Application Case Study: Vacuum Control in Electron Beam Welding

Introduction

Industrial procurement has come a long way over the past decade, combining all sorts of technologies and processes intended to reduce a company's risk when they seek out goods and services. This is especially true in high-tech industries where the risk of bad solutions can be infinitely compounded by bad vendors. We encountered this exact problem on a recent project, where an electron beam welding company (our client) needed help in bidding on an aerospace contract opportunity for an end user. With this project, our client not only needed to supply

highly technical process control solutions, but also had to complete a thorough prequalification process demonstrating their competence before being allowed to bid. Hearing this, we knew we could help on both fronts, and agreed to jump right in.

About Us

As a veteran-owned small business, Whitman Controls is dedicated to supplying premium quality, reliable, technologically advanced instrumentation for use in nearly any application. Our Bristol, CT manufacturing facility embodies over 40 years of engineering, fabrication, and customer service expertise, serving both end-user and manufacturing customers nationwide through direct and distribution channels.

Application Summary

Electron beam welding is a highly advanced welding technique chosen for its ability to create incredibly precise, complex welds in ultra-sensitive applications. Electron beam welding systems generate free electron particles which are then accelerated to high velocities and directed along a joint seam between two separate materials. These electrons impact the materials, kinetically generating heat that causes the materials to melt and fuse into each other. Electron beam welding is very versatile, able to produce welds from fractions of a millimeter to over 18" in thickness - that is, joining materials from thin foils to very thick structural shapes. To increase electron beam welding's accuracy and quality, welds are produced under high vacuum which purges the weld area of air molecules and potential contaminants that can distort the weld. For this reason, very precise vacuum control is imperative for effective electron beam welding.

Challenge

As a reputable aerospace electron beam welding system OEM, our client was sent a Request for Proposal (RFP) package that entailed fabricating hull components to be used on an upcoming aircraft project. To produce these components, our client needed to construct new electron beam welding systems specifically designed for this application that would meet specifications spelled out in the RFP. As with most aerospace projects, this end-user's RFP included extremely specific expectations for the fabrication process and the resulting components alike. Because of the critical nature of the project, the RFP required potential vendors to complete a prequalification process before submitting a bid which would allow the end user to confirm that each vendor was competent and qualified to bid on the job. Given this context, our client’s

request was two-part: could Whitman recommend vacuum control sensors and help provide responses to the RFP's prequalification requirements (as outlined below)?

Select Application Requirements:

- New electron beam welding systems would be designed and constructed specifically for the materials, shapes, weld profiles, and quality specifications described in the RFP.
- Each system would include a main component chamber that could pull down to high vacuum (10-4 Torr per Aerospace Material Specification AMS-2680).
- Each system would include a weld emitter chamber that could pull down to even higher vacuum (10-5 Torr or greater per AMS-2680).
- Each vacuum chamber must be able to achieve and maintain a setpoint accuracy of +/- 2.0 InHg or better.
- All components must be constructed and installed to ensure absolute defense against contamination.
-

Select Prequalification Requirements:

- Vendor to provide a copy of their formal documented project management process that will ensure that any and all controllable sources of delays will be actively averted at no cost to the end user.
- Vendor to specify how they will ensure that all equipment, devices, and materials used in the project will be free of foreign materials and shall not pose any contamination risks to the fabricated components.
- Vendor to confirm that they can provide fully traceable documentation for all equipment, devices, and materials used in the project.
- Vendors to provide a copy of their formal documented quality control program that governs all internal and external works provided in the project.

"Funny enough, finding sensors that checked all of our project's technical boxes wasn't the hard part of our search. It was finding a vendor whose organization met all of our business' needs and could help us get through the prequalification process to begin with." -
Procurement Manager, confidential Electron Beam Welding System OEM

Solution

With our client's request made clear, we decided to tackle the technical part of the challenge first. To meet the vacuum specifications spelled out above, all we needed were simple vacuum switches – one to control vacuum levels in the weld chamber, and another to control vacuum levels in the weld emitter chamber. For each chamber, vacuum pumps would be engaged to draw air down, and the switches would close once the required vacuum level setpoints were achieved. These switches would stay closed throughout the weld process so long as vacuum stayed below the setpoint. If vacuum ever rose above the setpoint in either chamber, the corresponding switch would open and an emergency abort process would initiate. With the technical problem out of the way, we moved on to the prequalification portion of the RFP.

Our client would be responsible for generating responses and documentation to the RFP's prequalification requirements, but we could certainly provide input that our client could build their case around. To this end, we provided four items:

- **Procurement Agreement** – we proposed the use of a formal procurement agreement to our client, which they could use as evidence of proactive sourcing practices with our sensors that would directly hedge against project delays. This agreement would cover guaranteed delivery dates, surplus supply to have backup units on hand, and available alternative model numbers in stock that could be used in a pinch.
- **Quality Control Documentation** – as an ISO 9001 certified manufacturer, Whitman Controls provided a copy of our certification along with a brief summary of how we would ensure the quality and integrity of our sensors.
- **Traceability** – we provided examples of our traceability documentation that identified the points of origin, associated upstream suppliers, and raw material certificates that would come along with our sensors.
- **Contamination Defense** – for both the weld chamber and weld gun vacuum sensors, we recommended Whitman Controls model W117V Ultra Pure Stainless Steel Vacuum Switches specifically to address the RFP's contamination concerns. The W117V is constructed of hygienic stainless steel materials which are fully welded and helium leak checked to pass a 4 x 10-9 Std CC/sec leakage standard (which is the same standard used for medical devices where any level of detectable impurities cannot be tolerated).

Results

With our recommendations in hand, our client produced a wonderfully thorough prequalification response that the end user accepted without any comments. Clearly, the end user appreciated the steps that our client took to offer assurances and mitigate risks. A few weeks after submitting their proposal, our client was notified that they were the successful bidder and would be awarded the project. As of this writing, our client is finalizing their designs for the electron beam welding systems to be used on the project, which once approved will receive our Whitman W117V vacuum switches as suggested. While we can't name any specifics, the next time readers look up weather forecasts in North America, there's a chance that that forecast was generated using data collected by aircraft sensors produced on this project!

Data Bullets

- **99.9999%** electron beam efficacy using advanced vacuum controls
- **+/- 1.2** Inches Hg vacuum setpoint repeatability on W117V sensors
- **1** day's lead time on in-stock OEM sensor models
- **186** pages of prequalification documentation required by this RFP

I

Here at Whitman Controls, our values drive us to provide the highest level of servant partnership that you can find. To discuss your applications or to learn more about our capabilities, please contact us at (800) 233-4401, via email at info@whitmancontrols.com, or online at www.whitmancontrols.com