metal bellows production to use high-quality, industry-compliant, and application-specific materials to produce metal bellows, and BellowsTech is no different. However, BellowsTech takes it a step further in the manufacturing process. BellowsTech helps customers get the most out of their parts, saving them costly repairs and extending assembly cycle life, by using a precise production method that focuses on quality at every stage. This process reduces diaphragm misalignments.

As you might imagine, when misalignments occur in flexible parts designed for motion, this leads to potential premature failures. Metal bellows are often designed to withstand millions of cycles, for a near-infinite life. They are also typically produced using costly materials, so part failure and replacement can cost customers a lot of money, not to mention the downtime that is needed for repairs to take place. This is why BellowsTech uses a two-step stamping process when producing bellow diaphragms that helps ensure the consistency and reliability of our metal bellows assemblies.

First, we form the diaphragm shape, allow the metal to relax, and then move to a second process to stamp out the metal diaphragm. Since the tolerances in our stamping tooling are extremely tight, the resulting diaphragms are of the highest quality and virtually burr-free. This process allows more control over the diaphragms' final tolerances, ensuring a cleaner, more consistent weld and a better-performing assembly overall.



Formed Bellows Diaphragms

The customer mentioned the functionality of our metal bellows as a reason they loved our products, including “leak-tight sealing that allows for adjustment for however many cycles and length of time is necessary.”

Better Service & Support

It is not just our exceptional products and reliable manufacturing that interested this company in BellowsTech for these space imaging projects. When asked what appealed most to the company about working with BellowsTech, one of their Research Scientists, said the below.

“BellowsTech has produced parts for similar projects in the past that functioned well, and we enjoyed the cooperation with BellowsTech’s engineering department.”

Our trained on-site bellows design engineers have niche knowledge of bellows design and engineering specifics and are easily reachable to provide technical knowledge regarding your edge-welded bellows application. Having a sales and engineering staff that works in unison allows us to quickly provide engineering specifics related to key projects to ensure that our customers get exactly the part their project requires without adding to their timeline.

We know that trust is extremely important to our customers in critical industries. Thankfully, we have been able to establish a relationship of trust within the aerospace industry for over a decade by offering fast and effective service and exceptional parts that function at or above our customers’ expectations.

Adding Value

BellowsTech also offers other ways to save our customers money and increase efficiency in production through our tooling process. As an added benefit to our customers, we offer in-house custom tooling that reduces costly metal scrap and saves time in production. For customers who want to avoid tooling costs altogether, we offer a wide variety of standard die sizes for most common sizes and applications.

The Result

BellowsTech was able to deliver quality custom metal bellows for the 2013 IRIS imaging mission which helped NASA further study the Sun’s solar weather. We are also currently producing similar metal bellows for the MUSE mission, set to launch in 2027. Our customer was impressed with BellowsTech’s knowledgeable engineering support and the metal bellows we supplied for IRIS which have been working as intended for more than ten years. Ultimately, the successful partnership between our aerospace customers and the BellowsTech team has and continues to lead to a better understanding of how the solar atmosphere functions.



To learn more, visit bellowstech.com

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