INSPECTION TRENDS
NOVEMBER 2023
THE MAGAZINE FOR MATERIALS INSPECTION AND TESTING PERSONNEL

Friction Stir Welding Inspection

Combining Ultrasonic Examination Methods

IN THIS ISSUE: CWI CORNER — SO, YOU WANT TO BE A CWI? ■ NAVSEA STANDARDS Q&A

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

[**NOVEMBER 2023** | VOLUME 26 | NUMBER 4]

CONTENTS

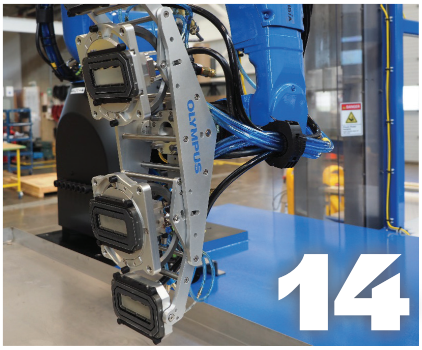
[FEATURES]

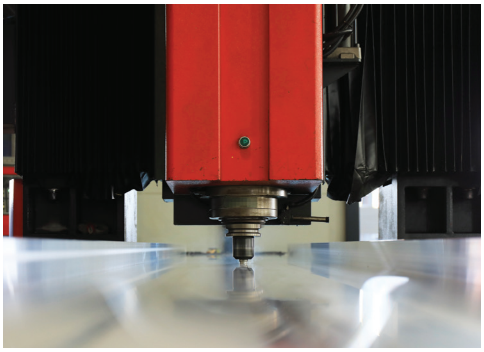
[DEPARTMENTS]

INSPECTION TRENDS (ISSN 1523-7168 Print) (ISSN 2689-0631 Online) is published quarterly by the American Welding Society. Editorial and advertising offices are located at 8669 NW 36 St., #130, Miami, FL 33166; telephone (800) 443-9353. Printed by LSC Communications, Liberty, Mo. Periodicals postage paid in Miami, Fla., and additional mailing offices. POSTMASTER: Send address changes to Inspection Trends c/o American Welding Society, 8669 NW 36 St., #130, Miami, FL 33166. Readers of *Inspection Trends* may make copies of articles for personal, archival, educational, or research purposes, and which are not for sale or resale. Permission is granted to quote from articles, provided customary acknowledgment of authors and sources is made. Starred (*) items excluded from copyright.

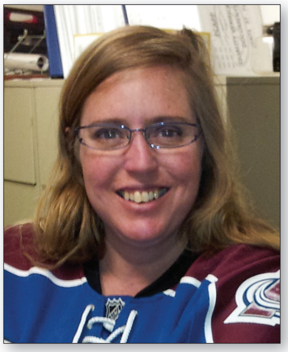
COVER PHOTO:

Friction stir welding is a process unlike most others in that no liquid-state weld pool exists. As such, the potential defects in the weld are quite different. (Credit: Shutterstock.)





Section Support for CWIs



MARJORIE OLIVER

Marjorie Oliver is a Senior Certified Welding Inspector (SCWI) from Bailey, Colo. She has been a continuous AWS member since 1999 and is active in the Colorado Section, where she has been secretary and chair and is now the program director. Here, she shares insights into how AWS membership and Section involvement can benefit aspiring CWIs.

Can you share your journey to becoming a SCWI?

The owners of the company I had been working for decided it was time to retire and sold the company. I had wanted to be out in the field, but that was not a popular decision for women back in the early 1980s. One of the owners of the old company took me aside and said, "This new company is not going to be a good fit for you. You need to go see this guy who runs this other company." He was a welder, good at connecting sources, and an ironworker. I set up an interview with the company and started with them immediately. As I started doing inspection work and learning the ropes, I found out about the CWI program, and after I had been in the field for a few years, the owner of the company decided it was time for me to take the CWI exam. That's when [former Colorado Section Chair] Neil Kirsch helped me focus my studying and gave me some pointers on the test prep. I jumped in the deep end of the pool, took the test, and managed to pass the first time through, which was rare back then, without taking any of the available preparation courses.

When it came time to do my second nine-year renewal, I was at a steel fabricator that was AISC certified, and they had a lot of government contracts. Some of those people were looking at our credentials. They said, "You're an engineer, you've been in this business a good number of years, you should think about becoming an SCWI." I decided I'll do this instead of just renewing my CWI. By that time, I was an active member and had found out about the Section library. I borrowed the materials I could from our Section library and used all my contacts to help out with the remainder of the required study materials for the test preparation. Once again, I jumped in with both feet and managed to pass that one the first time through, too.

What got you interested in getting involved with your local Section?

One thing that stuck out was how active the Section was, especially compared to other organizations. I had people wanting me to join other engineering societies, but when it came to doing research, putting together publications, and things of that nature, they weren't very active. They seemed more like social clubs and just strictly for networking. The way AWS Sections work with students and members in their local areas — and the fact AWS is the organization that does the research, puts the codes together, and updates them — were huge factors. The Section library and a whole network of people who could give technical assistance were a big draw. And, of course, there are the discounts on purchases and on the renewals of my certification. Another big benefit would be the online training courses for fulfilling class hours and getting necessary knowledge updates.

PUBLISHER: Annette Alonso
aalonso@aws.org

EDITOR: Carlos Guzman
cguzman@aws.org

[EDITORIAL]

MANAGING EDITOR: Kristin Campbell
kcampbell@aws.org

SENIOR EDITOR: Cindy Weihl
cweihl@aws.org

ASSOCIATE EDITOR: Alexandra Quiñones
aquinones@aws.org

EDUCATION EDITOR: Roline Pascal
rpascal@aws.org

[DESIGN & PRODUCTION]

MANAGING EDITOR, DIGITAL & DESIGN:
Carlos Guzman
cguzman@aws.org

PRODUCTION MANAGER: Zaida Chavez
zaida@aws.org

ASSISTANT PRODUCTION MANAGER:
Brenda Flores
bflores@aws.org

[ADVERTISING]

MEDIA SALES EXECUTIVES:

Lea Owen
lea@aws.org

Scott Beller
sbeller@aws.org

SUBSCRIPTIONS REPRESENTATIVE:

Giovanni Valdes
gvaldes@aws.org

AMERICAN WELDING SOCIETY

8669 NW 36 St., #130, Miami, FL 33166-6672
(800/305) 443-9353

How does an AWS membership support CWIs?

There are other programs out there for training, and they all try to hype themselves up as being a good alternative to the AWS CWI Seminar program, but when people get done with that, they're hanging out there in space on their own. Those programs don't have the rest of the support to offer like AWS does. One of the things we do as Section leaders, especially [former AWS President and current Colorado Section Chair] Bob Teuscher, is visit Seminar classrooms. He typically visits each class group sometime during the week and says, "Any of you guys who are local need to come to the Section meetings. And when you get through this, you're gonna have to worry about getting your hours for renewals, and we can help with that." He introduces them to the idea of participation. We try to do everything we can here at the local level to push active membership.

What would you say is the best thing about being an SCWI?

The whole process of being an SCWI and then applying that and working with some of the new kids coming onboard and helping them to become qualified welders, especially the ones who get nervous. Some of them I've worked with hear "Senior" and they get more than a little nervous. I say, "This is a qualification. You're just proving that you're qualified to do what you do all day every day. It's not scary. It's not a test. We're going to throw some material in front of you; just weld like you do all the time and you'll be fine." I think being able to work with some of the younger people and give them a positive feel for what they're doing is one of the best things I'm able to do, along with helping them in their knowledge.

MARJORIE OLIVER (*bids@kdmsteelworks.com*) is lead estimator and SCWI at KDM Steelworks, Loveland, Colo. She is also the program director for the AWS Colorado Section.

Evident Names New CEO and COO

Evident Corp., Tokyo, Japan, has appointed William Wesley "Wes" Pringle as CEO and Hiroyuki Yoshimoto as president and COO. Effective immediately, Pringle takes over for Evident's interim CEO Eric Anderson.

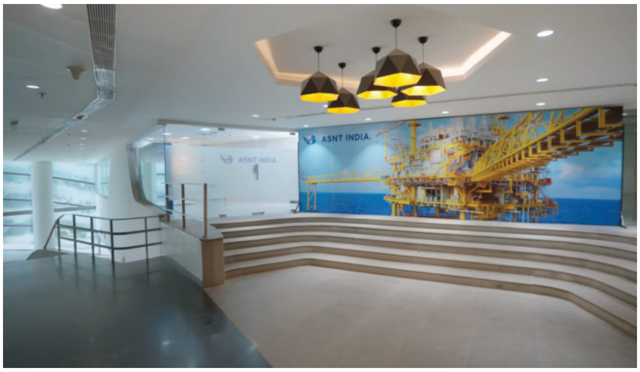
Pictured are Evident's new CEO Wes Pringle (left) and president and COO Hiroyuki Yoshimoto.

Pringle has a 30-year career driving growth and business transformation across a variety of industries, including consumer, industrial, healthcare, and software-enabled businesses. Prior to joining Evident, Pringle ran several companies for Danaher including Fluke Corp., a global test and measurement provider, which he led for almost ten years. More recently, he served as head of portfolio operations at the private equity firm Onex Corp., where he helped more than a dozen portfolio companies accelerate performance.

Yoshimoto has led global companies headquartered in Japan and the United States. Prior to joining Evident, Yoshimoto had several senior leadership roles at global manufacturing companies such as Nissan Motor Corp. Group and Nidec Corp. Most recently, he served as senior vice president and Japan representative at American Express.

ASNT India Facility Opens in Chennai

ASNT, Columbus, Ohio, has established ASNT India Private Ltd., known as ASNT India, a new subsidiary for-profit corporation to conduct business operations in India and to serve interests in Asia and the Middle East. Located in Chennai



ASNT India aims to certify more than 500 technicians annually in India and the Gulf region.

in Tamil Nadu, ASNT India will enable ASNT to expand and improve its certification portfolio and increase its global nondestructive examination (NDE) research and scholarship activities.

Nestled in Ambattur Industrial Estate and spanning 7500 sq ft, the training hub features advanced NDE technology and offers hands-on training that equips participants for the industry. The training hub was inaugurated during the ICENDE-2023 Conference and Exhibition hosted by the ASNT India Section in August 2023. ASNT India is now officially open and provides ASNT-approved training courses, publications, and certification exams (including computer-based and practical lab exams).

This launch aligns with the demand for skilled NDE technicians, notably in Make in India initiatives. The company aspires to certify more than 500 technicians annually, enhancing the workforce across India and the Gulf region.

"The opening of ASNT India further solidifies our position as a global society, benefiting our members in the U.S. and abroad," said Neal J. Couture, ASNT executive director. "With the launch of our facility, we are excited to focus on delivering the ASNT 9712 program, associated training courses, and expanding our membership in the area. We are committed to providing top-notch services to the NDT community in India, and we look forward to building strong relationships with our members and partners in the region."

NDTMA and AATA Partner on Nationwide NDE Apprenticeship Program

The Nondestructive Testing Management Association (NDTMA), a nonprofit trade association for the NDE industry, and the American Aerospace Technical Academy (AATA), have partnered on a nationwide apprenticeship program.

In 2016, AATA received approval from the U.S. Department of Labor to establish an NDE apprenticeship program as well as serve as an approved program provider in California. Recently, the company also established a mutual agreement to be a program provider with the state of Texas and has five other state approvals pending. AATA is now partnering with NDTMA to help expand the reach of the program to both apprentices and employers nationwide.

"NDT is a great career that does not require a college degree and has a lot of earning potential. It does require completion of a specific curriculum and work experience for certification and, more importantly, for competency in a job that keeps the public safe," stated Marybeth Miceli, executive director of NDTMA. "The apprenticeship program that AATA has established over the years is designed to accomplish this, and we are excited to help them expand the program to more companies and apprentices nationwide through our membership and marketing programs."

AATA's apprenticeship program currently meets the educational and on-the-job training guidelines of National Aerospace Standard (NAS) 410, *NAS Certification & Qualification of Nondestructive Test Personnel*, as well as ASNT SNT TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*. The intention is that the two-year program will be expanded to include specific training for the oil and gas sector so technicians who wish to get additional sector certifications can.

AWS Life Member Carleton A. Richardson Passes Away

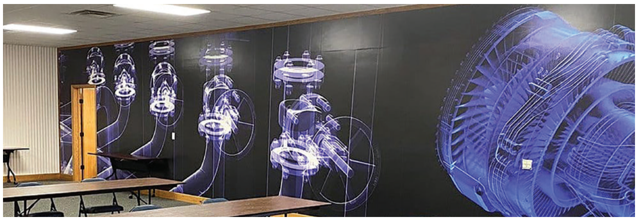
Carleton Richardson was an AWS Life Member and the founder of ABC Testing Inc., a nondestructive examination business.

AWS Life Member Carleton "Carl" Richardson passed away July 26 at his summer home in Wareham, Mass., after a long illness. He was 88. Richardson enlisted in the U.S. Coast Guard and was stationed on the weather cutter USCGC *Cook Inlet* (WAVP-384) for four years. He later founded ABC Testing Inc., Bridgewater, Mass., a nondestructive examination business that is still in operation by the Richardson family. He joined AWS in 1982 and was active in the Boston Section. He served as secretary from 1990 to 1991, first vice chair from 1991 to 1992, program committee chair from 1991 to 1992, chair from 1992 to 1993, and Section foundation representative from 2017 to 2018 and 2018 to 2019. Richardson was also active in the ASNT and enjoyed his time as a youth hockey coach and a Cub Scout leader. He is survived by his wife, Carol

Richardson; his children, Bruce and Robin; five grandchildren; and three great grandchildren.

AINDT Constructs New Training Facility

The American Institute of Nondestructive Testing (AINDT), a provider of nondestructive examination (NDE) education, has begun construction of a 6000-sq-ft training facility in Brainerd, Minn. It's scheduled for completion by December 2023.



AINDT is expanding its training facility, which will offer three course formats that blend online and in-person training.

With the construction of the new facility, AINDT aims to further enhance its offerings, now featuring three training formats to cater to all clients' needs: online courses, blended (online and traditional) training courses, and traditional full-format classroom training.

Donald Booth, CEO of AINDT, expressed his enthusiasm: "We are always looking for ways to enrich our student experience, and this facility is a testament to that commitment. By expanding our campus and providing diverse training formats, we ensure that we cater to the varied needs of our clients in the NDT industry."

A notable feature of AINDT's program is the provision of student housing during their training courses at no additional cost. This is anticipated to save clients thousands of dollars.

"This isn't just about cutting costs," Booth continued. "It's about providing a unique and immersive learning environment. Removing the burden of accommodation expenses means our clients can more easily provide their employees with training that will make them better able to provide critical inspection services."

ASNT Offers New ISQ Ultrasonic Phased Array Qualification

ASNT, Columbus, Ohio, has released a new exam under the Industry Sector Qualification (ISQ) Oil and Gas program. The ultrasonic testing phased array (UTPA) pressure equipment weld examination covers the detection, characterization, and location of manufacturing weld discontinuities found in pressure equipment. Each candidate's ability to perform UT is assessed through a hands-on, practical examination. They will inspect, locate, interpret, and evaluate discontinuities and properly document test results for a minimum number of specimens containing actual or artificially induced discontinuities that represent those found in the product type and industry sector for which qualification is sought. Candidates must pass the UTPA weld examination using manual and semiautomated scanning techniques. For more information, visit *certification.asnt.org/Get_Certified/ISQ/Ultrasonic-Testing-Phased-Array.aspx*. IT

Camera System with Transport Box Simplifies Remote Visual Inspection

The Everest Ca-Zoom HD pan, tilt, and zoom (PTZ) camera system offers precise, efficient, and secure confined-space inspections for a variety of industries, including oil and gas, power, chemical, pharmaceutical, and food and beverage. A 22-kg (48.5-lb), all-in-one wheeled transport box holds all items of the system in one container and makes traveling and setup at the inspection site simple. A backpack option with essential cables is also available and enables hands-free climbing and easier access to inspection spaces. The advanced camera system is equipped with two PTZ camera heads and accompanied by all essential accessories. The handheld control unit provides an intuitive operating system with image capture and laser measurement capabilities, catering to the demands of vessel and tank inspections. The handheld pendant also allows inspectors to move freely during the inspection. The camera offers high-definition images with a resolution of 1920 × 1080 pixels, and its light output is composed of four LEDs delivering a brightness of 2980 lumens for visibility in dark environments.

Waygate Technologies
bakerhughes.com/waygate-technologies

Phased Array Ultrasonic Testing Instrument Offers Fast Inspections

The Panther™ 2 phased array ultrasonic testing instrument with total focusing method delivers a 10 gbit/s data throughput. It is scalable up to 16 stackable units working together for up to 2048 channels for even higher speed and resolution. The instrument stands up to harsh industrial environments, making it ideal for manufacturing, laboratory, and field settings. The second-generation instrument bears a reinforced and rugged design with casing that incorporates external fans for optimized heat dissipation with no air intake. Users can completely automate their process, customize displays, create unique supervision software, develop specific analysis features, and monitor productivity with established benchmarks with the software development kit. The acquisition software, Acquire™, is fully compatible with CIVA and ULTIS software for simulation, experimentation, and advanced analysis. This compatibility allows users to integrate the instrument into their existing inspection systems.

Eddyfi Technologies
eddyfi.com

AWS Provides Hardship Relief

If you are an AWS member or customer who is experiencing hardship due to natural disasters or extraordinary circumstances, the Society may be able to help.

Give us a call at (800/305) 443-9353 and speak with one of our AWS customer service representatives to update us about your challenging situation. They will let you know what type of relief options may be available for different AWS products and solutions as a result of your current circumstances.

In times of need, to the best of our ability, the Society will make every effort to help you get back on your feet.

BY BRETT J. CHEREFKO

So, You Want to be a CWI?

An AWS CWI recalls his exciting days-in-the-life adventures

Brett J. Cherefko

Are you currently considering a career as an AWS Certified Welding Inspector (CWI)? If so, I would like to take a moment to share with you some of my adventures and experiences as a CWI. It has been a challenging, exciting, and rewarding endeavor.

I struck my first arc at a New Jersey, family-owned fabrication shop in the late 1980s. At Cherefko & Son, we would inspect/repair tanker trucks for the fuel delivery industry. I would often find myself climbing around inside tanker trucks, performing visual weld inspection and weld repairs.

One day, the winds of change blew, propelling me south to the state of Virginia. Shortly after settling in, I took a weld test in hopes of getting a new job. The inspector giving the test asked if I had any weld inspection experience. I said, "Yeah, every week for the past 14 years." He appeared intrigued and asked if I would like a job as a welding inspector, at which point I told him I would. We then made plans to meet at a hotel near Boston, Mass.

Upon arriving to the hotel, my new boss greeted me with a cup of coffee, a book on magnetic particle inspection, a horseshoe-type device with a power cord attached, and a plastic bottle. After two-and-a-half hours of indoctrination into the nondestructive examination (NDE) world, we headed out to the job site. My boss pointed to a crane parked next to a big hole in the ground and instructed me to be back here at 6:45 the next morning. The work was a tunnel project, an aqueduct for Boston.

The next morning, I climbed into a man cage with several other men, and a crane lowered us down a 350-ft-deep shaft to the 17-mile-long tunnel below. They unhooked the man cage and began hoisting materials. I found the weld team supervisor torch-cutting a chain link used to attach his welding machine to the steel tunnel wall liner where it had been secured. He asked me if I was the CWI there to inspect his work. I said, "I don't know anything about a CWI, but I do have a magnet and some red powder." He just shook his head.

After returning home, I spoke to my boss about the CWI question, and he informed me that he would like me to become an AWS CWI. Then, I enrolled in the week-long CWI seminar. I studied, but I was becoming nervous. So, I headed down to Chesapeake, Va., in the shadow of the Newport News Shipyard industry, and immersed myself in the week-long course. It was very informative and a huge help in preparing me for the test-taking experience. I passed all three portions of the test on my first try and have never looked back.

Not Your Typical Day at the Office

9/11

On a crisp fall morning, while working a pipeline outage at the University of Maryland in College Park, September 11, 2001, unfolded. I was waiting for the group of welders to complete their tasks so I could inspect. Unable to leave, I listened to the news reports on the radio. I climbed to the roof and was able to see the smoke rising from one of my other job sites, the Pentagon. We finished our tasks, and I headed for home. At 5:00 p.m., I got on Route 495, also known as the Beltway. The Beltway was completely empty and very surreal because it's never empty. A few military vehicles raced about while I tried to call back home, but I struggled to connect. Finally, I reached Cherefko & Son, and my father answered. We were both relieved to hear each other's voices. My father knew I was working at the Pentagon Wedge One renovation.

The previous week I had been at the Pentagon, exactly where the plane struck, but I had finished my inspections. The following week, I was requested back at the Pentagon to inspect some welded piping connections located deep underground. I showed up at the gate and was greeted by a soldier armed with an M16 rifle that was also fitted with a grenade launcher. "No book bags, no back packs, no lunch boxes!" he shouted. When I finally entered the work area, the smell of smoke still lingered. I noticed a strange shadow on the wall. It was hundreds of pieces of shattered tempered glass. It formed a silhouette of the windowpane that had been violently forced from the opposing wall by an explosion. On my desk, I still have a piece of charred limestone that I picked from the rubble.

Mission Impossible

One inspection job was like a scene from a movie. After inspecting the helicopter landing pad on the roof of a hospital located in Charlottesville, Va., I was asked to inspect a structural steel connection for the penthouse addition, which would be utilized to access the helicopter pad. To inspect the connection, we had to climb on top of the elevator car and take it to the top. The thyssenkrupp operator hacked the control panel, and with the wires hanging out, set the car in motion. "Hang on. Here we go!" It was dark, but light snuck in through small gaps that outlined the elevator doors at each floor as we rushed past. I leaned over and looked down the adjacent 80-ft-deep elevator shaft, and it was a long way down. After two clicks to tighten the hard hat so it wouldn't blow off, I realized that an elevator ride feels a whole lot faster when you are on top of the car. When I got home that evening, my wife asked how my day went. I said, "Just another day as a CWI."

On another job, I donned a double set of medical scrubs, was escorted into a clean room, and while suspended by my safety harness, I was slowly lowered by a hand-powered crane into a pharmaceutical manufacturer's mixing tank.

Quantico

At another point, I showed up for my first day of work at the FBI Academy, located within the Quantico Marine Corps Base in Stafford County, Va. I was setting up my workstation in the corner of a job trailer when a loud explosion shook the trailer and everything in it. Startled, I ran outside. Looking around, I could see nothing that was destroyed. I then heard someone say, "First day on the job?" I looked over to an adjacent job trailer to see a guy taking a smoke break, leaning on the handrail, and answered him by saying yes. "The boys are just training; you will get used to it," he said. There was nothing in my job description under the category of work environment that included flashbang grenades. This was one of my most interesting job sites to date.

AWS Seminar

Most recently, it was time to renew my CWI credential. For my second nine-year renewal, I elected to retake Part B. I again looked to AWS to guide me through their test-taking process and enrolled in the three-day seminar. Everything we covered in the study group, including the questions on the test, were all tasks I had experienced in the past 18 years as a CWI.

Conclusion

I have driven more than 1000 miles every week for a decade. I have worked up and down the east coast, from South Beach, Miami, Fla., to the tunnel project in Framingham, Mass. I have influenced engineers to rethink their design because they did not account for the lack of a welded connection at the bar joist seat when they switched to a nonballasted roof design.

Throughout my career, I have inspected powerhouse boilers, churches, gas pipelines, components for fighter jets, steam turbines, apparatuses for the nuclear powerhouse industry, bridges new and in service, water towers, schools, hospitals, museums, and various components for all branches of the armed services. I have been asked to inspect concrete, soils, mortars, fireproofing, post tension construction methods, painting for bridges, cranes, metal framed trusses, and pre-engineered metal buildings, all of which are extensions of my CWI career. I now work at a machine shop in Sandston, Va. We work with some of the biggest names in the industry.

Lastly, but most importantly, I met my beautiful wife on a jobsite. She thought CWIs were pretty cool. IT

BRETT J. CHEREFKO (*b.cherefko@gmail.com*) is an AWS CWI and a weld process specialist, Kosmo Machine, Sandston, Va.

IT FEATURE

BY JEFFREY WELLS

Autonomous Friction Stir Welding Inspection in Aerospace Production

Recommended techniques and inspection automation are discussed

The friction stir welding (FSW) process was developed to join materials that are difficult to fusion weld, such as aluminum alloys — Fig. 1. The weld quality is very high, and the material structure is uniform. It is commonly used in aerospace manufacturing where high-strength welds are required for large structures, such as rocket propulsion fuel tanks.

Friction stir welding is a process unlike most others in that no liquid-state weld pool exists. As such, the potential defects in the weld are quite different. The defects present in such welds are typically incomplete joint penetration, wormholes, porosity, kissing bonds, and root toe defects. Furthermore, because of the nature of the weld process, defects can be orientated in any direction.

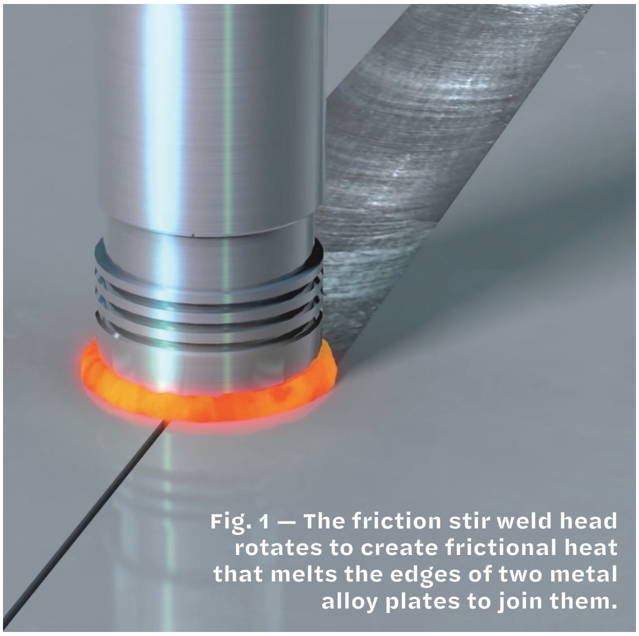


Fig. 1 — The friction stir weld head rotates to create frictional heat that melts the edges of two metal alloy plates to join them.

The best method for inspecting friction stir welds is phased array ultrasonic testing (PAUT) using water-coupled wedges. The increased number of zones covered by the phased array ultrasound provides accurate defect detection and location.

Typical FSW Flaws

Some typical flaws that inspectors need to look for in friction stir welds include incomplete joint penetration, kissing bonds (entrapped oxide), voids and tunnels (Fig. 2), wormholes, and hooks. These flaws can be oriented in the weld's longitudinal and transverse directions.

Recommended PAUT Technique for FSW

Phased array probes can be used to inspect the entire weld volume with a single-pass scan. High speed, accuracy, and versatility make phased array a popular technique for FSW inspection.

For example, to inspect for longitudinal flaws, two 10-MHz, 64-element transducers with 45-deg shear wave angles are used. The first probe's orientation is skewed 90 deg, and the second is skewed 270 deg from the weld center line.

To inspect for transverse flaws, two 10-MHz, 128-element transducers with 45-deg shear wave angles are used. These probes are mounted laterally to cover the weld zone completely, skewing one probe at 0 deg and the second at 180 deg from the weld center line.

Water wedges are the most efficient way to couple and contour along the inspected component. These closed-chamber boxes hold the sensors at precise angles, efficiently couple to the part, and recuperate water for minimal water loss.

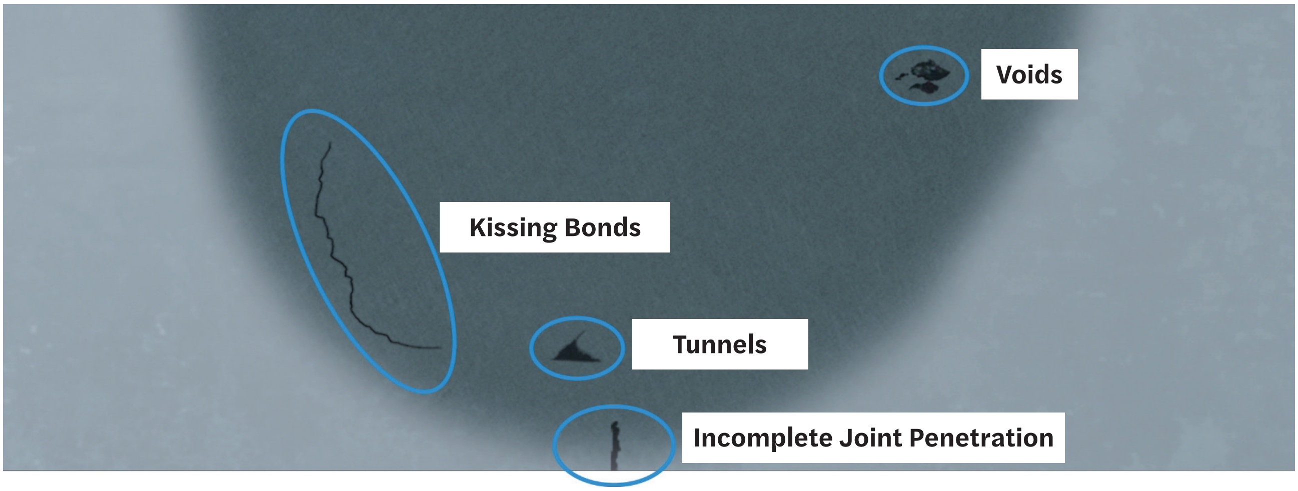


Fig. 2 — Cross section of a friction stir weld and examples of typical flaws.

The phased array probes and wedges can be mounted on an inspection head that positions the probe-wedge assemblies for full weld coverage. Figure 3 shows how each probe can be precisely mounted to create a single-pass inspection. The inspection head is designed to provide optimal and uniform pressure across all the sensors; it is compact to access tight areas and retracts the sensors to avoid areas that are not a target for testing.

Detection Capability

Using the phased array probe configuration shown in Fig. 3, small flaws with a high single-to-noise ratio (SNR) can be detected. Figure 4 shows the scan results for a typical calibration standard for FSW inspection. On the most minor flaws (0.13 mm [0.005 in.] deep × 0.25 mm [0.009 in.] wide × 1.27 mm [0.05 in.] long), a 14-dB SNR can be achieved. On the most significant flaws (0.51 mm [0.02 in.] deep × 0.25 mm [0.009 in.] wide × 2.16 mm [0.085 in.] long), an SNR of up to 33 dB is achieved.

Automated FSW Inspection

Although phased array is a highly efficient inspection technique, automation is required to provide positioning precision, remove operator dependency, and maintain production speed requirements for manufacturing. Using stationary collaborative robots, shown in Fig. 5, results in a workflow that efficiently calibrates before and after inspection, accurately places sensors on inspection components, and manages water coupling and recuperation. Such systems enable you to achieve the FSW inspection results shown in Fig. 4 at 75 mm (2.95 in.) per second or higher speeds.

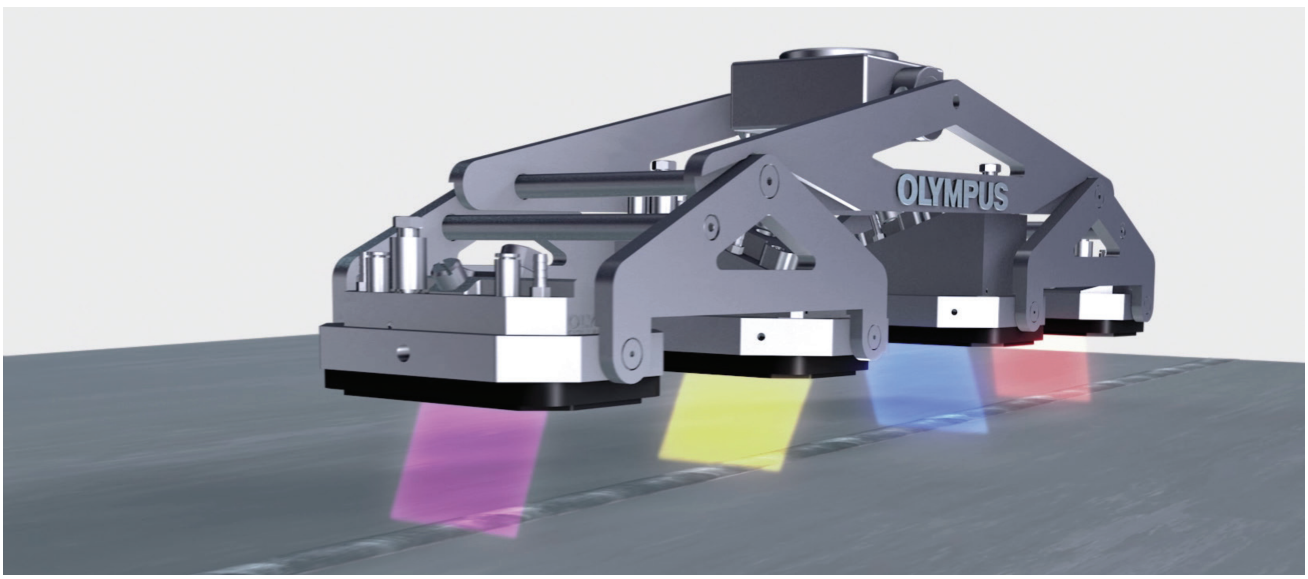


Fig. 3 — Friction stir welding inspection head.

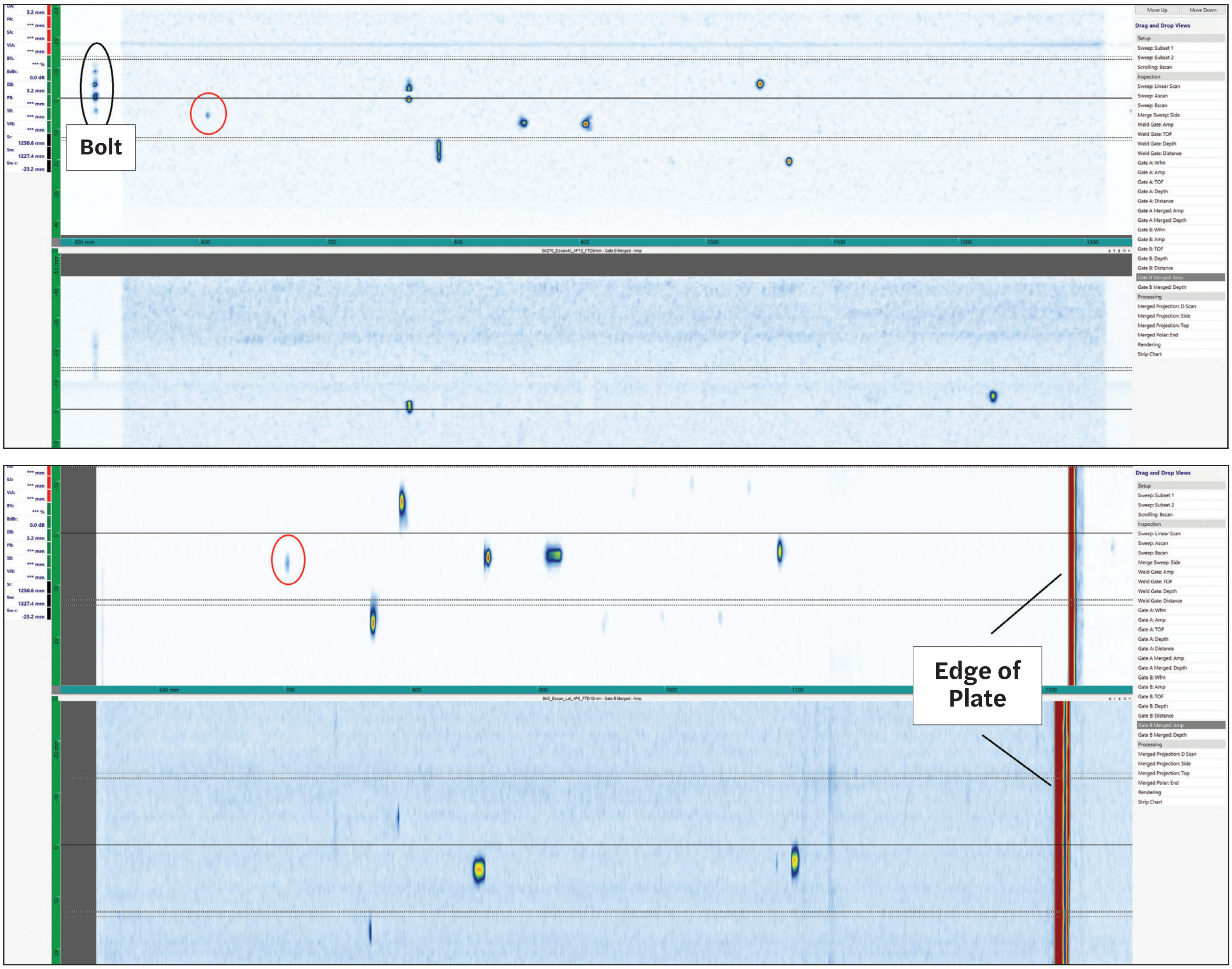


Fig. 4 — Phased array inspection results on a calibration standard showing six transverse, longitudinal, and oblique notches 0.25 mm [0.009 in.] wide × 2.16 mm [0.085 in.] long, four 45-deg 1.8 mm [0.071 in.] flat-bottom holes, and two small notches (circled in red) 0.25 mm [0.009 in.] wide and 1.27 mm [0.05 in.] long.

Factory 4.0 Inspection System

Factories of the future require dynamic use of floor space to optimize resources and production workflow. Like the one shown in Fig. 5, stationary collaborative robot inspection systems are ideal tools when production environments allow for dedicated space. However, through innovations with automated guided vehicles (AGVs), it is now possible to combine the benefits of phased array and collaborative robots with the portability of AGVs. Figure 6 shows how all these technologies can be combined. Using this method, the inspection can be transported to the components rather than the components to the inspection station. This also expands the possibility for aerospace manufacturers to harness the power of phased array and automation for friction stir welding inspection. IT

Fig. 5 (left) — Collaborative robot (cobot) phased array inspection system. Fig. 6 (right) — Phased array automated guided vehicle inspection system.

JEFFREY WELLS (*jeffrey.wells@evidentscientific.com*) is systems and integrations sales manager of the Americas at Evident Industrial, Waltham, Mass.

HOBART INSTITUTE OF WELDING TECHNOLOGY

UPSKILL YOUR TEAM

CUSTOMIZED TRAINING AVAILABLE

Visit us online:
www.welding.org
hiwt@welding.org

©2023

400 Trade Square East, Troy, OH 45373
Phone 937.332.9500 • Fax 937.332.9550

State Board of Career Colleges and Schools Registration No. 64

Hobart Institute of Welding Technology is a 501(c)3 non-profit corporation

Hobart institute of Welding Technology does not and will not discriminate on the basis of disability, race, color, religion, sex, national origin, or age.

BY PATRICK TREMBLAY

Combining PHASED ARRAY ULTRASONIC TESTING AND TIME-OF-FLIGHT DIFFRACTION to Increase Productivity

The challenges and benefits of integrating these technologies into a production workflow are examined

In the contemporary landscape of economic models, the prevalence of the just-in-time manufacturing approach has induced a profound transformation. This shift places immense pressure on the supply chain to attain efficiency. Tasks that do not directly contribute to an immediate escalation in production throughput often incur the disdain of upper management. Within this context, material welding introduces a conundrum wherein nondestructive examination (NDE) is begrudgingly acknowledged, at best, as a necessary inconvenience and, at worst, as an adversary of productivity. This article explores technologies that exert far less disruption on welding production.

Current Situation

One of the predominant inspection methods employed in welding applications is radiographic testing (RT), which has held its ground for decades in verifying the weld integrity of manufactured equipment and structures. As a well-established volumetric nondestructive inspection approach, RT enjoys widespread endorsement from major inspection codes and certifying bodies worldwide, boasting a documented history of effectively detecting volumetric flaws such as porosities. While its merits are widely recognized, so too are its drawbacks. One notable challenge lies in using radioactive sources, necessitating the clearance of the weld vicinity to mitigate radiation safety concerns. This clearance requirement, undoubtedly disruptive to production, often prompts inspections to be relegated to night shifts when the premises are unoccupied. Additionally, the traditional film-based RT requires film processing, leading to a considerable time gap between the inspection procedure and the final determination of weld acceptance or rejection.

Replacement Option

With the continuous evolution of codes and standards, a shift from conventional film radiography to advanced ultrasonic testing has garnered significant attention for both manufacturing and in-service inspection of welds (Ref. 1). Beyond the evident safety advantages over RT, this transition also brings about heightened productivity and reduced implementation costs, driving the swift adoption of alternative ultrasonic techniques (Ref. 2).

The current pinnacle of this progression involves phased array ultrasonic testing (PAUT) and time-of-flight diffraction (TOFD) (Ref. 3). The synergy between these methods presents a robust and dependable approach to weld inspection. The amalgamation of these techniques guarantees a high probability of defect detection and precise sizing. It retains flexibility in addressing practical challenges frequently encountered in the field, such as unconventional joint geometries or minor deviations from nominal specifications (Ref. 4).

This volumetric inspection technique offers two principal advantages in contrast to the established conventional film RT method. First, it eliminates radiation hazards. Second, the analysis results are swiftly accessible, allowing NDE teams to collaborate seamlessly with welding crews. This real-time feedback mechanism aids productivity by minimizing the occurrence of subpar welds.

Over the past decade, PAUT and TOFD have conclusively proven their worth as alternatives to RT across various weld inspection applications and global markets, receiving recognition from multiple certifying bodies. Notably, each technique has distinct strengths concerning the types of defects it's most attuned to. RT excels in detecting volumetric flaws such as porosities or slags, whereas PAUT outperforms RT in identifying planar defects such as cracks. Consequently, a meticulous assessment of the inspection technique should ideally be performed on a case-by-case basis.

While it's possible to perform PAUT and TOFD inspections sequentially, concurrently utilizing these methods offers many advantages that make any other approach counterproductive. This approach not only enhances the efficiency of inspection crews by minimizing the number of scans and manipulations required but also significantly impacts data quality. Sequential application often challenges maintaining identical mechanical references, such as scan starting positions and offsets from the weld center line. This variance can lead to imprecise indication positioning. Additionally, using different scanners for PAUT and TOFD, each with distinct encoder calibrations, might result in inaccuracies in length sizing of indications.

However, practically implementing simultaneous PAUT and TOFD is a more complex endeavor than it may appear. Let's discuss the numerous challenges inherent in effectively executing such an inspection while examining a recently developed system to address these challenges.

Technique Combination Challenges

PAUT and TOFD techniques require distinct hardware and software requisites tailored to each method. While the market offers various inspection systems dedicated solely to PAUT or TOFD, concurrently, the scarcity of options excelling in both techniques is evident. Addressing these technique-specific disparities presents challenges, particularly concerning operator training and proficiency.

An intriguing challenge arises from the dissimilarities between PAUT and TOFD techniques — the expertise of a PAUT-focused operator might not seamlessly extend to calculating precise probe-center separation (PCS) values for specific TOFD configurations nor to accurately interpreting TOFD data. Similarly, an adept TOFD operator might encounter difficulties configuring sectors or electronic scans for PAUT. Consequently, a typical inspection scenario involves the involvement of two specialized operators.

The complexity of a scanning device accommodating the concurrent application of PAUT and TOFD is noteworthy. At a minimum, the scanner must accommodate four search units comprising two PA probes and a TOFD pair. However, as the material thickness increases, TOFD inspections necessitate multiple depth zones, entailing more TOFD probes and an expanded PCS to cover the volume of interest comprehensively. To optimize inspection efficiency, particularly when assessing thin-wall and heavy-wall components within a single shift, the scanner must offer flexibility to cater to a wide range of thicknesses. This adaptability enhances the effectiveness of the inspection team, contributing to streamlined operations.

A Portable System with Embedded Software

A portable PAUT and TOFD system that combines both techniques with embedded software and a versatile modular scanner represents a solution. The TOPAZ® product family (Fig. 1) and Gekko® (Fig. 2) are battery-operated systems that handle various applications.

Fig. 1 — The TOPAZ64 PAUT portable system.

Fig. 2 — The Gekko flaw detector.

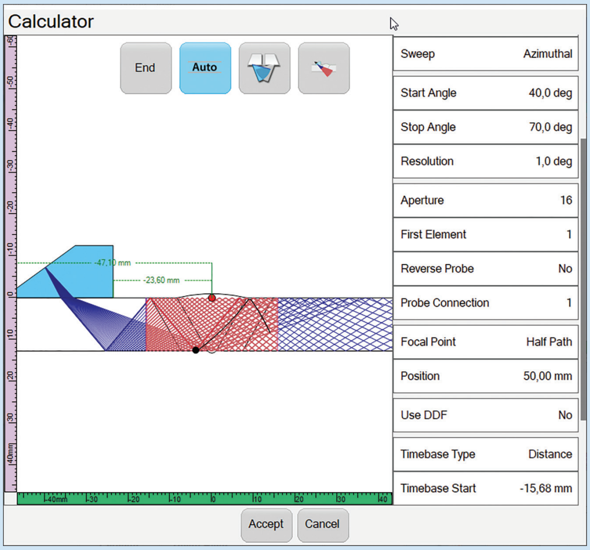


Fig. 3 — The PAUT software platforms offer a suite of analysis tools that include functionalities such as volumetric merging, gate selectors, automatic amplitude-drop sizing, and synchronization and elimination of TOFD lateral waves.

One of the main software improvements of this inspection platform is the visual feedback integrated into setup creation — Fig. 3. The onboard calculator simplifies the development of a comprehensive scan plan and evaluating volume coverage, encompassing even the heat-affected zone. In contrast, the initial-generation systems necessitate executing this phase within PC-based software and transferring it manually to the embedded system.

Reporting remains a pivotal task of the inspection process. Modern software platforms allow users to generate an indication table swiftly and produce customizable, print-ready PDF reports. Data analysts can now pick information for inclusion in reports — from hardware settings and scan plans to indication specifics — and also append personalized fields.

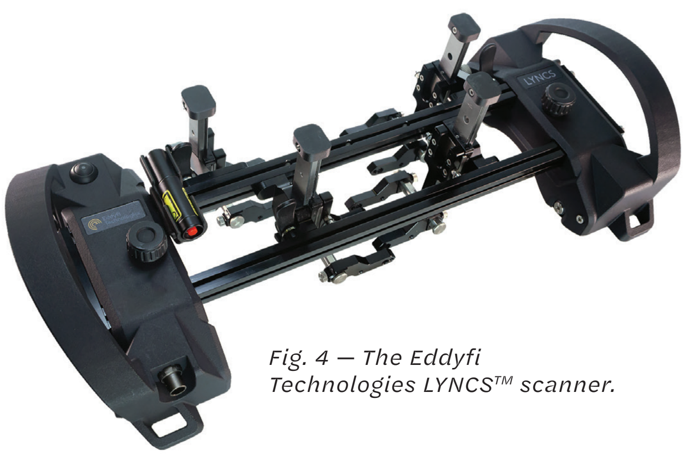


Fig. 4 — The Eddyfi Technologies LYNCS™ scanner.

Modular Scanner

During an inspection campaign, the size and geometry of the welds can vary a lot. To maximize the efficiency of the inspection crew, the scanner used for the simultaneous use of PAUT and TOFD needs to adapt to as many inspection configurations as possible — Fig. 4.

The basic LYNCS scanner kit allows the two-sided inspection of circumferential welds from nominal pipe size four (NPS 4) and up, and up to two in. for thicknesses. Its compact design allows it to operate in clearances as low as 4.3 in., increasing its application range. The adjustable tensioning system of the four probe holders allows adequate coupling to the inspection surface in all conditions.

For thicknesses larger than two in., the TOFD inspection is usually performed in more than one zone. Therefore, when used simultaneously with PAUT, more than four probe holders are required. Also, larger PCS values are required to cover the bottom of the volume of interest. Optional extension kits are available to extend the range of applicability of the scanner for thicknesses up to six in. When axial welds need to be inspected, the scanner can be converted using an optional mechanical part. In its axial configuration, the scanner allows the inspection of longitudinal seam welds.

Conclusion

Substituting PAUT and TOFD for RT in weld inspection eradicates radiation hazards and facilitates prompt feedback to the welding team. This can enhance production rates while reducing expenses related to substandard outputs. The simultaneous use of PAUT and TOFD is a compelling inspection method for welded joints. IT

Works Consulted

1. Frost & Sullivan. 2013. Replacement of radiography by phased array ultrasonic testing drives global ultrasonic NDT equipment market, analysis of the global ultrasonic nondestructive test equipment market. Mountain View, Calif.
2. Chauveau, D., Blettner, A., Cadith, J., and Rivenez, J. 2011. Comment, pratiquement, améliorer la radioprotection des opérateurs CND par l'utilisation d'autres méthodes et/ou techniques? COFREND, Dunkerque, France.
3. Hatsch, J., Chauveau, D., and Blettner, A. 2008. Méthodes alternatives à la gammagraphie à l'Iridium, projet alter-X. COFREND, Toulouse, France.
4. Laprise, F., Berlanger, J., and Maes, G. 2012. Sectorial scan PAUT combined with TOFD, a robust weld inspection technique in lieu of RT. 18th Conference on Nondestructive Testing, Durban, South Africa.

PATRICK TREMBLAY *(ptremblay@eddyfi.com)* is senior UT applications expert at Eddyfi Technologies, Quebec, Canada.

Statement of Ownership, Management, and Circulation for U.S. Postal Service (Required by U.S.C. 3685)

1. TITLE OF PUBLICATION: Inspection Trends
2. PUBLICATION NO.: ISSN 1523-7168
3. DATE OF FILING: October 4, 2023
4. FREQUENCY OF ISSUE: Quarterly
5. NO. OF ISSUES PUBLISHED ANNUALLY: 4
6. ANNUAL SUBSCRIPTION: $45.00
7. MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION: 8669 NW 36 St., #130, Miami, Miami-Dade County, Florida 33166
8. MAILING ADDRESS OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS:
   8669 NW 36 St., #130, Miami, FL 33166
9. NAMES AND COMPLETE ADDRESS OF PUBLISHER, EDITOR, AND MANAGING EDITOR:
   PUBLISHER: Annette Alonso, AWS, 8669 NW 36 St., #130, Miami, FL 33166
   EDITOR: Carlos Guzman, AWS, 8669 NW 36 St., #130, Miami, Fl 33166
10. OWNER: NAME: American Welding Society Inc. ADDRESS: 8669 NW 36 St., #130, Miami, FL 33166
11. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES, OR OTHER SECURITIES: None
12. The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes: Has not changed during preceding 12 months
13. Publication Title: Inspection Trends
14. Issue Date for Circulation Data Below: August 2022
15. EXTENT AND NATURE OF CIRCULATION:

	Average No. Copies Each Issue during Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies Printed (Net Press Run)	36,658	41,100
B. Paid and/or Requested Circulation		
1. Paid/Requested Outside-County Mail Subscriptions Stated on Form 35	36,220	39,884
2. Paid In-County Subscriptions Stated on Form 3541	None	None
3. Sales through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution	None	None
4. Other Classes Mailed through the USPS	None	None
C. Total Paid/Requested Circulation	36,220	39,884
D. Free Distribution by Mail (Samples, Complimentary and Other Free)		
1. Outside-County as Stated on Form 3541	None	None
2. In-County as Stated on Form 3541	None	None
3. Other Classes Mailed through the USPS	15	10
4. Free Distribution Outside the Mail (Carriers or Other Means)	None	None
E. Total Free Distribution	15	10
F. Total Distribution	36,235	39,894
G. Copies Not Distributed	423	1206
H. Total	36,658	41,100
I. Percent Paid and/or Requested Circulation	99.96%	99.97%

16. Statement of Ownership will be printed in the Fall November 2023 issue of this publication.
   I certify that the statements made by above are correct and complete:
   Annette Alonso, Publisher

THE ANSWER IS

BY ALBERT J. MOORE JR.

Q Your last article stirred up a firestorm at our facility. We need to know whether or not our Level III can fulfill the requirements of NAVSEA standards with regards to training, qualifying, and certifying our nondestructive examination (NDE) personnel; providing welder workmanship training and written examinations; developing NDE procedures; and signing documents that require approval by an Examiner.

A I'll respond to your inquiry the best I can. I'm not holding myself as an expert, so I preface my response with the disclaimer that you should check with your customer to verify exactly what they are looking for because you may be working with a contract that was signed many years ago that invoked military standards or NAVSEA standards that were enforced at the time. If your procedures (i.e., your written practice, welding procedure specifications, nondestructive examination [NDE] procedures, and more) were approved, they are valid until the contract is fulfilled or completed. Should the customer issue a new contract for the same or similar product, the purchase order may invoke more recent NAVSEA standards and additional requirements that differ from the previous contract.

To respond to your concerns with regards to the Level III currently providing services to your employer, I will clarify the requirements using my words and not exact quotes. The statements I make are based on my understanding of the standards.

Currently, NAVSEA T9074-AS-GIB-010/271, *Requirements for Nondestructive Testing Methods*, Rev 1, applies to new and recent contracts. It is moving toward the terms NDT Operator, Inspector, and Examiner to differentiate between personnel qualified and certified in accordance with the requirements issued in September 2014 and NDE personnel qualified and certified in accordance with ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*, or ASNT's Central Certification Program (ACCP). Let's say the terminology is in transition.

The initial certification and recertification of the NDE-qualified person must be performed by an Examiner. NAVSEA T9074-AS-GIB-010/271, Rev 1, does state that the NDT Operator is equivalent to the Level I, the Inspector is equivalent to the Level II, and the Examiner is equivalent to the Level III. However, there are differences for an NDE-qualified person performing NDE in accordance with NAVSEA T9074-AS-GIB-010/271, Rev 1, or ASNT's SNT-TC-1A and ACCP. The written practice developed by the activity (contractor) must incorporate the modifications included in Rev 1. Those modifications stipulate that the recommendations regarding training, hours of relevant experience, etc. are considered minimum requirements. Another requirement is the questions for the examinations be based on standards that are applicable to the work performed for the Navy (i.e., NAVSEA and United States Military Standards [MIL-STDs]). In many cases, the fabrication documents would include NAVSEA technical publication S9074-AQ-GIB-010/248, *Requirements for Welding and Brazing Procedure and Performance Qualification*; T9074-AS-GIB-010/271; S9074-AR-GIB-010/278, *Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels*; MIL-STD-22D, *Department of Defense Design Criteria: Welded Joint Design*; and MIL-STD-2035A, *Department of Defense Test Method: Nondestructive Testing Acceptance Criteria*. Projects that involve building hull sections would need to include questions on NAVSEA T9074-AD-GIB-010/1688, *Requirements for Fabrication, Welding, and Inspection of Submarine Structure*, or MIL-STD-1689A, *Department of Defense Manufacturing Process Standard: Fabrication, Welding, and Inspection of Ships Structure*. These requirements are not invoked when the candidate is qualifying to SNT-TC-1A or ACCP.

Another requirement of NAVSEA T9074-AS-GIB-010/271 is that the certified individual must be recertified by examinations that are of equal difficulty as the initial examinations. NDT Operators and Inspectors must be recertified every three years, and the NDT Examiner must be recertified every five years. NDE personnel certified to SNT-TC-1A:2020 can be recertified at five-year intervals by their employer through continued satisfactory performance or by taking one or more examinations as deemed appropriate by the Level III.

The bottom line is that an individual qualified and certified to SNT-TC-1A (without the inclusion of the modifications required by NAVSEA T9074-AS-GIB-010/271) or ACCP is not qualified to NAVSEA requirements. The Level III qualified to SNT-TC-1A or ACCP is not qualified to approve or sign for the welder workmanship training or NDE procedures or qualify and certify NDE personnel if NAVSEA T9074-AS-GIB-010/271, Rev 1, is invoked by the customer. Only an NDT Examiner who has been qualified by another NDT Examiner can qualify or certify NDE personnel. The Examiner must be qualified and certified for the NDE method before qualifying and certifying another individual for that NDE method. IT

ALBERT J. MOORE JR. (*amoore999@comcast.net*) is president and owner of NAVSEA Solutions/Marion Testing & Inspection, Burlington, Conn. He is an AWS Senior Certified Welding Inspector, an NDT Examiner per NAVSEA TP271, and an ASNT SNT-TC-1 Level III. He is also a member of the AWS Qualification & Certification Committee and the B1 Committee on Methods of Inspection.

CLASSIFIEDS / ADVERTISER INDEX