IT INSPECTION TRENDS

MAY 2025

THE MAGAZINE FOR MATERIALS INSPECTION AND TESTING PERSONNEL

What CWIs Must Know about the Latest AWS A3.0

How to Correctly Use Welding Symbols for Slotted Hollow Structural Steel Members

New SCWI Credential Path

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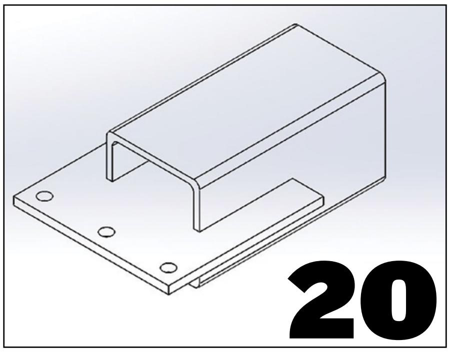


The Evolution and Impact of the CWI Roundtable

BRIAN WALL

Have you ever found yourself navigating the complex world of the Certified Welding Inspector (CWI) industry, yearning for more resources to discuss intricate codes? Have you dreamed of a place where you could meet peers, industry experts, and seasoned professionals to tackle various scenarios and codes? Imagine an event dedicated to enhancing your understanding, deepening your knowledge, and clarifying your doubts.

In 2011, CWIs Rich Harris and Louis Verhas saw this very need. By 2012, they turned their vision into reality with the birth of the CWI Roundtable. What started as a small gathering of three to four members, graciously hosted by Babcock and Wilcox, an energy technology and service provider based in Akron, Ohio, and Lincoln Electric, quickly gained momentum.

Fast forward to today, the CWI Roundtable has expanded tremendously. The event has fostered a vibrant community thanks to its members' dedication to AWS's mission of "advancing the science, technology, and application of welding and allied joining and cutting processes worldwide, including brazing, soldering, and thermal spraying." At the Roundtable, CWIs can share insights and exchange knowledge.

Community engagement in welding and allied processes is a game-changer. It facilitates knowledge sharing, enhances problem-solving, and builds valuable networks that support professional development. We've seen firsthand how Roundtable discussions drive innovation, foster motivation, uphold quality and safety standards, and advocate for the interests of welders and the industry. Through a culture of collaboration, learning, and continuous improvement, we've built a dynamic, resilient network of professionals that welcomes everyone from novices to seasoned Senior CWIs.

Our social events, which provide attendees with professional development hours, cover a diverse range of topics. For those experienced in the field, these events offer in-depth discussions and exploration. For those seeking to expand their knowledge, the events provide a friendly and professional environment to dive into new subjects. A recent topic included special additives specifications and their developments with the latest technology. We've delved into the importance of CWI endorsements and explored new code changes. Our events also offer hands-on opportunities, ensuring participants gain practical experience.

The CWI Roundtable now spans District 10, with new hosts eagerly accommodating meetings. By rotating venues and hosts, members can stay connected to their home sections while expanding their networks district-wide. We're always on the lookout for fresh ideas and topics along with anyone interested in speaking or hosting. This constant influx of new perspectives and volunteer efforts keeps the Roundtable dynamic, relevant, and beneficial for all.

For more information on the CWI Roundtable, email Brian Wall at *bawall5@yahoo.com*.

BRIAN WALL (*bawall5@yahoo.com*), CWI/CWE, is the CWI Roundtable coordinator for District 10 and quality manager at Butech Bliss, Salem, Ohio.

ASNT and AWS to Expand Welding and NDE Training and Certification in India

The American Society for Nondestructive Testing (ASNT), Columbus, Ohio, and AWS, Miami, Fla., have signed a program agreement formalizing their collaboration to expand, develop, and implement training and certification activities for welding and nondestructive examination (NDE) professionals in India and the Middle East region. This agreement solidifies both organizations' commitment to address the growing demand for skilled professionals in these critical industries.

"This program agreement marks a significant milestone in our joint efforts to advance the NDT [nondestructive testing] and welding professions in India," said Neal Couture, ASNT CEO. "By combining our resources and expertise with AWS, we are creating a comprehensive training and certification ecosystem that will empower NDT and welding professionals and contribute to business growth in India."

This partnership will leverage the strengths of both organizations to provide quality training and certification opportunities. A key element of the agreement is reciprocal access to each other's authorized training and certification facilities. This will enable ASNT and AWS to conduct qualification and certification training and examination services at each other's approved locations, significantly increasing accessibility for professionals seeking to advance their careers.

ASNT, through its subsidiary ASNT India, operates a facility in Chennai, India, providing NDE education and certification. This existing presence, combined with AWS's expertise in welding education and certification, provides a strong foundation for expanding, developing, and implementing a wide range of training and certification activities for welding and NDE professionals in India and the Middle East.

"By combining AWS's established leadership and expertise in welding education and certification with ASNT's recognized leadership in NDT, we are creating a powerful platform for professional development in India and the Middle East," said Richard Arn, AWS vice president of welding and technology. "This collaboration addresses the growing need for highly skilled welding and NDT professionals, ensuring the region's industries have access to best-in-class training and certification."

ASNT and AWS will also establish a new training and certification center in Gujarat, India. This facility will serve as a hub for program activities, providing training and examination resources to individuals and organizations in the region.

AWS Hosts CWI Seminar

AWS held a Certified Welding Inspector (CWI) seminar from March 9 to 14 at its World Headquarters in Miami, Fla. Rick Monroe served as the seminar's instructor. Monroe is a Senior CWI, a Certified Welding Educator, the owner of National Welding Lab & Inspection, and an instructor at CT State Asuntuck.

The seminar attendees were Carlos Almeida Cabrera, Kurt Diehl, Jose Holguin, Ryan Leach, Henry Marcano, John Marousky, Matthew Mason, Jose Palmerin, Sean Sage, and Jaren Stidd.

The attendees of a CWI seminar pose outside of AWS Headquarters.

Wabtec to Acquire Evident's Inspection Technologies Division

Wabtec Corp., Pittsburgh, Pa., a provider of transportation solutions, has agreed to acquire Evident's Inspection Technologies division, Waltham, Mass. This division was formerly part of the Scientific Solutions division of Olympus Corp., a global provider of nondestructive examination, remote visual inspection, and analytical instruments solutions for mission-critical assets. Recognized for its brands and reference-standard technologies, Inspection Technologies brings complementary technologies to Wabtec's Digital Intelligence business.

The acquisition, valued at $1.78 billion (approximately $1.68 billion after tax benefits), is subject to customary adjustments. Wabtec anticipates completing the purchase of Inspection Technologies by the end of the first half of 2025.

With a 50-year history in advancing mission-critical applications, Inspection Technologies serves its global customer base through a geographically distributed sales force and four engineering and production facilities in North America and Japan with more than 1300 team members.

"The addition of Inspection Technologies aligns with our growth strategy to accelerate the innovation of scalable technologies, increase our installed base, expand high-margin recurring revenues, and continuously drive operational performance," said Rafael Santana, president and CEO of Wabtec.

Inspection Technologies' industry presence and product portfolio will expand Wabtec's capabilities with advanced automated inspection products. The integration will also leverage Wabtec's extensive software development expertise and engineering depth.

"The combination of our two skilled teams and complementary portfolios will accelerate the development of first-class intelligent monitoring solutions to meet the changing needs of the industries we serve," said Karen Smith, executive vice president of Evident Inspection Technologies.

Baron Mechanical Opens Weld Testing and Certification Center in Texas

Baron Mechanical has launched a new weld testing and certification facility in Port Arthur, Tex. This expansion supports industries that rely on high-quality welding with new and advanced testing equipment.

Baron Mechanical offers precision certification and consulting services at its new weld testing facility in Port Arthur, Tex.

The facility is outfitted with the latest welding and mechanical testing equipment, providing fast, accurate, and reliable results for clients in oil and gas, construction, and manufacturing. The investment includes high-precision machining tools for base material preparation, automated testing systems for efficiency, and the latest software for data analysis and reporting.

The facility is equipped to handle a wide range of weld qualification and certification services, including welder and welding operator qualification testing, welding procedure qualification testing, welding procedure specification development, and consulting for compliance and code requirements.

With multiple testing stations designed to accommodate shielded metal, gas tungsten, gas metal, and flux cored arc welding, Baron Mechanical can efficiently process weld tests with full material traceability and certification.

The company has invested in a full range of destructive and nondestructive weld examination equipment. Clients will receive detailed certified test reports to verify compliance with required codes.

Testing services include tensile and bend testing, Charpy impact testing, ferrite content analysis, hardness testing (Brinell, Rockwell, Vickers), metallographic examination, stress relieving (ASME compliant), and elemental analysis.

This investment in advanced equipment enables faster turnaround times, improved accuracy, and greater reliability for clients needing immediate weld certification.

ASNT Champions NDE on Capitol Hill

On March 10, the American Society for Nondestructive Testing (ASNT), Columbus, Ohio, hosted its first Day on the Hill event, bringing together members from across the nation to advocate for the critical role of nondestructive examination (NDE) on Capitol Hill, Washington, D.C. Key priorities included advancing workforce development initiatives to address the growing need for skilled NDE professionals and driving innovation and investment in the NDE industry.

ASNT members met with Congressional representatives and their staffs to discuss the importance of NDE in various sectors, including infrastructure, transportation, manufacturing, and energy. They emphasized the economic and safety benefits of utilizing NDE technologies and the need for continued support from policymakers.

"This event underscores the essential contributions of NDT [nondestructive testing] professionals in ensuring the safety and reliability of our nation's critical infrastructure, including bridges, pipelines, power plants, and transportation systems," said ASNT CEO Neal Couture. "We are eager to bring our members' expertise to Capitol Hill to advocate for policies that enhance public safety, strengthen our skilled workforce, and foster innovation and investment in the NDT field."

The two-day event began with a comprehensive training session to prepare participants with a thorough understanding of ASNT's advocacy agenda, legislative priorities, and effective communication strategies for engaging with policymakers. The day concluded with a networking reception.

On March 11, attendees participated in a series of scheduled meetings with members of Congress and relevant committees. These meetings focused on critical issues, including workforce development initiatives, infrastructure safety, and the increased need for skilled NDE professionals to meet the demands of industries such as aerospace, energy, and transportation.

"NDT professionals are at the forefront of protecting lives and ensuring the integrity of critical systems," said Garra Liming, ASNT director of public relations and government affairs. "ASNT on The Hill is an opportunity to amplify the voices of our members and advocate for the resources and policies that will empower the next generation of NDT."

ASNT's Day on The Hill highlights the organization's commitment to advancing the NDT profession, safeguarding public safety, and proactively addressing the challenges posed by a rapidly evolving workforce landscape.

USA DeBusk Adds CIMA Inspection

USA DeBusk, Deer Park, Tex., a provider of industrial services to energy and infrastructure sectors, has acquired CIMA Inspection, Pasadena, Tex., a nondestructive examination (NDE) services specialist serving customers nationwide. The acquisition enhances USA DeBusk's NDE inspection capabilities and expands its service offerings while also broadening CIMA Inspection's geographic reach and creating new opportunities for business growth and collaboration.

"We're excited to add CIMA's NDT [nondestructive testing] knowledge, expertise, and resources to our service portfolio," said USA DeBusk CEO Andrew DeBusk. "Combined with our existing NDT tube inspection capabilities and expansive line of complementary industrial services, we are able to offer customers unparalleled proficiency, efficiency, and value. In CIMA, we found an organization that fits our customer-first approach, and we are eager to bring this new level of synergy and service to the market."

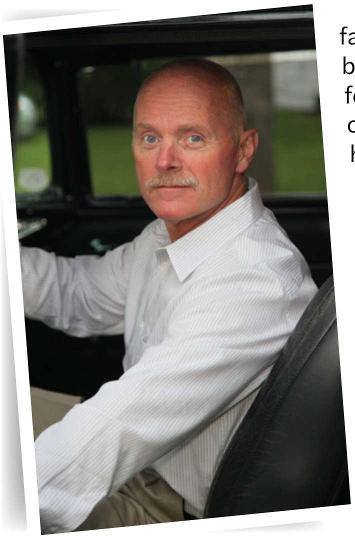
'We are excited to join forces with USA DeBusk and unite two workforces that are aligned in both their core values and their commitment to safety, integrity, and customer satisfaction," said CIMA Inspection CEO William J. Campbell. "Like USA DeBusk, CIMA is culture-driven, growth-oriented, and committed to continual improvement. Both organizations have long histories of service to the same core markets, giving us a combined knowledge base that will benefit customers and expand opportunities for NDT industry leadership."

The company's NDE inspection services will be branded as CIMA Inspection, a USA DeBusk Co.

BY KRISTIN CAMPBELL

Joining the Family Business + Utilizing CWI Skills = An Equation for Success

Robert W. O'Neal Sr. has turned his passion for inspection into a nearly 45-year career



Robert W. O'Neal Sr., a CWI since November 1991, has enjoyed a long career in the field.

Picture this: It's 1979, your father opens an inspection business, and you start working for him the next year, right out of high school. The rest, well, is history.

That is what happened to Robert W. (Bob) O'Neal Sr. when World Testing Inc. (*worldtesting.com*), Mt. Juliet, Tenn., was started by his father, Vernon O'Neal Sr.

In addition to now being a long-term CWI, he's an ASNT NDT Level III and enjoys participating in the AWS Nashville Section. Learn about O'Neal's meaningful career in the family-owned-and-operated business.

Working with Family and Inspecting Various Projects

World Testing has grown over the years to cover both destructive and nondestructive examination (NDE) along with structural inspection. The company performs services in its labs and on customers' sites, whether a sample or production part is sent, or brings a mobile darkroom or other portable equipment to a site. In addition, World Testing is a subcontractor for construction and engineering firms throughout the United States. Its main office is in Mt. Juliet, Tenn., and its field office is in Millington, Tenn.

O'Neal's interest in inspection began after learning several NDE methods, then he became involved with visual inspection.

"I enjoy performing inspections because of the value my work adds to the products that I inspect, ensuring they meet the code requirements that the end user expects," O'Neal said.

Wanting to become a CWI was born from shadowing his father on several structural steel projects.

"He gave me the appropriate study materials and personally taught me the art of being a good inspector," O'Neal emphasized — Figs. 1 and 2.

In November 1991, O'Neal achieved CWI status. His favorite inspection method is magnetic particle testing (MT). "It's relatively simple, but very rewarding when you find a defect," O'Neal said.

When his father passed away in 2002, he took over the business with his brother, Vernon L. (Butch) O'Neal Jr. They honor their father by running the company the way he taught them, focusing on honesty and integrity.

"I've worked on many types of projects over the years," O'Neal shared, "ranging from the Supercompactor that went to the Advanced Mixed Waste Treatment Project in Idaho to a 100-ton hydraulic crawler crane in Dubai. The Dubai job really put the 'world' in World Testing."

Fig. 1 — The father and son team are photographed in the early 1980s.

Fig. 2 — In this historic image, Vernon O'Neal Sr. performs ultrasonic testing calibration.

Fig. 3 — This very large top head for a reactor vessel in Louisiana underwent RT.

Fig. 4 — O'Neal's favorite project has been helping to restore the No. 576 Steam Locomotive in Nashville, Tenn.

The team also performed radiographic testing (RT) for Contract Fabricators Inc., based in Mississippi, on a very large top head for a reactor vessel in Louisiana — Fig. 3. There's a video on the company's YouTube channel with a time lapse of this vessel going together, labeled Complex Fabrication - FCC Reactor - Large Assembly. Overall, the vessel was 116 ft long and 28 ft in diameter.

His favorite project has been supporting the restoration of the No. 576 Steam Locomotive in Nashville, Tenn. — Fig. 4. Hardness testing, positive material identification, MT, and radiography were performed on this 1942 train. View the video by Nashville Steam, available on their YouTube channel, labeled No. 576 - The Road to Revival, Episode 4. In the segment, O'Neal details the MT process and testing for cracks on the very large connecting rods on the wheels. "My great grandfather worked on the railroad as a shop worker, so that's a little bit of our inspiration to give back," O'Neal pointed out.

Currently, O'Neal serves as the president of World Testing, but he rarely tells people that and prefers to focus on the important work being done. His brother, Butch, is the general manager and Vernon L. (Trey) O'Neal III, Butch's son, is the field services manager. Overall, there are 28 employees, including eight CWIs. The management team has more than 150 years of NDE experience.

"I've worked here for almost 45 years," O'Neal said. "My day-to-day is primarily filled with my role of supporting the great group of employees who make up the team. At this point in my career, my aim is to help them achieve their career goals. I have the opportunity to speak with many of our clients about their welding programs and how I can help them with code compliance."

The biggest challenge the business faces is finding individuals who are already qualified and can make contributions from day one.

"Because of this, we train and certify our own personnel to perform various NDE methods as we prepare them to become welding inspectors," O'Neal said.

Giving Good Advice

O'Neal's words of wisdom for current and future CWIs, after being one for more than 30 years, are as follows:

"Don't limit yourself to one area of inspections. Broaden your knowledge on inspections and welding with various codes and standards to ensure your future success."

These methods sure haven't let him down.

The Sky's the Limit

Looking forward, O'Neal said, "I see myself doing more teaching than performing inspections. The good thing about working at a testing lab is that you see and use a wide range of codes and standards."

Most often, projects require adhering to customer specifications and the following AWS codes: D1.1, *Structural Welding Code — Steel*; D1.2, *Structural Welding Code — Aluminum*; D1.3, *Structural Welding Code — Sheet Steel*; D1.4, *Structural Welding Code — Steel Reinforcing Bars*; AASHTO/AWS D1.5, *Bridge Welding Code*; D1.6, *Structural Welding Code — Stainless Steel*; and D17.1, *Specification for Fusion Welding for Aerospace Applications*.

In addition, O'Neal said World Testing loves being an AWS Sustaining Corporate Member, which enables the business to have online access to AWS standards.

Parting Thoughts

Below are more words from O'Neal that pay tribute to his father and also reflect on being part of the AWS Nashville Section.

"I started my NDE career at an early age," he said, "and I remember going to AWS Nashville Section meetings with my father in the early '80s. I didn't realize at the time how much of an opportunity it was to network with other members."

And after serving for 17 years as the Nashville Section treasurer, he concluded, "It's not difficult to realize how blessed I've been to have met so many good people in the industry." IT

KRISTIN CAMPBELL *(kcampbell@aws.org)* is managing editor of *Inspection Trends.*

BY ALBERT J. MOORE JR.

Q We're welding stainless pipe and getting sugaring on the inside diameter. We are tigging the root, and like everyone else, we're using argon for the shielding gas. It is an open root, so no backing ring is involved. We're purging the inside diameter with argon, but we are still seeing sugaring there. The customer is concerned that the molecules are being disrupted and the material is no longer stainless. What is the story?

A First, what's this tigging you're speaking of?

Next, you are welding stainless steel, so my question is, what type of stainless steel? There are several families. We have the ferritic stainless steel that contains more than 11% chromium. It is ferromagnetic and corrosion resistant. The crystalline structure is body-centered cubic at room temperature and contains insufficient carbon to respond strongly to quenching.

We have martensitic stainless steel, which is similar to ferritic stainless steel. It contains at least 11% chromium but has more carbon than the ferritic stainless steel. It is hardenable when cooled quickly, and some are air-hardenable. When hardened, the crystalline structure is body-centered tetragonal (shaped like a shoe box). It, too, is ferromagnetic.

The third family is used extensively by industry: austenitic stainless steel. It contains at least 11% chromium and enough nickel additions to retain the face-centered cubic crystalline structure at room temperature. Generally, austenitic stainless steel is not strongly magnetic, doesn't contain sufficient carbon to respond to quenching, and can form some martensite when cold worked. It is noted for its good ductility, slightly higher strength over low-carbon steel, and good corrosion resistance.

Duplex stainless steel has a crystalline structure containing both body-centered cubic and face-centered microstructures at room temperature. It is stronger than austenitic stainless steel and more resistant to sensitization when welded. That means, if it is welded following the proper procedure, it is less prone to intergranular stress corrosion and cracking. Alas, if you don't weld it properly, you can end up with some Sigma phase, which makes it somewhat brittle. And all those good properties? Well, suffice to say the outcome isn't pretty.

Then, there is the precipitation-hardened stainless steel that is hardenable when heated to a high temperature, forcing the alloying constituents to go into solution, and then it is quenched. This creates a supersaturated state with the alloying constituents. We're not done yet; we have to heat it to a low temperature to trigger precipitation. The response is more of a clumping action where some of the alloying constituents form small clumps within the atomic lattice, thereby distorting the lattice. That, in turn, increases the strength of the alloy system. Once again, if the proper welding procedure isn't followed, the clumped alloys will precipitate to the grain boundaries, thereby weakening the affected region. One secret to successful welding is to order the precipitation stainless steel in the annealed condition so it can be formed, welded, and heat treated to produce optimum strength.

The common feature of all stainless steels is their improved corrosion resistance compared to carbon and high-strength low-alloy steels. Chromium provides corrosion resistance through a mechanism called passivity, which is the ability to form chromium oxides when the alloy is exposed to oxygen. If the protective oxide layer is disturbed, chromium immediately oxidizes to provide corrosion resistance.

Passivation is not the same as the property of passivity. The element in austenitic stainless steel that offers very little in the way of promoting corrosion resistance is iron. So, passivation is a process where the surface of the austenitic stainless steel is treated with an acid to remove the iron from the exposed surface, leaving a very thin (a couple of Angstroms) layer of chrome and nickel that improves the corrosion resistance of the metal. This thin layer can be easily damaged, destroying the benefit of the passivation process.

In a nutshell, to retain the superior corrosion resistance of stainless steel, we have to protect the surface from conditions that could prevent the clean formation of chromium oxide. Thus, we need to protect the surface of the stainless steel while welding it. The side of the joint we're welding on is protected from excessive oxidation by the argon used as our shielding gas to protect the molten weld pool. If one is welding with the shielded metal arc, submerged arc, or flux cored arc welding processes, the slag layer protects the molten weld pool, as does the CO_2.

On the inside of the pipe or the opposite side of the sheet or thin plate, there is little in the way of a protective barrier. The absence of an effective barrier allows the hot metal to become severely oxidized.

Isn't it the chromium oxide that gives us the passivity (i.e., the corrosion resistance of stainless steel) we want?

You hit the nail on the head. The hot chromium is exposed to oxygen, and it does oxidize. In a dry environment, all is good. The chemistry of the underlying alloy is not affected; it is still what it was before welding, and the mechanical properties are still what they were. The problem arises when the piping is placed into service and a liquid that is considered an electrolyte is introduced into the pipe. The base metal that wasn't heated to a high temperature is what it always was: stainless steel with a thin, clear, protective layer of chromium oxide. However, the surfaces exposed to the high temperature of welding and oxygen are heavily oxidized, but they are composed mainly of chromium oxide, nickel oxide, and iron oxide. The oxide doesn't have the same chemical composition as the oxide coating of the unaffected base metal. Therein lies the problem.

The issue is galvanic corrosion. Two different metals in the presence of an electrolyte create a battery — that's right, a battery that produces electricity. The voltage potential between the unaffected base metal and the heavily oxidized root surface is the source of our corrosion problem.

I've performed demonstrations for welders and inspectors in which I fill several plastic cups with salt water (or vinegar and water) and then take welding filler metal, one of carbon steel or austenitic stainless steel and the other aluminum wire, connect them with wire to form several voltaic cells in series, and successfully light up an LED. Remember the potato or lemon battery you made in science class back in grade school? It's the same thing here.

The purpose of purging the inside of a pipe while we weld it is to protect the root from oxidation while we deposit the root bead and the second (maybe even the third) layer of the weld. The idea is to have the inside surface of the pipe (or the opposite side of the weld joint) protected from oxidation so that both the inside of the pipe and the root bead have the same degree of oxidation. If the oxidation level is the same for the inside surface of the root bead and pipe, no galvanic action results when an electrolyte is introduced.

The secret is to reduce the oxygen level to prevent excessive oxidation while welding. This is true with other metals besides stainless steel, such as titanium, zirconium, etc. Still, those are reactive metals whose mechanical properties are adversely affected if they are exposed to even small amounts of oxygen while welding, so proper purging is absolutely necessary when welding them.

How do we ensure the level of oxygen is low enough to prevent oxidation (sugaring or decarbonizing in less-trained circles)?

We have to displace the air inside the pipe. Air comprises both nitrogen and oxygen in the proportions of about 80% nitrogen and 20% oxygen. Generally, the open ends of a pipe spool are blocked off with tape or plugs. Enough argon is fed into the pipe to displace the air, reducing the oxygen to a level low enough to prevent oxidation. Argon is heavier (more dense) than air, so the argon settles toward the bottom of the pipe and displaces the air upward. Only if it was this easy. The truth of the matter is that argon and air are going to mix. It has something to do with Charles Dalton and a few other notable men of years gone by who were messing around with gases in their spare time. So, assuming the gases will thoroughly mix, we can estimate how many times we have to displace the air volume in the pipe spool to reduce the oxygen to a tolerable level (see the table below).

Let's assume there is 20% oxygen inside the pipe spool. We displace the air volume by 1, and the percentage of oxygen is reduced to 10%. Once again, we displace the volume of gas in the pipe spool; the rate of oxygen is 5%. Displace again and oxygen is down to 2.5%; again, 1.25%; again, 0.625%; again, 0.31%; and so on. This assumes complete mixing of the gases with no leakage (because we taped the joints).

Let's play with this a bit. The math is not that hard. Let's start with a 6-in. pipe that is 10 ft long. We want to calculate how long we need to purge the pipe spool using argon at a specified flow.

Let's assume we set the flow meter on the argon tank used for the purge to 20 ft^3/h.

It is easy enough to figure out how many hours of argon flow is required to sufficiently reduce the oxygen level if we know the volume of the pipe spool. Then, we multiply the hours by 60 to get the minutes of flow needed.

Let's try an example:

- 6-in. pipe: 3-in. radius (never mind the wall thickness, it isn't significant)
- Area of I.D.: Area = πr^2 or $3^2 \times 3.1416 = 28.27$ in.$^2 \approx 29$ in.^{2}
- Volume: V = Area × length, where the length of the spool is 10 ft = 120 in.

So, $V = A \times L = 29 \times L =$ 29 in.^{2} × 120 in. = 3480 in.^{3}.

Convert cubic inches to cubic feet: 3480 in.$^3/12^3 = 2$ ft^3.

To reduce the oxygen to no more than 0.25%, we need to displace the volume of the pipe spool by a factor of 7 times.

$7 \times 2 = 14$ ft^3 of argon. At a flow rate of 20 ft^3/h, 14⁄20 = 0.7 hours.

Convert hours to minutes: 0.7 h × 60 min/h = 42 min of purge time.

That calculation did not consider any gas leakage at the joints. Lesson: Tape all the weld joints except the one you are welding. Peel the tape from the joint you are welding as you progress around the joint.

Remember, argon is heavier than air, but we assume gases are mixed thoroughly, so you need to allow the air/argon mixture to escape at the highest point. A small hole in the end of the pipe spool is usually all that is needed to allow the air/argon mixture to exhaust. If you want to get fancy, use a Magnehelic® gauge (pressure differential gauge) to balance the gas pressure inside the pipe with the atmospheric pressure outside the pipe.

Number of Times the Volume Is Displaced	Percentage of Oxygen in the Pipe Spool
Start	20%
1	10%
2	5%
3	2.5%
4	1.25%
5	0.63%
6	0.31%
7	0.16%
8	0.08%

Now that the oxygen level in the pipe is at an acceptable level, it is advisable to reduce the flow rate of the argon to simply replace any argon lost through leakage and maintain a slight positive pressure to prevent air from being drawn into the pipe. For pipe diameters up to 4 or 5 in., 5 ft^3/h sounds right. Let's not forget that one must increase the flow rate of the purge gas to account for higher leakage rates when there are several unwelded joints in the spool.

Some of the problems I've seen are as follows:

1) The welder didn't close off the ends of the pipe spool. The welder stuffed the argon hose into an open end and thought that was all they needed to do.

2) The system was not vented; the pipe ends were sealed with plastic plugs, but the plugs kept blowing out. The welder didn't understand why they kept blowing out.

3) The spool was vented at the high point, but the purge gas flow rate was too high. As the welder made the root pass, the molten weld pool blew out (not the same as a melt-through), leaving a big hole through the root as they were about to close the weld.

4) The pipe spool had several joints, each with a 1⁄16-in. root opening. The welder didn't tape the open root joints. They couldn't understand why the root was "sugared" (oxidized). I pointed out that a single joint in the 4-in. pipe with a 1⁄16-in. root opening represented a hole measuring 1⁄16 × 12 in. or the same size as a hole measuring 1 × ¾ in. The ¼-in. hose they used to purge the spool couldn't keep up with the volume of argon leaking out of each joint.

5) Insufficient flow time. The welder set the flow meter and immediately started to weld their first root.

Since the goal is to deposit a weld with a clean root surface (i.e., no discoloration), don't forget to clean the inside diameter of the pipe. It has nothing to do with gas purging, but it doesn't hurt to remind ourselves that the base metal surface has to be cleaned inside and out to get the high-quality weld we strive for. It's another of those problems I've seen several times.

What I've described is a way of approximating the time and flow needed to reduce oxygen levels for commercial work and is usually good enough for many jobs. When all is said and done, paying attention to details does pay dividends. If one is working on high-purity or sanitary piping, an oxygen meter is essential to accurately measure the oxygen level in the pipe. IT

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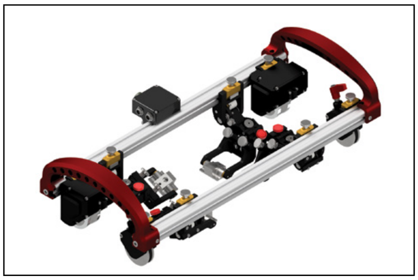
Upgraded X-Ray Detector Improves Efficiency in Large-Format Inspections

The upgraded D-DR 3643 NDT flat panel x-ray detector streamlines field operations with its thinner, more compact frame, making handling and positioning easier. Weighing 20% less than its predecessor, thanks to a glass-free transmission fluid temperature sensor, the detector's design enhances portability without sacrificing durability, passing a 1-m (3.28-ft) drop test. The sensor's 351 × 427 mm (13.8 × 16.8 in.) active area enables large-object inspections and captures profile images, and a pixel pitch of 99 µm and spatial resolution of 100 µm ensure high-quality, precise inspection results. Capable of handling x-ray sources up to 450 kV and gamma sources with a maximum frame time of 180 seconds, it provides versatility for a wide range of applications. The detector also features long battery life, a hot-swap function, and IP 67 protection, making it reliable in harsh environments. Wireless operation, wired data transmission, and power supply options offer flexible usage. The device operates with D-Tect X inspection software, equipped with tools like multigain calibration and the X-filter, to simplify image optimization and enhance inspection efficiency.

DÜRR NDT
duerr-ndt.com

Modular Inspection Platform Enhances Weld and Corrosion Testing

The Radix is an advanced weld inspection platform designed for both automated and manual inspection in industrial environments. It ensures precise weld integrity assessments across different materials and structures and excels in corrosion mapping, offering comprehensive data collection on surface and subsurface conditions. The system's modular design provides flexibility, allowing it to adapt to various weld geometries while ensuring precise and reliable data collection, even in challenging conditions. The scanner features self-adjusting probes that maintain perpendicularity to weld surfaces, minimizing errors and delivering consistent results. With a lightweight structure under 15 lb, the product is easy to transport and deploy. It can be quickly reconfigured without tools, offering efficiency and ease of use in diverse inspection scenarios. Additionally, the system includes a sealed encoder for durability, an optional motor pack for enhanced automation, and ergonomic features to improve portability.



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INSPECTION INSIGHTS

A summary of selected AWS Weld Wednesday podcast episodes hosted by Jason Becker. ***Visit weld.ng/podcasts*** for more episodes.

Let's Talk about WPSs, PQRs, and PQTRs

Jason Becker and guests Padraic Bean, a weld process consultant, and Charlie Cross, a welding technical specialist, both with The Lincoln Electric Co., discussed some of the critical documentation processes in the welding industry. Their conversation examined Welding Procedure Specifications (WPSs), Procedure Qualification Records (PQRs), and welder certification processes, highlighting best practices for developing, implementing, and maintaining these essential documents.

Planning and Preliminary WPS Development

The experts emphasized that successful welding procedure development begins with thorough planning before any welding commences. Many manufacturers miss this critical first step. They recommended creating a matrix of all materials, thicknesses, and joint configurations that need welding procedures. This matrix helps organize the required qualification testing by the code or project specifications and ensures all production needs are addressed efficiently.

From this foundation, welding professionals can develop preliminary WPSs based on what the experts call "The Big Six" essential elements:

1. Process: Identifying the welding process to be used (e.g., GMAW, FCAW, SMAW, GTAW)

2. Base metal: Specifying the material type and grade (e.g., ASTM A36, ASTM A572 Grade 50, API materials)

JASON BECKER is an AWS CWI and CWE and owner and operator of Weld Works Training Center in Orlando, Fla.

3. Filler metal: Selecting appropriate consumables based on base metal requirements

4. Thermal conditions: Determining preheat and interpass temperature requirements

5. Joint design: Detailing the configuration (e.g., groove welds, fillet welds)

6. Parameters: Establishing the machine settings (e.g., wire feed speed, voltage, amperage, travel speed).

Even companies not working to specific code requirements can benefit significantly from developing preliminary WPSs. These documents establish consistent baseline procedures, help train personnel, and provide measurable performance metrics for quality and productivity improvements. As Cross stated, "What gets measured gets managed."

Creating PQRs

After developing the preliminary WPS, the next step is qualifying the procedure through testing. This process involves:

1. Preparation: Cutting and beveling material according to specifications, ensuring proper joint configurations

2. Data collection planning: Setting up methods to record all essential variables during welding

3. Test welding: Performing the weld while meticulously documenting the exact parameters used

4. Documentation: Recording precise values without ranges at this stage; the PQR represents a snapshot in time of exactly what was done.

Data collection must happen in real time during welding. This often requires two people — one performing the weld and another recording parameters. Modern equipment with digital recording capabilities (e.g., Power Wave Manager, Arc Tracker) can simplify this process.

Once the test piece is complete, it undergoes a series of tests required by applicable codes:

1. Visual inspection: The most fundamental evaluation that can identify many issues

2. Nondestructive examination: Methods such as radiographic, ultrasonic, magnetic particle, or penetrant testing

3. Mechanical testing: Destructive testing, including bend tests, tensile tests, impact tests, and macroetching.

The experts strongly advocated for prevalidation testing before formal qualification. Simple macro examinations can identify potential issues, like incomplete fusion or porosity early, saving considerable time and expense. As Bean stated, "I can't stress enough how much validation can save you."

If testing reveals defects, the collected data helps pinpoint potential causes. Porosity might indicate gas issues, failed impact tests could suggest heat input problems, and slag inclusions might indicate inadequate interpass cleaning.

Developing WPSs

Once testing passes and the PQR is established, it serves as the foundation for creating WPS documents:

- The PQR remains securely filed as the validated record of exact parameters
- WPS documents are created based on the PQR but include allowable ranges for variables
- Code-specified qualification ranges determine the scope of each WPS (e.g., material thickness, positions)
- Multiple WPS documents can often be developed from a single PQR.

The experts discussed applying maximum code-allowed ranges. While some codes permit up to 25% parameter variance, such wide ranges might not produce acceptable welds. They emphasized that WPS documents should reflect technical judgment, not just maximum allowable ranges.

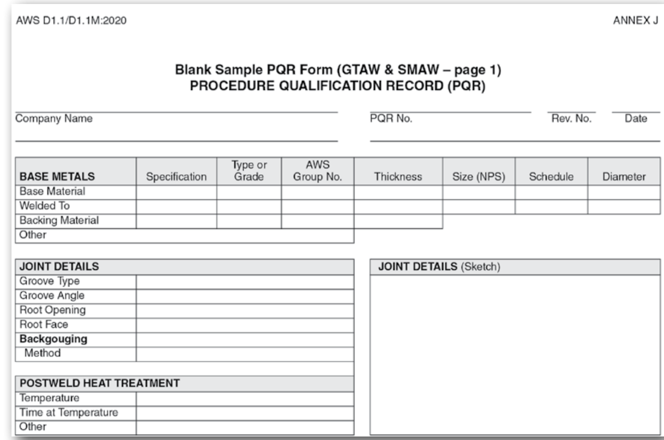
WPS forms can vary in appearance. Many codes provide sample forms in annexes, and *aws.org* offers downloadable templates. Check both code books and contract documents, as the latter might contain more-stringent requirements.

A key point was the importance of making WPS documents accessible and usable. As Bean noted, "The WPS is my time as a welding professional to explain to the welder exactly what they have to do." Creating clear documents prevents welders from spending time interpreting procedures instead of performing productive work.

Welder Qualification and Certification

The final stage involves qualifying the welders to the established procedures and certifying the welders using a Performance Qualification Test Record (PQTR). Some considerations discussed were as follows:

- Welders must be qualified to specific WPS documents
- Testing determines the welder's qualification ranges (e.g., positions, material types)
- Companies can make qualification requirements more stringent than code minimums
- The welder who performed the original PQR test is automatically qualified to that procedure



AWS D1.1/D1.1M:2020 ANNEX J

Blank Sample PQR Form (GTAW & SMAW – page 1)
PROCEDURE QUALIFICATION RECORD (PQR)

Company Name | PQR No. | Rev. No. | Date

BASE METALS	Specification	Type or Grade	AWS Group No.	Thickness	Size (NPS)	Schedule	Diameter
Base Material							
Welded To							
Backing Material							
Other							

JOINT DETAILS	
Groove Type	
Groove Angle	
Root Opening	
Root Face	
Backgouging	
Method	

POSTWELD HEAT TREATMENT	
Temperature	
Time at Temperature	
Other	

JOINT DETAILS (Sketch)

A partial sample of a PQR template available at aws.org.

- AWS B2.1/B2.1M-AMD1, *Specification for Welding Procedure and Performance Qualification,* is a valuable document for implementing welder qualification procedures.

Educational Resources

When asked about implementing WPS/PQR training in educational settings, the speakers recommended several approaches:

- Capstone projects where students develop procedures and perform testing
- Utilizing the AWS B2.1 documents as a framework for procedure development
- Purchasing Standard Welding Procedure Specifications (SWPSs) from AWS for typical applications
- Taking advantage of instructor scholarships for AWS online courses and training.

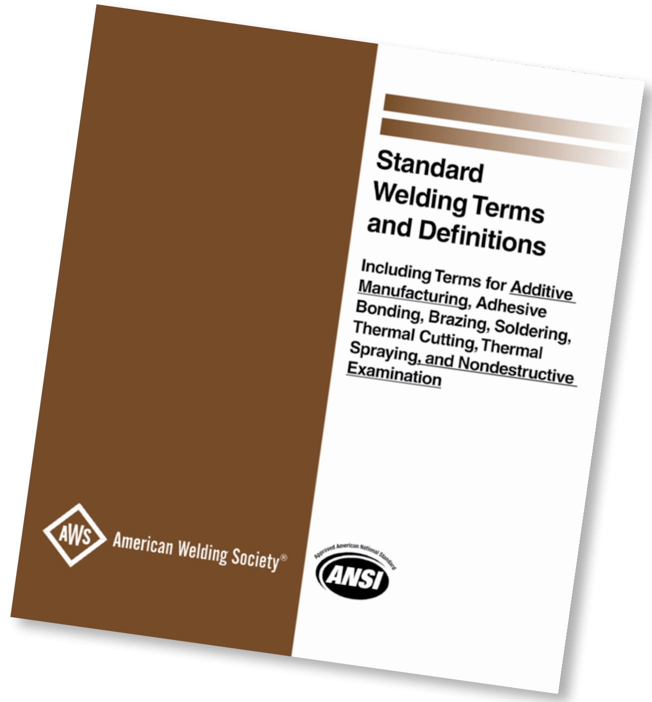
Resources mentioned included the AWS online learning and training platforms, Lincoln Electric training programs, and local AWS Section involvement.

Conclusion

The experts stressed that thorough documentation alone isn't sufficient; welders must have access to these documents and actually use them in production. They shared that when consulting with companies, they ask three critical questions: "Do you have welding procedures? Are they any good? Do your welders use them?" Unfortunately, getting affirmative answers to all three questions is rare.

While welding documentation may not seem exciting, it forms the backbone of quality control, consistency, and cost efficiency in welding operations. Welding to codes and standards requires precise documentation to ensure safety and performance, and proper documentation prevents rework, provides measurable standards, and contributes to more efficiency. IT

What CWIs Must Know about the Latest AWS A3.0 Edition



An overview of the changes and additions to this essential AWS publication

AWS formed the A2 Committee on Definitions and Symbols to establish standard terms and definitions that aid in communicating welding information. The new edition of AWS A3.0M/A3.0:2025, *Standard Welding Terms and Definitions Including Terms for Additive Manufacturing, Adhesive Bonding, Brazing, Soldering, Thermal Cutting, Thermal Spraying, and Nondestructive Examination*, is the major product of the work done by the AWS A2B Subcommittee on Definitions in support of that purpose.

The evolution of AWS A3.0M/A3.0 is shown in the table below:

January 18, 1940	*Tentative Definitions of Welding Terms and Master Chart of Welding Processes*;
May 7, 1942	*Definitions of Welding Terms and Master Chart of Welding Processes*;
A3.0-49	*Standard Welding Terms and Their Definitions*;
A3.0-61	*AWS Definitions, Welding and Cutting*;
A3.0-69	*Terms and Definitions*;
A3.0-76	*Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
A3.0-80	*Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
ANSI/AWS A3.0-85	*Standard Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
ANSI/AWS A3.0-89	*Standard Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
ANSI/AWS A3.0-94	*Standard Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
AWS A3.0:2001	*Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
AWS A3.0M/A3.0:2010	*Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Spraying, and Thermal Cutting*;
AWS A3.0M/A3.0:2020	*Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Spraying, and Thermal Cutting*; and
AWS A3.0M/A3.0:2025	*Standard Welding Terms and Definitions Including Terms for Additive Manufacturing, Adhesive Bonding, Brazing, Soldering, Thermal Cutting, Thermal Spraying, and Nondestructive Examination*

The present publication, AWS A3.0M/A3.0:2025, defines over 1500 terms, with numerous illustrations to support and clarify the definitions as well as classification charts and corollary information related to welding and allied processes. This latest revision includes significant enhancements to the following:

- Additive manufacturing
- Gas metal arc welding (GMAW) process variations
- Hybrid welding
- Nondestructive examination
- Plastic welding
- Qualification – procedure and performance
- Submerged arc welding process variations
- Temper bead welding
- Waveform-controlled welding
- Welding test positions

New terms and definitions have been introduced, and existing terms and definitions have been modified in these and other areas. Of significance are new/modified terms and definitions for surfacing weld test positions; procedure and performance qualification for brazing, soldering, and welding; gas metal arc welding transfer modes and process electrical variations; submerged arc welding process variations with multiple electrodes; nondestructive examination methods and their application; and measurement of arc energy for waveform-controlled welding.

About Nondestructive Examination

With slight modifications for clarity, Clause C1.5.6 in Annex C, nondestructive examination, states the following:

The standard term **nondestructive examination** (NDE) was first introduced in the 2001 edition of AWS A3.0. With several recognized choices, the subcommittee spent several meetings discussing which would be selected as the standard term. This even included solicitation of input from other organizations, including the American Society of Mechanical Engineers (ASME), American Society for Nondestructive Testing (ASNT), and American Society for Testing and Materials (ASTM). Also part of this selection process was the review of dictionary definitions for examination, evaluation, inspection, and testing. This exercise also fell short of revealing the best choice, as each was considered a synonym of the others.

The attention then turned to a look at the general usage of these terms as applied in the welding and welding quality control community. Below are definitions for these activities in terms of their general application:

(1) examination. The act of observing an object in terms of its appearance, size, shape, or other physical characteristic.

(2) evaluation. The act of comparing attributes with some standard.

(3) inspection. A general term describing the activities associated with the overall quality assurance function, including activities occurring before, during, and after the welding activity.

(4) testing. The act of determining the suitability of a material or object for its intended purpose by directly subjecting it to service conditions.

Based on the above, and after significant discussion, the choice for the standard term became **nondestructive examination** (NDE) and it was defined as the "process of determining acceptability of a material or a component in accordance with established criteria without impairing its future usefulness." At that time, the other choices were each listed as a "nonstandard term when used for **nondestructive examination**."

While preparing the 2020 edition of AWS A3.0, the subcommittee revisited these definitions from the standpoint of whether listing the alternate terms as being nonstandard was technically correct regarding their common usage. Since all of the forms are used by various standards, reference documents, and industry segments, it was decided that rather than being nonstandard terms, they are really alternatives to the standard term, with all having the same general meaning. It was agreed that nondestructive examination should remain the standard term, but the definitions for the others were listed as "**See nondestructive examination**." While this may appear to be a minor change, it is quite significant. This means that any of these term variations may be used and they all have the same meaning.

At this same time, the existing definition also came into scrutiny. What was questioned was the portion of the definition stating ". . . determining the suitability of some material or component for its intended purpose . . ." It was realized that the act of performing nondestructive examination could not, in and of itself, guarantee that a component was suitable for its intended purpose. As a result, the new definition was changed to the "process of determining the acceptability of a material or a component in accordance with established criteria without impairing its future usefulness."

Relevant Changes for CWIs

The latest edition of A3.0 contains many changes that affect Certified Welding Inspectors (CWIs), particularly regarding the addition and modification of terms and definitions related to procedure and performance qualification.

When a CWI is asked to review documentation related to procedure and performance qualification, it's not uncommon for the terminology to be inconsistent. To clarify, the A2B Definitions Subcommittee reviewed AWS's B2 qualification standards and other industry standards. Then, it attempted to standardize the terms and their definitions to describe the activities and documentation types.

Although the terms *certification* and *qualification* are often used interchangeably, their meanings are significantly different, as follows:

■ **Certification.** A credential attesting to a type or level of qualification.

■ **Qualification.** See **performance qualification** and **procedure qualification**.

■ **Performance qualification.** Demonstration of an individual's ability to produce an acceptable test coupon in accordance with an applicable qualification standard. Variations of this term are brazer performance qualification, brazing operator performance qualification, solderer performance qualification, soldering operator performance qualification, welder performance qualification, and welding operator performance qualification.

■ **Procedure qualification.** Demonstration of a process for joining or surfacing using specified materials and techniques resulting in a test coupon meeting applicable requirements.

Therefore, *qualification* relates to the activity used to demonstrate that a particular set of variables can produce an acceptable result in terms of mechanical properties and soundness (procedure) and the individual's capability to apply a qualified procedure that leads to an acceptable result in terms of soundness (performance). *Certification*, on the other hand, is the documentation that verifies the individual's qualification.

Another term used in AWS documents is *qualifier*, which is defined as "an employer, organization, or individual(s) responsible for conducting, supervising, and documenting qualification testing in accordance with an applicable standard. **See also AWS Qualifier**, **AWS Welder Performance Qualifier**, and **AWS Welding Procedure Qualifier**."

This term is associated with various AWS personnel certification programs. For instance, an *AWS Qualifier* is an individual employed by an Accredited Test Facility to monitor and document the qualification of AWS Certified Welders. AWS also administers the CWI endorsements Welder Performance Qualifier (WPQ1) and Welding Procedure Qualifier (WPQ2). Passing the WPQ1 examination qualifies an individual as an **AWS Welder Performance Qualifier**, and passing the WPQ2 examination qualifies them as an **AWS Welding Procedure Qualifier**.

The 2025 edition of AWS A3.0 includes a clarification of the transfer modes in the GMAW process.

Transfer Mode Clarification

Another item to note is not a change but a clarification of the transfer modes in the GMAW process. With the advent of inverter-based power sources and computer-controlled output, it is essential to understand the metal transfer mode is not entirely dependent on the power source output mode selected. The transfer mode is a visual observation of how the metal is transferred across the arc. A power source set in pulsed mode may still be creating an arc that is in short-circuiting transfer mode. This may result in a discrepancy with the applicable code. The three main GMAW transfer modes are short-circuiting, globular, and spray. The spray mode has the following subsets: conventional (CV) spray, pulsed spray, and rotational spray. The short-circuiting mode has two main subsets: CV and pulsed short-circuiting.

The better a CWI understands these terms and their correct usage, the better prepared that individual is to perform a CWI's essential duties.

Final Thoughts

It must be understood that the A2B Definitions Subcommittee cannot be the ultimate judge regarding 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. One exception: When using a nonstandard term may endanger personal safety, that term is defined as both nonstandard and incorrect. The A2B Definitions Subcommittee has neither the authority nor the desire to dictate welding terminology but considers it within its province to establish standard and nonstandard terms.

We encourage you to acquire AWS A3.0, keep it handy, and consult it during inspection and reporting to ensure you follow the most accurate and latest definitions and reflect those in your reports. IT

This article was edited by Carlos Guzman, *Inspection Trends* editor, using excerpts from A3.0M/A3.0:2025 and contributions from AWS's A2B Subcommittee on Definitions members **Larry Barley** (OTC-Daihen); **David Beneteau** (CenterLine); and A2B Subcommittee on Definitions Chair and AWS 2025 President **Richard Holdren** (ARC Specialties).

FEATURE

BY CHRIS THUROW

How to Correctly Use Welding Symbols for Slotted Hollow Structural Steel Members

Apply these principles to avoid misinterpretations

AWS A2.4:2020, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*, provides the tools needed to facilitate communication between the designer, welder, and inspector about the requirements for a given weld. These symbols and the rules and conventions for their application are widely understood and utilized across the welding industry. In some instances, however, careful thought is required to ensure that the symbol used is correct for the weld detail required. The confusion may lie not in the welding symbol itself but in applying the *arrow side-other-side* convention, which is critical for properly understanding where the weld specified by the weld symbol should be placed on the joint.

AWS A2.4:2020, Clause 6.1, states, "Information applicable to the arrow side of a joint shall be placed below the reference line. Information applicable to the other side of a joint shall be placed above the reference line." Figure 1 illustrates this convention.

Welding industry professionals are likely familiar and comfortable with this concept. Once understood and with a bit of experience, it becomes intuitive to look at a symbol and, based on the orientation of the symbol relative to the joint and on which side of the reference line information is placed, visualize how the joint is to be prepared and the weld completed. Still, on occasion, a situation arises that causes even experienced personnel to misunderstand the application of these conventions. One such example is addressed in this article.

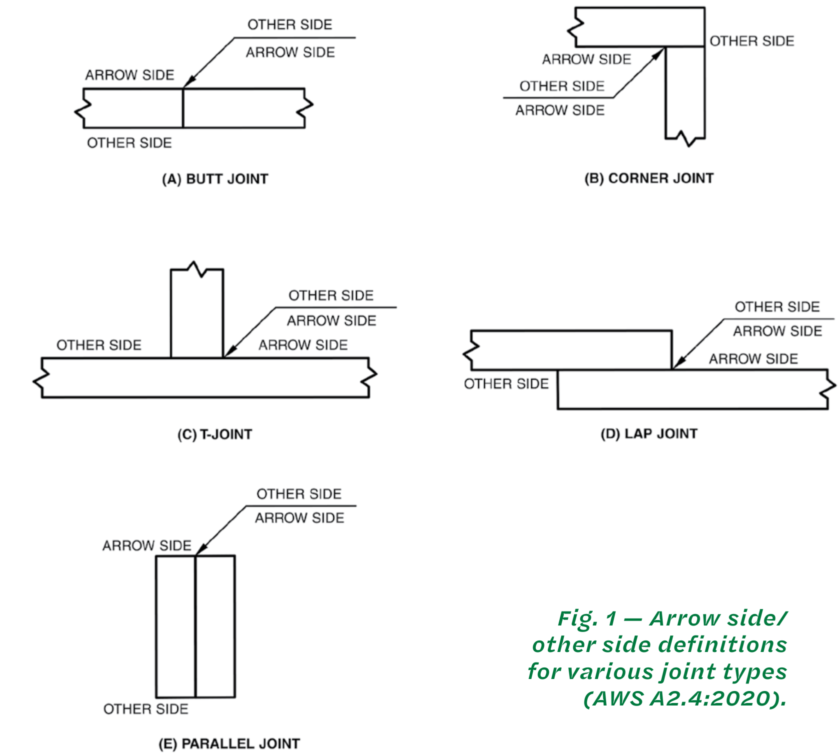


Fig. 1 — Arrow side/other side definitions for various joint types (AWS A2.4:2020).

Misunderstood Applications

In structural steel design, a common detail is to have a hollow structural steel tube slotted to accept a plate gusset, which is then attached to the larger structure — Fig. 2. This slotted tube is typically welded with fillet welds on the exterior of all four areas where the tube wall contacts the gusset plate. When employing symbols to communicate this requirement, it may seem natural to use double fillet weld symbols to indicate a fillet weld is required on each side of the gusset plate. However, this is an incorrect application of the symbol and, if interpreted correctly by the welder, will result in a much different weld configuration than desired (should it even be physically possible to complete).

It is emphasized that AWS A2.4 states that information applies to the *arrow side* and the *other side* of the *joint*. To understand exactly what constitutes the *joint*, we look at the information provided in AWS A3.0M/A3.0:2025, *Standard Welding Terms and Definitions*. This defines a *joint* as "the junction of workpiece(s) before and after joining" and further references Figs. B1 and B2; illustrations from A3.0 Fig. B1 are reproduced in Fig. 3.

Note that the area defined as the joint is shaded in these figures. In every case, there is a surface of one member of the joint bearing on a surface of the other member and a path from one side of the joint to the other, which includes one surface from each member. When applied to a common T-joint, the location of the joint itself, and thus the applicability of information shown on the welding symbol, is clear — Fig. 4.

When a second T-joint is added to the opposite side of the horizontal member (Fig. 5), two distinct joints are created, here designated *Joint A* and *Joint B*. The welding symbol, whose arrow points only to *Joint A*, only applies to *Joint A* and calls for a fillet weld to be applied to both sides of the joint.

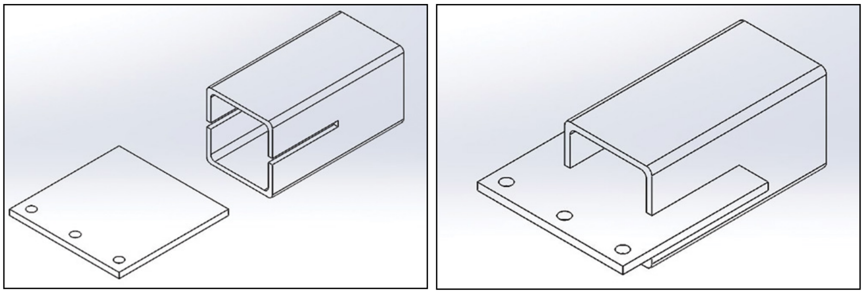


Fig. 2 — Slotted tube and plate connection.

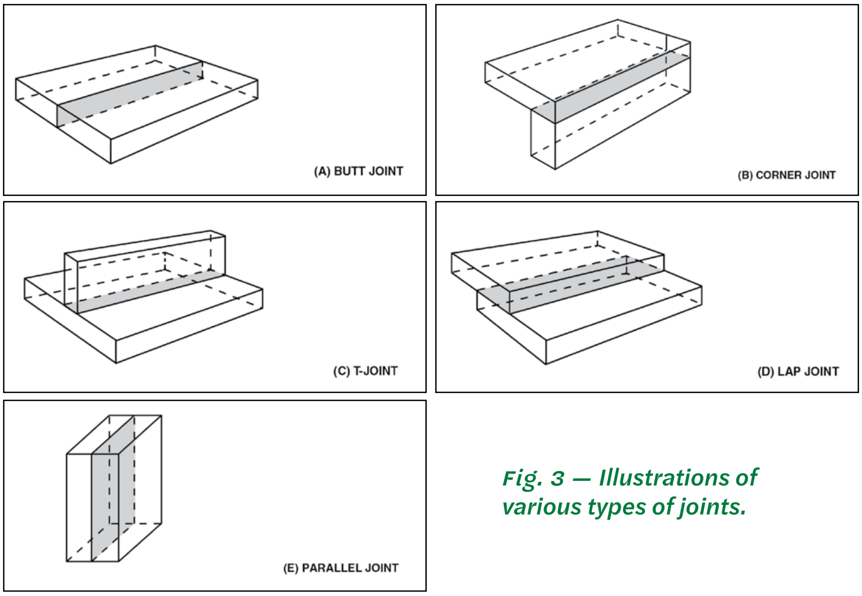


Fig. 3 — Illustrations of various types of joints.

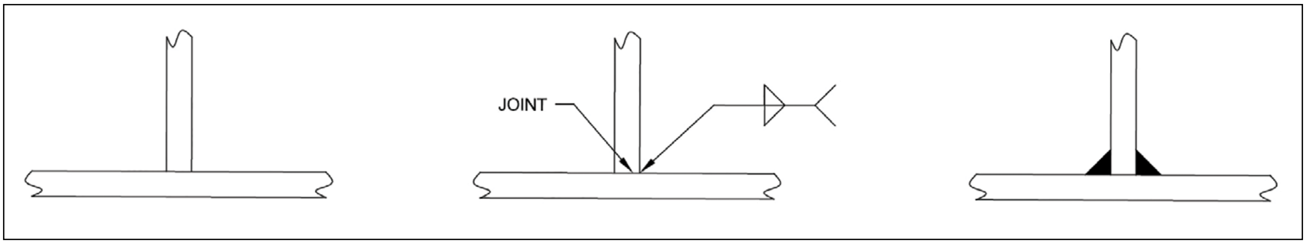


Fig. 4 — A simple T-joint with welding symbol specifying a double fillet weld.

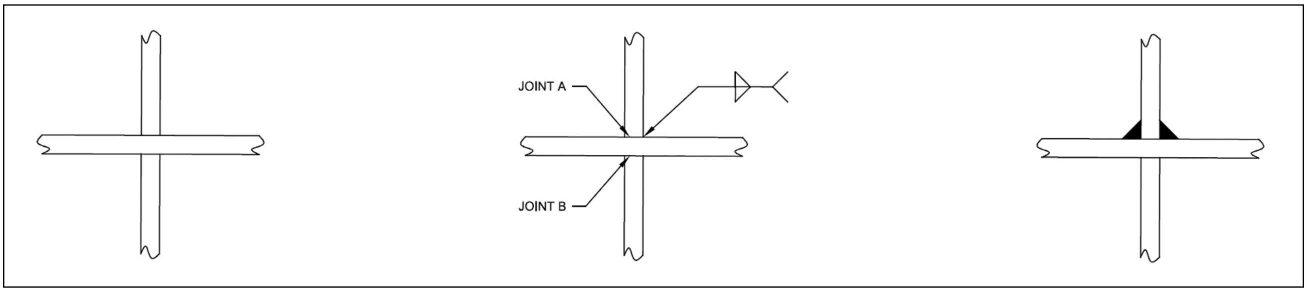


Fig. 5 — Opposite T-joints with welding symbol specifying a double fillet weld.

The same is true when multiple joints are on the same side of the member, as is the case with the formed channel illustrated in Fig. 6. Each leg of the channel forms a distinct joint, and a welding symbol specifying a double fillet weld on one of the joints calls for a fillet weld to be applied to each side of that joint only.

If a fillet weld is desired on the outside of each leg of the channel, a separate single fillet symbol is required for each leg — Fig. 7.

Combining these concepts, we have the case of the slotted hollow structural tube welded to a plate. In this case, if the designer uses a double fillet symbol, as shown in Fig. 8, what is actually being called for is a fillet on the outside and inside walls of the tube.

If a weld is desired between the outside wall of the tube and the plate on both sides of the plate, again separate welding symbols must be used — Fig. 9.

If a weld on the exterior of all four walls of the tube is required, four separate single fillet symbols are used to communicate this — Fig. 10. Keep in mind that it may not be necessary to use symbols to indicate every weld required; notes in the tail of the symbol or other drawing notes may also be used to communicate these requirements.

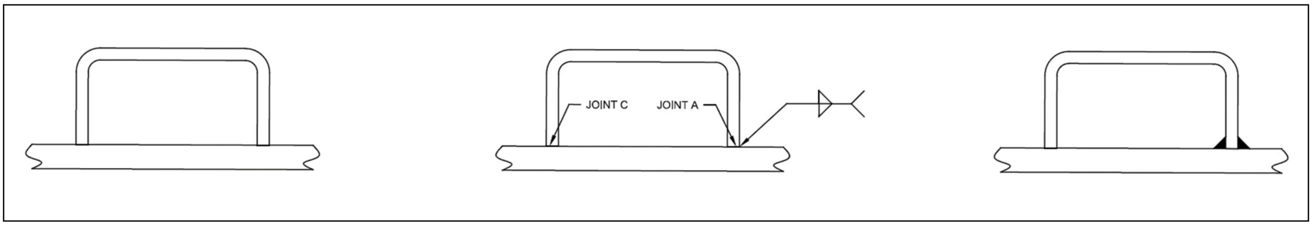


Fig. 6 — Channel on plate with welding symbol specifying a double fillet weld.

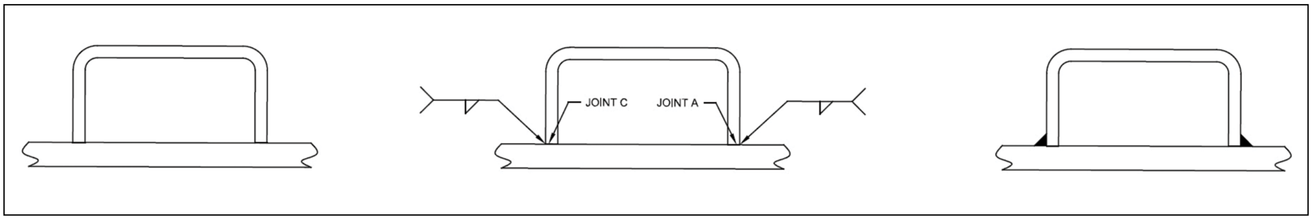


Fig. 7 — Channel on plate with welding symbol for each leg.

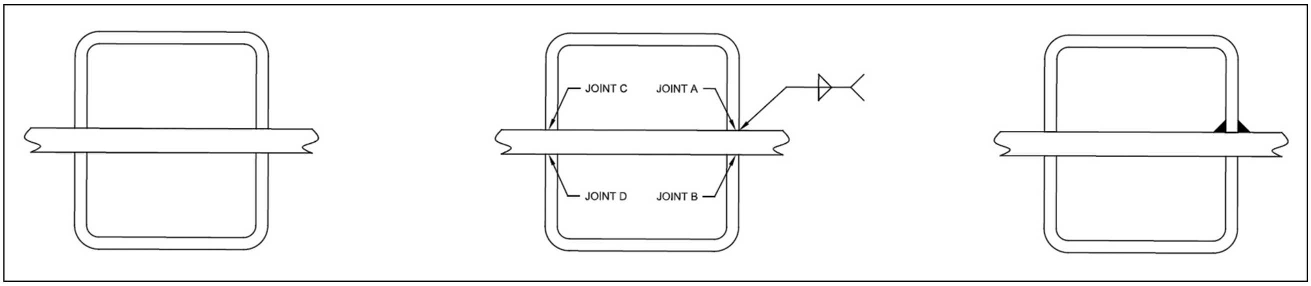


Fig. 8 — Slotted tube and plate with welding symbol specifying a double fillet weld.

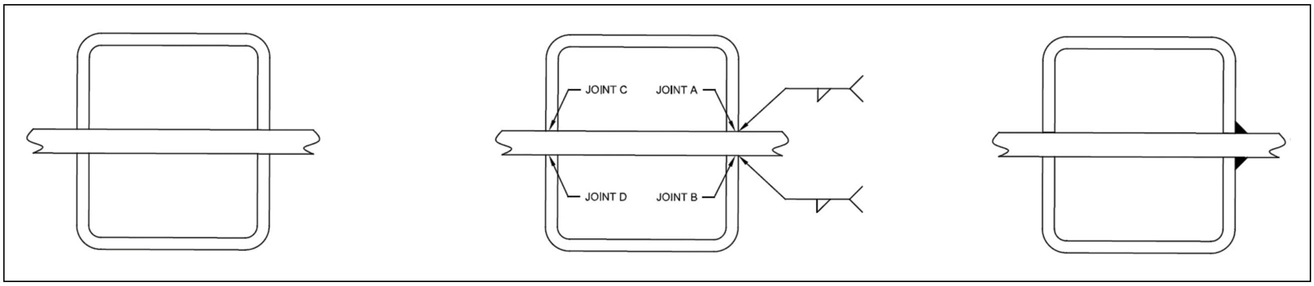


Fig. 9 — Slotted tube and plate with welding symbols on opposite sides of plate.

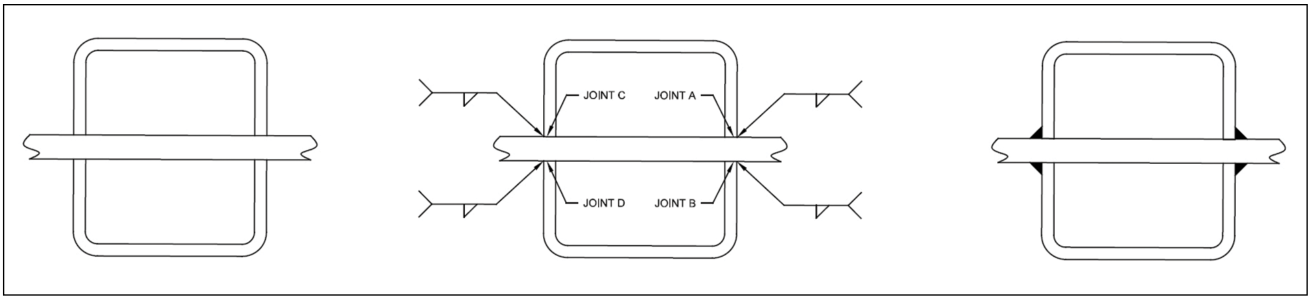


Fig. 10 — Slotted tube and plate with welding symbols for each joint.

Conclusion

Starting from the first principles and the simple example of a standard T-joint, it becomes clear how to properly interpret the joint and apply the correct welding symbols on a slightly more complex configuration.

This common misunderstanding is a reminder that while much of the use of welding symbols becomes second nature with experience, the designer must always be aware of the fundamental requirements and that what may seem like the obvious application is not always correct.

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BY THE AWS CERTIFICATION DEPARTMENT

IT FEATURE

A New Way to Obtain the AWS SCWI Credential

The transition from a single exam to stackable credentials is explained

The landscape of welding inspection certification is evolving to meet the dynamic demands of the industry. The current way to earn the Senior Certified Welding Inspector (SCWI) credential requires passing a single exam. However, the AWS Qualification and Certification Committee, responsible for all AWS Certification Programs, identified the need for a more comprehensive task-centered approach to the SCWI certification. Consequently, on April 1, 2025, the SCWI credential transitioned to a stackable credential path that entails obtaining four Certified Welding Inspector (CWI) endorsement examinations, serving as stackable credentials.

This article explores the current SCWI credential process, the new changes, and the implications for welding inspection professionals.

Current Single-Exam SCWI Credential Procedure

The SCWI credential used to be attained by passing a single exam that provided a means for Certified Welding Inspectors (CWIs) to demonstrate their knowledge and skills at a more advanced level, provided that the candidate continued to meet the SCWI's required qualification requirements regarding education and work experience.

Early in 2016, the Subcommittee on Welding Inspectors (QCWI) recognized the need for an alternative path to obtain the SCWI credential, as outlined in Clause 6.1.4 of AWS QC1:2016-AMD1, *Standard for AWS Certification of Welding Inspectors*.

In 2020, the AWS Certification Department conducted a SCWI discovery survey to gather feedback from the welding industry. The survey findings underlined the importance of highlighting the SCWI's role in the following six areas:

1. Qualifying welding procedure specifications
2. Quality assurance
3. Qualifying welders
4. Supervision and coaching of CWIs
5. Engaging in welding technology-related duties
6. Project management.

Thus, a decision was made to transition from the single-exam path to stackable credentials based on the specifications outlined in QC1:2016-AMD1 and B5.1:2013-AMD1, *Specification for the Qualification of Welding Inspectors*, which the SCWI discovery survey validated. The transition requires the applicants to take mandatory endorsement exams to become SCWIs.

New SCWI Stackable Credential Path

A stackable credential is a series of assessments that need to be achieved to obtain a final certification. The stackable credentials that comprise the new SCWI pathway are as follows:

1. Welder Performance Qualifier

This assesses a candidate's knowledge, skill, and ability to conduct welder performance qualification tests. Based on AWS B2.1/B2.1M:2014-AMD1, *Specification for Welding Procedure and Performance Qualification*, the examination establishes a best practice for welder testing.

2. Welding Procedure Qualifier

This assesses a candidate's knowledge, skill, and ability to conduct welding procedure qualification tests adhering to industry codes, customer specification requirements, or both. While procedure qualification may differ from code to code, this examination uses the requirements of AWS B2.1 and AWS D1.1, *Structural Welding Code — Steel*.

3. Welding Coordination and Quality Assurance

This assesses a candidate's knowledge, skill, and ability to understand the importance of welding coordination activities, the scope and purpose of the prominent welding quality assurance programs used today, and the principles and practices of auditing quality management systems that apply to welded components.

4. Nondestructive Examination (NDE) Coordination

This assesses a candidate's knowledge, skill, and ability to coordinate the application of NDE methods to meet code and customer requirements. This examination will cover the advantages and disadvantages of the most commonly used NDE methods.

The Certification and Education page on the AWS website (*aws.org/certification-and-education*) provides more detailed information about the new CWI/SCWI endorsements and the new SCWI stackable credential. You may also contact the AWS Certification Department at (800) 443-9353 or *aws.org/contact-us*.

Benefits and Conclusion

The transition to a stackable credential path for SCWI certification carries several benefits for welding professionals and the welding industry. By offering a more comprehensive assessment of skills and knowledge, the stackable credentials enhance the credibility and competency of CWIs. Additionally, the flexibility to pursue endorsements in any order empowers individuals to tailor their certification journey to their career goals and interests.

The evolution of the SCWI credentialing pathway from a single exam to stackable credentials reflects a commitment to continuous improvement and excellence in welding inspection certification. This new approach can enhance the skills of welding professionals, advance their careers, and contribute to the quality and safety of welded products and structures. IT

FEATURE

BY CARLOS GUZMAN

Inspection Expo & Conference 2025 Highlights

The Inspection Expo & Conference (IEC) took place February 5–7, 2025, in St. Louis, Mo., drawing inspection industry professionals from across the country and the world. This collaborative event, organized by AWS, the American Institute of Steel Construction (AISC), the Association for Materials Protection and Performance (AMPP), and the Nondestructive Testing Management Association (NDTMA), offered participants a multifaceted experience.

Attendees connected with leading experts, explored cutting-edge developments, and built professional relationships with peers dedicated to inspection excellence and materials integrity. The conference featured in-depth sessions on advances in welding inspection, nondestructive examination (NDE), coating inspection, and structural steel inspection. Participants discovered sector-specific applications, received updates on evolving industry standards and certification requirements, and participated in meaningful exchanges regarding professional ethics.

Celebrating IEC's third edition, Richard Holdren, AWS's 2025 president, delivered the opening welcome speech, describing it as "the only conference by inspectors, for inspectors." Holdren emphasized the importance of diversity and cross-industry collaboration and encouraged attendees to visit exhibitors and attend sessions from different tracks to gain diverse perspectives. He concluded by thanking the planning committee, the conference co-chairs, and the AWS staff for all their efforts in making this year's IEC a reality.

Michael Turnbow, a retired Tennessee Valley Authority executive with over 35 years of NDE experience and current chairman of the American Society of Mechanical Engineers (ASME) NDE personnel qualification and certification project (ANDE), delivered a keynote addressing major challenges in inspection reliability, personnel qualification, and the need for improvement in certification standards. Turnbow spoke about ANDE-1, *ASME Nondestructive Examination and Quality Control Central Qualification and Certification Program*, a performance-based qualification standard incorporating the Systematic Approach to Training (SAT). This methodology, successful in military and industry applications for over 70 years, enhances human performance and efficiency by allowing progression based on demonstrated proficiency rather than time-based requirements.

IEC will return in 2026. For more information, visit the conferences page at ***aws.org/community-and-events***.

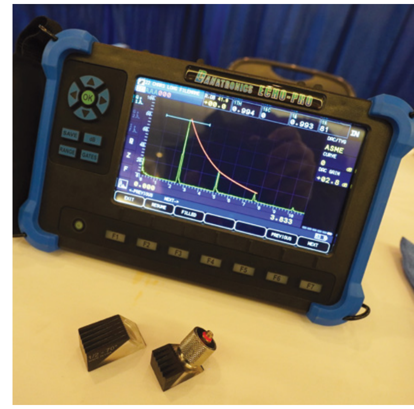
Richard Holdren, AWS's 2025 president, delivered the opening welcome speech.

Michael Turnbow delivered the keynote presentation to a full room.

The conference featured in-depth sessions on advances in welding inspection, NDE, coating inspection, and structural steel inspection.

Exhibitor Spotlight

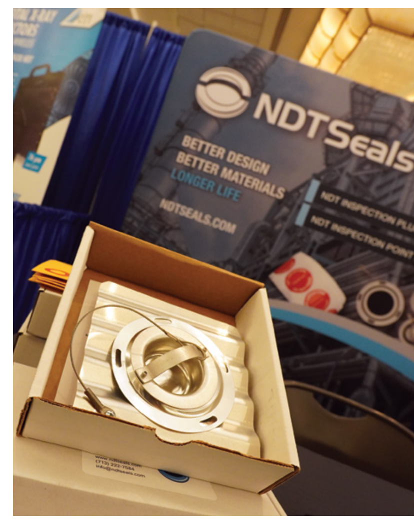
The expo floor featured exhibitors from across the industry who displayed their innovations and services. Inspection equipment manufacturers and distributors set up displays and demonstrations alongside educational institutions and IEC's partner associations. Exhibitors capitalized on this valuable opportunity to showcase their products and services while forging meaningful connections with attendees. A selection of products is featured as follows:



***Danatronics** displayed their ECHO PRO portable ultrasonic flaw detector and angle beam transducers.*

***KTA-Tator** offers a comprehensive set of services that includes coatings and corrosion inspection; steel and concrete inspection; nondestructive, mechanical, and laboratory testing; engineering; fabrication assessment; environmental consulting; and contract administration.*

*The VJ-4 from **ViewTech Borescopes** is its newest articulating video borescope, featuring a high-quality camera, intuitive navigation, on-screen annotation, and a reference measurement function.*



***NDT Seals** manufactures patented NDE inspection plugs and point labels designed to indentify and access thickness locations on insulated and noninsulated pipe and equipment to monitor structural integrity.*

***Mecaweld Technology** presented its weld inspection and real-time weld monitoring systems for applications such as laser welding, 3D printing, and most of the typical arc welding processes.*

***Sonatest** showed its latest portable phased array detector, the Veo3, suitable for weld inspection, corrosion mapping, and composite testing. The detector features real-time, multiscan/multitechnique capabilities, including TFM, PAUT, and TOFD.*

***DÜRR NDT** provides digitalization products for the NDE industry, such as networked, digital radiography systems and software. These include high-resolution imaging plate scanners and flat panel detectors.*

CARLOS GUZMAN (*cguzman@aws.org*) is managing editor, digital and design, and *Inspection Trends* editor.

NDE SCHOOL PROFILES

Attention schools in training and testing for materials evaluation, weld inspection, and quality assurance:

Included in this section are welding schools across the country that have taken this advertising opportunity to promote their resources, both to industry in need of welders and to those searching for a solid career path to employment and growth. Reach more than 64,000 readers, many of whose livelihoods depend on quality assurance, materials testing, or weld inspection, with your school profile.

The National Center for Welding Education and Training (dba Weld-Ed) is a partnership of community colleges, universities, business and industry, and the American Welding Society. It is funded by the National Science Foundation. The Center's primary mission is to increase the quantity and quality of welding and materials joining technicians to meet industry demand through curriculum reform and educator professional development. Additional information is available at *weld-ed.org*.

Weld-Ed
National Center for Welding Education and Training

Asheville-Buncombe Technical Community College

A-B Tech offers a welding associate's degree and diploma as well as a certificate in basic welding. The Welding Technology curriculum provides students with a sound understanding of the science, technology, and applications essential for successful employment in the welding and metal industry. Instruction includes consumable and nonconsumable electrode welding and cutting processes. Successful graduates of the Welding Technology curriculum may be employed as entry-level technicians in welding and metalworking industries. Career opportunities also exist in construction, manufacturing, fabrication, sales, quality control, supervision, and welding-related self-employment. For more information, visit *abtech.edu/welding*.

340 Victoria Rd.
Asheville, NC 28801 / (828) 398-7684
G. Michael Keller, Welding Tech. Chair
georgemkeller@abtech.edu
abtech.edu

AB Tech
Community College

Austin Community College

The Welding Technology program at Austin Community College offers varied certificates and AAS degrees to prepare students for a range of welding careers. Areas of specialty include welding inspection and ultrasonic testing, structural welding, orbital tube welding, and pipe welding. Our Architectural and Ornamental Metals program includes fabrication, blacksmithing, power hammer, and metal sculpture. We now offer a 4-year Bachelors of Applied Technology in Advanced Manufacturing; our AAS programs satisfy the first two years of the bachelor's.

Riverside Campus
1020 Grove Blvd.
Austin, TX 78741

Round Rock Campus
4400 College Park Dr.
Round Rock, TX 78665

(512) 223-6220
austincc.edu/welding

WELDING TECHNOLOGY
Austin Community College

Del Mar College

Del Mar College is a comprehensive community college in Corpus Christi, Tex. Our Welding Applied Technology program is an Accredited AWS Testing Facility and offers skill development in SMAW, GMAW, GTAW, FCAW, and various other processes on plate and pipe welding to industry standards. Certificate and Associate Degree programs offered. Visit us on the web or call 1-361-698-1200 for information.

101 Baldwin Blvd.
Corpus Christi, TX 78404-3897
delmar.edu

DMC
DEL MAR COLLEGE

Garrett College Continuing Education & Workforce Development

Garrett College is an affordable public community college that is located in scenic western Maryland near Deep Creek Lake, a four-season resort destination. Students in the welding program build a welding foundation in the classroom and then transition to the lab for hands-on training. Students may earn OSHA, National Center for Construction Education and Research (NCCER), and American Welding Society (AWS) Certifications. Class length is 9 months, with two classes per week in the evening.

687 Mosser Rd.
McHenry, MD 21541
Program Coordinator Information:
Joshua Hook
(301) 387-3087
joshua.hook@garrettcollege.edu

Hill College

Hill College's Welding Program provides comprehensive, hands-on training to prepare students for success in the high-demand welding industry. Offered at both Hillsboro and Cleburne campuses, the program features state-of-the-art technology and partnerships with Lincoln Electric and NC3. Students can choose from multiple pathways, including a Basic Welding Certificate or an Associate of Applied Science in Welding Technology. With a focus on real-world experience, graduates gain essential skills and are workforce-ready upon program completion

Hill County Campus
Hillsboro, TX 76645
Cleburne Technical Center
Cleburne, TX 76031
Joe Price
jprice@hillcollege.edu
(254) 659-7984
hillcollege.edu

Lakeshore Technical College

Gain in-demand, high-paying welding skills at our nationally recognized college where you can become welding workforce-ready in weeks. Experienced faculty and testers, high-tech labs and classrooms, affordability, and graduate placement rates position Lakeshore among the best. Our state-of-the-art KOHLER Center for Manufacturing Excellence serves as the area's only AWS Accredited Test Facility. Learn about flexible start dates throughout the year and programs ranging from basics to robotics welding at *gotoltc.edu* today.

1290 North Ave.
Cleveland, WI 53015
(888) 468-6582
admissions@gotoltc.edu
gotoltc.edu

Georgia Trade School

At Georgia Trade School disruption is part of our magnetic culture. For 13 years, we have changed what a postsecondary education looks like in one of the most cosmopolitan markets in the United States. Seven times our boutique welding school has been named a Cobb Chamber Top 25 Small Business of the Year in a county with over 46,000 businesses. With over 2000 graduates across 20 states in energy, construction, manufacturing, shipbuilding, film, and television our efforts to "Rebuild America" have led to critical acclaim and commercial viability. This transformative program changes lives and is a pathway to middle class security.

Ryan Blythe
rblythe@georgiatradeschool.com
4231 Southside Dr.
Acworth, GA 30101
(770) 590-9353
georgiatradeschool.com

Hutchinson Community College

HutchCC offers flexible welding programs, including one- or two-semester certificates, a two-year certificate, associate degree options, and customized industry training. Students receive hands-on experience and classroom instruction in GMAW, SMAW, GTAW, FCAW, and cutting methods while working with carbon steel, stainless steel, and aluminum. Our comprehensive program ensures a strong understanding of welding processes. Training is available at our Hutchinson and Newton campuses and through dual credit programs at three area outreach locations.

1300 N. Plum
Hutchinson, KS 67501
(620) 665-3500
hutchcc.edu/weldit
welding@hutchcc.edu
Welding Program Advisor
(620) 728-8187

Mitchell Technical College

Mitchell Technical College offers an industry-driven Welding and Manufacturing Technology program providing skills for graduates to excel in welding, machining, drafting, laser/plasma cutting systems, robotics, and lean manufacturing techniques. Instruction is AWS code-based during the second year. Students learn clearly defined and communicated welding quality standards. They also learn to test welds by various methods, including dye penetrant, radiographic, visual, and tensile load testing as well as bend-and-break testing conducted by a CW within an ATF.

Mitchell Technical College
1800 E. Spruce St.
Mitchell, SD 57301
(800) 684-1969
mitchelltech.edu

Monroe County Community College

MCCC's Welding Technology Education includes training in SMAW, GMAW, FCAW, and GTAW of ferrous and nonferrous materials. Our state-of-the-art, hands-on training facility emphasizes mechanical and manual thermal cutting processes and techniques. American Welding Society (AWS) SENSE certification may also be attained through our ten-week QC-10 (entry level) and QC-11 (advanced level) offerings. MCCC proudly offers multiple certificate pathways, including a Basic Welding Certificate, Advanced Welding Certificate, and a Nondestructive Testing Certificate program in addition to the Associates in Applied Science Degree in Welding Technology that will transfer to both Ferris State University and Wayne State University. Apprentice training is available to companies with registered apprenticeship programs.

Steve Hasselbach-CWI, (734) 384-4118
shasselbach@monroeccc.edu
Jennifer St. Charles, (734) 384-4112
jstcharles@monroeccc.edu

Pennsylvania College of Technology

Pursue an associate degree in Non-Destructive Testing at Penn College and you'll train alongside faculty with real-world experience in a state-of-the-art NDT lab equipped with cutting-edge technology. Get hands-on experience with ultrasonic, radiographic, TOFD, phased array, and magnetic particle testing. Gain essential hours towards your American Society of Non-Destructive Testing (ASNT) certification while learning career-advancing welding techniques in our recently expanded 55,000-square-foot facility.

One College Ave.
Williamsport, PA 17701
(800) 367-9222
admissions@pct.edu
pct.edu/welding

Rock Valley College

Rock Valley College's welding program is located at the Advanced Technology Center offering 25 welding booths, five robotic welding cells, and eight oxyfuel stations. Welding processes being taught include GMAW, FCAW, GTAW, SMAW, oxyfuel, and welding robotics (Fanuc ArcTool Certification). Rock Valley College is an AWS Certified Accredited Testing Facility. Staffed by three full-time faculty, welding coordinator, seven part-time instructors, and a student worker. For more information, contact academic chair, Bill Isham.

William "Bill" Isham
w.isham@rockvalleycollege.edu
Belvidere, IL
(815) 921-3546
(800) 973-7821

Odessa College

Nationally recognized as one of the leading colleges in the country, Odessa College has an award-winning Welding Technology program that provides educational training for tomorrow's welding technicians. The four specialized lab areas are equipped with 75 welding stations for instruction on SMAW, GMAW, FCAW, GTAW, SAW, and robotic welding procedures. Learn the cutting process in oxyfuel, plasma, and CAC-A in both manual and mechanized methods. The modern classrooms utilize Smartwall technology with Lincoln Electric virtual welding training systems to enhance the learning experience. Students have the opportunity to earn a one-year certificate or a two-year AAS degree in Welding Technology. The program is an AWS Educational Institution Member and an active NC3 member with several trained instructors. Our AWS Student Chapter is active on the OC campus and in our community.

Syed Muhammad Naqvi – CWI/CWE
snaqvi@odessa.edu
(432) 335-6306
odessa.edu

PIT Instruction & Training LLC Pit Weld U

Located in Mooresville, N.C., Pit Weld U, an Accredited Testing Facility, offers industry-focused manual and robotic welding courses, fabrication, and print reading classes. The certificate-based program allows students to be selective in their course scheduling, providing a quick, cost-effective path into the industry segment of choice. Tuition includes AWS certification testing and OSHA-10 certification in general safety, providing graduates with a foundation to a successful career. Veterans may use GI funds to attend, and all students are eligible for scholarships available courtesy of industry partners.

156 Byers Creek Rd.
Mooresville, NC 28117
(704) 230-4361
visitPIT.com

Schoolcraft College

Located in one of the largest manufacturing areas of the USA, Schoolcraft College offers certificates and associates degrees in an AWS Accredited Test Facility. The college provides state-of-the-art welding and fabrication equipment in an innovative, dynamic, and productive environment. Small class sizes give easy access for students to knowledgeable, industry-trained experts and CWI instructors who strive to educate students for real-life on-the-job scenarios. Schoolcraft College offers classes in all major welding processes as well as specialized classes in blueprint reading, inspection, metallurgy, OSHA 30, CAD, robotics, mechatronics, and CNC manufacturing. Schoolcraft College also offers courses for AWS certifications in aerospace, ASME, D1.1, B2.1, and several other codes and standards to enrolled students as well as local skilled tradesmen and tradeswomen.

Coley McLean
cmclean@schoolcraft.edu
Livonia, MI 48150
(734) 462-7020 • schoolcraft.edu

Tri-County Technical College

The Welding program at Tri-County Technical College has trained welders for industry since 1965. Training is provided in structural, pipe, and fabrication welding using SMAW, GMAW, and GTAW processes. Students have the option of an associate degree program or certificate programs with varying skill sets. There are 76 modern weld stations to accommodate training needs. Four Certified Welding Inspectors/Educators are on staff to provide welder certification testing and customized company training.

Matthew Woodall
wwoodall@tctc.edu
7900 Hwy. 76
P.O. Box 587
Pendleton, SC 29670
(864) 646-1635
tctc.edu

United Technical Inc.

Train, test, and certify as an AWS Certified Welder at our facility in southeast Michigan. The ability to train all common processes (GMAW, GTAW, SMAW, FCAW, etc.) on any material (steel, stainless, aluminum, titanium, copper, etc.) makes United Technical your answer for any welding training need. Our classes emphasize hands-on training, so students spend most of their time actually welding. With years of experience focused on corporate welding training, we know what it takes to create a true welding professional. Our in-house CWIs and CWEs enable United Technical to support manufacturing companies of any size.

1081 E. North Territorial Rd.
Whitmore Lake, MI 48189
(248) 667-9185
Robert Dines
info@unitedtech1.com
unitedtech1.com

Welder Training and Testing Institute

WTTI maintains a freestanding campus in Pennsylvania, housing a weld lab equipped with 65 work stations. Training is provided in all major welding processes. Classrooms are fully equipped to support lessons in theory, blueprint reading, and fitting. Specialized on-site training is available to industry. WTTI also offers CWI and NDT training and certification as well as welder certification through our AWS Accredited Test Facility and ISO 17025 Accredited Laboratory.

729 E. Highland St.
Allentown, PA 18109
(800) 223-WTTI
info@wtti.edu

Tyler Junior College

Tyler Junior College (TJC) is a comprehensive community college in Tyler, Texas, recognized as one of the top colleges in Texas. Its one-year certificate and two-year associate degree pathways in welding technology prepare students for entry-level code welding for industry. Training is provided in blueprint reading and layout as well as SMAW, GMAW, FCAW, GTAW, and pipe welding. In addition, the welding program follows the AWS SENSE entry-level guidelines for welder training. Many TJC welding graduates secure a great job before graduation. Let us help you prepare for a rewarding career in a high-demand field. Call or visit our website.

1540 SSW Loop 323
Tyler, TX 75701
(903) 510-2390
(800) 687-5680
tjc.edu/welding

Waubonsee Community College

The Welding Technology program at Waubonsee Community College offers students options of two certificates, as well as an Associate in Applied Science Degree. Class sizes are small to ensure students get focused and individualized attention. Waubonsee's welding program includes classes in each of the basic processes, including OFW, TB, OFC-A, PAC, SMAW, GMAW, FCAW, and GTAW. Additionally, the curriculum includes two courses specifically devoted to pipe welding with GTAW and SMAW in all positions.

Rt. 47 @ Waubonsee Dr.
Sugar Grove, IL 60554
(630) 466-7900, ext. 2263
btwe@waubonsee.edu
waubonsee.edu

Weber State University

Welding Engineering Technology at Weber State University in Utah is an ABET/TAC accredited 4 year B.S. program that prepares graduates to work as Welding Engineers in the Manufacturing Industry. The program has six areas of focus, welding and manufacturing, design and structural, quality assurance and codes, robotic and electrical, management and teamwork. Graduates enter the industry with hands-on skills and the knowledge to tackle any welding problem. Scholarships are available. Open Enrollment.

Mark Baugh Professor
Manuf. Engineering Technology/
Welding Engineering Technology
1447 Edvalson St. Dept 1802
Ogden, UT 84408-1802
mbaugh@weber.edu
(801) 6266305