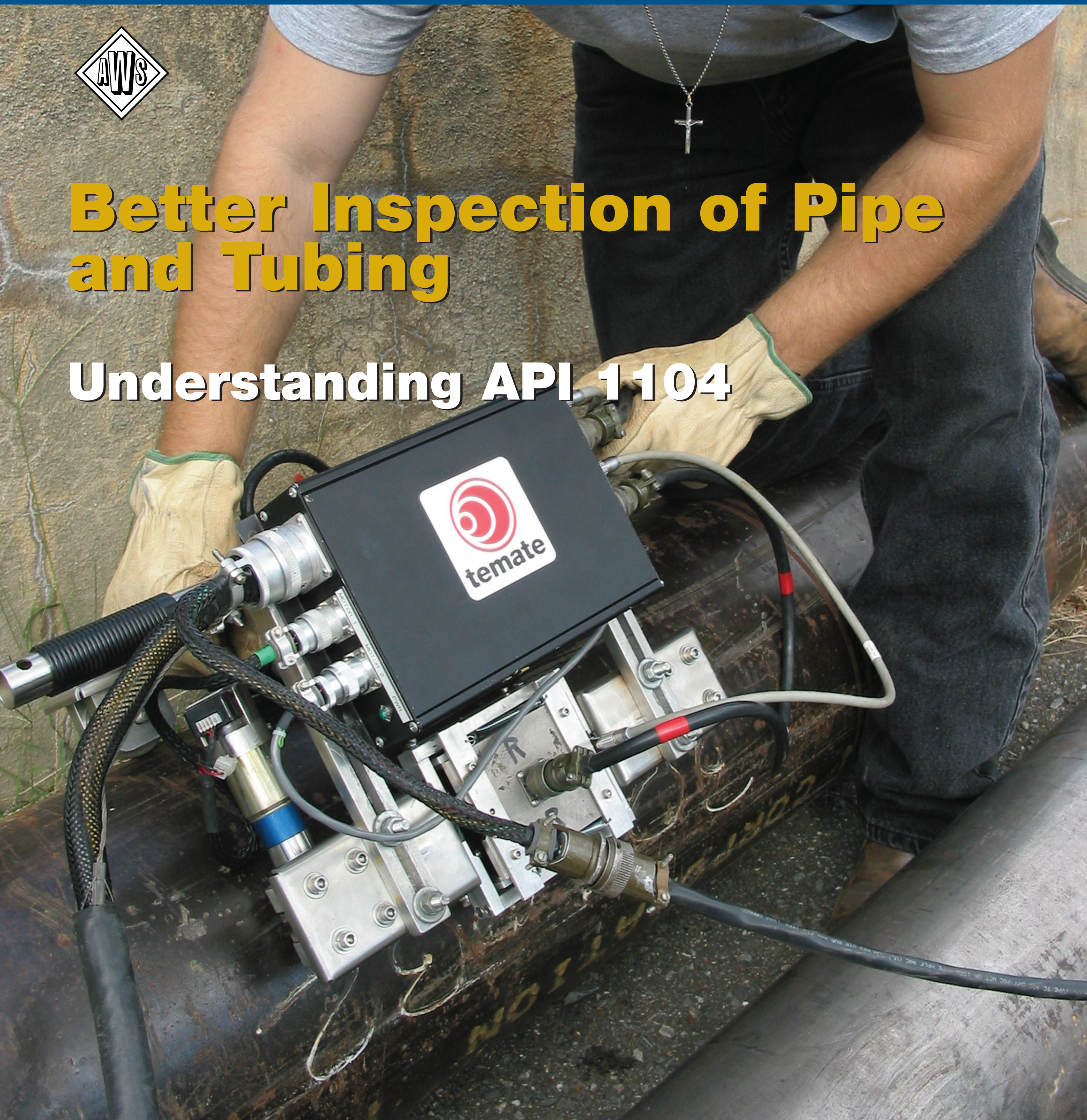
OCTOBER 2006 — FALL • VOLUME 9 • NUMBER 4

INSPECTION TRENDS

THE MAGAZINE FOR MATERIALS INSPECTION AND TESTING PERSONNEL



Better Inspection of Pipe and Tubing

Understanding API 1104

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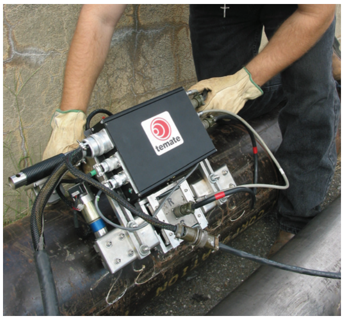

On the cover: *Automated electromagnetic acoustic transducer (EMAT) equipment being used for inspection of pipe welds. (Photo courtesy of Innerspec Technologies, Inc., Lynchburg, Va.)*

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AWS MISSION STATEMENT

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

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editor's note

Dear Readers,

Welcome to the final issue of *Inspection Trends* for 2006. I know it's hard to believe, but fall has arrived and the start of the new year is fast approaching. It seems like yesterday that we were worried about the arrival of 2000 and whether the computers would all shut down and everyday life would come to a screeching halt as a result. Now we're closer to the end of the decade than to the beginning. The computer question proved to be of no real concern, but many of the other issues we had back then remain with us today: we're still pressed for time, still called upon to do more work with fewer resources. Plus, remember when we were told the use of computers would turn us into a paperless world? Well, whoever had that idea sure was proven wrong. I don't know about you, but I'm drowning in paper, both at work and at home.

Our goal at *Inspection Trends* is always to help you do your jobs better and faster. This issue concentrates on inspection of pipe and tubing, with two articles focusing on specific inspection processes and two with the goal of helping you to better understand API 1104. There's also a new department titled Inspection Best Practices, which will continue to run throughout next year. We hope you can use the information there to refresh your basic inspection know-how.

We're also planning ahead to 2007. Following is the editorial calendar for next year. I've included the deadlines for submission of articles and hope that some of you will be encouraged to write for the magazine. You might be thinking to yourself, "I can't do that, I'm not a professional writer." That may be true; few of the people who write for *Welding Journal* or *Inspection Trends* are. You are, however, one of the experts in your field and, most likely, have knowledge that could be of real help to your fellow inspection professionals. If you'd like to share some of that knowledge, contact me at *mjohnsen@aws.org* or at (800) 443-9353, ext. 238.

Winter (January)	Basic Metallurgy for Inspectors The Benefits of the AWS Certified Welding Supervisor Program Deadline for submission of articles, November 14
Spring (April)	Applying Technology to Visual Weld Inspection Acoustic Emission Testing Deadline for submission of articles, February 17
Summer (July)	Understanding Corrosion Radiographic Interpretation Deadline for submission of articles, May 15
Fall (October)	Inspection in the Chemical and Petroleum Industries Eddy Current Testing Deadline for submission of articles, August 18

I hope next year's topics offer what you need and, as always, I look forward to hearing from you.

Sincerely,

Mary Ruth Johnsen
Editor

Inspection Trends

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BP Continues Inspections to Resume Operation at Prudhoe Bay

BP America, Inc., recently announced it expects completion of work on its Eastern Operating Area (EOA) bypass pipelines by the end of October. Startup of the bypasses is dependent upon regulatory approval. The company decided to shut down the entire 400,000 barrels per day Prudhoe Bay oil field after a problem was found at its Flow Station 2 (FS2). In March, more than 200,000 gallons of oil spilled from the Western Operating Area (WOA) transit line due to corrosion. On August 6, a second spill of four to five barrels was detected on the EOA pipeline. According to the Joint Pipeline Office, which provides oversight of the entire Trans-Alaska Pipeline System, the next day, BP announced it would ramp down about 1000 wells over a three-to-five day period and replace 16 miles of transit pipelines.

According to BP, the most recent smart pig data from the FS2 transit line revealed areas where wall thickness had been reduced by more than 70% in a few places. The 30-in.-diameter pipeline has a wall thickness of 3/8 in. The company stated the following reason for deciding to shut down the entire oil field. "The unexpected results from a recent smart pig inspection that indicated greater corrosion than predicted, as well as the discovery of an oil leak on the same line, have called into question the condition of oil transit lines across Prudhoe Bay."

Bob Malone, chairman and president of BP America, and Steve Marshall, president of BP Exploration Alaska, recently appeared before the U.S. House of Representatives Energy & Commerce Committee subcommittee on Oversight and Investigations. At that time, Marshall promised the following:

- The company would run an in-line inspection tool in each of the Prudhoe Bay Oil Transit Lines that are returned to service.
- Continue to attempt to determine corrosion mechanisms and modify mitigation programs accordingly.
- Include all BP-operated oil transit lines on the North Slope into the U.S. Department of Transportation's Pipeline Integrity Management Program.
- Replace 16 miles of WOA/EOA oil transit lines regardless of the outcome of in-line inspections in order to ensure acceptable velocity rates.
- Change the organizational structure with the addition of a technical director to provide independent assurance of the company's integrity management efforts.
- Increase spending on Prudhoe Bay major maintenance to $195 million in 2007, a fourfold increase from 2004 spending levels.

The company recently said it had completed 5300 ft of ultrasonic inspections in the EOA and 5560 ft of UT in the WOA. According to the company, results continue to show no significant anomalies have been found outside of those identified in the original pig run.

AWS Issues New Study Guide for API 1104

The American Welding Society recently issued AWS API-M:2006, *Study Guide for API Standard 1104, Welding of Pipelines and Related Facilities, Twentieth Edition*. The guide contains information on the use of API Standard 1104 that will help students prepare for using the standard as well as preparing for code-related examinations such as for the AWS Certified Welding Inspector exam. Material is provided for each of the 13 sections of the standard and both appendixes; it features more explanatory material than previous study materials and illustrates the reasoning behind certain provisions of the standard. Exercise questions and answers are provided for each topic.

Students attending the AWS API Code Clinic Seminar receive a copy of the guide. It is also available from World Engineering Xchange (WEX) Ltd. at *www.aws.org/standards* or (888) 935-3464 (U.S., Canada) or (305) 824-1177. The cost is $54 for AWS members; $72 for nonmembers. Additional information on the seminar is available at *www.aws.org/education/seminar.html*.

RNDT Receives Accreditation for Multiple Nondestructive Testing Methods

RNDT, Inc., Johnstown, Pa., recently received accreditation from the Performance Review Institute, Warrendale, Pa., for multiple nondestructive testing methods from the National Aerospace and Defense Contractors Accreditation Program (Nadcap) and ISO/IEC 17025.

The ISO standard pertains to international requirements for the competence of testing and calibration laboratories. These accreditations, along with several other certifications, satisfy global requirements for nondestructive testing laboratories including those for aerospace clients.

RNDT specializes in high-quality radiographic and ultrasonic imaging as well as magnetic particle, liquid penetrant, visual, and acoustic emission inspections.

Applied Ultrasonics and Nippon Steel Form Partnership

Applied Ultrasonics, Birmingham, Ala., recently entered into a technology license and development agreement with Nippon Steel Corp., Japan, regarding the firm's Esonix® ultrasonic impact technology (UIT).

Ultrasonic impact technology can be used on any metallurgy for enhancing the physical and mechanical properties of the metal, which results in improved service characteristics such as enhanced fatigue life, improved wear resistance, and increased corrosion resistance.

Under the agreement, both companies will further develop the technology. Nippon Steel through its wholly owned subsidiary, Nippon Steel Technoresearch, has exclusive rights to market, license, implement, and support Esonix® UIT throughout eastern Asia.

Quality Inspection Services Promotes Three

Quality Inspection Services (QIS), Inc., Buffalo, N.Y., recently named three people to key positions in the company. Ted

Mike Devine

Doug Murdock

Ted Kendrick

Kendrick was named vice president of northeast operations, Mike Devine was named vice president of sales, and Doug Murdock was named operations manager of the Connecticut office. Previously, Kendrick was operations manager for the Syracuse, N.Y., office. Devine began working at QIS in 2004, following 20 years of sales experience including 14 years in the sales of nondestructive testing equipment in the northeast region. Murdock joined QIS in 2005 as an NDE supervisor at the Hartford, Conn., office. He has 30 years of NDE experience and is an AWS CWI, an API inspector, and is an ASNT Level II in five disciplines of NDE.

VideoRay and BlueView Announce Multibeam Sonar Purchase

VideoRay LLC, a maker of underwater inspection class remotely operated vehicles (ROVs), recently agreed to purchase for resale 50 ProViewer 450 sonar systems from BlueView Technologies. VideoRay has been evaluating multibeam technology as a tool for enhancing operations and navigation in low-visibility water.

The equipment also offers advantages in water with good visibility. For example, hull searches for attached devices can be performed on tanker-size vessels by scanning large swaths at a time. Protrusions and details such as weld joints can be observed from a greater distance than possible with visual detection alone.

New Applications Promise New Growth in Mature Mechanical Test Equipment Market

Expanding end-user application opportunities seem to suggest a strong revival in the saturated mechanical test equipment market, according to an analysis from Frost & Sullivan, Palo Alto, Calif., *www.testandmeasurement.frost.com*.

According to the report, this market earned revenues of $627.4 million in 2005 and is likely to reach $811.7 million in 2012. The demand for the equipment is no longer confined to traditional end-user industries such as automotive, aerospace, metals, plastics, and ceramics. In addition, growth opportunities exist in Asia and eastern Europe due to increased industrial activity in those regions.

"Emerging end-use applications such as biomedical engineering, biotechnology, semiconductors, micromachining, and medical devices offer promising opportunities and are expected to significantly enhance the growth potential of the mechanical test equipment market in future," said S. Vidyasankar, Frost & Sullivan research analyst.

However, the growing move toward nondestructive examination poses a considerable challenge to equipment vendors. According to the report, with the gain in acceptance of NDE techniques and the availability of various kinds of simulation and analysis software, mechanical or destructive testing runs the risk of being pushed into the background.

"Destructive or mechanical testing is highly essential to understanding the failure mechanism of various components and is unlikely to be replaced entirely by NDT," Vidyasankar said. "Industry specifications and standards will continue to drive the demand for mechanical test equipment in the years to come."

To receive a virtual brochure that provides an overview of this analysis, send an e-mail to Tori Foster, corporate communications, at *tori.foster@frost.com* with your full name, company name, title, telephone number, fax number, and e-mail address.❖

your calendar

mark

Dates and locations are subject to change.

ASNT Fall Conference and Quality Testing Show. Oct. 23–27. Hilton Americas, Houston, Tex. Contact ASNT, (800) 222-2768, *www.asnt.org*.

◆ **FABTECH International & AWS Welding Show.** Oct. 31–Nov. 2, Georgia World Congress Center, Atlanta, Ga. Contact American Welding Society, (800) 443-9353, ext. 462; *www.aws.org*.

The 54th Defense Working Group on NDT. Oct. 31–Nov. 2, Wyndham Albuquerque Hotel, Albuquerque, N.Mex. Contact: TSgt. Letitia Edgerson, U.S. Air Force 58th Special Operations Wing, Kirkland Air Force Base; COMM (508) 853-6401; DSN 263-6401; *letitia.edgerson@kirtland.af.mil*; *hometown.aol.com/dodndt*.

◆ **Quality Control in Welding Conference.** Nov. 1. FABTECH International & AWS Welding Show, Georgia World Congress Center, Atlanta, Ga. Contact American Welding Society Conferences Dept., (800) 443-9353 ext. 223, *www.aws.org*.

Ultrasound World III. Nov. 5–8. Hilton Clearwater Beach Resort Hotel, Clearwater Beach, Fla. Contact UE Systems, (800) 223-1325, *info@uesystems.cm; www.uesystems.com/tiw.*

Aerospace Testing North America Expo 2006. Nov. 14–16. Anaheim Convention Center, Anaheim, Calif. Contact North American Help Desk, Christine Ellis, The Facet Co., (734) 453-3500; FAX: (734) 453-3843; *facet@facetcompany.com*; *www.aerospacetesting.com*.

ASNT 16th Annual Research Symposium. March 26–30, 2007. Wyndham Orlando Resort, Orlando, Fla. Contact American Society for Nondestructive Testing at *www.asnt.org*. Questions concerning abstracts should be directed to Jacquie Giunta at *jgiunta@asnt.org* or (614) 274-6003, ext. 213.

Educational Opportunities

EPRI NDE Training Seminars. EPRI offers NDE technical skills training in visual examination, ultrasonic examination, ASME Section XI, UT Operator Training, etc. Contact Sherryl Stogner, (704) 547-6174, *sstogner@epri.com*.

Nondestructive Examination Courses. A course schedule is available from Hellier, 277 W. Main St., Ste. 2, Niantic, CT 06357, (860) 739-8950, FAX: (860) 739-6732.

Preparatory and Visual Weld Inspection Courses. One- and two-week classes presented in Pascagoula, Miss., Houston, Tex., and Houma and Sulphur, La. Contact Real Educational Services, Inc., (800) 489-2890; *info@realeducational.com*.

Boiler and Pressure Vessel Inspectors Training Courses and Seminars. For complete course listings and schedules, contact Richard McGuire, manager of training, (614) 888-8320, *rmcquire@nationalboard.org; www.nationalboard.org.*

CWI/CWE Course and Exam. A ten-day program presented in Troy, Ohio. Contact Hobart Institute of Welding Technology (800) 332-9448; *www.welding.org; hiwt@welding.org.*

T.E.S.T. NDT, Inc., Courses. CWI preparation, NDE courses. On-site training available. T.E.S.T. NDT, Inc., 193 Viking Ave., Brea, CA 92821; (714) 255-1500; FAX (714) 255-1580; *ndtguru@aol.com*; *www.testndt.com.*

AWS Certification Schedule

Certification Seminars, Code Clinics and Examinations

Application deadlines are six weeks before the scheduled seminar or exam. Late applications will be assessed a $250 Fast Track fee.

Certified Welding Inspector (CWI)

Location	Seminar Date	Exam Date
Long Beach, CA	Nov. 5-10	Nov. 11
Beaumont, TX	Nov. 5-10	Nov. 11
Portland, OR	Nov. 5-10	Nov. 11
Atlanta, GA**	Nov. 5-10	Nov. 11
Louisville, KY	Nov. 12-17	Nov. 18
St. Louis, MO	EXAM ONLY	Dec. 2
Miami, FL	Dec. 3-8	Dec. 9
Columbus, OH *	Dec. 11-15	Dec. 16
Corpus Christi, TX	EXAM ONLY	Dec. 16
Fresno, CA	Jan. 7-12, 2007	Jan. 13, 2007
New Orleans, LA	Jan. 7-12	Jan. 13
Knoxville, TN	EXAM ONLY	Jan. 20
Corpus Christi, TX	Exam Only	Jan. 27
Pittsburgh, PA	Jan. 21-26	Jan. 27
Seattle, WA	Jan. 21-26	Jan. 27
Miami, FL	Jan. 21-26	Jan. 27
Denver, CO	Jan. 28-Feb. 2	Feb. 3
Indianapolis, IN	Jan. 28-Feb. 2	Feb. 3
Milwaukee, WI	Feb. 4-Feb. 9	Feb. 10
Atlanta, GA	Feb. 4-Feb. 9	Feb. 10
Miami, FL	EXAM ONLY	Feb. 15
Dallas, TX	Feb. 11-16	Feb. 17
San Diego, CA	Feb. 11-16	Feb. 17
Norfolk, VA	Feb. 25-Mar. 2	Mar. 3
Anchorage, AK	Feb. 25-Mar. 2	Mar. 3
Boston, MA	Mar. 4-9	Mar. 10
Portland, OR	Mar. 4-9	Mar. 10
Mobile, AL	EXAM ONLY	Mar. 17
Perrysburg, OH	EXAM ONLY	Mar. 17
Rochester, NY	EXAM ONLY	Mar. 17
Houston, TX	Mar. 18-23	Mar. 24
Miami, FL	Mar. 18-23	Mar. 24
Phoenix, AZ	Mar. 25-30	Mar. 31
Chicago, IL	Mar. 25-30	Mar. 31
York, PA	EXAM ONLY	Mar. 31
Corpus Christi, TX	EXAM ONLY	Apr. 7
Miami, FL	EXAM ONLY	Apr. 19
Baton Rouge, LA	Apr. 15-20	Apr. 21
Portland, ME	Apr. 15-20	Apr. 21
Columbus, OH*	Apr. 16-20	Apr. 21
Las Vegas, NV	Apr. 22-27	Apr. 28
Nashville, TN	Apr. 22-27	Apr. 28
St. Louis, MO	EXAM ONLY	Apr. 28
Jacksonville, FL	Apr. 29-May 4	May 5
Baltimore, MD	Apr. 29-May 4	May 5
Waco, TX	EXAM ONLY	May 5
Detroit, MI	May 6-11	May 12
Miami, FL	May 6-11	May 12
Corpus Christi, TX	EXAM ONLY	May 19
Long Beach, CA	EXAM ONLY	May 26
Birmingham, AL	Jun. 3-8	Jun. 9
Hartford, CT	Jun. 3-8	Jun. 9
Miami, FL	EXAM ONLY	Jun. 14
Fargo, ND	Jun. 10-15	Jun. 16
Kansas City, MO	Jun. 10-15	Jun. 16

* Mail seminar registration and fees for Columbus seminars only to National Board of Boiler & Pressure Vessel Inspectors, 1055 Crupper Ave., Columbus, OH 43229-1183. Phone (614) 888-8320. Exam application and fees should be mailed to AWS.
** To register for Lincoln Electric Southeast Training Center seminars in Atlanta, Ga., call (888) 935-3860.

For information on any of our seminars and certification programs, visit our website at **www.aws.org** or contact AWS at (800/305) 443-9353, Ext. 273 for Certification and Ext. 449 for Seminars.

Please **apply early** to save Fast Track fees. **This schedule is subject to change without notice.** Please verify the dates with the Certification Dept. and confirm your course status before making final travel plans.

9-Year Recertification for CWI and SCWI

Location	Seminar Dates	Exam Date
Dallas, TX	Nov. 13-18, 2006	NO EXAM***
Orlando, FL	Dec. 4-9	NO EXAM***
New Orleans, LA	Jan. 22-27, 2007	NO EXAM***
Denver, CO	Feb. 12-17	NO EXAM***
Dallas, TX	Mar. 19-24	NO EXAM***
Sacramento, CA	Apr. 23-28	NO EXAM***
Pittsburgh, PA	Jun. 11-16	NO EXAM***

***For current CWIs needing to meet education requirements without taking the exam. If needed, recertification exam can be taken at any site listed under Certified Welding Inspector.

Certified Welding Supervisor (CWS)

Location	Seminar Dates	Exam Date
Portland, OR	Nov. 6-10, 2006	Nov. 11, 2006
Atlanta, GA**	Jan. 15-20, 2007	Jan. 21, 2007
Houston, TX	Jan. 22-26	Jan. 27
Baton Rouge, LA	Feb. 12-16	Feb. 17
Rosemont, IL	Mar. 19-23	Mar. 24
Nashville, TN	Apr. 16-20	Apr. 21
Columbus, OH	May 7-11	May 12

Certified Radiographic Interpreter (RI)

Location	Seminar Dates	Exam Date
Long Beach, CA	Nov. 6-10, 2006	Nov. 11, 2006
Louisville, KY	Nov. 13-17	Nov. 18
Long Beach, CA	Jan. 29-Feb. 2, 2007	Feb. 3, 2007
Indianapolis, IN	Feb. 26-Mar. 2	Mar. 3
Houston, TX	Mar. 26-30	Mar. 31
Philadelphia, PA	Apr. 30-May 4	May 5
Nashville, TN	Jun. 4-8	Jun. 9

Radiographic Interpreter certification can be a stand-alone credential or can exempt you from your next 9-Year Recertification.

Certified Welding Educator (CWE)

Seminar and exam are given at all sites listed under Certified Welding Inspector. Seminar attendees will not attend the Code Clinic portion of the seminar (usually first two days).

Senior Certified Welding Inspector (SCWI)

Exam can be taken at any site listed under Certified Welding Inspector. No preparatory seminar is offered.

Certified Welding Fabricator

This program is designed to certify companies to specific requirements in the ANSI standard AWS B5.17, *Specification for the Qualification of Welding Fabricators*. There is no seminar or exam for this program. Call ext. 448 for more information.

Code Clinics & Individual Prep Courses

D1.1, API-1104, Welding Inspection Technology, and Visual Inspection workshops are offered at all sites where the CWI seminar is offered. D1.1 and API-1104 Code Clinics are held on Sundays and Mondays and are prep courses for CWI Exam-Part C. Welding Inspection Technology is held Wednesdays and Thursdays and is a general knowledge course and a prep course for CWI Exam-Part A. The Visual Inspection workshop is usually held on Fridays and is a prep course for CWI Exam-Part B.

On-site Training and Examination

On-site training is available for larger groups or for programs that are customized to meet specific needs of a company. Call ext. 219 for more information.

Circle No. 5 on Reader Info-Card

American Welding Society

Founded in 1919 to advance the science, technology and application of welding and allied joining and cutting processes, including brazing, soldering and thermal spraying.

SEE US AT THE FABTECH/AWS SHOW BOOTH #11106

profile

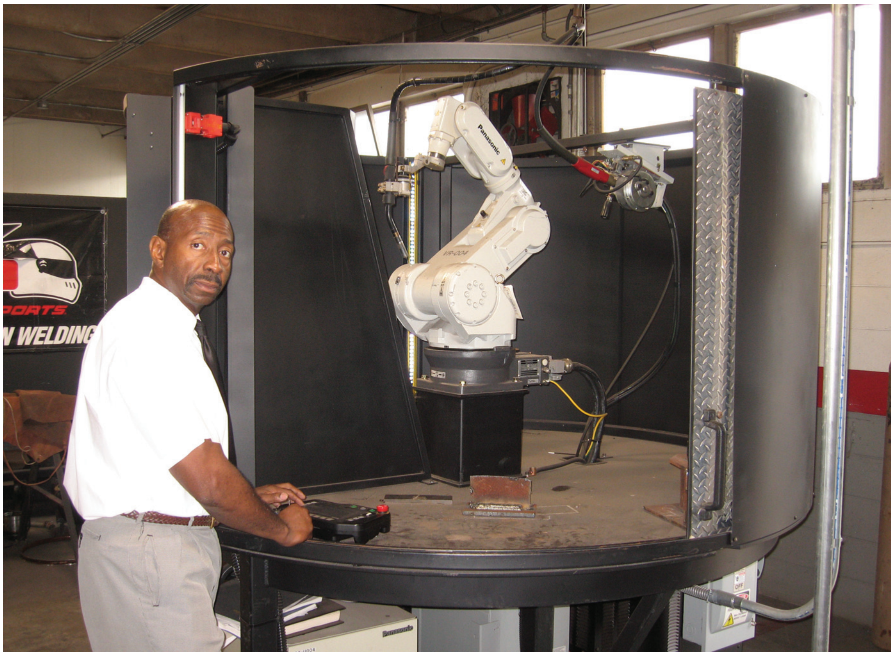
Teacher Takes the Mission of Advancing the Science of Welding to Heart

Over the years, Jackie Woods has earned an impressive list of degrees and certifications. He expects to receive a doctorate in administration of higher education from Auburn University in January, and possesses a variety of teaching-related state and national certifications. He is an AWS Certified Welding Inspector, Certified Welding Educator, and Certified Welding Supervisor. He holds ASNT Level II certifications in magnetic particle testing and penetrant testing and is a Level I in ultrasonic testing. He has also earned a variety of welding-related qualifications.

While there are a number of reasons why he has wanted to acquire these credentials, one is foremost: "I am always looking for ways to enhance my skills so I could offer more to the field of welding technology."

That's why Woods attended a seminar and then took the Certified Welding Supervisor exam about six months ago. "I always try to look at welding technology as a science," Woods said. "That program is all about improving productivity at less cost. Knowing more about better weld quality and improved weld management are all beneficial. I felt it would help me offer more to industry."

Woods has been a full-time welding instructor at Lurleen B. Wallace (LBW) Community College in Andalusia, Ala., since July 1981. That same year, he married his wife, Beverly. The couple now has four children. In his spare time, he enjoys weight lifting and karate.



Jackie Woods has incorporated automation into the welding curriculum at Lurleen B. Wallace Community College, Andalusia, Ala.

Professional Life

An Andalusia native, Woods also attended LBW, receiving an associate degree in applied science back when it was called a junior college. During his time as an instructor at the school, he has incorporated automation into the welding curriculum and facilitated its certification as an AWS Accredited Testing Facility.

His skills as an educator have been recognized by the American Welding Society, which selected him as a corecipient of the National Howard E. Adkins Memorial Instructor Membership Award in 1998. Chancellor Fred Gainous appointed him in 1999 to serve as program faculty leader for welding to facilitate faculty input into major Alabama college system initiatives, including certification of programs, curricula revisions, and comprehensive development. Woods cites Gainous as his mentor as an educator. "He provided me with an opportunity to serve in key positions that inevitably helped the science of welding technology within the Alabama two-year college system."

Woods became a CWI in August 1991. On weekends and at other times as needed, Woods works as a CWI for a number of local manufacturers. Although he does perform inspections, that has not been his primary role as a CWI. Much of what he does correlates to his role as a welding instructor, since much of his time is spent in the testing and qualification of welders, training, and the writing of Welding Procedure Specifications.

"The thing I enjoy most about my job is interacting, motivating, and mentoring welding students," Woods said. "In addition, I also enjoy having the opportunity to watch my students gain the necessary skills for finding employment in the welding technology field. So far, I have played a pertinent role in helping four of my graduates to become Certified Welding Inspectors."

Providing training and qualifying welders to the requirements of AWS D1.1, *Structural Welding Code — Steel*, is the most interesting and challenging part of his work, Woods stated. But the toughest challenge he faces is "trying to improve weld quality and productivity by taking the blacksmith image out of welding technology."

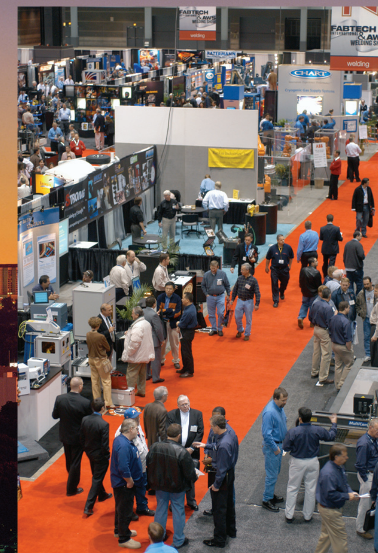
One complaint, however, is that he feels most welding instructors in postsecondary institutions in Alabama have limited access to the research and other information needed to keep them informed about the latest developments in learning, performance, and practices in welding.

Improving Welding's Image

"I believe welding instructors are the key to implementing positive and successful changes in the way in which society views the welding profession," Woods said. "Welding educators can improve the image of welding through effective, specialized professional development, and through proficient use of automated, computer-controlled welding machines, including robots. Change can also come through professional development for welding instructors as a vital part for improving instruction for students."❖

Selected Programs and Events

Conferences
Resistance Welding School
Professional Program
Seminars
Special Events



In addition to experiencing North America's largest fabricating and welding trade show, be sure to attend your choice of welding conferences, seminars and other Society programs! Register at www.aws.org/expo

10TH AWS/AA ALUMINUM WELDING CONFERENCE

Aluminum lends itself to a wide variety of industrial applications, but because its chemical and physical properties set it apart from other metals, welding of aluminum requires special processes, techniques, and expertise. At this conference, a distinguished panel of aluminum-industry experts will survey the state of the art in aluminum welding technology and practice. (Member of AWS, FMA or SME: $550, nonmember: $685. More info at www.aws.org/expo.)

Monday, October 30, 2006

SESSION 1: INTRODUCTION

8:30 AM - 9:15 AM
Welcome and Overview of Aluminum Welding
Tony Anderson, ESAB Welding & Cutting Products
An overview covering the various applications of aluminum welding, the numerous alloys, appropriate welding processes, and fundamental differences between the welding of aluminum and other materials.

9:15 AM - 10.00 AM
The Aluminum Designation System & Characteristics of Aluminum Alloys
Pete Pollak, The Aluminum Association, Inc.
Presentation explains AA's aluminum alloy and temper designation system, as well as the physical and mechanical properties of aluminum alloys.

10:00 AM - 10:45 AM
Aluminum Welding Metallurgy
Frank G. Armao, The Lincoln Electric Company
The basics of aluminum alloy metallurgy and the effects of welding on alloy properties. Presenter discusses filler alloy selection and judicious use of preheat.

11:00 AM - 11:45 AM
Filler Alloy Selection Primary Characteristics
Tony Anderson, ESAB Welding & Cutting Products
Attendees will gain an understanding of the various filler alloy selection variables, including welded component service requirements and the characteristics of the base alloy being welded. The understanding of these variables is essential when designing a successful welding procedure specification.

11:45 AM - 12:30 PM
Metal Preparation for Aluminum Welding
William Christy, Novelis
Metal Preparation is one of the key steps in producing good quality welded joints.

12:30 PM - 1:30 PM: Lunch (on your own)

SESSION 2: FUSION WELDING PROCESSES

1:30 PM - 2:15 PM
Gas Metal Arc Welding of Aluminum Alloys
F. G. Armao, The Lincoln Electric Company
Talk considers metal transfer modes, shielding gas types, wire feed systems, and power source selection — constant voltage, constant current, pulse or variable polarity.

2:15 PM - 3:00 PM
Gas Tungsten Arc Welding and Variable Polarity Plasma Arc Welding of Aluminum
W. Christy, Novelis
This presentation consists of a discussion of the two processes and how they are applied to welding aluminum.

3:15 PM - 4:00 PM
High Energy Density Beam Welding of Aluminum
W. Christy, Novelis
The speaker discusses laser and non-vacuum electron beam welding of aluminum alloys.

4:00 PM - 4:45 PM
Application of the AWS D1.2 Structural Welding Code – Aluminum
T. Anderson, ESAB Welding & Cutting Products
Presenter serves on the D1.2 Committee and reveals the extent of the Code's latest revision: when, where and how to apply the D1.2 for qualification provisions to ensure quality workmanship and structural integrity.

Tuesday, October 31, 2006

SESSION 3: DESIGN

8:30 AM - 9:15 AM
Design and Performance of Aluminum Welds
T. Anderson, ESAB Welding & Cutting Products
Presentation will focus on how to factor strength, toughness, fatigue, corrosion and other variables into design of aluminum welds to extract maximum performance.

9:15 AM - 10:00 AM
Aluminum Weld Discontinuities: Causes and Cures
Kyle Williams, Alcoa Technical Center
Learn about discontinuities normally encountered in aluminum arc welds, methods to detect them, possible causes of the faults, and the means to avoid them.

10:00 AM – 10:45 AM
Robotic Applications
F. G. Armao, The Lincoln Electric Company
This speaker discusses the latest developments in arc welding power source design and wire feeding concepts for robotic arc welding of aluminum. New programmable power source output wave forms for popular aluminum wire chemistries offer additional flexibility for those seeking to optimize production applications.

SESSION 4: SOLID STATE PROCESSES

11:00 AM - 11:45 AM
Overview of Solid State Joining Processes for Aluminum
Donald J. Spinella, Alcoa Technical Center
Overview of solid state joining process used on aluminum including ultrasonic, upset butt, flash, friction, high frequency, and explosive welding.

11:45 AM - 12:30 PM
Friction Stir Welding–Solid State Joining – Combination Extruding & Forging
Jeff Defalco, ESAB Welding & Cutting Products
Presents Friction Stir Welding as a viable solid-state aluminum welding process during which parent material melting, filler metal, and shield gases are absent. The resultant benefits of eliminating the ill effects caused by the solidification-related phenomenon are presented.

12:30 PM - 1:30 PM: Lunch (on your own)

1:30 PM - 2:15 PM
Mechanical Fastening
J. Hutchison, Alcoa Fastening Systems
The speaker will discuss the aspects of mechanical fastening for aluminum, as well as multi-material combinations. Specific comparisons will be made between various types of mechanical fastening systems, adhesives, and welding. Advantages and drawbacks for all systems will be considered.

2:15 PM - 3:00 PM
Resistance Spot Welding of Aluminum
D. J. Spinella, Alcoa Technical Center
Review of resistance welding processes commonly used to join light gauge structures; highlighting design, performance, quality assurance, and production issues associated with aluminum.

3:15 PM - 4:00 PM
Panel Discussion

MORE PROGRAMS...

WELDING NEW MATERIALS FOR THE AUTOMOTIVE INDUSTRY

The emphasis of this conference will be on the new advanced high-strength steels (AHSS) which are becoming quite popular in the automotive industry. A speaker from Dofasco will discuss some of the dual-phase steels, while an engineer from Mittal Steel will talk about other grades, including the martensitic steels. The weldability of all of these grades will be the main issue of the conference. Experts will cover such processes as resistance welding, gas metal arc welding, laser welding, hybrid welding, and spot friction welding. (Member of AWS, FMA or SME: $345, nonmember: $480. More info at www.aws.org/expo.)

Tuesday, October 31, 2006

9:00 AM – 9:40 AM

Welding Dual-Phase Steels for Automotive Applications

Elliot Biro, Senior Research Specialist, Dofasco

This presentation will consist of what dual-phase steels are. It will include the variants in dual-phase microstructures and the changes that occur when heating the materials during welding. The talk will then present results from various welding experiments showing how best to weld these materials using resistance spot welding, gas metal arc welding and laser beam welding.

9:40 AM – 10:20 AM

Spot Friction Welding in Automotive Body Construction

Tsung-Yu Pan, Senior Technical Specialist, Ford Motor Company, Ford Research and Advanced Engineering

Spot friction welding (SFW), a novel variation of the linear friction stir welding (FSW) process, is a low-temperature solid state welding process producing coalescence of metals through heat generated from a spinning tool. It offers cost advantage, energy saving, and is better vs. resistance spot welding (RSW) and self-piercing riveting (SPR) for aluminum lap joining.

10:35 AM – 11:15 AM

Weldability and Joint Design of AHSS for Automotive Applications

Min Kuo, Ph.D., Platform Manager, Product Applications, Mittal Steel, USA Research & Development Center

This presentation will include current and future trend of AHSS applications. Brief introduction of weldability with grade lower than 900 MPa products. Weldability of martensitic grades and their automotive applications. Welding processes include RSW (Resistance Spot Welding), GMAW (Gas Metal Arc Welding) and LBW (Laser Beam Welding). AHSS Joint Design Concept will be discussed.

11:15 AM – 11:55 AM

Magnetic Pulse Welding Solutions for the Automotive Industry

Yoav Tomer, Director, Product Marketing, Pulsar Ltd., Israel

Magnetic pulse welding is becoming one of the preferred solutions for joining similar and dissimilar metal combinations of aluminum, copper, steel and stainless steel. It is only an issue of fast return on investment (ROI). It is mainly an issue of a stable and reliable process which provides high production rate with minimal scrap and rework. More than that, in many cases, such as in welding of dissimilar metals or in applications which require very high strength with minimal wall thickness (CO_2 air conditioning systems, for example), magnetic pulse welding (MP-Weld) is the only solution that works. Typical MP-Weld applications are automotive air conditioning components, aluminum fuel filters, cables, and body parts.

12:00 PM – 1:30PM: Lunch

1:30 PM – 2:10 PM

Fiber Lasers and Applications for the Automotive Industry

Eric Stiles, Laser Division Manager, Fraunhofer USA, Center for Coatings and Laser Applications

High power fiber lasers offer large improvements over conventional lamp pumped Nd:YAG laser technology in terms of beam quality, electrical efficiency and power scalability. Better beam quality makes the fiber laser interesting for applications such as remote welding, deep penetration welding, and high speed welding or cutting, where previously only CO_2 lasers were considered. This presentation gives an overview of the technology and new application developments for the automotive industry.

2:10 PM – 2:50 PM

High Strength Steels Mandate the Use of Ultrasonic Inspection for Resistance Spot Welds

Robby Hawkins, Marketing and Sales Manager, Spot Weld Applications, IRT ScanMaster Systems

Historically the hammer and chisel were the tools of choice for quickly checking resistance spot welds during the final assembly of vehicles. Over the last several years automakers have continued to expand the use of high strength steels in the manufacturing of cars and trucks. High strength steels, with their superior strength over conventional steels, make it virtually impossible to verify the spot welding process using a hammer and chisel without scrapping the component being inspected. This presentation will focus on the growing implementation of ultrasonic inspection in production in order to efficiently inspect spot welds created using high strength steels.

3:05 PM – 3:45 PM

Laser Welding of Zinc-Coated Advanced High Strength Steels

Y. Norman Zhou, Canada Research Chair in Microjoining and Associate Professor and Director, Centre for Advanced Materials Joining, Dept. of Mech. Eng., University of Waterloo

This presentation will provide an overview of the research activities on laser welding of advanced high strength steels at the University of Waterloo. This research is part of the effort to improve vehicle fuel efficiency by reducing the body weight. This talk will focus on the weldability of various zinc-coated dual-phase and TRIP steels and also the formability of welded joints.

3:45 PM – 4:15 PM: Question and Answer Session

RESISTANCE WELDING SCHOOL

This two-day resistance welding school is sponsored by the American Welding Society and the Resistance Welding Manufacturing Alliance, and conducted by industry specialists with extensive resistance welding experience. The basics of resistance welding and real-life application of the process are covered. Each participant may learn at their own pace, and discuss specific welding concerns with the instructors. You are invited to bring your own samples for discussion. Please plan to be present for both days of the school. The program is limited to 100 students. The registration fee includes a copy of the Resistance Welding Manual, Revised Fourth Edition (a $125 value) and a course binder containing all instructor presentations. Participants will also receive a certificate of completion. In addition, there will be a tabletop reception following the first day of classes, demonstrating the latest resistance welding products offered by RWMA-member companies. (Member of AWS, FMA or SME: $425, nonmember: $660. More info at www.aws.org/expo.)

Wednesday, November 1, 2006

7:45 AM – 8:00 AM

Welcome and Introduction to Resistance Welding

Bill Brafford, Technical Liaison Manager; Tuffaloy Products

8:00 AM – 8:30 AM

Basics of Resistance Welding Video – Part I

8:30 AM – 11:00 AM

Electrodes and Tooling

Bill Brafford, Technical Liaison Manager, Tuffaloy Products

Focus on the classification, selection and maintenance of electrodes and fixtures as they pertain to numerous applications. By revealing some problem solving techniques and suggestions, Bill will familiarize you with some powerful problem/evaluation/solution techniques that will keep your production process running longer – and operation more efficient.

11:10 AM – 2:15 PM

Welding Controls

Don Sorenson, Director of Engineering, ENTRON Controls, Inc.

This discussion focuses on the selection, descriptions and applications of welding timers, contactors, and accessories. Packed with a punch, Don drives home $H = I^2 RT$ in a way you'll never forget. He shows you how this invaluable formula is used in every resistance welding application – every day – every cycle – all the time!

12:15 PM – 1:15 PM: Lunch Served

2:30 PM – 5:00 PM

Electrical Power Systems

Kurt Hofman, President, RoMan Engineering Services

This session reviews the descriptions and maintenance of electrical power components and conductors from the weld control to the electrode. This lively presentation has something for everybody. Utilizing several small demonstrations, Kurt helps you understand this very important part of the resistance welding process which will keep you on the edge of your seat!

5:00 PM – 6:30 PM: Tabletop Exhibits & Reception

Thursday, November 2, 2006

8:00 AM – 10:00 AM

Welding Processes & Machines

Tim Foley, Sr. Applications Engineer, Automation International

This session will reinforce the very essence of how the resistance welding process works and how the process relates to each of the four resistance welding processes. This session will be full of application examples from each process and how machinery utilizes the individual components and elements illustrated in the other sessions.

10:15 AM – 10:45 AM

Basics of Resistance Welding Video – Part II

10:45 AM – 12:00 PM

Troubleshooting and Maintenance

Bruce Kelly, President, Kelly Welding Solutions

With over 30 years experience in the auto industry, specifying, installing and troubleshooting resistance welding systems, Bruce will give you tips on how to find the reasons why welds don't turn out the way you would like. This presentation is filled with real life examples of problems that baffled maintenance persons.

12:00 PM – 1:15 PM: Lunch Served

1:15 PM – 3:15 PM

Initial Machine Set–Up

Bob Matteson, Director – Product Development, Taylor–Winfield, Inc.

Bob takes you through the selection and maintenance procedures of proper weld schedules and preventive maintenance programs designed to make your resistance welding operations profitable. Hands-on demonstrations peak this presentation

3:15 PM – 3:30 PM: Question and Answer Session

QUALITY CONTROL IN WELDING

Quality control must be kept up front in the planning of welds. It's not enough to rely solely on control charts, statistical process control or Taguchi methods. The human factor must take front seat. Here is where we get into such aids as certified material testing reports for electrodes, real time sensing and control of welding processes, and the use of six sigma/lean manufacturing. These are the tools to ensure that weld quality can be established the first time around. (Member of AWS, FMA or SME: $345, nonmember: $480. More info at www.aws.org/expo.)

Wednesday, November 1, 2006

9:00 AM – 9:40 AM

Six Sigma and Lean Manufacturing in Shipbuilding

Bahadir Inozu, Chairman and Professor, School of Naval Architecture & Marine Engineering, University of New Orleans. Dr. Inozu is also CEO of Novaces, L.L.C.

Recently, several major shipyards in the U.S. have begun to implement a Lean Manufacturing strategy. During the last two years, Northrop Grumman Ship Systems (NGSS) has been transitioning their Lean Manufacturing program to a Lean Six Sigma program in conjunction with the Lean Six Sigma in Shipbuilding project sponsored by Advanced Maritime Technology Application Center at University of New Orleans. The Lean Six Sigma approach used for process improvement at Avondale, Ingalls and Gulfport shipyards of NGSS along with the training requirements for implementation. The workforce training strategy will be described to help understand the prerequisites for shipyard implementation. Then domino effects and resulting financial impact of defects are presented. In welding, some of the results include reductions in the cost of welding wire, in the cost of weld rework due to improved quality, and reduced inspection time.

9:40 AM – 10:20 AM

Proper Procurement of Filler Metal

Roger Swain, President, Euroweld, Ltd.

A document initiated more than 30 years ago has become more valuable in the present state of things. The original document was aimed at filler metal used in the nuclear industry, and is identified as A5.01. In a further step, the International Standards Organization has taken the A5.01, simplified it, and re-introduced it as ISO 14344. The benefit to industry is something to hang its Q.C. hat on, as it will guide users on how to procure filler metals, enabling companies to do it right the first time.

10:35 AM – 11:15 AM

Arc Welding Process Control for the Earthmoving, Construction and Agricultural Equipment Manufacturing Industry

Jerry Warren, Chief Welding Engineer, Case-New Holland, and Bernard Banzhaf, Welding Specialist, CNH Supplier Development

The authors present a concise method for developing, implementing and consistently applying basic process control to arc welding in this industry. The scope is based on the use of AWS D14.3/D14.3M:2005 – *Specification for Welding Earthmoving, Construction and Agricultural Equipment*. Sub-topics include procedures, welder/operator qualification, inspector certification, auditor training, verification testing and process auditing.

11:15 AM – 11:55 AM

Ultrasonics in the Current Industry

James F. Strunk, QA Manager, CB&I, Blaymore II, co-authored by Ronald W. Kruzic, Corporate QA/NDE Consultant

Current customer and supplier requirements for safety and enhanced security measures for radioactive isotopes have led to alternative examination methods for radiography of plate type structure butt welds. The ASME Code Sections I and VIII in Code Case 2235, and the API Standards 620 and 650 in Appendix U, have adopted the rules for the use of ultrasonic examination in lieu of radiography. This presentation will discuss the requirements, technique, and acceptance criteria for the use of ultrasonics in these applications.

12:00 PM – 1:30 PM: Lunch

1:30 AM – 2:10 PM

Role of Traceability in Quality Assurance

Tom Siewert, Group Leader, Materials Reliability Division, National Institute of Standards and Technology (NIST)

As a chain is only as strong as its weakest link, so a quality system is only as strong as its weakest component. This presentation covers some of the issues associated with traceability of measurements, from the perspective of a researcher within a National Measurement Institute. It will also include some of the changes in several of our verification programs as we switch to the requirements of the 2005 version of ISO 17025 "General requirements for the competence of testing and calibration laboratories," from the old system of traceable to NIST.

2:10 PM – 2:50 PM

Intelligent Digital Laser Vision Technology Insures Six Sigma Level Robotic Welding Quality Is Achieved

Jeff Noruk, President, Servo-Robot Corp.

What gets measured gets improved. 1. Automated weld measurement provides required information. 2. Increase your productivity, uptime and weld quality by only welding what is within your processes capability. 3. How to determine if your process is capable of welding the parts that have been designed for you. 4. Before, during, after – automated weld inspection provides unprecedented information for process improvement of the welding process.

3:05 PM – 3:45 PM

Arc-Weld Monitoring for QC in Manual Welding Applications

Stephen Ivkovich, Co-Founder & Director, IMPACT Engineering

Manual welding continues to be a viable means of producing production welded assemblies, particularly low-cost or low-volume components. Ensuring quality and tracking information from these processes has lagged automated welding applications, primarily due to the cost and/or lack of computerized technology in the process. New Arc-weld monitoring methods and tools have been successfully used to assure quality in a number of real-world production manual welding applications. This case study will highlight the quality and information enhancements.

3:45 PM – 4:15 PM

Arc Welding Quality Monitoring with Thru-Arc Signals & Laser Vision

Ta-Chieh Huang Senior Engineer, Arc Welding, Lasers, and Automation, Edison Welding Institute

To monitor the quality of arc welding is a difficult thing to achieve. In this presentation, we attempt to monitor quality with through-the-arc signals with laser sensor to provide an additional dimension of quality interpretation. The ultimate goal is to be able to determine the quality of the weld quasi real-time (immediately after the weld is complete), or to be able to determine the deteriorated quality if signatures can be captured with the laser-sensor assisted analysis.

THE NEW SPOT WELDING CONFERENCE

For decades, resistance spot welding as been the main process used by many fabricators of sheet metal, especially the automotive industry. But now the curtain has gone up on a number of new spot welding methods, many of which are already finding applications in industry. This list of new processes includes the likes of kinetic, plasma arc, laser, friction, and ultrasonic spot welding. (Member of AWS, FMA or SME: $345, nonmember: $480. More info at www.aws.org/expo.))

Thursday, November 2, 2006

9:00 AM – 9:40 AM

SOAR - Science Based Weld Software for Resistance Spot Welding, Pulsed Arc Welding, and Laser Spot Welding Procedures

Phillip W. Fuerschbach, Principal Member Technical Staff, Sandia National Laboratories

Three software programs for spot welding are available from Sandia National Laboratories' SOAR project. SOAR stands for Sandia Optimization Analysis Routines. The programs are applicable for 2 or 3-dimensional heat flow spot welds, and will determine adjacent temperatures, optimal pulse parameters, and spot weld sensitivities to variations in thickness and base metal temperature. These programs can be used for many different metals and alloys, including 1018, HY80, and HY130 steels, 304 and 17-4PH stainless steels, 6061 aluminum, Ti-6Al-4V, and Inconel 718.

9:40AM – 10:20 AM

Kinetic Spot Welding

John Banker, Vice President, DMC Clad Metal

Explosion welding is a well-known, low cost technology for producing large clad plates. It is typically performed in relatively remote or isolated environments due to the massive energy resulting from the explosive detonation. The Kinetic Spot Welding process employs similar technology, but is appropriate for conventional fabrication shop environments. The process produces spot welds using the impact of a high velocity projectile in place of the explosives. The projectile can be accelerated using a deflagrating product such as gunpowder or using hydraulic, pneumatic, or electromagnetic techniques. The equipment is similar to a carpenter's nail gun. The technology can be used to produce spot welds between most metal combinations, similar or dissimilar. Examples include aluminum-to-aluminum, tantalum-to-steel, and others.

10:35 AM – 11:15 AM

Plasma Arc Spot Welding

R. V. Hughes, Vice President, Arc Kinetics LLC (North America) and Technical Director of Arc Kinetics Ltd (UK)

In 1989, the presenter devised a unique solution to Jaguar Cars Ltd.'s need to join steel underbody stampings with a one-sided plasma spot welding process. The application was awarded a Ford European Operations Technical Innovation Award in 1992. During the last six years, significant technical development of the original plasma spot welding process has been undertaken. Patents are either pending or granted on the following: a special arc striking method giving up to 20,000 weld starts between consumable changes, a spot brazing process for joining coated materials and a special variant for the spot welding of aluminum alloys. Development of heavy duty, yet compact, welding guns has continued at a rapid pace. The robustness, relatively low capital cost, and ease of maintenance compared to, for instance, laser welding equipment, have generated significant interest for the process in the United States. This paper reviews all the major innovations mentioned above.

11:15 AM – 11:55 AM

Ultrasonic Spot Welding of Metals

Matt Short, Project Engineer, Edison Welding Institute

The principles and applications of ultrasonic spot welding of metals will be presented, with this including a review of the operating features of the lateral drive and wedge-reed welding systems, and the main process parameters. The basis for formation of the solid state bond in ultrasonic welding will be discussed, as will the range of materials capable of being welded by ultrasonics. The use of ultrasonic welding for seam and torsion welding will be shown, and an overall summary of process advantages and disadvantages given. The range of uses of ultrasonic metals welding will be described. Finally, recent developments in the ultrasonic metal welding process will be noted.

12:00 PM – 1:30 PM: Lunch

1:30 PM – 2:10 PM

Spot Friction Welding – a New Spot Joining Method

Tsung-Yu Pan, Senior Technical Specialist, Ford Motor Company, Ford Research and Advanced Engineering

Spot friction welding (SFW) is a new process to make spot, lap-weld, joints without fusing. It uses a rotating tool with a probe pin plunging into the upper sheet and a backing anvil beneath the lower sheet supporting the downward force. It has been used in the mass-production of aluminum automotive body structures, and has also been demonstrated in aluminum rail cars and aircraft structures, as well as in joining magnesium, steel, and mixed metals.

(continued...)

(The New Spot Welding Conference continued...)

2:10 PM – 2:50 PM

Laser Welding of Sheet Metal Components

Tim Morris, Technical Sales Manager, Trumpf Inc., Laser Technology Center

Through recent advancements in technology laser welding is finding more and more application in the fabrication and assembly of sheet metal components as an alternative to traditional resistance spot welding. Increases in beam quality, advances in scanner technology and the development of highly flexible systems are the reasons for this success. An overview of laser welding technology and application methods will be given along with specific details on successful laser welding applications in sheet metal.

3:05 PM – 3:45 PM

Improving Electrode Tip Life in Resistance Spot Welding of Aluminum

Y. Norman Zhou, Canada Research Chair in Microjoining and Associate Professor and Director, Centre for Advanced Materials Joining, Dept. of Mech. Eng., University of Waterloo

This presentation will summarize research and development activities on electrode tip life in resistance spot welding of aluminum at the University of Waterloo. This research is part of the effort to improve vehicle fuel efficiency by reducing the body weight. This talk will focus on electrode degradation mechanisms, and techniques to improve electrode life.

3:45 PM – 4:15 PM: Question and Answer Session

AWS PROFESSIONAL PROGRAM

Pick and choose between concurrent sessions for the latest in welding research and commercial developments. Pay by the day or attend the entire four-day program, with special discounts for students and members of AWS, SME or FMA. Four-day Professional Program for member of AWS, FMA or SME: $225 (nonmember: $360). Four-day Student Professional Program for members: $75 (nonmember: $90). One-day Professional Program (Tuesday or Wednesday only) for members: $150 (nonmember: $285). Half-day Professional Program (Monday or Thursday only) for members: $75 (nonmember: $210 More info at www.aws.org/expo.)

Monday, October 30, 2006

SESSION 1: WELDING/JOINING PROCESS DEVELOPMENT

- High Speed Narrow Groove Submerged Arc Welding for Thin Steel Panels
- Out-of-Position Wet Welding with AWS-E6013 Electrode Grade at Three Water Depths
- The Effect of Parameters of the Pulsed Current GMA Welding on the Stability of Resistance of the Welding Arc
- The Interaction of Pulsed Current GMA Welding Variables on the Shape and Size of the Weld
- Buried Gas Tungsten Arc Welding with Convective
- Closure-Welding of Radioactive Materials Containers at the Department of Energy Hanford Site
- A Novel Welding Wire Surface Preparation

SESSION 2: ELECTRON BEAM WELDING

- Integration of Electron Beam Diagnostics in Weld Transfer and Quality Control Procedures
- An Overview on the Past 50 Years of Nonvacuum Electron Beam Welding
- Utilizing Advantages of Electron Beam Welding to Join Aluminum Components
- Pulsed Electron Beam Welding and Microstructure
- Advanced Electron Beam Free-Form Fabrication (EFFF) Methods
- Electron Beam Welding at the Micron Scale
- High-Productivity Welding of HSLA-100 Using the EBW Process

SESSION 3: APPLIED TECHNOLOGY

- Welding for Repair of Chloride Stress Corrosion Cracking – How Far Can We Go?
- Application of Robotic Arc Welding Technology for Manufacture of Two Wheeler Frames
- Portable and Intelligent Stud Welding Inverter for Automotive and Sheet Metal Fabrication
- Laser Brazing in the Automotive Industry Status Report
- Cold Metal Transfer
- Delta Spot
- TOPTIG: Robotic TIG Welding with Integrated Wire Feeder Assures Weld Speed and Weld Quality

Tuesday, October 31, 2006

PLENARY PRESENTATION

- Research Advances in Welding and Joining in Japan

SESSION 4: WELDING MATERIAL CHARACTERIZATION

- Transformations of X70 Pipeline Steel
- Ultra-Supercritical Steam Boiler Steel Weld Repair
- A Novel Technique for Studying of Phase Transformations: Part 1: Single Sensor DTA, Development & Verification
- A Novel Technique for Studying of Phase Transformations: Part 2: Single Sensor DTA, Range of Applications
- Thermodynamic Modeling Using Thermo-Calc in the Development of Specialty Welding Consumables

SESSION 5: WELDING CONSUMABLES DEVELOPMENT

- SAW Ferritic All-Weld Metal: Achieving ANSI/AWS A5.23-97 FXXA6-ECM2-M2 Mechanical Properties
- Response of Exothermic Additions to the Flux-Cored Arc Welding Consumable Electrode
- Realization of an Fe-based Filler Metal for Superaustenitic Stainless Steels
- Characterization of Welding Fume from Stainless Steels and High-Mn Consumables
- Development of a Cr-free Welding Consumable for Reduction of Cr Fume Emissions

SESSION 6: LASER BEAM WELDING/PROCESSING

- Predicting Sigma Formation in Mo-Bearing Stainless Steels
- Controlling Massive Transformations in Laser Welded Stainless Steels
- Hydrogen Effects on Laser Engineered Net Shape Repaired Welds
- Rationalizing Machining Tolerances for Laser Weld Fit-Up
- Porosity Characterization for Nd: YAG CW Laser Welds: Investigating the Effect of Square Wave Modulation
- Determination of the Constitutive Properties of Laser Welds in 304L Stainless Steel

SESSION 7: FRICTION & RESISTANCE WELDING/MATERIALS BONDING PROCESSES

- Brazing 304L Stainless Steel to 5083 Aluminum Using A1719 Filler Material
- Stud Welding of Painted and Hot Dip Galvanized Steels
- A Study of Friction Behavior with Application to Ultrasonic Welding (Consolidation) of Aluminum
- Assessment of Spot Geometry and Mechanical Properties of Resistance Welding by Using Statistical Analysis
- Microstructures and Mechanical Properties Inertia Friction Welds Between 304 SS and AA 6061-T6
- Modeling of Resistance Spot Weld Fracture Behavior in Advanced High Strength Steels

Wednesday, November 1, 2006

PLENARY PRESENTATION

- Research Advances in Welding and Joining in Germany

SESSION 8: ARC & WELD POOL OBSERVATION, MEASUREMENT AND SENSING

- Measurement of Gas Tungsten Arc Weld Pool Surface
- Metal Transfer in Double-Electrode Gas Metal Arc Welding
- Double Wire GMAW: A Closer Look at the Out-Of-Phase Pulsing
- High Speed Filming of AC and MF RSW: A Comparison
- Correlation Between GMAW Process and Weld Quality Parameters: A Neural Network Approach Applied in the Automotive Industry
- Development of Novel Gases and Procedures for High Speed Welding Using Melt-In Plasma Process
- Factors that Influence Transition Current During GMAW
- Prevent 50-59% of Weld Distortion and Weld Cracking with New Sub-Harmonic Process
- Apply Lean to Welding Operations: Case Study
- Simulation of Weld Pool Dynamics and Final Weld Shape
- Droplet Temperature and Evaporation in GMAW

SESSION 9: DEFECT ANALYSIS & MITIGATION

- The Mechanism of Porosity Formation in Underwater Wet Welds
- High Speed Welding Defect Formation and Mitigation
- A Hybrid Laser+GMAW Process for Control of the of Bead Humping Defect
- Understanding Bead Hump Formation in GMAW at High Travel Speed Using a Numerical Simulation
- Defining a Critical Weld Dilution to Avoid Solidification Cracking in Aluminum

SESSION 10: RESIDUAL STRESS MANAGEMENT IN WELDED JOINTS

- Improvement of Fatigue Strength In Non-Load Carrying Cruciform Fillet Welded Joint By Weld Metal Phase Transformations
- Effect of Martensite Start and Finish Temperatures on Structural Steel Welds
- Study of Crack Propagation Through a Welded Pipeline Section
- Reduction of Weld Residual Stress in Alloy 22 by Pro-Active Thermal Management
- Statistical Methods for Fatigue Life Prediction of Welded Joints

SESSION 11: FRICTION STIR WELDING

- Friction Stir Spot Welding of Advanced High-Strength Steel
- Microstructural and Mechanical Characterization of Friction Stir Welded (FSW) Alloy 690
- Development of a Novel Technique for Hot Torsion Testing of Samples with Non-Uniform Temperatures
- Inhomogeneity of Microstructure and Plastic Deformation in Cast Superalloy IN738 Friction Stir Weld
- Probing Temperature Distribution and Material Flow in Friction Stir Welding of Dissimilar Aluminum Alloys
- Metallurgical Evaluation of Friction Stir Welded Copper
- Modeling of Simultaneous Heat Transfer and Deformation in Friction Stir Welding

Thursday, November 2, 2006

PANEL SESSION

- Current Industrial Challenges in Welding and Joining

SESSION 12: SEGREGATION AND CRACKING PHENOMENA

- Elevated Temperature Cracking in Alloy C22
- Microstructure Evolution and Hot Ductility Behavior of Heat-Resistant Stainless Casting
- Fusion Boundary Macrosegregation: the Mechanism
- Insight into the Metallurgical Mechanism of Ductility Dip Cracking in Ni Based Filler Metals
- Intermediate Temperature Grain Boundary Embrittlement in Austenitic Filler Metals

SESSION 13: STAINLESS STEEL WELDING

- The Weldability of Nitrogen Enriched Austenitic Stainless Steel (316LN) Under Blended Shielding Gas Conditions
- Effect of Welding Variables on the Microstructure of DuplexStainless Steel Welds
- Microstructural Development of Mo-bearing Stainless Steels
- An Experimental and Theoretical Study of GTAW of Stainless Steel Plates with Different Sulfur Concentrations

AWS SEMINARS

Seven unique seminars will give you opportunities to gain practical knowledge on welding and inspection in a lively forum with expert instructors. Seminars are discounted for members of AWS, SME, or FMA. More info at www.aws.org/expo.

ROAD MAP THROUGH THE 2006 D1.1/D1.1M:2006 STRUCTURAL WELDING CODE – STEEL

Monday, October 30, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

This one-day program provides a comprehensive overview of AWS D1.1:2006, *Structural Welding Code–Steel*. Each code section, including General Requirements, Design of Welded Connections, Pre-qualification, Qualification, Fabrication, Inspection, Stud Welding, and Strengthening and Repair of Existing Structures, will be summarized with emphasis on their interrelationships and usage. In addition, the role of mandatory and non-mandatory annexes will be reviewed, along with tips on using the code Commentary. This program will benefit managers, engineers, supervisors, inspectors, and other decision-makers who need comprehensive understanding of what is, and what is not, covered by AWS D1.1:2006 to improve their job effectiveness. Attendees must bring their own copy of D1.1:2006, *Structural Welding Code–Steel.* Order it online at http://www.awspubs.com or contact The AWS Store at (305) 826-6193.

PRICING AND PROFITABILITY – CONTROLLING THE COSTS OF WELDING

Monday, October 30, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

If you're responsible for estimating the cost of welding and determining which process and selection of weld joints is required, then you'll want to attend this course.

This program will provide a value-added experience for estimators, small job shops, and owner operators. Topics to be covered include responsible weld design, weldment cost elements, welding process efficiencies, deposition efficiencies, and Weld Cost Express.

You'll learn how to compare costs associated with use of different weld joint geometries, processes, and filler metal combinations; application of code and standards documents when generating an estimate; how to document welding variables and the costs associated with them; and how economic order lot quantities affect the weld estimate.

INSPECTION TO THE 2006 D1.1 STRUCTURAL WELDING CODE–STEEL

Tuesday, October 31, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

This one-day course is devoted to inspection of structural steel welds. Inspector qualifications and the responsibilities of inspectors and contractors will be covered. Inspection procedures and techniques are highlighted as a prelude to a detailed review of the inspection acceptance standards. Test method fundamentals will be covered, where necessary, to understand the more in-depth tables and criteria, along with tips on what to look for in inspection reports.

Supervisors, engineers, inspectors, and auditors will gain a better understanding of weld quality from this presentation.

Attendees must bring their own copy of D1.1:2006, *Structural Welding Code–Steel.* Order it online at http://www.awspubs.com or contact The AWS Store at (305) 826-6193.

METALLURGY APPLIED TO EVERYDAY WELDING

Tuesday, October 31, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

Metallurgy of welds in carbon and low alloy steels doesn't need to be complicated. This short course will help you understand how welding affects the properties of base materials, and how weld defects occur.

Owners, inspectors, engineers, and supervisors who specify welding and need to understand the interaction of base, filler, and welding processes should attend.

THE WHY AND HOW OF WELDING PROCEDURE SPECIFICATIONS

Wednesday, November 1, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

If you are responsible for planning a welding operation, which of the following items are most critical: base metal, welding process, filler metal, current and range, voltage and travel speed, joint design tolerances, joint and surface preparation, tack welding, welding position, preheat and interpass temperature, or shielding gas? This course provides the answers.

This program will benefit owners, managers, engineers, and supervisors who must qualify, write, or revise their own welding procedure specifications to satisfy codes and contract documents.

Topics covered:
- Proper preparation and qualification of welding procedure specifications
- Selecting and documenting welding variables
- Documenting standard procedure qualification testing for commonly used processes for joining ferrous plate and pipe materials.

You can learn:
- Specify essential and nonessential variables commonly used in sample AWS, ASME, and API code formats
- Use standards when preparing procedures
- Document welding variables and qualification tests
- Avoid the pitfalls in revising previously qualified procedures.

INTRODUCTION TO MT, PT, UT AND RT

Wednesday, November 1, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $345, nonmember: $480

The morning session (8:30 AM-noon) will introduce the nondestructive methods of magnetic particle (MT) and liquid penetrant (PT) testing, and explain inspection techniques and operating principles for visible and fluorescent MT and PT. The discussion will cover basic principles of magnetic particle testing, with emphasis on the characteristics of longitudinal and circular magnetism, and will summarize the use of MT equipment such as yokes, prods, central conductors, and coils. The liquid penetrant testing discussion will include solvent removable, water washable, and post emulsifiable penetrant testing methods.

The afternoon session (1 PM-4:30 PM) will introduce and review the fundamentals of ultrasonic and radiographic testing. Specific topics will include the principles and physics of each method, equipment, measurement techniques, and each method's advantages and disadvantages. A special section on weld inspection using ultrasonics with AWS D1.1:2006, *Structural Welding Code–Steel* will be included.

WELDING OF STAINLESS STEELS (BASICS AND AVOIDING WELD DEFECTS)

Wednesday & Thursday, Nov. 1-2, 2006 • 8:30 AM – 4:30 PM
Member of AWS, FMA or SME: $550, nonmember: $685

The program focuses on the basic weldability of all types of stainless steels. If you need a comprehensive look at the weldability of stainless steels, particularly the 300 series, this course is for you.

Topics covered:
- Why alloys are "stainless"
- Stainless-steel differences
- Selecting a stainless for use
- Mechanical properties
- Properties after welding
- Heat treatment factors
- Selecting filler metals
- Gas vs. flux shielding
- Code requirements

You'll learn:
- Five stainless-steel types
- The effects of welding on all types of stainless steels
- Why some stainless steels require preheat and others prohibit it
- Answers to your questions about selecting and welding stainless steels.

SPECIAL EVENTS

The following are among the special programs to be held at the 2006 Fabtech Int'l. & AWS Welding Show in Atlanta. Many more programs will be held at the show, including management and marketing seminars, poster sessions, brazing programs, a job fair, and the U.S. Open Weld Trials. Visit our website at www.aws.org/expo for more information and free show registration.

AWS OPENING SESSION & ANNUAL BUSINESS MEETING

October 30, 9:00 AM

AWS President Damian J. Kotecki will give the Presidential Report, and Gerald D. Uttrachi will be inducted as AWS President for 2007. The 2006 Class of AWS Counselors and Fellows will also be introduced. Open to all AWS Members and Show registrants.

COMFORT A. ADAMS LECTURE: MODELING IS GREAT – SO WHAT?

October 30, 11:00 AM

Dr. John M. Vitek, Sr. Research Scientist, Oak Ridge National Laboratory, is this year's Adams Lecturer.

AWS OFFICERS/PRESIDENTS/COUNTERPARTS RECEPTION

October 30, 6:30 PM

This reception is held annually during the Show and is open to all registrants. Take advantage of this opportunity to meet the AWS Officers, and network with members and prospects.

FABTECH INTERNATIONAL & AWS WELDING SHOW OPENING CEREMONY

October 31, 8:45 AM

A short, symbolic ceremony opens the Fabtech International & AWS Welding Show, the largest trade show and educational conference for the metal forming, fabricating and welding industries.

AWS NATIONAL NOMINATING COMMITTEE

Open Meeting October 31, 10:00 AM

AWS Members will submit their recommendations for National Officers to serve during 2008.

END USER FORUM

Lunch session, October 31, 10:00 AM

Members of the end-user community engage in provocative discussions on real-life productvity issues. Cost for the forum and luncheon is $25, and it is open to all show registrants.

GAWDA 500: WELDING THE NASCAR WAY

October 31, 11:00 AM

Sponsored by the Gases and Welding Distributors Association (GAWDA). Open to all registrants. NASCAR will be roaring into the convention center with a presentation by Gary Nelson, one of the NEXTEL Cup Series most winning crew chiefs and the former vice president of Research and Development for NASCAR.

AWS AWARDS/AWS FOUNDATION RECOGNITION CEREMONY & LUNCHEON

October 31, Noon

The cost for attending the ceremony and luncheon is $30, and it is open to all show registrants. For advance reservations, register on line at www.aws.org/expo.

R. D. THOMAS, JR. INTERNATIONAL LECTURE – QUALITY ASSURANCE IN WELDING SHOPS – THE NEW ISO STANDARD 3834:2005

November 1, 10:00 AM

Prof. Dr.-Ing. Detlef von Hofe, chair of CEN/TC 121-Welding, and vice president of the European Federation for Welding, Joining and Cutting is this year's Thomas Lecturer. American Council of IIW meeting immediately following lecture at 10:30.

COMPLIANCE WITH OSHA'S HEXAVALENT CHROMIUM STANDARD

November 1, 10:30 AM

Free session on meeting the new OSHA requirements pertaining to hexavalent chromium exposure.

IMAGE OF WELDING AWARD CEREMONY

November 2, 10:00 AM

Join the Image of Welding Committee (a subcommittee of the Welding Equipment Manufacturers Committee) and special guests as they recognize the individuals and organizations that have excelled in promoting the image of welding in their communities. RSVP to Adrienne Zalkind at 800-443-9353, ext. 416.

What's New in API 1104

The latest edition of the standard contains some significant changes

The American Petroleum Institute issued the 20th edition of API Standard 1104, *Welding of Pipelines and Related Facilities*, in November 2005. The standard covers the welding of butt-joint, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, and nitrogen. Where applicable it also covers welding on gas distribution piping.

In addition, API 1104 includes procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing, as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic particle, liquid penetrant, ultrasonic, and visual inspection.

The standard applies both to new construction and in-service welding.

The CWI Test

Candidates for the AWS Certified Welding Inspector examination who choose the API 1104 open codebook exam must use the 20th edition. This change became effective June 1, 2006.

The new API 1104 exam consists of 60 multiple choice questions taken in the same two-hour format as previous CWI tests. The new exam is not compatible with any previous editions of the code.

Candidates are responsible for purchasing the API 1104 20th edition and, if not in possession of a bound copy of the standard, must present proof of purchase for any photocopies presented.

Significant changes include elimination of hole-type penetrameters and removal of nick break testing requirements.

Changes to the Standard

Significant changes include a new revision in the radiographic testing acceptance standard, the total elimination of the use of hole-type penetrameters, removal of the nick break testing requirement, and improved practices for welding on in-service pipelines. These and other changes from the 19th edition are detailed as follows:

◆ Definitions have been added, corrected, and clarified.

◆ A new revision in the radiographic testing acceptance standards is in the area of "burn-through" (known as melt-through in AWS terminology).

◆ A significant revision in the procedures for radiographic test methods involves the total elimination of the use of hole-type image quality indicators (IQIs/penetrameters) and will now only allow the use of wire-type IQIs (either ASTM or ISO).

◆ The primary change to the Mechanized Welding section, which was previously called "Automatic Welding," was its renaming, and in the Procedure and Welder Qualification segment, the requirement for nick break testing was removed. The Qualification of Welders and Equipment was rewritten for clarity.

◆ In Appendix A, the following was included: "Reference imperfection sizes (a*), which fall between the crack tip opening displacement (CTOD) values of 0.005 in. to 0.010 in. can be derived with an equation illustrated in the new edition of API 1104 as opposed to the graphical extrapolation method."

◆ Appendix B improved the recommended practices for welding onto in-service pipelines. Significant revisions include clarification pertaining to discrepancies that exist between Appendix B and the main body of API 1104, the allowance of trade-offs that may be made between the carbon equivalent of the materials being welded and the thermal severity of the pipeline operating conditions without the need for procedure requalification, the revision of essential variable requirements for welder qualification and provisions for multiple qualification of an in-service welder, and additional in-service welding guidance (welding sequence, time delay prior to inspection, etc.).

Department of Transportation Use

This edition replaces the 19th edition (with 2001 errata). However, the U.S. Department of Transportation (DOT) has not yet incorporated the 20th edition into regulation by reference into the *Federal Register.* This is expected to occur within the next 6–12 months. Consult the DOT Office of Pipeline Safety Web site, *http://ops.dot.gov/*, for updates.

The 20th edition of API 1104 is 68 pages long and can be purchased through World Engineering Xchange (WEX), Ltd., at (888) 935-3464 or *www.aws.org/standards*; and Global Engineering Documents at (800) 854-7179 or *www.global.ihs.com*. Additional information is also available at *www.api.org/cat*.❖

*Based on information provided by the American Petroleum Insitute, Washington, D.C., (*www.api.org*).*

Improved Assessment of Pipeline Integrity

Recent advances in ultrasonic inspection of girth welds are key to ensuring pipeline integrity

BY JEFF STETSON

Oil and gas pipelines have always been subject to critical inspection because of the possible catastrophic effects of rupture, in terms of environmental damage, human injury, lost production revenue, and repair costs. Consequently, it has always been a prime objective of manufacturers of inspection equipment and systems to develop products that are easy to operate and provide fast, reliable, accurate results that allow rapid sentencing of pipes and weldments.

The Historical Benchmark

Pipeline girth welds were historically inspected using x-ray film — Fig. 1. This technique provided, and still provides, easy-to-interpret, two-dimensional gray scale images of the weld and, with minimal training, an operator could interpret the image and determine the relative quality of the weld. While radiography is still widely accepted, like any other technique, it does have its drawbacks and disadvantages. Specifically, radiography creates radiation hazards that require personnel to be shielded or removed from the immediate site during the actual inspection. In most cases, this involves locating the inspection several welds behind the welding crew to ensure the safety of personnel. Unfortunately, conducting inspections several welds away from the welding process increases rework if the welding process drifts out of the control standard. So, ideally, the inspection should follow each weld or be performed as close to the welding process as possible.

Furthermore, with radiography, each inspection requires relatively long cycle times to ensure adequate image resolution. This introduces a delay, which could amount to 8 to 24 welds, so that there might be a requirement for several inspection stations to meet productivity demands. In addition, this delay can also have a negative effect on the ability to react to issues of weld process control in a timely manner. As a result, there will be a need for significant rework if the process drifts from the standard.

Fig. 1 — Radiography being carried out on a pipeline.

While being a reliable, field-proven technique, it must also be borne in mind that traditional radiography creates a two-dimensional image or picture of a weld, normal to the radiation source. As a result, weld cracks oriented perpendicular to the surface are often not detectable and present a possible failure mode if unchecked. Additionally, the nature of the two-dimensional radiographic image provides little information on the depth or orientation of an anomaly making it virtually impossible to employ risk-based acceptance techniques to determine the acceptability of a weld. On the other side of the coin, perfectly acceptable welds are often rejected by inspectors reviewing x-ray films, simply because of the lack of adequate inspection data.

The Rise of Automated Ultrasonics

Technical advancements in and extensive utilization of the mechanized or "automatic" welding process over the past two decades means that this process is starting to take over from manual techniques on larger-diameter pipe. As a consequence, this change in fabrication technology has opened the door for improved inspection methodologies (Fig. 2), specifically automated ultrasonic inspection or AUT.

Automated ultrasonic inspection systems typically employ an array of individual ultrasonic probes positioned on the upstream and downstream sides of a weld, with each probe focused on specific areas of the weld volume. A mechanical drive system provides controlled motion of the complete probe array, allowing the individual probes to scan the length of the weld to provide a comprehensive volumetric ultrasonic picture of the weld or pipe wall. Typically, ultrasonic inspection data are obtained on a 1-mm scan increment and the data for each probe are presented to the operator in strip chart form. While to the untrained eye the large amount of data displayed in a strip chart can seem unwieldy, a trained operator can easily interpret inspection results in real time. Defects can then be sized and located within a three-dimensional space and fed into sentencing software to determine the real acceptability of the weld.

Fig. 2 — An early ultrasonic flaw detector for weld inspection.

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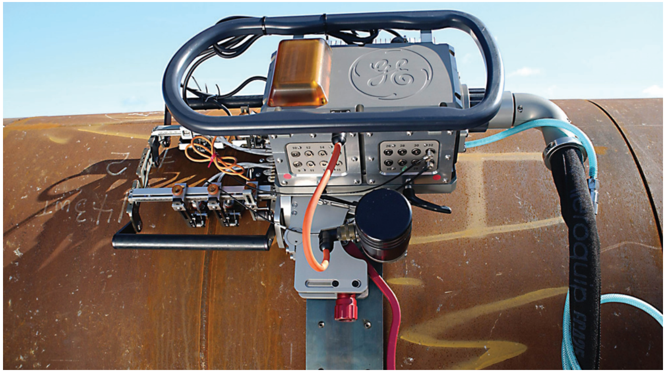

Fig. 3 — Locating all the ultrasonic electronics on the scanning head minimizes the effects of external electrical noise.

Fig. 4 — The remote computer of the Weldstar AUT system displays inspection results for real-time interpretation.

Automated ultrasonic testing has solved most of the issues associated with radiography. Benefits include the following:

- ◆ AUT does not pose a radiation hazard to personnel.
- ◆ AUT cycle times per weld, including acquisition and interpretation of data, are typically less than 4 minutes for large-diameter pipes. Girth welds can be inspected as soon as the weld is appropriately quenched providing near real-time process feedback to the weld crew and dramatically reducing the cost of rework.
- ◆ AUT provides a tremendous amount of data, allowing accurate sizing and location of defects, and facilitating the use of alternative acceptance criteria. For example, techniques such as engineering critical assessment (ECA) reduce repair rates and speed up production, while maintaining weld integrity and providing overall cost savings to a project.

Advancements in AUT

While the benefits of AUT for pipeline girth weld inspection are well documented, AUT does have areas that can be improved.

Historically, one particular area of concern has related to the sensitivity of high technology electronics to electrical noise. Welding equipment, overhead power lines, and other high-power electronics can generate electrical noise. Electrical noise overlaid on an ultrasonic channel can dramatically affect data integrity and, in some cases, completely mask the ultrasonic reflection from a defect, rendering the AUT system ineffective. Over the last several years, advancements in electronics and computers have benefited all inspection methods, especially AUT. State-of-the-art AUT systems, like GE's new Weldstar, are now engineered to minimize electromagnetic interference. Unlike older systems, where the ultrasonic signals must travel on long umbilicals between the remote ultrasonic electronics and the scanner head, all ultrasonic electronics on Weldstar are located on the scanner head — Fig. 3. This dramatically improves overall system performance by preventing outside electrical noise from impacting the quality of the inspection.

Another area of significant technical advance has been in the introduction of phased array probes to reduce the complexity of system design. Until relatively recently, AUT systems were built with numerous channels of conventional ultrasonics. Such systems are optimized using a variety of techniques to provide excellent inspection quality. The only drawback to this architecture is that each ultrasonic channel typically requires an individual ultrasonic probe, making the probe arrays somewhat large and unwieldy, especially for complex inspections that can require 30 or more probes to provide adequate weld coverage. Several years ago, phased array ultrasonics was introduced to AUT with the intention of simplifying probe arrays. In theory, phased array ultrasonics should allow a pair of probes to replace a complete array of conventional probes on an AUT scanner and, to a large extent, this is precisely the case. However, specific critical ultrasonic shots require conventional probes for a proper girth weld inspection. Specifically, these are those required for time of flight diffraction (TOFD) and transverse defect detection and for high refracted angle shots, such as are required to inspect the LCP. Recognizing the benefits of both conventional and phased array ultrasonics, today's state-of-the-art AUT system includes both techniques in a common, hybrid inspection tool. Consequently, the same system can fire both phased array and conventional shots during a scan, leveraging the advantages of each technique to ensure maximum inspection integrity — Fig. 4.

As mentioned earlier, the Achilles heel of AUT hardware has always been a functionally simple part of the system — the umbilical cable connecting the scanner to the control electronics. This was again the case in the development of earlier phased array-based AUT systems. Formerly, because of the size of the phased array electronics, the phased array instrumentation had to be packaged remotely from the scanner head. Consequently, in addition to power and control lines, a separate coaxial cable for each individual ultrasonic channel needed to be packed into the umbilical cable. For 128-channel phased array systems, this meant 128 coaxial cables. Eventually, umbilicals became large, unreliable, and expensive to repair and replace. The latest generation of AUT systems takes advantage of the evolution of electrical packaging techniques and all 16 conventional ultrasonic channels and 128 phased array ultrasonic channels are now packaged within the scanner head itself. The umbilical cable contains only the wiring necessary to provide power, control, and communication with the scanner head; the net result is umbilical simplicity and reliability and enhanced system performance.

Conclusions

Oil and natural gas exploration and the resultant pipeline infrastructure are increasingly being accomplished in remote areas of the world with demanding environments. New pipelines are planned for some of the harshest environments on earth — from offshore deep water installations to pipelines in the arctic tundra. These pipelines will be subjected to stresses rarely experienced in the past. The highest quality construction materials and manufacturing processes will be used for these pipelines, and the methods and tools employed to inspect them must be infallible. Traditional radiography and older generation AUT may not be up to the task, but new state-of-the-art systems will be.❖

Alternative Acceptance Criteria for Pipeline Girth Welds

An overview is provided of API 1104, Appendix A, which can be used to evaluate weld imperfections using alternative acceptance criteria

BY STEVEN T. SNYDER

Weld acceptance criteria for pipeline girth weld volumetric nondestructive testing and inspection is provided in Section 9 of API 1104, *Welding of Pipelines and Related Facilities* (Ref. 1). Like most AWS and ASME codes, it is primarily based upon workmanship criteria, with the primary importance placed on the discontinuity/imperfection length. The appendix is used to calculate alternative acceptance criteria for NDE, different from the standard workmanship criteria used in most all industry.

The use of Appendix A for more critical applications does not prevent use of the API 1104 Section 9 requirements for determining acceptance criteria for welds. Instead, the Appendix presents the minimum requirements to facilitate use of an "alternative acceptance criteria." The purpose of the Appendix is to define, on the basis of technical analyses, such as fracture mechanics analysis or fitness-for-service criteria, the effect of various types, sizes, and shapes of weld anomalies, discontinuities, or imperfections for the suitability of a specific critical weld joint design and qualified procedure for a specific service. Use of the Appendix for the evaluation of any and all weld imperfections is completely at a company's discretion. Appendix A covers only circumferential welds between pipes of equal nominal wall thicknesses. Other limitations include, but are not limited to, welds subjected to applied axial strains of more than 0.5%. Fabrication of steel centenary risers (SCRs) used extensively in the oil and gas industry is an example of where this alternative acceptance criteria has or may have been applied by qualified NDE personnel with the appropriate experience to apply alternative acceptance criteria.

Considerations

Welding Procedure Qualifications

The qualification of welding procedures to be utilized when Appendix A is invoked shall be in accordance with API 1104 Sections 5 or 12 and per Section A.3.1 of the Appendix, which also imposes exceptions and/or additional requirements that any responsible company's welding engineer/management and NDE personnel must consider through front end engineering design review.

Of primary consideration is the crack tip opening displacement (CTOD) test results that are to be performed in accordance with A.3.3, which states "it is to be performed per BS 7448: Part 2 (Ref. 2) as supplemented by this Appendix." The CTOD testing determines the material/weld fracture toughness. According to Appendix A, the CTOD values can be 0.0005 or 0.010 in. or a value somewhere in between.

Determining these values for a project is typically accomplished by a limited number of qualified destructive testing companies. Test specimens from the base metal, weld metal, and heat-affected zones, which have preinduced fatigue cracks, are placed in a test fixture. The rate of crack growth and displacement from the adapted clip gauge are then monitored. Section A.3.2 of the Appendix provides further detail and guidance.

The CTOD values obtained for each welding procedure qualified must include, from the weld metal and heat-affected zone, three specimens each with acceptable results at or below the lowest anticipated service temperature (refer to A.3.3 in the appendix for further details). This WPS qualification CTOD value, along with the strain value, becomes the basis for determination/calculation of the welding NDE alternative acceptance criteria to be utilized for the specific project. The company must perform a stress analysis to determine the maximum axial design stresses for the pipeline.

Typical NDE Acceptance Criteria Applied to Pipeline Girth Welds

Workmanship. Does not consider the effects of discontinuities or defects on the probability of failures. These criteria are conservative and primarily were developed to monitor and observe the welder's performance rather than the overall weld integrity.

Fracture mechanics, engineering critical assessments (ECAs), and fitness for service (FSS). These are all based upon the actual applied stress(es), measured material properties, and use of calculations to determine the actual flaw size that would cause a failure. The maximum allowable flaw size is defined, with an appropriate design safety factor also considered and factored in, which is what Appendix A facilitates.

One observation that seemingly could provide better clarification in the current Appendix A is that Section A.3.2, Fracture Toughness Testing, does state "for the purpose of the Appendix, the minimum fracture toughness can be 0.005 in. or 0.010 in. or a value between these two values"; however, Table A-1, Acceptance Limits for Buried Volumetric Imperfections, clearly states in the Notes: "The simplified limits given in this table may be applied for minimum CTOD levels of either 0.005 in. or 0.010 in. with Table A-3 of Appendix A, i.e., 'Imperfection Length Limits' stating the same requirement." Which means it does not state "or a value between these two values" when one when one would need to consider the use of this table.

Applying Acceptance Criteria Using Appendix A

As noted, Table A-1 of Appendix A provides alternative accep-

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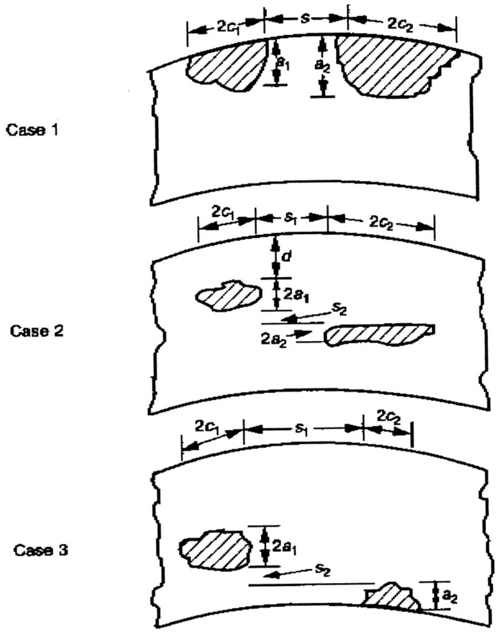

Interaction exists if	If interaction exists, effective imperfection size is
$s < c_1 + c_2$	$a_a = a_2$ $2c_a = 2c_1 + s + 2c_2$
$s_1 < c_1 + c_2$ and $s_2 < a_1 + a_2$	$2a_a = 2a_1 + s_2 + 2a_2$ $2c_a + 2c_1 + s_1 + 2c_2$
$s_1 < c_1 + c_2$ and $s_2 < a_1 + a_2/2$	$a_a = 2a_1 + s_2 + a_2$ $2c_a = 2c_1 + s_1 + 2c_2$

Fig. 1 — Length and vertical extent for evaluation of imperfection interactions from three cases in API 1104. Note the uniformity of nomenclature. All lengths are assigned a value of 2c, all surface-breaking flaw heights are assigned a value of a, and all embedded flaws are indicated as 2a. Spaces between flaws are indicated by s and the distance from the tip of the flaw to the nearest surface is d.

tance criteria limits for buried volumetric imperfections, using the simplified limits to be applied for CTOD values within the ranges previously stated, i.e., either 0.005 or 0.010 in.

API 1104 does make provision for the use of both NDE methods, radiographic testing (RT) or automated ultrasonic testing (AUT). AUT seems to treat porosity as a planar flaw in Appendix A, i.e., Table A-1, A5.1 (for ECA style criteria); however, no provision is made in paragraph 9.6.2 of API 1104. Therefore, it would seem to require assessment of some items not possible to reliably characterize when utilizing AUT vs. radiography, i.e., for cluster pores and single pore sizes. This could be considered unfortunate as it does impose the notion that AUT is to look like radiography in these regards (Ref. 3). Consider that many codes expect manual UT and/or AUT to duplicate standard radiographic interpretations, which is not considered a reasonable expectation or insinuation. Although conventional radiography may well be adequate for measuring an imperfection's length, it is substantially insufficient for determining an imperfection's height or discontinuity sizing, particularly for planar discontinuities or cracks, incomplete fusion, and some types of incomplete penetration. Consider that API 1104 requires that the accuracy of the NDE sizing technique be established, but provides no guidance in this regard. It is believed that the current requirements of A.5 in Appendix A can be satisfied by use of automated ultrasonic testing utilizing zonal discrimination techniques (Ref. 4), in which the weld bevel is actually divided into zones for AUT examination accordingly, per the AUT qualified testing procedure.

Appendix A addresses the inspection and acceptable limits for these planar and volumetric imperfections in Sections A.5 and A.5.2. The length and height of an imperfection, and its depth below the surface as well as imperfection interaction relations (proximity of one flaw to another) must also be considered.

Calculations for applying alternative acceptance criteria are illustrated in Appendix A Section A.7.1–A.7.9. The API 1104 appendix has one set of calculations for fractures based solely on brittle fracture.

Sample parameters for calculations utilizing API 1104 Appendix A:

Parameters:

Pipe diameter	30.0 in.
Wall thickness	0.577 in.
Crack tip opening displacement attained	0.01 in.
Maximum applied strain	0.002 (100% yield) (inches per inch)
Examination error	0.05 in. (flaw height measurements)

First, see Fig. 1, the length of the surface flaws: the separation "s" must be greater than the average of the two flaw lengths to avoid interaction. For example, 2_{c1} = 12.5 mm so 2_{c2} = 6.25 mm. $c_1 + c_2$ = 6.25 mm. 12.5 mm is the required minimum separation. Otherwise the flaws interact if less than 12.5 mm apart. For subsurface flaws, the rules for length are the same.

For height, two buried flaws 2.3 mm high each, we can look at case 2. A subsurface flaw has a height 2_{a1}, so 2_{a2} = 2.3 mm, for example, if buried. Vertical separation must be less than the average of the two flaws' heights, i.e., $s < a_1 + a_2$ causes interaction. If "a" is 1.15 mm, then they must be separated by 2.3 mm vertically, otherwise interaction occurs. If one of the flaws is surface and the other subsurface, case 3 states that for interactions $< a_1 + (a_2)/2$, which is essentially the same as case 2 since the surface flaw total vertical dimension is "a" (not 2a as it is for subsurface flaws).

For API 1104 Appendix A interaction consideration, we can summarize by stating that a separation of two flaws by less than the average length or height of those flaws (as appropriate) constitutes interaction (see also API 1104 Fig. A-6, Criteria for Evaluation of Imperfection Interaction).

Conclusions

The requirements presented in this overview of API 1104 Appendix A are considered optional, and the requirement to utilize Appendix A when API 1104 is specified as the construction code must be agreed upon by the buyer and purchaser. The appendix may appear to not provide for a user-friendly approach; rarely would most AWS CWIs ever be exposed to the requirements of this appendix in the API 1104. This article may be used to gain a basic understanding of the appendix and its application upon review. Of course, radiographers and/or automated ultrasonic testing personnel would be exposed to the determined acceptance criteria of this appendix or be required to use the simplified limits stated on a more frequent basis as part of an approved NDE operating procedure.❖

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Exam:
Nov. 11

Louisville, KY
Seminar:
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Exam:
Nov. 18

Long Beach, CA
Seminar:
Jan. 29-Feb. 2
Exam:
Feb. 3

Indianapolis, IN
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Mar. 31

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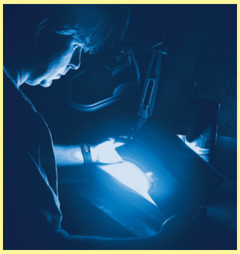

The AWS Radiographic Interpreter training and certification program assures employers and practitioners alike that the principles of radiographic interpretation are reliably applied to the examination of welds. If your job responsibilities include reading and interpretation of weld radiographs, this program is for you. You'll learn proper film exposure, correct selection of penetrameters, characterization of indications, and use of acceptance criteria as expressed in the AWS, API and ASME codes.

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Tube Inspection and Measurement with Ultrasonic EMAT

Electromagnetic acoustic transducer systems can handle high temperatures, rough surfaces, and fast scanning with increased reliability

BY BORJA LOPEZ

For years, manufacturers and customers have designed sophisticated couplant delivery systems and immersion tanks to permit inspection and measurement of pipes and tubes using ultrasonic piezoelectric transducers. The ability to provide safe and reliable volumetric inspection and measurement has been a strong incentive to overcome the challenge of integrating couplant-dependant ultrasonic systems in automated, industrial environments.

Electromagnetic acoustic transducer (EMAT) technology was developed in the 1980s as a noncontact, dry-inspection alternative to piezoelectric transducers. Initially confined to laboratories and high-end applications, it has experienced growing popularity with the advent of more powerful equipment and greater understanding of its capabilities.

An EMAT consists of a magnet and a coil of wire and relies on electromagnetic acoustic interaction for elastic wave generation. Using Lorentz forces and magnetostriction, the EMAT and the metal test surface interact to generate an acoustic wave within the material. Figure 1 compares generation of ultrasound with piezoelectric and EMAT transducers.

EMATs have all the benefits of ultrasonic testing (UT), but because the sound is generated in the part inspected, they enjoy the following advantages:

- Dry inspection (no couplant). Not having couplant permits more reliable readings (no couplant errors) and makes this technology easier to automate and integrate in production. High inspection speeds and the ability to inspect materials up to 1200°F are also a fundamental advantage of EMATs.
- Insensitive to surface conditions. EMATs are not sensitive to oxides, oil, water, or uneven surfaces and can inspect through thin coatings of material.
- Easier probe deployment. EMATs are not affected by the angle of incidence of the probe, and they can be made flexible to adapt to undulations and different contours.
- Unique wave modes. Because they do not depend on liquid to transmit the sound, EMATs can generate any type of wave mode including horizontally polarized shear energy (SH). Shear horizontal energy does not mode convert when striking surfaces that are parallel to the direction of polarization. This is key to inspecting austenitic welds and other materials with dendritic grain structures (e.g., some stainless steels). Other types of waves that can be easily generated with EMATs are guided or plate waves (Lamb or SH at 90 deg), available on materials up to 0.5 in. (13 mm) in thickness.

The main disadvantage of EMAT is the low efficiency of the transducer, which requires high power and very precise electronic designs to generate and detect the signals. This disadvantage has become less relevant with new hardware and software tools that permit complex signal processing in real time.

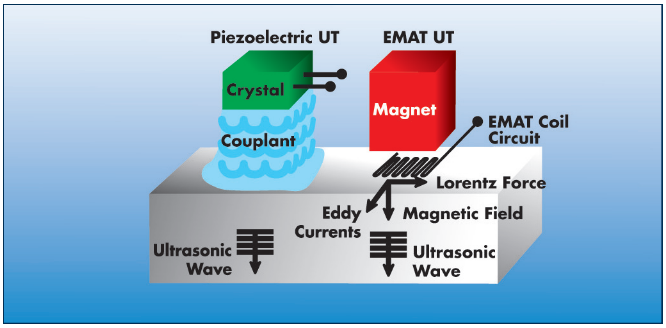

Fig. 1 — Comparison of piezoelectric UT to EMAT UT.

Fig. 2 — A probe for in-line inspection at 1200°F.

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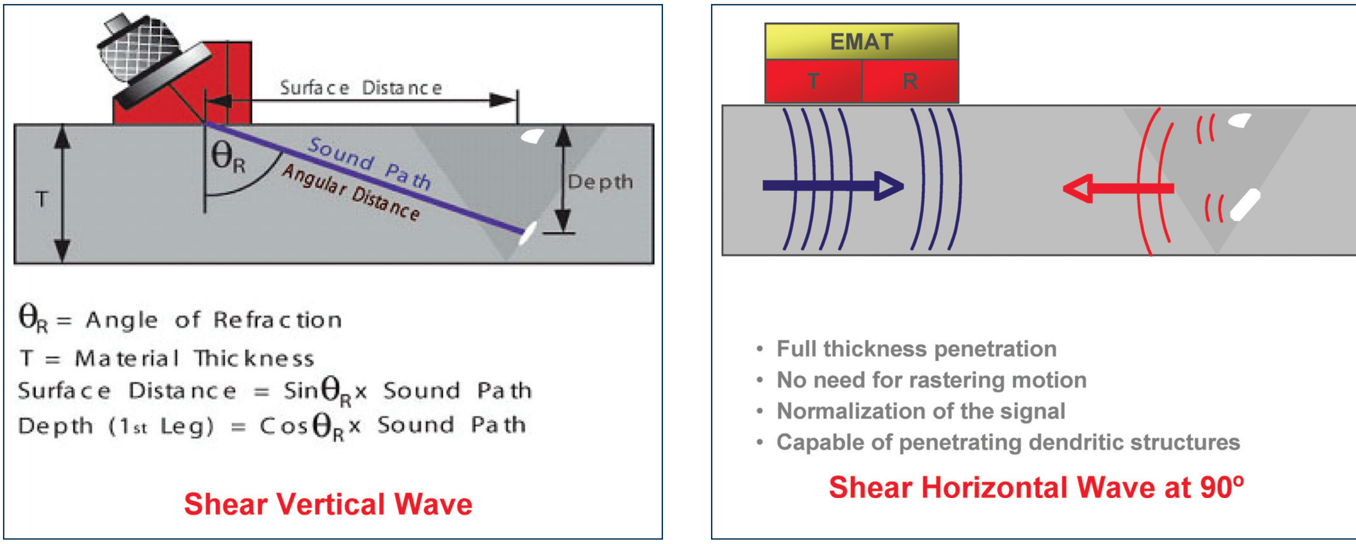

Fig. 3 — Shear vertical vs. shear horizontal guided waves.

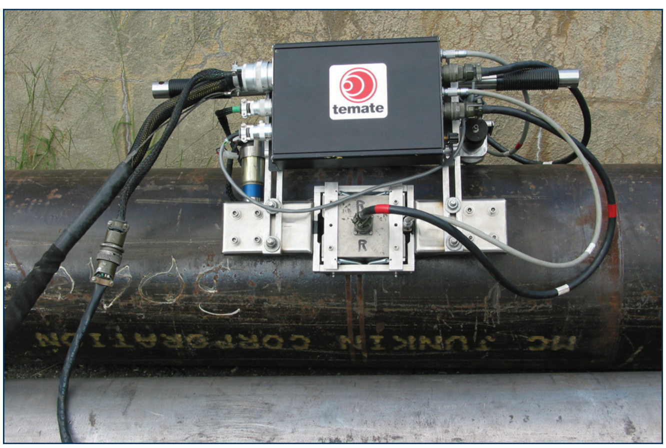

Fig. 4 — The temate® Ti-P sensor detects cracks, pitting, and wall loss due to corrosion on pipelines in the field.

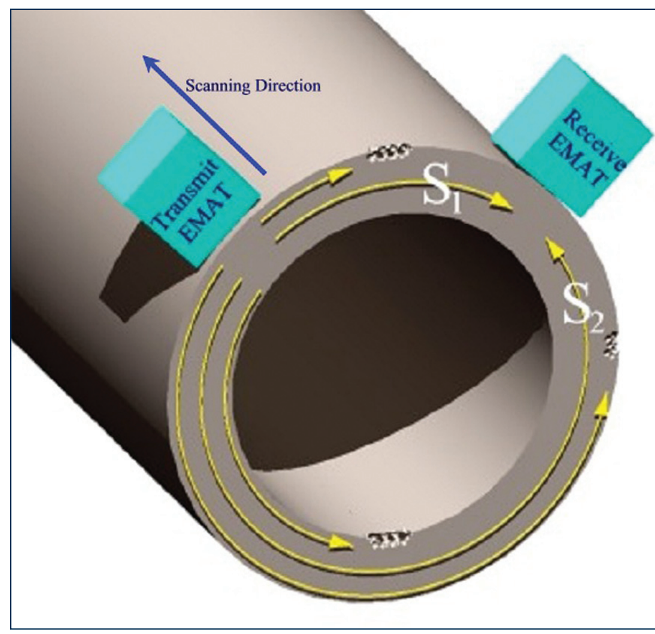

Fig. 5 — Axial scanning.

Tube Inspection and Measurement with EMAT

EMAT systems have already been installed in industrial plants around the world for the following applications:

◆ Thickness measurement.
◆ Longitudinal and girth weld inspection.
◆ Full volume inspection.

Thickness Measurement

Ultrasonic meters are widely popular for measuring thickness in tubes because of their ability to provide accurate measurements from one wall. However, inspection of tubes at high temperatures and with rough surfaces (e.g., cast iron pipes) have been out of reach for conventional piezoelectric transducers.

New EMAT systems have been implemented successfully to measure materials up to 1200°F. The EMAT transducer stands 0.040–0.100 in. (1 to 2.5 mm) from the material to permit airflow and avoid overheating. Figure 2 shows an EMAT probe with integrated electronics and air cooling for in-line inspection at high temperatures.

Weld Inspection

Electromagnetic acoustic transducers provide many advantages over conventional UT for weld inspection. The shear wave is most commonly used for ultrasonic weld inspection. Shear vertical (SV) and shear horizontal (SH) both have particle vibrations perpendicular to the wave direction — Fig. 3. Conventional ultrasonic inspection utilizes the SV wave, with an angle of between 30 and 60 deg from the normal beam. Maintaining the position of the probe is critical to obtaining an accurate inspection. A limitation of SV waves in weld inspection is the inability to cover the full vertical volume of the material. At some points, defects may even limit complete inspection.

On the other hand, shear horizontal energy can be extremely useful for weld inspection in two ways.

1. Shear horizontal waves do not mode convert (change direction, speed, and motion) when striking surfaces that are parallel to the direction of polarization. This is especially relevant when examining austenitic welds and materials with den-

dritic grain structures (e.g., certain stainless steels).

2. At 90 deg, shear horizontal energy becomes a guided wave that fills up the full volume of the material and permits inspection of the full cross section of the weld. The advantages of using SH waves at 90 deg for weld inspection include the following:

- ◆ SH waves fill the volume of the material independent of thickness enabling inspection of the entire weld.
- ◆ No "rastering" motion or "phased array" of sensors is necessary for inspection resulting in space-efficient inspection equipment.
- ◆ Separate transmitter and receiver permits normalization of the signal for self-calibration, guaranteeing maximum reliability.
- ◆ Less sensitivity to probe positioning during inspection contributes to ease of automation and integration into production.
- ◆ Minimize root and crown spurious reflections by selecting the appropriate wave mode.

Guided wave EMAT systems have been successfully implemented for in-line inspection on many types of automated welding lines, including resistance, submerged arc, laser beam, and electron beam welding machines.

Full Volume Inspection

The unique contribution of EMAT to volumetric inspection of tubes derives from its ability to generate guided waves (shear horizontal at 90 deg and Lamb). Guided or plate waves can travel from a few millimeters to tens of meters constrained within the boundaries of the material where they are generated. Guided waves are effective on plates up to 0.5 in. (13 mm) in thickness.

The advantages of guided waves in tube inspection are as follows:

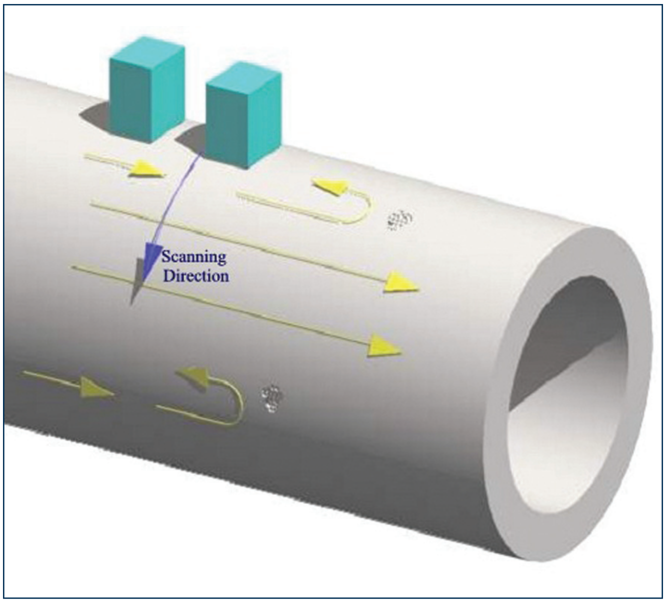

Fig. 6 — Circumferential scanning.

- ◆ Ability to cover large areas of material with one transducer.
- ◆ Permit inspection of inaccessible areas.
- ◆ Detect certain defects that are not visible with other wave modes.

An example of how the three advantages are met in a unique application is the temate® Ti-P system for inspection of pipelines while in service — Fig. 4. This automatic inspection system is designed for detection of cracks, pitting, and wall loss due to corrosion on pipelines in the field. It has two main modes of operation:

- ◆ Axial scanning (Fig. 5). The pitch-catch sensor configuration (separate transmitter and receiver) sends ultrasonic guided waves around the pipe circumference. Defects such as cracks, pits, and wall loss provide attenuation of sound and/or phase shift due to time-of-flight change. The system provides 100% volumetric pipe inspection at high speeds by moving the sensors axially along the pipe. Different wave modes can be used to provide differentiation of different types of defects.
- ◆ Circumferential scanning (Fig. 6). The sensors are arranged along the pipe in a pitch-catch configuration to send and receive ultrasound down the length of the pipe up to 3 ft (1 m) in either direction (selected electronically). This technique is especially useful for inspection of pipeline supports and air-to-ground interfaces to detect cracks, pits, and wall loss.

Conclusion

Created as a noncontact, dry alternative to piezoelectric transducers, ultrasonic EMAT systems are no longer limited to laboratories and high-end applications, and are now widely used in industrial environments and in-service operations.

The ability of EMAT systems to provide volumetric ultrasonic inspection without the inconvenience and problems associated with a liquid couplant, and the capability to easily generate guided waves make it the technique of choice for demanding applications where speed, reliability, and quality of readings are paramount to the success of the inspection. ❖

Reader Comments on CWI 'Endorsements'

I am a long-time AWS member and a current AWS SCWI. My purpose here is to draw attention to a change of policy by the AWS with regard to the AWS CWI program. Many of the parties who may be interested in this policy change (such as representatives of certain industry groups, specification-writing bodies, employers of CWIs, and of course CWIs themselves) are likely not yet aware of the changes taking place in the AWS CWI program. I myself was only informed of this change recently because my AWS SCWI certification was nearing expiration, and AWS sent me the recertification package, part of which detailed the policy change regarding the AWS CWI program.

The policy change to which I am referring (though it has not been clearly called a policy change by AWS) is AWS's new plan to offer additional codebook examinations as an "endorsement" to a CWI's certification documents. This is permitted by the recently issued revision to the AWS publication, QC1:2006, *Standard for AWS Certification of Welding Inspectors*, which is the governing standard for that program.

Of all of the various changes in the 2006 edition of QC1, the one change that is potentially controversial because it is in effect a change to an AWS policy that has stood for over 30 years is the aforementioned plan to offer codebook examinations as "endorsements." Why is this a policy change? Because for the past 30 years, AWS has been stating by the granting of certifications that the AWS policy is that if an inspector can read and interpret one code, then the inspector possesses the skill to read and interpret any code. AWS determines if the inspector in question possesses the skill to read and interpret a code by the administration of a codebook exam during the CWI test (and to a lesser degree by the administration of the practical exam during the CWI test, for which the candidate must use and interpret the AWS-supplied specification).

Additionally, this policy is actually written in certain AWS publications. For example, in the AWS publication, *Welding Inspection Technology* (4th edition, 2000), on pages 1–12 of Module 1 where it describes the CWI program, it states "the CWI certificate does not state what code the inspector used on the examination. A CWI is qualified to use and interpret any welding code or standard." Another example, the PowerPoint® presentations that AWS furnishes to the instructors who lead the CWI seminars make similar statements. Even AWS's latest CWI brochure (available at *www.aws.org/certification/certed2006.pdf*) reinforces this standpoint when at the description of the D1.1 Code Clinic it trumpets "as a leading construction code, D1.1 is the ideal tool to teach effective code use."

This policy now appears to have been changed. The 2006 edition of QC1 defines the term endorsement as "approval of an additional skill documented in writing, and added to a certification credential." Note that the definition clearly states "additional skill." If AWS now starts giving endorsements for codebook examinations, then according to the QC1 definition of the term endorsement, AWS is effectively stating that this is an additional skill. This is to all intents and purposes a policy shift by AWS to the position that a CWI does not possess the skill to read and interpret a code unless specifically tested on that code. The plan to issue endorsements for such skills as radiographic interpretation is not at issue. By the QC1 definition of the term endorsement, radiographic interpretation (for example) is not a skill that the CWI has been determined to possess by way of the CWI test. Radiographic interpretation would be an "additional" skill, and therefore an endorsement could be appropriate. The problem is strictly with the plan for codebook test endorsements, which is not an additional skill.

What Is Driving This Change?

From what I have been able to gather, there seem to be a number of things driving this whole codebook endorsement thing. These include:

- A perception that it is wanted by certain industry segments;
- A belief that it will help to eliminate the thorny problem of the existence of CWIs who do not have the necessary skills (apparently there have been a number of complaints against CWIs regarding code interpretation);
- A belief that it will add value to the CWI certification;
- Increased revenue.

It may well be that certain industry groups would like verification that a particular CWI has taken a codebook test on their particular code of interest, and that would seem like a need or request that AWS can help with. However, let's analyze this for a moment. If an industry segment asks for this, what they are in effect asking for is some form of additional assurance of competence of each individual CWI that may work in their industry. The new plan to issue codebook endorsements does nothing to satisfy that need, whether real or perceived. How can I make that statement? Think about the following:

Even if an individual has taken the codebook test portion of the CWI examination using the codebook of interest to our supposed industry segment, all that is required to pass this test is a score of 72%. I think we all would agree that if we got our day-to-day codebook issues right only 72% of the time, we wouldn't be in business long. Additionally, a CWI can renew his/her certification indefinitely without having to ever retake a codebook test. Can anybody honestly think that a codebook endorsement (let's even presume a score of 100 was obtained, even though that information would not show up on the endorsement) that states that a CWI took the codebook portion of the test using the codebook of interest to our supposed industry segment provides any value at all 8 or 10 or 14 or 20 years later? If there is no assurance that the CWI has been using the code of interest in the meanwhile, what value does that 14-year-old "endorsement" provide? The answer is none.

Regarding the belief that this will add value to the CWI certification, I just cannot buy into that. The entire time in my career in which I have been a CWI or an SCWI, the position of AWS (up until now) is that I possessed the skill (proven by testing) of being able to read and use a code or other standard. How can having this taken away from my certification add value to my certification? Quite the contrary, the first time AWS indicates on some CWI's wallet card which code was used during the CWI test, they will in effect be downgrading my and every other CWI's certification. They will be stating that a CWI is only good for the code listed.

Though on the date I write this I can no longer find it on the AWS Web site, previously the codebook endorsement was being publicized as a means of satisfying the nine-year recertification requirements. This may be perceived by certain individual CWIs as value-added (though to me it seems more like sugar coating), but it would do nothing to lessen the problem detailed in the above example. A CWI tests to D1.1 in year 1, at year 9

The opinions expressed herein are those of the authors and not those of the American Welding Society.

gets "endorsement" for D1.5, at year 18 gets "endorsement" for API 1104 — at year 25 what is the value of that D1.5 endorsement received 16 years before? I can only hope that the fact that I no longer find this particular bit of information on the AWS Web site means that those responsible for this are having another long, hard look at it.

For those CWIs who pay for and maintain their own certifications, and there are many, this cannot be perceived as value added. They already have large time and financial burdens to bear because many must maintain multiple certifications (NDT, Special Inspector, state and/or local certifications, etc.) in order to work in their fields. This would only add to their certification costs. The same holds true for those organizations, such as testing labs, that serve many industries. They cannot view as positive the possibility of having to pay for their CWIs to test to numerous codes.

This sort of initiative could possibly increase revenue for AWS. That is good, as the certification program is the number one revenue generator for AWS and those revenues are used to further the art and science of welding, which benefits us all. However, a certification program that does not serve a clear industry need is destined to fail, and failure could actually hurt revenues. There will certainly be a number of CWIs who will say, "Enough is enough!" People are willing to pay a fair price for a credential that certifies they have additional skills and knowledge to offer, but they will quickly see through having to pay extra for something that up until now they already possessed.

Are There Any Alternatives to This Plan?

There are a number of ways that the issue of CWI code reading competence could be more effectively addressed than does the new "endorsement" plan. Fundamental to any solution is for all parties to understand that AWS will never be able to certify the total competence of an individual, no matter how many tests they give. The CWI test has to be viewed in much the same way as a welder's performance qualification test. All it does is indicate if a person has the necessary skills to be able to do a particular job — it does not indicate that a person will indeed satisfactorily perform the required duties every day. It is the employer's responsibility to ensure that an individual is able to and does perform satisfactorily.

QC1 is very well written with regard to the employer's responsibilities. Paragraphs 1.3, 1.4, and 1.5 of the 2006 edition (available for free download on the AWS Web site at *www.aws.org/certification/CWI/certqc1-06.pdf*) are very clear on this. Taken together, these paragraphs state, "In the certification process, AWS conducts an examination to determine a person's general knowledge of welding inspection and related technical areas. No determination is made of an individual's capabilities in applying that knowledge within a specific work environment or under actual working conditions. It shall be the responsibility of the employer to determine that the SCWI/CWI/CAWI is capable of performing the duties involved in his/her particular welding inspection assignment. This standard is intended to supplement the requirements of an employer, code, or other documents and shall not be construed as a preemption of the employer's responsibility for the work or for the performance of the work." I cannot imagine that this could be written any clearer.

So if we have the following givens:

- There is a perceived problem with the performance of some CWIs with regard to codebook reading skills;
- AWS is attempting to address this problem, which indicates that individual employers are not living up to their responsibilities as outlined in QC1, and;
- Codebook endorsements will not solve this problem.

Then what are some possible alternatives? First of all, the qualification requirements for CWI could be tightened up. What passes for the required initial welding-related experience can be pretty broad. If you are the guy who delivers welding electrodes for the local distributor, you likely have the minimum qualifications to take the CWI test. The second thing that could be done would be to require some sort of additional "maintenance" of the inspector's certification, over and above what is required now. Currently, a CWI simply has to document two years of welding-related employment in a three-year period. This could also be tightened up to something similar to what The Welding Institute requires for its CSWIP program. Additional documentation that provides proof of continuing welding inspection-related experience would be necessary, and it would have the added benefit of making the employer document that they are fulfilling their QC1 responsibilities.

The additional codebook examination idea does not need to be scrapped. What does need to happen is that it not be tied in with QC1, and that it not be considered an "endorsement." In fact, divorcing it from QC1 would have the benefit of opening it up for anybody to take the exam. This could conceivably evolve into AWS offering an independent third-party service that verifies if an individual can properly interpret any particular code or standard. If I am a structural steel design firm, it may well benefit me to have my design engineers take an AWS test on the D1.1 Code. Divorcing it from QC1 would give AWS the flexibility to be able to tailor codebook exams for many different possible end users, not just welding inspectors. This would certainly have a net positive effect on revenues — additional tests, additional seminars, etc. — and could well be more lucrative than codebook "endorsement" tests that are tied to QC1 and therefore limited to welding inspectors.

To sum up, I disagree with the recent policy change in the AWS CWI program, specifically the plan to issue "endorsements" for additional codebook tests. As I have described, the details of this new plan do not appear to have been completely thought through as the new plan, as conceived, will not solve any perceived need and will also effectively downgrade the certifications of all CWIs.

I would like to emphasize that I am definitely not trying to disparage the work done on this issue by those volunteers of the various involved AWS committees. As a member of one of the AWS technical committees, I am well aware of the hard work and commitment that these professionals have given this. I do feel though that with a bit more work, some useful solutions can surely be found that will satisfy the needs of all interested parties. My hope is that this open letter to the editor of *Inspection Trends* will help to make all of the possible stakeholders in the AWS CWI program aware of what changes will soon be taking place, such that they can better inform themselves and voice their positions on this important matter.

Clifford Mankenberg
AWS member and Senior Certified Welding Inspector

Responses from AWS Certification Committee Members

I read Mr. Mankenberg's comments with a great deal of interest, and I wanted to respond to a few of his major issues. I am a member of the Certification Committee, and I remember the heated discussion that took place when we came out with another change in QC-1-96, the SCWI. There were complaints about how this would *downgrade CWIs, but it didn't, and today many of the people who complained are SCWIs. So, let's move on to current issues.*

First, I would like to say that CWIs are **not** *qualified to interpret any codes; and I do not believe that AWS policy or the Board of Directors would suggest that due to the liability of such a statement. In fact, codes in this country are legal documents and can only be interpreted by the committees that write them. The welding code committees that most CWIs are familiar with are ASME and AWS D1. Both of these committees publish interpretation documents and have a formal inquiry process for public request for interpretation. I believe what the writer is trying to say is that CWIs have demonstrated by their open book standard exam their ability to* **use** *and* **apply** *a selected code for the purpose of performing visual weld inspection in accordance with their capabilities as stated in AWS B5.1, Table 1, and that they have been certified by AWS QC-1 to do this task. If more specific knowledge of the code is required, then it is normally the responsibility of the employer to provide additional training for the CWI.*

But, as the writer correctly pointed out, the Welding Inspection Technology *(WIT) documents and PowerPoint® presentation revised in 2000, which a private subcontractor wrote, did in fact make the statement "that a CWI is qualified to use and* **interpret any codes** *or standard." As I pointed out in the previous paragraph, this is neither AWS policy nor the position of the Certification Committee. This statement will be corrected in the* WIT, *which is currently being revised. It is unfortunate that when training documents are not proofread carefully, or required to be approved by committee, personal opinion can find its way into the documents without notice. Incidentally, there is a disclaimer in the beginning of all AWS training documents stating, "AWS cannot guarantee that it is error free."*

The writer is also correct in stating that the CWI card has never stated codebook exams, and I do not believe that this administrative practice will change in the near future.

The format that AWS staff is developing to document a supplemental standards exam will be a separate card where other endorsements like the RI and the ACCP VT will be recorded. As the writer pointed out, taking a Standards Exam today to a current edition will not demonstrate in years to come that the CWI has kept current. These exams are not designed to qualify any level of competency beyond that demonstrated in successfully passing an exam, at a given period of time, which required preparation training and enough knowledge of the code to pass a test. On one of my recent CWI jobs, the customer's verification inspector did not ask which D1.1 Code edition I tested on, he simply wanted to know if I had used the Structural Code *on my CWI exam. The industry apparently recognizes and accepts the open book exams as one substitute for an employer's responsibility to train and prepare CWIs to work with standards, even if we argue the point.*

Today we are experiencing changes as CWIs. There are more frequent requests where a particular job, organization, or agency is requiring that a CWI be used who has taken a particular open book standards exam. This may exclude some CWIs from working on these jobs. Under the old QC-1, there was no allowance for taking an additional standards exam, but now you can. I understand that many of us do not like to see this code-specific trend, but it is not our choice when a customer requires a specific code exam for CWIs to work a job. In fact, it happened to me personally twice this year on a structural steel project. Since I work as an independent CWI, and I have no "employer" to provide me with training to demonstrate my familiarity with the required code being used on this job, I had to show one customer my old test score report to prove that I had used AWS D1.1 on my exam, and the other verification inspector who knew me, accepted my word that I had taken the AWS D1.1 Exam. Without that I would have lost this $50 per hour job.

AWS will develop additional code and standards workshops, and, incidentally, the writer's suggestion of opening these up to any interested party is an excellent idea, which I am sure AWS will consider. Currently some people who now take the CWI/WIT prep course have no intention of taking the exam, but simply want to know more about welding and inspection. I have a few such people in most of the seminars that I teach.

So, in summary, changes are occurring as the CWI program matures and industry becomes more "specifically oriented." AWS cannot afford to allow our past dominance as a certifying body of welding inspectors to become diluted by other competitive organizations that now offer specialized endorsements and additional code exams. Expanded options must be made available through AWS to enable its CWIs to be competitive with other welding inspectors certified by the CWB, API, SSI, and ACCP VT to mention a few. And, finally, I would like to invite anyone interested to attend our open Certification Committee meetings, especially if you are interested in greater Certification Committee involvement. We are currently looking for new members who have an interest in contributing on one of our many new subcommittee projects and feel they can attend meetings regularly.

Bob Wiswesser
Chair, AWS Certification Committee
Senior Certified Welding Inspector

I have not met Kip Mankenberg, but I have communicated with him on several occasions. He's knowledgeable, and he is a volunteer on the B1A Committee on Methods of Inspection. His concerns are real, and his opinions are sincere.

I believe he, like many others, misunderstand the intent of the changes the Certification Committee has made and how these changes affect them as CWIs. Where the misinformation comes from is not as important as the Certification Committee making an effort to correct the misunderstandings.

One step is for the AWS Education Department to correct the information contained in its textbooks and slide presentation. Likewise, the AWS instructors have to understand what the Certification Committee policy is with regard to the intent of the open book examination. The information contained in both the slide presentation and the textbooks are one person's interpretation of QC1. It does not represent the position taken by the Certification Committee nor does it properly interpret the relevant paragraph contained in QC1 concerning the intent of the open book examination. The Certification Committee researched past editions of QC1 and found no instance where it was stated or implied that passing any one open book examination qualified the CWI for all welding codes and standards. While the instructors have the right to their personal opinions and to disagree with the Certification Committee's official position, as contractors or employees being paid by the AWS, they have a responsibility to instruct the students based on the published policy. They can express their personal beliefs outside the classroom.

I believe one of the objections is that many individuals perceive the additional open book examinations as a money grab by AWS. The cost of an open book examination is a fraction of the cost of the "Boot Camp" or some of the other alternatives to the nine-year renewal process.

Another objection is the listing of the specific open book examination on the CWI card. This has been addressed by the decision to issue a separate card for the listing of AWS-issued endorsements.

While the Certification Committee states that taking an additional open book examination is strictly a voluntary decision, it is ultimately the customer or company utilizing the services of the

CWI that will make the decision of what specific, if any, open-book examination is required for their work. They, primarily Departments of Transportation, have been asking for it; in some cases demanding that prospective candidates show evidence they passed a specific open book examination. Now the information is available and made more convenient to both the inspector and prospective employer/customer. It only affects those CWIs who work for customers or employers that impose that requirement. I suspect the majority of the CWIs will be unaffected.

I still believe it is a win-win situation for CWIs and SCWIs. They can renew on their ninth year by several means: professional development hours earned by taking relevant courses at local colleges or seminars offered by professional societies such as ASM, ASME, AWS, AISC, ASNT, ASQ, etc.; they can complete the 14-day marathon "Boot Camp" session; they can retake the entire CWI or SCWI examination; or they can take an open-book examination using the welding standard that is relevant to their sector of the welding industry.

Al Moore
Member, AWS Certification Committee
Senior Certified Welding Inspector

(Editor' Note: With regard to the CWI seminar materials mentioned by both Wiswesser and Moore, the D1.1 slide set has been corrected and the revision of *Welding Inspection Technology* (WIT-T) is scheduled for the first half of next year.)

E-mail your comments to Mary Ruth Johnsen, *mjohnsen@aws.org*

Reader Comments on Following Best Safety Practices

I would like to comment on the July article featuring SSG Darrin Mack (Summer 2006 *Inspection Trends*, Profile, page 10). There is a picture of Mr. Mack showing him with a chipping hammer in his hand without wearing safety glasses. He is also not wearing safety shoes designed for spark and molten metal protection. Even though this picture was staged, it should still reflect all safety procedures required of welders and shop personnel.

You have very good articles that I find helpful, and I do not wish to be overly critical or petty, but I felt this needed to be addressed.

Todd Hankel
MTTC Welding Instructor and CWI
Minnesota Correctional Facility
Stillwater, Minn.

You are absolutely correct. We should have paid more attention to this photo. Rest assured it does not reflect the normal operations of the AWS Weld Lab. The photo was taken only a day or two before Darrin Mack was to leave AWS. Since he wasn't prepared to work in the lab that day, we did stage the photo, and because he wasn't actually chipping, we neglected to have him put on safety glasses. I'd like to thank you and the other readers who pointed out the problems with this photo. We'll try to be more careful in the future.

Mary Ruth Johnsen

Inspection and Testing Professionals Wanted

The American Welding Society is recruiting volunteers to serve on the U.S. Technical Advisory Group (TAG) to ISO/TC 44/SC 5 on Testing and Inspection of Welds. The TAG is responsible for developing U.S. positions on draft International Standards on Testing and Inspection of Welds.

The TAG conducts most of its business by correspondence (e-mail and Web based). However, we are always looking for U.S. experts to represent us at meetings of ISO/TC 44/SC 5, which can be held in Europe and North America.

TAG members are required to have Internet access, but broadband service is not required. Learn more about this committee's work by contacting TAG Secretary Brian McGrath at (800) 443-9353, ext. 311, (e-mail at *bmcgrath@aws.org*) or ISO/TC 44/SC 5 Secretary Andrew Davis at (800) 443-9353, ext. 466, (e-mail at *adavis@aws.org*).

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- *Dr. Jeff Dietrich, Institute for Trends Research:* Economic Forecasting.
- *John Stropki, Lincoln Electric:* Improving the Productivity of the American Workforce.
- *Mike Molinini, Airgas:* Welding Distribution Channels
- *Phil Pratt, SilverHawk Associates:* Solution Management to Deliver Value.

In addition, AWS Past Presidents Ernest Levert and Lee Kvidahl will participate in our Industry Leader Panel Discussion.

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Inspection

Best Practices

Understanding Weld Discontinuities

Discontinuities may be classified as defects (rejectable) depending on acceptance criteria in a particular specification or code. Discontinuities are rejectable only if they exceed specification requirements in terms of type, size, distribution, or location.

Discontinuities may be found in the weld metal (WM), heat-affected zones (HAZ), and base metal (BM) of weldments made in the five basic weld joint types: butt, T-, corner, lap, and edge.

Table 1 lists the most common types of discontinuities in butt, T-, corner, lap, and edge joints. Where the table indicates the discontinuity is generally located in the weld, it may be expected to appear in almost any type of weld. The exception is tungsten inclusions. Tungsten inclusions are found only in welds made by the gas tungsten arc and plasma arc welding processes.

Specific types of weld and base metal discontinuities are more common when certain welding processes and joint details are used. Table 2 lists the discontinuities commonly encountered for particular weld processes. High restraint and limited access to portions of a weld joint may cause a higher than normal incidence of weld and base metal discontinuities.

Table 1 — Common Types of Discontinuities (Legend: WM = weld metal zone; BM = base metal zone; HAZ = heat-affected zone; WI = weld interface)

Type of Discontinuity	Location	Remarks
Porosity	WM	Porosity could also be found in the BM and HAZ if the base metal is a casting.
(a) Uniformly scattered		
(b) Cluster		
(c) Piping		
(d) Aligned		
(e) Elongated		
Inclusion	WM, WI	
(a) Slag		
(b) Tungsten		
Incomplete Fusion	WM/WI	WM between passes.
Incomplete Joint Penetration	BM	Weld root.
Undercut	WI	Adjacent to weld toe or weld root in base metal.
Underfill	WM	Weld face or root surface of a groove weld.
Overlap	WI	Weld toe or root surface.
Lamination	BM	Base metal, generally near midthickness of section.
Delamination	BM	Base metal, generally near midthickness of section.
Seam and lap		Base metal surface generally aligned with rolling direction.
Lamellar tear	BM	Base metal, near HAZ
Crack (includes hot cracks and cold cracks)		
(a) Longitudinal	WM, HAZ, BM	Weld metal or base metal adjacent to WI.
(b) Transverse	WM, HAZ, BM	Weld metal, may propagate into HAZ and base metal.
(c) Crater	WM	Weld metal at point where arc is terminated.
(d) Throat	WM	Parallel to weld axis. Through the throat of a fillet weld.
(e) Toe	WI, HAZ	
(f) Root	WI, HAZ	Root surface or weld root.
(e) Underbead and HAZ	HAZ	
Concavity	WM	Weld face of a fillet weld.
Convexity	WM	Weld face of a fillet weld.
Weld reinforcement	WM	Weld face of a groove weld.

Excerpted from AWS B1.10:1999, Guide for the Nondestructive Examination of Welds.

Table 2 — Discontinuities Commonly Encountered with Welding Processes

Welding Process	Porosity	Slag	Incomplete Fusion	Incomplete Joint Penetration	Undercut	Overlap	Cracks
Arc							
SW (Stud welding)	X		X		X		X
PAW (Plasma arc welding)	X		X	X	X		X
SAW (Submerged arc welding)	X	X	X	X	X	X	X
GTAW (Gas tungsten arc welding)	X		X	`X	X		X
EGW (Electrogas welding)	X		X	X	X	X	X
GMAW (Gas metal arc welding)	X		X	X	X	X	X
FCAW (Flux cored arc welding)	X	X	X	X	X	X	X
SMAW (Shielded metal arc welding)	X	X	X	X	X	X	X
CAW (Carbon arc welding)	X	X	X	X	X	X	X
Resistance							
RSW (Resistance spot welding)	X*		X	X			X
RSEW (Resistance seam welding)	X*		X	X			X
PW (Projection welding)			X	X			X
FW (Flash welding)			X	X			X
UW (Upset welding)			X	X			X
Oxyfuel Gas							
OAW (Oxyacetylene welding)	X		X	X	X	X	X
OHW (Oxyhydrogen welding)	X		X	X			X
PGW (Pressure gas welding)	X		X				X
Solid-State**							
CW (Cold welding)			X				X
DFW (Diffusion welding)			X				X
EXW (Explosion welding)			X				
FOW (Forge welding)			X				
FRW (Friction welding)			X				
USW (Ultrasonic welding)			X				
Other							
EBW (Electron beam welding)	X		X	X			X
ESW (Electroslag welding)	X	X	X	X	X	X	X
IW (Induction welding)			X				X
LBW (Laser beam welding)	X		X	X			X
PEW (Percussion welding)			X				X
TW (Thermite welding)	X	X	X				X

* Porosity in resistance welds is more properly called voids.
** Solid-state is not a fusion process, so incomplete joining is incomplete welding rather than incomplete fusion.

The Society is not responsible for any statement made or opinion expressed herein. Data and information developed by the authors are for specific informational purposes only and are not intended for use without independent, substantiating investigation on the part of potential users.

ANSWERED BY
KENNETH ERICKSON & KIP MANKENBERG

Q: I have often seen contract specifications requiring nondestructive examination (NDE) of complete-joint-penetration weldments either using the magnetic particle (MT), radiographic (RT), or ultrasonic (UT) testing method. I understand that ultrasonics and radiography are considered volumetric testing methods whereas magnetic particle is more of a surface examination technique. Shouldn't the requirement state only UT or RT and not include MT since this testing technique will not produce the same results?

A: Thank you for addressing this commonly misunderstood issue. Not only have we been witness to this same requirement but also have seen liquid penetrant (PT) included as a testing option as well. The majority of design engineers want either UT or RT to be performed on the more critical moment connections consisting of complete-joint-penetration welds. When the contract specifications are developed, the final review does not always pick up on specific NDE requirements in regard to the joint type and/or the criticality of selected welds. The pre-project meeting (which we strongly suggest be held) is a perfect format in which to raise this question and others regarding the welding practices, procedures, quality requirements, and testing that are to be followed. Then the issue has not only been addressed by all concerned parties, but the vehicle to document any changes and/or clarifications can be initiated.

In lieu of either RT or UT, PT or MT may be permitted to be substituted for less critical welds in which only a final surface NDE inspection is required. Magnetic particle is normally the test method of choice unless the material is nonferrous in nature. Both MT and PT can be used more extensively by requesting additional inspections such as after each weld pass or after completing a percentage of each weld volume before examination.

Several factors also need to be contemplated before employing one test method instead of another. Schedule, cost, safety, base material composition, access, type of defect sought, etc., are all issues that need to be considered before requesting NDE services.

Q: I have been inspecting cell tower welds for the last year. I was contacted a month ago about a stepped monopole that had "severe cracking at the baseplate welds." I completed a visual inspection and did not observe any cracks. I issued a report. The engineering company that originally inspected responded with the following e-mail:

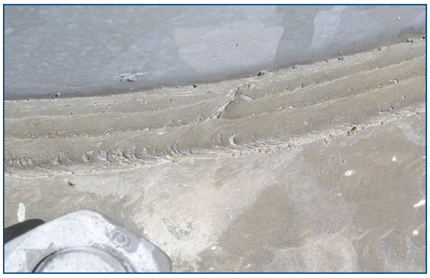
"After reviewing the limited visual weld inspection report for the site, it is my opinion that further investigation should be conducted as to the condition of the steel above and below the welds.

"As shown in several of the photos, there is a dark line above and below the welds on the steel of the tower. This line is believed by our firm to be caused by overheating of the steel during welding operations. This overheating may have caused weakening of the steel that could not be detected by a visual inspection. In order to test the density/strength of the steel, we would recommend and request a Level 3 ultrasonic inspection be performed.

"Another thing to note is that the steel was galvanized after welding. As galvanizing is a liquid, it should have filled all of the cracks and holes leaving no edges or spaces. This is not the case. Galvanized materials are permanent and should not need maintenance.

"Our concern is also based on the fact that we have seen structures of this design and age in our area fail, none of which were loaded as heavily as this one. Their failure has not been the weld, but at the point where the weld edge meets the structure surface."

I have never heard of this as in my experience there is always some discoloration after welding from the heat. I have attached a photo of the "burn line," which is what they are calling the darker area about the weld. This does not look like a burn line to me. I would like to know if, when this condition is observed on a weld, it warrants a more detailed inspection.



A: It is not uncommon for the base metal near the weld in the heat-affected area to change color cosmetically during and after the welding operation. This discoloration alone does not mean that an overheating condition resulted. Generally,

Inspection Trends encourages question and answer submissions. Please mail to the editor (mjohnsen@aws.org).

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CLIFFORD "KIP" MANKENBERG is a construction supervisor for Shell International Exploration & Production, Houston, Tex. He is an AWS Senior Certified Welding Inspector and an ASNT National NDT Level III Inspector in five methods.

base plates are a large enough heat sink regardless of the weld size or thickness that overheating would not be an issue when the welding is performed in accordance with a qualified welding procedure(s). If the base metal and weld area were overheated, other visual indicators such as warping of the base material and/or extreme surface scaling may be noticeable.

Performing an ultrasonic inspection of the area in question will not provide any further information regarding a possible overheating issue or weakening of the base/weld material other than to identify inherent welding indications. If heat treatment was required and not performed properly and/or the metal is of a grade containing a chrome alloy, then ultrasonic testing could locate and identify possible heat treating or delayed cracking. Metallurgical replication and hardness testing would provide more usable and valuable information in regard to metal/strength changes following the welding process in the case of overheating concerns.

The galvanization issue may be no more than that the surface area to be galvanized was not properly prepared, cleaned, and/or at the proper temperature range to accept the galvanizing material.

If failures have been noted in the past resulting from the same location area between the weld and base metal, take another look at the joint design and the welding procedure utilized. You may also want to consider employing a volumetric nondestructive examination such as ultrasonic testing on these welds after welding along with periodic surface examinations thereafter as what you are describing may be a result of incomplete fusion or severe undercut that has propagated during the service life.

Q: We have a number of structural assemblies that we are building for a new client to AWS D1.1. There is a skewed fillet weld arrangement on some of the members in some of the assemblies. Though the drawing doesn't give a dimension for the angle between the members, calculating it out from the other dimensions on the drawing shows that the angle is 140 deg. Annex II of D1.1 only shows how to calculate skewed fillet welds up to 135 deg. What should we do?

A: Though you don't state to which edition of the D1.1 Code you are working, it must be an older edition as the old Annex II (Effective Throats of Fillet Welds in Skewed T-Joints) is called Annex B in the 2006 Code. In the 2002 edition of the Code, AWS added additional rules for skewed fillets that if adhered to really help to eliminate confusion of this type. Specifically, for fillet welded skewed T-joints with an angle of greater than 100 deg, paragraph 2.3.3.2 of the 2006 edition requires that the contract documents indicate the required throat and that the shop drawings indicate the required leg size to obtain this.

Even though you are likely working to an older edition of the Code, you should get the responsible engineer involved. At an angle of 140 deg, some sort of groove welded configuration that provides equal strength is likely to be cheaper. If a fillet weld is chosen, one thing to make sure of is that the eventual weld has a convex shape. It is difficult to measure concavity of skewed fillet welds, so it is best to avoid having to measure it at all.

Q: I have recently been asked to review some WPSs that were submitted by one of our new subcontractors for an upcoming project. I am actually pretty impressed, as they seem to have done a very good job. However, one thing that bothers me is that some of the PQRs have been revised. I can't find that this is prohibited by the Code, but it just does not seem like a good practice. What are your thoughts on this?

A: In general, a PQR should not be revised. It is a certified record of a specific sequence of tests. If a change must be made, for instance to correct some sort of error that was made in the initial recording of information, then both the change and the reason for the change should be made clear to avoid confusion or uncertainty when the record is reviewed in the future. Good practice should be followed in making the correction (one line through the error, initials of the person making the correction, and the date of the correction), and a brief note on the reason for the change (such as "editorial correction") should be made.

Other changes to the record that may need to be made would normally be additions. An example of an addition that might need to be made to a PQR would be if when the test plate was welded and tested there was some test plate material remaining, and at a future date it was decided to perform additional mechanical testing on this remnant material. A good way to document this additional information would be to put it on a separate signed document, and attach it to the original. This should keep the original PQR unchanged and unchallenged, and still properly document the additional testing that was performed.❖

just **the facts**

The Inspector's Duties

BY LYNDSEY DECKARD

The duties of the CWI or steel inspector working on a project requiring conformance with D1.1, *Structural Welding Code — Steel*, are varied. They go well beyond the visual inspection of completed welds. Prior to commencement of welding the inspector must do the following:

- ◆ Confirm that each Welding Procedure Specification (WPS) to be used conforms to D1.1.
- ◆ Verify mill certification of materials to be used.
- ◆ Confirm proper edge preparation.
- ◆ Verify proper fitup.
- ◆ Verify welding equipment applicability and condition.
- ◆ Verify the welder has a copy of the WPS available to him or her and confirm that proper work records are being kept.

Section 6 of AWS D1.1:2006 contains the requirements for inspection of welds including the following. Sections 6.2 through 6.5 of the Code are reproduced here.

6.2 Inspection of Materials and Equipment

The Contractor's Inspector shall make certain that only materials and equipment conforming to the requirements of this code shall be used.

6.3 Inspection of WPSs

6.3.1 Prequalified WPS. The Contractor's Inspector shall make certain that all prequalified WPSs to be used for the work conform with the requirements of Section 3, Section 5, and the contract documents.

6.3.2 WPSs Qualified by Test. The Contractor's Inspector shall make certain that all WPSs qualifed by test conform with the requirements of Sections 4 and 5, and contract documents.

6.3.3 WPSs in Production. The Contractor's Inspector shall make certain that all welding operations are performed in conformance with WPSs that meet the requirements of this code and the contract documents.

6.4 Inspection of Welder, Welding Operator, and Tack Welder Qualifications

6.4.1 Determination of Qualification. The Inspector shall allow welding to be performed only by welders, welding operators, and tack welders who are qualified in conformance with the requirements of Section 4, or shall make certain that each welder, welding operator, or tack welder has previously demonstrated such qualification under other acceptable supervision and approved by the Engineer in conformance with 4.1.2.1.

6.4.2 Restesting Based on Quality of Work. When the quality of a qualified welder's, welding operator's, or tack welder's work appears to be below the requirements of this code, the Inspector may require that the welder, welding operator, or tack welder demonstrate an ability to produce sound welds by means of a simple test, such as the fillet weld break test, or by requiring complete requalification in conformance with Section 4.

6.4.3 Retesting Based on Qualification Expiration. The Inspector shall require requalification of any qualified welder or welding operator who has not used the process (for which they are qualified) for a period exceeding six months (see 4.1.3.1).

6.5 Inspection of Work and Records

6.5.1 Size, Length, and Location of Welds. The Inspector shall make certain that the size, length, and location of all welds conform to the requirements of this code and to the detail drawings and that no unspecified welds have been added without the approval of the Engineer.

6.5.2 Scope of Examinations. The Inspector shall, at suitable intervals, observe joint preparation, assembly practice, the welding techniques, and performance of each welder, welding operator, and tack welder to make certain that the applicable requirements of this code are met.

6.5.3 Extent of Examination. The Inspector shall examine the work to make certain that it meets the requirements of this code. Other acceptance criteria, different from those described in the code, may be used when approved by the Engineer. Size and contour of welds shall be measured with suitable gauges. Visual inspection for cracks in welds and base metal and other discontinuities should be aided by a strong light, magnifiers, or such other devices as may be found helpful.

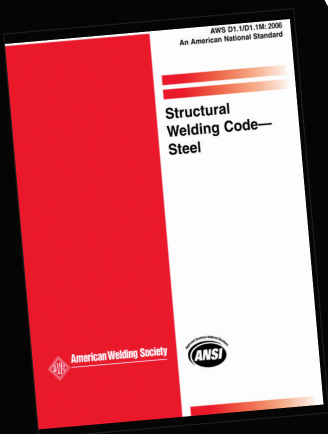
6.5.4 Inspector Identification of Inspections Performed. Inspectors shall identify with a distinguishing mark or other recording methods all parts or joints that they have inspected and accepted. Any recording method which is mutually agreeable may be used. Die stamping of cyclically loaded members without the aproval of the Engineer shall be prohibited.

6.5.5 Maintenance of Records. The Inspector shall keep a record of qualifications of all welders, welding operators, and tack welders; all WPS qualifications or other tests that are made; and such other information as may be required.❖

*Lyndsey Deckard (*Deckard@pbworld.com*) is Quality Manager of the Vehicle Division of Parsons Brinckerhoff Transit & Rail Systems Inc. He is an AWS Senior Certified Welding Inspector, an ASQ Certified Quality Auditor, and a member of the AWS Certification Committee, the Examination Question Bank Subcommittee, and the Ethics Subcommittee.*

codes red

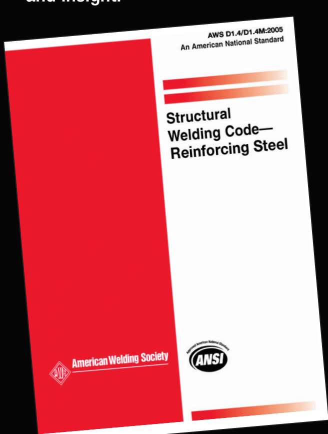
(There's more to D1 than D1.1)



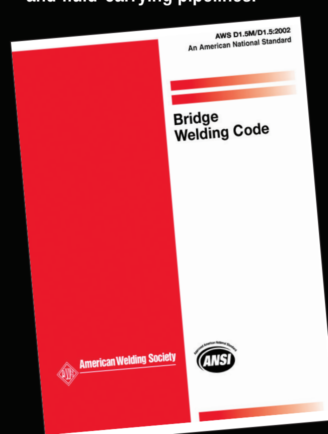
NEW! *AWS D1.1/D1.1M:2006 Structural Welding Code—Steel* has been the authoritative American National Standard in steel construction for more than 75 years. The newest edition contains 540 pages of crucial data and insight.

AWS D1.2/D1.2M:2003 Structural Welding Code—Aluminum is the single most important reference available on welding requirements for any type of aluminum alloy structure, except pressure vessels and fluid-carrying pipelines.

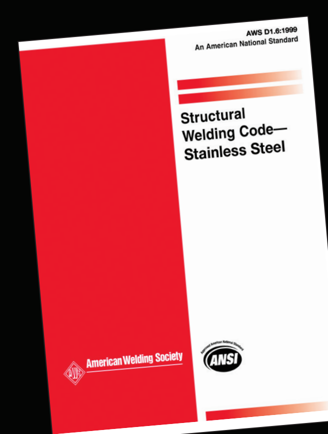
AWS D1.3-98 Structural Welding Code—Sheet Steel, among other things, defines the allowable capacities used in sheet steel applications in which the transfer of calculated load occurs.



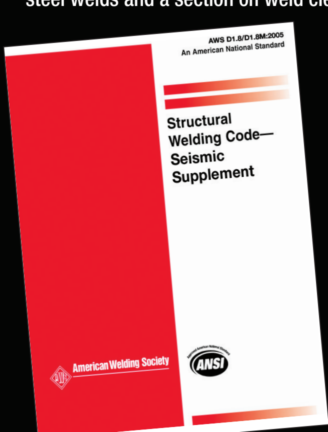
AWS D1.4/D1.4M:2005 Structural Welding Code—Reinforcing Steel now contains a comprehensive approach to radiographic testing of reinforcing steel welds and a section on weld cleaning.



AWS D1.5/D1.5M:2002 Bridge Welding Code covers welding requirements of the American Association of State Highway and Transportation Officials (AASHTO) for welded highway bridges.



AWS D1.6:1999 Structural Welding Code—Stainless Steel covers requirements for welding stainless steel assemblies and components (excluding pressure vessels and piping) using GMAW, FCAW, SAW, and stud welding.



NEW! *AWS D1.8/D1.8M:2005 Structural Welding Code—Seismic Supplement* complements AISC Seismic Provisions to help ensure that welded joints designed to undergo significant repetitive inelastic strains as a result of earthquakes have adequate strength, notch toughness, and integrity to perform as intended.

AVAILABLE SOON! *AWS D1.9/D1.9M:2007 Structural Welding Code—Titanium* covers requirements for design, welding, and inspection of any type of titanium structure. Includes qualification requirements for weld procedures and personnel.

The power of D1: Working under ANSI procedures, the contributors and reviewers of AWS D1 codes have built upon the work of hundreds of prior experts who, since the first D1 code in 1928, have continuously labored to represent proven practices. The result is a resource that provides a consensus of the finest minds in the industry on the most reliable approaches to achieving a successful final outcome. That's why D1 code books have been mandated by local, state, and overseas codes, approved by ANSI, adopted by the Defense Department, preferred by NASA, and required by contracts for countless industrial and construction applications.

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Westbury, NY 11590

Camera Provides High-Resolution, Real-Time Thermal Images

The HSI3000 is an ergonomically designed, hand-held, compact, easy-to-use thermal imaging camera. It can be used as a detection and diagnostic tool for condition monitoring of electrical and mechanical systems and building diagnostics. It features a 160 x 120, uncooled microbolometer array capable of producing high-resolution, real-time thermal images displayed on a bright 3.5-in. color LCD with LED backlight in any of the three user-selectable color palettes. Two measurement cursors, movable anywhere in the image, provide temperature readings at each cursor location, and indicates real-time differential temperature measurement between the two points anywhere along the 14°–482°F range. Up to 1000 images can be stored and recalled. It comes with a battery, AC adaptor, USB cable, user manual and software CD, carrying case, wrist strap, SD card, and SD card reader.

Palmer Wahl Instrumentation Group 203
234 Old Weaverville Rd.
Asheville, NC 28804-1228

Portable Analyzer Measures Light Element Content

The NITON XLt 898He is a portable nondestructive analysis tool for light element content in alloy material. It provides fast, laboratory-quality chemical analysis of content such as magnesium,

aluminum, silicon, and phosphorus in materials such as aluminum and titanium alloys, nickels, superalloys, and stainless steel. The system fills the interior of the unit's measurement head with pure helium, purging atmospheric air from the x-ray analysis path, and allowing light element x-rays to contact the high-resolution x-ray detector.

Thermo Electron Corp. **204**
81 Wyman St.
Waltham, MA 02454

Whiteboard System Aids in Planning

The 365-day YearMaster Wall Calendar Planner®, a large magnetic whiteboard system, gives both a view of your year together with day-to-day details that allow for instantly changeable, long-term planning, organizing, and communicating. It displays 12 month rows and 31 columns across, giving a daily line view of each month and includes a comprehensive supply kit with write-on tools, magnetic cardholders, cards, PC card-keying template, write-on magnets, magnet status signals in 10 colors, and printed magnetic sets. It is available in 4 x 6 ft, and 4 x 12 ft sizes, displaying 3 to 14 events a day.

Magnatag Visible Systems **205**
2031 O'Neill Rd.
Macedon, NY 14502

High-Speed Camera Uses 3-CCD Color Technology

The IK-TF9C camera can inspect large surfaces with precision and high color fidelity. It is a 2048 x 1536 pixel output resolution, 3-chip, color CCD camera. It offers a rate of 20 fps (full frame) and 40 fps (partial scan). It features the company's proprietary progressive scan

technology, which eliminates image jitter. It weighs 165 g and measures 44-mm wide x 44-mm high x 78.3-mm deep. Features include a C mount for lenses, an 8-bit RGB digital output, and Camera Link® compatibility.

Toshiba America
Imaging Systems Div. **206**
9740 Irvine Blvd.
Irvine, CA 92618-1697

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