INSPECTION TRENDS

MAY 2026

THE MAGAZINE FOR MATERIALS INSPECTION AND TESTING PERSONNEL

AWS

A CWI's Guide to Borescope Inspection

Anatomy of a Welded Repair

Evaluating AWS Standard Welding Procedure Specifications

IN THIS ISSUE: BUILDING A WELDING AND INSPECTION PROGRAM ■ SCHOOL PROFILES ■ IEC HIGHLIGHTS

CONTENTS

[**MAY 2026** | VOLUME 29 | NUMBER 2]

[FEATURES]

[DEPARTMENTS]

INSPECTION TRENDS (ISSN 1523-7168 Print) (ISSN 2689-0631 Online) is published quarterly by the American Welding Society. Editorial and advertising offices are located at 8669 NW 36 St., #130, Miami, FL 33166; telephone (305) 443-9353. Readers of *Inspection Trends* may make copies of articles for personal, archival, educational, or research purposes, and which are not for sale or resale. Permission is granted to quote from articles, provided customary acknowledgment of authors and sources is made. Starred (*) items excluded from copyright.

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

COVER PHOTO:

A handheld articulating video borescope used for remote visual inspection. (Credit: ViewTech Borescopes.)

PUBLISHER: Annette Alonso
aalonso@aws.org

EDITOR: Carlos Guzman
cguzman@aws.org

[EDITORIAL]

EDITOR-IN-CHIEF: Cindy Weihl
cweihl@aws.org

MANAGING EDITOR: Kristin Campbell
kcampbell@aws.org

ASSOCIATE EDITOR: Roline Pascal
rpascal@aws.org

ASSOCIATE EDITOR: Alexandra Quiñones
aquinones@aws.org

ASSISTANT EDITOR: Rachel Bheecham
rbheecham@aws.org

[DESIGN & PRODUCTION]

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

PRODUCTION MANAGER: Zaida Chavez
zaida@aws.org

ASSISTANT PRODUCTION MANAGER:
Brenda Flores
bflores@aws.org

[ADVERTISING]

MEDIA SALES EXECUTIVES:

Scott Beller
sbeller@aws.org

Cara Collins
ccollins@aws.org

Lea Owen
lea@aws.org

SUBSCRIPTIONS REPRESENTATIVE:

Giovanni Valdes
gvaldes@aws.org

AMERICAN WELDING SOCIETY

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

Developing a Quality Management System Manual

BY JIM MASON

Perhaps you are a Certified Welding Inspector (CWI) with a few years under your belt. Perhaps you were lucky enough to have worked under a seasoned inspector who served as your mentor. Now you are working for a new company that wants you to develop its quality management system (QMS) manual. This may seem overwhelming at first. Nevertheless, you have been tasked with it, and you are expected to produce a functioning quality product. After all, you're a CWI. You're supposed to know everything, correct?

Take a deep breath and relax. Think back to when you first decided to achieve your CWI certification. No doubt that seemed overwhelming, too. The CWI test humbles both seasoned inspectors and engineers alike. It notably has a very high failure rate among first-time test takers, and rightly so.

However, you achieved it. Getting started, it felt like you had to eat an elephant, and yet you did, one bite at a time. Developing your first QMS manual can be done in the same way.

Although quality control manuals are required in many industries, this editorial focuses on the boiler, pressure vessel, and power piping industry, which comprises most of my experience.

Developing your QMS manual boils down to understanding the codes of construction your company operates under, including ASME *Boiler and Pressure Vessel Code* Section IX; the requirements of your local jurisdiction; and the problems fitters and welders face every day in their work. Whether your company's focus is new construction, repairs, or both, the premise remains the same. Simply put, your job is to ensure your company complies with the law.

Make no mistake, boiler and pressure vessel codes are set in stone. Throughout the history of the American Society of Mechanical Engineers (ASME) and the National Board of Boiler Inspectors (NBBI), catastrophic failures have occurred that resulted in loss of life and/or significant financial losses, often forcing businesses to go out of business. Rules were adopted and modified from lessons learned. Much is at stake for your company, its employees, and the people they serve.

Take another deep breath. You can do this.

First, familiarize yourself with the rules and regulations of the jurisdiction in which your company operates. Those rules typically reference adopted construction codes. Ensure your company has the latest editions of those codes, including ASME Section IX and the National Board Inspection Code (NBIC) when applicable.

Ensure you are well-versed in ASME Section IX and the qualification of welding procedures and welders. Ensure your company's welding procedure specifications, procedure qualification records, and welding procedure qualification records satisfy the requirements of Section IX, the applicable construction codes, your jurisdiction, and the NBIC, when applicable. Also, it is crucial that you fully understand what it takes to fabricate your company's product or facilitate a repair.

Now it's just a matter of envisioning each step of the process, considering the quality control measures needed, and methodically putting pen to paper as thoroughly and concisely as possible. Proofread and condense what you can without sacrificing the message.

Lastly, if your product or service falls under the NBIC, get to know the staff at the National Board. They are happy to answer any questions you may have and will review your manual and make appropriate recommendations to save you time, effort, and heartache when it's time to submit it for approval. IT

JIM MASON (*jim.mason@grda.com*) is NBBI technical program manager QA/QC, Grand River Dam Authority (GRDA), Chouteau, Okla. He is an AWS CWI and a National Board-commissioned In-Service Inspector with an R endorsement.

AWS Hosts CWI Seminar

AWS held a Certified Welding Inspector (CWI) seminar March 15–20 at its World Headquarters in Miami, Fla. The class was taught by David Viar, who is a CWI, Certified Welding Educator, and Certified Welder with Techno-Weld Welding Consultants. Viar also serves as mechanical technologies department chair and welding program coordinator at Moraine Valley Community College, Palos Hills, Ill. He is the past chair of the AWS Chicago Section and the District 13 director.

The seminar attendees were Jacob Abcug, Edward Frazer, Steven Hemenway, Daniel Lee, Jose Martinez, Matthew McGrath, Matthew Moore, Sean Riedell, Mark Serrano, Fabian Villota, and Tanner Wagner.

AWS, ASNT, and ASTM International Unite for NDT Week 2026

More than 150 industry leaders and technical experts from AWS, the American Society for Nondestructive Testing (ASNT), and ASTM International gathered at AWS World Headquarters in Miami, Fla., for the first-ever NDT Week 2026. Held January 18–23, the four-day collaborative event focused on a singular, driving theme: "Together, We Set the Standard."

As the nondestructive testing (NDT) industry undergoes rapid evolution, this gathering brought together the three premier standards organizations. The goal was to navigate topics such as artificial intelligence (AI), shifting workforce needs, and the future trajectory of inspection technologies.

"Innovation in our industry doesn't stand still, and neither can standards and certification," said Neal Couture, FASAE, CAE, ASNT CEO. "By working together, the NDT community ensures that standards and certification remain relevant, credible, and aligned with how the work is evolving in the field. This collaboration allows us to keep pace with emerging technologies like artificial intelligence."

At NDT Week 2026, committees worked deeply on key action items, including method and program alignment, supporting exam development, and long-term strategy.

A focus of the week was the integration of AI into established standards.

"These are the discussions that move the industry forward," said Paul Lang, ASNT chief global strategy

AWS CWI seminar attendees posed for a photo with instructor David Viar (standing, fourth from left).

officer. “We need to accelerate standardizing this fast-moving technology to create a solid regulatory framework companies can lean on. Investing in our people means staying aligned with where the industry is headed and how we can keep raising the bar.”

The week was anchored by keynote sessions from two thought leaders exploring the impact of AI on asset integrity and inspection:

- Lennart Schulenburg, CEO of VisiConsult X-ray Systems & Solutions, delivered the keynote “AI in NDT – Chance or Disruption?” Schulenburg addressed how standards may begin as theory but quickly become the practical foundation of the industry, especially as AI and digital inspection continue to evolve.

- Kelly P. Caillier, founder and CEO of KDC Reliability, presented “Overcoming Uncertainty: Augmenting Asset Integrity Inspection Strategies and Insights with Artificial Intelligence.” With 29 years of leadership experience and a patent-pending neural network (RM-23), Caillier shared insights on calculating effectiveness in asset integrity systems.

The AWS, ASNT, and ASTM collaboration at NDT Week 2026 reinforces a unified commitment to building the expertise that keeps quality and consistency front and center for the global NDT community.

ESAB to Acquire Eddyfi Technologies

ESAB Corp., North Bethesda, Md., has signed a definitive agreement to acquire Eddyfi Technologies, Quebec City, Quebec, Canada, a provider of advanced inspection and monitoring technologies, for $1.45 billion.

The acquisition is expected to be funded with a combination of cash on hand, debt, and $318 million of fully committed equity and is expected to close in mid-2026. As part of the transaction, the company has made commitments to maintain Eddyfi’s workforce and head office in Quebec City.

“Eddyfi is expected to deliver high-single-digit organic growth with gross margins exceeding 65%,” said Shyam P. Kambeyanda, president and CEO of ESAB Corp. “As we integrate the business and deploy the ESAB Business Excellence System (EBXai), we anticipate unlocking $20 million of synergies and additional operational and commercial benefits.”

“Joining forces with ESAB marks an exciting new chapter for our team,” said Martin Thériault, chair and founder of Eddyfi Technologies. “ESAB brings the scale, resources, and long-term commitment needed to support our people, strengthen our impact with customers, and honor the legacy we have built. This is far from being the end of our story. It is the beginning of a new chapter defined by growth, pride, and renewed momentum.”

North Star Imaging Achieves Nadcap Accreditation for Nondestructive Testing at California Facility

North Star Imaging (NSI), a provider of advanced digital radiography (DR) and computed tomography (CT) systems and inspection services, recently announced its California facility has earned Nadcap® accreditation for Aerospace Quality System (AC7004) and Nondestructive Testing (AC7114 and AC7114/6).

This award from the Performance Review Institute affirms that NSI meets the highest industry standards for quality and technical excellence. Its California site earned a 36-month accreditation for Aerospace Quality System and a 12-month accreditation for Nondestructive Testing following a comprehensive audit.

“Nadcap accreditation is a significant milestone that reflects our unwavering commitment to quality, precision, and continuous improvement,” said Rebecca Rudolph, general manager of NSI. “It reinforces NSI’s position as a trusted partner to aerospace, defense, and advanced manufacturing industries where regulated image quality and compliance are paramount."

This accreditation aligns with the company's long-term strategy to deliver quality and reliability across all facilities. The company is also preparing for its next Nadcap audit at its Florida facility in early 2026.

Georgia Southern Researchers Increase Crack Detection Accuracy Using Advanced Ultrasound Technique

A team at Georgia Southern University, Statesboro, Ga., has developed a method that improves crack signal detection during nondestructive inspections by approximately 15% using the total focusing method, an enhanced ultrasonic testing technique. The research is detailed in the paper "Ultrasonic Detectability of Planar and Volumetric Weld Defects: A Simulation-Based Signal-Response POD Study" by Chowdhury Irtiza, Bishal Silwal, and Hossein Taheri. The work won the best research award in the poster competition at the 2025 International Mechanical Engineering Congress & Exposition.

The project builds on industry-standard ultrasonic inspection practices, which rely on high-frequency soundwaves to identify internal flaws based on returning echoes. Conventional approaches often struggle to detect certain types of cracks, especially in large or complex structures where access is limited and internal damage cannot be visually confirmed.

The Georgia Southern team addressed this challenge by integrating simulation modeling with the total focusing method, a technique that captures a substantially larger volume of raw echo data than traditional inspections. By processing this expanded dataset, researchers generated more detailed and reliable defect images, resulting in stronger crack-signal responses and a more accurate assessment of structural conditions.

The research effort was supported within Georgia Southern's Allen E. Paulson College of Engineering and Computing, where student researcher Irtiza contributed to the development and validation of the improved method under the guidance of Associate Professor Hossein Taheri. Their collaboration has advanced inspection reliability in a field where increased accuracy can directly influence public safety, maintenance planning, and infrastructure resilience.

Irtiza intends to continue this work through doctoral studies at Georgia Southern, focusing on further advancements in ultrasonic analysis and detection capability.

Waygate Technologies Recognized by Frost & Sullivan for 2026 Remote Visual Inspection Leadership

Waygate Technologies, a Baker Hughes business headquartered in Huerth, Germany, has earned the 2026 Global Company of the Year Recognition in the remote visual inspection industry. This recognition, presented by Frost & Sullivan, highlights the company's leadership in driving measurable outcomes, strengthening its market position, and delivering customer-centric service.

Winners are selected through Frost & Sullivan's benchmarking process, which evaluates strategy effectiveness and execution. According to the organization, Waygate Technologies demonstrated strong alignment between strategic planning and operational performance.

The company's work in remote visual inspection includes video borescopes, pan-tilt-zoom camera systems, and cloud-enabled inspection platforms designed for industrial inspection workflows. Frost & Sullivan noted Waygate Technologies' consistent performance within professional inspection circles.

The company also emphasizes inspection workflows supported by digital tools, including a cloud platform and guided procedures. These capabilities were cited as highlighting the company's role in shaping developments in the field of remote visual inspection. IT

Pan-Tilt-Zoom Inspection Camera Enables Enhanced Industrial Environment Inspections

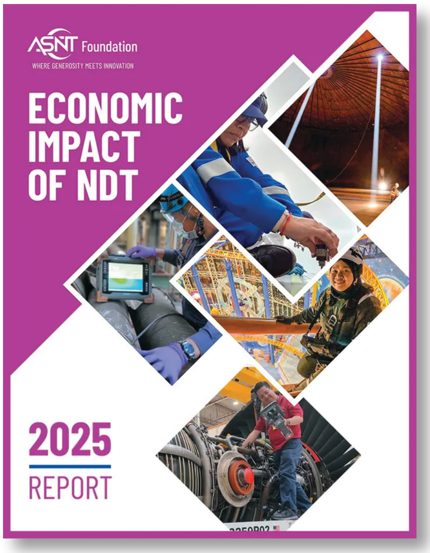
The Mentor Zoom pan-tilt-zoom (PTZ) camera system supports visual inspection of confined and hard-to-reach industrial environments, including pressure vessels, piping, underground and storage tanks, sewers, and nuclear facilities. It is designed for harsh environments and can support remote inspection and maintenance monitoring at depths of up to 40 m underwater. The system includes two full HD camera heads: a 70-mm (2.76-in.) unit with 10× optical zoom and a 130-mm (5.12-in.) unit with 30× optical zoom. Both provide 60 fps video output and faster camera-head movement. The 130-mm camera also features 4000-lumen integrated illumination for extended inspection range. The control unit has a removable touchscreen with an integrated joystick and a 3 m (9.8-ft) cable. Touch-aim, zoom-to-rectangle, and to-focus functions quickly adjust PTZ and focus during inspection. The system captures textured 3D environmental views and automatically generates detailed 3D models for verification with digital twin features. Inspection results may be documented in standard formats or marked directly in 3D using the generated mesh. The system integrates with the InspectionWorks data platform and includes an on-device AI hardware accelerator.

Waygate Technologies
bakerhughes.com/waygate-technologies

NDT Report Highlights Industry Value and Workforce Priorities

The *Economic Impact of NDT Report 2025* presents a comprehensive, data-driven analysis of the scale, reach, and economic value of the nondestructive testing (NDT) industry. It examines the current U.S. NDT workforce of 89,800 professionals and projects market growth from $3.3 billion today to nearly $7 billion by 2035. The report analyzes the U.S. NDT market across equipment, services, and software, along with key industry drivers, constraints, and emerging trends. It also outlines the rapid evolution of advanced inspection methods, digital tools, and data-driven technologies that are transforming NDT and the way value is delivered. Readers can learn about the direct economic contributions of the NDT industry and the cost savings it generates by preventing failures, extending asset life, and reducing operational risk. These benefits support infrastructure, transportation systems, energy production, and manufacturing operations nationwide.

ASNT Foundation
foundation.asnt.org



BY RACHEL BHEECHAM

From Navy Vet to CWI

The AWS Detroit Section's former chair has enjoyed more than 40 years in the industry

Maatz, seen here in 1983, did his own welding work on his first car — a 1971 Chevrolet Chevelle.

A summer job at a friend's family's fabrication shop during high school, assisting around the shop and working in the humid Ohio heat, jump started Donald Maatz Jr.'s interest in welding and a career that has now spanned more than 40 years.

After high school, Maatz joined the Navy, where he followed a progression that might sound familiar to those who served the United States at the time: boot camp, Machinist Mate "A" School, temporary duty on the USS *Barney* (DDG-6), nuclear power school, time at a nuclear prototype reactor, and finally the Navy's Submarine Emergency Welding School. Along the way, he learned about welding engineers, and his fate was sealed.

"I was a part of the inaugural crew where I helped commission the USS *Pittsburgh* (SSN-720) (see the July 2021 Welding Journal to learn more). One day, they had trouble with a weld repeatedly failing inspection. They said they were going to bring down a welding engineer — the first time I ever heard of one — to make sure it was done right. After that event, it was done right, and I was like, oh, you can be a welding engineer, not only a welder," Maatz said.

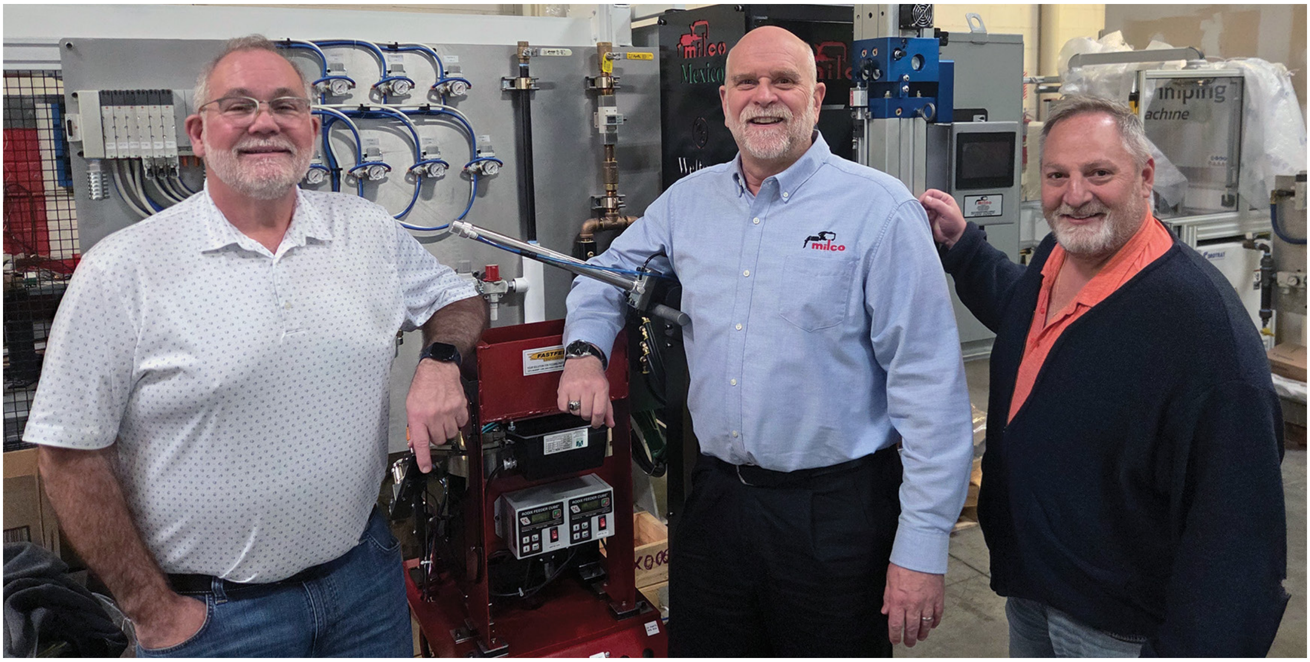
After the Navy, he had a brief stint as a road mechanic before attending The Ohio State University, where he earned a bachelor's degree in welding engineering. Maatz took a job at Ford Motor Co., where he was selected for a rotational program that taught him about various aspects of manufacturing and numerous welding processes before finding a home at their Ohio Assembly plant, where he primarily focused on resistance welding and began his journey toward becoming a Certified Welding Inspector (CWI).

"From day one, even in the fabrication shop as a teenager, where I knew nothing about a code or a standard, they wanted me to look at the weld. Did you tie in the sides? Do you have any undercut? Do you have enough bead reinforcement? I know these terms now. Back then, I was never welding to a standard. I was just making welds," he remembered.

In the Navy, things were different, and they were much more stringent when it came to welds. "They were very adamant and exacting, looking back on it. In an emergency, you make a repair weld, but as soon as you pull into the yard, a certified welder is going to replace your weld," he said.

Welds are never defective or bad; instead, they are either acceptable or discrepant to the standard under which the weld was done.

At Ford, Maatz was exposed to many different types of welding: resistance welding, arc welding, arc repairs, silicon-bronze brazing, and more. However, the majority of his role was focused on resistance spot and projection welding, which he credits with teaching him the importance of evaluation in the field. It taught him about destructive and visual evaluation of welds, leading to what has now become his mantra: make welds that meet engineering intent.



Maatz (center) with Milco Manufacturing owners John Pippin (left) and Jeff Beach (right).

Maatz at the decommissioning of the USS *Pittsburgh*.

Maatz believes that welds are never defective or bad; instead, they are either acceptable or discrepant to the standard under which the weld was done.

This was the beginning of his understanding of the importance of codes and standards. After Ford, he worked as a laser welding engineer for a year, where the focus was very much on quality, exposing him to standards he'd not previously encountered in his career. Shortly after, he moved into an engineering consultant role before becoming the lab manager, focusing on qualifications, characterizations, and overseeing every process at RoMan Engineering Services. It was during his time at RoMan that he became a CWI.

Maatz considers his CWI certification to be almost a golden ticket. "As soon as people hear you have your CWI, it is instant credibility," he said.

While Maatz does not use his CWI knowledge daily, he still finds it useful to have. In his most recent CWI experience, he served as the third-party auditor ensuring everything was up to standards. He credits it as a great experience, where both he and the clients were able to learn from each other's capabilities.

"They weren't really used to an audit process, but I'd been doing it for years. I'd have them with me while providing updates, listening in, and then asking for their feedback and perspective," he said. This was only part of the highlight of his experience, as he also emphasized the importance of problem-solving and served as a mentor about how to interact with management, which Maatz stated he thoroughly enjoyed.

Maatz has since returned to resistance welding at Milco Manufacturing, a resistance welding gun manufacturer, where he can apply both his applied knowledge and training expertise. This includes continuing to be a mentor through his volunteer work with AWS. Aside from being active within his local Detroit Section, including serving as the former chair, he is on several AWS committees and is heavily involved in the inspection and quality aspects of several resistance welding processes, including serving as an instructor at the RWMA (Resistance Welding Manufacturing Alliance) Emmet A. Craig Resistance Welding School since 2015.

Yet, Maatz does not consider himself a welding expert. "After doing something for 40 years, you ought to be pretty good at it, and I guess I'm getting there," he said. As an example of his belief that learning never stops, he carries a unique electrode cap in his pocket as a physical reminder to never judge a book by its cover. IT

RACHEL BHEECHAM (*rbheecham@aws.org*) is the assistant editor of *Inspection Trends*.

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

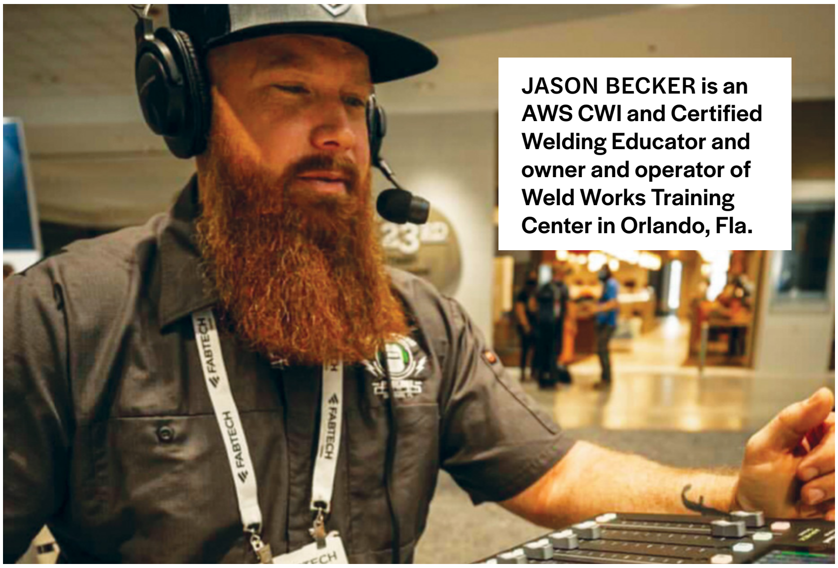
WELD WEDNESDAY with AWS

How to Prepare for the AWS CWI Exam

Why preparation, discipline, and the right training make the difference on exam day

Becoming an AWS Certified Welding Inspector (CWI) is a major milestone for many welding professionals, but it can also be one of the most demanding certification processes in the trade. In the episode "Everything You Need to Know to Pass the CWI Exam," *Arc Junkies* podcast host Jason Becker breaks down what it takes to prepare for the exam, based on his own experience and years of being a participant of AWS tests and seminars. The CWI exam is difficult, but it is achievable with the right preparation, mindset, and commitment.

This episode serves as a roadmap for anyone considering the certification, covering eligibility, exam structure, study resources, training options, and real-world advice on navigating both the preparation period and test day. For detailed information on eligibility, requirements, resources, and how to apply, visit *aws.org/certification-and-education*.



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

Understanding What the CWI Exam Tests

According to AWS requirements, candidates must pass three separate exams, known as Parts A, B, and C, to earn the CWI credential. Each part tests a different competency, and the minimum passing score for the CWI certification is an overall composite score (average of the three exam parts) of 72%. Additionally, the minimum passing score for each CWI exam part is 72%.

Part A is the Fundamentals exam, a closed-book, computer-based test. This section focuses on general welding knowledge, including metallurgy, welding processes, nondestructive testing, fabrication methods, welding symbols, and basic math. Becker acknowledges that the time limit sounds intimidating but notes that well-prepared candidates often finish early.

Part B is the Practical exam requiring hands-on application, not a computer-based test like Parts A and

C. This section blends physical evaluation with written interpretation and uses weld replicas, inspection tools, photographs, and a unique "Book of Specifications." Becker emphasizes that this book is an industry-based, simulated code published by AWS for exam purposes only, but it's based on the structure of real codes such as AWS D1.1/D1.1M:2025, *Structural Welding Code – Steel*; American Petroleum Institute (API) Standard 1104, *Welding Pipelines and Related Facilities;* and ASME *Boiler and Pressure Vessel Code* (BPVC) Section IX. Candidates who rely on memory and their own practices instead of strictly following the Part B specifications are likely to fail. The goal of this exam is not to test real code knowledge but to see whether the candidate can carefully read, interpret, and apply written requirements.

Part C is the Code Book exam. It is open-book and computer-based, with the number of questions varying depending on the code or standard selected. Many candidates choose AWS D1.1 or API 1104, though additional codes and standards are now available. Becker advises candidates to select the code or standard they will use most once they obtain their CWI credential.

Exam Order and Why Timing Matters

Becker strongly recommends scheduling Parts A and C as soon as possible after Part B to stay mentally engaged in "test mode." Spreading the exams too far apart allows every day work and distractions to creep back in, making it harder to stay focused and prepared.

The Case for In-Person Training

Although online resources and self-study materials are widely available, Becker is a strong advocate of in-person CWI training, especially for candidates who come straight from the field. He points out that inspection concepts, code navigation, and formal terminology can be unfamiliar to welders who have spent most of their careers working hands-on.

In-person seminars provide immediate instructor feedback, exposure to realistic practice exams, and hands-on experience with inspection tools and weld samples. Becker recommends two-week programs whenever possible. The extra time allows candidates to absorb information more thoroughly and feel comfortable before exam day. He also advises candidates to research training providers carefully. The key takeaway is that candidates should choose a class that fits their learning style, budget, and schedule.

How to Study Smarter, Not Just Harder

Preparation varies by exam section, but Becker emphasizes that memorization alone is not enough. For Part A, he recommends focusing on foundational knowledge and official AWS documents, many of which are available for free. These cover certification requirements, safety standards, welding symbols, and inspection fundamentals. A critical point is understanding standard AWS terminology, as nonstandard slang terms are never used on the exam. (See the latest version of AWS A3.0, *Standard Welding Terms and Definitions*.)

For Part B, Becker encourages candidates to become comfortable with reading procedures, interpreting specifications, and using basic inspection tools without overthinking the process. AWS provides all tools on test day, and personal equipment is not allowed. According to Becker, the practical portion becomes manageable once candidates understand how to read the book and use the tools correctly.

Part C preparation revolves around speed and accuracy in navigating the code book. Becker explains that candidates should memorize the code layout, understand what each clause contains, and use tabbing strategically rather than excessively. Footnotes, he warns, are critical and often change the meaning of a requirement entirely. Highlighting and notes are allowed before test day, but any writing in the code book during the exam can result in disqualification.

Discipline Outside the Classroom

Beyond books and practice exams, Becker stresses the importance of lifestyle discipline during preparation. He shared how his structured schedule during training included consistent study hours, minimal distractions, healthy food choices, and avoidance of social distractions. Studying in a quiet environment, turning off notifications, and treating preparation like a full-time responsibility helped him stay focused and absorb the massive amount of information required.

Becker also advises becoming an AWS member when preparing for the exam to take advantage of significant discounts on exam fees, books, standards, online courses, and seminars.

A Challenging Exam with a Real Payoff

Becker argues that most unsuccessful attempts to pass the test come down to lack of preparation rather than lack of ability. For those willing to commit the time and effort, the certification can open doors to new responsibilities, higher earning potential, and long-term career growth.

In the end, it is not just about passing a test, it is about approaching the profession with seriousness and integrity. IT

Nondestructive Examination Coordination Endorsement

Understanding the requirements, scope, and impact of this endorsement

The Nondestructive Examination Coordination (NDEC) endorsement demonstrates an individual's understanding of nondestructive (NDE) qualification and certification programs, core NDE testing methods, and key NDE coordination components and activities.

AWS QC1, *Specification for AWS Certification of Welding Inspectors*, allows endorsements to be added to the Certified Welding Inspector (CWI) and Senior Certified Welding Inspector (SCWI) certifications. Endorsements indicate additional knowledge, skill, or ability documented in writing and added to an individual's certification credential(s).

This endorsement satisfies one of the four required endorsements leading to SCWI certification, which are Welder Performance Qualifier, Welding Procedure Qualifier, Welding Coordination and Quality Assurance, and NDEC.

The NDEC endorsement meets a portion of the requirements for SWI Alternative Qualification in AWS B5.1:2013 AMD1, *Specification for the Qualification of Welding Inspectors*, and Alternative Certification for the SCWI in QC1.

The inspector who seeks the NDEC endorsement should be assessed for the following capabilities:

- **NDE qualification and certification programs**: Demonstrate an understanding of the programs and governing standards that determine how NDE agencies are assessed and what the training and certification requirements are for NDE practitioners.
- **NDE methods**: Demonstrate an understanding of the basic elements necessary for each of the major NDE methods. This will prepare the holder to oversee the selection of the appropriate NDE method, considering each method's advantages and limitations.
- **NDE coordination**: Demonstrate knowledge of inspection test plans, sampling protocols, probabilities of detection, and how to interpret data collected from NDE reports.

Domain	Subdomain	Percent of Questions on Examination
Domain 01 Qualification and Certification	0101 Standards for NDE Quality Management	20%
	0102 NDE Qualification and Certification Standards	
Domain 02 Methods	0201 Visual Testing	30%
	0202 Magnetic Particle Testing	
	0203 Liquid Penetrant Testing	
	0204 Radiographic Testing	
	0205 Ultrasonic Testing	
	0206 Leak Testing	
	0207 Eddy Current Testing	
	0208 Positive Metal Identification	
Domain 03 NDE Coordination	0301 ITP-QP	50%
	0302 Data Analysis	
	0303 Approved Operating Procedures	
	0304 Selection of NDE Methods and Techniques	

Table 1 — Test specifications are shown.

Initial Certification or 9-Year Recertification Eligibility

For existing CWIs, successful completion of this endorsement satisfies the examination requirements for a 9-year recertification, provided that the endorsement is taken during the immediate 9-year period.

IMPORTANT: For new candidates to the CWI program, this examination is not an option for initial certification. It is not a CWI Part C Codebook exam and does not meet the requirements of Clause 6.2.1 of the AWS B5.1:2013 AMD1, nor does it follow the guidelines of Clause 7.1.

Training and Examination Requirements

This endorsement has no mandatory training requirements. Candidates are encouraged to attend an AWS seminar or conduct self-study to become familiar with the exam information.

Candidates who hold CWI or SCWI credentials and who wish to take this examination to add as an endorsement to their AWS credentials must be current in their AWS certification status.

Successful candidates must correctly answer 70% of the questions to receive this endorsement.

Test Specifications

Test specifications are a breakdown of exam content areas along with the proportion of the exam devoted to each content area — Table 1.

Informative References for Self Education

The following is a list of informative reference books to assist those wishing to learn and understand the major welding quality assurance programs used in industry today.

- ANSI/ASNT CP-9712 (2023), *ASNT Standard for Qualification and Certification of NDT Personnel* or ISO 9712: 2021, *Non-destructive testing — Qualification and certification of NDT personnel*
- ANSI/ASNT CP-189 (2020), *ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel*
- API RP 578, *Material Verification for New and Existing Assets*
- ASNT, *Recommended Practice No. SNT-TC-1A* (2024)
- ASTM E1003-22, *Standard Practice for Hydrostatic Leak Testing*
- ASTM E1212-17, *Standard Practice for Establishing Quality Management Systems for Nondestructive Testing Agencies*
- ASTM E1359-17, *Standard Guide for Auditing and Evaluating Capabilities of Nondestructive Testing Agencies*
- ASTM E164-19, *Standard Practice for Contact Ultrasonic Testing of Weldments*
- ASTM E165-23, *Standard Practice for Liquid Penetrant Testing for General Industry*
- ASTM E2884-22, *Standard Guide for Eddy Current Testing of Electrically Conducting Materials Using Conformable Sensor Arrays*
- ASTM E543-21, *Standard Specification for Agencies Performing Nondestructive Testing*
- ASTM E709-21, *Standard Guide for Magnetic Particle Testing*
- ASTM E797-21, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*
- ASTM E94-22, *Standard Guide for Radiographic Examination Using Industrial Radiographic Film*
- AWS B1.10M/B1.10:2016, *Guide for the Nondestructive Examination of Welds*
- AWS B1.11/B1.11M:2015, *Guide for the Visual Examination of Welds*
- AWS B5.17:2014, *Specification for the Qualification of Welding Fabricators*
- AWS D10.4M/AWS D10.4, *Guide for Welding Austenitic Stainless Steel Piping and Tubing*
- AWS, *Welding Handbook,* Volume 1, Welding and Cutting Science and Technology, 10th edition
- ISO 9001, *Quality management systems — Requirements*

Exam Delivery and CBT Exam Timing Information

The examination is a computer-based test (CBT) delivered at a Prometric testing center.

The overall seat time allotted is 150 minutes (2 hours and 30 minutes) from check-in to check-out at the test center. The time available for answering questions is 135 minutes (2 hours and 15 minutes).

Endorsement Renewal and Professional Development Hours

This endorsement does not require renewal. It is automatically renewed at each CWI renewal or recertification. The endorsement will continue to be listed in an approved manner.

Candidates who complete pre-exam training to prepare for the Welding Coordination and Quality Assurance endorsement examination may gain professional development hours (PDHs) in accordance with QC1, clause 16.5. IT

SCWI Maintenance Structure

The SCWI maintenance structure aligns with the AWS QC1:2016-AMD1 requirements. Under QC1 Clauses 15 and 16, SCWIs must complete renewals at the three-year and six-year marks and undergo complete recertification in the ninth year of their certification cycle.

To renew, as per QC1:2016-AMD1, Clause 15, the SCWI will need to attest that they have had no period of continuous work inactivity exceeding two years in activities described in AWS B5.1 during the previous three years of certification.

To recertify, per QC1:2016-AMD1, Clause 16, SCWIs may recertify using one of three flexible pathways:

- Complete a committee-approved endorsement at any time within the nine-year period.
- Accumulate the required PDHs.
- Attend an AWS 9-Year Recertification Seminar before their certification expiration date.

Discover the Value of CWI/SCWI Endorsements

AWS CWI and SCWI endorsements represent a pinnacle of achievement for inspectors seeking to deepen their knowledge, skills, and abilities and add to their credentials in the welding industry.

These specialized credentials symbolize your commitment to excellence and continuous learning and serve a strategic purpose for CWI and SCWI recertification.

In addition to the NDEC endorsement, the other 13 endorsements AWS currently offers are as follows:

Welder Performance Qualifier
(required for initial SCWI certification)

Showcase your knowledge, skill, and ability to conduct welder performance qualification tests.

Welding Procedure Qualifier
(required for initial SCWI certification)

Showcase your knowledge of developing and qualifying welding procedures.

Welding Coordination and Quality Assurance *(required for initial SCWI certification)*

Validates your specialized knowledge in welding quality assurance and coordination.

D1.1 Structural Steel

Demonstrate your knowledge in structural steel welding, covering material and design, fabrication, inspection, and qualification in the industry.

D1.2 Structural Aluminum

Demonstrate your knowledge in aluminum welding, covering material and design, fabrication, inspection, and qualification.

D1.5 Bridge Welding

Showcase your knowledge of bridge welding standards, including material and design, fabrication, inspection, and qualification.

D15.1 Railroad Welding

Demonstrate your expertise in welding railroad cars and locomotives, covering material and design, fabrication, inspection, and qualification.

D17.1 Aerospace Welding

Demonstrate your knowledge in aerospace welding, encompassing the specific requirements and standards for materials, design, fabrication, and inspection within the aerospace industry.

ASME *BPVC*, Section IX, Power B31.1 and Process B31.3 Piping

Showcase your proficiency in welding power and process piping systems, aligning with the rigorous standards of ASME codes.

API 1104 Pipeline Welding

Demonstrate your knowledge in pipeline welding, covering material and design, fabrication, inspection, and qualification in the industry.

This credential enhances your professional value, positioning you as a crucial asset to companies in the pipeline industry. Invest in career advancement and elevate your welding credentials with the API 1104 endorsement.

Magnetic Particle Testing of Welds

Demonstrate your knowledge in conducting magnetic particle testing of welds.

Penetrant Testing (PT Type II – Method C)

This endorsement signifies proficiency using the solvent-removable method for visible penetrant testing of welds on ferrous and nonferrous materials.

ISO Welding Standards

Demonstrate your knowledge of ISO welding standards, including material and design, fabrication, inspection, and qualification.

For more information about these endorsements, visit *aws.org/certification-and-education,* or contact the AWS Certification Department at (800) 443-9353 or *aws.org/contact-us*.

IT FEATURE

BY CHRISTINE O'CALLAGHAN AND DUNCAN WHITE

Clearer Views, Better Data:
A CWI's Guide to Video Borescope Inspection

Best practices to achieve accurate and reliable results

For decades, the primary tools of the AWS Certified Welding Inspector (CWI) were simple: a flashlight, a mirror, a fillet gauge, and a keen pair of eyes. But as engineering designs become more complex and tolerances tighten, the areas that require nondestructive examination (NDE) are becoming increasingly difficult to access.

Enter the industrial video borescope, a remote visual inspection (RVI) tool packed with adjustable lighting, photography, videography, annotation, and often measurement capabilities that elevate welding inspections to new heights. However, possessing the tool is only half the task. A borescope is not simply a camera on a wire; it is a sophisticated optical instrument that requires a few simple techniques and care guidelines to yield accurate results.

This article explores best practices for leveraging borescope technology to identify discontinuities such as porosity, incomplete penetration, and burn-through, ensuring that what we see on the screen accurately reflects the weld's quality.

Beyond the inspection, we will also explore the often overlooked post-inspection phase and cover proper reporting techniques. Finally, we will demystify the purchasing process by breaking down exactly which features matter for welding applications, helping you make an informed decision for your specific needs.

Best Inspection Techniques

The biggest hurdle for CWIs performing borescope inspections is image clarity. The issue is not solely the camera's resolution, but also how the operator manages the environment. Inside a stainless-steel pipe or a polished pressure vessel, for example, the environment is hostile to photography. It is dark, reflective, and geometrically complex.

Mastering the Light

Lighting is the single most critical factor in borescope inspection. A common mistake is immediately cranking the lighting output to 100%. In a reflective welding environment, this causes "blooming" where the light bounces off the metal surface and blinds the camera sensor, washing out the details of the weld bead — Figs. 1 and 2.

- **Dial in the exposure**. Use the brightness controls to find the optimal lighting level. Often, lower light allows the sensor to capture contrast better. When your target area is close — for instance, when inspecting a root pass in a small diameter tube — back the lights down. Also, take advantage of modern borescope's exposure control settings to reduce glare in tight or reflective areas.
- **Angle of incidence**. If glare persists, slightly articulate the tip. Changing the camera angle relative to the weld

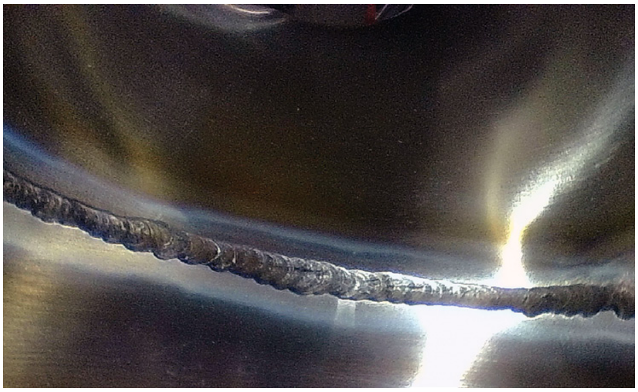


Fig. 1 — A borescope image showing excessive lighting, causing blooming.

Fig. 2 — A borescope image showing adjusted lighting, avoiding blooming.

surface by just a few degrees can often deflect glare away from the lens.

Stability and Image Capture

Blurry images are the enemy of good reporting. Unlike a regular digital single-lens reflex (DSLR) or mirrorless camera, a borescope has a small sensor and often uses a slower shutter speed in low light.

■ **Stabilize the instrument**. The steadier you hold the handset and the insertion tube, the sharper the image. If possible, brace your hand against the pipe entry or a solid surface.

■ **The "rule of multiples."** Never take just one picture. When you identify a relevant indication, whether it is a cluster of porosity or a suspected crack, capture three to four images from slightly different angles or lighting intensities. This redundancy ensures you are not stuck with a single, ambiguous photo that would require a reinspection.

Video Inspection Technique

Video offers context that still images cannot. However, erratic camera movement will make reviewing the footage difficult. A pro tip for video inspection of linear welds (like longitudinal pipe seams) is the "insert-and-pull" method:

1. Insert the probe all the way to the end of the inspection zone

2. Orient the camera to the 12 o'clock position (or your specific target)

3. Start recording

4. Slowly and steadily pull the insertion tube out toward you. This method is smoother than pushing the probe in, as the tension on the tube helps keep the camera head steady.

Finally, though borescopes have built-in screens, connecting them to a larger monitor or other devices via HDMI or Wi-Fi can significantly enhance defect recognition and facilitate real-time team collaboration.

Accessories

Borescopes do the heavy lifting during a weld inspection, but the right accessories can make the job easier. One accessory CWIs find helpful is the centering device — Fig. 3. This attachment for the insertion tube helps keep the scope centered in the pipe, providing a consistent view of the weld around the entire circumference. That means better lighting and fewer blind spots. It also helps protect the scope from rubbing against the wall.

Other add-ons, such as stiff yet flexible guide tubing or rigidizers, can improve control during insertion. They add stiffness when you need it, making it easier to push through longer runs or tight areas without fighting the scope. These accessories are not mandatory for every job, but they are good tools to have if needed.

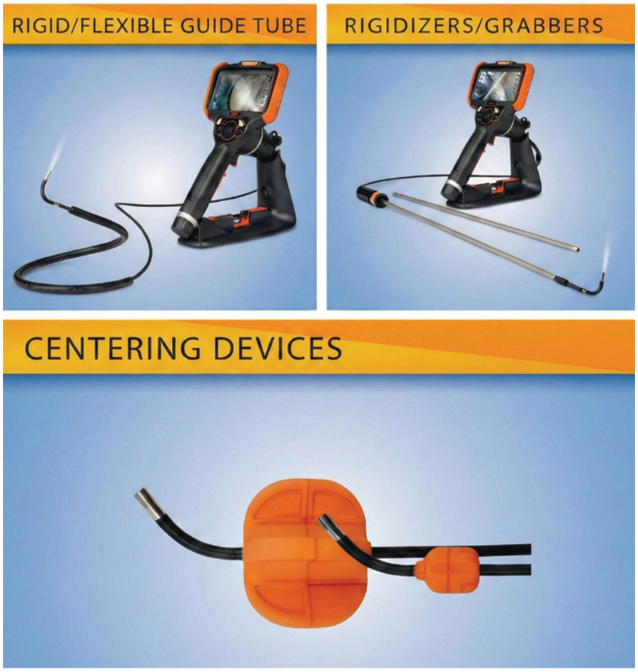


Fig. 3 — Centering devices and other borescope accessories help position the borescope's insertion tube, providing a steady and consistent look at the weld.

Fig. 4 — Use your device's text annotation tools to label images immediately, including date/time, weld number, quadrant or clock position, and viewing direction.

Annotation and Context

The last step of any inspection is the signed report. In the world of RVI, where the image is the data, visual evidence must be definitive.

A close-up photo of a crack looks exactly like a close-up photo of a crack from a different inspection. Always use the text annotation features on your device to label images immediately — Fig. 4. Ensure the date and time stamp are active, and clearly identify the weld number, the specific quadrant or clock position, and the direction of the view. One more tip: Set up image folders before starting the inspection. A little prep work upfront keeps your files organized and makes inspecting and reporting more efficient.

Verification vs. Estimation

Historically, sizing a defect via a borescope was a guessing game. Today, on-screen measurement technologies such as stereo and 3D measurement allow inspectors to quantify defects with high precision. While not every inspection requires this level of detail, these tools are invaluable for critical validation. If you spot a pore or an undercut that looks borderline, using these measurement tools can provide the data needed to accept or reject the weld based on specific code criteria (e.g., American Society of Mechanical Engineers [ASME] B31.3, *Process Piping*). Even if you don't use advanced measurement, having a reference object of known size in the frame can help in estimating the scale of the flaw.

Streamlining the Paperwork

A disorganized folder of JPEGs can quickly become a reporting nightmare. Many borescopes now offer inspection reporting software designed to automate code-compliant reports with a few clicks, no more clicking and dragging — Fig. 5. Look for solutions that let you flag images and add comments, such as International Organization for Standards (ISO) or ASME codes. This not only speeds up turnover packages but ensures your data is consistent, searchable, and professional.

Best Practices for Care of the Borescope

A video borescope is a fine optical instrument housing tiny charge-coupled device (CCD) or complementary metal-oxide-semiconductor (CMOS) sensors, hair-thin wires, and complex articulation cables within a ruggedized exterior that shields an intricate optical assembly.

Common Handling Pitfalls

■ **The coiled hose error**. Whether mechanical or servo motor, do not operate the articulation joystick if the insertion tube is coiled in a tight loop (like a garden hose). This puts immense tension on the internal cables. If you feel unusually high resistance on the joystick, stop.

ISO-440_WFI-Loop_01\W-04_REJECT_Crater

Section	ISO-440_WFI-Loop_01
Area	W-04_REJECT_Crater
Component	
Photo	DCIM0122.JPG
Comments	REJECT. Crater pipe / shrinkage void detected at weld termination. Grind and re-weld required.

☐ Flag Image | Back to Summary

Fig. 5 — Inspection report excerpt generated using ViewTech's borescope inspection Report Maker pairs high-resolution borescope imagery with precise defect location data and corrective action notes, to support clear inspection documentation.

■ **Protect the bending section**. The most sensitive part of the scope is the bending section where the borescope articulates. Never grab the bending section and maneuver it with your fingers. Only use the joystick or control knobs to move the tip. Manually forcing it can strip the internal gears or snap the cables.
■ **The yank**. If the probe seems stuck, perhaps caught on a burr or a tack weld, resist the urge to yank it. Forceful pulling will stretch the outer braiding and damage the data wires. Instead, gently manipulate the joystick to wiggle and steer the head free while applying light tension.

Environmental Limits

Welds can be hot, and electronics can only withstand so much heat. A standard mistake is rushing to inspect a weld before it has cooled.
■ **Temperature**. Refer to your user manual for the maximum heat capacity of your borescope. Extreme heat can delaminate the camera lens and fry the sensor.
■ **Chemical compatibility**. Be mindful of cleaning agents. The insertion tube is often coated with materials resistant to oil and water, but harsh solvents can degrade this coating over time. Again, refer to your user manual.

Daily Hygiene

Avoid letting the camera tip fall onto hard concrete floors. When packing up, ensure the insertion tube isn't draped where it can be stepped on or crushed by equipment cases. Clean then store your borescope in its provided case, leaving it ready for the next inspection. These sound like basics, but impact damage and crushing are the leading causes of premature borescope failure.

Considerations when Purchasing a Borescope

If you are in the market for a unit to support your welding inspections, it is easy to get lost in spec sheets. Below is what matters for weld inspection.
■ **Scope type**. The articulating video borescope has become the versatile standard for complex welding inspections. However, rigid and semirigid borescopes are available for straight-line access or simple overhead checks.
■ **Versatility**. When comparing units, consider how the system achieves different viewing angles. Many systems use interchangeable optical adapters or screw-on tips to switch between a forward and a side view. Alternatively, dual- or triple-camera probes integrate multiple lenses into a single tip, allowing the operator to toggle between views electronically without retracting the insertion tube to swap components.
■ **Articulation**. You generally have a choice between 2-way (left/right) and 4-way (360 deg) articulation. For straight runs, 2-way may suffice, but for navigating elbows, T-joints, or complex headers, 4-way articulation is often indispensable. It allows you to look back at a root pass or navigate through a lateral turn without rotating the entire insertion tube.
■ **Durability and materials**. Look at the construction of the insertion tube. Tungsten braiding and stainless-steel construction are industry standards for a reason — they offer the best balance of flexibility and armor against the rough internal surfaces of carbon steel piping.
■ **Diameter**. The probe must fit your smallest access point with room to spare. If you are inspecting small instrumentation taps, a 0.85, 1.1, or 2.2 mm is necessary. If you have open access, a 3.9, 6.0 mm, or wider probe often offers better lighting and durability.
■ **Focal range**. This is critical. Some borescopes are designed for far focus (seeing down a longer space). Most often, for welding, you need near focus or macro capabilities. Ensure the scope you choose is optimized for the depth of inspection you can achieve.
■ **Support and cost of ownership**. Finally, when shopping, reputable borescope providers often offer a no-cost demonstration or trial period. This allows you to validate that the probe diameter fits your specific access points and that the image quality meets your code requirements before committing capital. During this demo, consider ease of use; an intuitive interface ensures that inspectors spend their time analyzing the weld, not fighting the menu system.

Furthermore, consider the long-term partnership with your equipment provider. In the harsh environments CWIs work in, accidental damage to the insertion tube is often a matter of when, not if. Investigate the manufacturer's repair costs and policies: Calculate the lifetime cost of ownership by accounting for repair costs and the average turnaround time for repairs. Rapid turnaround times are essential when a project is on hold. Some providers offer borescopes on loan to negate downtime.

Conclusion

The video borescope has graduated from a novelty to a necessity in the welding inspector's toolkit. It allows us to verify the integrity of the root, the most critical part of many welds, without destructive testing. However, the tool is only as good as the operator. By understanding how to manage lighting, prioritizing image stability, and respecting the intricate nature of this industrial equipment, we can elevate inspection standards.

As we move toward digital reporting and tighter quality standards, the ability not only to see the weld but also to capture clear, actionable data will define the next generation of professional inspection. IT

CHRISTINE O'CALLAGHAN (*christy@viewtech.com*) is a remote visual inspection service and support specialist, and **DUNCAN WHITE** is director of sales and marketing at ViewTech Borescopes, Traverse City, Mich.

FEATURE

BY ALBERT J. MOORE JR.

Anatomy of a Welded Repair

How chemistry, heat treatment, and stress management shape long-term reliability

We, welders, are a curious lot. Our typical response to the question, "Can you weld this?" is "I can weld anything except the crack of dawn or a broken heart!" Self-confidence is never in short supply. And for the most part, we get the job done.

This is a story of a welded repair I was involved with nearly a decade ago. Any repair that survives a decade of use is a success.

Background

A customer called the office to tell me that an essential piece of equipment had suffered a catastrophic failure. Being somewhat cautious, I asked, "What is the material of construction?" The answer, "It's steel." From my desk, I can hear the wheels in the caller's head whirling around, and he's thinking, "What else would it be if I'm asking him if he can weld it?"

I like to believe that with age comes wisdom, so I respond with, "It can probably be welded, but how we weld it will depend on what the alloy is." "That's no problem, we have one of those positive material identification (PMI) guns," the customer responded. "The PMI gun isn't going to tell me what I need to know. We need a chemical analysis from a metallurgical laboratory. We need to send a sample out for a chemical analysis," I said.

The demeanor changed, and the panic is evident in his voice. "How long is that going to take?" he asked. "A couple of days is typical," I told him. The client said, "But we need it right away; production is at a standstill."

I'm a problem solver by nature, but I resisted the urge to jump in with both feet because I needed to do a little research to find out what caused the failure and which alloy needed to be repaired. If the repair is unsuccessful and the component fails when it's returned to service, the customer isn't going to shrug and say, "At least he tried." The reality is I will never hear from that customer again.

Chemical Analysis

My typical customers know from experience that one of my first questions will be, "What is the material we'll be welding?" In many cases, they have already sent a sample to a laboratory for analysis.

When a chemical analysis is needed, people think in terms of the various metallic alloys added to iron. They often don't understand how certain alloying or trace elements can adversely affect steel's weldability. The lighter elements, such as carbon, sulfur, and phosphorus, are "bad actors" when it comes to welding. The laboratory and the customer tend to gravitate toward using PMI guns because they are quick and relatively inexpensive. A PMI gun is fine for separating 304 austenitic stainless steel from 316 or 317 stainless steel. Still, the test method is not sensitive enough to quantify the amount of lighter elements present in the parts, like carbon or sulfur, so it will not differentiate low carbon, medium carbon, or high carbon steel — or a free machining steel containing sulfur that has poor weldability, or a steel alloy with low carbon and low sulfur that is easily welded. No, I need a chemical analysis that identifies all the elements listed by the carbon equivalent formula we choose to use.

Fig. 1 — Fracture through the part.

There are a few carbon-equivalent formulas in use, so I tell the laboratory what elements must be reported. I make it clear that the results from a PMI gun are not acceptable.

Chemical analysis is used to determine the minimum preheat temperature needed to mitigate cracking, and it helps me select a filler metal with a chemical composition similar to the steel being welded. Each carbon equivalent formula provides useful guidelines, but these guidelines are specific to that formula. Rule number one is never mix the guidelines from one carbon equivalent formula with the guidelines of a different formula.

I also consider the method used to manufacture the broken component. The part may be cast, forged, hot rolled, or cold rolled. Each manufacturing method influences mechanical properties such as tensile strength, yield strength, ductility, and toughness. Casting can be notorious for having a high sulfur content. We can accommodate the higher sulfur content by using a filler metal with a high manganese content. Fortunately, in this case, the component was a forging, so issues with high sulfur are rarely a problem.

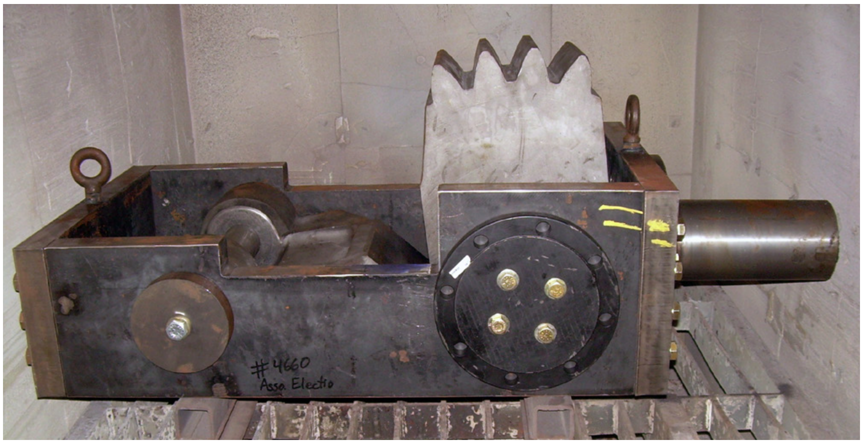


Fig. 2 — Shown are the two halves of the broken component in a fixture that holds the proper alignment and provides access for welding. That broken component stayed in the fixture until the repair was completed.

Heat Treatment

The state of heat treatment also plays a role in determining a component's properties. It is important to know whether the original part was supplied in the annealed, normalized, tempered, or quenched and tempered condition, as it may require a heat treatment before welding, or a postweld heat treatment to develop the properties required after welding. The drawings in this case stated that the forging was normalized. Welding heats the metal to the melting point; how the weld and adjacent areas cool, and any subsequent postweld heat treatment, must be considered when developing the repair procedure.

Residual Stress

Consider the residual stress associated with the welded repair. The magnitude of the residual stress is comparable to the base metal's yield strength. Multiple welds intersecting at different angles can produce a resultant stress that exceeds the tensile strength of the base metal, increasing the potential for cracking. Intersecting welds can be treated as vectors with both direction and magnitude to predict the resultant (stress) magnitude and direction. My usual analysis considers the residual stress in the longitudinal direction of each intersecting weld. The higher the strength of the base metal, the greater the potential for cracking at weld intersections. Cracking potential can be reduced by undermatching the filler metal. Typically, filler metals with lower strength have better ductility so that the weld can undergo some plastic deformation (yield) and the residual stress will "relax" without cracking. However, thick components with thick welds can develop triaxial stresses that can initiate a crack at an abnormality (e.g., a small slag inclusion or incomplete fusion) in the weld.

In-process stress relief can be used to reduce residual stresses to a level less likely to trigger a crack. It's not that "thinner" components do not develop triaxial stresses; it's just that thicker sections are more rigid and so they tend to be more troublesome and more prone to cracking.

These are the primary factors I consider when developing a repair: chemistry, manufacturing method, heat treatment, and residual stresses. With due consideration, we are ready to develop a welding procedure specification to facilitate the repair.

Component Analysis

Next, we needed to examine the component that needs repair. This repair involved a component weighing around two tons. It was a machined forging with integral gear teeth that engaged another gear that opened and closed the jaws of a very large pair of tongs that gripped large chunks of steel weighing up to several tons. The tongs pick up and move large, heavy pieces of metal to a furnace that heats them to high temperatures, then move the hot metal to a forge where it is pounded into shape. The cross section of the part where the fracture was located was about 14 in. wide by 18 in. thick. Figure 1 shows the cross section through the fracture. The failure may have initiated in a couple of locations, but the fracture appeared brittle, with no visible deformation.

In preparation for welding, the fracture surfaces were machined to form a double U-groove. About 1 in. of the fracture was not machined to leave sufficient root face to facilitate fit-up and alignment of the two broken pieces. To maintain alignment and critical dimensions, a fixture was fabricated to hold the two pieces — Fig. 2.

Figure 3 shows the part being placed in the fixture; notice the

Fig. 3 — This photo shows the size of the part that has to be repaired by welding two pieces together. Notice the workers placing the two halves into the fixture and ensuring they are properly aligned.

relative size of the workers and the component.

Preheat

Now that we have addressed the mechanics of the repair, how was the preheat temperature determined? We performed the chemical analysis, so I knew exactly what the chemistry was. Now it is time to put that information to use.

The chemistry was determined to be as follows:

Carbon – 0.43%, Chrome – 0.99%, Manganese – 0.2%, Molybdenum – 0.2%, and Nickel – 0.19%. The balance was Fe.

$$Ce = C\ \frac{Mn}{6} + \frac{Si}{6} + \frac{Cr}{5} + \frac{Mo}{5} + \frac{V}{5} + \frac{Ni}{15} + \frac{Cu}{15}$$

$$Ce = 0.427 + 0.2/6 + 0.99/5 + 0.2/5 + 0.19/15$$

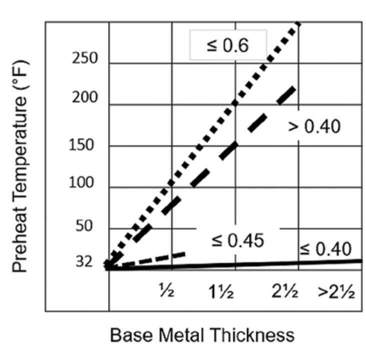
$$Ce = 0.7$$

The chemistry is similar to that of American Iron and Steel Institute (AISI) 4140 steel. When those values reported by the laboratory are plugged into the carbon equivalent formula typically included in AWS, American Society for Testing Materials (ASTM), and American Society of Mechanical Engineers (ASME) standards (see Fig. 4), the calculated value was 0.7. That is "off the scale" or, simply stated, the carbon equivalent formula isn't reliable for the alloy that had to be welded.

A different approach was needed to determine the preheat temperature required to weld this particular alloy. The solution I've used for many years has been to use an isothermal transformation diagram (available from the American Society for Materials) for the alloy system I need to weld.

Figure 5 is the isothermal transformation diagram for AISI 4140 published by the American Society for Metals (ASM), which includes several important features I would like to point out. The line labeled A_f is the temperature at which the steel is fully austenitized; i.e., it is the temperature necessary to ensure that all the steel is in the face-centered cubic condition, and, if held for sufficient time, all the alloying constituents will go into solution. The iron is the solvent; the alloying elements are the solute. The process of transforming from body-centered cubic to face-centered cubic begins when the temperature reaches A_s. The transformation to austenite is complete once the steel is heated to the austenite finish temperature, A_f.

Three horizontal lines at the bottom of the diagram are labeled M_s, M_{50}, and M_{90}. Upon cooling from the austenitizing temperature, M_s is the temperature where the retained austenite starts to decay into martensite, M_{50} is the temperature at which 50% of the retained austenite



≤ 0.40	Weldability is good.
≤ 0.45	Weldability is good provided C ≤ 0.22%, P ≤ 0.06%, and plate thickness is ≤ ¾-inch.
> 0.40	C > 0.22% special precautions required. Low hydrogen practices, high preheat and high heat input required.
< 0.6	Low hydrogen practices must be used. High preheat, high interpass temperature maintained, stress relief is recommended.

Fig. 4 — The carbon equivalent formula typically used for a low-carbon steel was not appropriate for the alloy that needed to be repaired. A different approach was needed.

has decayed into martensite, and M_{90} is the temperature where 90% of the retained austenite has decayed into martensite. The material is considered to be fully hardened.

When austenite decays into martensite, the crystalline structure becomes body-centered tetragonal, instead of being body-centered cubic, as is the case for ferrite. Martensite is shaped like a shoebox; that is, the cubic shape is elongated like a shoebox to accommodate the extra carbon. This happens while the metal is in the solid state, so it has to deform under high stress. As the atoms' crystalline arrangement changes, it becomes susceptible to cracking. The trick is to ensure the parts being welded are hot enough to prevent retained austenite from decaying into martensite.

There's more to be discovered if the isothermal transformation diagram for 4140 is studied. Let's assume a preheat of 800°F is used. If one follows a horizontal line from 800°F on the left axis and traces a straight horizontal line toward the right axis, we see the austenite begins to decay into ferrite and cementite after a lapse time of about three seconds. After a lapse of 100 minutes, all the austenite has decayed into ferrite and cementite; i.e., there is little to no retained austenite left to decay into martensite upon cooling below 650°F, thus a hard, brittle microstructure and crack-inducing strain are avoided.

Figure 6, extracted from the Welding Procedure Specification (WPS), indicates that the specified preheat temperature is 700°F. This is slightly above the Ms temperature of 650°F. The high preheat/interpass temperature ensures Martensite does not form while welding is underway. Both the fixture and the welded-repaired pieces were heated in an oven and wrapped in blankets to maintain the preheat temperature while the parts were positioned on the welding positioner and readied for welding.

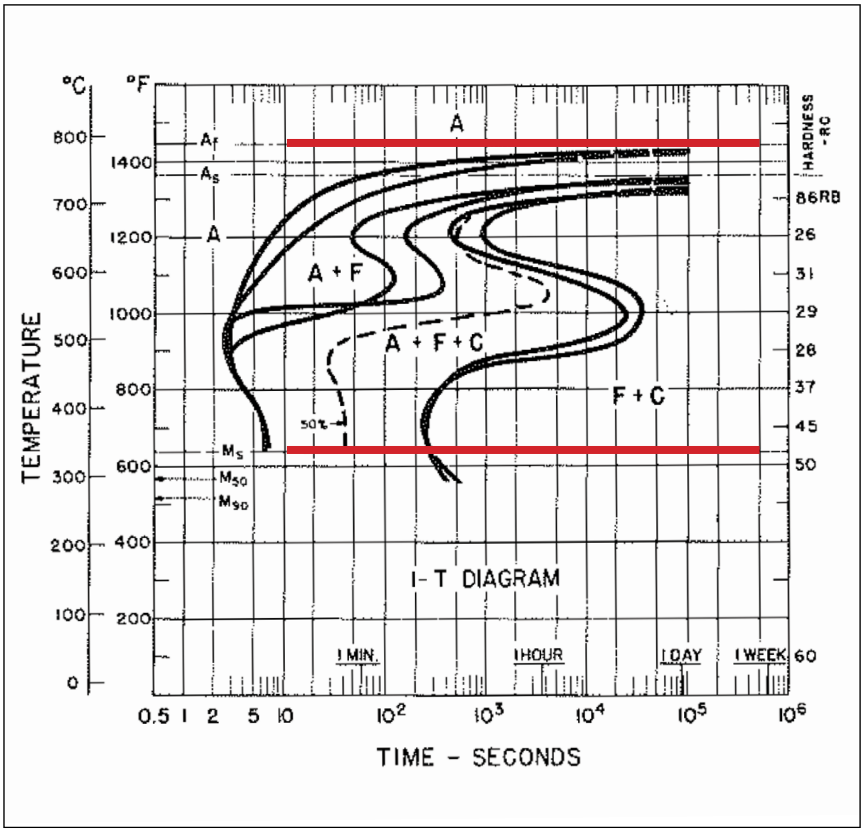


Fig. 5 — Isothermal transformation diagram for AISI 4140 alloy steel. The line near the top, identified as A_f, is the temperature at which the microstructure is fully austenitic. The line toward the lower half of the graph, identified as M_s, is the temperature at which austenite begins to decay into martensite. (Credit: ASM International, *Atlas of Time-Temperature Diagrams for Iron and Steels*.)

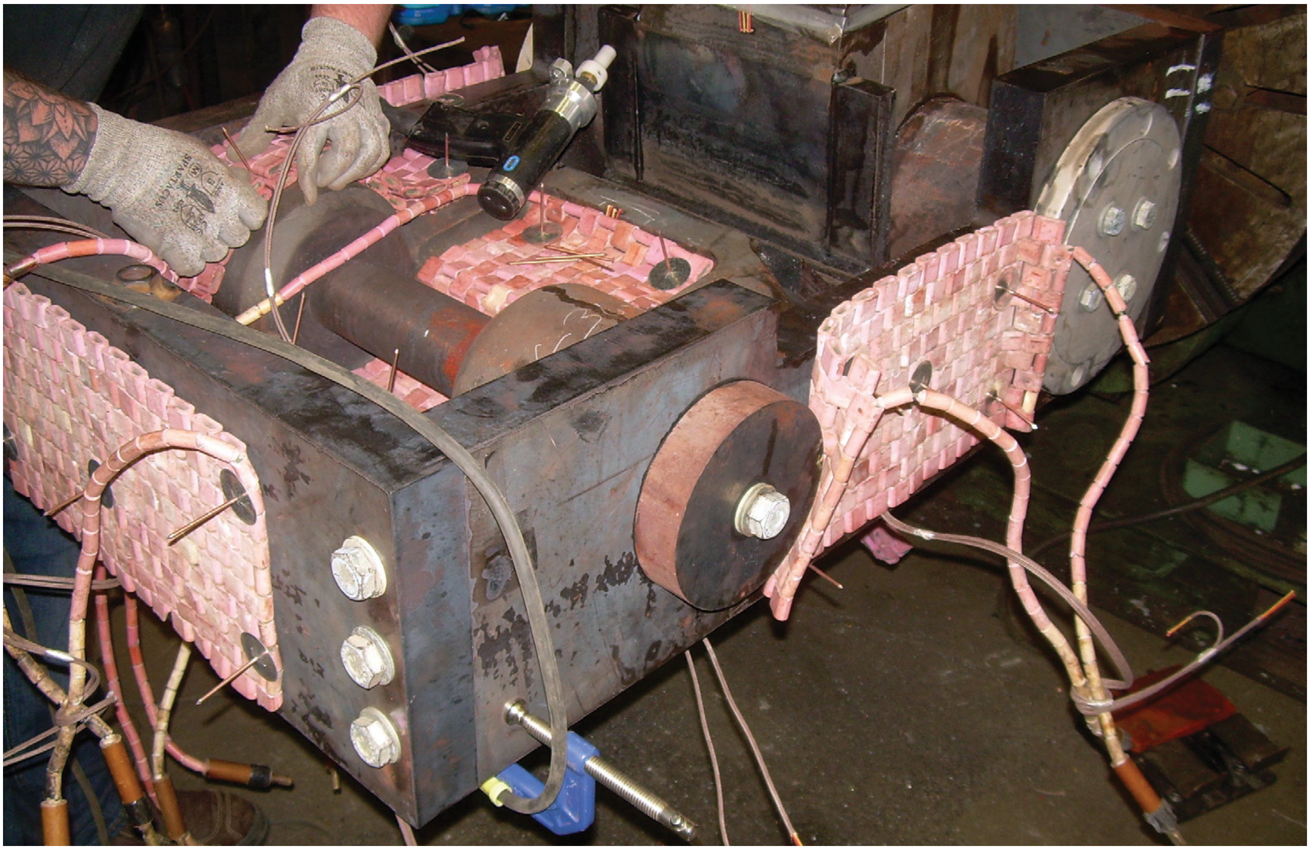
Preheat / Interpass Temp. / PWHT			
Preheat/Interpass Temperature:	Maintain 700° F	Max. Interpass Temp.:	800° F
PWHT:	Stress Relief	Max. Temp.:	1150° F to 1175° F
Time @ Temp.:	1 hour per inch of weld deposit	Max. Cooling Rate:	100°F/hour
	Normalize	Min. Hold Temp.:	1500° F
		Min. Hold Time:	1 hour/inch of Weld
		Cooling Rate:	200° F per hour
Note:	Furnace cool with furnace door open. Remove from furnace and air cool once the weldment has cooled to 400° F.		

Fig. 6 — Excerpt from the WPS used for the repair of the 4140 low-alloy steel forging, identifying the in-process stress relief and consisting of normalizing.

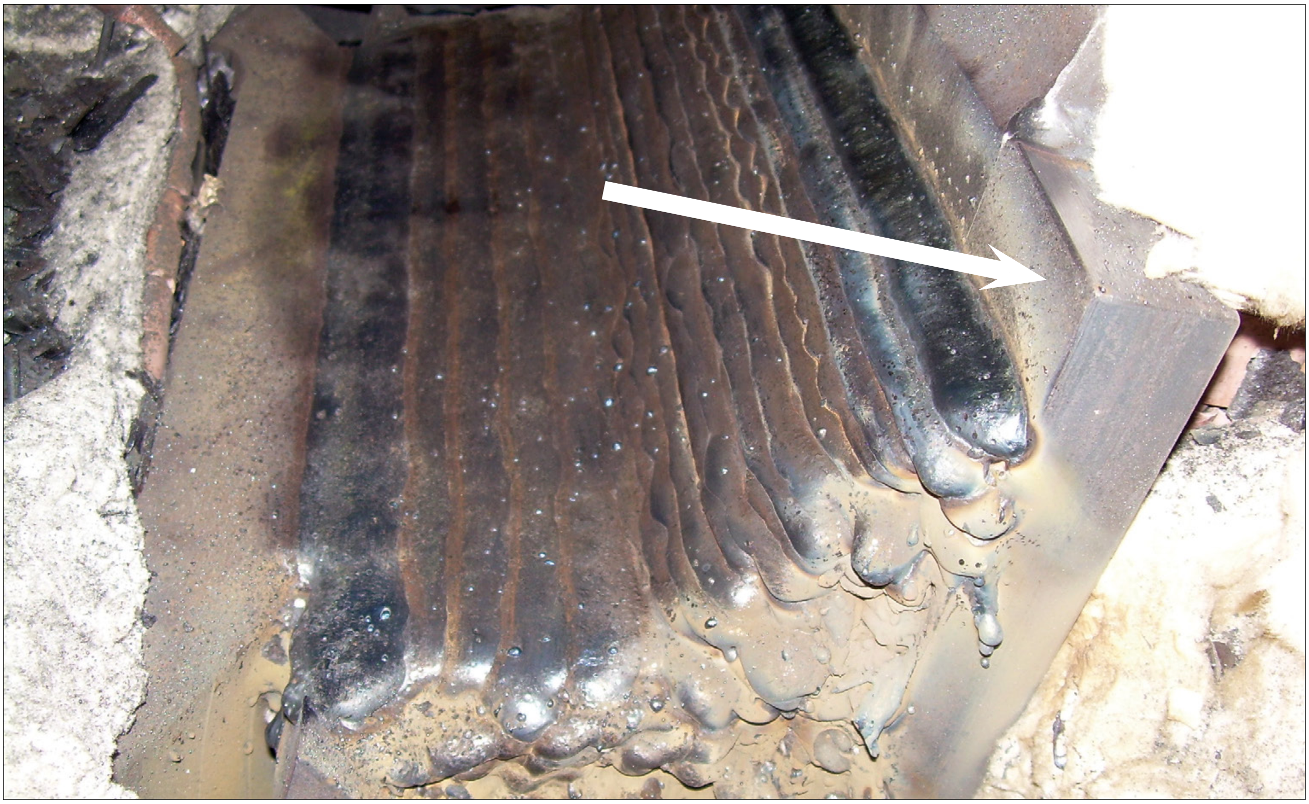
The Repair

Electric resistance heating blankets were used to prevent the welds and base metal from cooling below 700°F during welding. The parts were initially welded from one side until a sufficient weld deposited to hold the pieces securely in position. Then the second side was back gouged to sound metal. Once the back gouge was completed, continuous-current dry-particle magnetic particle testing was performed to verify that the back gouge depth was sufficient to remove any compromised base metal and the entire crack. The second side was then welded until a total of three inches of weld was deposited.

The assembly, including the fixture, was transported to the heat-treating facility for an in-process stress-relief



The fixture was fitted with electric resistance heaters to ensure the preheat and interpass temperature was maintained during the multiple cycles of welding and thermal stress relief.



Nearing the end of the welding, one more cycle of welding to go. The arrow points to the extension tabs to ensure the weld in the groove is sound. The tabs will be removed once welding is completed.

operation. The WPS indicates the temperature for in-process stress relief was 1150° to 1175°F for roughly three hours, based on the thickness of the deposited weld. The weldment was wrapped in insulating blankets during transport to and from the heat-treat facility.

Then it was back into the welding positioner, and a check was made to verify the interpass temperature was at least 700°F before welding resumed. The fixture holding the parts was turned side to side while welding to ensure the residual forces on both sides of the butt joint were balanced and maintained proper alignment. Another in-process stress relief was performed once another 3 in. of weld had been deposited.

Next, it was back into the welding positioner for more welding. The cycles of welding followed by in-process stress relief were repeated each time 3 in. of weld were deposited. Once the weld was completed, a normalizing operation was performed to ensure a uniform microstructure was attained, the residual stresses were reduced to a minimum to mitigate, and any diffusible hydrogen was minimized to mitigate the probability of delayed cold cracking, and ensure any martensite that may have inadvertently formed was tempered.

The selection of filler metal was uncomplicated because the choices were very limited. A filler metal that produced a low-hydrogen deposit and a close match in properties between the base metal and the filler metal after thermal stress relief was available from one supplier. The flux-cored electrode chosen met AWS A5.29, E101T2-GM-H4. The tradename of the flux-cored electrode was Dual Shield II 4130 SR, with shielding gas composed of 75% argon and 25% carbon dioxide.

The WPS presented the welding parameters as a graph showing the permitted ranges for wire feed speed, arc voltage, contact tip-to-work distance (CTWD), and amperage. Because the flux cored arc welding process uses a constant-voltage power supply, the arc voltage remains essentially constant once set by the welder. Likewise, once set, the wire feed speed is a constant unless the welder changes it. The CTWD is a constant as long as the welder visually monitors the distance from the end of the contact tip to the surface of the weld pool. This isn't usually a problem when the welder understands that changing the CTWD profoundly affects the amperage.

Reputable electrode manufacturers provide recommended ranges for welding parameters on their websites. The parameters are usually presented in a tabular format; I convert the parameters into a graph that is easier for the welder to use. I've yet to have a welder complain about the presentation. The graphic included by the WPS is for this specific flux cored electrode is depicted in Fig. 7.

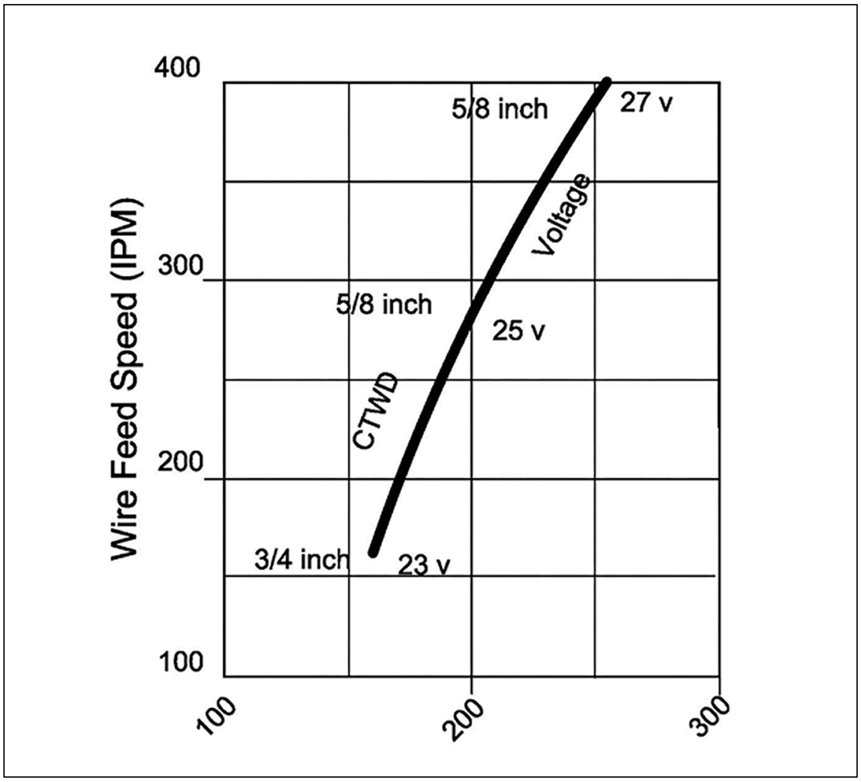


Fig. 7 — Graphic presentation for the welding parameters used with 0.045-in.-diameter Dual Shield II 4130 SR.

Conclusion

The repair was successful, and it took about 10 days to complete and to reinstall the component. The machine has been in operation since 2017 without further problems. Proper planning and coordination enabled us to repair a key component that was no longer in production. The successful repair salvaged a multimillion-dollar machine that was integral to the plant's continued operation. Key to the success of the repair was the cooperation of the welding contractor and their insistence that their welders faithfully followed the WPS.

ALBERT J. MOORE JR. (*amoore999@comcast.net*) is owner of NAVSEA Solutions, Burlington, Conn. He is an AWS Senior Certified Welding Inspector and an ASNT NDT Level III. He is also a NOCTI certified welding instructor.

This article is based on a presentation by the author at a joint meeting of ASNT and AWS in Groton, Conn.

IT FEATURE

BY JAMES SCOTT

Evaluating AWS Standard Welding Procedure Specifications

Understand the benefits and limitations of these documents

In welding and fabrication, maintaining quality, consistency, and compliance is essential, especially when producing critical components for pressure vessels, piping systems, bridges, and structural supports. A tool designed to support these requirements is the AWS standard welding procedure specification (SWPS). As a Certified Welding Inspector (CWI), I still see a great deal of ignorance regarding the proper orchestration of qualifying welding procedures.

SWPSs are prequalified, code-compliant welding procedures published by AWS. They allow fabricators and contractors to perform welding in accordance with recognized standards without having to develop and qualify their own procedures from scratch. While they offer several benefits, they also have limitations.

This article provides an unbiased breakdown of both the advantages of SWPSs and their potential drawbacks to help welding professionals.

Advantages

1 Time and Cost Savings

One of the most cited advantages of using a SWPS is the significant reduction in the time and cost associated with procedure development. Traditional welding procedure specifications (WPSs) must be supported by a procedure qualification record (PQR), which involves material procurement, welding trials, destructive testing, and documentation. This process can cost thousands of dollars and take days or weeks.

A SWPS is a ready-to-use document that can be implemented completing a demonstration weld (per ASME *Boiler and Pressure Vessel Code* Section IX). For occasional or short-term work, especially when working with common base materials and processes, this approach can offer efficiency without sacrificing quality or compliance.

2 Code Compliance and Broad Acceptance

SWPSs are written to comply with major welding codes, such as the following:

- AWS D1.1, *Structural Welding Code — Steel*
- AWS D1.2, *Structural Welding Code — Aluminum*
- AWS D1.3, *Structural Welding Code — Sheet Steel*
- ASME *Boiler and Pressure Vessel Code* Section IX
- NAVSEA technical publications
- *National Board Inspection Code*
- American Bureau of Shipping

This ensures the procedures meet code requirements and can be confidently submitted for inspection or customer approval. Some organizations use SWPSs for support of excavation or other temporary structural applications where code clarity on certain materials is limited. In some cases, these prequalified documents help users avoid the need to qualify materials not explicitly listed in code tables, which can be costly and complex.

3 Proven, Validated Procedures

Each SWPS is supported by multiple validated PQRs tested under real-world welding conditions. These records, not provided to the user, ensure the welding process produces sound welds within the specified parameter range. Because these procedures are vetted by committees consisting of experts, they represent standardized best practices for commonly welded base metals and processes, such as shielded metal arc, gas metal arc, flux cored arc, and gas tungsten arc welding.

4 Useful for Training and Entry-Level Fabricators

SWPSs are valuable tools for technical schools, training programs, and small contractors without in-house welding engineers. They provide a solid baseline that can later be adapted or replaced as technical capabilities grow.

Limitations and Considerations

Despite their benefits, SWPSs are not without limitations. These are important to understand to avoid misuse or overreliance, especially in complex or high-risk welding situations.

1 Generic Procedures

An SWPS is designed to be broadly applicable, meaning it may lack specific details welders need for certain applications. Important variables, such as preheat temperature based on material thickness or filler metal selection for specific alloy combinations, may be too general to serve all welding situations effectively.

For example, an SWPS for stainless steel may list acceptable filler metals as ER3XX. However, joining grades such as 321 to 321 stainless may require precise filler metal choices (e.g., ER347), which are not explicitly detailed in the SWPS. In such cases, welders and supervisors must seek clarification, often from sources outside the SWPS.

2 Dependence on User Knowledge

While the SWPS is code compliant, it assumes the user understands welding variables, metallurgy, and code interpretation. Preheat requirements, for instance, may be stated only as "sufficient to prevent cracking," without specifying values based on thickness or carbon equivalent. If a welder is working on thick-section carbon steel and isn't provided with preheat charts or supervision, they may lack the information needed to ensure sound welds.

This highlights the importance of training and managerial oversight. In shops where supervisors or engineers don't have the expertise to interpret or supplement the SWPS, gaps in application can occur, particularly when dealing with postweld heat treatment (PWHT) or notch toughness requirements not addressed in the standard document.

3 Limited Acceptance in Some Codes

Certain codes, such as AWS D1.1, provide exceptions allowing SWPS use, but also emphasize that they may not meet all WPS content requirements outlined in the code. In these cases, approval by the engineer or inspector of record is often required. Additionally, some standards place limitations on which SWPSs can cover base metals and thicknesses, commonly restricting use to carbon and stainless steels between ⅛ and 1½ in. (See Section 6, "Qualification," in the 2025 edition of AWS D1.1.)

Furthermore, when used under ASME *Boiler and Pressure Vessel Code* Section IX, users must complete a demonstration weld to validate that the procedure is being followed properly. This step, while manageable, is sometimes overlooked or misunderstood, which can lead to noncompliance if improperly implemented.

4 Risk of Misuse

One of the primary concerns raised by welding experts is that SWPSs can be misused when management lacks technical knowledge. The issue lies in treating SWPSs as shortcuts rather than tools.

Welders are not typically metallurgists or code experts. An SWPS shouldn't be the only source of welding guidance.

A real-world example illustrates this risk: a welder joining stainless steel to carbon steel using ER70S-3 filler metal (intended for carbon steel) based on online advice. Had an SWPS been available that clearly specified ER3XX only, it might have triggered a question rather than a misstep. But even then, the SWPS would not have explicitly called out the correct filler metal unless supplemented.

Conclusion

AWS SWPSs are practical, cost-effective options for many organizations, particularly when welding common base metals using manual or semiautomatic processes. They are especially useful for small shops and short-run projects. However, they are not a replacement for technical knowledge, oversight, or training. Organizations must understand their limitations, especially when working with specialty alloys, thick sections, or when notch toughness and PWHT are critical. Supplementing SWPSs with clear shop instructions, preheat charts, and supervision ensures welders have the full context they need to perform their jobs safely and correctly.

SWPSs work best as part of a broader quality management system, one that includes competent leadership, trained welders, and a commitment to doing more than just meeting the letter of the code. IT

JAMES SCOTT (*james.scott@browardschools.com*) is the applied welding technologies instructor at McFatter Technical College, Davie, Fla., and an AWS CWI.

BY ROLINE PASCAL

Instructors guide students through hands-on practice, helping bridge classroom instruction with practical skills used in the field.

A GUIDE TO

Building a Successful Welding and Inspection Program

A veteran educator and CWI shares ten steps for developing workforce-ready training programs

The welding and inspection industry are the cornerstone of the manufacturing sector, with a growing demand for skilled labor. Educational institutions play a critical role in preparing both students and career changers with the skills needed to enter and advance in the field.

With decades of experience in welding education and program leadership, Gordon Reynolds, a former senior director of trades programs and current AWS Certified Welding Inspector (CWI) seminar instructor, shares best practices for planning, developing, and sustaining effective training programs.

1 Start with Local Industry Needs

A strong training program begins with a clear understanding of local workforce needs. Before developing curriculum or purchasing equipment, educators should connect directly with employers to understand what skills are actually in demand.

"The very first thing, in my opinion, is to build a strong advisory committee and find out what your local businesses need," Reynolds said. "Because in the end, they're the customers for your students, and your students are your product. If there aren't jobs for them, it's pointless to have a program. You train people for employment, for careers."

This industry-first approach helps ensure that training aligns with real-world expectations and leads to meaningful employment opportunities for graduates.

2 Build the Programs with a Clear Plan

Successful programs are designed with growth in mind. Reynolds' experience building a program from an empty facility highlights just how important that planning phase can be.

"I started the program from scratch," he recalled. "They gave me a 10,000 square foot room and said, 'Here, turn this into a welding program.' There was nothing in there except for the smell of creosote from the linesman program that was previously in there."

Within months, the program went from zero to 165 students and eventually expanded across multiple campuses. The takeaway is to start with a solid foundation, and plan for growth. Programs should be designed to adapt and scale as demand increases.

3 Prioritize Both Skill and Teaching Ability

Instructor quality can make or break a training program. One of the biggest challenges is finding individuals who not only understand welding, but also know how to teach it effectively.

"You have teachers, somebody who's professionally trained, been through college, has their teaching certificate, but they don't know how to weld," Reynolds explained. "And on the other side, you have welders... that don't know how to teach."

Strong programs recognize this gap and work to close it from both directions. Reynolds suggests programs helping instructors build technical skills while also providing pedagogical training for industry professionals entering education.

4 Invest in Ongoing Instructor Training and Development

Maintaining program quality requires ongoing investment in instructors. Administrative support plays a key role here.

Gordon Reynolds leads a classroom session, helping students build the skills they'll need in real-world welding and inspection careers.

"One of the big problems I've seen over the years . . . the administrators, whether at the school or at the district level, don't give the proper support. And I'm not just talking financial because obviously welding programs are expensive to run. But they also need to give the support for the instructors that may need to go get some additional training."

Whether it's professional development opportunities like the AWS Foundation's Weld-Ed series or training from various schools or industry partners like Miller Electric, Lincoln Electric, and the Hobart Institute offers, giving instructors the chance to continue learning ultimately strengthens the program as a whole.

"If administrations saw the benefit that their instructors would get from it, I think they would be much more willing to support their instructors and send them to these workshops and classes," Reynolds said.

5 Make Career Pathways Clear to Students and Families

For programs to thrive, students, and often their families, need to see a clear path from training to a stable, well-paying career. That connection doesn't always happen automatically, so programs need to communicate it intentionally.

"You have to show the pathway from the classroom to meaningful employment, good jobs with good pay and good benefits," Reynolds explained.

This is especially important at the high school level, where parents play a huge role in decision-making. When programs can demonstrate career opportunities, they not only attract students but build the trust needed to keep them engaged.

6 Bring School Counselors on Board

School counselors also play a major role in shaping student decisions, but they may not always understand the value of skilled trades careers.

"Counselors can quite often be the biggest enemy to enrollment because they'll tell the kids, 'Well, you don't want to do welding. It's dirty, it's dangerous,'" Reynolds noted.

To change this, programs need to actively engage with counselors. Inviting counselors to visit training facilities, demonstrating modern equipment and processes, and sharing student success stories can help shift those perceptions.

When counselors better understand the opportunities available, they're more likely to guide students toward them.

7 Use Hands-On Experience to Drive Interest

Exposure is one of the most effective ways to attract students. Giving them a chance to experience welding firsthand can spark interest.

Reynolds states how interactive demonstrations, career days, and lab visits can allow students to connect with the trade in a meaningful way. These experiences often serve as the first step toward long-term interest in welding careers.

"When I was teaching at the high school, they would have a career day in the spring . . . we would set up a booth, and I would always bring an oxyacetylene torch and a little portable booth, and we let the kids come down and play with fire, do a little bit of oxyacetylene welding under supervision with one or two of my advanced students and myself. That really seemed to capture their imaginations," Reynolds said.

8 Prepare Students for Advancement, Not Just Placement

Training programs should go beyond immediate job placement and help students see a path for long-term growth. Encouraging students to pursue certifications expands their opportunities.

"You don't want to be under a welding helmet for 40, 45 years," Reynolds said. "You want to learn, you want to grow, you want to improve your earning potential . . . there's so much more to this industry."

Certifications such as the CWI can open doors to inspection, supervision, and higher-paying roles. For students pursuing inspection roles, understanding how to work with codes and standards is essential.

"What a lot of people don't understand, especially when they first come into these seminars, is they're not there to memorize the code book. They're just there to learn how to navigate it," Reynolds explained.

Programs should emphasize how to interpret codes, locate critical information, and apply requirements in real-world situations. Building these skills helps students succeed in certification exams and prepares them for advancement in the field.

9 Connect Training to Real-World Experience

Students benefit most when classroom instruction is tied directly to real-world applications. Instructors who bring firsthand industry experience into the classroom can offer practical insight and better prepare students for the expectations they will face on the job.

"I was very fortunate in my welding career before I began my career in education in that I had a wide variety of experiences as a welder," Reynolds said.

He gained that experience by working in several different environments early in his career. While still in high school, he worked in a job shop, taking on smaller structural and specialty projects. After graduation, he joined a large fabricator, where he contributed to building nuclear power plants as well as large-scale structural work for multistory buildings. He also spent time working on heavy equipment such as rock crushers, gaining an appreciation for the demands of large, heavy fabrication. Later, in a sheet metal shop, Reynolds refined his gas tungsten arc welding skills, working with thin ferrous and nonferrous materials. Each of these roles added a different layer to his expertise, giving him a well-rounded perspective on the trade.

"I was able to bring that into the classroom and share my experiences with students and what it took to qualify in the various processes," Reynolds said.

10 Set the Standard for Work Ethic and Continuous Learning

Technical skills alone are not enough. Employers consistently value reliability, attitude, and professionalism. Reynolds emphasized that this message comes through in conversations with industry partners.

"Just because you get a Certified Welding Inspector certificate doesn't mean you've reached the top of the hill. In fact, that's just the beginning of the learning process."

"A longstanding point of conversation with members of my advisory committee . . . is 'We want somebody that's going to show up on time every day,'" Reynolds noted.

This remains one of the most common concerns among employers. Showing up on time and being dependable are traits that impact job performance. Training programs play a key role in helping students develop these habits early.

Programs should also reinforce continuous learning.

"The next thing is the desire to learn and to improve, Reynolds said. "Just because you get a Certified Welding Inspector certificate doesn't mean you've reached the top of the hill. In fact, that's just the beginning of the learning process."

By emphasizing professionalism, accountability, and a willingness to keep learning, programs can better prepare graduates to grow and succeed over the long term.

Conclusion

Effective welding and inspection training programs are built on a combination of industry alignment, skilled instruction, and a focus on student outcomes. By implementing these best practices, educators can create programs that not only attract students but also prepare them for sustainable careers in the welding industry.

As Reynolds puts it, "You train people for employment, for careers." Programs that keep this goal at the forefront will continue to meet the evolving needs of both students and industry. IT

ROLINE PASCAL (*rpascal@aws.org*) is the associate editor of *Inspection Trends*.


SILVER SPONSORS
CarestreamNDT


Howdy Y'all
WELCOME TO


IEC
AWS
American Welding Society
aws.org


AUSTIN


VIEWTECH
BORESCOPES
ARTICULATING
VIDEO BORESCOPES
VJ-3
VJ-4


WÖHLER


IEC

BY CARLOS GUZMAN

IEC 2026 Brings Inspectors, Innovation, and AI to Austin

The 2026 Inspection Expo & Conference (IEC), which took place at the beginning of February in Austin, Tex., united welding inspectors, engineers, manufacturers, and industry leaders from across North America for two days of technical education, professional development, and forward-looking discussion. Hosted jointly by the American Welding Society (AWS) and the American Institute of Steel Construction (AISC), IEC once again reinforced its reputation as the only conference designed specifically "for inspectors, by inspectors."

The conference provided a comprehensive look at the current state and future direction of welding inspection. Core technical topics included corrosion control, nondestructive examination (NDE), steel construction, coatings inspection, and evolving quality control requirements. A unifying theme running through nearly every session was how artificial intelligence (AI) and digital tools are reshaping inspection methods, documentation, and professional responsibilities.

Leadership Sets the Tone

The event was co-chaired by William F. Newell Jr., serving as the 2026 IEC AWS chair, and Todd Alwood, the 2026 IEC AISC chair. Together, they emphasized both technical rigor and professional growth as guiding principles for the conference.

Newell opened the conference by encouraging attendees to explore unfamiliar topics and challenge long-held assumptions. His career-long involvement in national and international code bodies underscored the importance of maintaining technical integrity as inspection practices evolve.

Alwood, vice president of membership and certification at AISC, highlighted the importance of certification, education, and workforce development, particularly as the construction industry faces widespread retirements and increasing demand for qualified inspectors.

A Keynote Grounded in Perspective

The conference's keynote address, delivered by Jeff Noruk, president of Servo-Robot Corp., set a pragmatic tone for the AI discussion that followed throughout the week. His presentation examined the intersection of welding engineering, automation, inspection systems, and AI, while reminding attendees that successful robotic welding and automated inspection have existed long before today's surge in artificial intelligence.

Noruk emphasized that while AI will accelerate automation, particularly in high-mix, low-volume welding environments, it should be viewed as an evolution rather than a replacement for engineering judgment and proven processes.

AI Takes Center Stage

Multiple sessions explored how machine learning, automated image analysis, and predictive analytics are being introduced into inspection workflows to enhance consistency, efficiency, and documentation.

One of the most anticipated presentations, given by AWS's CEO Carey Chen, detailed the Society's internal AI initiative known as "AWStin." The session traced AWS's structured journey toward AI adoption, from assessing organizational readiness and achieving leadership alignment to identifying high-impact use cases. Chen emphasized that AI was not pursued as a novelty, but as a strategic tool embedded into AWS's long-term priorities.

Additional sessions addressed the practical application of AI in weld image analysis, NDE data interpretation, and quality management systems. Speakers repeatedly stressed a common point: AI tools are intended to support, not replace, the inspector's professional judgment and accountability.

Codes, Standards, and Compliance

IEC delivered extensive coverage of recent and upcoming code changes affecting inspectors. Detailed sessions examined updates to AWS D1.1/D1.1M:2025, *Structural Welding Code – Steel*, highlighting revisions to visual acceptance criteria, NDE personnel qualification requirements, and welding procedure qualifications.

Other technical highlights included discussions on the 2025 Research Council on Structural Connections (RCSC) *Specification for Structural Joints Using High-Strength Bolts*, addressing new bolt groups, revised pretensioning methods, and updated contractor and inspector responsibilities.

Presentations on digital radiography, advanced ultrasonic testing methods such as total focusing method (TFM), and phased-array technologies provided insight into both emerging capabilities and qualification challenges.

Coatings inspection, corrosion prevention, and compliance with AISC and building code inspection requirements rounded out the technical program, offering inspectors practical guidance applicable across a wide range of project types.

Investing in the Next Generation

IEC's program also covered the future of the inspection workforce. Sessions on recruitment, training, and mentorship explored strategies for attracting new talent, transferring institutional knowledge, and building sustainable inspection programs amid a shrinking labor pool.

One standout presentation by Shanen Aranmór (founder of Weld Like A Girl™, Yuma, Ariz., and AWS director-at-large) introduced education efforts aimed at children and young adults, demonstrating how early exposure to welding inspection concepts can spark long-term interest in technical careers. These workforce-focused discussions reinforced the idea that people, not just technology, remain central to inspection quality and public safety.

Ethics and Professional Responsibility

Preceding IEC was the one-day conference *Upholding Integrity: Legal and Ethical Standards in the Welding Industr*y, which brought together Certified Welding Inspectors (CWIs) and welding professionals for a focused professional development program. The event examined the legal and ethical responsibilities associated with the CWI credential, highlighting the impact of inspection decisions on public safety, regulatory compliance, and professional accountability. Through real-world case studies and discussions, participants explored documentation practices, liability considerations, and common ethical challenges in the field, with particular emphasis on AWS QC1, *Standard for AWS Certification of Welding Inspectors*. Speakers reminded attendees that CWIs often serve as de facto subject matter experts, with judgments that directly affect liability exposure and industry trust.

The conference concluded with attendees gaining practical insights and tools to support sound, defensible decision-making in their professional practice.

A Conference Looking Forward

As IEC 2026 came to a close, attendees left Austin with a clear message: the inspection profession is evolving rapidly, but its foundation remains unchanged. New tools, including AI, will continue to enhance inspection capabilities, yet human expertise, ethical responsibility, and adherence to codes and standards remain paramount.

By balancing innovation with experience, and technology with accountability, the 2026 Inspection Expo & Conference reaffirmed its role as a vital forum for shaping the future of welding inspection. IT

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

THE ANSWER IS

BY ALBERT J. MOORE JR.

Q I am a new quality control manager for a large manufacturing company. I'm a Certified Welding Inspector (CWI), and I supervise a team of CWIs responsible for ensuring our manufacturing process consistently meets quality objectives. While I am proud of the skill and workmanship of our workforce, our department faces a significant challenge: We need to add inspectors. Many candidates we interview have little to no practical experience, and placing them directly on the production floor poses a risk to quality and safety. Simply put, we are struggling to find individuals who can step into these roles and be immediately effective. What is the best way to address this challenge?

A Welcome to the world of manufacturing. It is an uncomfortable fact that there is a shortage of skilled workers at all levels. The short answer is that we have to learn to do more with fewer people. We can mechanize, we can automate, and we can take advantage of artificial intelligence, but those solutions are unlikely to help you in the near term.

What can you do? Mentor. It is unlikely that your human resources department will have experienced designers, machinists, welders, or inspectors walking in off the street asking for employment. You need to train and mentor the people that you can hire. And even that can be a challenge. I have clients who have been visiting their local community colleges and offering jobs to people who are about to graduate, and yet they still aren't getting applicants. The pay they offer is above that of their competitors; they have a matching 401(k), health benefits, vacation time, and still, they are getting few applicants. While the companies are in a position to grow, they can't because of manpower shortages.

Back to mentoring. If you find an applicant who is willing to learn, consider yourself fortunate. None of us are born knowing it all. Schools at any level teach the basic skills, and very few are specialized enough to graduate people who can hit the floor running. As one of my professors told me, "Al, I have you in my class for 40 hours. I cover the basics. You will learn more during your first week on the job than I can teach you in a semester[-long] class."

Your employer needs to develop in-house training to help the new hire develop the skills needed to meet the company's needs. The training can consist of classroom training, on-the-job experience, or better yet, team the new hire with an experienced worker who can share their knowledge and experience.

It is unfortunate that many employers wait until a Baby Boomer has retired before hiring a replacement. Our employer expects the new hire to know what to do on their first day on the job. It isn't going to happen. The new hire needs to adjust to the new environment, learn how the system works, and learn how to perform their new job assignment. The process can be made smoother and more efficient by teaming the new employee with a willing mentor. That can be easier said than done, because not everyone is a good mentor. Some experienced workers are going to view the new hire as competition, someone who is there to replace them. If that's the case, that individual is probably a poor choice to be a mentor.

I worked in the trades for more than 20 years. I learned the trade by serving an apprenticeship as an ironworker. I attended evening classes and worked with experienced journeymen during the day. Some journeymen were willing to teach me what I didn't know (and that was a lot), but a few had no interest in sharing their knowledge. I appreciated the journeymen instructors who taught the classes at night and the journeymen who shared their knowledge on the job site. They were my mentors, and I still maintain friendships with many of those people, even though I've been out of the trades for a good number of years. The apprenticeship programs are a tried-and-true system of bringing new people into the trades. The system is effective and efficient at putting people to work as soon as practical.

When I graduated from college and went to work, I was fortunate to be paired with an older engineer who served as my mentor. As my professor predicted years earlier, I learned more during my first week on the job under my mentor's tutelage than I did in the college classroom.

When I taught the AWS CWI seminars, we covered a lot of material, but it was just enough so that a person who studied before and during the seminar could pass the examinations. While many newly minted CWIs think they are welding experts, they quickly find out there is a lifetime of learning ahead of them. I was fortunate to team up with a welding engineer who taught me so much more than what the CWI examinations covered. He was my mentor for much of my early career. When we first joined forces, he taught me how to develop a welding procedure, how to properly document the qualification of the welding procedure specification (WPS), and how to administer a welder qualification test. Over the years, I leaned on him more than I probably should have, but I felt comfortable asking him questions, knowing that he was a reliable source of information and a friend.

I wouldn't be where I am today without the time and patience of my mentors. I try to follow in their footsteps and share what I know with younger people who are interested in learning more about welding and nondestructive examination.

The bottom line is that you, as the department head, can institute a mentoring program in your department. Recognize that new hires are unlikely to have the exact experience you would like them to have, and they aren't going to know everything (even if they think they do). It can be a win-win for both you and the new hire if you invest some time with them and provide the training they need to be proficient at their new job. Training should not be a one-time event where you overwhelm them with information; instead, it can be regularly scheduled training sessions over a period of time. This allows the new hire to absorb the information presented and put it to use. It also helps you build a relationship with the new hire so they feel comfortable going to you with questions.

Pair the new hire with a more experienced individual who is willing to share their knowledge and experience. Give the new hire assignments that allow them to excel in short order. It will build their competence and confidence as they successfully complete their assigned tasks. Don't throw them into the deep end of the pool and expect them to swim like a dolphin. That approach results in too many candidates sinking and drowning. Everyone likes to feel like they're winning, and everyone likes to succeed. As a manager, your task is to give them the tools they need to succeed and feel like they are winning. Mistakes are going to happen; expect them, but have a recovery plan in place and turn them into a learning experience. Take a long view; this is a long game, so treat it as such. While short-term results are needed, it is more productive to keep long-term success in mind.

In conclusion, you need people to meet your immediate needs, but recognize that experienced people are in short supply. Determine your department's long-term goals and equip new hires with the tools needed to achieve them. Hire people who are willing to learn. Use a combination of supplemental training, pairing the new hire with a willing mentor, and give them tasks they can successfully complete to enhance their skills. As they gain experience and knowledge, challenge them with more complex job assignments. Everyone wins; everyone succeeds. IT

> **"I wouldn't be where I am today without the time and patience of my mentors. I try to follow in their footsteps and share what I know with younger people who are interested in learning more about welding and nondestructive examination."**

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

CLASSIFIEDS / ADVERTISER INDEX

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 60,000 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 (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

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) 626-6305

TCTC
Tri-County Technical College

UNITED TECHNICAL

WEBER STATE UNIVERSITY

Tyler Junior College

Tyler Junior College (TJC) is a comprehensive community college in Tyler, Tex., 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

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

TJC™
WELDING TECHNOLOGY

WAUBONSEE®
COMMUNITY COLLEGE
Where futures take shape

WELDER TRAINING & TESTING INSTITUTE®