IT INSPECTION TRENDS
AUGUST 2023
THE MAGAZINE FOR MATERIALS INSPECTION AND TESTING PERSONNEL

New Technology for Heat Exchanger Inspection

Welding Audits

www.ironworkers.org

IRON WORKERS INTERNATIONAL SETS THE STANDARD HIGH WITH **ACCREDITED RIGGER & SIGNAL PERSON CERTIFICATION**

The National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence, has granted accreditation to the Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program.

WHY IS IT IMPORTANT?

MEET REQUIREMENTS

OSHA's Subpart CC requires signal person qualification by a third-party qualifier.

MEET DEMAND

While an OSHA letter of interpretation recognizes apprenticeship programs that train and assess riggers and signal persons as third-party qualified evaluators, many contractors, states and municipalities require a Qualified Rigger and Signal Person Certification.

REDUCE COST

Third party certification comes with a hefty price tag without input on testing from subject matter experts, ironworkers and their contractors. The Iron Workers' certification eleminates the recertification cost of $500 per person.

IMPROVE SAFETY

Ensuring that only trained, skilled and competent ironworkers complete rigging and signaling tasks elevates workplace safety standards and reduces risk.

WHAT IS IT?

Iron Workers International Certification Board's (I.I.C.B.) Rigging & Signalperson Certification Program is accredited by the National Commission for Certifying Agencies (NCCA), the accrediting body of the Institute for Credentialing Excellence. The I.I.C.B. joins an elite group of more than 130 organizations representing over 315 programs that have obtained NCCA accreditation.

HOW IS IT DONE?

- 6,000 HOURS OF HANDS ON EXPERIENCE
- 3-PART EXAM
- TESTING & RECERTIFICATION EVERY 5 YEARS
- IRON WORKERS RIGGING & CRANE COURSE

[**AUGUST 2023** | VOLUME 26 | NUMBER 3]

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AWS MISSION STATEMENT: The mission of the American Welding Society is to advance the science, technology, and application of welding and allied joining processes worldwide, including brazing, soldering, and thermal spraying.

COVER PHOTO:

Industrial furnace and heat exchanger in petrochemical plant. (Credit: iStock.)

BY ERIC LICHTFUSZ

What's Wrong with MIG and TIG?

AWS Certified Welding Inspectors (CWIs), especially those who travel to different job sites and shops, are often inundated with slang terminology and nonstandard terms for welds, welders, power sources, welding equipment, and many others. We've all heard terms such as *buzz box*, *stinger*, *heliarc*, *weld puddle*, *whip*, *bubble gum weld*, and so on. Two of the most recognized examples are the acronyms MIG (metal inert gas) and TIG (tungsten inert gas), which are nonstandard terms for gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW), respectively. Many consider MIG or TIG as just names for particular welding processes without realizing they are acronyms. Surprisingly, a Google search for "what is MIG welding" points to various websites explaining almost everything about the MIG welding process except, in most instances, what the letters mean.

My question is, what type of metal are you welding with so-called MIG welding using an inert gas? MIG may be appropriate in some instances, but if you're welding ferrous and using some argon/carbon dioxide gas blend for shielding, the gas is not classified as inert. It's an active gas. This makes the acronym MIG incorrect or, at the very least, technically inaccurate.

As an AWS CWI, why do I care? I care because I've been certified and trained by AWS to be an expert and apply terminology accurately. AWS defines MIG welding as a nonstandard term for GMAW. The 2020 edition of AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*, explains in its foreword the Society's position on nonstandard terms: "It must be understood that the Definitions Subcommittee cannot be the ultimate judge in terms of the preferability, acceptability, or correctness of any term for a specific situation. Such determinations are left to the discretion and opinion of the welding terminology user. There is one exception: when using a nonstandard term may endanger personal safety, that term is defined as both nonstandard and incorrect. The Definitions Subcommittee has neither the authority nor the desire to dictate welding terminology but considers it within its province to establish standard terms and nonstandard terms."

The definition for TIG is more accurate than the one for MIG; however, the AWS A3 standard defines TIG as "a nonstandard term for gas tungsten arc welding."

Another example is shielded metal arc welding (SMAW). SMAW is known to many as *stick welding* or *stick electrode welding*; both are also considered nonstandard terms by AWS. For example, what kind of stick do you use with this process, and what do you do with this stick?

Many other terms may be familiar to many and considered nonstandard to AWS, but instead of a short editorial, I would need to write a book to cover all of them. Fortunately, AWS A3.0 (available through the AWS bookstore at *pubs.aws.org*) includes more than 1500 terms with numerous illustrations to support and clarify definitions. I highly suggest you get familiar with it. You'll be a better CWI for it, and your clients will thank you, too. IT

Eric Lichtfusz (*eric.lichtfusz@roush.com*) is a CWI-manager at Roush Industries, Livonia, Mich. He is also an AWS Detroit Section executive committee senior past chair and ASNT Level II inspector.

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ASNT2023 THE ANNUAL CONFERENCE

23-26 October | Houston, TX

EVOLUTION

From advances in technology, to artificial intelligence and machine learning, to an everchanging workforce, the NDT industry is EVOLVING at a rapid pace. Be a part of the EVOLUTION at the largest gathering of NDT professionals from around the world at ASNT 2023: The Annual Conference. Join us in Houston, Texas for four days of quality professional development, a vibrant exhibit hall, networking, and the latest developments in NDT.

FEATURED SPEAKERS

John Register

KEYNOTE | 23 OCTOBER 2023 | 4PM

Amputate Fear and Embrace Your New Normal Mindset

Bader Busbait

FEATURED TALK | 24 OCTOBER 2023 | 3:30 PM

Inspection Technologies Evolution Fueled by the Industrial Revolution 4.0

WHERE THE NDT WORLD COMES TOGETHER!

ASNT Opens Houston Facility

The American Society for Nondestructive Testing (ASNT) recently established the ASNT Houston facility in Texas, which will offer nondestructive examination training courses, computer-based certification testing, and a laboratory for in-house practical examinations. The opening aligns with ASNT's strategic plan, particularly in expanding and improving its certification portfolio and implementing a regional growth strategy.

"ASNT's headquarters has now moved to Houston," said Paul Lang, ASNT Certification Services LLC executive director. "The new facility represents a transformative approach to serving the NDT industry. The choice of the area was deliberate, considering Houston's location being the epicenter of ASNT's largest industry — oil and gas — while also being a central hub for other industries, including aerospace and infrastructure."

Apart from housing computer-based testing and practical examination laboratories, the facility will serve as a venue for in-person certification preparation courses. Initially, ASNT NDT Level III courses will be available, with plans to broaden the offerings to include Level II, ASNT 9712, and Industry Sector Qualification coursework. In addition, the facility will host outreach events, such as demonstrations and community gatherings, in collaboration with local trade schools, high schools, and the ASNT Greater Houston Section.

Bain Capital Acquires Evident

Bain Capital Private Equity, Tokyo, Japan, a global private investment firm, has acquired all shares of Evident Corp., formerly known as the Scientific Solutions Division of Olympus Corp. Closing of the transaction followed the receipt of necessary approvals from all relevant authorities and regulators in Japan and other jurisdictions.

"We are excited to have completed the regulatory approval process and successfully close this transaction. Looking forward, we are committed to working with the management team to realize attractive growth opportunities in product innovation and expansion into new global markets to create value for all stakeholders," said Yuji Sugimoto, partner of Bain Capital Japan.

Yoshitake Saito, president and CEO of Evident, said, "In partnership with Bain Capital, we will further advance our goal to expand our position as a leading workflow solution provider in life science and industrial markets. We are convinced that this collaboration will strengthen us in serving our customers with world-class products and services."

Evident manufactures microscopes for life science and industrial applications, videoscopes for remote visual inspection, and nondestructive examination equipment.

CWB Group to Become Certification Body

The Canadian Welding Bureau (CWB Group), a not-for-profit, industry-funded organization that administers third-party certification systems in Canada, will become a certification body for nondestructive examination (NDE) by early 2024. The organization will certify individuals to the Canadian standard CAN/CGSB-48.9712, *Non-destructive testing — Qualification and certification of NDT personnel*. The organization has a history of administering third-party

ASNT Houston *is managed by Jesse Hernandez (second from left) and Joe Levy (second from right). Oversight for ASNT Houston is provided by Paul Lang, executive director of ASNT Certification Services LLC (far left), and Neal Couture, CAE, executive director of ASNT (far right).*

What to Expect at the Inspection Expo & Conference (IEC) 2023

IEC 2023 will offer inspection professionals a unique opportunity to make connections and gain cutting-edge knowledge at the Renaissance Austin Hotel on November 8-10 in Austin, Tex.

During this three-day event, experts from the American Welding Society (AWS), the American Institute of Steel Construction (AISC), the Association for Materials Protection and Performance (AMPP), and the Nondestructive Testing Management Association (NDTMA) will join forces on presenting a comprehensive array of topics related to nondestructive examination (NDE); steel construction; and welding, coating, and corrosion inspection.

IEC will provide a convenient venue where attendees can meet with leading companies to exchange ideas, learn best practices, and discover new products and services centered around NDE. They'll also learn from an array of top-notch education sessions covering topics such as inspection auditing, welder qualification, complex coating, mechanical testing, weld cracking, bridge infrastructure, metallurgy, heat treatment, robotics in NDE, inspection tools and equipment, and many more.

Registration is open and includes access to the exhibit floor, keynote presentations, two breakfasts, two lunches, and a reception. Keynote speakers will include Greg "Boss" Wooldridge (a three-time leader of the Blue Angels) and Todd Niemann (principal engineer at Fickett Structural Solutions, who was the structural metals and bridge inspection engineer for the Minnesota DOT at the time of the I-35W bridge collapse in August 2007). The exhibit hall will be open for participants to meet with suppliers and see what's new and what's next in the inspection industry.

Additionally, arrive a day early and attend the Update to the Codes event on November 7. The full-day program, presented by the industry's most respected professionals and code committee members, will offer valuable insights and updates on codes by the American Petroleum Institute (API), AWS, the American Society of Mechanical Engineers (ASME), and the National Board of Boiler and Pressure Vessel Inspectors (NBBI).

Visit ***aws.org/iec*** for the latest updates.

certification systems in Canada, including the national visual welding inspector program under CSA W178.2.

The CWB Group will continue to work in partnership with the existing network of NDE training delivery organizations and examination delivery organizations to ensure the needs of Canadians are met.

"The CWB Group is excited to take on this new role and looks forward to continuing to support the Canadian industry. Our decision to become a certification body for NDT personnel is a result of industry professionals showcasing a need for it, and we are happy to comply. We are and always have been committed to helping the industry grow strong and be competitive now and in the future," said Craig Martin, VP of Certification.

Previan Purchases Sensor Networks

Previan, Quebec, Canada, has bought Sensor Networks Inc. (SNI), State College, Pa., a provider of sensing tools and technologies for inspection and remote monitoring of safety-critical components. As a result of the transaction, SNI will officially become part of the Previan Group and see its nondestructive examination (NDE) solutions powered through the Eddyfi Technologies business unit.

All SNI's people and technologies will be added to Eddyfi Technologies' portfolio. The company will be responsible for promoting the Sensor Networks' brand in major industries where it is well established, including energy, power generation, aerospace, defense, rail, and manufacturing. Within Eddyfi Technologies, SNI's conventional and phased array ultrasonics probes, permanently installed ultrasonic examination corrosion monitoring systems, and remote visual inspection instruments will be added to the range and complement the offering of NDE technologies. IT

Founded in 2014, Sensor Networks Inc. provides standard and customized ultrasonic transducers, remote visual tooling, and remote nonintrusive corrosion monitoring in various petrochemical, energy, power generation, and aerospace applications. The company employs some 100 people, headquartered in State College, Pa., with satellite offices in Houston, Hong Kong, and Osaka.

Kit Prepares Users for API and ASNT Oil and Gas Sector Exams

The Oil & Gas Sector UT – Shear Wave Kit gets users ready for the American Petroleum Institute (API) Qualification of Ultrasonic Testing Examiners Detection (QUTE) and Sizing (QUSE) exams as well as the American Society of Nondestructive Testing (ASNT) Industry Sector Qualification — Oil & Gas (ISQ-O&G) UT shear wave (UTSW) exam. The kit is designed to emulate the API and ASNT O&G-UTSW-4 Revision 00 protocols and assist in the training and testing of UT technicians for both conventional and phased array UT. The kit contains 12 flaws covering both fabrication and in-service indications to be evaluated in four specimens. Flaws are randomly placed, with two to four flaws per specimen. If multiple kits are purchased, flaw placements will be mixed. The kit comes with a document package that includes a certificate of conformance, as-built computer-aided design (CAD) drawings, measuring and test equipment certificates, and test sheets.

FlawTech Inc.
flawtech.com

Handheld Rotating Bolt Hole Scanner Achieves Variable Speeds

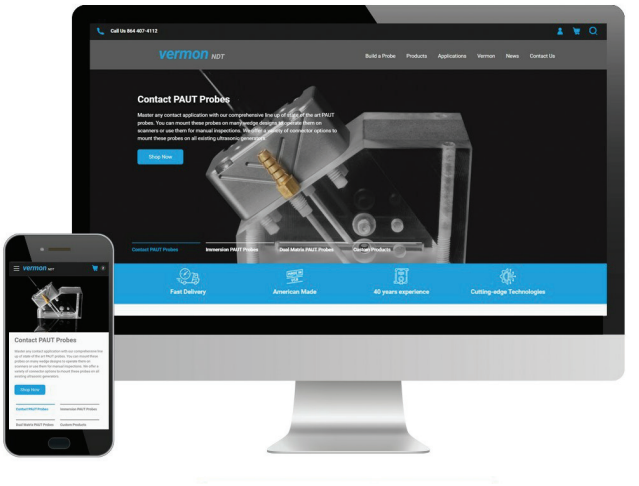
The ECS-4 handheld rotating bolt hole scanner boasts variable speeds of 125–2250 rpm and increased torque over the ECS-1 model. It utilizes a rotary transformer to couple eddy current signals from the probe to the instrument. The lightweight, 7-oz scanner also showcases an ergonomic form factor, with the probe exiting at a right angle from the scanner. Its three buttons for null, erase, and on/off are within easy reach of the user's thumb. Compatible eddy current instruments include the EVi as well as the EddyView® II, Pro, and Premium models. The scanner also operates on the NORTEC® 600 and 2000 eddy current flaw detectors. Additionally, the probe features a four-pin Fischer connector with O-rings. Compatible probe styles include the URB, URBA, US-5000, and SSB as well as other brands' probes.

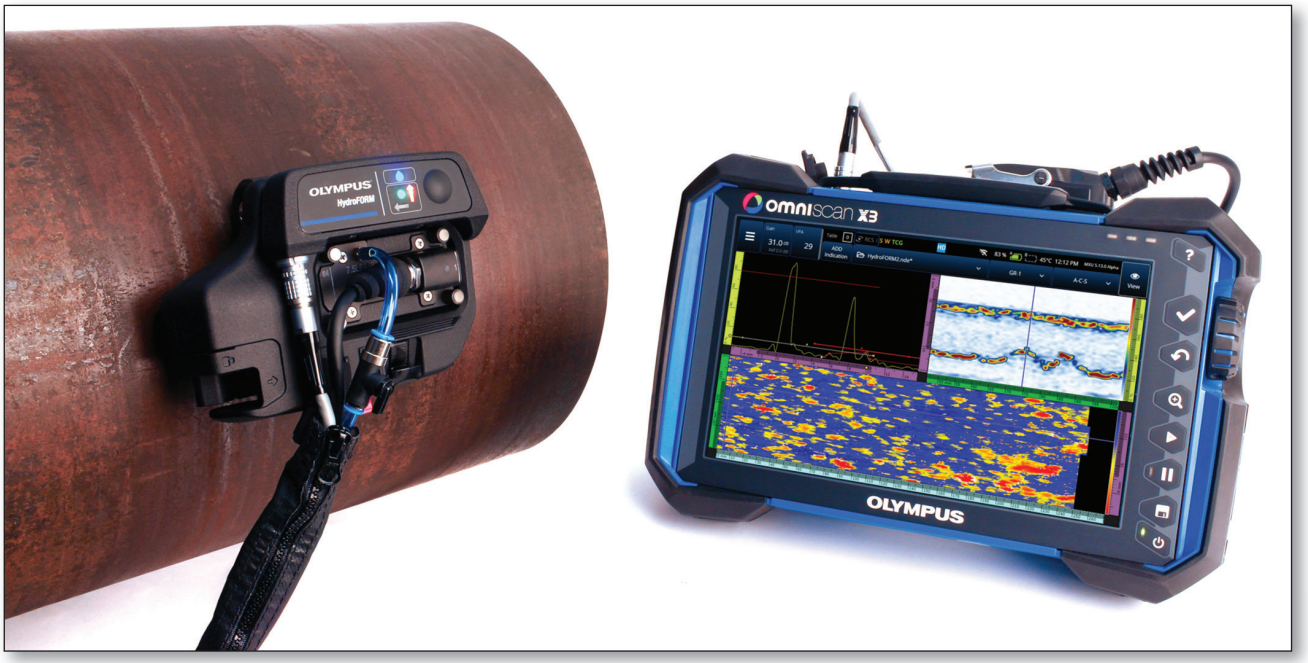
UniWest
uniwest.com

Online Store Features a Wide Selection of PAUT Probes

The Vermon NDT online store (*pautprobes.com*) provides customers around the world with access to a wide range of a phased array ultrasonic testing (PAUT) probes to facilitate how professionals in the nondestructive examination industry obtain their equipment. The company's PAUT probes are compatible with all instrument and system connectors, providing seamless integration into existing setups. The online store offers contact, immersion, and dual-matrix PAUT probes with almost 2000 configurations. Customers can also find an extensive selection of wedges to complement their application requirements.

Vermon NDT
pautprobes.com





Next-Gen Scanner Enables Two-Axis Corrosion Mapping

The next-generation HydroFORM™ two-axis encoding corrosion mapping scanner increases the efficiency of phased array scanning. Equipped with the ScanDeck™ module and an integrated index axis encoder, the improved model is easy to deploy and allows one-person operation. It also addresses a broader range of inspection applications due to an enhanced water column and bubble management system. When used with the OmniScan™ X3 flaw detector, the ScanDeck module provides feedback and remote functionality that minimize operator interactions with the instrument. It also allows the operator to start data acquisition on the OmniScan unit remotely. Directly in the operator's eyeline while scanning, status lights indicate which encoder is active (index or scan axis), when the optimum index position has been reached, whether the coupling is sufficient, and if the maximum scan speed is exceeded.

Evident
olympus-ims.com

Start Your Engines: Car Television Series and Racetracks Begin a Welder's 20-Year Career

Most people fall into a career through influences from their high schools or parents, but that wasn't the case for Padraic L. Bean. While attending East Brunswick High School in East Brunswick, N.J., Bean was at a loss as to which direction he wanted to go. The high school did not offer any welding programs or courses or even a shop class. But he was a frequent viewer of the Discovery Channel television series *Monster Garage* and *American Hot Rod*. He was fascinated watching people take an idea and a stack of material and then turn them into a work of art. From there, a career spanning nearly 20 years began to form.

Upon graduating high school in 2004, Bean attended Wyoming Technical Institute (WyoTech) in Blairsville, Pa., the following year for automotive technology. Once he took courses in chassis fabrication and street rods, he knew he wanted to pursue a career in welding and fabrication. After finishing his studies at WyoTech, he enrolled in Divers Academy International, Gloucester Township, N.J., in hopes of a future career in underwater construction and welding. Although he decided to stick to structural welding, his experiences at Divers Academy International opened his eyes to the different career paths in the welding industry. And he received his certification as a commercial diver.

Padraic L. Bean

Bean was heavily into motorsports. In between WyoTech and Divers Academy, he worked as a welder and fabricator at several companies that housed NASCAR and Rally teams, including Penske Racing in 2007 and Subaru Rally Team USA. He also worked at Front Row Motorsports in 2013.

Then he relocated to Alstom/Bombardier Transportation in New York, where he worked in manufacturing and building commuter railcars. He started as a welder on second shift then moved on as a tooling fabricator. After a couple of years, the company invested in his talents and skills and sent him to Hobart Institute of Welding Technology, Troy, Ohio, where he became an AWS Certified Welding Inspector (CWI) and Certified Welding Educator (CWE) in 2016. This allowed him to transition from a welder to a quality-assurance/quality-control role. Afterward, he held various supervisory jobs within Alstom/Bombardier Transportation, including welding inspector, welding technician, and responsible welding coordinator. He then moved on to The Lincoln Electric Co. in Euclid, Ohio, as its senior customer training instructor.

1. Why did you decide to become an AWS CWI and CWE?

I became an AWS CWI/CWE to advance my career. I did not have a college degree, and the best way for me to do it was through professional certifications. I was lucky enough to work for a company that was willing to invest in me and took the opportunity when given.

2. What inspection processes do you use at Lincoln Electric? What welding/inspection processes do you teach as a training instructor?

At Lincoln Electric, the vast majority of inspection I do is visual inspection. However, at Alstom, I held multiple SNT-TC1A Level II certifications in magnetic particle, dye penetrant, and straight beam ultrasonic testing.

3. How has becoming an AWS CWI and CWE been beneficial to your professional career?

Becoming a CWI has been a game changer in my career. Since becoming a CWI/CWE, I have been able to train

welders, train inspectors, and become a member of the AWS D1K Subcommittee on Stainless Steel. All of these doors opened once I became a CWI.

4. What words of encouragement do you have for individuals thinking about becoming an AWS CWI and/or CWE?

Becoming a CWI is not easy. It takes dedication and a willingness to learn. However, like everything that is difficult to accomplish, the sense of pride you get from success is great. Once you attain your CWI, the possibilities for professional development are endless.

5. What is the highlight of your career?

I would say the highlights of my career would be building [NASCAR] Cup cars that took first and second place in the Daytona 500, being part of projects that transport 25-million-plus people a year, and being part of a company that is on the cutting edge of welding technology and helping manufacturers implement that technology.

BY VAHID SHAHSAVARI, SÉBASTIEN SAVARD, AND DAVID AUBÉ

Overcoming the Challenges of Ferrous

Heat Exchanger Inspection

The benefits of probe pusher-puller systems and specialized electromagnetic examination methods are investigated

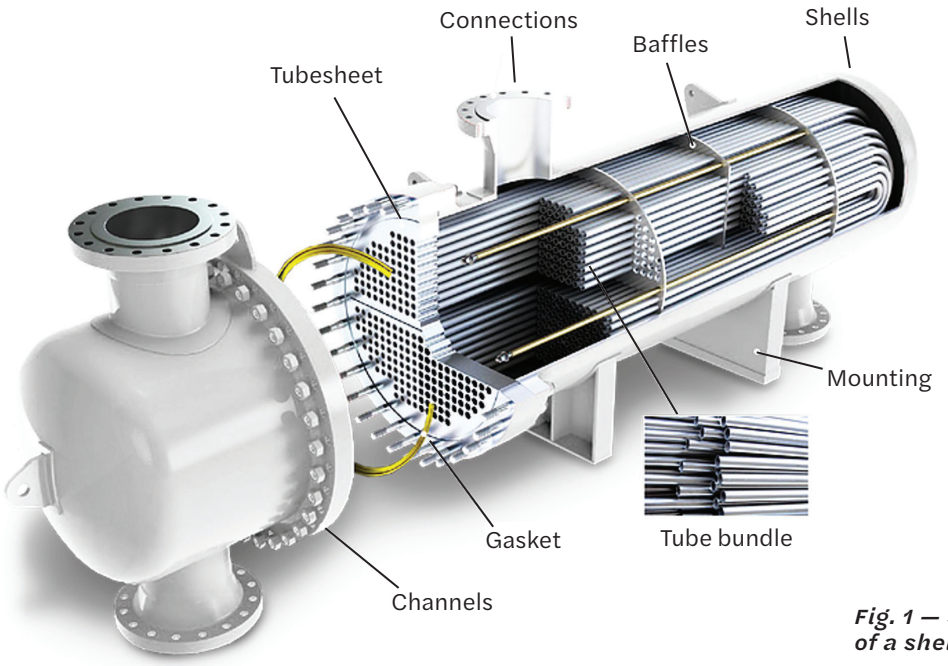


Fig. 1 — Schematic representation of a shell and tube heat exchanger.

Heat exchangers play a crucial role in various industries by facilitating the efficient transfer of heat between fluids at different temperatures all while ensuring the fluids do not come into direct contact with each other. The shell and tube heat exchanger stands out as one of the most widely used designs among the different types of heat exchangers. This type of heat exchanger comprises a cylindrical shell enclosing a bundle of tubes — Fig. 1. While one fluid flows through the tubes, another fluid passes through the shell. Heat transfer occurs as heat is exchanged from the hot fluid to the cooler fluid through the walls of the tubes.

The tubes in a shell and tube heat exchanger are available in various materials depending on the specific application requirements. While both ferromagnetic and nonferromagnetic materials can be used, magnetic properties hold minimal significance in the selection process. Instead, the tube material is determined by factors such as the nature of the fluids, operating temperatures and pressures, and the potential presence of corrosive or abrasive substances within the fluids. The most common materials used for the tubes in a shell and tube heat exchanger include copper, stainless steel, titanium, carbon steel, and Inconel®, among others.

THE CRITICAL ROLE OF TUBING INSPECTION

Tubing inspection ensures heat exchangers' safety, reliability, and optimal performance. Over time, these essential components can develop various defects, such as corrosion, erosion, pitting, and cracking, significantly impacting their performance, energy efficiency, and overall safety. Hence, it is critical to inspect heat exchangers regularly to detect and address any emerging defects or issues.

Electromagnetic testing (ET) methods are commonly used to conduct tube inspections in heat exchangers. Conducting a tube inspection using ET methods requires meticulous preparation, careful selection of equipment and probes, and the execution of an accurate inspection procedure.

The inspection process typically involves inserting a probe into the tube through an opening in the bundle and pushing it along the entire length. Subsequently, the probe is pulled back manually or through an automated pusher-puller system while continuously monitoring and recording the eddy current signal. Figure 2 illustrates this tubing inspection process, depicting an inspector manually maneuvering the probe to examine the tubes within the bundle.

Fig. 2 — Manual inspection of a bundle by an inspector.

During the inspection, the probe generates a magnetic field that interacts with the tube's material. Any variations in the material, such as cracks, corrosion, or other defects, can affect the eddy current signal, which is detected and analyzed to identify the location and characteristics of the defect. By employing robust tubing inspection techniques, heat exchangers can be safeguarded against equipment failures, maintenance costs can be reduced, and the life span of the equipment can be extended.

COMPLEXITY AND CARBON STEEL TUBE CONSIDERATIONS

Inspecting heat exchangers poses significant challenges driven by their intricate design, varying sizes, and complexity. This process typically requires specialized equipment and expertise, potentially requiring considerable time and financial investments. Moreover, fouling, corrosion, or other defects further complicate inspections, risking inaccurate or incomplete results.

The consequences of missing the detection and characterization of key defects within heat exchanger tube bundles can be severe. Lengthy factory shutdowns during routine maintenance at petrochemical plants become inevitable, resulting in high costs. Even worse, undetected flaws can lead to unexpected production shutdowns, exacerbating the financial impact.

Some of the inherent difficulties when inspecting heat exchangers are as follows:

- **HARSH ENVIRONMENTS:** Heat exchangers are subjected to demanding operating conditions characterized by elevated temperatures, high pressures, and corrosive chemicals.
- **LIMITED ACCESS:** Often, tubing is situated within tight or hard-to-reach spaces, posing challenges to conducting comprehensive inspections of the tube bundle.
- **REDUCED DATA QUALITY:** Maintaining a consistent pulling speed through the day poses challenges for technicians manually handling the probe. Variations in probe pulling speed during acquisition can significantly impact data quality, slowing down the analyst's job.
- **LONG AND INCONSISTENT ACQUISITIONS:** For large exchangers, even a little additional time spent on each tube can result in significant overall delays, leading to prolonged and inconsistent acquisitions. This is particularly critical considering that heat exchangers' average daily shutdown costs range between $2–4 million (U.S. currency).
- **LIMITED DETECTION CAPABILITIES WITH CONVENTIONAL METHODS:** Conventional methods often exhibit restricted detection capabilities, potentially leading to overlooked flaws and shortcomings in identifying issues.

Choosing an appropriate inspection technique for heat exchangers hinges upon several factors, such as the tube material and the specific application requirements. Many heat exchangers in the industry are constructed using carbon steel tubing, which is prone to the formation of pits, corrosion, and cracks. High permeability and wall thickness can also pose challenges when using conventional examination methods. These defects are commonly observed in the free-span region and near or beneath support plates.

ADVANCEMENTS IN CARBON STEEL TUBE INSPECTION

Although inspecting carbon steel tubes presents significant challenges, advancements in specialized equipment and techniques can offer effective alternatives. An example is Eddyfi Technologies' Probot™, a probe pusher-puller system for tubing inspections in industrial applications — Fig. 3. This system surpasses Balance of Plants (BoP) inspection requirements and provides the oil and gas and other sectors with a productivity-enhancing tool. The device is sealed to IP65 standards, making it well-suited for various industrial applications. Probot integrates into Eddyfi Technologies' product lineup, such as the Magnifi® and Ectane® data analysis and acquisition tools, which offer functionalities designed for inspecting tubing in industrial applications. Figure 4 depicts the full assembly of the probe pusher-puller system, including all the necessary accessories. This setup equips inspection professionals with what they need to conduct high-speed inspections of carbon steel tube heat exchangers.

Probot offers broad compatibility by employing most industry-standard probes, such as eddy current testing (ECT), remote-field testing (RFT), near-field testing (NFT), magnetic-field leakage (MFL), and soon, remote-field array (RFA). The system allows for precise control of the probe motion during heat exchanger inspections with speeds ranging from 0 to 8.2 ft/s (0 to 2.5 m/s), depending on the application. By automating the probe motion during heat exchanger inspections, the device delivers high-quality data at optimized speeds. Figure 5 illustrates an application of the system used for an inspection of a large heat exchanger.

Fig. 3 — Probot probe gun and pusher-puller system.

REMOTE-FIELD ARRAY EXAMINATION

With more than a hundred tubes per bundle in a single petrochemical heat exchanger, inspection becomes a consequential job when numerous heat exchangers must be inspected during a shutdown. Time sensitivity and accuracy are crucial factors in this scenario. To ensure successful tubing inspection, it is vital to carefully choose the appro-

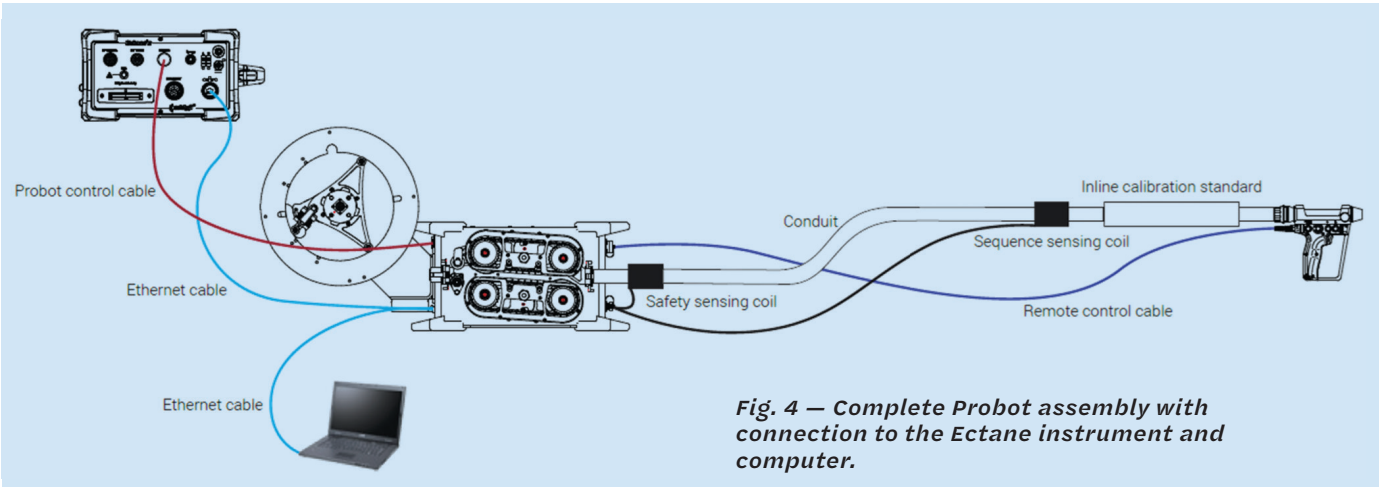


Fig. 4 — Complete Probot assembly with connection to the Ectane instrument and computer.

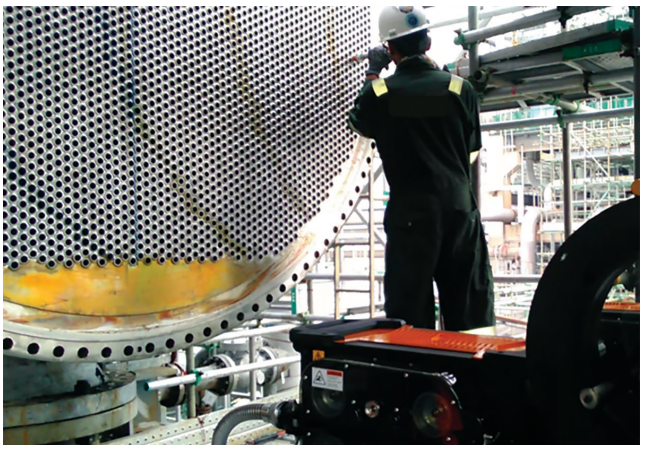


Fig. 5 — Application of the probe pusher-puller system on a large heat exchanger.

priate inspection technology in conjunction with using an automated pusher-puller system to optimize the process.

While RFT technology is widely used for inspecting carbon steel heat exchanger tubing, it does have inherent limitations. One major challenge is its ability to identify critical defects such as pitting, corrosion, and baffle wear, especially when these defects are concealed beneath or near support plates. Distinguishing these defects from the support plate signal itself poses a substantial challenge. Consequently, effectively detecting and characterizing critical defects like pitting and corrosion becomes challenging, potentially compromising the integrity of heat exchanger tubing.

The commonly used alternative to RFT, Internal Rotating Inspection System (IRIS), also comes with its own set of limitations. IRIS is relatively slow in acquisition speed compared to RFA at around 4 in./s (100 mm/s). This makes the inspection process time consuming, especially when dealing with a large number of tubes in heat exchangers. Moreover, IRIS requires extensive preinspection preparation, involving thorough cleaning of the tubes to remove excessive fouling. In addition, the tubing needs to be filled with water to facilitate the transmission of ultrasonic waves. This preparation adds to the overall time investment and may result in additional water disposal costs.

Conducting RFA inspections requires the Ectane 3 inspection instrument and Magnifi acquisition and analysis software version 5.1 or higher, both of which are designed to support RFA technology and optimize data analysis. Figure 6 shows Ectane 3 with the new RFA probe.

Fig. 6 — Ectane 3 with the RFA probe.

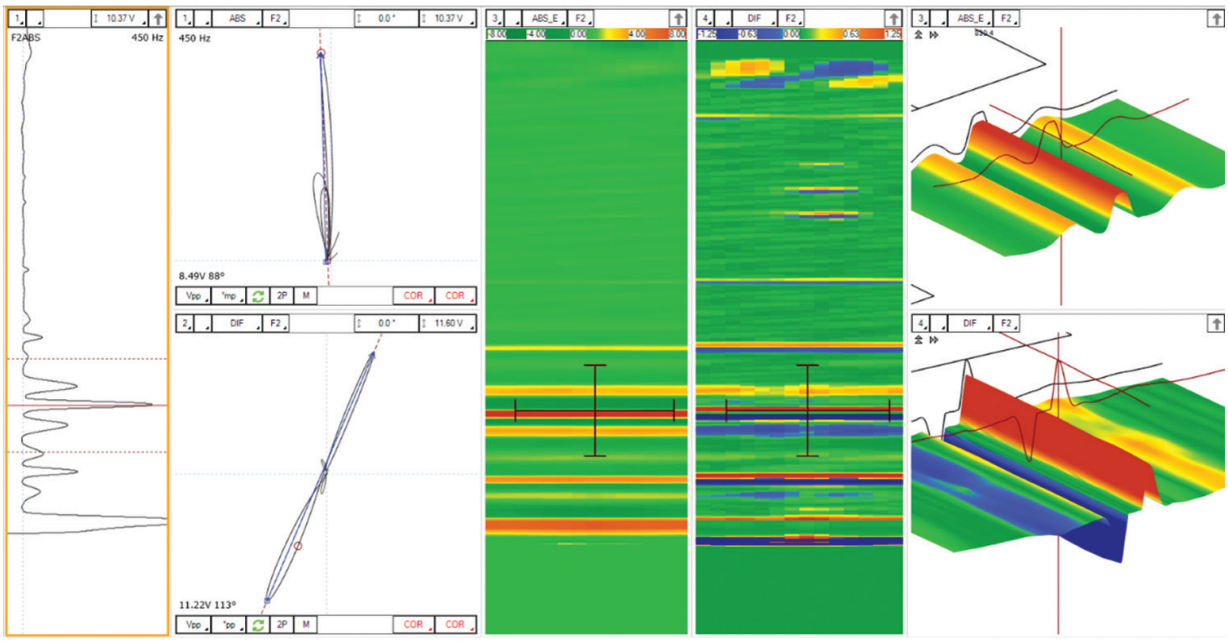


Fig. 7 — Conventional RFT and RFA results compared on a calibration standard.

Support plate near through-wall hole of a real bundle

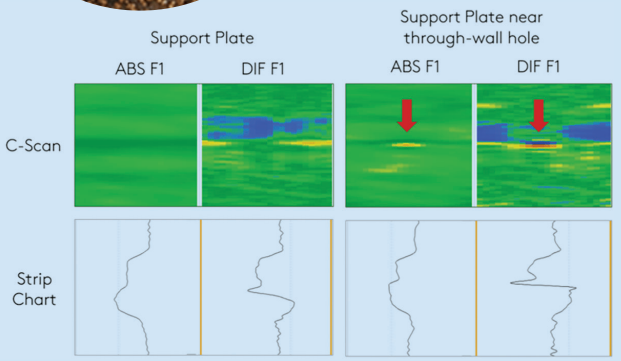


Fig. 8 — RFT and RFA results compared on a real bundle.

The RFA probe's design combines a conventional dual driver with two bobbin coils and a high-density array of coils. Leveraging a patent-pending, low-frequency multiplexing protocol, these RFA tube probes deliver high-resolution C-scan imaging for ferrous heat exchangers, achieving speeds comparable to conventional RFT acquisition, typically up to 12 in./s (300 mm/s).

The C-scan functionality of the RFA probe facilitates a visual scan around the circumference of the tube, leading to a better understanding of defect morphology and the probability of detection. During tube scanning with the RFA probe, conventional RFT strip charts and Lissajous plots for both absolute and differential channels are simultaneously acquired and displayed — Fig. 7.

RFA technology detects pits and small defects near tubesheets and support plates, providing an intuitive C-scan representation of the tube's condition. The method also improves detection coverage by reducing blind zones around external features by up to 75% compared to standard RFT inspections. Figure 8 illustrates this capability through a comparison of strip charts and C-scans for both the absolute and differential channels using RFT and RFA.

As shown in Fig. 8, the strip charts recorded for the support plate with a machined through-wall hole show no major deviation from the nominal support plate signal. However, the absolute and differential C-scan signals indicate the presence of a defect, providing a distinct indication.

CONCLUSION

Automated pusher-puller systems and RFA technology present opportunities to enhance traditional inspection methods, benefiting industries. These advanced tools enable operators to efficiently and reliably collect real-time C-scans, facilitating the assessment of heat exchangers and ensuring a comprehensive inspection of tubing. By incorporating these methods and technology, petrochemical plants can prioritize equipment safety, minimize the risk of failures, and improve overall efficiency. IT

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Guidelines for Submitting an *Inspection Trends* Feature Article

Have you ever thought about writing a feature article for consideration in *Inspection Trends*? If so, our staff stays on the lookout for original, noncommercial, practical, and hands-on stories. Potential ideas to focus on could include a case study, a recent company project, and tips for handling a particular inspection process.

Here's an easy breakdown of our guidelines:

- The text of the articles should be about 1000 words and provided in a Word document.
- Line drawings, graphs, and photos should be high-resolution JPG or TIFF files with a resolution of 300 or more dots per inch.
- Plan on about one figure for every 500 words and provide captions for every image. Also, if a nice lead photo is available, please include it for review.
- The authors' names, along with the companies they work for and their positions, should be listed.

If you'd like to discuss a particular idea or email a submission for evaluation, please contact *Inspection Trends* Editor Carlos Guzman at *cguzman@aws.org*.

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FEATURE

BY WILLIAM C. LAPLANTE

How WELDING AUDITS Are an Essential Part of Business

Critical aspects of weld auditing involving inspections, observations, and decisive questions are discussed

As a business, what is required prior to submitting a contract to a supplier for weldment fabrication? In a word, homework. Top-tier companies — such as original equipment manufacturers (OEMs) and engineering, procurement, and construction (EPC) contractors — perform business research of potential suppliers. In addition, on-site welding audits provide an opportunity to garner meaningful information in determining a supplier's corporate culture of quality and innate qualifications (i.e., competency, capability, capacity, and compliance). During the auditing process, one of the driving questions is, does the supplier possess the requisite qualifications to perform the respective work to meet contract requirements? An effective welding audit will answer that question as well as identify a supplier's strengths and weaknesses.

This article examines key aspects of weld auditing involving inspections, observations, and decisive questioning. Expressions such as *supplier*, *contractor*, and *fabricator* shall be considered synonymous as well as the terms engineering authority (EA), OEM, and EPC. An EA is responsible for a project, which includes subcontracting, of fabrication work and the performance of supplier welding audits.

EA SUPPLIER SELECTION RESEARCH

Welding audits are a prudent part of business during the EA's supplier selection process. Welding audits reflect a seriousness of purpose where an EA depends on reliable and accurate information to make an informed supplier selection decision. Thoroughness is critical in performing supplier research, during which having a questioning attitude is an asset. Select a supplier based on competency and capabilities rather than by price, aggressive production scheduling, a promised completion and delivery date, or reputation alone.

What pertinent experience, knowledge, and expertise does the supplier have to offer relative to the proposed contract (e.g., procedure qualification records [PQRs], welding

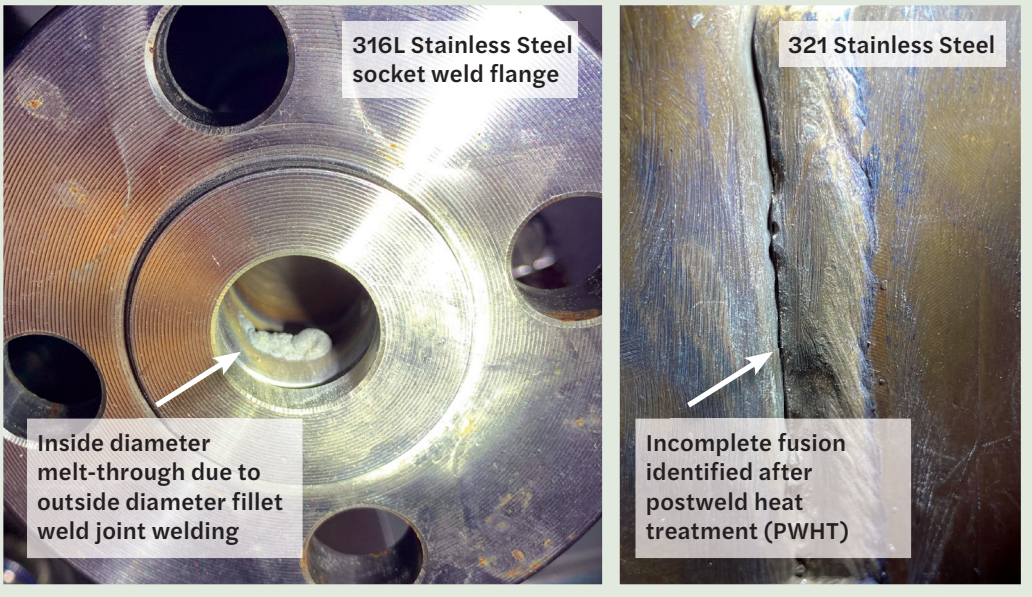

Fig. 1 — Visual testing (VT) of weld discontinuities detected during a welding shop walkdown inspection.

procedures specifications [WPSs], welder qualifications, qualified inspectors, and equipment)?

When performing a welding shop walkdown inspection, examine welds and weldments for quality of workmanship (Fig. 1). You should also scrutinize the quality system and the quality assurance manual. Be cognizant of the presence of a culture of quality or the lack thereof. Throughout the selection process, be mindful of the potential for supplier development costs, such as providing engineering, technical, and quality personnel to provide on-site production support and quality assurance.

Be diligent when performing supplier research because, as the robustness of the supplier selection process increases, the propensity to make a poor, ill-informed supplier selection decision decreases. Having multiple EA auditors perform a welding audit is an astute consideration (e.g., welding engineers, welding and nondestructive examination [NDE] inspectors, and quality assurance/quality control [QA/QC] personnel).

WELDING AUDIT PREPARATION

A pivotal factor is fully understanding the proposed fabrication project requirements to prepare for a supplier welding audit. Why? Because an auditing checklist is developed that details project requirement must-haves and specific questions for the supplier. Also, a checklist collects objective evidence such as 1) answers to welding audit questions, 2) audit findings and any corrective actions to be completed by the supplier prior to the onset of fabrication or the contract being awarded, and 3) supplemental evidence. That is, additional evidence serves as a supplement to the checklist, such as discussion, observation and inspection notes, photographs, and supplier-provided documents. A checklist is a prerequisite for auditing.

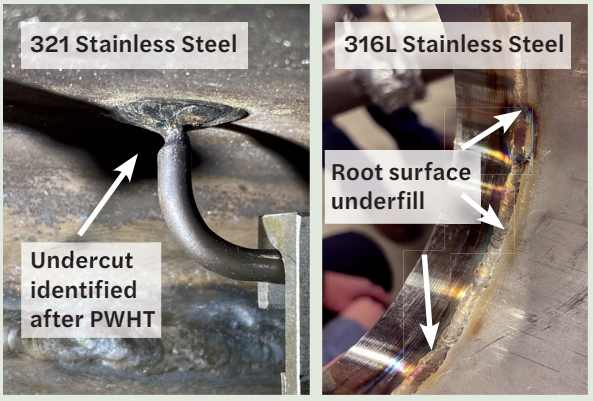

Fig. 2 — VT weld discontinuities as inspected during a welding shop walkdown inspection.

Examples of checklist welding audit questions and on-site tasks to be performed

- Perform a detailed review of code-qualified PQRs and WPSs pertinent to the proposed fabrication project. Review welder performance qualification records (WPQRs) and welder continuity logs.
- Do welders and inspectors undergo an annual visual acuity test (e.g., Jaeger J1/J2) and a color perception exam?
- Conduct a welding shop walkdown inspection during which the corporate culture of quality will be revealed via shop-floor work practices as well as weld and weldment inspections. Inspect welds and weldments and the quality of workmanship for fitups, weld bead profiles, distortion and alignment, and weld discontinuities and defects — Fig. 2.
- Are welding engineers and welding supervisors on staff?
- Are AWS Senior Certified Welding Inspectors (SCWIs) and AWS Certified Welding Inspectors (CWIs) on staff? What about American Society of Nondestructive Testing (ASNT) Level II and III inspectors? Any others?
- Examine the condition of production equipment. How often is welding, testing, and metrology equipment as well as inspection tools calibrated?
- How are base metal materials stored? Is positive material identification (PMI) performed on materials during receiving? Examine the base metal storage area.
- How are welding filler metals stored, controlled, and distributed? What prevents an incorrect welding filler metal from being employed throughout production? Examine the welding filler metal storage area.
- Is weld traceability maintained during the project (e.g., weld maps and drawings)?
- Is traceability maintained for base metal materials, welding filler metals, and fluxes? Are certified material test reports (CMTRs) archived?
- Are in-process inspections conducted? Are weld joint fitups inspected prior to welding? How is strict technical compliance to WPSs, codes, drawings, and contract documentation ensured during production? What assurances are made that WPS variables and parameters are being followed during production welding?
- Do personnel receive training on shop safety, welding symbols, and VT weld discontinuities? Examine training records for welders, fitters, inspectors, and quality personnel.

Fig. 3 — Observing welders perform tubesheet gas tungsten arc welding (GTAW) in the fabrication of a feedwater heater.

WELDING AUDITING PURPOSE

What is the purpose of performing supplier welding audits? The answer is threefold: 1) to determine if the supplier possesses the requisite qualifications to execute the respective work to meet contract requirements; 2) to protect the EA by mitigating costly occurrences of mediocre, marginal, and noncompliant welds and weldments resulting in extensive rework or repairs, warranty and insurance claims, cost of delay and liquidated damages, and litigation. There are risks associated with the subcontracting of weldment fabrication work, especially for time-sensitive power plant outages, defense manufacturing, and civil infrastructures, during which a shocking amount of unplanned costs and delays may occur due to poor supplier performance and noncompliant welds and weldments; and 3) to qualify a supplier so they may be placed on the approved supplier list for potential future contracts. Quality of workmanship and compliance to drawing and contract criteria are vital elements in the fabrication of safe, reliable, and trustworthy weldments — Figs. 3–7. An on-site welding audit performed by a qualified auditor will reveal the strengths and weaknesses, the corporate culture of quality, and the unseen supplier facts. More information on the criticality of performing on-site welding audits can be found in William C. LaPlante's *Welding Journal* article titled "Preventing Rust on Stainless Steel Pipes." (See pages 100–104 of the September 2014 issue.)

UNSEEN FACTS

In performing welding audits to assess the strengths and weaknesses of a supplier, discreet and unseen facts may be revealed, such as the following:

- if a supplier is understaffed and has an insufficient number of qualified engineering, technical, and supervisory personnel working on the shop floor to scrutinize and oversee production work;
- if the supplier employs an effective quality system and possesses a workplace culture of quality, or if the corporate culture focuses more on speed, scheduling, cost, and the quantity of work as opposed to the quality of the work;
- if a supplier's management turns a blind eye, thereby failing to fund departments to purchase updated code books, NDE equipment and QA/QC tools or to provide funding for personnel qualification training;
- if a supplier subcontracts its clients' fabrication work without disclosing this;
- if the supplier's management takes a hands-off reactive approach vs. a proactive approach and only corrects quality problems if identified by the EA;

- if a supplier relies on the EA to fund and provide engineering, technical, and quality personnel throughout the tenure of the project;
- if the supplier overestimated its capabilities in quoting the proposed contract work scope;
- if quality personnel at a company are understaffed, overworked, or overwhelmed in addressing and resolving chronic quality issues;
- if a supplier utilizes EA project weldments for welder and fitter on-the-job training practice, during which quality suffers;
- if there is difficulty recruiting and retaining qualified personnel to the point where the employee turnover rate is problematic; and
- if a workable supplier business relationship is doable (i.e., complementary philosophies, attitudes, and quality culture).

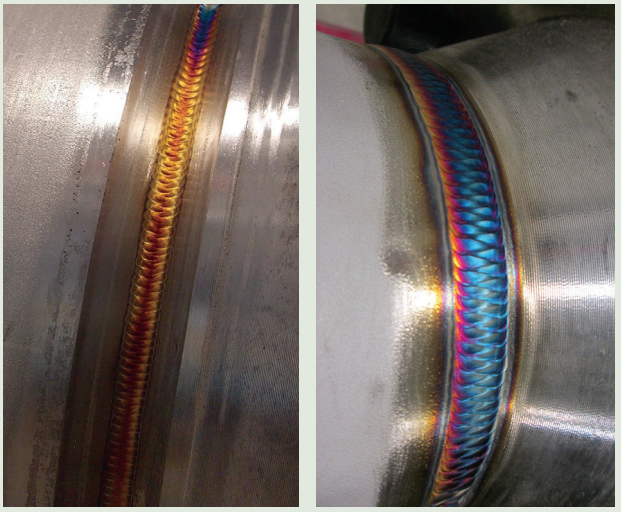

Fig. 4 — Left — Observations of piping weldments, manual GTAW hot pass/second pass, 30 in. diameter, 316L Stainless Steel pipe. Right — Manual GTAW cover/cap pass, 12 in. diameter, 316L Stainless Steel reducer fittings.

KNOWING WHAT TO LOOK FOR

Being prepared and attentive and asking insightful questions during an on-site supplier welding audit is essential. Valuable information and operations characteristics can be garnered during on-site discussions and during a welding shop walkdown inspection, as opposed to remote conferencing, phone audits, and internet research alone. Auditors with welding inspection training can better identify visual weld discontinuities and defects. In addition, EA weld auditors with welding or fabrication engineering backgrounds are sharp at identifying fabrication operations and practice shortcomings. Welding auditors will purposely look for the fundamental shop soundness of a welding shop with an increased understanding and awareness of what to scrutinize, thereby increasing the reliability and accuracy of an audit. During a welding audit, auditors concentrate on the areas essential in the fabrication of the proposed project weldments. Additionally, fundamental shop soundness attributes command a great deal of scrutinization when determining a supplier's innate qualifications throughout the auditing process.

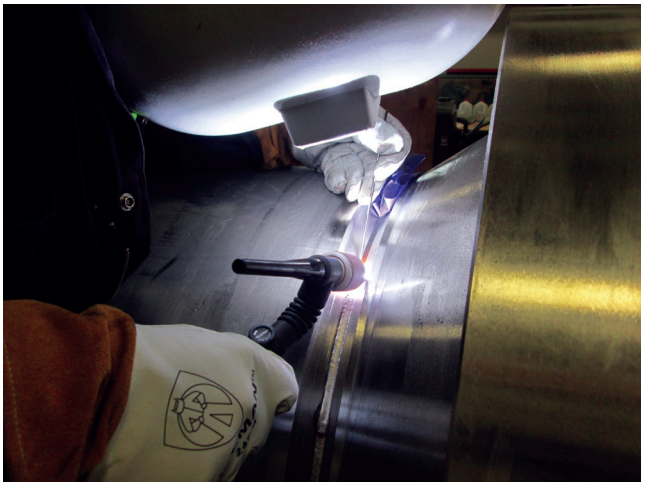

Fig. 5 — Observations of a GTAW root pass, 24 in. diameter, 316L Stainless Steel pipe.

SUPPLIER'S FUNDAMENTAL SHOP SOUNDNESS

Fundamental shop soundness attributes include the following:

1. **ARC-ON TIME.** Arc-on time is used in the calculation of the arc-on time percentage. For example, if a welder is welding three minutes out of ten, the arc-on time percentage is 30%. On average, the arc-on time percentage within a welding shop utilizing manual welding processes (i.e., GTAW and shielded metal arc welding [SMAW]) and semiautomatic processes (i.e., gas metal arc welding [GMAW] and flux cored arc welding [FCAW]) is < 13%. Mechanized and automatic arc-on time percentages are greater. Arc-on time percentages reflect the production efficiency and productivity characteristics of a welding operation.
2. **GRINDING TIME.** Grinding time decreases arc-on time. Whereas, as the proficiency and skills of manual welders and the utilization of mechanization and automation processes increase, the necessity to grind each weld bead after welding decreases. Extensive weld

bead grinding time reflects an ominous trend directly affecting weld and weldment quality, fabrication costs, aesthetics, and productivity.

3. **COMPETENCY** in production, engineering, and quality leadership (i.e., managers, supervisors, and leads).

4. **COMPLIANCE AND IN-PROCESS INSPECTIONS.** What quality methods are utilized during fabrication to assure strict technical compliance with WPSs, codes, drawings, and contract documentation? Also, in-process inspections must be performed to mitigate rework, repairs, and final inspection nonconformities. It's too late to circumvent costly consequences when weld and weldment nonconformities or discontinuities are identified during a final inspection or First Article Inspection activity. In addition, what assurances are made that WPS variables and parameters are being followed during production welding? Prior to welding and cutting, are weld joint fitups and the location and orientation of components inspected (e.g., vessel nozzles)?

5. **EMPLOYEE TURNOVER RATE.** Employee turnover damages morale, decreases productivity, and adds perpetual onboarding costs to a business. The recruiting and retention of qualified personnel is critical.

6. **TRAINING.** Quality workmanship is contingent upon personnel (e.g., welders, fitters, and inspectors) being trained and possessing the requisite proficiency and knowledge required for their jobs. Training personnel engaged in activities affecting weld and weldment quality is crucial in achieving quality products. Apprenticeship, mentorship, and internship programs are invaluable for training.

7. **SHOP-FLOOR LEADERSHIP.** Enough qualified personnel must work on the shop floor to scrutinize and oversee weldment fabrication daily. Understaffing is a problem when there is a lack of principal personnel on the shop floor — such as welding supervisors, QA/QC engineers, manufacturing engineers, and welding inspectors — to support welders and fitters. For example,
   - confirming correct welding filler metals are being utilized;
   - directing what and how work task assignments are to be completed;
   - answering questions and assisting in drawing interpretations;
   - confirming the correct weld joint fitup, location, and orientation of components prior to welding or cutting.
   - providing a hands-on approach to troubleshooting and resolving production and process problems;
   - ensuring safe work practices are being followed;
   - performing in-process inspections that ensure WPS, code, drawing, and contract documentation compliance;
   - evaluating NDE results;
   - developing tooling, fixturing, and templates; and
   - coaching welders and fitters.

8. **MECHANIZATION AND AUTOMATIC WELDING.** Mechanized and automation technologies increase arc-on time and weldment productivity, decrease rework and repairs, decrease distortion, and mitigate the recruitment of highly skilled manual welders. Also, be mindful of the application of said technologies for cutting, arc gouging, and weld joint prepping machining and beveling systems. The consistency of workmanship quality and overall weld and weldment quality increases with above-mentioned technologies.

9. **CONTINUOUS IMPROVEMENT.** Apply the Kaizen philosophy, where there are actions to improve practices and processes.

10. **UTILIZATION OF A QUALITY MANAGEMENT SYSTEM (QMS).** Neglecting to utilize a QMS increases the risk of continuing rework and repairs, inadequate workforce training and employee empowerment, lack of continuous improvement initiatives, deficient process controls, late deliveries, decreased product quality and customer satisfaction, and increased waste. For example, what quality mechanism is in place to ensure strict technical compliance to WPSs, codes, drawings, and project contract documentation during production?

11. **QUALITY OF WORKMANSHIP.** The corporate culture of quality will be revealed via shop floor work practices and weld and weldment inspections. Employees who demonstrate professionalism and pride in workmanship stand out as do those who do not. Weld and weldment quality workmanship receives a great deal of visibility during an audit and are subject to scrutiny.

12. **WELDING SHOP HOUSEKEEPING**. Apply the 5S methodology. The following should also be followed: Apply welding shop Environmental, Health, and Safety (EHS) guidelines, utilize calibrated equipment, employ foreign object debris or foreign object damage (FOD) prevention practices, manage incoming receiving inspections, and manage test cells.

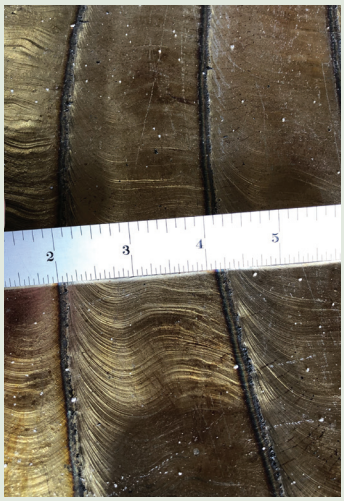

Fig. 6 — Observations of a carbon steel, submerged arc welding (SAW) strip cladding application using an EQNiCr-3 strip electrode (Inconel® Weldstrip 82), 60 mm (2.36 in.) wide × 5 (0.196 in.) mm thickness. Flux: Record NFT 201 agglomerated basic flux.

Fig. 7 — Fabrication of a structural steel weldment employing the GMAW process.

CONCLUSION

Welding audits are a prudent part of business and are instrumental in determining if a supplier possesses the requisite qualifications to execute respective work to meet contract requirements. Poor supplier performance results in a staggering amount of unplanned costs and delays (e.g., project cost overruns, the incurrence of cost due to delay and liquidated damages, and missing time-sensitive weldment installations). Being diligent and thorough in performing an on-site welding audit prior to awarding a fabrication contract is important. IT

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THE ANSWER IS

BY ALBERT J. MOORE JR.

Q My employer asked me to look into what is involved to take on work for the U.S. Navy. We have an opportunity to quote a job that is required to meet Naval Sea Systems Command (NAVSEA) S9074-AR-GIB-010/278, *Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels*. Just the length of the title is a little intimidating and, frankly, I don't know where to start. Can you provide me with an outline of what it would take to gear up for this type of work? I appreciate any help you can offer.

A That is a big chunk of meat your employer is biting off. If this is a one-time project, walk away and don't look back. However, if your employer is looking at NAVSEA work as a new long-term market, then I say, "Dive in and hold on tight!"

Navy Standards. First off, there is an upper-tier military standard that defines the item that needs to be constructed (i.e., a ship, a motor, a radar system). That upper-tiered document references many lower-tiered documents, of which NAVSEA S9074-AR-GIB-010/278 is one. This document governs any equipment, piping systems, or pressure vessels that go inside the ship. Other examples include NAVSEA T9074-AD-GIB-1688 Rev 1, *Requirements for Fabrication, Welding, and Inspection of Submarine Structure*, which covers the fabrication requirements for the hull of a submarine, and MIL-STD-1689A, *Fabrication, Welding, and Inspection of Ships Structure*, which covers the hull structure of a surface ship.

The three Navy standards mentioned will reference other lower-tiered documents that may be applicable to the fabrication of the item being constructed. By now, you may be realizing the pile of military standards and specifications is growing higher and higher. Don't let it overwhelm you because most won't apply to your project; just know that they exist.

You mentioned NAVSEA S9074-AR-GIB-010/278, so that will be our starting point. Without going into too much detail, it includes the requirements for quality assurance, materials, welding, design, and inspection. It includes lower-tier military specifications for the qualification of nondestructive examination (NDE) personnel; raw materials such as base metals, filler metals, valves, pipe, and pipe fittings; and more.

NAVSEA T9074-AS-GIB-010/271 Rev 1, *Requirements for Nondestructive Testing Methods*, is one of the lower-tier documents. It covers the qualification requirements of NDE personnel. ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*, is the basis of how NDE personnel are qualified and certified, but those recommendations are modified by NAVSEA T9074-AS-GIB-010/278 Rev 1. The NDE operator (similar to the Level I), NDE inspector (similar to the Level II), and NDE examiner (similar to the Level III) must recertify by written examinations. Because AWS's QC1 program and ASNT's SNT-TC-1A permits recertification by means other than written examinations, the Certified Welding Inspector and Senior Certified Welding Inspector as well as individuals certified as a Level I, II, and III do not meet the requirement of NAVSEA T9074-AS-GIB-010/271 Rev 1. The contractor is responsible for verifying the vendors providing NDE services and their NDE personnel are properly qualified and certified. One way to separate those people qualified to SNT-TC-1A vs. NAVSEA T9074-AS-GIB-010/271 Rev 1 is to ask to see copies of the NDE personnel's most recent examinations and test scores. This is an important question to ask because to meet the requirements of NAVSEA T9074-AS-GIB-010/271 Rev 1, all NDE personnel must be requalified by written examination. Unlike SNT-TC-1A, certifications cannot be extended by continued satisfactory performance.

NDE Examiner. A key person in any NDE program is the NDE examiner. There are numerous functions that must be performed by the NDE examiner. They may be an employee or hired through an outside agency. When the service of an examiner is secured through an outside agency, their qualifications have to be reviewed and approved by the contractor to ensure they are properly qualified and certified in accordance with NAVSEA T9074-AS-GIB-010/271 Rev 1. Then authorization is granted by the contractor for the examiner to act on matters related to NDE on behalf of the contractor. A letter of agreement must be issued describing the scope

of work that will be performed by the NDE examiner. Those functions typically include the following:

- Developing the welder workmanship program,
- Providing training to the welders and NDE personnel,
- Performing the requisite audits of the welder qualification program,
- Performing the annual technical performance evaluation of the NDE personnel,
- Reviewing and approval of NDE documentation submitted by subcontractors and vendors, and
- Developing and approving the written practice that describes how the contractor qualifies and certifies NDE personnel and qualifies outside vendors to provide NDE services.

Welding Procedures, Welders. NAVSEA S9074-AQ-GIB-010/248 Rev 1, *Requirements for Welding and Brazing Procedure and Performance Qualification*, is another lower-tier document referenced by NAVSEA S9074-AR-GIB-010/278. It addresses how welding procedures and welders are qualified. The purchase order or special provisions issued by the shipyard often include additional requirements for how a welding procedure specification (WPS) is qualified. One provision often included is the review and approval of radiographs of the welded qualification coupon by the shipyard before the qualification coupon is sliced and diced for mechanical testing. All WPSs must be submitted for review and approval before production welding can start.

NDE performed on the welded qualification coupon must be performed by individuals qualified in accordance with NAVSEA T9074-AS-GIB-010/271 Rev 1. Qualification to ASNT SNT-TC-1A is not sufficient.

There are several elements to welder qualification. Each welder must complete a welder workmanship training course and pass a written examination to ensure they understand the requirements of each NAVSEA standard that applies to the work. Typically, as a minimum, the welder workmanship training must cover NAVSEA S9074-AR-GIB-010/278; MIL-STD-22D, *Welded Joint Design*; and MIL-STD-2035A, *Nondestructive Testing Acceptance Criteria*. The welder also has to weld a coupon and pass an annual visual acuity

examination. The welder must pass the visual acuity examination every year and pass the welder workmanship examination every three years. The welder workmanship training program must be approved by the NDE examiner and possibly a shipyard or an authorized NAVSEA representative. The welder qualification program has to be audited every two years and certified by the examiner as being fully functional and properly implemented.

Raw materials, including filler metals for welding, must be ordered to a military specification. When AWS filler metals are used, they must be ordered to the applicable AWS A5.X filler metal specification with testing by the manufacturer to Schedule J.

Your incoming/receiving inspectors must segregate the incoming materials from the other stock until it has been checked and accepted as meeting the appropriate military standard. The materials received must have the supporting certified material test reports (CMTRs) issued by the manufacturer. The incoming/receiving inspectors have to check the CMTRs against the applicable material specification to ensure the chemistry is within permitted ranges, the mechanical properties are acceptable, and they must verify the heat/lot numbers on the CMTR matches the information marked on the material. The "approved" materials can then be moved into stock. Raw materials used for military work must be stored separately from those materials ordered to commercial material specifications. Commercial materials cannot be commingled with material used for military work.

Drawings. There's one last subject to consider, drawings. These are supposed to include the classification of the welds. The classification of the welds — M for machinery, P for piping, and A for pressure vessels — determine what examinations must be performed on the welds and to what extent they must be tested. The classification of the welds also determines the inspection class for acceptance. The inspection class determines how much undercut is permitted, how much and how large spatter is allowable, how much weld face reinforcement is acceptable, etc. If the weld classification isn't listed by the drawings, ask your customer to provide the missing information. It is better to find out each weld must pass radiography before you start the job rather than after the weldment is completed and ready to ship.

Procedures. Your employer will have to develop several procedures that will describe how certain functions or processes are controlled. The following is a partial list of the procedures your employer will have to develop:

1. The written practice for the qualification and certification of NDE personnel

2. NDE procedures

3. Welder workmanship training

4. Procedure for the procurement and control of filler metals

5. Procedure for the inspection of incoming materials

6. Procedure for the storage of approved raw stock

7. Procedure for control materials and maintaining material traceability

8. Other procedures, as needed, to meet the requirements of the applicable military standards and the customer

Review the Request for Quotation and More. I've tried to highlight some of the common areas that catch new contractors off guard. Make sure you review the request for quotation and purchase order closely and pay attention to additional requirements issued by the shipyard or customer. Those additional provisions are intended to clarify some of the provisions included in the military standards or they may include additional requirements invoked by the customer. If you are working through an intermediary, make sure they have provided your employer with any "special provisions" included in the original purchase order. Just because the procedures are not requested as part of your quote, don't think for a minute they aren't required. They can be requested at any time before, during, or after construction. The job might be completed and shipped before the U.S. Navy comes in and asks to review the procedures, certifications, and to verify that all the procedures have the necessary approvals.

Conclusion. I hope this review is informative. It isn't all-inclusive and doesn't cover all the nuances, but it should give you a general idea of what's required to weld to U.S. Navy requirements. IT

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