EB INDUSTRIES

ValveTech

CASE HISTORY

PRECISION WELDING MAKES SPACE EXPLORATION POSSIBLE

Space exploration is a catalyst for engineers to move into new and creative means of manufacturing. It demands more robust components to build a spacecraft that travel to the moon and beyond while carrying crew and cargo on repeated trips. These parts require strong, precision welds to meet stringent standards. They must hold in extreme environments that include drastic changes in temperature, pressure and can withstand contact with highly caustic gases and liquids.

The cost of a potential unserviceable failed weld in space can make a billion-dollar satellite a useless paperweight, or worse yet, cost the life of an astronaut that relies on that assembly. One such company that manufactures these assemblies is ValveTech, Inc. VTI designs and manufactures components for the ***Dreamchaser***, a vehicle designed to transport crew and cargo to destinations such as the space station and back, as well as the ***Orion***, a vehicle that will carry astronauts into deep space, sustain them and return them to Earth.

ValveTech, located in Phelps, NY, produces parts for commercial and military aircraft. Started by Michael Mullally, the firm is now owned and operated by his daughter, Erin Mullally. Its ongoing success is tightly linked to the welding provided by EB Industries.

Every day, EB Industries provides innovative precision welding to numerous parts for ValveTech, as it has since ValveTech opened its doors in 1986.

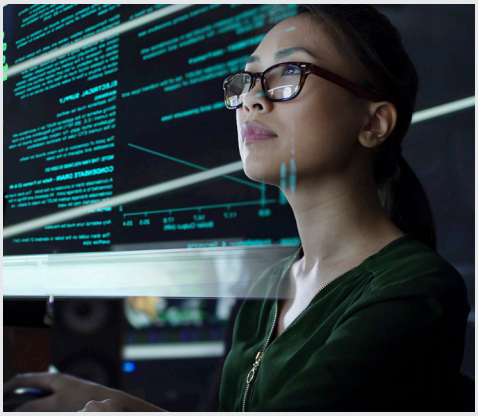
Jeff Pullano, Chief Engineer at ValveTech, explains the relationship his company has with EB Industries, "They are not a vendor; they are a partner."

This relationship proves vital when VTI is tasked with producing welded mission-critical components for space exploration, such as thruster valves. Welds are the glue that is integral to every piece.

SPACE TRAVEL IMPOSES DIFFICULT CONDITIONS

Some of the challenges ValveTech faces providing components that go into the Dreamchaser and the Orion crew capsule include:

- ***Short timeframe***
- ***Material issues***
- ***Extremely tight tolerances***
- ***Size constraints***
- ***Additional testing such as dye penetrant and x-ray and standards must be met such as AWS D17.1, 2, 3***



ValveTech relied on EB Industries to tackle these challenges and improve part production processes for future products.

Space-bound parts face a myriad of challenges not encountered by mere earth-bound welded components.

A vehicle going into space will encounter extreme temperatures. For example, components for the Dreamchaser need to withstand temperatures ranging from -400° F to +300° F.

Drastic pressure changes are also an issue. The shock load applied during the launch can exceed 5,000Gs. In addition, there are tremendous forces required to re-enter the Earth's atmosphere in return. For these reasons, welds on the Dreamchaser valve must withstand 5,000 p.s.i. ValveTech tests the welds to hold up to more than twice that value, expecting the welds to remain coupled under 12,500 p.s.i.

Mass and volume are additional considerations for space travel. There is not an inch of spare room; every bit is used. Like aircraft, every ounce on-board is accounted for to maximize lift. For this reason, components and any corresponding welds must be as small as possible. In some cases, the thickness of a strand of hair can be considered too large.

Launch dates are set in stone. No component manufacturer wants to be the reason a launch date is delayed. For that reason, timetables are strict and leave very little wiggle room. Manufacturers need to select vendors that they can rely on for on-time delivery.

Space vehicles use highly combustible fuel. These are often caustic to metals and pose a threat of flammability. Any metal used needs to be resistant to both.

The most important consideration is the fact that the ValveTech components are considered fracture critical. If the part should break, lives could be lost. For this reason alone, the stress of manufacturing a quality item weighs heavily on everyone involved in its construction. ***Failure is not an option.***

A COLLABORATION THAT SUCCEEDS IN NEW YORK AND BEYOND

Erin calls it a marriage, stating, "They are our only welder. We dump everything on them." Through their long-standing relationship, EB Industries and ValveTech have been through several challenging times together. After Hurricane Sandy hit in 2012, EB Industries ran on multiple generators for weeks to satisfy its commitments to ValveTech. Despite the ongoing power outage, EB Industries met all of ValveTech's required delivery dates. This past year during the Covid-19 pandemic, both companies needed to reduce staff. To allow for a production schedule that could deliver ValveTech's parts on time, EB Industries staggered shifts. Erin states that throughout the pandemic, ValveTech had late deliveries from every supplier and vendor, except EB Industries.

"They are the only one I can seem to count on," Erin said.

ValveTech engineers collaborate with EB Industries from very early design stages through full-scale production on every project, including a fracture critical component on the Orion crew capsule.

At first, ValveTech proposed using nitronic-60 for the part, since it would be subjected to significant loads at take-off and again to re-enter the Earth's atmosphere. The engineering team knew they also required a compatible material, since the components are used in a hydrazine (rocket fuel) environment; whereas typical stainless could ignite, high nickel stainless is more resistant.

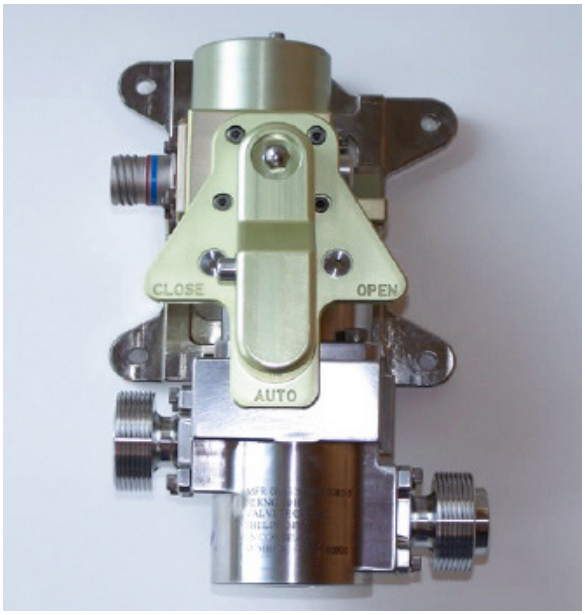
Nitronic-60 is known for its strength and appeared to be a quality material candidate. However, upon experimentation, both EB and VTI engineers found welding nitronic-60 resulted in too much out-gas and spit, a very messy weld. As a result, the team considered monel and hastelloy before EB Industries suggested inconel.

Propellant, 0.1 to 5.0 lb

ValveTech has qualified and flown a number of propellant control valves for small, monopropellant rocket engines in the 0.1 to 5.0 LBf. range. The valve design uses an AF-E-411 elastomeric puck for exceptional sealing capability.

Photo from: valvetech.net

Solenoid, 2-way Latching



Part number 12085-5 is used on the International Space Station in the Hydrogen Vent Assembly and Major Constituent Analyzer in the Environmental Control and Life Support System. The valve is totally pressure balanced using edge welded Inconel bellows.

Photo from: valvetech.net

Propellant, 50 to 100lbs

Part number 15027 is a dual seat propellant control valve qualified for thrusts from 50 to 100 LBf. Derivative designs will fly on VEGA, Mars Science Laboratory and other U.S. Government Programs. These designs use ValveTech's patented Center Guide Technology for high cycle life and reliability. They are all welded stainless steel construction and use an AF-E-411 puck in an annular type seat for seat sealing.

Photo from: valvetech.net

During the material selection phase on the Dreamchaser, ValveTech provided 9-inch samples of each metal to EB Industries. EB performed test welds, and the components were then pulled apart to determine tensile strength. The ValveTech welds were subjected to up to 12,500 p.s.i. to validate they won't rupture. Inconel proved more robust than the base metal, stainless steel, and ValveTech went on to use inconel welded to stainless steel in other parts.

After completing the material selection, the engineering teams moved to the weld design phase of the project. Welds for space components have extremely tight tolerances - .100" +/- .015. EB Industries recommends the appropriate process - electron beam or laser welding. In the case of ValveTech's space components, EB advised the use of the electron beam and angled the beam to prevent the part from heating up, potentially destroying it.

Because the Dreamchaser and Orion parts are considered fracture critical components, ValveTech supplies spares to EB Industries, which are then tested using dye penetrant and x-ray to verify the integrity of the welds. In addition, samples from every batch are tensile tested, pulled apart to determine the strength of the weld under pressure. These welds and corresponding tests are performed throughout the design and manufacturing process.

While picking the suitable material and weld design are essential, the parts must ultimately be welded and delivered on schedule- even when the schedule suddenly changes.

Erin admits, she calls EB Industries and often says, "I'm sorry! The components are already late. I am going to miss our launch!" But together, the two companies always find a way to make the deadline.

The miniature welds that are precisely placed and more substantial than most must be done quickly. To save time, ValveTech has been known to send an engineer on the 6-hour drive to Long Island with the parts in hand to have EB Industries weld them and send the engineer back to Phelps the same day.

Microscopic, extreme precision placed welds provided by EB Industries enable ValveTech to produce components that resist shock, random vibration, incredible amounts of thrust in a caustic environment, all in a timely fashion.

The high-quality components produced by the EB Industries/ ValveTech collaboration can be considered out-of-this-world.

Literally.