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On the cover: A pipe welder performs a downhill root pass weld on a gas transmission pipeline using metal-cored wire. (Photo courtesy of Hobart Brothers.)
AWS Is Sound in 2010

It is always a pleasure to report good news, and as the newly elected AWS treasurer, I am especially glad to continue in that tradition. The Society is healthy and growing, and we are also undertaking a number of new initiatives that should ensure continued growth in the years ahead. Some recent highlights of AWS activities follow:

New Headquarters: We have completed the purchase of a new headquarters facility for AWS. Located in Doral, Fla., just west of Miami International Airport, the new building has 120,000 sq ft of usable floor space — more than three times the space in the present facility.

Investment Subcommittee: The AWS Finance Committee has established a new Investment Subcommittee to manage all invested funds of the Society. At a meeting last January, the Subcommittee conducted a thorough review of various investment programs available and confirmed that our present investment firm is doing an excellent job for AWS.

International Business: Revenues from international business conducted by the Society were up 47% in 2009 compared to the previous year, a trend largely driven by a wide-scale increase in AWS certification of personnel in other countries. This strong interest in AWS training and certification outside the United States is being ably handled by a growing number of AWS international agents around the world.

Certification: Interest in AWS certification is very strong, generally, both domestically and overseas. At present, AWS-certified personnel total more than 32,300 — another record number. One notable new program is the AWS Certified Welding Sales Representative (CWSR), which allows welding distributor sales personnel to document the value-added expertise they offer to their customers.

Exhibitions: The 2010 FABTECH show, set for Nov. 2-4 in Atlanta, is shaping up very well. Floor space sales in the welding portion of the show are presently 133,000 sq ft and rising, a 25% increase over space sold by this date when we were last in Atlanta four years ago. AWS has been active in trade show business internationally, as well. We hosted a pavilion of American exhibitors at the Beijing-Essen Welding and Cutting Show last month in China. Also, our own AWS Weldmex show in Mexico City in May was joined by two co-located shows — METALFORM Mexico and FABTECH Mexico — making our event the largest annual metalworking exhibition in all of Latin America.

Welding Journal: Our Welding Journal has gone digital, and is now being supplied electronically to our international members. This ensures immediate delivery all over the world, and it provides significant savings on delivery costs to the Society. Beyond this, the Spanish-language edition of the Welding Journal introduced in 2008 has been well received in Spanish-speaking countries, and is now self-supporting through advertising revenues.

D1.1 Publishing Cycle: AWS's best-selling code, D1.1, Structural Welding Code — Steel, has just changed to a five-year publication cycle. Now available, the 2010 D1.1 Code will not be revised until 2015, which gives buyers assurance that the latest revision will remain in effect for a full five years.

Capital Campaign on Workforce Development: The AWS Foundation's Capital Campaign on Workforce Development is in high gear, with the AWS Solutions Opportunities Squad (SOS) working effectively to bridge the gaps between welding educators and employers. AWS has also worked in partnership with Weld-Ed to produce a new InDemand Careers in Welding magazine specifically aimed at young people about to enter the workforce. To fund welding training directly, AWS awarded a record $390,000 in scholarships to more than 400 students in 2009.

AWS Membership: The year 2009 was also a record-setter in terms of AWS membership. Membership in the Society has topped 61,000 for the first time ever, and we are still growing. This is a significant achievement at a time when many other associations are seeing a decline in membership.

Finally, from a financial standpoint, AWS is in excellent shape. The Financial Report that begins on page 34 of this issue of the Welding Journal shows record net assets and reserves for the Society, and revenues for 2009 were at an all-time high.

As AWS Treasurer, I pledge that I will do my utmost to protect the Society's assets, while maintaining an atmosphere conducive to continuing growth and service to our members. I welcome your suggestions on how we can accomplish this most effectively, working together.

Robert G. Pali
AWS Treasurer
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Lobbying, Politics Recession-Proof

The current economic recession appears to have had little or no impact on the industries of lobbying and politics. For calendar year 2009, lobbyists reported receiving almost $3.5 billion in fees — the most ever. The previous record was set in 2008, when $3.3 billion was spent. Not surprisingly, healthcare led all other sectors with $550 million in amounts paid to lobbyists. Also among the top industries in 2009 were finance, energy, and transportation. In the political arena, the 2010 Congressional elections are reported to be on track to be the most expensive ever, with the total cost to approach $4 billion.

NIST to Increase Focus on Standards

Citing an increased urgency in the need to coordinate and engage federal agencies on the use of private sector standards, the National Institute of Standards and Technology (NIST) has announced it is increasing its efforts in this vital area. Specifically, NIST has identified the following two goals it will be pursuing:

1. Working more effectively with industry and private sector standards developers on the development of timely and effective standards, and working more effectively across federal agencies to make sure that federal efforts to work with the private sector are effectively planned and coordinated.
2. The NIST is hoping to continue the success of the National Technology Transfer and Advancement Act, which, since its implementation in 1997 under OMB Circular A-119, has resulted in more than 3000 government-specific standards being replaced with private sector standards. Also, NIST has identified more than 9000 citations of private standards incorporated by reference in regulatory documents and a similar number used in federal procurement actions.

Science and Technology Policy Office Looks at Commercializing University Research

Recognizing that transferring viable university research discoveries to the marketplace poses a particular challenge, the Office of Science and Technology Policy (OSTP) is working with all stakeholders, including universities, companies, federal research labs, entrepreneurs, and investors, to identify ways to increase the economic impact of federal investment in university research and development.

Among the practices and models that OSTP is examining are business plan competitions; programs that encourage multidisciplinary collaboration between faculty and students in different disciplines, such as science, engineering, business, and medicine; technology transfer and sponsored project offices; university-industry collaborations that increase investment in precompetitive research and development that is beyond the time horizon of any single firm; university participation in regional economic development initiatives and efforts to strengthen “clusters”; and supportive university policies such as “industrial leave” that allow faculty members to work for a new or existing company to commercialize their research.

Senators Seek to Include Manufacturing Provisions in Clean Energy Legislation

Ten U.S. Senators are leading an effort to amend clean energy legislation currently pending in Congress to address U.S. manufacturing concerns. In an open letter, these Senators call for legislation to do the following:

- Provide assistance for retooling and clean energy manufacturing;
- Support research, development, and deployment of low-carbon industrial technologies;
- Keep energy costs low for manufacturers;
- Provide full funding for rebates to energy-intensive, trade-exposed industries;
- Clarify federal and state greenhouse gas standards; and
- Promote meaningful international action.

Hexavalent Chromium Standard Applicable

As of May 31, the Hexavalent Chromium Standard issued by the Occupational Safety and Health Administration (OSHA) is fully implemented. The final component was the adoption by employers of appropriate engineering controls to address exposures that would otherwise exceed the permissible limit of 5 micrograms per cubic meter of air. Also, OSHA has recently published Hexavalent Chromium, a booklet outlining requirements of the standard. It is available at www.osha.gov/Publications/OSHA-3373-hexavalent-chromium.pdf.

President’s Council Studying the Future of Advanced Manufacturing

The President’s Council of Advisors on Science and Technology (PCAST) is conducting a study on how to enhance U.S. advanced manufacturing capabilities. The council has identified four categories of inquiry: development of new manufacturing technologies, support for new manufacturing firms, support for existing manufacturing firms, and a national manufacturing strategy. The council is an advisory group of scientists and engineers appointed by the president to provide science and technology advice.

White Paper Assesses the Present and Future of American Manufacturing

A new white paper, Innovation and Product Development in the 21st Century, prepared by the Hollings Manufacturing Extension Partnership (MEP) Board, discusses the state of domestic manufacturing and the characteristics of good manufacturers, and plots a course to improve the competitiveness of manufacturing in the United States. The MEP is managed by the National Institute of Standards and Technology. The report finds that there are reasons for concern about industry’s future, but there are also reasons for optimism. The white paper is available at www.nist.gov/mep/upload/MEP_advisory_report_4_24l.pdf.

Web Site Gives Energy Efficiency Incentives

Funded by the U.S. Department of Energy, the Database of State Incentives for Renewables & Efficiency (DSIRE) is a comprehensive source of information on state, local, utility, and federal incentives and policies that promote renewable energy and energy efficiency. It is located at www.dsireusa.org.
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Entries Sought for AWS Image of Welding Awards

The American Welding Society (AWS), Miami, Fla., is accepting entries in the 8th Annual Image of Welding Awards program. It’s open to all welding industry professionals and presented by AWS along with the Welding Equipment Manufacturers Committee (WEMCO), a standing committee at AWS. The entry deadline is July 12.

Awards are issued in seven categories. All individuals, organizations, and groups may be nominated for multiple categories. Self-nominations are also welcome. Winners will be honored at the Image of Welding Awards Ceremony to be held during the FABTECH Show Nov. 2–4 at the Georgia World Congress Center in Atlanta, Ga.

The program recognizes the following categories: Individual; Section; Large Business; Small Business; Distributor; Educator; and Educational Facility.

Nominations will be judged by WEMCO. To see the names of past winners and download a nomination form, visit www.aws.org/awards/image.html. Completely fill out and return the nomination form to image@aws.org, FAX to (305) 443-1552, or mail to AWS Image of Welding Awards, 550 NW LeJeune Road, Miami, FL 33126.

Pipe Fitting Prototype Tools Implemented at Shipyards

A Navy Metalworking Center (NMC) project is applying improved pipe-preparation methods and automated technologies to decrease construction costs through the reduction of worker-hours in General Dynamics Electric Boat and Northrop Grumman Shipbuilding-Newport News pipe shop welding processes. Welding methods for small-diameter pipe less than 3 in. on Virginia Class Submarines (VCS) involve complex configurations for setup, fiup, fixturing, and welding.

The NMC and Integrated Project Team developed prototype pipe fitting tools, a modified Accu-fit tool and a ball pivot tool. Also, NMC developed a mobile weld fixture to weld pipe bosses that has the potential to reduce manual welding pass times.

The center examined and evaluated all aspects of current VCS small-diameter pipe preparation, fitting, and welding methods at both shipyards. Process improvements centered on development of pipe fixturing and tooling to enhance the pipe fitters’ ability to fit and stage pipe details in advance of the welder.

The pipe fitting tools and automation methods developed in this project were evaluated for process improvements at both shipyards’ pipe shops. They are undergoing demonstration testing at those shipyards and will be fully implemented on VCS hull 786 by this December.

The prototype pipe fitting tool evaluations demonstrate a potential reduction of 6250 worker-hours per hull; pipe boss automation fixturing demonstrates a 1500 worker-hours per hull reduction; reduced fatigue for pipe welders through fitting and tacking pipe details in optimum ergonomic positions demonstrates a 1180 worker-hours per hull reduction; and pipe fitting tools are being transitioned to VCS shipyards with low capital cost investments.

North American Market for Ceramic Coatings Set to Increase

High-Performance Ceramic Coatings: Markets and Technologies (AVM015E), a new report from BCC Research, claims the North American market value of high-performance ceramic coatings was an estimated $1.4 billion in 2009 and is expected to increase to more than $2 billion in 2014, for a 5-year compound annual growth rate of 7.6%.

Thermal spray coatings, the largest segment of the market, is projected to grow at a rate of 8.1% to reach more than $1.4 billion in 2014. Its value is estimated at $953 million in 2009. Chemical vapor deposition, the second-largest segment, is estimated at $183 million in 2009, down from $213 million in 2008. It’s expected to increase by a 5-year compound annual growth rate of 3.8% to reach nearly $221 million in 2014.

Bishop-Wisecarver Launches Video Contest

Bishop-Wisecarver Corp., Pittsburg, Calif., started a video contest in celebration of its 60th year anniversary to discover the most creative application using DualVee guide wheels. To enter, send a 60-s video explanation of your innovative use of the product. Videos are to be submitted to the 2010 Creative DualVee Contest community page on YouTube by June 15; the winning video will be announced on June 30. The winner will get a four-day, three-night vacation for two to California worth up to $2000 plus airfare.
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How fast can you switch? Find out at our booth at FABTECH in Atlanta, November 2-4, 2010. Winners of fastest time each hour will receive valuable Fibre-Metal head, face and eye protection equipment, plus a chance to win an Apple iPad!

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National Center for Welding Education and Training Dedicated at Lorain County Community College

A dedication celebrating the National Center for Welding Education and Training at Lorain County Community College (LCCC), Elyria, Ohio, took place on April 22. The 4000-sq-ft building, also known as Weld-Ed, was recently renovated with support from a $4.9 million grant from the National Science Foundation. It represents a partnership between business and industry, community and technical colleges, universities, the American Welding Society (AWS), and government.

Officials from LCCC were joined by representatives from the National Skills Panel in Maryland, Washington, D.C., California, and Alabama as well as by local representatives from General Motors and Lincoln Electric.

Located in the college’s Nord Advanced Technologies Center, the Weld-Ed portion of the facility has been redesigned to include welding lab facilities, new classrooms, and offices. The lab facilities were built using up-to-date technology in the materials-joining industry through partnerships with welding equipment and supply manufacturers.

“This center signifies our national and local response as well as our commitment to the changing nature of our manufacturing environment in a very positive and progressive manner,” said LCCC President Dr. Roy A. Church.

The college is the lead institution for the Weld-Ed initiative that will increase the number of welding technicians to meet workforce demands. In addition, the center will promote a reform in welding education by providing technologically current educational materials and professional development opportunities to two-year colleges and other educational institutions.

The focus will be technician education at community colleges, but secondary and post community college education will be supported through LCCC’s model of vertical articulation where students can take coursework while still in high school, secure their associate’s degree at LCCC, and their bachelor’s degree through the University Partnership.

The Weld-Ed center provides education driven by industry needs through a network of regional partners. Educator workshops are offered at regional locations and online courses supplemented by national conferences, print media, and web casts. Instructors can exchange ideas and be exposed to equipment via demonstrations at their institutions; webcasts of demonstrations; and/or travel to modern factories.

Partner institutions of higher education include the following: Chattanooga State Tech Community College, Honolulu Community College, Illinois Central College, The Ohio State University, North Dakota State College of Science, Pennsylvania College of Technology, Texas State Technical College, Weber State University, and Yuba College. Other partners include the American Welding Society and Lockheed-Martin.

Lorain County Community College is the only approved provider in Ohio for the Manufacturing Skills Standards Council. Allied processes such as brazing, soldering, cutting, and thermal spraying will be part of the center’s range.

Highlights of the renovated Weld-Ed lab include interactive video distance learning compatible classrooms with SMART boards, a new CNC plasma cutting table and plasma cutting heads, the capability of live feed welding from the lab, four handicapped-accessible booths, a new robotic welding cell, multiple welding processes available in the booths, and an increase in gas tungsten arc welding booths from 6 to 14.
CenterPoint Energy Presents Pipeline Welding Techniques to College Students

Welding technology students from Alexandria Technical College benefited from hands-on training by CenterPoint Energy. They learned proper techniques for construction pipeline welding to code.

CenterPoint Energy recently provided a day of hands-on training for the welding technology students at Alexandria Technical College, Alexandria, Minn. Students learned the proper techniques for construction pipeline welding to code. In addition to steel piping, they also learned about plastic piping, fittings, valves, and emergency field repair procedures.

Construction piping technicians from CenterPoint Energy’s Alexandria area office guided the seminar. Lowell Hjelle, Randy Hittle, and Al Jongerius are certified in pipeline codes for working with low- and high-pressure steel and plastic materials. The students appreciated learning new techniques and experiencing the hands-on opportunity.
Hypertherm Recognized in *PARADE* Magazine for No Layoff Policy

Hypertherm, Hanover, N. H., was recently featured in *PARADE* Magazine's April 11 issue that contained the annual salary survey, What People Earn. In “Saving Jobs, Building Loyalty” by Daryl Chen (page 6), the manufacturer of plasma arc cutting equipment was noted for never laying anyone off in its 41 years.

“Instead, in slack periods, employees take on jobs that temp workers ordinarily do,” the article stated. “When production slowed last year, for instance, some factory-floor hands cut grass and raked the company grounds. Not only did they not complain, CEO and founder Dick Couch jokes, ‘we’ve had difficulty convincing some to go back to their jobs indoors.’ More seriously, he stresses, ‘Showing respect for people pays a higher dividend than any short-term cuts in payroll achieve.’”

Samsung Heavy Industries to Secure 1000 More Patents by 2015

Samsung Heavy Industries will acquire about 1000 more patents by investing $445 million to develop eco-friendly shipbuilding technologies by 2015. Also, the company recently completed the basic design of a ship that runs on natural gas.

“We will develop technologies in three major fields — design, engine systems, and gas emission processing. The key is to cut harmful substances in emissions and reduce fossil fuel consumption, while maintaining ship speed,” said Ha Mun-geun, managing director at the product technology research center of Samsung Heavy Industries' shipbuilding and marine engineering think tank.

Additionally, Ha said the company secured ten patents in gas supply systems, as it recently completed the conceptual design
of the natural gas-powered ship. Such a ship can cut CO₂ emissions 20–25%, nitrogen compounds 90%, and sulfur compounds more than 99% vs. those powered by heavy oil.

Alanod-Solar Unveils Laser Welding Facility for Solar Thermal Absorbers

Alanod-Solar’s laser welding facility in North Ridgeville, Ohio, is set to manufacture absorber fins for solar thermal collectors.

Alanod-Solar recently inaugurated a high-capacity laser welding facility located in North Ridgeville, Ohio, where its laser welded Miro-Fin® absorber fins for solar thermal collectors will be manufactured and distributed. The product is configured to meet the needs of solar thermal designs in North America.

The new continuous laser welding line is run by a subsidiary, Alanod Westlake Metal Industries. Its production capacity exceeds five million square feet of absorber fins per year. Also, the facility

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employs 20 individuals from the Greater Cleveland region, and is used for production, warehousing, and distribution purposes.

**Int’l Sheet Metal Apprentice Competition Turns Out Winners from Three States**

The Annual International Sheet Metal Competition, hosted by the International Training Institute (ITI) and held in Las Vegas March 15–18, attracted more than 325 sheet metal apprentices and their families from the U.S. and Canada.

Five apprentices from four Sheet Metal Local Joint Apprenticeship Centers around the U.S. took top honors in five sheet metal disciplines. Each competition, no matter the discipline, consisted of a written test, sketching projects, a shop project, and a blueprint reading test.

Michael Collins, an apprentice from Local #17, Boston, Mass., won first prize in the heating, ventilating, and air conditioning category. In addition, two apprentices from Missouri took home first place finishes — Ryan Burton, an apprentice from Local #2 in Kansas City, Mo., won in the industrial/welding category, and Dustin Walker, an apprentice from Local #36 in St. Louis, won in the service category. Washington state was represented by two first-place finishes as well, both from Local #66 out of Tacoma, Wash. Casey Wilson-Williams won top honors in the testing, adjusting, and balancing in heating and air conditioning category, while Lee Posey, an apprentice from nearby Gig Harbor, Wash., won in the architectural discipline.

“The competition is challenging because those who make it in are the United States’ and Canada’s top apprentices,” said James Shoulders, executive administrator for ITI. “These men and women are dedicated to perfecting their craft.”

**Maritime Administration Grants Totaling $14.7 Million to Help Small Shipyards**

The U.S. Department of Transportation’s Maritime Administration (MARAD) awarded $14.7 million in grants to help improve 17 small shipyards in 16 states. The funds will help these shipyards purchase modern equipment and train workers. Also, the grants will go to shipyards around the country that provide essential services to commercial and government ships.

Among the shipyards that will receive grants are as follows: Fraser Shipyards, Inc., Superior, Wis., with $257,990 for a cutting machine and welding equipment; Marisco, Ltd., Kapolei, Hawaii, with $1,079,224 for cranes, forklifts, welding machines, compressors, and a dust collector; and Earl Industries, LLC, Portsmouth, Va., with $923,496 for a laser cutting machine and two 5-ton bridge cranes.

What’s more, Pacific Fishermen Shipyard and Electric LLC, Seattle, Wash., will get $643,095 for a worker training program, sand blast paint and booths, sand blast grit recovery systems, man lifts, and a 15-ton crane.

— continued on page 107

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Friends and Colleagues:

I want to encourage you to submit nomination packages for those individuals whom you feel have a history of accomplishments and contributions to our profession consistent with the standards set by the existing Fellows. In particular, I would make a special request that you look to the most senior members of your Section or District in considering members for nomination. In many cases, the colleagues and peers of these individuals who are the most familiar with their contributions, and who would normally nominate the candidate, are no longer with us. I want to be sure that we take the extra effort required to make sure that those truly worthy are not overlooked because no obvious individual was available to start the nomination process.

For specifics on the nomination requirements, please contact Wendy Sue Reeve at AWS headquarters in Miami, or simply follow the instructions on the Fellow nomination form in this issue of the Welding Journal. Please remember, we all benefit in the honoring of those who have made major contributions to our chosen profession and livelihood. The deadline for submission is July 1, 2010. The Committee looks forward to receiving numerous Fellow nominations for 2011 consideration.

Sincerely,

Nancy C. Cole
Chair, AWS Fellows Selection Committee
American Welding Society

Fellow Description

DEFINITION AND HISTORY
The American Welding Society, in 1990, established the honor of Fellow of the Society to recognize members for
distinguished contributions to the field of welding science and technology, and for promoting and sustaining the professional
stature of the field. Election as a Fellow of the Society is based on the outstanding accomplishments and technical impact of the
individual. Such accomplishments will have advanced the science, technology and application of welding, as evidenced by:
  * Sustained service and performance in the advancement of welding science and technology
  * Publication of papers, articles and books which enhance knowledge of welding
  * Innovative development of welding technology
  * Society and chapter contributions
  * Professional recognition

RULES
1. Candidates shall have 10 years of membership in AWS
2. Candidates shall be nominated by any five members of the Society
3. Nominations shall be submitted on the official form available from AWS Headquarters
4. Nominations must be submitted to AWS Headquarters no later than July 1 of the year prior to that in
   which the award is to be presented
5. Nominations will remain valid for three years
6. All information on nominees will be held in strict confidence
7. No more than two posthumous Fellows may be elected each year

NUMBER OF FELLOWS
Maximum of 10 Fellows selected each year.

AWS Fellow Application Guidelines
Nomination packages for AWS Fellow should clearly demonstrate the candidates outstanding contributions to the advance-
ment of welding science and technology. In order for the Fellows Selection Committee to fairly assess the candidates qualifica-
tions, the nomination package must list and clearly describe the candidates specific technical accomplishments, how they con-
tributed to the advancement of welding technology, and that these contributions were sustained. Essential in demonstrating the
candidates impact are the following (in approximate order of importance).

1. Description of significant technical advancements. This should be a brief summary of the candidates most
   significant contributions to the advancement of welding science and technology.
2. Publications of books, papers, articles or other significant scholarly works that demonstrate the contributions cited
   in (1). Where possible, papers and articles should be designated as to whether they were published in
   peer-reviewed journals.
3. Inventions and patents.
4. Professional recognition including awards and honors from AWS and other professional societies.
5. Meaningful participation in technical committees. Indicate the number of years served on these committees and
   any leadership roles (chair, vice-chair, subcommittee responsibilities, etc.).
6. Contributions to handbooks and standards.
7. Presentations made at technical conferences and section meetings.
8. Consultancy — particularly as it impacts technology advancement.
9. Leadership at the technical society or corporate level, particularly as it impacts advancement of welding technology.
10. Participation on organizing committees for technical programming.
11. Advocacy — support of the society and its technical advancement through institutional, political or other means.

Note: Application packages that do not support the candidate using the metrics listed above
will have a very low probability of success.

Supporting Letters
Letters of support from individuals knowledgeable of the candidate and his/her contributions are encouraged. These
letters should address the metrics listed above and provide personal insight into the contributions and stature of the
candidate. Letters of support that simply endorse the candidate will have little impact on the selection process.

Return completed Fellow nomination package to:

Wendy S. Reeve
American Welding Society
Senior Manager
Award Programs and Administrative Support
550 N.W. LeJeune Road
Miami, FL 33126

Telephone: 800-443-9333, extension 293

SUBMISSION DEADLINE: July 1, 2010
CLASS OF 2011
FELLOW NOMINATION FORM

DATE
NAME OF CANDIDATE

AWS MEMBER NO. YEARS OF AWS MEMBERSHIP

HOME ADDRESS
CITY STATE ZIP CODE PHONE

PRESENT COMPANY/INSTITUTION AFFILIATION
TITLE/POSITION

BUSINESS ADDRESS
CITY STATE ZIP CODE PHONE

ACADEMIC BACKGROUND, AS APPLICABLE:

INSTITUTION
MAJOR & MINOR

DEGREES OR CERTIFICATES/YEAR

LICENSED PROFESSIONAL ENGINEER: YES NO STATE

SIGNIFICANT WORK EXPERIENCE:

COMPANY/CITY/STATE POSITION YEARS

COMPANY/CITY/STATE POSITION YEARS

SUMMARIZE MAJOR CONTRIBUTIONS IN THESE POSITIONS:


IT IS MANDATORY THAT A CITATION (50 TO 100 WORDS, USE SEPARATE SHEET) INDICATING WHY THE NOMINEE SHOULD BE SELECTED AS AN AWS FELLOW ACCOMPANY NOMINATION PACKET. IF NOMINEE IS SELECTED, THIS STATEMENT MAY BE INCORPORATED WITHIN THE CITATION CERTIFICATE.

SEE GUIDELINES ON REVERSE SIDE

SUBMITTED BY: PROPOSER AWS Member No.

Print Name

The Proposer will serve as the contact if the Selection Committee requires further information. Signatures on this nominating form, or supporting letters from each nominator, are required from four AWS members in addition to the Proposer. Signatures may be acquired by photocopying the original and transmitting to each nominating member. Once the signatures are secured, the total package should be submitted.

NOMINATING MEMBER: NOMINATING MEMBER:
Print Name Print Name
AWS Member No. AWS Member No.

NOMINATING MEMBER: NOMINATING MEMBER:
Print Name Print Name
AWS Member No. AWS Member No.

SUBMISSION DEADLINE July 1, 2010
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Q: I was looking for strength of aluminum joints brazed with the standard AWS BA1-4 eutectic filler metal for design purposes. I found some papers comprising data — all of them are shear strength of Alloys 3003 and 6061 joints. However, these published strength values are in a very wide range, from 15.4 to 23.2 ksi. How can we evaluate these numbers? What strength, minimum of the range or middle of the range, can I take to calculate the projected thickness and overlap of the base metal tubes and plates? What reference source can you recommend to find out strengths of brazed joints of different metals?

A: The strength of brazed joints depends on many factors such as strengths of base metal and filler metal, overlapping size, joint clearance, brazing process parameters, defects of the joint, and even the shape of tested specimens. Therefore, published strength values may differ from each other in a great range. So, the very first advice is you can accept data of that publication that comprise testing results of the same base metals you have and that are brazed by the same process you are planning for your production. For instance, if you are going to braze tubes or sheets of A6061-T6 alloy in a vacuum with AWS BAl-4, try to find published data exactly matching the similar base metal and process.

Next point you have to pay attention to is the testing procedure: 1) shape and sizes of the specimens, 2) standard number (if mentioned), and 3) number of tested specimens. The best scenario is that the test was performed using the conventional standard AWS C3.2M/C3.2:2008, Standard Method for Evaluating the Strength of Brazed Joints. If there is no reference to the standard, you have to compare the specimen’s shape and procedure to this standard.

That is a general approach to the evaluation of references when we are looking for the strength of brazed joints. Now, let’s talk about some material science details and brazing technology in conjunction with the strength of brazed joints manufactured with the BA1-4 eutectic filler metal.

The special feature of brazing aluminum alloys with Al-Si eutectic filler metal is that both melting point of the braze (577°C) and brazing temperature (~600°C) are significantly higher than the temperature of heat treatment of aluminum alloys used as base metals. Beside, the brazing temperature is pretty close to melting temperature of base aluminum alloys. Therefore, the strength and structure of the base metal is of prime importance for the joint strength. Figure 1 shows the ratios between ultimate tensile strengths of the base A6061 alloy, the cast BAl-4 alloy, and the brazed joint made in a vacuum furnace. Despite the strength of the
base metal after solution heat treatment and aging is as high as 290 MPa (42 ksi), the strength of the joint is close to the strength of cast brazing filler metal. The postbraze solution treatment and aging significantly improve the strength of the joint — to 276 MPa (-40 ksi) — due to recovery of mechanical properties of the base metal (Ref. 1).

The strength of the base Alloy A3003 strongly depends on hardening treatment mode. The wrought Alloy A3003-H12 has tensile strength 19 ksi (131 MPa) at elongation 10%, while the wrought Alloy A3003-H14 has tensile strength 24 ksi (165.6 MPa) at elongation 18%.

We tested brazed joints of the first one in the form of sheet % in. thick and got the shear strength of joints in the range of 15.6 to 17.3 ksi (107.6 to 119.4 MPa) for joints manufactured by vacuum brazing and 12.7 to 16.8 ksi (87.6 to 116 MPa) for joints manufactured by torch brazing with the Nokoloc flux. We do not have data for the Alloy A3003-H14; however, I would expect the strength of brazed joints to be slightly better than that of the alloy A3003-H12 due to the higher strength of the base metal.

The wide range of strength values after torch brazing resulted from two factors inherent in this method of brazing: 1) local erosion of the base metal and, 2) possible local overheating of the base metal. If you have a skilled, experienced operator and a quality control system in your production, you can choose the average value of the range, which is 14.8 ksi. Otherwise, you’d better accept the lowest value 12.7 ksi for your design calculation.

There is another important reason for a wide scatter in shear strength values that was suggested by Dr. Yury Flom, NASA Goddard Flight Center. People often use different overlap lengths in their test specimens. In many cases, the overlap length is not mentioned in publications. From practical considerations, it is recommended to use only shear strength results obtained on 4T lap specimens, where T is thickness of the specimen. Shorter overlap lengths give higher shear strengths (Ref. 2). It is important to use the overlap length at which the joint becomes equally strong with the base metal (or close to it, since some joints still fail within the braze even with long overlaps).

The strength of the eutectic Al-12%Si alloy (BA1-4) goes down with increasing temperature. So, if the service temperature of brazed parts is 200°C (392°F), you should expect a significant loss in the joint’s strength, up to 50%. And likewise, if the brazed parts work in a cryogenic environment (at -196°C), the strength of brazed joints will be higher than that measured at room temperature. For special applications like these, I would advise you to test your brazed joints at the exact working temperature.

References
Much of our welding future depends on the ability of the industry to adapt and promote its technologies to new energy industries.

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■ Advances in Submerged Arc Welding of Wind Towers
Teresa Melfi - Lincoln Electric Co. - Cleveland, OH

■ Capabilities in Offshore Welding at Kiewit Offshore Services
Richard Marslender - Kiewit Offshore Services, Ltd. - Ingleside, TX

■ The Use of a Tempering Parameter for the Control of PWHT of Grade P91 and Other CESF Steels
Jeff Henry - Structural Integrity Associates - Chattanooga, TN

■ Using the Latest Technology for Heating and Welding Chrome-Moly Pipe
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■ Explosion Welding and Its Application in Downstream Oil Refineries
Michael Blakely - Dynamic Materials Corporation - Sugar Land, TX

■ Duplex Stainless Steels and Nickel-Based Alloys: An Overview
Cheryl Botti - ATI Allegheny Ludlum - Brackenridge, PA

■ Laser-Based Additive Processes for Energy – Related Applications
Todd Palmer - Pennsylvania State University - State College, PA

■ Energy Applications for Advanced Joining Processes
Ed Hansen - ESAB Welding & Cutting Products - Florence, SC

■ The Nuclear Scene
Nate Ames - Edison Welding Institute - Columbus, OH

■ Dissimilar Metal Welding
Donald J. Tillack - Tillack Metallurgical Consultants Inc. - Catlettsburg, KY

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Q: I am about to start welding procedure specification development in preparation for manufacturing a welded aluminum structure. I have only developed welding procedures to the requirements of the American Welding Society (AWS) D1.1, Structural Welding Code — Steel, with which I am very familiar. Can you please provide me with any information on the differences I will need to consider when working with the AWS D1.2, Structural Welding Code — Aluminum? Any information about areas that may cause me problems during welding procedure development would be greatly appreciated.

A: You have asked a very good question. While the process of welding procedure development for aluminum is in many ways the same as that for steel, there are some very significant differences between the requirements of the two codes. Also, there are some details associated with the qualification testing of aluminum that most certainly can cause problems if not fully understood.

Range of Material Thickness

One fundamental difference between these two codes, which is not normally a problem, but which I will mention anyway, is that the AWS D1.1 steel code has a specific limitation on thickness for which it is intended to be used. Steel less than \( \frac{3}{8} \) in. in thickness is not intended to be used with this code but rather with the AWS D1.3, Structural Welding Code — Sheet Steel. The AWS D1.2 aluminum code has no such restriction.

Prequalification of Welding Procedure Specifications

The AWS D1.1 steel code has, for many years, made use of prequalified welding procedures. The code provides the applicable requirements, which if conformed to, will allow the user to produce documented welding procedure specifications without the formal process of producing welding procedure qualification records and associated mechanical testing.

The AWS D1.2 aluminum code, on the other hand, does not have the provision for the prequalification of welding procedure specifications. All procedures developed with the AWS D1.2 aluminum code must be tested to be qualified in accordance with the code requirements. (Discussion within the AWS D1G Subcommittee on Aluminum Structures would suggest that prequalified welding procedure specifications may be something we see in the future.)

Guided Bend Testing

There are some significant differences between the procedures used within these codes for guided bend testing. The particular differences that I would like to point...
out are those related to the special bending conditions that are required when qualifying procedures in accordance with the AWS D1.2 aluminum code. Because of the physical characteristics of some aluminum alloys, there are some very specific differences between how some alloys are bend tested.

- The M23 base alloys (6xxx series) may be bend tested under any of the two conditions, as-welded or annealed. In the as-welded condition, if the test sample is over ⅛ in. (3 mm), its thickness shall be reduced to ⅜ in. (3 mm) thickness before bending and then bent over a diameter of 2⅜ in. (52 mm). Specimens of less than ⅛ in. (3 mm) thickness shall be bent over a diameter of 16% thickness. Annealed specimens of M23 material of ⅛ in. (10 mm) thickness shall be bent over a 6% thickness diameter. The annealing practice that is conducted to the sample before bending is as follows: Hold for 2 to 3 h at 775°F (410°C) then cool at 50°F/h (28°C/h) to 500°F (260°C). The rate of cooling below 500°F (260°C) is unimportant.

- Welds made with M24 (2xxx series) material shall be annealed and bent over an 8 thickness diameter.

- Welds made with M27 (7xxx series) material shall be bend tested within two weeks of welding. (This requirement is associated with the 7xxx material’s ability to substantially improve mechanical properties through natural aging, precipitation hardening at room temperature.)

- Welds made with F23 (4xxx series) filler metal on any M21, M22, or M23 (1xxx, 3xxx, 5xxx, or 6xxx series) material shall be bent in the same manner as M23 material.

One other suggestion with regard to bend testing is to pay particular attention to the note provided within the AWS D1.2 aluminum code that states that the wrap-around guided bend fixture is the preferred method of bend testing aluminum weldments — Fig. 1. Although the plunger type guided bend test fixture is an option for use within the code, I suggest that you use the wraparound fixture, particularly for the higher-strength materials.

As can be seen above, the special bend testing requirements for aluminum are rather extensive. I can assure you that if these requirements are not followed, there is a high probability that problems will be encountered during procedure qualification testing.

Reduced Section Tension Tests

One other item to consider is related to obtaining the minimum tensile strength requirements when conducting reduced section tension tests. Minimum tensile strength requirements for aluminum are based on the annealed or overaged condition of the weld heat-affected zone (HAZ) dependent on whether welding the nonheat treatable or the heat-treatable aluminum alloys. Be aware that when welding the heat-treatable aluminum alloys, particularly the 6xxx series, care should be exercised to prevent the overheating of the base alloy during the welding process. Careful adherence to interpass temperature should be maintained, and preheating limits should be observed to prevent excessive welding temperatures. Consideration should be given to welding parameters, amps, volts, and travel speeds that govern heat input during the welding process. These parameters may need to be adjusted in order to lower the overall heat input during welding. The tensile strength of the HAZ of the heat-treatable alloys can be substantially lowered (to levels lower than that acceptable to the code) if welded with excessive heat input.

Conclusion

Yes, there are some differences between the AWS D1.1 and AWS D1.2 codes in terms of welding procedure qualification requirements. These differences are to be expected as they address the procedure qualification of two substantially different materials. It has been my experience that the two most common areas of difficulty experienced during the welding procedure development process for aluminum are associated with bend testing and tension tests, which I have listed above.

There are also other issues such as porosity and incomplete fusion, which tend to be more prevalent in aluminum than in steel. However, these are more related to specific preweld preparation methods and welding techniques, and not directly associated with differences in code requirements.
Fahrenheit, Celsius Temperatures of Thermal Gradients Questioned


The article is an important guide to the welding and postweld heat treating attention needed when fabricating these advanced steels. However, there are two errors within the article, which Newell may wish to revise. While his translation of degrees Fahrenheit into the metric degrees Celsius is accurate for the actual PWHT temperatures, the range calculated between the minimum and maximum temperatures allowed and the range of thermal gradients are incorrect, due apparently to the use of the equation to calculate actual temperatures, rather than temperature differences.

The range between minimum required and maximum allowed PWHT temperatures is stated on page 34 as 50° to 75°F, but translated as 10° to 24°C. The actual range is 28° to 42°C. Similarly, the possible thermal gradient from outside to inside of a thick section is stated on page 35 as 70° to 200°F, but incorrectly translated as 21° to 93°C. The actual range is 39° to 111°C.

B. M. Patchett

Dr. Patchett is correct. My intent in the article was to illustrate that the actual range of temperatures could be quite tight in the one instance while thermal gradients through the wall thickness could be large. In fact, the actual ranges experienced could be much tighter or larger depending on the composition, differences in component thicknesses, or geometries.

If you calculate the Celsius “equivalent” as I did from just the degrees Fahrenheit, the ranges are as shown. However, the actual range in Celsius would indeed be much larger as suggested. This is the curse of listing multiple units of measure or attempting to show a range with multiple units. Metric conversion calculators should only be used for actual temperatures. For a temperature difference, whether a tolerance or range, simply multiply degrees Fahrenheit by 5/9 to get degrees Celsius.

William F. Newell Jr.

Welding Career Article Admired by Instructor


For a few moments, while reading your fine article, I thought a joke had been played on me. How did this fellow get into my classroom and copy my stuff? Your in-depth models and research hit right on the nail head of what I’ve done for many years. Posted on my bulletin board for the last 25 years is a basic education plan that I share with my students:

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1. Attitude (“I want to learn.”)
2. Facts (from books and teachers)
3. Skills (practice good enough to teach it, then teach it)

Now I know where this concept comes from. At the beginning of each course, I explain these to the new students and give examples of success stories of former students. I also invite former students to talk to the new students and share with them their successes. After safety training, once in the shop, I let them explore simple learning tasks using welding methods with a high degree of self satisfaction. This involves things that they can share with parents and others. The fire is now lit!

I would love to see the graphic models in your article a little larger. Our state’s welding competency models are also geared toward manufacturing training standards even though my students end up in construction trades about 75% of the time.

My courses will now look into your career ladder profile as a model to use for a welding student’s career pathway for training and education. This is one of the best works I’ve seen in the Welding Journal in my 23 years of AWS membership and 25 years of teaching. Thanks for sharing the Web sites and for a great job you did with this.

Robert Thomas
Chairman, AWS Holston Valley Section

Welding Instructor,
Unicoi County High School
Erwin, Tenn.

Thank you so much for this very encouraging letter. This work has indeed been a labor of love. I fully agree with you about the three tenants.

I have been fortunate after my retirement from The Ohio State University to be engaged by the National Science Foundation Weld-Ed Center, who paid for the competency model surveys that were a part of this article. These diagrams are being posted on the Weld-Ed Web site.

It is amusing that the e-mail I received just before yours was from my high school alumni association. A letter from one of my classmates (class of 1963) complained about how gangs and violence and classroom disruptions have changed our New York high school into an environment unconducive to learning. But I agree with you that if we can reinstate your three tenants, we can again help our youth progress into a career where they can excel. Showing them a career ladder gives hope to this nation’s most valuable resource — our youth.

I am committed to this goal and from your letter, I know you are as well. Thank you; together, we will provide the “helping hand” needed by our youth.

David W. Dickinson
Chairman, AWS Holston Valley Section
Welding Instructor, Unicoi County High School
Erwin, Tenn.
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— continued on page 31
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Fiscal 2009 year in review —
Gesana Villegas, Associate Executive Director – Finance

Highlights for 2009

Despite the economic recession in 2009, AWS was able to have a year of growth. As our Treasurer Robert G. Pali states in his editorial on page 4, it was a difficult year for the welding industry as most welding-related businesses suffered declines ranging from 25 to 35%. Our 2009 operational performance remained strong and we achieved new historical marks as noted in our audited financial statements. Our total operating revenues exceeded $26 Million and one of our departments surpassed $10 Million in revenues. The surplus of revenues over expenses was 2.5% lower than 2008; however, we were very fortunate to be able to generate a nice surplus despite a sluggish economy. We were able to see signs of recovery in the marketplace as evidenced by the rate of returns on our investment portfolio. The operating fund transferred $6.5 Million to the reserve fund since January 2009 due to the positive cash flows. Our positive financial results helped us achieve a new milestone in terms of our total net assets, which increased by $13.1 Million or 46.7% to an all-time high of $41.3 Million. Our financial position is the highest in its 90-year history.

AWS Foundation Highlights for 2009

The AWS Foundation was in its fourth year of the Capital Campaign – “Welding for the Strength of America” and the AWS Welder Workforce Development Program, which was initiated by a pledge of $1 Million from two distinctive companies at the end of 2006. The campaign was kicked off by a generous gift from a donor in 2006. In 2008, another elite company donated $300,000 designated for the AWS Welder Workforce Development Program. Since the campaign began, a total of $3.42 Million has been raised through December 31, 2009. This total excludes AWS contribution in the amount of $1.6 Million ($1.1 Million approved in 2008 to increase scholarships awards to future welding professionals and $500K donated in 2006).

In general, contributions were impacted in 2009 as the charitable giving index dropped in connection with the economic slowdown. The AWS Foundation secured alternative sources of funds through its partnership with Lorain Community College’s National Center for Welding Education & Training (Weld-Ed). Weld-Ed was created as a result of a $5 Million grant from the National Science Foundation. The support received from Weld-Ed has funded various projects such as the InDemand Magazine, www.CareersinWelding.com, and a welding school locator. The Careers in Welding In demand magazine has been completed and distributed. The www.CareersinWelding.com Web site was completed and launched in January 2010. The Careers website was completed first with additional sites to follow including www.JobsInWelding.com and www.EducatorsinWelding.com. All of the sites will be integrated into the AWS website as a complement/supplement. The capital campaign amount to date mentioned above excludes the funding received from Weld-Ed, which amounted to approximately $255,000 for fiscal year 2009 to support project development for the Weld-Ed grant.

For the 2009–2010 academic term, the AWS Foundation awarded nearly $390,000 in scholarships to more than 400 students. Since 1991, when the AWS Foundation began awarding scholarships, more than $4.5 million has been awarded to approximately 3,000 students. The AWS Foundation continues to receive more requests each year for scholarship funds. During 2009, the AWS Foundation was able to award for the first time, grants to companies/schools for welder workforce development. With a lot still to be done to address the critical workforce shortage in the welding industry, the AWS Foundation continues to diligently seek funding focusing on welder workforce from “Recruitment to Retire.” AWS continues to be committed to leading the effort to provide trained workers at all levels for the welding profession. One hundred percent of the contribution will be used to support welder workforce development and educational opportunities for welders and you can assist in this effort. You can help in the mission of alleviating the welder workforce shortage; please contact Sam Gentry at sgentry@aws.org.

AWS Highlights for 2009

Convention – Our annual convention was affected by economic conditions and we experienced a decline in square footage in comparison to the 2008 Show. The number of exhibitors decreased by 12.4% compared to the square footage drop of 18.1%, an indication that exhibitors are still attending the show, however are downsizing in square footage. This is the fifth FABTECH International and AWS Welding show. The Show was held in November 2009 in Chicago. The AWS/WELDMEX show was held in June 2009 in Monterrey, Mexico. The 2009 show was co-located with FABTECH Mexico and METALFORM. Although the show was impacted by the flu incident and the economic downturn, the show was successful with attendance at 6,100.

Membership – Total Membership was at a record high of 60,050 and has increased by 4,978, or 9% over a one-year period. The retention rate on membership renewals is at 80.6%. The “welder” recruitment campaign was launched in February 2009. There are 1,634 members classifying themselves as “welders” who have joined AWS since the program was launched in February 2010, bringing the total of welders as members to 4,619.

Certification – The Certification Department continued to be the top revenue-producing business.

— Continued on page 35
unit and it is the first department to surpass $10 Million in revenues. Total Certified Welding Inspectors (CWIs) is at an all-time high of 30,909. CWI international certification revenues increased from $2.2 Million in 2008 to $3.2 Million in 2009, a growth of 47.3%. Spanish, Chinese and Portuguese language assisted CWI exams are now available to international agents administering the exams. New agents in Colombia, Ecuador, Bolivia, Saudi Arabia and Peru have been added.

Technical – Hard copy book sales and electronic/subscription sales of document revenues continue to produce favorable results. AWS royalty revenues were at $3.6 Million in comparison to $2.9 Million in 2007, an increase of 21%, both non-D1.1 years. Since the outsourcing of our order fulfillment services, we have seen positive financial results. Their dedication to AWS publications has resulted in improved customer service.

Publications – The downturn in the economy set a challenge for this department. Revenues were $1.4 Million, a drop of 21.7%. The number of ad pages decreased by 19.9%. The Spanish Welding Journal generated $106K in revenues, an increase of 68.4% in comparison to 2008. Three issues were published in 2009 versus two issues in 2008. An increase in the Spanish audience has been noted.

In Summary

The 2009 operational results added strength to our financial position. We are cautiously optimistic that fiscal year 2010 will achieve positive financial results. As we gradually recover from the recent economic recession, which fortunately did not impact us on a great scale, we will continue to monitor our key financial indicators on a regular basis to ensure we are making prudent financial decisions going forward.

Our strong Statement of Financial Position continues to gives us the ability to provide and fund future programs and opportunities for our members, volunteers, and the welding industry. We strive on providing the highest customer service for our members.

The AWS Board of Directors and AWS Foundation Trustees would like to express their appreciation to all of our members, volunteers, industry leaders, and the cooperation of organizations with which we share common goals in helping us make this a successful year as we begin to see economic stability.

Growth at a Glance
REPORT OF INDEPENDENT CERTIFIED PUBLIC ACCOUNTANTS

To the Board of Directors
American Welding Society, Inc. and AWS Foundation

We have audited the accompanying combining statement of financial position of American Welding Society, Inc. and AWS Foundation (the “Organizations”) as of December 31, 2009, and the related combining statements of activities and cash flows for the year ended December 31, 2009. These combining financial statements are the responsibility of the Organizations’ management. Our responsibility is to express an opinion on these combining financial statements based on our audit. The prior year summarized comparative information has been derived from American Welding Society, Inc. and AWS Foundation’s 2008 combining financial statements and, in our report dated April 1, 2009, we expressed an unqualified opinion on those combining financial statements.

We conducted our audit in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the combining financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the combining financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

In our opinion, the combining financial statements referred to above present fairly, in all material respects, the financial position of American Welding Society, Inc. and AWS Foundation as of December 31, 2009, and the changes in their net assets and their cash flows for the year then ended in conformity with accounting principles generally accepted in the United States of America.

Morrison, Brown, Argiz & Farra, LLP
Certified Public Accountants
Miami, Florida
April 15, 2010
# AMERICAN WELDING SOCIETY, INC. AND AWS FOUNDATION
## COMBINING STATEMENT OF FINANCIAL POSITION

### FOR THE YEAR ENDED DECEMBER 31, 2009 (WITH COMPARATIVE TOTALS FOR DECEMBER 31, 2008)

<table>
<thead>
<tr>
<th></th>
<th>Operating Fund</th>
<th>Reserve Fund</th>
<th>AWS Foundation</th>
<th>Total 2009</th>
<th>Total 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASSETS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash and cash equivalents</td>
<td>$1,020,415</td>
<td>$100</td>
<td>$155,244</td>
<td>$1,175,759</td>
<td>$1,453,769</td>
</tr>
<tr>
<td>Certificates of deposit</td>
<td>2,166,958</td>
<td>51,187</td>
<td>-</td>
<td>2,218,065</td>
<td>2,252,444</td>
</tr>
<tr>
<td>Short term mutual bond funds</td>
<td>-</td>
<td>1,017,232</td>
<td>-</td>
<td>1,017,232</td>
<td>-</td>
</tr>
<tr>
<td>Accounts and other receivables, net of allowance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>for doubtful accounts of approximately $304,000 and $189,000 at December 31, 2009 and 2008, respectively</td>
<td>2,897,249</td>
<td>-</td>
<td>-</td>
<td>2,897,249</td>
<td>2,006,433</td>
</tr>
<tr>
<td>Pledges receivable</td>
<td>-</td>
<td>-</td>
<td>352,320</td>
<td>352,320</td>
<td>714,120</td>
</tr>
<tr>
<td>Inventory</td>
<td>60,240</td>
<td>-</td>
<td>-</td>
<td>60,240</td>
<td>235,908</td>
</tr>
<tr>
<td>Prepaid and other assets</td>
<td>928,094</td>
<td>-</td>
<td>77,168</td>
<td>1,005,262</td>
<td>936,521</td>
</tr>
<tr>
<td>Deposits and other receivables</td>
<td>36,145</td>
<td>-</td>
<td>153,469</td>
<td>192,614</td>
<td>23,261</td>
</tr>
<tr>
<td>Investments</td>
<td>-</td>
<td>25,296,487</td>
<td>7,884,592</td>
<td>33,181,079</td>
<td>21,319,331</td>
</tr>
<tr>
<td>Property and equipment, less accumulated depreciation</td>
<td>2,564,059</td>
<td>-</td>
<td>-</td>
<td>2,564,059</td>
<td>2,564,812</td>
</tr>
<tr>
<td><strong>TOTAL ASSETS</strong></td>
<td>$9,677,060</td>
<td>$26,364,956</td>
<td>$8,023,389</td>
<td>$31,065,409</td>
<td>$31,506,589</td>
</tr>
<tr>
<td><strong>LIABILITIES:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts payable and accrued expenses</td>
<td>$1,130,643</td>
<td>$100</td>
<td>$50,104</td>
<td>$1,180,747</td>
<td>$867,278</td>
</tr>
<tr>
<td>Deferred membership, subscription and seminar income</td>
<td>2,178,256</td>
<td>-</td>
<td>-</td>
<td>2,178,256</td>
<td>2,474,752</td>
</tr>
<tr>
<td><strong>TOTAL LIABILITIES</strong></td>
<td>3,308,899</td>
<td>-</td>
<td>50,104</td>
<td>3,359,003</td>
<td>3,342,030</td>
</tr>
<tr>
<td><strong>COMMITMENTS AND CONTINGENCIES (NOTE 11)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NET ASSETS:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrestricted</td>
<td>6,368,161</td>
<td>26,364,956</td>
<td>78,088</td>
<td>32,811,205</td>
<td>20,329,668</td>
</tr>
<tr>
<td>Temporarily restricted</td>
<td>-</td>
<td>-</td>
<td>3,846,163</td>
<td>3,846,163</td>
<td>3,278,062</td>
</tr>
<tr>
<td>Permanently restricted</td>
<td>-</td>
<td>-</td>
<td>4,649,038</td>
<td>4,649,038</td>
<td>4,565,839</td>
</tr>
<tr>
<td><strong>TOTAL NET ASSETS</strong></td>
<td>6,368,161</td>
<td>26,364,956</td>
<td>8,573,289</td>
<td>41,306,406</td>
<td>28,164,569</td>
</tr>
<tr>
<td><strong>TOTAL LIABILITIES AND NET ASSETS</strong></td>
<td>$9,677,060</td>
<td>$26,364,956</td>
<td>$8,823,389</td>
<td>$44,665,409</td>
<td>$31,506,589</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these financial statements.
### OPERATING ACTIVITIES:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year 2009</th>
<th>Year 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convention</td>
<td>$1,889,859</td>
<td>$1,530,042</td>
</tr>
<tr>
<td>Educational Services</td>
<td>$359,817</td>
<td>$357,133</td>
</tr>
<tr>
<td>Marketing and corporate communications</td>
<td>$357,133</td>
<td>$209,766</td>
</tr>
<tr>
<td>International activities and governmental affairs</td>
<td>$6,375</td>
<td>$209,766</td>
</tr>
<tr>
<td>AWS Foundation</td>
<td>$551,483</td>
<td>$551,483</td>
</tr>
<tr>
<td>WEMCO</td>
<td>$160,348</td>
<td>$80,665</td>
</tr>
<tr>
<td>RWMA</td>
<td>$2,929,600</td>
<td>$1,376,669</td>
</tr>
<tr>
<td>Membership</td>
<td>$1,530,042</td>
<td>$2,759,751</td>
</tr>
<tr>
<td>Certification</td>
<td>$4,006,057</td>
<td>$7,341,741</td>
</tr>
<tr>
<td>Technical</td>
<td>$3,648,924</td>
<td>$4,283,711</td>
</tr>
<tr>
<td>Publications</td>
<td>$250,000</td>
<td>$209,766</td>
</tr>
<tr>
<td>Administration</td>
<td>$17,550</td>
<td>$17,550</td>
</tr>
<tr>
<td>Board approved programs</td>
<td>$65,000</td>
<td>$65,000</td>
</tr>
<tr>
<td>TOTAL OPERATING FUND BEFORE TRANSFER</td>
<td>$26,049,776</td>
<td>$7,032,705</td>
</tr>
<tr>
<td>INTERFUND TRANSFER</td>
<td>$6,500,000</td>
<td>$6,500,000</td>
</tr>
<tr>
<td>TOTAL OPERATING FUND AFTER TRANSFER</td>
<td>$26,049,776</td>
<td>$582,705</td>
</tr>
</tbody>
</table>

### RESERVE:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year 2009</th>
<th>Year 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain (loss) on investments</td>
<td>$4,005,145</td>
<td>($4,005,145)</td>
</tr>
<tr>
<td>TPPS, Inc.</td>
<td>$2,129</td>
<td>$2,129</td>
</tr>
<tr>
<td>Interest and dividends</td>
<td>$626,610</td>
<td>$626,610</td>
</tr>
<tr>
<td>TOTAL RESERVE FUND BEFORE TRANSFER</td>
<td>$4,633,884</td>
<td>$4,633,884</td>
</tr>
<tr>
<td>INTERFUND TRANSFER</td>
<td>$6,500,000</td>
<td>$6,500,000</td>
</tr>
<tr>
<td>TOTAL RESERVE FUND AFTER TRANSFER</td>
<td>$11,133,884</td>
<td>$11,133,884</td>
</tr>
</tbody>
</table>

### AWS FOUNDATION:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year 2009</th>
<th>Year 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donations</td>
<td>$286,005</td>
<td>$173,245</td>
</tr>
<tr>
<td>Interest</td>
<td>$118,006</td>
<td>$81,107</td>
</tr>
<tr>
<td>Gain (loss) on investments</td>
<td>$854,422</td>
<td>$487,044</td>
</tr>
<tr>
<td>Net assets released from restrictions by satisfaction of purpose restrictions</td>
<td>$183,895</td>
<td>($183,895)</td>
</tr>
<tr>
<td>Operating expenses</td>
<td>($154,500)</td>
<td>($154,500)</td>
</tr>
<tr>
<td>Scholarships</td>
<td>($283,842)</td>
<td>($283,842)</td>
</tr>
<tr>
<td>Fellowships</td>
<td>($75,892)</td>
<td>($75,892)</td>
</tr>
<tr>
<td>Fundraising and other</td>
<td>($104,776)</td>
<td>($104,776)</td>
</tr>
<tr>
<td>TOTAL AWS FOUNDATION FUND BEFORE TRANSFER</td>
<td>$1,397,098</td>
<td>$681,010</td>
</tr>
<tr>
<td>INTERFUND TRANSFER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL AWS FOUNDATION FUND AFTER TRANSFER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Net Assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Assets, Beginning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Assets, Ending</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of these financial statements.
## COMBINING STATEMENT OF CASH FLOWS

**FOR THE YEAR ENDED DECEMBER 31, 2009 (WITH COMPARATIVE TOTALS FOR THE YEAR ENDED DECEMBER 31, 2008)**

<table>
<thead>
<tr>
<th>Operating Fund</th>
<th>Reserve Fund</th>
<th>AWS Foundation</th>
<th>Total 2009</th>
<th>Total 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CASH FLOWS FROM OPERATING ACTIVITIES:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in net assets before interfund transfer</td>
<td>$7,032,765</td>
<td>$4,633,884</td>
<td>$1,475,248</td>
<td>$13,141,837</td>
</tr>
<tr>
<td>Adjustments to reconcile change in net assets to net cash provided by operating activities:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Gain) loss on investments</td>
<td>-</td>
<td>(4,005,145)</td>
<td>(1,346,096)</td>
<td>(5,351,241)</td>
</tr>
<tr>
<td>Depreciation</td>
<td>218,852</td>
<td>-</td>
<td>-</td>
<td>218,852</td>
</tr>
<tr>
<td>Provision for losses on accounts receivable</td>
<td>115,000</td>
<td>-</td>
<td>-</td>
<td>115,000</td>
</tr>
<tr>
<td>Changes in operating assets and liabilities:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in accounts and other receivables</td>
<td>(1,005,816)</td>
<td>-</td>
<td>-</td>
<td>(1,005,816)</td>
</tr>
<tr>
<td>Decrease in pledges receivable</td>
<td>-</td>
<td>361,200</td>
<td>361,200</td>
<td>237,230</td>
</tr>
<tr>
<td>Decrease (increase) in inventory</td>
<td>175,668</td>
<td>-</td>
<td>-</td>
<td>175,668</td>
</tr>
<tr>
<td>(Increase) decrease in prepaid and other assets</td>
<td>(72,501)</td>
<td>-</td>
<td>3,760</td>
<td>(68,741)</td>
</tr>
<tr>
<td>(Increase) decrease in deposits and other receivables</td>
<td>(22,412)</td>
<td>-</td>
<td>(146,941)</td>
<td>(169,353)</td>
</tr>
<tr>
<td>Increase (decrease) in accounts payable and accrued expenses</td>
<td>263,365</td>
<td>-</td>
<td>50,104</td>
<td>313,469</td>
</tr>
<tr>
<td>(Decrease) increase in deferred membership, subscription and seminar income</td>
<td>(286,496)</td>
<td>-</td>
<td>-</td>
<td>(296,496)</td>
</tr>
<tr>
<td><strong>NET CASH PROVIDED BY OPERATING ACTIVITIES</strong></td>
<td>6,408,365</td>
<td>628,739</td>
<td>397,305</td>
<td>7,434,409</td>
</tr>
</tbody>
</table>

| **CASH FLOWS FROM INVESTING ACTIVITIES:** | | | | |
| Decrease (increase) in certificate of deposits | 36,478 | (2,129) | - | 34,349 | (107,088) |
| Purchases of property and equipment | (218,869) | - | - | (218,869) | (211,022) |
| Increase in short term bonds | - | (1,074,232) | - | (1,074,232) | - |
| Purchases of investment securities | - | 6,108,378 | (401,159) | 6,709,527 | (7,529,725) |
| **NET CASH USED IN INVESTING ACTIVITIES** | (182,531) | (7,128,239) | (401,159) | (7,721,949) | (7,867,955) |

| **CASH FLOWS FROM FINANCING ACTIVITIES:** | | | | |
| Interfund transfers | (6,500,000) | 6,500,000 | - | - | - |
| **NET CASH (USED IN) PROVIDED BY FINANCING ACTIVITIES** | (6,500,000) | 6,500,000 | - | - | - |

| **NET DECREASE IN CASH AND CASH EQUIVALENTS** | (274,156) | - | (3,854) | (278,010) | (67,280) |
| **CASH AND CASH EQUIVALENTS, BEGINNING** | 1,294,571 | 100 | 159,688 | 1,453,769 | 1,521,150 |
| **CASH AND CASH EQUIVALENTS, ENDING** | $1,020,415 | $100 | $155,244 | $1,175,759 | $1,453,769 |

The accompanying notes are an integral part of these financial statements.
NOTE 1. NATURE OF ORGANIZATION AND SIGNIFICANT ACCOUNTING POLICIES

Organization and Purpose
The accompanying combining financial statements include the accounts of American Welding Society, Inc. (“AWS”), its wholly-owned subsidiary TPSS, Inc. and its affiliate, AWS Foundation (“Foundation”) (collectively, the “Organizations”).

All material inter-organization accounts and transactions have been eliminated in the combination. American Welding Society, Inc. and AWS Foundation are not-for-profit entities, exempt from income tax under Section 501(c)(3) of the Internal Revenue Code and are primarily engaged in welding technology, education and research activities. For income tax purposes, publication advertising revenue and rental income are considered “unrelated business income” and subject to income tax. TPSS, Inc., a taxable organization, engages in profit-oriented activities.

FASB Accounting Standards Codification
In June 2009, the Financial Accounting Standards Board (“FASB”) issued “The FASB Accounting Standards Codification and Hierarchy of Generally Accepted Accounting Principles,” which establishes the FASB Accounting Standards Codification (the “ASC”) as the source of authoritative principles recognized by the FASB to be applied by nongovernmental entities in the preparation of financial statements in conformity with generally accepted accounting principles (“GAAP”). This standard is effective for financial statements issued for interim and annual periods ending after September 15, 2009. The adoption of this accounting pronouncement did not have a material impact on the Organizations’ combining financial statements.

Basis of Accounting
The financial statements of the Organizations are prepared in accordance with the accrual basis of accounting. The accounts of the Organizations are maintained for internal reporting purposes in accordance with the principles of fund accounting.

Basis of Presentation
The financial statements of the Organizations have been prepared on the accrual basis of accounting and presented in accordance with an accounting standard issued by the FASB on Financial Statements of Not-For-Profit Organizations. The Organizations are required to classify their resources into three separate classes of net assets: unrestricted, temporarily restricted, and permanently restricted. In addition, the Organizations are required to present a statement of cash flows. The three classes of net asset categories are as follows:

Unrestricted — Net assets which are free of donor-imposed restrictions; all revenues, gains, and losses that are not changes in permanently or temporarily restricted net assets.

Temporarily Restricted — Net assets where the use by the Organizations is limited by donor-imposed stipulations that either expire by the passage of time or that can be fulfilled or removed by actions of the Organizations pursuant to those stipulations.

Permanently Restricted — Net assets where the use by the Organizations is limited by donor-imposed stipulations that neither expire with the passage of time nor can be fulfilled or otherwise removed by actions of the Organizations.

The transactions of the Organizations are categorized into separate funds. The purpose and net asset classification are as follows:

Operating — This fund is used to account for all unrestricted net assets of American Welding Society, Inc., except for those accounted for in the reserve fund. The operating fund also provides administrative support to the AWS Foundation.

Reserve — This fund is used to account for Board designated reserve funds which are to be used to supplement the cash needs of the operating fund and to account for the activities of TPSS, Inc.

AWS Foundation — AWS Foundation’s temporarily restricted net assets consists of donor-restricted contributions to be used for awards and scholarships. Permanently restricted net assets consist solely of an endowment fund.

Membership Fees and Services
Membership and subscription revenues are deferred when received and recognized as revenue over the life of the membership and subscription.

Contributions
In accordance with an accounting standard issued by the FASB, contributions received or made, including promises to give or pledges, are recognized at fair value in the period in which they are received or made.

Support that is restricted by the donor is reported as an increase in unrestricted net assets if the restriction expires in the reporting period in which the support is recognized. All other donor-restricted support is reported as an increase in temporarily or permanently restricted net assets, depending on the nature of the restriction. When a restriction expires (that is, when a stipulated time restriction ends or purpose restriction is accomplished), temporarily restricted net assets are reclassified to unrestricted net assets and reported in the Combining Statement of Activities as “Net assets released from restrictions”.

Promise to Give
Contributions are recognized when the donor makes a promise to give to the Organizations, that is, in substance, unconditional. All other donor-restricted contributions are reported as increases in temporarily or permanently restricted net assets depending on the nature of the restrictions.

When a restriction expires, temporarily restricted net assets are transferred to unrestricted net assets. The Organizations had unconditional promises to give of $352,920 as of December 31, 2009 (NOTE 2).

The Organizations use the allowance method to determine the estimated unconditional promise to give that are doubtful of collection. The allowance is based on prior years’ experience and management’s analysis of specific promises made.

Cash Equivalents
The Organizations consider all highly liquid investments with an initial maturity of three months or less to be cash equivalents.

Certificates of Deposit
At December 31, 2009, the Organizations had various
Note 1. Nature of Organization and Significant Accounting Policies (Continued)

Certificates of Deposit amounting to $2,218,095. The Certificates of Deposit bear interest between 1.25% and 1.95% and mature at various dates through August 23, 2010.

Investments

The Organizations report their investments under an accounting standard issued by the FASB on accounting for certain investments held by not-for-profit organizations. Under the standard, a not-for-profit organization is required to report investments in equity securities with readily determinable fair values and all investments in debt securities at fair value.

Purchased securities are stated at fair market value based on the most recently traded price of the security at the financial statement date. Donated securities are recorded at fair value and sold immediately. Realized and unrealized gains and losses are recorded in the Combining Statement of Activities.

Risk and Uncertainties

The Organizations have investments in mutual funds that are exposed to various risks, such as interest rate, market and credit risk. Due to the level of risk associated with certain investment securities and the level of uncertainty related to changes in the value of investment securities, it is at least reasonably possible that changes in risks in the near term would materially affect the Combining Statement of Activities. The Organizations, through their investment advisor, monitor the Organizations’ investments and the risks associated on a regular basis, which the Organizations believe minimizes these risks.

Property and Equipment

Property and equipment are defined by the Organizations as assets with an initial, individual cost of more than $1,000 and an estimated useful life in excess of one year. Property and equipment is stated at cost and is depreciated using the straight-line method over the following estimated useful lives of the respective assets:

<table>
<thead>
<tr>
<th>Asset Type</th>
<th>Estimated Useful Lives (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building and improvements</td>
<td>14-29</td>
</tr>
<tr>
<td>Furniture and equipment</td>
<td>5-7</td>
</tr>
<tr>
<td>Software</td>
<td>3</td>
</tr>
</tbody>
</table>

Inventory

Inventory consists primarily of work-in-process relating to various publications and is valued at cost. Cost is determined by the actual expenditures incurred in the production process.

Concentration of Credit Risk

Financial instruments that potentially subject the Organizations to a concentration of credit risk are cash, investments and certificates of deposit. The Organizations place their temporary cash and cash equivalents with high quality financial institutions. At times, cash deposits may be in excess of the Federal Deposit Insurance Corporation (“FDIC”) insured limits. The Organizations’ investments are subject to the normal “market risks” of these types of investments, which are traded in equity markets.

Volunteer Services

A large number of people have contributed significant amounts of time to the activities of the Organizations. Since these contributions do not meet the criteria for revenue recognition, they are not reflected in the Combining Statement of Activities.

Allocation of Expenses

The cost of performing the Organizations’ various activities have been summarized on a functional basis in the accompanying Combining Statement of Activities. Certain occupancy costs have been allocated among the activities benefited.

Prepaids and Other Assets

Prepaids and other assets consist primarily of an interest in a trade show (see Note 12) and work-in-process costs relating to various publications that have not yet been released for distribution. Once the publication is complete and ready for its intended use, the costs are amortized over the life of the publications, usually between two to three years. Additionally, expenditures which relate to programs for the next fiscal year are reported as a prepaid asset and are expensed during the next year as the related program function takes place.

Impairment of Long-Lived Assets

The carrying value of long-lived assets is reviewed if the facts and circumstances indicate that they may be impaired. The Organizations perform their review by comparing the carrying amounts of long-lived assets to the estimated undiscounted cash flows relating to such assets. If any impairment in the value of the long-lived assets is indicated, the carrying value of the long-lived assets is adjusted to reflect such impairment based on the fair value of the impaired assets or an estimate of fair value based on discounted cash flows.

Use of Estimates

The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Income Taxes

American Welding Society, Inc. and AWS Foundation are not-for-profit corporations and are exempt from federal income taxes under Section 501(c)(3) of the Internal Revenue Code. Accordingly, no provision for federal or state income tax is required for revenues derived from its tax-exempt function. The Organizations are taxed on unrelated business income less the related expenses. During the year ended December 31, 2009, there was no net income generated from unrelated business activities.

In the unlikely event an uncertain tax position existed in which the Organizations could incur corporate income tax management would evaluate whether there is a probability that the uncertain tax position taken would be sustained upon examination by a taxing authority. Reserves for uncertain tax positions would then be recorded if management determined it is probable either a position would not be
NOTE 1. NATURE OF ORGANIZATION AND SIGNIFICANT ACCOUNTING POLICIES (CONTINUED)

sustained upon examination or if a payment would have to be made to a taxing authority and the amount was reasonably estimable. As of December 31, 2009, management does not believe it has any uncertain tax positions which would result in the Organizations having a tax liability to a taxing authority.

Recently Adopted Accounting Pronouncements

Net Asset Classification of Funds

In February 2008, the FASB issued authoritative guidance on the net classification of donor-restricted endowment funds for a not-for-profit that is subject to an enacted version of the Uniform Prudent Management of Institutional Funds Act ("UPMIFA") of 2006. As of April 15, 2010, the state of Florida had not adopted the enacted version of the UPMIFA. This guidance improves disclosures about a Foundation's endowment funds (both donor-restricted and board designated) whether or not the Foundation is subject to UPMIFA (see NOTE 10). Exempt organizations are required to follow the laws and regulations of the Florida Uniform Management of Institutional Funds Act ("FUMIFA"). The provisions of this pronouncement shall be effective for fiscal years ending after December 15, 2008 and have been adopted by the Organizations (NOTE 10).

Fair Value Measurements

On January 1, 2008, the Organizations adopted the provisions of an accounting standard on the fair value measurements of financial assets and financial liabilities and for fair value measurements of nonfinancial items that are recognized or disclosed at fair value in the financial statements on a recurring basis. The standard defines fair value and also establishes a framework for measuring fair value and expands disclosures about fair value measurements (NOTE 4). In February 2008, the FASB issued guidance, which excludes accounting for leases and certain other accounting pronouncements that address fair value measurements from the scope of the accounting standard. The effective date of the accounting standard was delayed until fiscal years beginning after November 15, 2008 for all nonfinancial assets and nonfinancial liabilities that are recognized or disclosed at fair value in the financial statements on a nonrecurring basis.

In April 2009, the FASB issued guidance which provides guidelines for making fair value measurements more consistent with the principles presented in the original standard. The guidance is effective for interim and annual periods ending after June 15, 2009, with early adoption permitted for periods ending after March 15, 2009. The Organizations have considered the guidance in the standard in its determination of estimated fair values during 2009.

Subsequent Events

In May 2009, the FASB issued an accounting standard which establishes general standards of accounting for and disclosure of events that occur after the balance sheet date but before financial statements are issued or ready to be issued. The standard was adopted for the year ended December 31, 2009. The adoption did not have a material impact on the Organizations' financial statements. The Organizations have evaluated subsequent events through April 15, 2010 which is the date the financial statements were available to be issued.

Recently Issued Accounting Pronouncements

Not-for-Profit Entities: Mergers and Acquisitions

In April 2009, the FASB issued an accounting standard on not-for-profit entities mergers and acquisitions. The standard provides guidance on accounting for a not-for-profit's combination with one or more other not-for-profit entities, businesses, or non-profit activities. The standard also makes accounting for goodwill and other intangible assets applicable to not-for-profit entities. The standard is to be applied prospectively with early application prohibited and is effective for fiscal years beginning on or after December 15, 2009.

NOTE 2. PLEDGES RECEIVABLE

Unconditional promises to give that are expected to be collected within one year are recorded at net realizable value. Unconditional promises to give that are expected to be collected in future years are recorded at the present value of the estimated future cash flows. Amortization of the discounts is included in donations in the Combining Statement of Activities.

Pledges receivable include the following unconditional promises as of December 31, 2009:

<table>
<thead>
<tr>
<th>Amounts due in:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than one year</td>
<td>$328,440</td>
</tr>
<tr>
<td>One to five years</td>
<td>45,000</td>
</tr>
<tr>
<td>Total</td>
<td>373,440</td>
</tr>
</tbody>
</table>

Less: Unamortized discount $20,520

Net unconditional pledges $352,920

Pledges receivable in the amount of $352,920 as of December 31, 2009, are restricted for awards and scholarships. Management believes that all pledges are fully collectible. Therefore management has not recorded an allowance for collection losses.

NOTE 3. INVESTMENTS

Investments, which are comprised entirely of mutual funds, are presented in the combining financial statements at their fair market values and consist of the following at December 31, 2009:

**Vanguard Investments – Reserve Fund**

<table>
<thead>
<tr>
<th>Fund Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Stock Market Index Fund</td>
<td>$6,136,963</td>
</tr>
<tr>
<td>Total Bond Market Index Fund</td>
<td>4,975,640</td>
</tr>
<tr>
<td>Intermediate-Term Investment Grade Bond</td>
<td>3,058,855</td>
</tr>
<tr>
<td>Total International Stock Index Fund</td>
<td>2,901,330</td>
</tr>
<tr>
<td>Windsor II Fund</td>
<td>2,124,925</td>
</tr>
<tr>
<td>Short-Term Investment Grade Fund</td>
<td>2,038,226</td>
</tr>
<tr>
<td>Morgan Growth Fund</td>
<td>1,045,973</td>
</tr>
<tr>
<td>U.S. Growth Fund</td>
<td>1,045,973</td>
</tr>
<tr>
<td>Strategic Equity Fund</td>
<td>910,013</td>
</tr>
<tr>
<td>Explorer Fund</td>
<td>910,013</td>
</tr>
<tr>
<td>High-Yield Corporate Fund</td>
<td>116,000</td>
</tr>
<tr>
<td><strong>Reserve Fund Investments</strong></td>
<td>25,296,487</td>
</tr>
</tbody>
</table>

**Vanguard Investments - AWS Foundation**

<table>
<thead>
<tr>
<th>Fund Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Bond Market Index Fund</td>
<td>$2,288,164</td>
</tr>
<tr>
<td>Total Stock Market Index Fund</td>
<td>1,832,546</td>
</tr>
<tr>
<td>Intermediate-Term Investment Grade Bond</td>
<td>1,356,545</td>
</tr>
</tbody>
</table>
NOTE 3. INVESTMENTS (CONTINUED)

Total International Stock Index Fund 947,339
Short-Term Investment Grade Fund 944,357
Windsor II Fund 633,217
Explorer Fund 395,855
Morgan Growth Fund 338,416
U.S. Growth Fund 336,703
Strategic Equity Fund 188,665
Prime Money Market Fund 20,296
AWS Section Investments (1,497,501)

AWS Foundation Investments 7,884,592

Total Investments $ 33,181,079

AWS Foundation administers investments on behalf of certain affiliated sections. The investments aggregated $1,497,501 at December 31, 2009 and are not included in the combining financial statements.

Investment income consisted of the following for the year ended December 31, 2009:

<table>
<thead>
<tr>
<th>Description</th>
<th>Reserve Fund</th>
<th>AWS Foundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest and dividends</td>
<td>$ 628,739</td>
<td>$ 209,793</td>
</tr>
<tr>
<td>Investment fees</td>
<td>(34,097)</td>
<td>(16,022)</td>
</tr>
<tr>
<td>Net realized and unrealized gains on investments</td>
<td>4,039,242</td>
<td>1,362,088</td>
</tr>
</tbody>
</table>

$ 4,633,884 $ 1,555,859

Interest and dividends under the Reserve Fund includes the activities of TFPS, Inc.

NOTE 4. FAIR VALUE MEASUREMENTS

The FASB establishes a framework for measuring fair value. That framework provides a fair value hierarchy that prioritizes the inputs to valuation techniques used to measure fair value. The hierarchy gives the highest priority to unadjusted quoted prices in active markets for identical assets or liabilities (Level 1 measurements) and the lowest priority to unobservable inputs (Level 3 measurements).

The three levels of the fair value hierarchy are described as follows:

- **Level 1** Inputs to the valuation methodology are unadjusted quoted prices for identical assets or liabilities in active markets that the Organizations have the ability to access.
- **Level 2** Inputs to the valuation methodology include:
  - quoted prices for similar assets or liabilities in active markets;
  - quoted prices for identical or similar assets or liabilities in inactive markets;
  - inputs other than quoted prices that are observable for the asset or liability;
  - inputs that are derived principally from or corroborated by observable market data by correlation or other means.

If the asset or liability has a specified (contractual) term, the Level 2 input must be observable for substantially the full term of the asset or liability.

- **Level 3** Inputs to the valuation methodology are unobservable and significant to the fair value measurement.

The asset's or liability's fair value measurement level within the fair value hierarchy is based on the lowest level of any input that is significant to the fair value measurement. Valuation techniques used need to maximize the use of observable inputs and minimize the use of unobservable inputs.

Following is a description of the valuation methodologies used for assets measured at fair value. There have been no changes in the methodologies used at December 31, 2009.

**Mutual Funds:** Valued at the net asset value ("NAV") of shares held by the Organizations at year end.

**Certificates of Deposit:** Valued at fair value by discounting the related cash flows based on current yields of similar instruments with comparable durations considering the credit-worthiness of the issuer.

The preceding methods described may produce a fair value calculation that may not be indicative of net realizable value or reflective of future fair values. Furthermore, although the Organizations believe the valuation methods are appropriate and consistent with other market participants, the use of different methodologies or assumptions to determine the fair value of certain financial instruments could result in a different fair value measurement at the reporting date. The values assigned to certain investments are based upon currently available information and do not necessarily represent amounts that may ultimately be realized. Because of the inherent uncertainty of valuation, those estimated fair values may differ significantly from the values that would have been used had a ready market for the investments existed and the differences could be material.

The following tables represent the Organizations' financial instruments measured at fair value on a recurring basis at December 31, 2009 for each of the fair value hierarchy levels:

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Active Markets</td>
<td>Significant</td>
</tr>
<tr>
<td>Identical</td>
<td>Observable</td>
</tr>
<tr>
<td></td>
<td>(Level 1)</td>
</tr>
<tr>
<td>Assets:</td>
<td>$34,198,311</td>
</tr>
<tr>
<td>Certificates of deposit</td>
<td>$36,416,406</td>
</tr>
</tbody>
</table>

NOTE 5. PROPERTY AND EQUIPMENT, NET

Property and equipment consist of the following as of December 31, 2009:

<table>
<thead>
<tr>
<th>Description</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>816,726</td>
</tr>
<tr>
<td>Construction in-progress</td>
<td>151,278</td>
</tr>
<tr>
<td>Building and improvements</td>
<td>4,831,719</td>
</tr>
<tr>
<td>Furniture, software and equipment</td>
<td>4,618,179</td>
</tr>
</tbody>
</table>

| Total | 10,417,902 |

Less: accumulated depreciation | 7,852,943 |

$ 2,564,959

Depreciation expense was $2,188,852 for the year ended December 31, 2009.
NOTE 6. TEMPORARILY RESTRICTED NET ASSETS

Net assets of the AWS Foundation in the amount of $3,846,163 as of December 31, 2009, are restricted for awards and scholarships. Net assets of $183,895 were released from donor restrictions by granting awards and scholarships for the year ended December 31, 2009.

NOTE 7. PERMANENTLY RESTRICTED NET ASSETS

Net assets in the amount of $4,649,038 as of December 31, 2009, are permanently restricted endowments which are to provide a source of funds predominantly for educational, research and other charitable purposes.

NOTE 8. INTERFUND TRANSFER

Funds are periodically transferred from the Operating Fund to the Reserve Fund and the AWS Foundation Fund. For the year ended December 31, 2009, the Operating Fund transferred $6,500,000 to the Reserve Fund, due to positive financial results and cash flows.

NOTE 9. BOARD APPROVED PROGRAMS

American Welding Society, Inc.'s Board of Directors periodically approves expenditures for special programs designed to further the development and public awareness of welding technology, education and standards. Expenses incurred for special board approved programs during the year ended December 31, 2009 amounted to $65,000.

NOTE 10. ENDOWMENTS

The AWS Foundation’s (the "Foundation") endowment consists of two separate investment funds established for welding education, research and other charitable purposes. Its endowment includes donor-restricted endowment funds and board and temporarily restricted funds. As required by accounting principles generally accepted in the United States of America, net assets associated with endowment funds are classified and reported based on the existence or absence of donor-imposed restrictions.

The Foundation classifies as permanently restricted net assets (a) the original value of gifts donated to the permanent endowment, (b) the original value of subsequent gifts to the permanent endowment, and (c) accumulations or losses to the permanent endowment made in accordance with the direction of the applicable donor gift instrument at the time the accumulation is added to the fund. The unexpended earnings of the donor-restricted endowment fund that is not classified in permanently restricted net assets is classified as temporarily restricted net assets until those amounts are appropriated for expenditure by the Foundation.

The Foundation considers the following factors in making a determination to appropriate or accumulate donor-restricted endowment fund earnings:

1. The duration and preservation of the fund
2. The purposes of the Foundation and the donor-restricted endowment fund
3. General economic conditions
4. The expected total return from income and the appreciation of investments
5. Other resources of the Foundation
6. The investment policies of the Foundation

For the year ended December 31, 2009 the Foundation has elected not to add appreciation for cost of living or other spending policies to its permanently restricted endowment for inflation and other economic conditions.

### Reconciliation of endowments for its investments

<table>
<thead>
<tr>
<th></th>
<th>Donor &amp; Board Restricted Funds</th>
<th>Temporarily Restricted Endowment Funds</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset balances at</td>
<td>$1,571,528</td>
<td>$4,565,839</td>
<td>$6,137,367</td>
</tr>
<tr>
<td>December 31, 2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contributions</td>
<td>173,345</td>
<td>89,199</td>
<td>262,544</td>
</tr>
<tr>
<td>Interest and dividends</td>
<td>209,793</td>
<td></td>
<td>209,793</td>
</tr>
<tr>
<td>Other</td>
<td>(65,078)</td>
<td>(65,078)</td>
<td></td>
</tr>
<tr>
<td>Net investment</td>
<td>1,340,066</td>
<td></td>
<td>1,340,066</td>
</tr>
<tr>
<td>appreciation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset balances at</td>
<td>$3,235,554</td>
<td>$4,649,038</td>
<td>$7,884,592</td>
</tr>
<tr>
<td>December 31, 2009</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of Endowment Assets at December 31, 2009

- Mutual funds: $3,235,554
- Temporarily restricted funds: $4,649,038
- Total: $7,884,592

*Temporarily restricted funds are invested in the same account as donor and board restricted endowment funds.

### Permanently Restricted Net Assets

(1) The portion of perpetual endowment funds that is required to be retained permanently either by explicit donor stipulation or by UPMIFA: $4,649,038

### Funds with Deficiencies

From time to time, the fair value of assets associated with individual donor restricted endowment funds may fall below the level that the donor requires the Foundation to retain as a fund of perpetual duration. There were no such deficiencies in the endowment funds as of December 31, 2009.

### Strategies Employed for Achieving Objectives

To satisfy its long-term rate-of-return objectives, the Foundation relies on a total return strategy in which investment returns are achieved through both capital appreciation (realized and unrealized) and current yield (interest and dividends).

### Spending Policy and How the Investment Objectives Relate to Spending Policy

The Foundation has a policy of appropriating for distribution each year 5 percent of its endowment fund’s value over the prior 12 months through the calendar year-end preceding the fiscal year in which the distribution is planned. In establishing this policy, the Foundation considered the long-term expected return on its endowment. Accordingly, over the long term, the Foundation expects to maintain the purchasing power of the endowment assets held in perpetuity or for a specified term as well as to provide additional real growth through new gifts and investment return.

NOTE 11. COMMITMENTS AND CONTINGENCIES

### Operating Leases

During 2009, the Organizations entered into various operat-
NOTE 11. COMMITMENTS AND CONTINGENCIES (CONTINUED)

The Organizations entered into an agreement with Trade Show Consulting, LLC (“TSC”) to create a limited liability company known as Weldmex LLC (the “LLC”) to acquire and operate the Weldmex Trade Show, a show solely owned by TSC.

In consideration for the sale, transfer and assignment of the Weldmex Trade Show to the LLC, TSC was paid an initial sum in the amount of $400,000 on January 2, 2008. At the end of the 2008 Weldmex show, the Organization is to pay TSC $122,000 no later than sixty days from the completion of the show. The Organization is to also pay TSC $644,000 and $522,000, respectively, under the terms of the agreement which is included under the caption ‘Prepaid and other assets’, in the Combining Statement of Financial Position.

NOTE 12. WELDMEX LLC

On October 26, 2005, the American Welding Society, Inc. (the “Organization”) entered into a Publication Sales Agreement with World Engineering Exchange (“WEX”), whereby WEX has been given non-exclusive worldwide rights to duplicate, package, facsimile transmit, price, promote, distribute, sell and or lease the Organization’s documents and technical publications through paper and electronic media formats and compilations. On May 8, 2007, the term of the agreement was extended to extend the initial period to sixty (60) months commencing on January 1, 2006. The agreement can be renewed for two (5) year periods with the same terms and conditions except for the pricing which shall be negotiated by the parties in good faith.

WEX will pay the Organization royalties based on the percentages indicated per the agreement. The agreement is contingent upon the Organization’s continued performance, which includes the production and release of new and revised publications periodically. In addition, the list price shall be no less than the prices as indicated in the Organization’s catalog. Under the terms of this agreement, the Organization earned approximately $3,965,900 during the year ended December 31, 2009. Such amount has been included in revenues in various departments in the Combining Statement of Activities.

On April 2, 2007 the Organization entered into an agreement with The American Society of Mechanical Engineers (“ASME”), whereby ASME has the nonexclusive right to reproduce the Organization’s standards. ASME will pay the Organization royalties equal to 20% of the net sales per quarter. Under the terms of this agreement, the Organization received approximately $247,000 for the years ending December 31.

<table>
<thead>
<tr>
<th>Year</th>
<th>Royalty Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>$247,000</td>
</tr>
<tr>
<td>2011</td>
<td>$247,000</td>
</tr>
<tr>
<td>2012</td>
<td>$93,000</td>
</tr>
<tr>
<td>2013</td>
<td>$29,000</td>
</tr>
<tr>
<td>2014</td>
<td>$3,000</td>
</tr>
<tr>
<td>Total</td>
<td>$619,000</td>
</tr>
</tbody>
</table>

NOTE 13. EMPLOYEE BENEFIT PLAN

The Organizations have a simplified employee pension plan for all full-time employees. Full-time employees are eligible for participation in the plan the first day of the month after they are employed. Effective June 1, 2008, the Organizations will contribute a maximum of 7% of the employees’ base salary, composed of a 4% initial contribution and a match up to 3% of an employee’s voluntary contribution. The Organizations made contributions totaling approximately $416,000 during the year ended December 31, 2009.

NOTE 14. EMPLOYMENT AGREEMENT

The Organizations entered into an employment agreement with its Executive Director on December 18, 2009 for a term of three years; the first year commencing January 1, 2010. The Organizations will provide certain benefits for the period set forth in the agreement.
Quality Assurance in Field Heat Treatment

Industry has seen a greater need for field heat treatment of pipe steels such as P91 and P92

BY GARY LEWIS

Owners of energy companies, fabricators, and their construction partners are being tasked to implement new materials, welding processes, and project management resources. They are challenged to operate under increasingly adverse conditions, for longer periods of time, while enhancing return on investment objectives, competing on a global scale, and ensuring the safety and security of their people and communities. Things get even more complicated for senior executives, designers, and planners as the political and economic landscape grows ever more turbulent and unpredictable.

One aspect of industrial construction that has gained increased attention and scrutiny over the past couple of years, particularly in North America, has been the growing significance and execution of field heat treatment services.

Welding and Materials

The appeal and expanded use of advanced creep strength enhanced ferritic (CSEF) steels, like P(T) 91 and 92 in power generation service, and similar chrome-moly materials in refining, are attributed with having more favorable performance factors and some beneficial installation advantages, but have also accelerated the need to pay particular attention to heat treatment requirements during initial fabrication, and through post-welding processes in field construction.

Please take a moment and review carefully the article by William F. Newell Jr., beginning on page 33 of the April 2010 Welding Journal. It provides an excellent overview of material considerations and peripheral design aspects of CSEF steel.

Following are two important realities to keep in mind:

1. Pre- and postweld heat treatment are not optional with these materials.
2. As much as 90% of the material anomalies that have been exposed to date in the base and weld metal are attributable to improper heat treatment, not the welder’s iniquity.

While the predecessors to CSEF such as heavy-wall carbon steel, 2½ chrome-moly material, etc., are somewhat more forgiving by today’s standards, and may be able to tolerate wider deviations within the heat-affected zone (HAZ) (Fig. 1), new materials are dependent on more precise heating and cooling for tempering, transformation, and adequate stress relieving.

The American Welding Society (AWS) invited Superheat FGH to speak about limitations of existing field heat treatment practices at its Weld Crack Conference in 2008 to promote greater awareness of recommendations published in its latest edition of D10.10, Recommended Practices for Local Heating of Welds in Piping and Tubing. A number of examples were presented that exposed routine shortcomings of lax installation practices and introduced some new technological advancements and process controls being utilized to shore up quality assurance — Fig. 2.

Recent innovations in project management software, surveillance, and training tools have dramatically differentiated service providers and the benefits derived by more knowledgeable, forward-thinking owners and contractors.

Lots of talented people are working hard to improve weldability and handling issues in the field, minimize restrictive requirements to their lowest common denominators, while maintaining practicality for achieving intended design properties.

The AWS D10 Committee and ASME, as well as the Electric Power Research Institute (EPRI) in Charlotte, N.C., continue to pursue proactive improvements and have collaborated regularly over the past couple of years to address all aspects of using CSEF steel. Substantial intellectual and monetary resources continue to

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be invested to evaluate current and historical performance results of these materials, shoring up code rules, and updating recommendations and procedures for proper welding and handling.

**Field Heat Treatment**

Let’s pick up where Newell left off, with regard to material quality assurance: “Competent, experienced engineering and supervision are required to successfully obtain the mechanical properties that can be realized with CSEF steel.” Heat treatment is one of the most critical aspects of achieving design intentions and is regularly underappreciated by less-informed decision makers.

In many cases, traditional field heat treatment has become outdated and incapable of meeting the varying needs of the customers being served. Whether practices had become too lax, inconsistent, shortcuts encouraged, cost unmanageable, productivity disregarded, or limited expertise in general, the net effect is increased risk, inefficient use of limited or diminishing resources, and added “long-term” expense associated with unplanned business interruptions or premature failure of component parts. Problems can be further compounded since this work is often interdependent on other construction-related activity such as welding, rigging, and electrical work. As Newell concludes, this is not an area where you should pursue a low-cost alternative, as history proves time and again that you generally get what you pay for.

**Quality Assurance**

Heat treatment is required for a number of important reasons, the most common being as follows:

1. To achieve and maintain specific material properties and attributes.
2. To drive out hydrogen or moisture that can have an adverse effect on the material or lead to premature cracking and other related defects.
3. To relieve residual stresses and prevent stress corrosion cracking.

It is increasingly important to ensure uniform heating and temperature control throughout the workpiece, from the outside wall (OD in the case of a pipe or vessel) to the root of the weld or ID of the part, while managing the entire heated band width to ensure proper soak and gradient objectives. The more sophisticated the alloy, the more significant the need to ensure precise zone control.

**Setup and Labor Utilization**

Many companies have expressed an interest in, or attempted over the years, to...
make better use of their own internal labor pool or more familiar labor resources to contain costs or improve efficiency. In many cases, clients have been looking for new ways to use or retain existing craftsmen with special skills and ambition that have either been underutilized, looking for more work, or interested in expanding on their trade. Some markets require a percentage of local labor content and others feel more secure with employees who are already on the payroll. It’s not uncommon for small projects or inspection-driven work to emerge that may be better served with existing resources and avoiding mobilizing large numbers of people and equipment on short notice from a third-party heat treating contractor.

Superheat FGH recently introduced a number of technological and process-oriented tools to accommodate more flexible service models with an increase in quality assurance while reducing costs in the field.

Exclusive wrapping specification sheets, digitized prework order instructions, and formalized training modules give customers an opportunity, in very short order, to self-perform or “self-wrap” the components to be heated, in accordance with drawings that stipulate proper heater selection, thermocouple placement, and a preprogrammed temperature profile, all in accordance with AWS D10 recommendations and in conformance with the client’s weld procedures. Most importantly, the heat treatment service provider continues to run the process and take ownership. Customized drawings are easily generated from basic sketches, photos, or workpiece drawings — Fig. 3.

New devices such as Smart Light are often furnished and magnetically attached in the vicinity of the welder. These are more informative tools that are an improvement over temperature-indicating crayons, and provide a visual indicator to the welder that he or she is proceeding within specification, and not exceeding interpass temperatures. They also alert the welder to any deviation in advance of post-weld inspection services — Fig. 4.
Zone Control

Heat treat technicians commonly understand the basics of attaching a heating device to a piece of steel, with the objective of producing a chart confirming work has been done as requested. It’s becoming more apparent that a limited understanding of uniform temperature control can lead to producing charts that confirm that a thermocouple was heated satisfactorily, but not necessarily the entirety of the HAZ or heated bandwidth, or with any appreciation for the detrimental effects to the material, something that is increasingly more crucial when using advanced alloys.

A number of recent tests have highlighted the drawbacks associated with any heating tool, if misapplied. Experts are suggesting and frequently requiring placement of thermocouples under every heater or heat source, in very specific locations, to prevent overheating or hot spots associated with multiheater circuits or variable coil configurations that have gone undetected and proven to be a source of material weakness — Fig. 5.

Wireless and Remote Communications, Software

The most remarkable advances in the heat treatment industry can be attributed to the benefits derived from wireless communication, Internet access, software development, and networking. These technologies, used in tandem, provide the ability to manage large amounts of information, in real time, that can be visible, and subject to review by technicians, project managers, and quality experts at the corporate level, simultaneously, anywhere in the world. It is increasingly advantageous to capitalize on software developments that monitor related parameters like heater performance, thermocouple continuity, power consumption, secondary electrical outputs, etc., and alert those involved to any anomalies immediately, rather than catching something during inspection, having to cut out a weld, discard an expensive component, or start over with all of those associated costs and delays — Fig. 6.

Quality Management Center

Just as most power plants and refineries feature a central control room to oversee technical operations and performance of a variety of critical process components, the heat treatment business now utilizes recent communications advancements and incorporated this higher level of checks and balances, corporate oversight, and job-site surveillance into every job. Whether the service provider staffs the project or a customer chooses to “self-wrap,” a quality management center is staffed 24 hours a day, 365 days of the year to support the entirety of the project, take ownership of the process, compile and distribute a comprehensive digital turnover package, and enhance the productivity and proficiency of the job — Fig. 7.

Summary

As is true with many facets of construction and welding, success is generally a result of effective integration of many optimized, often underestimated subcomponents. Field heat treatment has risen to a level of strategic significance among plant owners, senior construction management, welding engineering, and material science professionals, as well as project planners, senior level estimators, and procurement staff.

It will take some discipline and appreciation for the “bigger picture,” but owners are beginning to see that first cost is not necessarily a good indicator of “actual” job costs or exorbitant long-term concealed costs. The “low bid” scenario alluded to in Newell’s previous article, as it pertains to heat treatment services, is becoming a thing of the past for more informed clients. Owners are starting to recognize the drawback to awarding contracts on the basis of open-ended cost structures, dilution tactics among multi-service providers, and complex contingency-based terms and conditions. Simplification and transparency are important keys to success.

While this article doesn’t afford the opportunity to drill down into the detail required to determine which attributes are most relevant to you, it has provided a means for raising awareness and to introduce some recent technological advancements that have come from customer’s priorities for sustainability and survival in the new millennium.
Induction Heating Delivers Production Benefits

A heavy-wall pipe fabricator discusses its change from flame to induction heating

BY AL SHERRILL

Fig. 1 — Energy Steel’s welding team, shown with a ProHeat™ 35 induction heating console, are (from left to right) shop foreman Patrick Siwa, welder-fitters Ryan Dean and Daniel Dixon, electrician James Schocke, lead fitter Dale Nurmi, lead welder John “Jay” Kelly, and lead subarc operator Raymond Tithof.

When Energy Steel & Supply Co., Lapeer, Mich., a supplier of material and replacement parts to the nuclear power industry, replaced its flame heating equipment with induction heating technology it was able to bring parts to temperature fast, reduce its labor and consumables costs, and begin performing heat treating of very large parts in-house. In addition, the quality assurance process was simplified and the data could be shared more quickly with its customers. The new technology has been well received by Patrick Siwa, fabrication department foreman, and his staff — Fig. 1.

The company uses the Miller ProHeat™ 35 induction heating system. The technology can bring parts to temperature faster than either electrical resistance or flame heating methods.

Carving a Niche at the Top

Siwa said, “The nuclear power plants that were built 30 years ago don’t have spare parts lying on the shelf. When they need a replacement part, it needs to be fabricated from scratch.”

These components are often replaced during a scheduled shutdown, a time when the plant goes off the power grid and purchases power from another supplier. While missed deadlines can be very costly, there is absolutely no room for error, no sacrifice of quality for speed, no cutting corners. The high standards and dedication to quality assurance, as well as the level of precision, are exceptionally high.

Most of Energy Steel’s work falls under the requirements of ASME Sections III and IX. It holds the N, NPT, NS, and U Code Symbol Stamp and Certificates of Authorizations. It is also accredited by The National Board of Boilers and Pressure Vessel Inspectors and has been awarded the R Code Symbol Stamp and Certificate of Authorization. The company focuses on parts and components related to the safe operation and shutdown of nuclear facilities.

Preheating large-diameter, heavy-wall pipe is facilitated using induction heating to concentrate the heat in the critical 3-T zone — Figs. 2, 3.

How Inductive Heating Works

An induction heating system works like an electrical transformer. It employs high-frequency coils to generate magnetic...
fields that cause electrical currents to flow in the metal parts. The metal's resistance to the current produces the heating internally. The induction coils can rest on or near the part and do not get hot themselves. The magnetic field creates eddy currents inside the part, exciting the part's molecules and generating heat. Because heating occurs slightly below the metal surface, little heat is radiated and the part comes up to temperature quickly.

Siwa recalled, “The person who came to demonstrate the system wrapped the blanket around the pipe and brought it up to temperature in 15 minutes. That is something that would have taken flame torches an hour to do. Once the unit was switched off, the coils were cool enough to be removed by hand.”

Looking back on Flame Heating

A direct comparison between using the former flame heating and the new system is difficult, since induction heating allows the company to perform much larger projects than before, but Siwa attempted to put it into perspective.

“Prior to using induction heating, welding on the discharge head would have taken three people,” Siwa explained. “Two people with flame torches would hold the preheat temperature while the other guy welds. Then the welder would back away and the other guys would keep it warm. If these are contract workers running the flame torches, it’s costing between $13 and $15 an hour each.”

At those prices, it would have cost $208 to $240 per day just for the contract workers, and this is a conservative estimate that doesn’t include the time to reach the preheat temperature or the cost of the propylene — between $140 and $560 per shift. Either the contract workers have to start two hours before the welder arrives, or the welder has to wait until the part is brought up to temperature.

“On one project, the welders did their own preheating,” Siwa said. “So, instead of welding the whole time they’re here, they would have to stop, heat the joint and then continue welding. On big jobs, we could have ten people with flame torches heating up a part. Since switching to induction heating, I no longer need workers for preheating and we can bring a large part to temperature about four times faster than with a weed burner.”

As an example of how induction heating has changed the workflow, the company recently began work on a hot-leg for a steam generator. When finished, it will carry steam at 12,000 lb/in.² from the generator. Prior to cladding with 308L and 309L stainless steel, two plates measuring 4 x 96 x 120 in. were welded back to back to cut down on warpage. They laid the induction cables in a circular pattern on top of a plywood platform. The coils were then covered by one inch of insulation to protect the cables from the heat given off by the plates. The plates rested on stops just above the insulation to prevent damage to the cables from the weight. While the company’s prototype submerged arc welding machine laid down a 60-mm strip of...
cladding on one side, the induction system maintained heat from the other side.

“We used the system to heat up that eight inches of metal to 250°F and hold it there continuously for a week,” Siwa said. “If we had to do that with flame torches, it would have taken four to six weeks and we would have gone through four or six bottles of propylene a day. Plus, every time we flipped the plates, we’d add another hour of preheating to our time (using four flame torches) before we could start welding again.”

### Heating up the Savings

The savings in labor and propylene were enough to justify the cost of switching to an induction heating system, but that’s only part of the savings. Additional benefits are realized in postweld heat treating. Prior to using induction heating, the company shipped its large components to a heat-treating facility accompanied by a QA expert who would hook thermocouples up to the part and monitor the part temperature. Now, the part is heated in the shop, saving transportation costs.

“We’re on a schedule at the heat-treating facility,” said John “Jay” Kelly, lead welder. “We have to reserve that furnace to control the heating process.

# Quality Assurance Benefits

Equally or more important than the savings created by induction heating are the higher levels of quality and quality assurance the new system provides.

“An induction system heats everything evenly,” said Siwa. “You’re never going to get that with a hand-held torch. It’s going to get hotter in one spot. It’s not going to be evenly heated throughout the part. But with induction heat, you can check the temperature at any point across the part and it will be perfect.”

To ensure this accuracy, the system uses four control and two monitoring thermocouples simultaneously — Fig. 4. The controller reads the control thermocouples and regulates the heat rise based on the hottest thermocouple and the cooling based on the coolest thermocouple. This ensures that heating and cooling rates do not violate procedure. Separate displays indicate the temperature of each thermocouple and indicate which are being used to control the heating process.

A digital recorder records time vs. temperature from the thermocouples. The data are encrypted and can be stored on flash drives for transfer to a computer for further analysis, storage, printing of hard copies, or to send files by e-mail.

“We have to supply charts to prove we got a part up to the temperature specified in the procedure and that we held it for so many hours,” said Siwa. “The induction system does that automatically. I can show minute-by-minute temperatures; I can do it every five minutes, every ten minutes, every hour, depending on what is required, and then e-mail it to our customers.

“Another plus to induction heating is that we don’t want the parts to repeatedly cool and heat because there’s a chance of stress cracking,” he explained. “By running the system during the night, we keep the part at the temperature we want, so when we walk in the door in the morning, we just start welding again.”

### Safety Gets a Boost

Because the system’s induction heating coils do not get hot nor need to be in direct contact with the part being heated (induction coils can be one to two inches away from the material), frames made from plywood can support the coils without presenting a safety hazard. To achieve and maintain the proper temperature on a pipe while the subarc machine clad the inside, the team built a plywood frame with the inductance coils wrapped around the outside, allowing the pipe to rotate freely inside.

“Induction heating has made our job a lot safer,” Kelly said. “With a weld burner, you have a three-foot wand with an open flame coming out the end of it. All it takes is somebody not paying attention for a moment or not being aware of the surroundings to present a potential safety hazard. Induction heating eliminates that.”

Fuel tanks presented a storage issue, also, Siwa added. They had to keep enough on hand so they didn’t run out in the middle of a job, but they had to be stored safely, away from any oxidizers.

### The Sales Manager Weighs in

Waylon Waters, Energy Steel’s sales manager, said, “There are very important benefits to using induction heating. We have confidence in this equipment. It allows us to be more accurate with our bids and timing for estimates. It helps in every aspect of our scheduling, and it saves money and other resources within the company. We work very hard to stay ahead of our competitors by continuing to improve our skill levels and equipment in every aspect of the business, and induction heating has greatly contributed to these goals.”
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Preparing for Nuclear Power — Round Two

Here’s a look at how Fluor is readying its welding programs for when construction begins on the next set of U.S. nuclear power plants

BY MATTHEW COX AND GARY R. CANNELL

Recently, there has been significant interest and justification for resuming nuclear power plant construction in the United States. The two primary reasons for this are the rising cost of energy (global demand has strained current power-generating capacity), and a desire to produce “clean” energy that will not contribute to global greenhouse gas effects.

It has been nearly 30 years since the last nuclear power plant started construction in the United States. Although there are no nuclear power plants currently under construction, several applications for permits have been submitted to the Nuclear Regulatory Commission and local governments. It is estimated that plant construction may resume as soon as 2012.

The Fluor Nuclear Power group is currently performing engineering and procurement activities and preparing for the construction of two advanced boiling water reactors to be built near Bay City, Tex. Nuclear plant construction is not new to Fluor; however, since the completion of units at Callaway, Wolf Creek, and V.C. Summer some 25 years ago, Fluor has not been actively involved in nuclear new-build construction. As a result, the company’s American Society of Mechanical Engineers (ASME) construction certifications were allowed to lapse. One of the first efforts in preparation for the upcoming STP project was to renew these certifications.

Welding plays a key role in the construction of nuclear power plants and therefore assumes a critical role in the certification process. This article provides a review of the preparation/demonstration activities associated with the Fluor Nuclear Power welding program in conjunction with renewal of ASME certifications for the construction of nuclear power plants.

Challenge

As noted above, Fluor was actively involved in the construction of nuclear power plants during the 1970s and 1980s. Many of the company’s employees who had been involved with that work are now either retired or have moved on to other careers. Some of the company’s procedures and manuals for nuclear power construction no longer exist and those that remained are out of date with respect to how Fluor does business today and current ASME codes and standards.

A project team, consisting of several experienced employees who had either worked on prior nuclear construction jobs or were involved with plant maintenance/modifications at operating facilities, was assembled to renew the ASME nuclear construction certifications. Among the many project tasks, including preparation of the quality assurance manual, procurement procedures, and construction procedures, was establishment of a nuclear welding program. Fluor has an existing and comprehensive program/organization for controlling nonnuclear welding activities, and there was some discussion about integrating the nuclear scope into that program. It was decided, however, that differences in philosophy and approach were significant enough to warrant separate programs. The challenge was to establish a nuclear welding program to support ASME certification renewal as well as provide a basis and structure to meet the needs of large-scale, commercial nuclear plant construction.

Nuclear Welding Program

Welding Manual

The company’s construction strategy includes use of a corporate welding manual that contains general procedures and practices from which project-specific manuals are written to control work at the project

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level. Project-specific manuals are needed to address unique conditions and practices required by the client, local codes and standards, craft issues/concerns, etc.

Fluor welding engineers prepared the corporate nuclear welding manual and then a specific manual for the renewal of the ASME certifications (named the N-Stamp Project). The project manual contained the normal elements of a welding program including requirements for Welding Procedure Specification (WPS) preparation and qualification, filler material procurement and control, repair welding, etc. What was new or different in this manual vs. that for a typical non-nuclear program was the incorporation of quality requirements unique to ASME Boiler and Pressure Vessel Code, Section III, Division 1. Close coordination with the quality assurance manual requirements for materials procurement and storage (filler metals), testing (Procedure Qualification Records [PQRs]), qualification, etc., was required to ensure code compliance.

Preparation for ASME Survey

Roles and Responsibilities. With the welding manual and the other program procedures complete, a detailed project organization with specific roles and responsibilities was developed in preparation for the ASME survey. A corporate welding engineer was assigned responsibility for preparation/approval of the corporate welding manual. Performance and qualification of project WPSs were also assigned to the corporate welding engineer. A project welding engineer reported up through Construction Engineering and had responsibility for all field welding activities.

Welding Facility and Materials Control. The ASME stamps were to be assigned to and controlled by the Fluor corporate office in Greenville, S.C. To accommodate survey activities, a temporary welding and fabrication facility was constructed. The facility included the basic hand tools, power tools, and welding equipment that would be necessary to weld the survey vessel.

A secure storage area was designated for filler material storage and measuring/test equipment. Project-assigned personnel controlled these areas for issuing and receiving purposes. Size, quantity, heat numbers, and serial numbers were among the features used to track the use of these materials and special equipment. In addition, this area had to meet storage- and cleanliness requirements based on procedures, codes, and manufacturers’ recommendations.

WPS, PQR, and Welder Certifications. Two gas tungsten arc welding WPSs were required to fabricate the survey vessel — Fig. 1. Materials for fabricating the vessel included carbon steel to itself and to stainless steel. The original plan called for utilizing existing Fluor PQRs to support the two WPSs; however, due to some minor uncertainties regarding existing POR test data and the desire to run through the new welding manual qualification process, new PQRs were completed.

Filler material and test coupons for both procedure and performance qualification were obtained in accordance with project procurement procedures. Two welders were qualified in accordance with ASME Section IX requirements and draft WPSs prepared for qualification testing. Procedure qualification record test coupons were welded per Section IX and documented in accordance with the welding manual requirements. The completed coupons were sent for evaluation to a testing lab that had been qualified according to Fluor nuclear power procedures. Procedure qualification record testing met all specified acceptance criteria of ASME Section IX and Section III, Subsection NB. The corporate welding engineer certified the PQRs as accurate, then placed them into the corporate welding manual. Copies of the qualified WPSs were placed in both the corporate and project welding manuals.

Materials Procurement. All quality-related materials were purchased from a supplier that had been audited and qualified to the Fluor procurement program and standards. The major components purchased for the survey vessel included pipe, fittings, heads, plate, and the welding filler metal. Actual purchase of the safety-related materials proved somewhat challenging. Each piece of material required a specific set of supporting documents that accompanied it throughout the purchasing process. Examples of supporting documents included Certified Material Test Reports, test documentation, packing lists, Certificates of Compliance, technical data, storage data, and receiving instructions.

Good, regular communication with the suppliers was key to obtaining correct materials having all the required supporting documentation. Once the materials were delivered, the receiving process had to be strictly followed. No materials could be used for construction until the receiving process was completed in accordance with procedures.

Work Package and Traveler. A work package process and traveler were developed to track quality-related and inspection activities during fabrication of the
survey vessel. Hold points were identified at various steps in the traveler for QC, and in some cases the authorized inspector, to examine the work and processes being performed.

Preliminary Survey. A preliminary survey was designed and conducted to identify any deficiencies in the procedures and processes put together for the actual ASME survey. Fluor conducted this preliminary survey with the assistance of a contracted authorized inspection agency. The authorized inspector performed the role of the ASME survey team during the preliminary survey. Several “observations and findings” were identified requiring corrective actions be taken to several of the written procedures and processes.

Welding of the Survey Vessel. Fabrication of the vessel began once the construction program procedures were in place. Welding activities were conducted just as they would be in the field, including work package sign-offs, inspections, etc. The vessel was not fully welded, as can be seen in Fig. 2; this was done to allow the ASME survey team to review critical points in the welding cycle, such as joint fitup, root pass deposition, and root backside condition. This also allowed the survey team to witness welding activities, should they ask to do so.

Survey and Results

The ASME survey team carefully and thoroughly reviewed the prepared procedures and processes. Welding procedures were scrutinized and reviewed to ensure compliance to code requirements. The survey team interviewed both the corporate and project welding engineers, asking about the use of essential, nonessential, and supplementary essential variables; PQR notation; and welder certification. In addition, the survey team witnessed the actual welding of the survey vessel. The welder was even questioned regarding such things as joint fitup, preheat, and location and use of the applicable WPSs. All in all, questions were readily and reasonably answered to the satisfaction of the survey team.

At the conclusion of the several-days-long survey, the N-Stamp project team met with the ASME survey team for a briefing on the survey results. The survey proved successful and Fluor was awarded its N, NA, and NPT ASME Stamps.

Lessons Learned

Fluor welding engineers discovered the following through the survey experience:

• The ability to efficiently and correctly procure materials will be critical to project cost and schedule. Because of additional safety and quality requirements, materials for nuclear construction generally take more time to procure than those for nonnuclear applications. Working closely with vendors and clearly putting expectations on the table at the outset of the procurement process will be important.

• Verbatim compliance to procedures and processes will be required. Personnel will not have the luxury of revising established processes “on the fly,” even if it is deemed justified. Procedures and processes must first be revised and approved, prior to any change in performing the work. This concept was reiterated several times during the preliminary survey as well as the actual ASME survey.

• Fabrication welding of the small survey vessel provided the opportunity to get a feel for how welding will be performed on a full-scale nuclear new-build project. All personnel involved in nuclear welding must be fully indoctrinated in the ASME process. As noted previously, there will be a steep learning curve for many of those involved in the upcoming projects. Fluor will continue to emphasize the importance of this aspect within its nuclear welding program.

Moving Forward

As noted previously, the primary challenge will be to train a new group of engineering and construction staff members for nuclear new-build construction. The effort expended and experience gained from the N-Stamp Project, including the development of a nuclear welding program, will provide the company with a good basis and structure to successfully move forward with the construction of nuclear power plants.

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Kentucky Power Plant Turns to Orbital Pipe Welding for Expansion

The Trimble County Two (TC2) is set to be the cleanest and most efficient coal-fired unit in Kentucky. Upon completion, the new generating plant will put a 750-MW advanced, pulverized coal-fired unit with environmental controls into service. The current timeline puts TC2 on schedule for commercial service in 2010. It will meet future energy needs and be located at the existing generating station in eastern Trimble County, a 2127 acre site near Bedford, Ky.

Louisville Gas and Electric Co. (LG&E) selected Bechtel Power Corp., a division of an engineering, construction, and project management firm, to design and build TC2, the second generating unit at the company’s Trimble County facility.

The many weld challenges on this project prompted Bechtel to select Gullco International Inc.’s Pipe Kat orbital welding machine. Factors contributing to this decision include safety, reduction of labor, increased production, and increased travel speed of the weld. Easy use, training, reliability, and accessibility to the weld were also significant considerations.

Upcoming Challenges
Supply a Tool for Specialized Welds

Given the scope of this expansion and the type of weld demands, conducting business the conventional way simply wasn’t going to cut it. Increased on-site challenges called for a more customizable tool. The range of orbital welding applications made possible with the Pipe Kat made it a valuable tool for the TC2 expansion project (see lead photo). Now able to automate those tasks that formerly would have been accomplished manually contributed to the project’s ability to remain on schedule and meet budgetary constraints.

Utilize L90 Pipe, Flux Cored Arc Welding

The L90 pipe chosen for this particular expansion required several inches of wall thickness which, ordinarily, would have meant time-consuming welds using the manual shielded metal arc welding process. Instead procedures were developed for the pipe to be welded with automatic orbital welding machines.

Bechtel prefers flux cored arc welding, and not only does the unit use this process, it works with most conventional power sources. Also, the machine is capable of making welds on pipes in sizes of 10 in. and up, and typical wall thicknesses in the...
Fig. 1 — Operators use a remote control to operate the welding carriage.

Fig. 2 — An operator’s role in setting up the proper equipment is essential. After completion, an orbital pipe weld can be viewed while it’s made.

Fig. 3 — Completed multipass welding takes place in an efficient, timely manner with an automatic orbital welding machine.

3–4 in. range. Speed, economic feasibility, and quality welds were the crucial demands.

Finding a Solution

Reduced Labor Costs, Increased Production

Automated orbital welding systems actually enhance an operator’s ability to make controlled, repeatable, quality welds — Fig. 1. Manual welding, on the other hand, is slower and subject to human error. The automated system produces a greater number of welds in less time. With this orbital welding equipment, heat input can be controlled and limited, no matter which operator produces the weld. This assures the welding procedure will be executed precisely.

Operator Importance with Setup, Making the System Work

Even though many of the variables are controlled and there’s a greater degree of accuracy with orbital welding, the operator’s role remains a significant one — Fig. 2. Inputting the settings, preparing the tube ends, centering the components to be welded in the fixture block, mating the weld head to the fixture block, initiating purge and shielding gases, and signaling the machine to begin the welding process all fall to the operator.

When the operator starts the weld, an electrode housed inside the weld head rotates in a precise orbit around the tube. This controlled process ensures that welds can be produced on a consistent, repeatable basis. The orbital welding system automatically starts and completes the weld, regulating arc current, travel speed, and other variables to provide a successful weld — Fig. 3.

Results

Power Plant Expansion Keeps to a Tight Schedule, Budget

This orbital welding system handled a 37½ deg bevel and used the flux cored welding process, which made it a good choice for this project. “Our schedule is tight so throughout the process, you need control that a conventional weld doesn’t necessarily produce,” said Bechtel’s Lead Welding Engineer Don Kriesche.

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New Code Requirements for Calculating Heat Input

Welders, inspectors, and engineers should be aware of the changes to QW-409.1 of ASME IX regarding waveform-controlled welding

BY TERESA MELFI

Welding waveforms are used to limit distortion, weld open roots, and to control HAZ properties. Waveform control is essential for common processes like uphill GMA pulse welding. Power sources that support pulsing (GMAW-P, GTAW-P, etc.) are the most common waveform-controlled power sources. Those marketed as synergic, programmable, or microprocessor-controlled are also likely to support waveform-controlled welding.

The correlation between heat input and mechanical properties is blurred when heat input is calculated using current and voltage readings from conventional meters. This includes external meters and even those located on the welding power source. It's not that the meters are incorrect — in fact, most are calibrated and tested to NIST standards. Rather, the inaccuracy involves the means of capturing and displaying the data.

Conventional DC meters display average voltage and average current. Conventional AC meters display RMS values. To accurately indicate the energy input to a weld, the voltage and current readings must be multiplied together at very rapid intervals that will capture brief changes in the welding waveforms. This frequency is in the order of magnitude of 10,000 times per second. Specialized meters are required to accomplish this.

Revisions to ASME Section IX provide a new method of calculating heat input that allows comparison of the heat input from various welding power sources and various welding waveforms. This will allow production welding to take place with a welding procedure specification (POR) using either conventional or waveform-controlled welding.

Calculating Heat Input

Many welding codes use the equation shown in Equation 1 to calculate heat input. Because the welding process (GMAW, SAW, etc.) is an essential variable, a process or efficiency factor is not included in the heat input calculation. The new equations that will be in the 2010 edition of ASME Section IX are shown in Equations 2 and 3, either of which gives equivalent results. Both equations are shown because some welding power sources and meters display energy values, and others display power values.

\[
\text{Voltage} \times \text{Amperage} \times 60 \\
\text{Travel Speed (in./min or mm/min)}
\]

Equation 1: Traditional heat input equation, ASME Section IX QW-409.1 (a).

\[
\text{Energy (Joules)} \\
\text{Weld Bead Length (in. or mm)}
\]

Equation 2: New heat input equation for meters displaying energy measurement (Joules), ASME Section IX QW-409.1 (c)(1).

\[
\text{Power (Joules/s or W)} \times \text{Arc Time (s)} \\
\text{Weld Bead Length (in. or mm)}
\]

Equation 3: New heat input equation for meters displaying power measurement (Joules/s or W), ASME Section IX QW-409.1 (c)(2).

Three examples from GMA welding are shown in Fig. 1. The axial spray waveforms are essentially constant, and the difference between the measurement methods is minimal. For the two waveform-controlled procedures, there is an error between the measurement methods that can be in a positive or negative direction. It is clear from the significant differences why a new measurement method is needed.

Changes in ASME Section IX

ASME codes and standards have a long history, now in their 125th year. The rules for welding were removed from the construction codes when ASME Section IX was published in 1941. ASME Section IX has become a global standard, referenced by the ASME construction codes, owners, engineering firms, and other fabrication and construction codes.

The ASME IX Standards Committee has subcommittees that address procedure and performance qualifications, materials, general requirements, and brazing. More than three years ago, a task group was formed to work on issues surrounding welding with complex waveforms from microprocessor-controlled power sources. The first result of this group's work will be a change to the measurement and calculation method for heat input.

QW409.1 is the main Section IX variable that deals with heat input. Currently, there are two ways to calculate heat input. Method (a) is the traditional heat input equation shown in Equation 1. Method (b) is a measurement of the volume of

TERESA MELFI is with The Lincoln Electric Co., Cleveland, Ohio. She is chair of the AWS A5B Committee on submerged arc welding, a member of the AWS A5 Committee on filler metal specifications, a member of ASME Section IX, including the materials subgroup and a working group on advanced waveform welding, and is the U.S. delegate to the International Institute of Welding commission that covers pressure vessels, boilers, and pipelines.
weld metal deposited. A new method (c) is added in the 2010 edition, which includes Equations 2 and 3.

Any of the methods can be used when welding following procedures that are not waveform controlled. When welding following waveform-controlled procedures, only methods (b) or (c) are permitted. With these methods, it is possible to determine the compliance of a production weld made using a waveform-controlled welding procedure to an existing qualified procedure, even when the procedure qualification was performed using nonwaveform controlled welding. An appendix to ASME Section IX has been provided to guide users through these code changes. The appendix provides guidance with new procedure qualifications, existing qualified procedures, and comparing heat inputs between waveform-controlled and nonwaveform-controlled welding. ASME Section IX does not mandate separate performance qualifications for waveform-controlled welding.

How to Comply with ASME Code Changes

To use method (c) of the code, a reading of energy (Joules) or power (Joules/s) must be obtained using a meter that captures the brief changes in a welding waveform and filters out extraneous noise. The simplest place to obtain this is from the welding power source. Many power sources that output pulsing waveforms will display these readings, although some might require software upgrades to enable this. Details and software upgrades for Lincoln Electric’s Powerwave “M” series and several other models are available free of charge at www.powerwave
For a power source that doesn’t support the display of energy or power, external meters are available. A meter with demonstrated accuracy in this application is the Fluke® 345 Power Quality Clamp Meter.

With the proper software installed, it is simple to access the energy reading — Fig. 2. In the setup menu, enable the option to “Display Energy.” When an arc is started, the energy value will begin to increment. The value will continue to increase, showing the real-time energy put into that weld — Fig. 3. When the welding stops, the final energy value will be displayed until welding resumes again. This value represents the amount of energy that went into that weld, from arc start to arc stop.

To calculate the heat input, the final value is simply divided by the length of the weld — Fig. 4. In this case, the heat input would be 22.3 kJ/3.6 in., or 6.2 kJ/in.

A detailed matrix has been developed showing how a PQR qualified with either waveform or nonwaveform-controlled welding may be used to support welding with waveform or nonwaveform-controlled procedures and QW-409.1(a) or QW-409.1(c). This can be downloaded from www.lincolnelectric.com.

**Summary**

The ASME Section IX welding and brazing standard is widely used by public agencies and private companies concerned about the safety and integrity of welds. Just as specifications change when new materials are developed, ASME Section IX has changed to recognize modern welding waveforms. The changes involve the measurement of energy or power made at very rapid intervals, and the use of these to calculate heat input. These code changes establish the relationship between heat input across a range of power sources and welding waveforms.

Welders, inspectors, and engineers should be aware of the new ways to calculate heat input. While no code can guarantee good workmanship, these changes make it easier for welders to use waveforms that help improve their welds. The new method will allow flexibility in the way one compares the heat input used in procedure qualification and in production welding.
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Mike Russell / TWI Ltd / Cambridge, UK

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Computer Radiology – Innovations for Film Quality Results in Industrial Applications
Terry Plasek / Fujifilm NDT Systems / Conroe, TX

The Application of Deformation Resistance Welding for Tubular Products
Brian Finnigan / SpaceForm Welding Solutions / Madison Heights, MI

Thermal Stir Welding (TSW) and Ultrasonic Stir Welding (USW) Processes for Solid State Welding Applications
Jeff Ding / NASA Marshall Space Flight Center / Huntsville, AL

Cladding and Additive Manufacture Using Laser Applied Powder (LAPTM) Processes
Scott Poeppel / Joining Technologies, Inc. / East Granby, CT

Automated Weld Seam Facing Tools Modified to Also Perform Back Gouging
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Dual Hot Wire/Cold Wire Gas Tungsten Arc Cladding Procedure Developed to Significantly Improve Deposition Rate
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Recent Developments in Ultrasonic Additive Manufacturing (UAM)
Matt Short / Edison Welding Institute / Columbus, OH
COMING EVENTS


♦ Trends in Welding Conf. Aug. 2–5, Cherry Valley Lodge, Newark, Ohio. Cosponsored by American Welding Society and Edison Welding Institute. Contact George Ritter (614) 688-5199; gritter@ewi.org.

♦ ICWJM 2010, Third Intl Conf. on Welding and Joining of Materials, and Intl Welding Show Peru. Aug. 9–11, Lima, Peru. To feature weldability of advanced alloys, modeling processes, distortion, advanced NDE of welds, welder training, special welding and joining processes, technology transfer, etc. Sponsored by the AWS Peru Section, organized by Soldexa S.A. and Pontifical Catholic University of Peru in collaboration with the University of Chicago. Visit www.pucp.edu.pe/icwjm/ingles/index.html.


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### 9-Year Recertification Seminar for CWI/SCWI

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<td>Wolf Robotics, Ft. Collins, CO</td>
<td>May. 24</td>
<td>(970) 225-7756</td>
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<td>Genesis-Systems, Davenport, IA</td>
<td>May 31</td>
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<td>ABB, Inc., Auburn Hills, MI</td>
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<tr>
<td>Lincoln Electric, Cleveland, OH</td>
<td>Oct 25</td>
<td>(216) 383-8542</td>
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### 9-Year Recertification Seminar for CWI/SCWI

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

For information on any of our seminars and certification programs, visit our website at www.aws.org/certification or contact AWS at (800) 443-9353, Ext. 273 for Certification and Ext. 455 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.
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AWS Members now have access to American Welding Society shirts, hats, accessories and more at the AWS E-store. All of the products in this store are branded with the American Welding Society logo. Don’t miss out on an assortment of great products.

FOR COMPLETE PRODUCT LINE
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www.logodogz.net/aws
Membership Committee Meets and President Addresses Israeli Welding Conference

The AWS Membership Committee members met in Biloxi, Miss. Committee Chairman Lee Kvidahl hosted the group for an interesting tour of Northrop Grumman Ship Systems in Pascagoula, Miss., on March 30. Attending the business meeting with Kvidahl were Vice Chair David Trees, Jim Appledorn, AWS President John Bruskotter, Mark Davidson, District 22 Director Dale Flood, Secretary Russ Norris, and AWS staff representatives Cassie Burrell, deputy executive director; and Rhenda Kenny, director, Member Services.

AWS President John Bruskotter gives a lecture entitled “AWS Energizes the World” at the Welding and Joining 2010 Conference, held last January in Tel Aviv, Israel. The conference was an International Institute of Welding Congress, jointly sponsored by IIW, the Israeli International Section of AWS, and the Association of Engineers and Architects in Israel (ISME).

CTSI Becomes AWS Vietnam Agent

Phil Lamey, president, and Steven Snyder, technical manager, representing Construction Technical Services, Inc. (CTSI), visited AWS headquarters April 21 to document the company’s authorization to serve as an AWS International Agent to conduct certification events in Vietnam. Shown in the photo (from left) are Priti Jain, AWS director, International Business and Certifications; Cassie Burrell, AWS deputy executive director; Steven Snyder; and Phil Lamey.
The AWS D14G Subcommittee on Welding of Rotating Equipment met near Aurora, Ind., to work on the latest revision of D14.6/D14.6M:20XX, Specification for Welding of Rotating Elements of Equipment, and put the finishing touches on a new specification, D14.9/D14.9M:20XX, Specification for Welding of Hydraulic Cylinders, both scheduled for publication early next year. Attendees included Troy McMurtrey, District 16 Director Dave Landon, Tom Landon, Jamie Slipke, David Ashley, Larry Schweinegruber, Ed Yevick, Joe Campbell, John Geelhoed, Rob Larsen, and Matt Rubin, AWS staff secretary. The meeting included a tour of Stedman, a producer of size-reduction equipment since 1834. Dennis Gilmore, Stedman president, offered an introductory talk, and Jason Potter, engineering manager, discussed various engineering topics. The tour guides were Dave Vest, manufacturing manager, assisted by Joe Bennett in unit sales.

Standard Approved by ANSI

Specifications for

Errata AWS A5.5
A5.5/A5.5M:2006, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding

The following erratum has been identified and incorporated into the current reprint of this document.

Page 10, Table 3, Note d, replaced reference to “Table 4” to “Table 7”.

Errata AWS A5.22
A5.22/A5.22M:2010, Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods

The following errata have been identified and incorporated into the current reprint of this document.

Page 5, Table 1FC, Note e, changed “A7.2.4” to “A8.1.4”.
Page 8, Table 1MC, Note f, changed “A2.3.7 and A2.3.8” to “A2.2.7 and A2.2.8”.
Page 9, Table 2, first column, changed “EXXXXTX G” to “EXXXTX-G”.
Page 15, Figure 4, changed “MICROETCH” to “MACROETCH”.

Standard Approved by ANSI

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Tech Topics
D14G Subcommittee on Welding of Rotating Equipment Meets in Indiana

The AWS D14G Subcommittee on Welding of Rotating Equipment met near Aurora, Ind., to work on the latest revision of D14.6/D14.6M:20XX, Specification for Welding of Rotating Elements of Equipment, and put the finishing touches on a new specification, D14.9/D14.9M:20XX, Specification for Welding of Hydraulic Cylinders, both scheduled for publication early next year. Attendees included Troy McMurtrey, District 16 Director Dave Landon, Tom Landon, Jamie Slipke, David Ashley, Larry Schweinegruber, Ed Yevick, Joe Campbell, John Geelhoed, Rob Larsen, and Matt Rubin, AWS staff secretary. The meeting included a tour of Stedman, a producer of size-reduction equipment since 1834. Dennis Gilmore, Stedman president, offered an introductory talk, and Jason Potter, engineering manager, discussed various engineering topics. The tour guides were Dave Vest, manufacturing manager, assisted by Joe Bennett in unit sales.

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Page 9, Table 2, first column, changed “EXXXXTX G” to “EXXXTX-G”.
Page 15, Figure 4, changed “MICROETCH” to “MACROETCH”. 
C3.7M/C3.7:20XX, Specification for Aluminum Brazing: This document presents the minimum fabrication, equipment, material, process procedure and inspection requirements for the brazing of aluminum by all of the processes commonly used — atmosphere furnace, vacuum furnace, and flux processes. Its purpose is to standardize aluminum brazing requirements for all applications in which brazed aluminum joints of assured quality are required. It provides criteria for classifying aluminum brazed joints based on loading and the consequences of failure and quality assurance criteria defining the limits of acceptable quality of each class. Stakeholders are aerospace and commercial brazing operators. S. Borrero, ext. 334.

C3.8M/C3.8:20XX, Specification for the Ultrasonic Pulse-Echo Examination of Brazed Joints. This document provides the minimum requirements for the pulse-echo ultrasonic examination of brazed joints. Its purpose is to standardize brazed-joint ultrasonic examination requirements for all applications in which brazed joints of assured quality are required. It provides minimum requirements for equipment, procedures, and the documentation of such tests. Stakeholders are aerospace and commercial brazing and inspection operations. S. Borrero, ext. 334.

C3.11M/C3.11:20XX, Specification for Torch Soldering. This document describes relevant equipment, fabrication procedures and quality (inspection) requirements for the torch soldering of materials. Included are criteria for classifying torch-soldered joints based on loading and the consequences of failure and quality assurance criteria defining the limits of acceptability in each class. Stakeholders are plumbing industry, food-handling equipment manufacturers, and the heating and air-conditioning industry. S. Borrero, ext. 334.

D11.2:20XX, Guide for Welding Iron Castings. This guide presents briefly the history and metallurgy of cast iron and the welding processes applicable to it. A new weldability test is detailed with instructions given for its application in specific cases. Provision is made for qualification of welding procedures and welders when necessary. Quality control practice is also included. Stakeholders are welders of iron castings. S. Borrero, ext. 334.

G2.1M/G2.1:20XX, Guide for the Joining of Wrought Nickel-Based Alloys. This guide describes the welding of different wrought nickel-based alloys, including solid-solution and precipitation hardening alloys. Included are descriptions of the alloys, filler metal selection, joint design recommendations, and a discussion of the appropriate welding processes. Stakeholders are consumers, designers, welding engineers, and welders. S. Borrero, ext. 334.

Technical Committee Meetings

June 16, Safety and Health Committee. Columbus, Ohio. Contact S. P. Hedrick, ext. 305.

June 29, 30, D3B Subcommittee on Underwater Welding. Metairie, La. Contact B. McGrath, ext. 311.


Candidates Sought for M.I.T. Award

November 2, 2010, is the deadline for submitting nominations for the 2011 Prof. Koichi Masubuchi Award, sponsored by the Dept. of Ocean Engineering at Massachusetts Institute of Technology (M.I.T.).

This award, including an honorarium of $5000, is presented each year to one person who has made significant contributions to the advancement of materials joining through research and development.

The candidate must be 40 years old or younger, may live anywhere in the world, and need not be an AWS member.

The nomination package should be prepared by someone familiar with the research background of the candidate. It should include the candidate’s résumé listing background, experience, publications, honors, and awards, plus at least three letters of recommendation from fellow researchers.

The award was established to recognize Prof. Koichi Masubuchi for his numerous contributions to the advancement of the science and technology of welding, especially in the fields of fabricating marine and outer space structures.

Send your nominations to Prof. John DuPont at jnd1@lehigh.edu.
Member-Get-A-Member Campaign

Listed below are the AWS members who are participating in the 2009–2010 MGM campaign. See page 83 in this Welding Journal or visit www.aws.org/mgmr for the rules and prize list.

The following standings are as of April 17, 2010. Call the AWS Membership Dept. (800/305) 443-9353, ext. 480, for information on your member-proposer status.

**Winners’ Circle**
Sponsored 20+ new members.
- J. Compton, San Fernando Valley
- E. Ezell, Mobile
- J. Merzhal, Peru
- G. Taylor, Pascagoula
- L. Taylor, Pascagoula
- S. Egdars, Detroit
- B. Mikesla, Houston
- W. Shreve, Fox Valley
- M. Karrgoula, Detroit
- S. McGill, NE Tennessee
- T. Wineland, Johnson-Atwood
- G. Woomer, Johnstown-Altoona
- R. Wray, Nebraska
- M. Haggard, Inland Empire

**President’s Club**
Sponsored 3–8 new members.
- S. Keskar, India
- J. Hennessy, Fox Valley
- D. Berger, New Orleans
- J. Ciaramitro, Central Florida
- J. Hope, Puget Sound
- J. Price, Detroit
- G. Baldrec, Rio Grande Valley
- B. Cebery, Fox Valley
- E. Ezell, Mobile
- J. Fitzpatrick, Arizona
- E. Ravelo, International
- J. Rodenbarger, Nebraska
- D. Scott, Mobile
- S. Singh, India
- T. Baber, San Fernando Valley
- G. Burion, New Orleans
- T. Morris, Tulsa
- P. Newhouse, British Columbia
- M. Pelegrino, Chicago

**President’s Honor Roll**
Sponsored 2 new members.
- J. Barber, Connecticut
- T. Blakeney, Green & White Mts.
- C. Bridwell, Ozark
- G. Callender, San Fernando Valley
- K. Carter, Tri-River
- R. Davis, Utah
- M. Haynes, Niagara Frontier
- K. Hurst, Kansas City
- S. Johnson, Lexington
- D. Mandina, New Orleans
- V. Matthews, Cleveland
- J. Medina, International
- J. Miller, Lancaster
- T. Moffitt, Tulsa
- B. Morgan, Kern
- F. Nguni, New Jersey
- T. Rowe, Tulsa
- M. Rudden, Colorado
- R. Sewell, International
- J. Sims, Syracuse
- S. Siviski, Maine
- T. Thomas, St. Louis

**3+ Student Member Sponsors**
- D. Saunders, Lakeshore
- C. Rogers, San Antonio
- G. Kirk, Pittsburgh
- H. Hughes, Mahoning Valley
- D. Berger, New Orleans
- J. Morash, Boston
- S. Miner, San Francisco
- C. Hartbarger, Mid-Ohio Valley
- G. Gambill, NE Mississippi
- D. Keller, Willamette Valley
- C. Lindquist, Central Michigan
- R. Durham, Cincinnati
- T. Palmer, Columbia
- J. Carney, Western Michigan
- M. Anderson, Indiana
- D. Kowalski, Pittsburgh
- A. Stute, Madison-Beloit
- D. Zabel, SE Nebraska
- M. Boggs, Stark Central
- A. Duron, New Orleans
- R. Hutchinson, Long Bch./Or. Cty.
- S. Siviski, Maine
- A. Baughman, Stark Central
- W. Wahrman, Long Bch.
- T. Gerber, Allegheny
- D. Aragon, Puget Sound
- J. Roberts, Sacramento
- J. Gerdin, Northwest
- J. Fox, NW Ohio
- J. Boyer, Lancaster
- V. Facchinato, Lehigh Valley
- W. Galvery, Long Bch./Or. Cty.
- W. Harris, Pascagoula
- J. Theberge, Boston
- M. Arand, Louisville
- J. Boyer, Lancaster
- R. Boyer, Nevada
- W. Davis, Syracuse
- J. Fox, NW Ohio
- J. Gerdin, Northwest
- J. Roberts, Sacramento
- D. Vranich, NE Florida
- K. Carter, Tri-River
- R. Schmidt, Philadelphia
- G. Smith, Lehigh Valley
- N. Baughman, Stark Central
- J. Daugherty, Louisville
- A. Reis, Pittsburgh
- G. Seese, Johnstown-Altoona

B. Wenzel, Sacramento
W. Garrett, Olympic
M. Vann, South Carolina
R. Vann, South Carolina
B. Byer, Johnson-Atwood
J. Ciaramitro, Central Florida
T. Garcia, New Orleans
T. Kline, Northern New York
R. Munns, Utah
W. Seyforth, Central Florida
S. Malton, Florida
H. Thompson, New Orleans
G. Rodeman, Sierra Nevada
R. Ledford, Birmingham
J. Stallsmith, South Carolina
H. Browne, New Jersey
T. Kunz, Pittsburg
R. Rummel, Central Texas
C. Schiner, Wyoming
J. Hill, Puget Sound
J. Fitzpatrick, Arizona
D. Howard, Johnson-Atwood
A. Mattox, Lexington
D. Roskiewicz, Philadelphia
J. Grossman, Central Michigan
M. Hayes, Puget Sound
R. Jones, Puget Sound
R. Madrigal, L.A./Inland Empire
A. Badeau, Washington, D.C.
T. Bridigum, Northwest
S. Colton, Arizona
D. Kearns, Northern Michigan
S. Liu, Colorado
M. McLaughlin, Reading
T. Strickland, Arizona
J. Boyd, San Diego
G. Callender, San Fernando Valley
R. Davis, Syracuse
S. Hansen, SE Nebraska
S. Henson, Spokane
R. Hily, Pittsburgh
E. Hinojosa, LA/Inland Empire
G. Kimbrell, St. Louis
A. Kitchens, Olympic Section
J. Lynn, Idaho/Montana
S. Mackenzie, Northern Michigan
D. Newman, Ozark
M. Pelegrino, Chicago
J. Pummer, Long Bch./Or. Cty.
R. Richwine, Indiana
J. Smith, Greater Huntsville
M. Stevenson, J.A.K.
R. Wilcox, Detroit
N. Carlson, Idaho/Montana
B. Chin, Auburn-Opella
J. Compton, San Fernando Valley
T. Crote, Drake Well
D. Crow, Houston
C. Gilbertson, Northern Plains
D. Hitchon, San Diego
J. McCutcheon, Arizona
S. McDaniel, Idaho/Montana
G. Moore, San Diego
H. Rendon, Rio Grande Valley
S. Robeson, Cumberland Valley
A. Rodden, W. Tennessee
District Director and Student Chapter Awards Announced

David W. Waceke, a student at Lawson State C. C., earned the Student Chapter Member Award in District 9.

Scott Gordon displays the Student Chapter Member Award presented to him by Stephen Liu (to his right), advisor, Colorado School of Mines Student Chapter, and some of his classmates.

District Director Awards

District 20 Director, William Komlos, has nominated the following AWS members to receive the District 20 Director Award: Richard “Woody” Cook and Richard Simkins with the Utah Section; and John P. H. Steele, PhD, PE, with the Colorado Section.

The District Director Award provides a means for District Directors to recognize individuals who have contributed their time and effort to the affairs of their local Section and/or District.

Student Chapter Awards

The AWS board of directors established the Student Chapter Member Award to recognize AWS Student Members whose Student Chapter activities have produced outstanding school, community, or industry achievements. This award also provides an opportunity for Student Chapter advisors, Section officers, and District directors to recognize outstanding students affiliated with AWS Student Chapters, as well as to enhance the image of welding within their communities.

Chris Harris was selected to receive the Student Chapter Member Award by Ray Sosko, advisor, AWS Central Piedmont C. C. Student Chapter, Charlotte Section, District 5. Harris, who is currently working toward an associate’s degree in welding technology, serves as the Chapter's secretary and treasurer. He has been an enthusiastic fund-raiser and membership coordinator for the Chapter, as well as a mentor to other students. Harris is also active in local parks and recreation and other community projects.

Zach Boring was selected to receive the Student Chapter Member Award by Tom Geisler, advisor, AWS Beaver Valley Student Chapter, Pittsburgh Section, District 7. Boring, an honor roll student in his senior year, has served as a Student Chapter officer for the past three years. He is a member of SkillsUSA, and is certified to AWS D1.1.

David W. Waceke was selected to receive the Student Chapter Member Award by Roy Ledford, advisor, AWS Lawson State C. C. Student Chapter, Birmingham Section, District 9. Waceke, a President’s List honoree, served the welding program as a tutor for the 2009 year, and received the Outstanding Student in the Welding Technology Program Award. He is Chapter chairman, and will represent his college at this year’s Louisiana State SkillsUSA competition.

Scott Gordon (see photo), AWS Colorado School of Mines Student Chapter, has been selected by Dr. Stephen Liu, Student Chapter advisor, to receive the Student Chapter Member Award. Gordon received his BS in metallurgical and materials engineering, and a master’s in metallurgical engineering, specialty welding engineering. He developed numerous projects to build and enhance facilities for the welding lab, and developed innovative ideas and initiatives for his master’s research, and conducted outreach to local and national industries for the Student Chapter.

To qualify for the Student Chapter Member certificate award, the individual must be an AWS Student Member affiliated with an AWS Student Chapter. The criteria and nomination form can be downloaded from the AWS Web page www.aws.org/sections/awards/student_chapter.pdf, or call the Membership Dept. at (800) 443-9353, ext. 260.

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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Pithampur, Dist. Dhar
Dhar, M.P 454 774, India

Affiliate Companies

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Altoona, PA 16602

AMG Welding, LLC
50 Jesse Ct.
Montville, NJ 07045

Arc Designs, Inc.
PO Box 1012
Cypress, TX 77410

Contract Fabricators, Inc.
105 Rolfing Rd.
Holly Springs, MS 38635

Custom Biogenic Systems
150 Shafer Dr.
Romeo, MI 48065

Falls Welding & Fabricating, Inc.
608 Grant St.
Akron, OH 44311

Mobil Engineering and Trading Co.
Unit 11-No 18 Jar Alley S. Mofatteh
7th Tir Tehran 1573747654, Iran

Sirron International, LLC
PO Box 1012
Cypress, TX 77410

Sky Tec Container Corp.
8027 S. Division Ave.
Grand Rapids, MI 49548

Streamline Fabrication, LLC
1500 Farmer Rd., Ste. C-2
Conyers, GA 30013

Thor Fabrication, LLC
PO Box 998, Franklin, LA 70438

Welding Distributor
Kabdwal Book International
179 D/42, Raigad Co-op. Housing Society
Sector-1, Charkop, Kandivali (W)
Mumbai 400 067, Maharashtra, India

Weldwell Speciality Pvt. Ltd.
401 Vikas Commercial Centre
Dr. C. G. Rd., Mumbai
Maharashtra 400074, India

Educational Institutions

Anoka-Hennepin Secondary
Technical Education Program
1353 W. Hwy. 10
Anoka, MN 55303

Camp Verde High School —
Agriculture Welding
1326 Montezuma Castle Hwy.
Camp Verde, AZ 86322

College of Southern Maryland
Center for Trades & Energy
17 Irongate Dr.
Waldorf, MD 20602

Dakota County Technical College
1300 145th St. E.
Rosemount, MN 55068

Livingston Area Career Center
1100 E. Indiana Ave.
Pontiac, IL 61764

Moberly Area Community College
101 College Ave.
Moberly, MO 65270

Mountainland Applied Technology College
1410 W. Business Park Dr.
Orem, UT 84058

Seminole High School
2100 SW Ave. D
Seminole, TX 79360

Tallinn University of Technology Library
Akadeemia Tee 1
EE 12618 Tallinn, Estonia

AWS Membership Counts

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Total corporate members... 1,879
Individual members..... 53,834
Student + transitional members... 9,149
Total members............... 62,983

AWS Levels of Membership Defined

As an AWS Sustaining Company Member, your company may have up to ten Individual Members ($800 value) listed on its roster at no additional charge. You may add your customers to the roster as a special “thank you.”

Supporting Company Members may have up to five Individual Members (a $400 value) listed under the corporate umbrella.

Welding Distributor Members receive up to five Individual memberships (a $400 value), as well as a listing on the Distributor Locator Map on the AWS Web site. The listing provides a hyperlink that will take visitors directly to your company’s Web page.

Educational Institution Members may have up to three Individual Members (a $240 value) listed on the school’s member roster at no additional charge.

Individual Members included in your company’s corporate membership receive a subscription to the monthly Welding Journal, as well as discounts on AWS publications, certification exams, educational seminars, and conferences. Contact Member Services at (800/305) 443-9353, ext. 259, or e-mail marthac@aws.org, for more information or to request Corporate Member application forms.
Activity: Several Section members supervised the testing of 30 Certified Welding Inspector candidates at Four Points Sheraton Hotel in Revere, Mass. James Shore, quality engineer with Boston Scientific, headed the program, assisted by Gary Hylan and Russ Norris.

MAINE

March 12

Shown are the entrants in the Lehigh Valley Section student welding contest held in March.

The top winners in the Reading Section-sponsored welding contest display their prizes.

Justin Heistand (right) is shown with Michael Sebergandio, Lancaster Section chair.

Gold Member Ken Jelonek (right) is shown with Josh Seitzer at the Lancaster Section program in April.

in the Gulf of Mexico
Activity: This was a joint meeting of the Lancaster, Reading, York-Central Pa., and Washington, D.C., Sections. The Gold Membership Award, for 50 years of service to the Society, was presented to Ken Jelonek, York-Central Pa. Section. Justin Heistand, Lancaster Section technical representative, received the Section Meritorious Award. Bruskotter received an oil painting of an Amish country scene, typical of the region where the meeting was held. The Lancaster Section hosted the event at Lancaster County Career and Technology Center in Mount Joy, Pa.

LEHIGH VALLEY
MARCH 25
Activity: The Section hosted its 40th annual student welding competition at Career Institute of Technology in Easton, Pa. Five area secondary technical schools sent two students each to compete on tasks centered around preemployment testing. The student placement was announced two weeks later at the annual student awards banquet where the prizes are awarded to the top placers. The entrants included Joseph Petri, Thomas Litz, Thomas Ruck, Frank Mennella, Jonathan Remmey, Eric Mantz, Nick Herbert, John Lezzatti, Ben Quinones, and Cory Buyanouits.

READING
MARCH 20
Activity: The Section hosted a welding contest for entrants from five local schools. Participating were members of the Reading, Lancaster, and York-Central Pennsylvania Sections. The event was held at Berks Career & Technology Center West in Leesport, Pa.

District 4
Roy C. Lanier, director
(252) 321-4285
rlanier@email.pittcc.edu

SOUTHWEST VIRGINIA
OCTOBER 29
Activity: The Section members toured the welding facilities at AREVA NP, Inc., in Lynchburg, Va. The program was conducted by Brian Kruse.

MARCH 18
Activity: The Southwest Virginia Section members met at Airgas Mid-America in Salem, Va., for a presentation on the company’s emergency response activities and AERO training and activities performed during a hazardous event. The presenters included AERO team member Clayton Chenard, and Robert Langmeyer, Airgas safety director.

APRIL 1
 Speaker: Mark Gilbert, welding instructor
Affiliation: New River C. C.
Topic: Explosion welding techniques
Activity: This SW Virginia Section program was held at New River C. C. in Dublin, Va.
Shown at the SW Virginia Section March program are (from left) Chair Wayne Johnson, Clayton Chenard, and Robert Langmeyer.

Secretary Bill Rhodes (left) and tour guide Brian Kruse are shown during the Southwest Virginia Section’s tour of AREVA.

Shantilly Smith displays her good cutting technique at the Reading Section contest.

Speaker Mike Dortch (left) is shown with Carl Matricardi, Atlanta Section chair.

Florida West Coast Section golfers take a break.

**District 5**

**ATLANTA**

April 15  
Speaker: Mike Dortch  
Affiliation: Alcotec, Inc.  
Topic: Aluminum welding and metallurgy  
Activity: The program was held at Southern Polytechnic State University in Marietta, Ga.

**FLORIDA WEST COAST**

March 20  
Activity: The Section hosted its 18th annual golf tournament at Walden Lake Golf and Country Club in Plant City, Fla. The event is a fund raiser for its scholarship fund. The annual scholarships are presented at the Section’s May 1st Shrimp-A-Roo outing.

**NORTH CENTRAL FLORIDA**

February 9  
Speaker: J. T. Mahoney, professor, applied welding technologies  
Affiliation: Santa Fe College  
Topic: How to obtain welding scholarships  
Activity: The Section hosted a students’ night program at Santa Fe College in Gainesville, Fla., for sixty-seven attendees. Fifteen students won AWS Student Memberships paid for by the Section.

**SOUTH CAROLINA**

March 18  
Speaker: Ben Magrone, Section chair  
Affiliation: Laurentide, Inc.  
Topic: The new AWS Certified Welding
District 6
Kenneth Phy, director
(315) 218-5297
KAPhyInc@gmail.com

NORTHERN NEW YORK
March 17
Activity: The Section hosted the regional SkillsUSA welding competition at Capital Region BOCES Career and Technical School in Albany, N.Y. The top scorers included Jared LaQuire, Benjamin Gigandet, Nick Cannito, Nathan Durland, and Joshua Chapleski.

Manufacturer program
Activity: The Section held nominations for the incoming slate of officers. The program was held at Trident Technical College’s welding technology lab in Charleston, S.C.

District 7
Don Howard, director
(814) 269-2895
howard@ctc.com

DAYTON
April 7
Speaker: Luke Banks, principal engineer
Affiliation: Digicon
Topic: Digital radiography, the new gold standard
Activity: Brian Galliers, chairman of the Miami Valley Section of ASNT, attended the program. The event was held at Bullwinkle’s in Franklin, Ohio, for 33 attendees.

PITTSBURGH
March 23
Speaker: Joel Weber
Affiliation: AMET
Topic: Digital weld-control systems
Activity: This Pittsburgh Section program was held at Twelve Oaks Mansion in Mars, Pa.

March 26
Activity: The Pittsburgh Section hosted a students’ day outing to tour Holtec, Inc. Welding Engineer John Manheim conducted the tour. The group studied the fabrication of dry fuel storage tanks and heat exchangers used in the nuclear power industry. The business meeting included presentation of awards to the students for their accomplishments in the weld-off competition held last December. More than 300 members, students, and instructors attended the event.

District 8
Joe Livesay, director
(931) 484-7502, ext. 143
joe.livesay@ttcc.edu

SYRACUSE
April 14
Activity: The Section members met at Haun Welding in Syracuse, N.Y., for a tour and hands-on demonstrations of its advanced gas metal arc welding equipment for stainless steel pipe. The presenters were Section Chair Tim Howell and Neal Chapman, Section secretary. They discussed the processes, training requirements, and applications for the equipment, then conducted the demonstrations.
Win Great Prizes in the 2010-2011 AWS Member-Get-A-Member Campaign*

ABOUT: AWS is looking for individuals to become part of an exclusive group of AWS Members who get involved and win. Give back to your profession, strengthen AWS and win great limited-edition prizes by participating in the 2010-2011 Member-Get-A-Member Campaign. By recruiting new members to AWS, you’re adding to the resources necessary to expand your benefits as an AWS Member. Year round, you’ll have the opportunity to recruit new members and be eligible to win special contests and prizes. Referrals are our most successful member recruitment tool. Our Members know first-hand how useful AWS Membership is, and with your help, AWS will continue to be the leading organization in the materials joining industry.

To recruit new Members, use the application on the reverse, or visit www.aws.org/mgm

PRIZE CATEGORIES
President’s Honor Roll: Recruit 1-2 new Individual Members and receive an AWS Sportpack bag.

President’s Club: Recruit 3-8 new Individual Members and receive an AWS hat and an AWS Sportpack bag.

President’s Roundtable: Recruit 9-19 new Individual Members and receive an AWS polo or denim shirt, hat and an AWS Sportpack bag.

President’s Guild: Recruit 20 or more new Individual Members and receive an AWS Messenger Bag, an AWS polo or denim shirt, a one-year free AWS Membership, the "Shelton Ritter Member Proposer Award" Certificate and membership in the Winner’s Circle.

Winner’s Circle: All members who recruit 20 or more new Individual Members will receive annual recognition in the Welding Journal and will be honored at the FABTECH Show.

SPECIAL PRIZES
Participants will also be eligible to win prizes in specialized categories. Prizes will be awarded at the close of the campaign (June 2011).

Sponsor of the Year: The individual who sponsors the greatest number of new Individual Members during the campaign will receive a plaque, a trip to the 2011 FABTECH Show, and recognition at the AWS Awards Luncheon at the Show.

Student Sponsor Prize: AWS Members who sponsor two or more Student Members will receive an AWS Sportpack bag.

The AWS Member who sponsors the most Student Members will receive a complimentary AWS Membership renewal.

LUCK OF THE DRAW
For every new member you sponsor, your name is entered into a quarterly drawing. The more new members you sponsor, the greater your chances of winning. Prizes will be awarded in November 2010, as well as in February and June 2011.

Prizes Include:
* Complimentary AWS Membership renewal
* AWS t-shirt
* AWS hat

SUPER SECTION CHALLENGE
The AWS Section in each District that achieves the highest net percentage increase in new Individual Members before the June 2011 deadline will receive special recognition in the Welding Journal.

The AWS Sections with the highest numerical increase and greatest net percentage increase in new Individual Members will each receive the Neitzel Membership Award.

*The 2010-2011 MGM Campaign runs from June 1, 2010 to May 31, 2011. Prizes are awarded at the close of the campaign.
AWS MEMBERSHIP APPLICATION

4 Easy Ways to Join or Renew:
- Mail this form, along with your payment, to AWS
- Call the Membership Department at (800) 443-9353, ext. 480
- Fax this completed form to (305) 443-5647
- Join or renew on our website <www.aws.org/membership>

Mr. Ms. Mrs. Dr. Please print. Duplicate this page as needed

Last Name
First Name
Middle Initial
Title
Birthday

Were you ever an AWS Member? ❑ YES ❑ NO
If “YES,” give year and Member #

Primary Phone ( ) Secondary Phone ( )

FAX ( ) E-Mail

Did you learn of the Society through an AWS Member? ❑ YES ❑ NO

If “YES,” Member’s name; Member’s # if known:

From time to time, AWS sends out informational e-mails about programs we offer, new Member benefits, savings opportunities and changes to our website. If you would prefer not to receive these e-mails, please check here ♣

ADDRESS

NOTE: This address will be used for all Society mail.

Company (if applicable)
Address
Address Con’t.

City State/Province Zip/Postal Code Country

PROFILE DATA

NOTE: This data will be used to develop programs and services to serve you better.

❑ Who pays your dues? ❑ Company ❑ Self-paid
❑ Sex: ❑ Male ❑ Female
❑ Education level: ❑ High school diploma ❑ Associate’s ❑ Bachelor’s ❑ Master’s ❑ Doctoral

PAYMENT INFORMATION (Required)

ONE-YEAR AWS INDIVIDUAL MEMBERSHIP $80
TWO-YEAR AWS INDIVIDUAL MEMBERSHIP $160 $135 (New Members Only)

New Member? ❑ YES ❑ NO

If yes, add one-time initiation fee of $12

INTERNATIONAL ADDRESSES

If you reside outside of the United States, please add $75 for book selection

Domestic Members add $25 for book selection ($192 value), and save up to 87% on other add-ons.

International Members add $75 for book selection (note: $50 is for international shipping, $25 is for book selection).

BOOK/CD-ROM SELECTION

(Pay Only $25... up to a $192 value)

NOTE: Only New Individual Members are eligible for this selection. Be sure to add $25 to your total payment.

ONLY ONE SELECTION PLEASE:
❑ Jefferson’s Welding Encyclopedia (CD-ROM only)
❑ Design and Planning Manual for Cost-Effective Welding
❑ Welding Metallurgy
❑ Welding Handbook (9th Ed., Vol. 3)
❑ Welding Handbook (9th Ed., Vol. 2)
❑ Welding Handbook (9th Ed., Vol. 1)

For more information, visit our website at www.aws.org/membership

Learn more about each publication at www.aws.orgpubs.com

❑ New Member ❑ Renewal

A free local Section Membership is included with all AWS Memberships. See Section Affiliation Preference (if known):

Type of Business (Check ONE only)

❑ Contract construction
❑ Chemicals & allied products
❑ Petroleum & coal industries
❑ Primary metal industries
❑ Fabricated metal products
❑ Machinery except elect. (incl. gas welding)
❑ Electrical equip., supplies, electrodes
❑ Transportation equip. — air, aerospace
❑ Transportation equip. — automotive
❑ Transportation equip. — boats, ships
❑ Transportation equip. — railroad
❑ Utilities
❑ Welding distributors & retail trade
❑ Misc. repair services (incl. welding shops)
❑ Educational Services (univ., libraries, schools)
❑ Engineering & architectural services (incl. assns.)
❑ Misc. business services (incl. commercial labs)
❑ Government (federal, state, local)
❑ Other

Job Classification (Check ONE only)

❑ President, owner, partner, officer
❑ Manager, director, superintendent (or assistant)
❑ Sales
❑ Purchasing
❑ Engineer — welding
❑ Engineer — design
❑ Engineer — manufacturing
❑ Engineer — other
❑ Architect designer
❑ Metallurgist
❑ Research & development
❑ Quality control
❑ Inspector, tester
❑ Supervisor, foreman
❑ Technician
❑ Welder, welding or cutting operator
❑ Consultant
❑ Educator
❑ Librarian
❑ Student
❑ Customer Service
❑ Other

Technical Interests (Check all that apply)

❑ Ferrous metals
❑ Aluminum
❑ Nonferrous metals except aluminum
❑ Advanced materials/Intermetals
❑ Ceramics
❑ High energy beam processes
❑ Arc welding
❑ Brazing and soldering
❑ Resistance welding
❑ Thermal spray
❑ Cutting
❑ NDT
❑ Safety and health
❑ Bending and shearing
❑ Roll forming
❑ Stamping and punching
❑ Aerospace
❑ Automotive
❑ Machinery
❑ Marine
❑ Piping and tubing
❑ Pressure vessels and tanks
❑ Sheet metal
❑ Structures
❑ Other
❑ Automation
❑ Robotics
❑ Computerization of Welding

American Welding Society
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Fax (800) 443-5647
Visit our website: www.aws.org

Member Services Revised 12/12/08

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❑ Chemicals & allied products
❑ Petroleum & coal industries
❑ Primary metal industries
❑ Fabricated metal products
❑ Machinery except elect. (incl. gas welding)
❑ Electrical equip., supplies, electrodes
❑ Transportation equip. — air, aerospace
❑ Transportation equip. — automotive
❑ Transportation equip. — boats, ships
❑ Transportation equip. — railroad
❑ Utilities
❑ Welding distributors & retail trade
❑ Misc. repair services (incl. welding shops)
❑ Educational Services (univ., libraries, schools)
❑ Engineering & architectural services (incl. assns.)
❑ Misc. business services (incl. commercial labs)
❑ Government (federal, state, local)
❑ Other

Job Classification (Check ONE only)

❑ President, owner, partner, officer
❑ Manager, director, superintendent (or assistant)
❑ Sales
❑ Purchasing
❑ Engineer — welding
❑ Engineer — design
❑ Engineer — manufacturing
❑ Engineer — other
❑ Architect designer
❑ Metallurgist
❑ Research & development
❑ Quality control
❑ Inspector, tester
❑ Supervisor, foreman
❑ Technician
❑ Welder, welding or cutting operator
❑ Consultant
❑ Educator
❑ Librarian
❑ Student
❑ Customer Service
❑ Other

Technical Interests (Check all that apply)

❑ Ferrous metals
❑ Aluminum
❑ Nonferrous metals except aluminum
❑ Advanced materials/Intermetals
❑ Ceramics
❑ High energy beam processes
❑ Arc welding
❑ Brazing and soldering
❑ Resistance welding
❑ Thermal spray
❑ Cutting
❑ NDT
❑ Safety and health
❑ Bending and shearing
❑ Roll forming
❑ Stamping and punching
❑ Aerospace
❑ Automotive
❑ Machinery
❑ Marine
❑ Piping and tubing
❑ Pressure vessels and tanks
❑ Sheet metal
❑ Structures
❑ Other
❑ Automation
❑ Robotics
❑ Computerization of Welding

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Member Services Revised 12/12/08
Shown at the Chattanooga Section weld competition are (from left) Chair Dusti Jones, Josh Traylor, Zahn York, Greg Harper, Timmy May, Ernest Beach, Nick Bowman, and Demetrius AppleBerry.

Grady Bingham (right) presents an award plaque to Demetrius AppleBerry at the Chattanooga Section welding competition.

Joe Livesay (far left), District 8 director, poses with (from left) Nick Bowman, Ernest Beach, and Greg Harper at the Chattanooga Section welding contest.

The winners in the Chattanooga Section high school welding contest are Josh Traylor (left) and Zahn York.

**CHATTANOOGA**

**MARCH 16**

Activity: The Section hosted a students’ night program featuring a welding contest for its secondary and postsecondary students. The top scorers were Zahn York, Josh Traylor, Demetrius AppleBerry, Nick Bowman, Ernest Beach, and Greg Harper. Assisting with the event were Chair Dusti Jones, weld instructor Grady Bingham, and Joe Livesay, District 8 director. The contest was held at Sequoyah High School in Chattanooga, Tenn.

District 6 Director Ken Phy (left, both photos) is shown with incoming Syracuse Section Chair Tim Howell (left photo), and outgoing Chair Bill Oliver (right photo).
Shown at the Dayton Section program are (from left) Chair Steve Whitney, speaker Luke Banks, and Brian Galliers, chair, local chapter of ASNT.

Students are shown at the Northeast Mississippi Section program in February.

Speaker Joel Weber (left) is shown with Dave Daugherty, Pittsburgh Section chair.

Presented Gilbert Diaz Jr. (right) is shown with Dale Kite, Mobile Section vice chair.

Jenny McCall (left) receives a speaker plaque from Teresa Hart, Mobile Section chair.

NORTHEAST MISSISSIPPI
February 18
Speaker: Scott Stinson
Affiliation: Thermadyne
Topic: Oxyfuel safety
Activity: The Section hosted a students’ night program at East Mississippi C.C. in Mayhew, Miss. Following the talk, Stinson demonstrated the proper ways to perform oxyfuel processes safely.

April 15
Speaker: Jenny McCall, GAWDA president
Affiliation: WESCO Gas & Welding Supply, president
Topic: How women can become more involved in welding
Activity: This Mobile Section program, attended by 30 members and guests, was held at Saucy-Q Barbecue in Mobile, Ala.

District 9
George D. Fairbanks Jr., director
(225) 473-6362
tfits@bellsouth.net

BIRMINGHAM
April 16
Activity: The Section presented David W. Waceke its Outstanding Student Chapter Member Award. Waceke is enrolled in the welding technology program at Lawson State C.C., where the award was presented. See page 77 for a photo and more details.

NEW ORLEANS
March 16
Speaker: Kevin Cuevas
Affiliation: Thermadyne
Topic: Innovative welding products
Activity: Industrial Welding Supply (IWS) sponsored this meeting for 103 attendees at Boomtown Casino in Harvey, La. Ricky “Mousey” Chaisson of IWS organized the event.

MOBILE
March 11
Activity: The Section members visited Alabama Roll Products in Theodore, Ala., for a tour of the facilities. Gilbert Diaz Jr., owner and president, conducted the event.

District 10
Richard A. Harris, director
(440) 339-5921
richaharris@windstream.net
The Racine-Kenosha Section members and students are shown at the March program held at Gateway Technical College.

Madison-Beloit Section members and students are shown at Fairbanks Morse Engine.

CLEVELAND
MARCH 9
Activity: The Section members visited the Lincoln Electric Co. Automation Center in Cleveland, Ohio. The visit included dinner and hands-on demonstrations of virtual reality arc welding training systems, welding videos, and an education cell to help teach robotic programming with gas metal arc welding. More than 80 people attended the tour. District 10 Director Richard Harris attended the program.

District 11
Etthiios Siradakis, director
(989) 894-4101
et.siradakis@airgas.com

WESTERN MICHIGAN
JANUARY 18
Speaker: Kevin Fleming
Affiliation: The Lincoln Electric Co.
Topic: WPS, POR, and WOR documentation and production-monitoring software
Activity: The program was held at the Lincoln Electric Co. facility in Grand Rapids, Mich.

Kevin Fleming discussed welding documentation issues at the Western Michigan Section program in January.

District 12
Sean P. Moran, director
(920) 954-3828
sean.moran@hobartbrothers.com

LAKE SHORE
APRIL 8
Activity: The Section members toured Pierce Manufacturing, Inc., Appleton, Wis., to study the aluminum welding processes used in the production of fire trucks, rescue trucks, and vehicles for homeland security. Dave Pahl, Patrick Casper, and Darrell Duckart conducted the program. Following the tour, the group dined at Germania Hall in Menasha, Wis.

MILWAUKEE
MARCH 18
Activity: The Section held a community education event in partnership with Waukesha County Technical College (WCTC) in Waukesha, Wis. It offered an opportunity for visitors to try welding and learn more about the various joining processes. Assisting were student Anni Quackenbush, Section Chair Karen Gilgenbach, WCTC instructors, and representatives from Miller and Lincoln Electric. Michael Shiels, WATC associate dean, presented.
Racine-Kenosha Section attendees are shown during their tour of Bucyrus International.

Chicago Section members are shown during their Central Steel & Wire Co. tour.

Dave Blaugh (left) accepts a speaker plaque from Chuck Hubbard, Chicago Section vice chair, at the April tour.

Shown at the March Racine-Kenosha Section program are (from left) Vice Chair Ken Karwowski, speaker Steven Jackson, and Chairman Dan Crifase.

Shown at the March Racine-Kenosha Section program are (from left) Pete Host, AWS Vice President Bill Rice, Hank Sima, Craig Teichlar, and Chuck Hubbard.

a talk detailing the welding programs available at the college.

**RACINE-KENOSHA**

**MARCH 29**

Speaker: **Steven Jackson**  
Affiliation: ESAB Welding & Cutting Products, territory sales manager  
Topic: A review of ESAB welding and hardfacing products  
Activity: The program was held at Gateway Technical College in Elkhorn, Wis.

**APRIL 13**  
Activity: Thirty-three Racine-Kenosha Section members and Gateway Technical College students studying welding and automated manufacturing toured Bucyrus International, Inc., Milwaukee, Wis., a manufacturer of mining equipment, excavators, draglines, trucks, shovels, and drills. The tour included the welding and machining departments and the company’s museum.

**District 13**

W. Richard Polanin, director  
(309) 694-5404  
*rpolanin@icc.edu*

**CHICAGO**

**MARCH 17**  
Speaker: **Bill Rice**, AWS vice president  
Affiliation: OKI Bering Supply, CEO
Shown at the Peoria Section meeting are (from left) Chair Kerwin Brown, speaker Craig Eppley, and Wayne Chuko from Lincoln Electric Co.

Topic: Status of AWS and the state of the welding economy
Activity: The program was held at Papa Passero’s in Westmont, Ill.

APRIL 14
Activity: The Chicago Section members toured Central Steel & Wire Co., in Chicago, Ill., to study its manufacturing operations. Dave Blaugh conducted the program for 35 attendees.

PEORIA
FEBRUARY 17
Speaker: Craig Eppley, clean-air group
Affiliation: The Lincoln Electric Co.
Topic: Welding fume control regulations
Activity: The program was held at Mark Twain Hotel in Peoria, Ill.

MARCH 18
Activity: The Peoria Section hosted its annual student welding contest at Illinois Central College in Pekin, Ill., for 31 contestants. Contest sponsors included S. J. Smith, Midwest Air Gas, Bessler Welding, Komatsu, Caterpillar, and Hanley Steel. Limestone High School students under the instruction of Shane Seals were the big winners.

District 14
Tully C. Parker, director
(618) 667-7795
tullyparker@charter.net

INDIANA
MARCH 15–20
Activity: The Section hosted a CWI training seminar and administered the CWI examination on the last day.

MARCH 24
Activity: Indiana Section Chair Tony Brosio conducted a business meeting followed by a tour of Morgan Lucas Racing in Indianapolis, Ind.

District 15
Mace V. Harris, director
(612) 861-3870
macevh@aol.com

District 16
David Landon, director
(641) 621-7476
dlandon@vermeermfg.com

District 17
J. Jones, director
(940) 368-3130
jjones@thermadyne.com

EAST TEXAS
MARCH 25
Speaker: Bill Meeks
Affiliation: Meeks Custom Welding, LLC
Topic: Welding cast iron
Activity: The meeting was held in Longview, Tex.
TULSA
MARCH 23
Activity: The Section members toured Linde Process Plants, LLC, in Catoosa, Okla., to study its sheet metal and fabricated structural metal operations. Tim Cruse, general foreman, conducted the tour.

MARCH 26
Activity: Several Tulsa Section members participated in a student engineering day event for seventh and eighth graders in the Tulsa County school system. The event was held at Riverside Vocational School. Working the AWS booth were Chair Jamie Pearson, Treasurer Ray Wilsdorf, Jay Rufner, and Secretary Dan Lawson.

HOUSTON
FEBRUARY 17
Speaker: Scott Witkowski
Affiliation: Dynamic Laboratories, Inc.
Topic: Basic requirements for welder qualification
Activity: The Section hosted its students’ night for 44 student attendees, including three of the finalists from the District 8 SkillsUSA contest. Joe Scott of Devasco donated a 36- by 0.75-in. electrode for each student. The program was held at Brady’s Landing in Houston, Tex.

MARCH 17
Speaker: Kelly Bronner, QC manager
Affiliation: Matrix Services
Topic: Old and new subarc welding techniques
Activity: The meeting was held at Brady’s Landing in Houston, Tex.

LAKE CHARLES
MARCH 17
Speaker: Clay Savoy, vice president
Affiliation: Savoy Technical Services

District 18
John Bray, director
(281) 997-7273
sales@affiliatedmachinery.com
Clay Savoy (center) receives a speaker gift from Lake Charles Section Chairman Tac Edwards (left) and John Bray, District 18 director.

Norm Bones (left) and Stephen Phillips (center) are shown with Ken Johnson, Puget Sound program chair.

Topic: New applications for radiographic and magnetic particle testing
Activity: Following the talk, Savoy demonstrated new forms of the testing procedures for 32 attendees.

Shown at the Lake Charles Section program are (from left) District 18 Director John Bray, Chair Tac Edwards, James Bobo, David Savoy, and Drews Fontenot.

Several members of the San Antonio Section Student Chapter posed at the April 13 event.

SAN ANTONIO
APRIL 13
Activity: The Section held a parent and student night event at the recently opened Floresville High School Welding Center. Rene Hernandez, district manager for Miller Electric, organized the event. AWS Vice President John Mendoza participated in the program.

District 19
Neil Shannon, director
(503) 419-4546
neilshnn@msn.com

BRITISH COLUMBIA
MARCH 25
Activity: Eighty-three Section members and guests toured Canron Western Constructors (CWC) in Delta, B.C., Canada. Following the tour, the group reconvened at a restaurant where Jim McLagan, CWC vice president, presented a talk on the fabrication of the Port Mann Bridge and nine other land bridges that are part of the same highway infrastructure upgrade project.

PUGET SOUND
APRIL 1
Speakers: Norm Bones, Stephen Phillips
Affiliation: Parametrix
Topic: Behind the scenes building of the Hood Canal Bridge
Activity: The program was held in Seattle, Wash.

ALBUQUERQUE
APRIL 1
Activity: The Section members visited Mega Corp. in Albuquerque, N.Mex., to study the manufacture of construction machinery. Jim Kunz and Joe Davis hosted the program. Matheson Tri-Gas was the meeting sponsor.

District 20
William A. Komlos, director
(801) 560-2353
bkoz@arctechllc.com

Joe Davis (left) and Jim Kunz hosted the Albuquerque Section program.
The Colorado Section hosted a seminar at the Colorado School of Mines in March.

Colorado Section participants are (from left) Dave Murphy, Steve Unrein, John Steele, speaker Ronald Smith, Tom Kienbaum, Past President Bob Teuscher, and Jesse Grantham. Jesse Grantham discussed welding opportunities for the Colorado Section members.

Enjoying their work judging the Utah SkillsUSA welding competition are (from left) Red Anderson, District 20 Director Bill Komlos, and Rex Hardman.

Graded A+ for sparks, students work hard to win a SkillsUSA welding award at the contest hosted by the Utah Section.

COLORADO

November 12
Speaker: Ronald Smith, executive VP  
Affiliation: Matheson Tri-Gas  
Topic: Construction of air-separation units  
Activity: The program was held at Linweld, Inc., in Denver, Colo.

December 10
Speaker: Jesse Grantham, owner  
Affiliation: Welding & Joining Management Group West  
Topic: Opportunities for AWS CWIs as ASNT Level I and II technicians  
Activity: This Colorado Section program was held at Welding and Joining Management Group in Westminster, Colo.

March 11, 12
Activity: The Colorado Section in conjunction with the Center for Welding, Joining, and Coating Research at Colorado School of Mines (CSM) hosted the Spring Welding Symposium at CSM in Golden, Colo., for 78 participants. The speakers included Jeff Hufsey, Bryan George, Mark Acton, Jeff Baxter, Steven Liu, Jesse Grantham, Dave Murphy, Chris Norris, Rex Hardman, Lynn Sturgill, Dave Fullen, Tom Tuttle, and Bill Komlos, District 20 director.

SOUTHERN COLORADO

February 22
Speaker: Myron Delgado  
Affiliation: The Lincoln Electric Co.  
Topic: Features of the Powerwave C-300 GMAW-P machine  
Activity: Following the talk, Delgado invited the 35 attendees to try their skills with the equipment. The program was held at General Air Services in Colorado Springs, Colo.
MARCH 15
Speaker: John Cantin, manager
Affiliation: Airgas Intermountain
Topic: The physics of gases and the safe handling of gas apparatus
Activity: Following the talk, Cantin demonstrated cryogenics and safety techniques for handling gas equipment. This Southern Colorado Section program was held in Colorado Springs, Colo.

UTAH
MARCH 26
Activity: The Section participated in the Utah state SkillsUSA welding competition held at Ironworkers Local Union 27 Training Facility in Salt Lake City, Utah. Judges included District 20 Director Bill Komlos, Miller Electric Training Manager Rex Hardman, and Red Anderson, Ironworkers Local 27 instructor and a CWI.

District 21
Nanette Samanich, director
(702) 429-5017
Nan07@aol.com

L.A.-INLAND EMPIRE
MARCH 12
Speaker: Alan Johnson, CWI
Affiliation: Johnson Inspection
Topic: AWS codes applicable to welding awning and canopy frames
Activity: The Section met with members of the Western Canvas Products Association to discuss welding used in the awning and canopy industry. Paul Luberoff and Doug Wallace of Airgas discussed the latest welding machine technology then conducted hands-on demonstrations of gas metal arc welding of 16-gauge steel and aluminum tubing. Jamie Nute of Sinclair Equipment Co. discussed and demonstrated “hot wedge” welding equipment for seaming, hemming, Keder preparation, and other fabric-welding techniques.

District 22
Dale Flood, director
(916) 288-6100, ext. 172
flashflood@email.com

SACRAMENTO VALLEY
MARCH 17
Speaker: Kerry Shatell, senior welding engineer
Affiliation: Pacific Gas and Electric
Topic: Case study of the failure of a penstock coupling
Activity: The program was held in Sacramento, Calif.

SAN FRANCISCO
MARCH 3
Speaker: Preston Whitney, sales manager

Shown at the Sacramento Valley Section meeting are (from left) Bruce Tanner, District 22 Director Dale Flood, speaker Kerry Shatell, and Treasurer Mark Feuerbach.

Shown at the San Francisco Section program are (from left) Chair Tom Smeltzer, Cynthia Venegas, and speaker Paul May.

Brian Rogers (right) receives the CWI of the Year Award from Tom Smeltzer, San Francisco Section chair.

Mario Rivera (left) and Lavon Bonte get some hands-on experience welding awning structural components at the L.A.-Inland Empire Section event.

Speaker Preston Whitney (right) is shown with Tom Smeltzer, San Francisco Section chair.
**Guide to AWS Services**

550 NW LeJeune Rd., Miami, FL 33126; (800/305) 443-9353; FAX (305) 443-7559; www.aws.org

Staff extensions are shown in parentheses.

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Provides liaison services with other national and international professional societies and standards organizations.

**GOVERNMENT LIAISON SERVICES**
Hugh K. Webster... hw@aws.org ... .(206)

Webster, Chamberlin & Bean, Washington, D.C., (202) 785-9500; FAX (202) 833-0243. Identifies funding sources for welding education, research, and development. Monitors legislative and regulatory issues of importance to the welding industry.

**CONVENTION AND EXPOSITIONS**
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Corporate Director, Exhibition Sales
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Organizes the annual AWS Welding Show and Convention, regulates space assignments, registration items, and other Expo activities.

Director, Convention and Meeting Services
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Welding Handbook Editor
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Department Information ..................... .(273)
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Managing Director, Technical Operations
Peter Howe... p@aws.org ... .(309)

Manages and oversees the development, integrity, and technical content of all certification programs.

Director, Int’l Business & Certification Programs
Priti Jain... p@aws.org ... .(258)

Directs all int’l business and certification programs. Is responsible for oversight of all agencies handling AWS certification programs.

**EDUCATION SERVICES**
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**AWS AWARDS, FELLOWS, COUNSELORS**
Senior Manager
Wendy S. Reeve... wre@aws.org ... .(293)

Coordinates AWS awards and AWS Fellow and Counselor nominees.

**TECHNICAL SERVICES**
Department Information ..................... .(340)
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Int’l Standards Activities, American Council of the Int’l Institute of Welding (IIW)

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**Manager, Safety and Health**
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**Senior Manager, Technical Publications**
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AWS publishes about 200 documents widely used throughout the welding industry.

**Staff Engineers/Standards Program Managers**
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Automotive Welding, Resistance Welding, Oxygen Gas Welding and Cutting, Definitions and Symbols, Sheet Metal Welding

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Rakesh Gupta... rg@aws.org ... .(301)

Filler Metals and Allied Materials, Int’l Filler Metals, Instrumentation for Welding, UNS Numbers Assignment

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Methods of Inspection, Measuring & Testing of Welds, Welding in Marine Construction, Piping and Tubing

Selvis Morales... s@aws.org ... .(313)

Welding Qualification, Structural Welding

Matthew Rubin... mrb@aws.org ... .(215)

Aircraft and Aerospace, Machinery and Equipment, Robotics Welding, Arc Welding and Cutting Processes

Reino Starks... r@aws.org ... .(304)

Welding in Sanitary Applications, High-Energy Beam Welding, Friction Welding, Railroad Welding, Thermal Spray

Note: Official interpretations of AWS standards may be obtained only by sending a request in writing to Andrew R. Davis, managing director, Technical Services, adavis@aws.org.

Op oral opinions on AWS standards may be rendered, however, oral opinions do not constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

**AWS Foundation**
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Gerald B. Uttrachi

Executive Director, AWS
Ray Shook, ext. 210, rsh@aws.org

Executive Director, Foundation
Sam Gentry, ext. 331, agentry@aws.org

**Solutions Opportunity Squad (SOS)**
Corporate Director
Monica Pfarr, ext. 461, mpfarr@aws.org

General Information
(800) 443-9353, ext. 699; rp@aws.org

AWS Foundation, Inc., is a not-for-profit corporation established to provide support for educational and scientific endeavors of the American Welding Society. Further the Foundation’s work with your financial support. Call for information.
When your critical welding requirements demand a high quality, low alloy, gas-shielded, flux cored electrode, insist on specifying Select-Arc. Select-Arc offers an expanding lineup of over 50 premium wires specially designed for welding low alloy and high strength steels. Whatever your application - from bridge construction to oil exploration equipment, pressure vessels to petroleum plants, mining machinery to submarines, and so many others - we can provide the flat and horizontal or all position low alloy electrode that is ideally suited to handle your individual need.

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Flash Rust Guide for Field Assessment Released

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Society for Protective Coatings
www.sspc.org
(877) 281-7772

Bulletin Describes Mitering Bandsaws

Recommended Guidelines for Evaluating Flash Rust is a nonmandatory guide with text and reference photographs describing how to perform a field assessment of the amount of flash rust on a steel surface by brushing the surface with a paint brush wrapped with a white cotton cloth then evaluating the color and amount of rust that transfers to the cloth. The guide was prepared by the National Shipbuilding Research Program Surface Preparation and Coatings Panel (NSRP SP-3).

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For Info go to www.aws.org/ad-index
The Welding Consumables 2010 C1.10 Product Catalog is available for the first time in a new Fast-Flip eBook online format. Features include intuitive, book-like navigation to make product selection easier. This catalog replaces the individual consumable family catalogs that were separated by process or brand. The format is smaller than traditional product literature to make its 600 pages more easy to use. Provided is in-depth information on the company’s full lines of welding consumables, including product features and applications, conformance, AWS requirements, test results, and typical operating procedures. Featured are diagrams, images, and dimensions for all packaging options. The link to the eBook is available on the home page of the Web site. Visit the Web site or call for a hard copy.

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New eBook Consumables Catalog Debuts Online
all [ɔːl]  

1. the whole of (used in referring to quantity, extent, or duration): all the cake; all the way; all year.
2. the whole number of (used in referring to individuals or particulars, taken collectively): all students.
3. the greatest possible (used in referring to quality or degree): with all due respect; with all speed.
4. every: all kinds; all sorts.
5. any; any whatever: beyond all doubt.
6. nothing but; only: The coat is all wool.
7. dominated by or as if by the conspicuous possession or use of a particular quality: all wealth.

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Friends and Colleagues:

The American Welding Society established the honor of Counselor to recognize individual members for a career of distinguished organizational leadership that has enhanced the image and impact of the welding industry. Election as a Counselor shall be based on an individual’s career of outstanding accomplishment.

To be eligible for appointment, an individual shall have demonstrated his or her leadership in the welding industry by one or more of the following:

- Leadership of or within an organization that has made a substantial contribution to the welding industry. The individual’s organization shall have shown an ongoing commitment to the industry, as evidenced by support of participation of its employees in industry activities.

- Leadership of or within an organization that has made a substantial contribution to training and vocational education in the welding industry. The individual’s organization shall have shown an ongoing commitment to the industry, as evidenced by support of participation of its employee in industry activities.

For specifics on the nomination requirements, please contact Wendy Sue Reeve at AWS headquarters in Miami, or simply follow the instructions on the Counselor nomination form in this issue of the Welding Journal. The deadline for submission is July 1, 2010. The committee looks forward to receiving these nominations for 2011 consideration.

Sincerely,

Alfred F. Fleury
Chair, Counselor Selection Committee
Nomination of AWS Counselor

I. HISTORY AND BACKGROUND

In 1999, the American Welding Society established the honor of Counselor to recognize individual members for a career of distinguished organizational leadership that has enhanced the image and impact of the welding industry. Election as a Counselor shall be based on an individual’s career of outstanding accomplishment.

To be eligible for appointment, an individual shall have demonstrated his or her leadership in the welding industry by one or more of the following:

- Leadership of or within an organization that has made a substantial contribution to the welding industry. (The individual’s organization shall have shown an ongoing commitment to the industry, as evidenced by support of participation of its employees in industry activities such as AWS, IIW, WRC, SkillsUSA, NEMA, NSRP SP7 or other similar groups.)
- Leadership of or within an organization that has made substantial contribution to training and vocational education in the welding industry. (The individual’s organization shall have shown an ongoing commitment to the industry, as evidenced by support of participation of its employees in industry activities such as AWS, IIW, WRC, SkillsUSA, NEMA, NSRP SP7 or other similar groups.)

II. RULES

A. Candidates for Counselor shall have at least 10 years of membership in AWS.
B. Each candidate for Counselor shall be nominated by at least five members of the Society.
C. Nominations shall be submitted on the official form available from AWS headquarters.
D. Nominations must be submitted to AWS headquarters no later than July 1 of the year prior to that in which the award is to be presented.
E. Nominations shall remain valid for three years.
F. All information on nominees will be held in strict confidence.
G. Candidates who have been elected as Fellows of AWS shall not be eligible for election as Counselors. Candidates may not be nominated for both of these awards at the same time.

III. NUMBER OF COUNSELORS TO BE SELECTED

Maximum of 10 Counselors selected each year.

Return completed Counselor nomination package to:

Wendy S. Reeve
American Welding Society
Senior Manager
Award Programs and Administrative Support
550 N.W. LeJeune Road
Miami, FL 33126
Telephone: 800-443-9353, extension 293

SUBMISSION DEADLINE: July 1, 2010
CLASS OF 2011
COUNSELOR NOMINATION FORM

DATE ___________________________ NAME OF CANDIDATE ___________________________

AWS MEMBER NO. ___________________________ YEARS OF AWS MEMBERSHIP

HOME ADDRESS

CITY ___________________________ STATE ______ ZIP CODE ______ PHONE ______

PRESENT COMPANY/INSTITUTION AFFILIATION

TITLE/POSITION ___________________________

BUSINESS ADDRESS

CITY ___________________________ STATE ______ ZIP CODE ______ PHONE ______

ACADEMIC BACKGROUND, AS APPLICABLE:

INSTITUTION

MAJOR & MINOR _________________________________________

DEGREES OR CERTIFICATES/YEAR _________________________________________

LICENSED PROFESSIONAL ENGINEER: YES ______ NO ______ STATE ______

SIGNIFICANT WORK EXPERIENCE:

COMPANY/CITY/STATE

POSITION ___________________________ YEARS ___________________________

COMPANY/CITY/STATE

POSITION ___________________________ YEARS ___________________________

SUMMARIZE MAJOR CONTRIBUTIONS IN THESE POSITIONS:

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

IT IS MANDATORY THAT A CITATION (50 TO 100 WORDS, USE SEPARATE SHEET) INDICATING WHY THE NOMINEE SHOULD BE SELECTED AS AN AWS COUNSELOR ACCOMPANY THE NOMINATION PACKET. IF NOMINEE IS SELECTED, THIS STATEMENT MAY BE INCORPORATED WITHIN THE CITATION CERTIFICATE.

**MOST IMPORTANT**

The Counselor Selection Committee criteria are strongly based on and extracted from the categories identified below. All information and support material provided by the candidate’s Counselor Proposer, Nominating Members and peers are considered.

SUBMITTED BY:

PROPOSER

AWS Member No. ___________________________

The proposer will serve as the contact if the Selection Committee requires further information. The proposer is encouraged to include a detailed biography of the candidate and letters of recommendation from individuals describing the specific accomplishments of the candidate. Signatures on this nominating form, or supporting letters from each nominator, are required from four AWS members in addition to the proposer. Signatures may be acquired by photocopying the original and transmitting to each nominating member. Once the signatures are secured, the total package should be submitted.

NOMINATING MEMBER: Print Name ___________________________

AWS Member No. ___________________________

NOMINATING MEMBER: Print Name ___________________________

AWS Member No. ___________________________

NOMINATING MEMBER: Print Name ___________________________

AWS Member No. ___________________________

NOMINATING MEMBER: Print Name ___________________________

AWS Member No. ___________________________

SUBMISSION DEADLINE JULY 1, 2010
AWS IS LOOKING FOR
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IN THE WELDING INDUSTRY

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• Individual (you or other individual)
• Section (AWS local chapter)
• Large Business (200 or more employees)
• Small Business (less than 200 employees)
• Distributor (welding products)
• Educator (welding teacher at an institution, facility, etc.)
• Educational Facility (Any organization that conducts welding education or training)

Entry deadline is July 12, 2010

For more information and to download the PDF nomination form online, visit www.aws.org/awards/image.html or call AWS toll-free at 800-443-9353.
New Plate and Tube Cutting Tools Featured on Web Site

The new corporate Web site for the North American market offers fully interactive features for the complete range of the company's CO₂ lasers. Other areas in the site include a full schedule of trade show appearances, all company contact information for sales and service, downloadable specifications and literature on the machines, pre-owned machine offerings, plus a password-protected area for customers and dealers to check on order status, download equipment manuals, and submit engineering data in a secure environment. Highlighted are the Series PS, PL, and TL plate and tube cutting machines featuring a constant beam distance system, flying optics, Panasonic resonator, Siemens CNC, motors and drives packages, plate-handling robotics, and integrated pallet tower automation.

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Specialty Abrasives Pictured in Catalog

The 32-page, full-color, 2010–2011 Specialty Abrasive Products catalog features the company's expanded line of mounted points, cut-off wheels, burrs, and kits. Included is a wide array of products for grinding, deburring, blending, and finishing stainless steel, aluminum, exotic metals, and mild steel. Featured are a new Type 27 and Type 1 unitized wheels, cut-off wheels for aluminum that cut without clogging, carbide burr kits, and a 64-piece countertop burr display. Visit the Web site to download the PDF catalog.

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TRUMPF Announces Six Personnel Changes

TRUMPF Inc., Farmington, Conn., has announced six key personnel changes. David Havrilla has been promoted to manager of products and applications. Havrilla replaces Juergen Stollhof who was named program manager of a new sales initiative, working with Paul Graham who was named product manager. Chris Pilcher was appointed regional sales manager for TRUMPF Canada. Michael Nuessler, most recently a service engineer with TRUMPF Mexico, now serves as sales engineer for laser products, based in Queretaro, Mexico. Bill Weston, with the company for ten years, has been named southwest regional sales manager.

Hobart Institute Names Director

Hobart Institute of Welding Technology, Troy, Ohio, has appointed Rich Green to the newly created position director of planning and development. Prior to joining the institute, Green worked at Edison Welding Institute as a project manager and workforce training manager for the Navy Joining Center.

De-STA-CO Appoints President

DE-STA-CO, a Dover company, Auburn Hills, Mich., has appointed Brian Nadel president. Nadel replaces Pat Carroll who now leads the Environmental Solutions Group, a newly formed organization within Dover Corp., bringing together Heil, Marathon, and Bayne Thinline. Nadel most recently served as president of Marathon Equipment Co.

Kiely Appoints Safety Department Head

J. F. Kiely Construction Co., Long Branch, N.J., has named Andrew Thomson head of its Health and Safety Dept. Prior to joining the company, Thomson served on a long-term health and safety project at the Pentagon.

Airgas Chair Honored by Chemical Heritage

Airgas, Radnor, Pa., chairman and CEO Peter McCausland has been awarded the Chemists’ Club’s Winthrop-Sears Medal during a meeting of the Chemical Heritage Foundation in Philadelphia. The award, established in 1970, recognizes individuals who have contributed to the vitality of the chemical industry and the betterment of humanity.

Metalworking Services Names Executive Director

Metalworking Services, Inc. (MSI), Cleveland, Ohio, has named Emily Lipovan executive director. Prior to joining the company, Lipovan served as executive director of Western Reserve Community Development Corp. Recently formed to provide association man-
management services to major trade associations, MSI is jointly owned by National Tooling and Machining Assn. (NTMA), and Precision Metalforming Assn. (PMA). The company will start by providing those services to PMA, NTMA, and the Industrial Fasteners Institute, then expand to other associations.

**CGW Hires Engineer**

CGW-Camel Grinding Wheels, Niles, Ill., has named Rodney Neil Finch application engineer responsible for market growth in the vitrified product line. Prior to joining the company, Finch was sales and grinding specialist with GTI Spindle Technology.

**Obituary**

**Ernest F. Nippes**

Ernest Frederick Nippes, 92, died April 3 at his home in Sanford, Fla. Born in New York City, he was a Life Member and a Fellow of the American Welding Society (AWS), who served as its national president (1968–1969).

Nippes received a doctorate in metallurgical engineering in 1942 from Rensselaer Polytechnic Institute (RPI) where he served as a professor in the Department of Materials Engineering, and later as department head and as director of the Division of Research and Sponsored Programs. He continued his work at RPI as an active professor emeritus through 1990. A champion of engineering education, he funded the Dr. Ernest F. Nippes ’38 Graduate Research Enhancement Award to benefit graduate students in materials engineering.

Following his retirement from RPI at 72, he and his wife moved to Martha’s Vineyard, Mass., where they operated Aldworth Manor in Vineyard Haven for many years before moving to Florida in 2005.

Nippes was a coinventor of the Gleeble™, a machine widely used today for the dynamic thermal-mechanical testing of materials and the physical simulation of processes. In 1957, he cofounded Dynamic Systems, Inc., to manufacture and distribute the devices.


A prolific researcher, he published more than 100 articles. He applied his expertise on the NASA Apollo and Gemini projects, the U.S. Navy’s USS Nautilus and USS Seawolf nuclear submarines, and numerous projects with the National Science Foundation. He was one of three American welding leaders invited in 1961 to visit research centers in Moscow, Kiev, and Leningrad as part of a National Academy of Sciences delegation.

He received the RPI Alumni Key Award and the Rensselaer Alumni Association honored him with its Albert Fox Demers Medal and the Teaching Award. He also received the David M. Darrin Counseling Award from Phalanx Honor Society, and was an inaugural member of the Phi Kappa Tau Hall of Fame.


Nippes is survived by his wife, Marilyn (Lynne), a sister, four sons, one daughter, eleven grandchildren, and five great-grandchildren.

**NEWS OF THE INDUSTRY**

— continued from page 14

**Han-Kwang Opens New Showroom**

Han-Kwang USA recently opened its 13,000-sq-ft Chicago-area facility with a showroom for laser machine demonstrations as well as application engineering, parts, and service departments. The showroom will typically house multiple plate and tube cutting laser machines for use in test cuts and time studies. Plus, interested individuals can see these CO₂ lasers in operation.

The parts department is stocked with consumable and mechanical components for a range of company lasers currently in the field and its offering, including new plate and tube cutting devices. Personnel at the facility include Eric Kim, operations manager, and Jane Lee, administrative assistant.

**Industry Notes**

- Nuts, Bolts & Thingamajigs (NBT), The Foundation of the Fabricators & Manufacturers Association, Intl., and the National Association for Community College Entrepreneurship joined forces to develop a national program building on NBT’s summer manufacturing camp blueprint.

- Faststream published its maritime employment review on the market for technical shipping people. The market for these jobs improved in the first quarter of 2010 with greater confidence from candidates and employers. Additional details can be found online at http://img.marinelink.com/imp/faststream_technical_marine2010.pdf.

- Recently, a presentation and plant tours at The Lincoln Electric Co.’s world headquarters in Cleveland and consumables manufacturing plant in Mentor, Ohio, took place as part of IndustryWeek’s Best Plants Conference.

- Vallourec, Boulogne-Billancourt, France, a tubular solutions company, is set to acquire 100% of Serimax, also in France, a provider of integrated welding systems for offshore line pipes.

- The International Training Institute, National Energy Management Institute, and Sheet Metal Occupational Health Institute Trust formed the Sheet Metal Industry Resource Alliance to ensure sheet metal workers are trained right and safety conscious.
THE AWS WELDER MEMBERSHIP
EXCLUSIVELY FOR WELDERS

To keep pace with the evolving needs of welders, the American Welding Society (AWS) has created a Membership exclusively for welders...
the AWS Welder Membership.

Welders who are committed to making their jobs, as well as their lives easier, are candidates for the AWS Welder Membership.

The AWS Welder Membership will allow you to save on welding equipment that you use every day, give you direct access to a health insurance program that fits your needs, provide you with the latest information in the industry and much more.

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◉ Discounts on welding equipment and tools of the trade offered by participating GAWDA distributors
◉ Health Insurance Program
◉ Publications exclusively for welders
◉ Discounts on auto and home insurance
◉ Discounts on dental, vision and pharmacy programs
◉ The Welder's Exchange bulletin board on the AWS web site
◉ and more...

Membership in AWS is a great way to nurture your professional development. Whether you're just starting out or a veteran welder, you'll benefit from becoming a member. Join today!

Call: (800) 443-9353, ext 480, or (305) 443-9353, ext. 480
Visit: www.aws.org/membership

American Welding Society
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BY PRAMATHESH DESAI

Welding, more than any other fabrication process, exposes the parts to rapid and extreme temperature changes that can lead to cracks in the weldments.

This article discusses what causes cracks, the proven methods used to prevent cracks from occurring, and some pointers on how to produce satisfactory crack-free weld joints under a wide variety of conditions. In all cases, careful monitoring of the temperatures is critical. In Fig. 1, the welder uses a contact-type temperature indicator as the torch preheats the flange to be welded. Figure 2 is a closer view of the indicator. Figure 3 illustrates the use of crayons that are formulated to melt at a precise temperature to alert when the desired temperature has been reached.

Areas Most Susceptible to Cracking

There are two areas in the joint that may crack as a result of the welding operation. The first is a portion of the heat-affected zone (HAZ) adjacent to the weld. The second area that may crack under certain conditions is the weld metal.

The weld metal is less prone to cracking than the HAZ because the weld metal used for most purposes generally has such a low carbon content that it does not change its properties as markedly as the...
Fig. 2 — A welding inspector at Stainless Steel LLC confirms the surface temperature of a weld using a contact-type digital temperature indicator.

base metal even under the most rapid rate of cooling likely to occur during welding.

Welders are usually most concerned about cracks in the base metal in the immediate vicinity of the weld. This is the metal closest to the weld that cools most rapidly, and in many cases undergoes critical changes in the structure and properties that may lead to cracking.

Effects of Heat Treating

Heating the joint area before welding (preheating) can prevent cracking. Preheating performs several important functions affecting weld quality:

• Removes hydrogen to reduce the effects of hydrogen-induced cracking
• Minimizes hard zones adjacent to weld
• Minimizes shrinkage stresses
• Reduces distortion.

The preheating operation effectively improves the ability of a welded joint to withstand service conditions.

The Welding Operation

The making of any weld involves two metallurgical processes:

1. Melting of the edges of the joint and of the electrode material, followed by solidification, which forms a single integral weld structure
2. Heating and subsequent cooling of the zone of the base metal adjacent to the weld.

The heat generated during welding has two effects on the welded joint. Depending on the metal's composition, the temperature reached, and cooling rate, there will be specific effects on the microstructure of the metal, strength, toughness, ductility, shock, and corrosion resistance.

Heat can cause distortion and shrinkage stresses in the weld joint depending on the amount of restraint, heating and cooling rates, and the time at maximum temperature. These two effects are interdependent and occur simultaneously.

The welded joint, although actually a single integral structure, may be considered to consist of three distinct zones that merge into one another: the weld metal, the HAZ, and the base metal.

The weld metal is the portion that has been in molten state. It consists of a mixture of the electrode material that has been deposited and the base metal that has been melted during welding. The HAZ consists of several distinctly different structures whose precise characteristics and extents depend upon the welding conditions.

Factors Affecting Weld Cracking

The factors that affect weld cracking include the following:

• Composition of the steel
• Rate of heating
• Maximum temperature reached
• Length of time at temperature
• Rate of cooling
• Hydrogen entrainment.

The chemical composition of steel has a very important bearing on the hardness and brittleness of the weld joint for several reasons. Higher carbon content promotes the formation of martensite, and the final hardness or martensite itself depends on the carbon content of the steel. This is why steels with higher carbon content are not considered easily weldable. Certain alloying elements such as molybdenum, manganese, vanadium, and chromium also have a distinct hardening effect that promotes the formation of the crack-inducing martensite.

Some contend that weld cracks result from the hydrogen introduced into the base metal from the coating on the welding rod. As hydrogen is more soluble in molten than in solid steel, it tends to es-
cape from the supersaturated solution as the metal cools down.

**Postweld Heating Effects**

Postweld heat treatment (PWHT) is often necessary to reduce cracking. During the welding process, the metal pieces being joined are subjected to extreme temperatures that can cause the crystalline structure of the metal to pass through various metallurgical phases. The PWHT reduces the hardness in the HAZ of the metals and effectively increases their ductility.

**Monitoring the Weld Temperatures**

Today, preheating is most commonly performed with the automatic electrical resistance method. But, how long the joint should be heated in order to reach the desired preheat temperature remains an inexact science. The preheat time depends on the metal thickness and many other factors, making it necessary to check the temperature from time to time to verify the preheating is proceeding properly.

An effective way to monitor the preheat temperature is to mark the desired surfaces with a calibrated phase-change temperature-indicating crayon. When the temperature rating of the crayon is reached, the mark will melt giving a distinct visual indication. Since the temperature indicator is in intimate contact with the surface to be tested, the phase change is virtually instantaneous.

Crayons, like those manufactured by Tempil®, are reliably accurate, conform to industry welding codes, and are traceable to NIST standards. Other applications are for verifying interpass and postweld heat treatment temperatures, and cool-down and annealing temperatures for manual and semi-automatic welding. Other products are useful where the critical surface is moving, rotating, or inaccessible, as well as to indicate when critical temperatures are reached for diagnostic work, racing car engines, electronic components, and even for use on the space shuttles.

Annealing is an important operation following welding. Annealing consists of controlled reheating to restore the over-hardened metal to the approximate hardness of the rest of the material. To do this, the piece is repositioned. The welding machine is energized and, in what is essentially a manually controlled operation, heat is varied until the correct annealing temperature is reached.

Even in procedures where the welding operation is fully automatic, the annealing is not usually automated. The welded assembly may need to be stress-relieved to an appropriate ductile condition by annealing. Using the correct temperature is extremely important. If it is too hot, the weld strength will be substandard. If it is not hot enough, the weld will remain hardened and brittle.

A wide variety of accurate temperature-indicating products are available.

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www.aws.org/CWSR
A computer-aided 3D design draws scaled modules, enabling an exact preview of the final result.

Aluminum plate undergoes cutting by a plasma machine.

Metal pieces were drilled with holes so water could spray out of them upon installation.

Welded Creatures Decorate Canadian Water Park

Many artistic shapes made of aluminum were created for a water playground

BY SERGE Y. TREMBLAY

Romain Julien recently helped to create a water park in the City of Pont-Rouge, southern Quebec, Canada, that’s filled with colorful, prehistoric figures fabricated from aluminum.

The founder and president of Mecanare, Inc., an industrial subcontracting company that performs general metal work located in Portneuf, near Quebec City, Canada, holds the amusement of children close to his heart. The idea for the park also became a reality thanks to the company’s engineering department that includes the two other owners, Frederic Riverin, a mechanical engineer, and Serge Y. Tremblay, a structural, non-destructive examination, and welding engineer.

The water playground was installed in early summer 2009. It has a maximum water depth of 4 in., allowing operation without a lifeguard according to the regulations in the Province of Quebec. Water consumption is kept low with 60 gal/min as well.

What’s the Best Metal to Use for Aquatic Conditions?

To make this project happen, Mecanare conducted research and development activities to select the material to be used and study its integration in the fabrication of structural aquatic features. These had to be able to withstand the wide stress range that can be applied to this type of structure in an aquatic environment. It is well known that winter conditions (especially in the Province of Quebec), sun, saltwater, and chemical products found in aquatic parks and pools can be detrimental to the appearance and longevity of the water playground modules.

Choosing Aluminum vs. Steel

After careful consideration, aluminum was selected. Since the properties of aluminum change with time and upon welding, it was important to consider all the factors that can affect the figures’ features throughout their life. Additionally, the company is certified by the Canadian Welding Bureau for steel and aluminum welding.

Real-life experiments and computer simulations, including water spray trials, were performed in conditions approaching the ones that would be encountered. By doing so, mistakes could be corrected in the development stage, and the product could be improved prior to installation.

Figure Assembly Time

Transforming the raw materials was performed in different steps and specific processes with equipment and techniques developed by the product development team.

Cutting, bending, rolling, polishing, and painting the structures were all carried out with a common goal established by Mecanare and its client. Every project is unique, with its own specific theme, conforming to the requested requirements and preferences.

SERGE Y. TREMBLAY
(sergeytremblay@geni-metal.ca) is vice president of Mecanare, Inc., Portneuf, near Quebec City, Canada, www.mecanarc.com.
A welder performs gas tungsten arc welding on a pipe piece.

While still being fabricated, this dragon already stands tall with its large head towering above its 8-ft, 6-in. body rings. When complete, it will be almost 26 ft in total length with a 10-ft, 11-in. tail.

A 7-ft-tall seahorse sprays water.

A 7-ft-tall seahorse sprays water.

A 7-ft-tall seahorse sprays water.

A pteranodon (prehistoric bird) made from aluminum is assembled by gas tungsten arc welding.

Preassembled in Mecanarc's shop, the dragon's 13-ft, 9-in. head has cutouts for its eyes and nose, mouth with a tongue, many pointy teeth, plus a spiked neck.

Green paint is sprayed on a palm tree's fronds.

A distribution of pipes that will carry water to the park's figures connect to an underground chamber.

A clear coat paint chosen for the aluminum pteranodon ensured the creature's details could be seen.

The water park comes together when workers apply its personalized concrete color slab.

Plasma Cutting, Welding the Various Sculptures

This first project, fabricated using 6061 aluminum, consisted of the following forms:

- a dragon almost 26 ft long with a 13-ft, 9-in. head, 8-ft, 6-in. rings for its body, and 10-ft, 11-in. tail;
- a 19-ft-tall structure with a platform and water tank topped by a 3-ft-tall, nearly 5-ft-wide pteranodon bird;
- a 7-ft-tall seahorse;
- dinosaur prints on the concrete floor;
- 13-ft-tall palm trees with leaves expanding 4 ft across; and
- 4-ft-tall dinosaur head-shaped water canons.

All the aluminum figures' features were drawn on SolidWorks, a 3D computer-aided design software, and plasma cut using a computerized table manufactured by Machitech, a company located near Quebec City. A subcontractor bent the aluminum round tubes with dimensions specified by the company.

Welding was performed by the company's welders using 0.045-in.-diameter 4043 filler metal and argon as the shielding gas. A polished finish was obtained by grinding for special effects, and finally the features were brought to life with paint-
The 3-ft-tall, nearly 5-ft-wide pteranodon perches atop a 19-ft-tall water tank.

These completed palm trees, made by turning raw aluminum material into a finished product, are 13 ft tall with fronds measuring 4 ft across.

Ing. Weld procedures were written by MetalQA, a specialist in welding engineering and training, and welds were inspected by Geni-Metal, a laboratory dedicated to inspection.

Fun Results for All

A second water park was also installed in Portneuf, another city close to Quebec City. It is planned that owners will be allowed to exchange modules with other owners after some years, with a principle similar to time sharing.

Both interactive water playgrounds were appreciated by parents during the summer of 2009, but even more by their children. Mecanarc delighted in seeing how happy the park made them.

These fun-filled, refreshing, and fairy tale like parks will certainly attract children from surrounding neighborhoods. Many other cities are interested in such an innovative and unique park for their young citizens.

The City of Pont-Rouge's water park features a dragon, platform with a water tank topped by a pteranodon, seahorse, dinosaur prints, palm trees, and dinosaur head-shaped water canons on a concrete slab. Children enjoy playing here among the art works.
Competition Is a Family Affair

Tulsa Welding School’s welding contest serves as a recruiting tool and as an orientation for students and their families

BY MARY RUTH JOHNSEN

At first glance, the high school welding contests at the Tulsa Welding School (TWS) campuses in Tulsa, Okla., and Jacksonville, Fla., look like any other welding competition around the country.

There’s a bunch of nervous, yet eager, students hoping to prove their skills, a set of blueprints and weld procedures for them to follow, inspectors ready to examine the weldments, and prizes ready to be awarded to the top finishers. What sets the contests apart is the large number of family members present (Fig. 1) and the welding-related and orientation activities the school sets up for them, which creates a festive atmosphere.

Tulsa Welding School’s sixth annual high school competition, which took place February 20 in Tulsa and February 27 in Jacksonville, drew 198 welders from 14 states in Oklahoma, and 147 contestants from 6 states in Florida. Including family members, instructors, staff, and vendors/exhibitors, there were more than 800 in attendance in Oklahoma and more than 600 in Florida. The Welding Journal attended the competition at the Florida campus, but the schedule and activities related to the competition are similar at both facilities.

The purpose of the competitions is to recruit students to attend Tulsa Welding School and to orient students and their families to the school and the area, explained Lawrence Brown, president and CEO. It’s a full day that includes tours of the facilities; exhibits and demonstrations by welding equipment manufacturers, prospective employers, and firms that provide student services such as housing; talks on financial aid, admissions, and availability of part-time jobs; and opportunities for parents and other family members to try welding and cutting for themselves.

“I understand now why my son is so passionate about welding,” explained Dixie Malach. She tried plasma arc cutting, shielded metal arc welding, and the virtual welding trainer The Lincoln Electric Co. demonstrated throughout the day. “I love it (welding),” she said. “It’s very cool, and I’ve got the pieces in the car to prove it.”

Malach attended the contest with her father, Philip Malach, and her son, Johnathan Malach, a welding student from William Blount High School in Maryville, Tenn.
THE AMERICAN WELDER

Fig. 3 — Lyndsi Tingle was one of six students from Franklin County Career & Technical Center, Franklin, Ky., who participated in the contest. Her fellow students said Tingle was instrumental in them deciding to enroll at TWS because of the research she did on the school. Tingle hopes to someday enter the weld inspection field.

Fig. 4 — John Grace (center) came out of retirement to help his former students at Dothan Technology Center, Dothan, Ala., prepare for the contest. With Grace are Justin Fuqua (left) and Demetrius Boykin. A third student, Tyler Cline, was competing at the time this photo was taken.

“I never thought he’d go blue collar,” Malach said. “I thought he’d go to a more traditional school. But I have also never known a 17 year old who could be so determined. He started welding and said, ‘This is what I want to do for the rest of my life.’” By the end of the day, the Malachs had signed Johnathan up to attend TWS.

What Was on the Line

The timed contest consisted of a shielded metal arc project requiring multiple electrodes, positions, and techniques — Fig. 2. Contestants were graded on their adherence to procedures and on the quality of their welds. A lot was at stake. Between the two campuses, more than $200,000 worth of scholarships, cash, and prizes of welding equipment and gear were awarded, including certificates worth $500 toward tuition given to each contestant who participated. Top prize at each campus was a full-tuition scholarship for the TWS master welder program, which is valued at $15,500; second place received a 50% scholarship; and third place received a 25% scholarship.

Why They Came

Randy Shewmaker, welding instructor at Franklin County Career & Technical Center, a high-school vocational/technical school in Franklin, Ky., brought six students to the competition. All six had already enrolled to start August 9 at TWS after doing some research about the school and speaking with a TWS recruiter who had visited them in Kentucky. The chance for the scholarship money was important, but so was the competition experience.

“We do a lot of competitions each year,” Shewmaker said. “We have a team that represents our school just like the basketball team or football team does. We do ten competitions a year. It’s a good way for them to show off their talent.”

When Shewmaker started at the school six years ago, the welding program had about 40 students. Nowadays, 100 to 120 students take welding each year. He credits the competition team for part of that growth. “We do recruiting, but also as notoriety of our students increases through the competition, more students have become interested. Everyone wants to be part of something successful,” Shewmaker said.

As with many athletic teams, Shewmaker started a welding booster club of parents, people from the local industry, and others interested in welding. Much of the travel expenses for the team, including the trip to Jacksonville, are funded through the booster club.

Darla Sandlin accompanied her son Evan Sandlin to the competition, as did Brandy Shaw with her son Thomas Clay. Both young men are students of Shewmaker. “It was important for us to come,” Sandlin said. “We needed to visit the school and see the facility and the community. He seems to feel very comfortable here.” Shaw agreed, adding her son has been interested in welding ever since his grandfather first showed him how to do welding repairs around the farm at a very young age.

“The economy may have some bearing on welding, but not as much as some industries,” Sandlin said. “These kids see the possibility of working for somebody else but then, at a relatively young age, starting a business of their own.”

The six students from Franklin all signed up to live in the same student-oriented apartment complex. They expressed interest in different avenues for a welding career. Lyndsi Tingle, one of two female contestants in the Jacksonville competition, hopes to eventually enter the welding inspection field (Fig. 3): Greg Frye said he’d like to do pipe welding; and Kyle Shupert hopes to become a pipeline welder and travel around the country.

John Grace retired in July 2009 as a welding instructor at Dothan Technology Center, Dothan, Ala. — Fig 4. He came out of retirement to help three of his former students — Demetrius Boykin, Justin Fuqua, and Tyler Cline — practice for the...
The top three finishers in Jacksonville were (from left) Daniel Nelms Jr., Lee County High School, Leesburg, Ga.; second place, Kyle Shupert, Franklin County Career & Technical Center, Franklin, Ky.; and third place, Eric Lamas, Warren Central High School, Bowling Green, Ky. Two weeks later, Nelms also won the Georgia state SkillsUSA competition.

Zach Settlemoir, South Tech, St. Louis, Mo., took top honors at the competition in Tulsa.

All four students from South Tech, St. Louis, Mo., who competed in the Tulsa competition placed in the top 25. Shown with their awards are (from left) Zach Settlemoir, first place, Paul McManus, eight place, Dan Whitney, twenty-fifth place, and Paul Buneta, third place. Standing behind is South Tech Welding Instructor Adam Holt.
Franklin County Career & Technical Center proved to be one of the top schools competing in Jacksonville. Shown from left are Kyle Shupert, second place, Thomas Clay, sixth place, Lyndsi Tingle, tenth place, Greg Frye, twentieth place, and Evan Sandlin, twenty-first place.

The scholarship is important because he wants to do his education on his own, but I told him not to be too nervous or put too much pressure on himself,” Candy Hallmark said. “We all came with him because we wanted to find him a place to live. We were concerned with safety.” Beasley eventually placed 13th in the competition.

The top finishers in Jacksonville were as follows: first place, Daniel Nelms Jr., Lee County High School, Leesburg, Ga.; second place, Kyle Shupert, Franklin County Career & Technical Center, Franklin, Ky.; and third place, Eric Lamas Warren Central High School, Bowling Green, Ky. — Fig. 5. The winners in Tulsa were Zach Settlemoir, South Tech, St. Louis, Mo., 2nd place, Dakota Moreau, Natchitoches, La., and third place, Paul Buneta, South Tech, St. Louis, Mo. — Fig. 6.

“A couple of schools shined at the contest. All four of the students from South Tech, St. Louis, Mo., that instructor Adam Holt brought to the Tulsa campus competition placed in the top 25. Besides achieving first- and third-place honors as mentioned previously, Paul McManus placed eighth and Dan Whitney placed twenty-fifth — Fig. 7. In Jacksonville, the students from Franklin, Ky., had similar success with five of the six students placing in the top 25 — Fig. 8.

“We have a lot of farm boys in our program,” Shewmaker said. “Most envision taking a job out of high school, but don’t envision additional training or schooling after high school. They need that extra education. If I don’t encourage that, I’m setting them up for failure.”

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Fast Facts about Tulsa Welding School

The stated mission of the Tulsa Welding School (TWS) is to produce “world-class welders and welding inspectors.”

The school offers the following programs:
- Master Welder — 7 months long
- Structural Welder — 3½ months long
- Welding Technology Associates Degree — 14 months long — includes seven months in the Master Welder program and then seven months of training in nondestructive testing techniques for welding quality assurance/quality control inspector (Tulsa campus only).

The majority of the training is hands on; students spend four days a week welding and one day each week in the classroom.

A new class starts every three weeks; a class graduates every three weeks.

Combined enrollment at the two campuses is 1250.

Cost for tuition, fees, and a kit of equipment is $15,500 for the Master Welder program. Financial aid and assistance in obtaining part-time work are available.

Tuition includes a student membership in the American Welding Society.

For more information, visit www.weldingschool.com or call

(877) 935-3539 (Tulsa campus)
(866) 574-2526 (Jacksonville campus)
Upgrade Your Terminology Know-How

The latest edition of A3.0, Standard Welding Terms and Definitions, which has just recently become available, includes significant enhancements to terms relating to brazing, resistance welding, and soldering. It addresses hybrid processes for the first time and includes new process groupings such as high energy beam welding (HEBW) and thermal gouging (TG).

Following is a sampling of the new terms/definitions included in A3.0.

assembly. One or more components, members, or parts fit in preparation for joining.

automatic process (XXXX-AU). An operation performed with equipment requiring occasional or no observation and no manual adjustment during its operation. Variations of this term are automatic brazing, automatic soldering, automatic thermal cutting, automatic thermal spraying, and automatic welding.
bailing up, brazing and soldering. The formation of globules of molten filler metal or flux due to insufficient base metal wetting.
brazing alloy. A nonstandard term for brazing filler metal.
brazing flux. A flux used for brazing. See noncorrosive flux. See also soldering flux and welding flux.
brazing symbol. A graphical representation of the specifications for producing a brazed joint. For examples and rules for their application, refer to AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
cap, resistance welding. A nonstandard term for electrode cap.
carbon arc brazing (CAB). A brazing process using heat from a carbon arc. This is an obsolete or seldom used process.
carbon arc gouging (CAG). A thermal gouging process using heat from a carbon arc and the force of compressed air or other nonflammable gas. See also oxygen gouging and plasma arc gouging.
differential thermal expansion. Dimensional effects resulting from differences in expansion coefficients and/or thermal gradients within a workpiece or assembly.
dissolution, brazing. Dissolving of the base material into the filler metal or the filler metal into the base material.
electrode adapter, resistance welding. A device used to adapt an electrode to an electrode holder.
electrode holder, resistance welding. A device used for mechanically holding and conducting current to an electrode or electrode adapter.
electrode pickup, resistance welding. Contamination of the electrode by the base metal or its coating during welding.
electron beam brazing (EBB). A brazing process using heat from a slightly defocused or oscillating electron beam.
flash, arc stud welding. Molten metal displaced from the weld joint and contained by a ferrule.
flash, flash welding. Molten metal displaced from the weld joint by expulsion or extrusion.
flowability, brazing and soldering. The ability of molten filler metal to be drawn into the joint or spread over the surface of the base material.
gas generator. Equipment producing a gas for joining or cutting.
hand soldering. A nonstandard term when used for manual soldering.
heat input. The energy applied to the workpiece during welding.
hybrid welding. The combination of two or more welding processes applied concurrently to produce a weld bead or nugget.
incomplete coalescence, solid-state welding. A weld discontinuity in which complete joining of joint faying surfaces has not been achieved.
joint remelt temperature, brazing and soldering. The temperature to which a brazed or soldered joint must be raised in order to remelt the braze metal or solder metal. The joint remelt temperature may be higher than the original process temperature.
laser beam brazing (LBB). A brazing process using a laser beam as the heat source.
liquidation, brazing. The separation of a low-melting constituent of a brazing filler metal from the remaining constituents, usually apparent in brazing filler metals having a wide melting range.
manual transgun, resistance welding. A transgun configured for manipulation by hand.
off time. The interval between welding cycles when operating in a repeat mode.
oil-bath dip soldering. A dip soldering variation using heat from a bath of heated oil. See also metal-bath dip soldering and salt-bath dip soldering.
parallel welding, resistance welding. A secondary circuit variation in which the welding current is conducted through the workpieces in parallel electrical paths to form multiple resistance spot, seam, or projection welds simultaneously.
plasma arc gouging (PAG). A thermal gouging process using heat from a constricted arc and the force of an orifice gas. See also carbon arc gouging and oxygen gouging.
power density. The power per unit area.
preheat, v. The act of applying heat to the workpiece(s) prior to joining, thermal cutting, or thermal spraying.
resistance welding time. The duration of welding current flow through the workpieces in single-impulse welding. See also weld interval.
sandwich brazement. A brazed assembly consisting of layers of dissimilar materials joined using preplaced brazing filler metal.
standoff distance, explosion welding. The distance between two plates to be joined.
susceptor. An inductively heated component positioned near a joint to aid in heating.
transgun. A resistance welding gun with an integral, closely coupled resistance welding transformer.
weld gauge. A device designed for measuring the shape and size of welds.
welding flux, submerged arc welding. A granular material comprised of metallic and nonmetallic constituents applied during welding to provide atmospheric shielding and cleaning of the molten weld metal and influence the profile of the solidified weld metal. This material may also provide filler metal and affect the weld metal composition. See active flux, agglomerated flux, alloy flux, bonded flux, fused flux, mechanically mixed flux, neutral flux, reconditioned flux, recycled flux, and virgin flux.
watering, brazing and soldering. The phenomenon whereby a liquid filler metal or flux spreads and adheres in a thin continuous layer on a solid surface.
workpiece connector. A device used to provide an electrical connection between the workpiece and the workpiece lead.
Welding aluminum requires special processes, techniques and expertise.

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SMU Graduate School Specializes in Green and Joining Technologies

The PhD program at Southern Methodist University works to develop advanced manufacturing technologies

BY HOWARD M. WOODWARD

Founded in 1911, Southern Methodist University (SMU), Dallas, Tex., has a full-time faculty of 660, a student-faculty ratio of 11 to 1, and nearly 11,000 students from the United States and 90 countries in its seven degree-granting schools. The university’s ten libraries house the largest private collection of research materials in the southwest.

Founded in 1925, the Lyle School of Engineering is one of the oldest engineering schools in the southwest and boasts a well-established graduate program in research and development in joining technologies. It offers eight undergraduate and 29 graduate programs, including master’s and doctoral degrees through five departments. Last year, the school granted 486 engineering degrees.

In addition to being home to the Research Center for Advanced Manufacturing (RCAM) and the Center for Laser-Aided Manufacturing (CLAM), the school is home to cutting-edge research in areas such as network and system security, advanced optics, bio-informatics, signal processing, photonics, air-quality, thermal science, and fluid mechanics. For the last eight years, the participants in the AWS Certified Welding Inspector 9-Year Recertification Seminar, conducted by AWS Past President Ed Bohnart, have visited SMU to tour the research center’s facilities.

Current Research Projects Underway

During 2008–2009, the university received $16.54 million in external funding for research aimed at solving local, national, and global problems. Current research projects include creating a national geothermal database; studying the mechanical and energetic basis of movement

HOWARD M. WOODWARD (woodward@aws.org) is associate editor of the Welding Journal.
Two of the buildings are designed to meet Leadership in Energy and Environmental Design (LEED) green building standards.

Leadership in Energy and Environmental Design (LEED) green building standards.

In order to respond to industry’s needs and better educate its undergraduate and graduate students in the area of manufacturing engineering, the Research Center for Advanced Manufacturing (RCAM) was established September 1999 — Fig. 1.

In 2005, SMU was awarded a National Science Foundation grant to join the multi-university Industry/University Cooperative Research Center (I/UCRC) for Lasers and Plasmas for Advanced Manufacturing (CLAM). The other I/UCRC members are the University of Virginia, University of Michigan, and University of Illinois at Urbana-Champaign.

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and human performance; monitoring seismic wave propagation related to verifying international nuclear arms-control treaties; studying particle physics at CERN’s Large Hadron Collider near Geneva, Switzerland; monitoring volcanoes to provide early warning of eruptions; searching for a glimpse of elusive “dark matter” deep within a Minnesota mine; developing tiny, high-performance camera systems for homeland security and the battlefield; determining ancient environments through sedimentary rocks to help understand Earth’s greatest mass extinction 251-million years ago; and developing improved antennas for wireless communications, satellite communication, and military applications.

The Engineering School

The Lyle School is among the fastest-growing engineering schools in the country. In the last four years, the enrollment has doubled, and in the last eight years the school has added three new buildings, the latest was opened April 16, 2010 — Fig. 1. Two of the buildings are designed to meet Leadership in Energy and Environmental Design (LEED) green building standards.

In 1997, Radovan Kovacevic joined the SMU faculty as the Herman Brown Chair Professor in Mechanical Engineering. A Fellow of AWS, ASME, and SME, Dr. Kovacevic’s main objective was to develop an internationally recognized program in advanced manufacturing. For the last 12 years he has worked with more than 100 graduate students, visiting scholars, and undergraduate interns; published and presented with his research team more than 250 technical papers; and was awarded four U.S. patents. The R&D programs in advanced manufacturing, funded by state and government agencies, The Brown Foundation, and industry, with more than $15 million, were developed to revolve around the joining technologies.

Currently, Dr. Kovacevic’s major research areas include laser cladding, micro-plasma powder cladding, metal deposition using electron beam melting, laser welding, hybrid laser-arc welding, friction stir welding, paint stripping by direct diode laser, development of lead-free solders reinforced with nanoparticles, mitigation of tin whiskers growth, laser beam welding of galvanized high-strength steels in a gap-free lap joint configuration, and laser micro-welding and machining.

Industry’s Involvement with the SMU Research Center

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development of a rapid manufacturing/repair system based on laser cladding, real-time visualization of the molten pool, rapid manufacturing by electron beam, study the mechanism of cathodic cleaning of aluminum oxides, and hybrid laser arc welding of difficult-to-weld materials.” Levert explained, “While every project is a success story in itself, the success of the project aimed at improving hybrid laser arc welding holds great promise. This project has been an excellent example of successful collaboration between industry and academia where research finds direct application. The SMU RCAM and CLAM provide an outstanding environment for educating and training the next-generation of research engineers. We are especially pleased that we have been able to engage graduate students and allow them to work directly with engineers and researchers from industry.

Steve Smith, vice president of engineering, Trinity Industries, Inc., stated, “Trinity Industries recruits engineering students with a strong interest in manufacturing who have a good balance of theoretical engineering and hands-on experience. SMU’s Research Center for Advanced Manufacturing has consistently attracted top graduate students with a strong interest in welding and manufacturing. Our experience with SMU’s engineering students has been outstanding.”

Dr. Geoffrey Orsak, dean, SMU Lyle School of Engineering, stated, “The RCAM and CLAM have brought a great deal of international visibility to the SMU Lyle School of Engineering. The quality and impact of the work conducted in these two aligned centers is simply spectacular.”

The laboratories

The SMU RCAM encompasses numerous laboratories, including Electron Beam Materials Processing, Abrasive Waterjet Materials Processing, R&D in Welding, Friction Stir Welding, Sensing and Control, Materials Characterization, Electroplating, and CAD/CAM. The CLAM has the following laboratories: Laser Materials Processing, Rapid Manufacturing, Reverse Engineering, Hybrid Welding, and Micromachining. The research activities are supported with the most advanced research and manufacturing equipment and software valued at more than $12 million in addition to a well-equipped machine shop and computing facility.

The RCAM and CLAM are internationally recognized for the work done on the development of a number of cutting-edge technologies such as rapid manufacturing processes based on a combination of additive processes (the deposition of material by different arc welding processes and laser cladding) with subtractive processes (milling, drilling, and turning), friction stir welding, electron beam materials processing, abrasive waterjet materials processing, micromachining by short pulse laser, hybrid welding of difficult-to-weld materials, surface modification in order to improve the resistance to heat, corrosion, abrasion, and, erosion, paint removed by a high-power direct diode laser and other innovative projects — Figs. 3, 4. The RCAM and CLAM laboratories are well-equipped with the latest lasers, welding, cutting, and diagnostic equipment to facilitate the students’ work in these areas.

The Research Teams

The current RCAM’s and CLAM’s research teams include nine PhD candidates, four research engineers, a Visiting Professor, an undergraduate intern, and the director of the centers — Fig. 2. Just in the last year, five PhD students have graduated from these programs.

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The SMU RCAM has developed an integrated platform for demonstrating and expanding the concept of multifabrication (MultiFab) where robotized additive operations based on laser cladding, microplasma powder cladding, and controllable metal deposition by gas metal and gas tungsten arc welding are combined with high-speed multi-axis machining via integrated software to control the CNC-
Students can gain valuable leadership experience through participation in the nearly 180 campus organizations. More than 2500 student volunteers serve annually through approximately 70 nonprofit agencies. Students also have the opportunity to participate in service-learning courses and alternative spring break national service projects.

The SMU Service House (SMUSH) is home to 28 student volunteers that offers a one-of-a-kind experience for serving others. It is a unique community of on-campus residents who care deeply for the community. Throughout the semester, “SMUSHies” perform a wide variety of service-oriented projects, ranging from providing after-school activities for kids in the Dallas area to assisting needy people, to cleaning up White Rock Lake.

Students’ Life on Campus

The school has implemented a gender-parity initiative with the goal to be the first school in the nation to enroll 50% female undergraduates. Currently, the Lyle School of Engineering has more than 35% female enrollment, which is much better than the national average of 19%.

Nearly 2000 undergraduate and graduate students live in 14 residence halls and two houses. About 2300 students are members of sororities and fraternities. The university employs 1779 students, including 33 postdoctoral, 674 graduate, and 1072 undergraduate students.
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BY Z. WANG, Y. M. ZHANG, AND L. WU

ABSTRACT

The weld pool surface may contain sufficient information to determine weld penetration. In this study, a high-speed camera-based vision system was used to image the weld pool surface during gas metal arc welding (GMAW). To calculate the depth of the weld pool surface from the acquired image, a calibration procedure is proposed to determine the parameters in the calculation equation. Welding parameters were designed to conduct a series of pulsed GMAW (GMAW-P) experiments. Modeling using experimental data shows that the change in arc voltage during the peak current period can predict the depth of the weld penetration with adequate accuracy. However, a direct application of this result is complicated by the need for a vision system. To find a method that can be used to monitor the weld penetration using signals that are easily measurable in manufacturing facilities, a possible relationship between a change in weld pool surface depth and a change in arc voltage was analyzed. The analysis suggested that the change in arc voltage during the peak current period may reflect accurately the change in weld pool surface depth during the peak current period. As a result, it is proposed that the depth of the weld penetration be determined from the change in arc voltage during the peak current period. The modeling result shows that the change in arc voltage during peak current can indeed provide an accurate prediction for the depth of the weld penetration during GMAW-P.

Introduction

Gas metal arc welding (GMAW) can be considered the most widely used arc welding process, preferred for its versatility, speed, and easy application in robotic automation. Pulsed GMAW (GMAW-P) is used to achieve a controlled metal transfer process over wide ranges of heat and mass input levels (Refs. 1, 2). It uses a low amperage to maintain the arc and a peak amperage to melt the welding wire and detach the resultant droplet. As a result, the desired spray transfer can be achieved at low average currents (Refs. 3, 4).

Weld penetration plays a fundamental role in determining the mechanical strength of welds, and thus, its control is critical. This study concerns partial penetration applications where the base metal is not fully melted through its entire thickness. For partial penetration applications, how deep the base metal is melted is referred to as the depth of weld penetration. This depth is often used as the measurement of the weld penetration. It is apparent that the depth of weld penetration is not directly visible. Many methods have been introduced to estimate it based on indirect measurements such as geometrical parameters of the weld pool (Ref. 5), temperature field (Ref. 6), oscillation frequency (Refs. 7, 8), and arc voltage (Ref. 9). To obtain indirect measurements, various techniques such as vision (Refs. 5, 10), ultrasonic (Ref. 11), acoustic emission (Ref. 12), and thermal (Ref. 6) have been used. However, most of those efforts focused on gas tungsten arc welding (GTAW). The GTAW process is less complex and much more stable in comparison with GMAW, which is the concern in this study. The GMAW process uses a consumable wire as an electrode to improve the productivity, and the resultant metal transfer of the melted wire complicates the process. Because of the metal transfer, the droplets impact the liquid weld pool periodically and cause the weld pool to fluctuate. For the pulsed GMAW studied in this paper, the arc pressure also changes periodically, resulting in significant fluctuation in the weld pool surface. The resultant complexity added additional difficulties to obtain indirect measurements needed to estimate the weld penetration.

Among the possible indirect measurements, the weld pool surface appears to be the most promising one with sufficient information to estimate the weld penetration. This is because many skilled welders

KEYWORDS

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GMAW-P
Machine Vision

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are capable of controlling the weld penetration only based on observation of the weld pool surface. Hence, methods have been proposed to measure the three-dimensional surface of the weld pool using structured-light and diffuse glass (Ref. 13), structured light and calibrated camera (Ref. 14), specular reflection from the weld pool (Refs. 15, 16), shape from shading (Ref. 17), binocular stereo vision (Ref. 10), and its variant biprism stereo vision (Ref. 18). In another effort, Zhang and Yan measured the average height of the weld pool tail boundary, i.e., depth information from a geometry approximation model in GMAW-P for thin plate (Ref. 19). Unfortunately, these methods are largely based on vision, and the suitability of their use in manufacturing facilities needs to be improved before they may be actually applied.

This paper explores the development of a simple yet innovative method to effectively derive the depth of the weld pool surface underneath the arc (referred to as the surface depth or SD hereafter) and relate the depth of the weld penetration (penetration depth or PD hereafter) with it. In order to study their relationship, SD is measured directly using machine vision from high-speed cameras. To use signals that are easily measurable to predict PD, the arc voltage is also measured and related to PD.

**Vision-Based Measurement Principle**

A high-speed camera, OLYMPUS i-SPEED, which is capable of capturing images up to 33,000 frames per second and of directly imaging the weld pool under the presence of the arc, is fixed in the upper side of the weld pool with angle $\theta$ to view the weld pool as shown in Fig. 1. The welding gun is perpendicular to the workpiece surface. For convenience of discussion, a welding gun coordinate system $OXYZ$ is established as shown in Fig. 1 with the workpiece upper surface as the OXY plane, gun axis as the Z-axis, and weld joint and travel direction as the X-axis.

A vision-based method for SD measurement is shown in Fig. 2. The SD in this paper refers to the maximum weld pool surface depth below the OXY plane, which can be measured using the Z-axis coordinate of the intersection between the Z-axis and the weld pool surface. A pinhole camera model is employed in this study. The scale in Fig. 2 has been adjusted for better illustration. There are three coordinate systems including the camera coordinate system $(O_x X_y Y_z C_z)$, the image coordinate system $(O_j X_i Y_i)$, and welding gun coordinate system. The object plane is parallel to the image plane and forms an angle $\beta$ with Z-axis. When the weld pool surface rises such that the intersection between the Z-axis and the weld pool surface rises from $P_Q$ to $P_2$, the corresponding point in the object plane changes from $P_0 Q$ to $P_0 2$ and the corresponding point in the image plane changes from $P_i 0 Q$ to $P_i 2$. The SD can thus be measured as

$$d_s = \pm |P_i 2 - P_i 0| / \cos \beta$$

where $d_s$ denotes the SD and a negative/positive $d_s$ indicates a weld pool surface above/below the OXY plane. Similarly, if the weld pool surface lowers, the SD will be

$$d_s = |P_2 P_0| / \cos \beta$$

Define $S_c$ as

$$S_c = |P_{ij} P_0| / |P_{ij} P_{i0}|$$

where $P_{ij}$ is the image point of $P_j$ ($j = 1, 2$) in the image plane while $P_{i0}$ is the corresponding point in the object plane. Then,

$$d_s = \pm S_c \times |P_{ij} P_{i0}| / \cos \beta$$
Hence,

$$d_s = S_c \times (y_{ij} - y_{i0}) / \cos \beta$$  (5)

where \(y_{ij}\) and \(y_{i0}\) are the y-ordinate of \(P_j\) \((j = 0, 1, 2)\) and the origin, respectively, in the image.

It is apparent that parameters \((S_c, \beta)\) and position of the origin in the image, i.e., \(O(x_{i0}, y_{i0})\), are needed in order to calculate the SD. To this end, a calibration based method was used.

**Calibration**

A circle has no directionality. Using this characteristic of a circle, a calibration procedure was designed to determine \(S_c, \beta\) and \(O(x_{i0}, y_{i0})\). A calibration circle with a cross was placed right below the wire tip and adhered to the workpiece upper surface as shown in Fig. 3.

Ideally, the optical axis of the camera forms no angle with the OYZ plane; however, there must be a small angle, denoted as \(\theta\) between them — Fig. 4. In addition, the camera may also have a small rotation angle \(\phi\) as shown in Fig. 4. As the circle has no directionality, the image of the circle will be an ellipse whose long axis is equal to the diameter of the circle and center is the center of the circle. If the parameters of the ellipse, including center position \((X_0, Y_0)\), major semi-axis \(a\), minor semi-axis \(b\), and rotation angle of the ellipse \(\alpha\) are obtained from image processing, one can easily determine

$$O = (X_0, Y_0)$$  (6)

$$\phi = - \alpha$$  (7)

$$S_c = r / a$$  (8)

where \(r\) is the actual radius of the circle in millimeter. Further,

$$\beta = \arcsin(b / a)$$  (9)

Also, the slopes and intercepts of the lines \(k_h, b_h, k_v, b_v\) can be obtained from image processing. Define \(\alpha' = \arctan(k_h)\) and \(\phi = \alpha' - \alpha\), then

$$\theta = \arcsin(\sin \phi / \sin \beta)$$  (10)

The image of the calibration circle is shown in Fig. 5. The area where the location of the calibration circle is selected to process, and the image processing results are shown in Fig. 6. The parameters for the ellipse and lines can easily be obtained from the processed image.

**Measurement Algorithm Test and Error Analysis**

The test principle is shown in Fig. 7. Two metal plates of identical size but different thickness are prepared with identical homocentric round orifices as shown in Table 1 — Measurement Algorithm Test Result

<table>
<thead>
<tr>
<th>Calculated Thickness (mm)</th>
<th>Actual Thickness (mm)</th>
<th>Relative Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.72</td>
<td>6.35</td>
<td>5.76</td>
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</table>

The test principle is shown in Fig. 7. Two metal plates of identical size but different thickness are prepared with identical homocentric round orifices as shown in Table 1 — Measurement Algorithm Test Result.
Fig. 7 (1). After positioning the camera and reference plate, the reference plane, i.e., the top surface of the reference plate, is imaged as shown in Fig. 7(2). Then the test plate is positioned on top of the reference plate with the two homocentric orifices perfectly aligned and imaged as shown in Fig. 7(3). The two images are then processed for the center points of the two ellipses, which can be used to calculate the thickness of the test plate.

In this study, both of the two plates are 100 x 50 mm, while the thickness is 2.54 mm and 6.35 mm for the reference and test plate, respectively. The diameters of the two identical round orifices are both 6.35 mm. The two original images are in Fig. 8A and B. The ellipse fitting and line fitting results are shown in Fig. 8C and D. The results of the thickness calculation are given in Table 1.

As can be seen in Table 1, there is an error between the actual and calculated thickness. This error can be considered an estimate of the error for the proposed depth calculation algorithm when the weld pool surface changes for 6.35 mm. This error occurs because the algorithm shown in Fig. 2 is actually an approximation of the accurate camera model. As shown in Fig. 9, the error produced by the approximation is $|PP'|$. The error is caused by the approximation used, so it is an inherent error of the depth calculation algorithm. The relative inherent error $\delta$ is

$$\delta = \frac{|PP'| - |PP'|}{|PP'|}$$

$$= \frac{\cos \eta}{\cos (\beta - \eta) \cos \beta} - 1 \quad (11)$$

It is apparent that, if $\eta \to \beta$, then $\delta \to 0$. In the case above, $\beta$ and $\eta$ can both be calculated from Equation 9, i.e., $\beta = \arcsin(b/a)$ using $a$ and $b$ from the image of the reference plate and $\eta = \arcsin(b/a)$ using $a$ and $b$ from the image of the test plate, resulting in $\beta = 0.576$ and $\eta = 0.548$. The relative inherent error is thus 2.67%.

There are additional error sources including possible unwanted self rotation of the camera, a small gap between the two plates used in the test, calculation error in calculating the centers of the two ellipses, and so on. The error given in Table 1 is the result of all these sources. However, in actual measurement, the change of the weld pool surface depth is much smaller than 6.35 mm used in the above test such that the error caused by the approximation of camera model is much reduced. Hence, in actual measurement, the error will be much smaller than 5.76% although 5.76% should be considered an acceptable accuracy for weld penetration control.

### Table 2 — Calculated Parameters List

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
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<tr>
<td>Average welding current ($I_p$) (A)</td>
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<tr>
<td>Average welding voltage ($U_p$) (V)</td>
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<tr>
<td>Average peak voltage ($u_p$) (V)</td>
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<tr>
<td>Average base voltage ($U_b$) (V)</td>
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<td>Change of welding voltage in every peak period ($\Delta U$) (V)</td>
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<td>Change of welding voltage in every peak period ($\Delta u$) (V)</td>
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<td>Change of welding voltage in every peak period ($\Delta U$) (V)</td>
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<td>Change of welding voltage in every peak period ($\Delta U$) (V)</td>
<td>0.56</td>
</tr>
<tr>
<td>Change of welding voltage in every peak period ($\Delta u$) (V)</td>
<td>0.38</td>
</tr>
</tbody>
</table>

| Average change of welding voltage in peak period ($\Delta \Delta U$) (V) | 2.28   |
| Average change of welding voltage in peak period ($\Delta \Delta u$) (V) | -0.33  |
| Average change of welding voltage in peak period ($\Delta \Delta U$) (V) | 0.56   |
| Average change of welding voltage in peak period ($\Delta \Delta u$) (V) | 0.52   |
| Average change of welding voltage in peak period ($\Delta \Delta U$) (V) | 0.56   |
| Average change of welding voltage in peak period ($\Delta \Delta u$) (V) | 0.38   |

### Table 3 — Welding Parameters when C = 11.4

<table>
<thead>
<tr>
<th>No.</th>
<th>TS (m/min)</th>
<th>WFS (m/min)</th>
<th>$I_p$ (A)</th>
<th>$I_b$ (A)</th>
<th>$i_p$ (ms)</th>
<th>$I_b$ (A)</th>
<th>$i_b$ (ms)</th>
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<td>12</td>
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<td>4.11</td>
<td>162</td>
<td>300</td>
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<td>70</td>
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<tr>
<td>13</td>
<td>0.42</td>
<td>4.80</td>
<td>189</td>
<td>300</td>
<td>8</td>
<td>120</td>
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<tr>
<td>14</td>
<td>0.48</td>
<td>5.49</td>
<td>216</td>
<td>300</td>
<td>8</td>
<td>180</td>
<td>18.7</td>
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</table>
Experimental Setup

The experimental setup is shown in Fig. 10. The welding machine runs at constant current (CC) mode and the current is controlled by the target computer through D/A. The Olympus i-Speed II camera acquires images at 1000 frames per second and stores them in a CF (compact flash) card. The arc voltage and actual current are synchronized with the images as shown in Fig. 11, measured by the target computer and stored in the host computer.

Surface Depth Measurement Experiment

An experiment was conducted to measure...
ure the weld pool surface depth where two 6.3-mm-thick mild steel (C1018) plates of 300 × 25.4 mm were welded in a square-groove butt joint with a 1.5 mm root opening in the flat position. The welding gun stayed stationary and the workpiece traveled with the welding tractor at a constant speed of 0.42 m/min. The contact tip to workpiece distance (CTWD) was 12 mm. The welding wire used was 1.2 mm (0.045 in.) mild steel ER70S-3. The wire feed speed (WFS) was 4.8 m/min (189 in./min). The welding current was pulsed between peak current 300 A and base current 120 A. The pulse period was 20.9 ms and the duty ratio was 38.3%. The shielding gas was pure argon and the flow rate was 18.9 L/min (40 ft³/h).

A weld pool image obtained by the high-speed camera is shown in Fig. 12. The center of the weld pool surface is defined as the center of the elliptical weld pool and is marked by the red asterisk as shown in Fig. 12.

Using the algorithm developed earlier, SD in the peak current period can be calculated and synchronized with the welding current/voltage waveforms as shown in Fig. 13. The average SD can also be calculated

$$\bar{d}_p = \frac{\sum d_{i,SD}}{k}$$  \hspace{1cm} (12)

where $k$ is number of the SD measurements used. Because the weld pool surface is fluctuating due to the metal transfer, measurement averaging is necessary. Denote any SD measurements in the $i$th peak period as $d_{i,SD}$. The change of the SD in the $i$th peak period is

$$\Delta d_{i,SD} = \max(d_{i,SD}) - \min(d_{i,SD})$$  \hspace{1cm} (13)

The average change in different peak periods is

$$\Delta d = \left( \sum_{i=1}^{n} \Delta d_{i,SD} \right) / n$$  \hspace{1cm} (14)

where $n$ is the number of peak current periods of concern.

All above measurements from the experiment are listed in Table 2 together with other parameters/variables such as the change of the voltage in the $i$th peak period ($\Delta V_{P_i}$) and the average change of voltage in different peak periods ($\Delta V$), which will be discussed later, the weld width ($W_f$), and the average of the weld penetration ($d_p$) that was measured through the gap from the backside.

**Modeling**

**Experiment Design**

In analyzing the GMAW process, not only the welding current/voltage, but also the wire feed speed and welding travel speed (TS) affect SD and PD. When the wire feed speed increases or the travel speed decreases, the PD increases. To concentrate the study on the effect of welding...
current/voltage, the metal deposition can first be controlled at a constant $C$.

$$WFS / TS = C$$  \(15\)

Then $C$ can be changed in order to study the effect from the metal deposition on the SD and PD.

When designing an experiment, the travel speed is first specified at a value from 0.3 m/min to 0.48 m/min, typical for GMAW. Then the wire feed speed is determined based on $C$ used. The average welding current has been determined approximately by the wire feed speed and is used as a constraint in the current pulse waveform design. Also, to facilitate the possibility where the arc voltage is easily measurable in manufacturing facilities with SD, the effect of the current on the relationship between arc length and arc voltage needs to be overcome. Hence, the peak current and its period are set constants and the base current and its period are determined based on the average current. In this study, 300 A and 8 ms were used as the peak current amperage and period. The welding parameters designed are shown in Tables 3-7 for five series of experiments with five different $C$.

![Fig. 11 — Synchronization of measurements.](image1)

![Fig. 12 — Weld pool image and weld pool surface center.](image2)

![Fig. 13 — Welding current/voltage and SD. Current and voltage signals shown are averages of the measurements for the present and last previous point.](image3)

**Table 8 — Experimental Results for Modeling**

<table>
<thead>
<tr>
<th>No.</th>
<th>$C$</th>
<th>$I_a$ (A)</th>
<th>$U_a$ (V)</th>
<th>$U_p$ (V)</th>
<th>$U_b$ (V)</th>
<th>$\bar{d}_s$ (mm)</th>
<th>$\Delta d_s$ (mm)</th>
<th>$\Delta U$ (V)</th>
<th>$W_f$ (mm)</th>
<th>$d_p$ (mm)</th>
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<td>11.4</td>
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<td>22.4</td>
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<td>0.84</td>
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<td>33.4</td>
<td>34.9</td>
<td>30.2</td>
<td>-0.01</td>
<td>0.30</td>
<td>1.06</td>
<td>9.17</td>
<td>3.74</td>
</tr>
<tr>
<td>53</td>
<td>18.2</td>
<td>298.3</td>
<td>35.1</td>
<td>35.6</td>
<td>34.5</td>
<td>0.33</td>
<td>0.24</td>
<td>0.79</td>
<td>14.69</td>
<td>4.09</td>
</tr>
<tr>
<td>54</td>
<td>18.2</td>
<td>334.9</td>
<td>37.1</td>
<td>38.4</td>
<td>35.7</td>
<td>1.05</td>
<td>0.16</td>
<td>0.94</td>
<td>7.41</td>
<td>4.35</td>
</tr>
</tbody>
</table>
Results and Discussion

Using the welding parameters in Tables 3–7, five series of experiments were conducted and the results are given in Table 8.

As can be seen from Table 8, when $WFS/TS$ is constant, with the increase in the average current, average change of SD in peak period decreases, while PD increases. Take $C = 11.4$ as an example; the relationship between the average change of SD in peak periods and the PD is shown in Fig. 14.

In analyzing the GMAW-P process, when the impact of droplets is not considered, the front of the weld pool head is pressed down by the arc and the molten metal flows upward to the tail of the weld pool during the peak period as shown in Fig. 15A. In the base period, the molten metal flows back to the front due to the decrease of the arc pressure and the weld pool surface rises as shown in Fig. 15C. When the metal deposition is unchanged, the SD and arc length will increase if the PD increases as shown in Fig. 15B.

From another point of view, if the weld penetration increases, it must be caused either by an increase in the base current or a decrease in the base period because the peak current amperage and period are kept constant. Since the arc pressure in the base period will increase if the base current increases or the molten metal will have less time to flow back if the base period time decreases, a deeper penetration will result in that less metal flows back by the end of the base period as shown in Fig. 15D. Further, it is likely that the weld pool surface will be pushed to the same level due to the unchanged peak current amperage and period. Hence, the change of SD during the peak period would tend to reduce as was observed from Table 8 and Fig. 14.

When the droplet is taken into consideration, the change of SD in peak current period should change. However, the peak current amperage and period are maintained unchanged and do not change with experiments. The effect of the impact of the droplet on the change of SD should be considered unchanged with experiment. Hence, the droplet should not change how the average change of SD in peak period is related to the weld penetration when the $WFS/TS$ is constant in the GMAW-P process.

Taking $WFS/TS$ as a factor into account, the weld penetration is the function of $\Delta d_p$ and $WFS/TS$

$$d_p = f(\Delta d_p, WFS/TS)$$

The interpolation of data can give a non-
parametric graphic model for the relationship (Equation 16) as shown in Fig. 16A. As can be seen, the surface in Fig. 16A is close to a plane. Hence, a plane model can be fitted
\[
d_p = -3.34 \times \Delta d_s + 0.01 \times WFS/TS + 4.31
\]
with a standard deviation of 0.27 mm. The fitting plane is shown in Fig. 16B with the interpolation of data. This linear plane model has sufficient accuracies for weld penetration control in the GMAW-P process.

Analysis of Model 17 shows that the second term with $WFS/TS$ has little contribution to the weld penetration. Hence, it is possible that the model can be simplified without consideration of $WFS/TS$. Using a straight line to fit, the result is shown in Fig. 17B and the resultant model is
\[
d_p = -3.45 \times \Delta d_s + 4.51
\]
with a standard deviation of 0.27 mm. The accuracy is as good as the plane model. Hence, the depth of the weld penetration can be predicted, with an acceptable accuracy, by the change of the weld pool surface depth during the peak current period.

### Modeling for Practical Application

While the result that the depth of the weld penetration can be predicted by the change of the weld pool surface depth during the peak current period is fundamental, its direct application in penetration control in manufacturing facilities could be complex if the weld pool surface depth is measured using a machine vision method. To find a method to monitor the weld penetration using signals that are easily measurable in manufacturing plants, a possible relationship between the change in weld pool surface depth and a change in arc voltage is thought because 1) a surface change will cause the arc length to change, and 2) a change in the arc length can be measured from the arc voltage. In the peak current period, the current is constant and the arc voltage is only determining the arc length. Hence, it is possible that the change of the arc voltage in the peak current period may reflect a change in weld pool surface depth.

For quantitative studies, let’s similarly define the change of the voltage in the $i$th peak period as
\[
\Delta U_{pl} = \max(U_{pl}) - \min(U_{pl})
\]
and the average change in different peak periods as
\[
\Delta U = \left( \sum_{i=1}^{n} \Delta U_{pl} \right) / n
\]
From the experimental data as given in Table 8, Fig. 18 is obtained. It is apparent that $\Delta U$ and $\Delta d_s$ are highly correlated as expected. A model can be easily established to correlate them.

Using $\Delta U$ to replace $\Delta d_s$, the following model is fitted:
\[
d_p = - 0.56 \times \Delta U + 0.08 \times WFS / TS + 2.69
\]

The standard deviation is 0.27 mm, and it is the same as for Model 17. Further, the following model can be fitted from the experimental data in Table 8
\[
d_p = - 0.71 \times \Delta U + 4.12
\]
Its standard deviation is 0.31 mm, slightly higher than that using both $\Delta U$ and $C = WFS / TS$. For weld penetration control, this model can be considered as effective as Model 21. Because Model 22 only uses voltage signals, it is suitable for practical applications in manufacturing facilities.

### Conclusions

- The weld pool surface indeed contains sufficient information to determine the depth of the weld penetration as expected during GMAW-P.
- The depth of the weld penetration can be determined with adequate accuracy from the change of the weld pool surface depth during the peak current period.
- The depth of the weld penetration can also be determined with adequate accuracy from the change in arc voltage during the peak current period.
• Because the arc voltage is easily measurable in manufacturing plants, the relationship confirmed in this study between the depth of the weld penetration and the change of the arc voltage during the peak current period provides a simple yet suitable method to monitor the weld penetration for manufacturing applications.

Acknowledgment

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References

Residual Stresses in Weld Thermal Cycle Simulated Specimens of X70 Pipeline Steel

The forces caused by the constrained expansion and contraction of X70 pipeline steel specimens, subjected to simulated weld thermal cycles, were measured by means of Satoh testing

BY M. I. ONSOIEN, M. M’HAMDI, AND O. M. AKSELSEN

ABSTRACT

The present work concerns Satoh testing of X70 pipeline steel and was undertaken in order to assess residual stresses in weld metal. Experiments using single, double, and triple temperature cycles were performed to study how different temperature histories affected the development of residual stresses in the tested specimens. In some of the single-cycle experiments, high tensile stresses or high compressive stresses were imposed on the sample at the start of the experiment to study the response of the sample to preloading. Residual stresses higher than 490 MPa have been measured. It was further found that samples with low austenite transformation temperature may build up higher residual stress than samples with higher austenite transformation temperature. A prerequisite for this behavior is that the transformation product in the first case has high yield strength and the transformation product in the second case reaches its yield limit. It is also shown that the effect of preloading on the shape of the o-T curve is negligible for temperatures above the A₃ temperature, i.e., the phase transformation relaxes the effect of different initial stresses and the final stress level is very similar for samples starting in high compression, high tension, or zero stress. It is further shown that the effect of multiple cycles on the shape of the o-T curve and on the final stress level is low, probably because of stress-strain relaxation during the phase transformations.

Introduction

The heat generated during welding causes a high temperature gradient in and around the welded area. This leads to nonuniform expansion and contraction of the material causing buildup of stresses. The stresses that are not recovered by elasticity in the material become residual stresses that might result in severe distortion and premature failure. Thermophysical properties such as heat capacity, thermal expansion coefficient, and density, as well as mechanical properties such as the elastic modulus and yield strength, contribute to the type and magnitude of residual stresses (Refs. 1–3).

Residual stresses may be determined by experimental means or estimated using numerical methods. Experimental methods include hole drilling (Ref. 4) and ultrasonic methods (Ref. 5) as well as X-ray and neutron diffraction methods (Refs. 6–9). Numerical methods, developed by a number of authors (Refs. 10, 11) using, e.g., a finite element code, allow the computation of residual stresses and their distributions based on input such as mechanical properties of the processed material, shape, and dimensions of the part, and loading conditions. However, the complexity of these methods limits their practical application. Often important material data are not available, and thorough descriptions of how the material data changes during a weld thermal cycle and during phase transformations are usually missing.

The aim of the present work is to analyze the stress development in the heat-affected zone (HAZ) of an X70 pipeline steel using the Satoh test (Refs. 12, 13). In this test, a specimen is mounted in a rigid steel frame and heated according to a controlled thermal cycle, simulating the heat cycle in the HAZ of a real weld. The forces caused by the expansion and contraction of the specimen are recorded by means of a load cell and a data-acquisition system. The collected experimental data can be used for the verification or calibration of numerical simulations of residual stresses in steel weldments (Ref. 14).

Materials and Experimental Procedure

The specimens for Satoh testing were machined from X70 pipeline steel with chemical composition and mechanical properties as given in Table 1. Metallographic analyses (Ref. 16) have shown that the material is composed of ferrite (86%) with bands of pearlite (14%). The average hardness is 200 HV₀. The continuous-cooling-temperature (CCT) diagram for the studied steel is given in Fig. 1.

The specimen geometry for Satoh testing is shown in Fig. 2. The Satoh test jig (Fig. 3) consists of a rigid weld steel frame into which the sample is mounted. An induction coil and a cooling gas (Ar or He) diffuser are mounted coaxially around the sample. This setup permits controlled heating and cooling of the sample according to the desired temperature cycle. The sample surface temperature is recorded by means of three chromel/alumel thermocouples (Type K) spot welded to the specimen gauge length, one at mid-length and one 10 mm above and one 10 mm below this position. During testing, expansion in the upper end is restrained by the top beam of the Satoh frame. Thus, the load cell in the lower end of the frame records the expansion of the specimen. The specimen fixtures are water-cooled to prevent thermal expansion of the jig, only expansion of the specimen is therefore imposed on the load cell (Ref. 15). Load cell and thermocouple signals are recorded by a...
Fig. 1 — CCT diagram for X70 pipeline steel used in current experiments (Ref. 16).

Fig. 2 — Specimen geometry for Satoh testing.

computer-controlled data-acquisition system. The heating cycles characterized by the peak temperature \(T_p\) and the cooling time from 800° to 500°C \(\Delta t_{85}\) are intended to resemble HAZ temperature cycles during real welding situations.

**Experimental Program**

Experiments using single, double, and triple temperature cycles were performed to study how different temperature histories affected the development of residual stresses in the tested specimens. Single-cycle experiments included heating to peak temperatures of about 1100°, 1200°, and 1350°C, prior to cooling using cooling time \(\Delta t_{85}\) of about 10, 15, and 20 s. In some of the single-cycle experiments, a high tensile stress or a high compressive stress was imposed on the sample at the start of the experiment to study the response of the sample to preloading. Double-cycle experiments included heating to the first peak temperature, cooling down to 150°C, before heating to the second peak temperature and subsequent heating to ambient temperature. Triple-cycle experiments included heating to the first peak temperature followed by cooling down to 150°C, prior to heating to the second peak temperature and cooling down to 150°C before heating to the third peak temperature followed by cooling to ambient temperature. The intermediate cooling temperature of 150°C is meant to represent the typical interpass temperature in a real welding situation. The main outline of the experimental program is given in Table 2.

**Results and Discussion**

**Single Cycle Experiments**

Figures 4 and 5 show temperature measurements in the center surface of the samples for various heating and cooling conditions. The heating rate in the ferrite region is around 680°C/s, while it is much lower, about 75°C/s, in the austenite region. Examples of recorded stress vs. center surface temperature \(\sigma-T\) curves for single-cycle experiments are shown in Figs. 6 and 7. During heating the samples expand and a compressive stress builds up due to the constrained axial displacement imposed by the rigid Satoh test frame. The compressive stress reaches its maximum, typically about 350 MPa, at around 600°–700°C before it decreases rapidly, due to the transformation from body-centered cubic ferrite to close-packed face-centered cubic austenite and stress temperature dependence, to below about 50 MPa at a temperature of around 900°C. On further heating, the compressive stress increases slightly, due to thermal expansion of the austenite, until the yield stress is reached and the \(\sigma-T\) curve starts to follow the austenite yield stress curve. During cooling, the sample starts to contract and the stress changes from compression to tension. The tensile stress reaches the yield stress for austenite and follows this stress until decomposition of austenite starts. In some cases, the stress relief due to volumetric expansion during phase transformation and associated transformation plasticity results in compressive stresses in the sample. Ferrite has high yield strength at low temperatures and thus there is lower compensation of contraction by plastic relaxation. As a result, the stress rises sharply after transformation is exhausted. The rapid buildup of tensile stress gives rise to residual stresses above 430 MPa for all specimens.

The current experiments show that the sample with a peak temperature of 1350°C and fastest cooling rate \(\Delta t_{85}\) of around 10 s has lowest transformation temperature and peak temperature, cooling down to 150°C, before heating to the second peak temperature and subsequent cooling to ambient temperature. Triple-cycle experiments included heating to the first peak temperature followed by cooling down to 150°C, prior to heating to the second peak temperature and cooling down to 150°C before heating to the third peak temperature followed by cooling to ambient temperature. The intermediate cooling temperature of 150°C is meant to represent the typical interpass temperature in a real welding situation. The main outline of the experimental program is given in Table 2.

**Table 1 — Chemical Composition and Mechanical Properties of Current X70 Steel**

<table>
<thead>
<tr>
<th>Elements (wt-%)</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>Al</th>
<th>Cu</th>
<th>Mo</th>
<th>Nb</th>
<th>V</th>
<th>Ti</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.09</td>
<td>0.30</td>
<td>1.71</td>
<td>0.012</td>
<td>0.001</td>
<td>0.07</td>
<td>0.05</td>
<td>0.05</td>
<td>0.04</td>
<td>0.02</td>
<td>0.05</td>
<td>0.01</td>
<td>0.02</td>
<td>0.005</td>
</tr>
</tbody>
</table>

YS = 581 MPa, UTS = 645 MPa, El = 21%
highest final stress — Fig. 5. In agreement with the CCT diagram of Fig. 1, the results show that phase transformation upon cooling occurs at lower temperatures when the $\Delta T_{85}$ is decreased as indicated by the stress relaxation associated with transformation plasticity. Given austenite has a higher thermal expansion coefficient than ferrite ($\alpha_T = 2.09 \times 10^{-5} \text{ K}^{-1}, \alpha_T = 1.29 \times 10^{-5} \text{ K}^{-1}$) (Ref. 16), one would expect that transformation at lower temperatures allows larger compensation of the accumulated thermal contraction strain. As a result, lower residual stresses would be expected for samples transforming at lower temperatures compared to samples transforming at higher temperatures (Ref. 17). The CCT diagram for this material (Fig. 1) shows that this sample contains a significantly higher amount of martensite giving rise to higher low-temperature strength (Ref. 16). Thus, the yield stress is not reached before the experiment is terminated such that a high residual stress is built up. The two samples with peak temperatures of about 1350°C and $\Delta T_{85}$ of around 15 and 20 s have higher transformation temperatures, resulting in lower strength of the material, such that the $\sigma$-$T$ curve follows the yield curve from about 130°C to ambient temperature — Figs. 6, 7. Similarly, samples with peak temperatures around 1200° and 1100°C and $\Delta T_{85}$ of around 15 and 20 s reach the yield stress before the experiment is terminated, while the sample with the fastest cooling rate ($\Delta T_{85}$ around 10 s), does not reach its yield limit, producing the highest final stress.

Samples with peak temperatures of around 1350°C reach higher final stress than samples with peak temperatures of 1200° and 1100°C — Fig. 8. This behavior is probably due to the increase in grain size with increasing temperature giving rise to enhanced hardenability, and thus higher strength. The grain growth is facilitated by the dissolution of precipitates at temperatures above around 1100°C (Refs. 18–20) giving rise to the decrease of the austenite strength during heating of the specimen to temperatures above around 1100°C, as seen in the $\sigma$-$T$ curves in Figs. 6 and 7.

**Effect of Preloading on the Evolution of $\sigma$-$T$ Curves**

When the samples are preloaded with a high compressive stress at the start of the experiment, further increase of compressive stress due to thermal expansion occurs at a much slower rate compared to the

---

**Table 2 — Experimental Program**

<table>
<thead>
<tr>
<th>Thermal Influence</th>
<th>Initial Stress State</th>
<th>1st Cycle $T_p$(°C) $\Delta T_{85}$(s)</th>
<th>2nd Cycle $T_p$(°C) $\Delta T_{85}$(s)</th>
<th>3rd Cycle $T_p$(°C) $\Delta T_{85}$(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cycle</td>
<td>Neutral</td>
<td>1100 10</td>
<td>1100 15</td>
<td>1100 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200 10</td>
<td>1200 15</td>
<td>1200 10</td>
</tr>
<tr>
<td>Compression</td>
<td></td>
<td>1350 10</td>
<td>1350 15</td>
<td>1350 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200 10</td>
<td>1200 15</td>
<td>1200 10</td>
</tr>
<tr>
<td>Tension</td>
<td></td>
<td>1200 10</td>
<td>1200 15</td>
<td>1200 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double cycle</td>
<td>Neutral</td>
<td>800 15</td>
<td>1000 15</td>
<td>1200 15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triple cycle</td>
<td>Neutral</td>
<td>1200 15</td>
<td>1200 15</td>
<td>800 15</td>
</tr>
</tbody>
</table>
experiments with no preloading. The maximum compressive stress for the sample with a compressive preload of 462 MPa was found to be 570 MPa at a temperature of 460°C. The very high compressive stress observed is just below the room temperature yield stress of the material, and thus well above the expected yield strength at this temperature (Ref. 21). The reason for this behavior must be a fairly steep temperature gradient within the sample such that the surface of the sample, where the temperature is measured, reaches high temperature faster than the interior of the sample. This is verified by mathematical modeling of the temperature distribution, using the FEM code Weldsim (Ref. 14).

In the modeling, a quarter of the sample geometry of Fig. 2 has been employed due to symmetry reasons and the measured temperature history at the surface has been imposed as a thermal boundary condition. (Refer to Ref. 16 for more details about the simulation conditions.) Figure 9 shows the calculated temperature difference between the surface and center of the samples as a function of temperature. A further increase in the temperature results in a rapid reduction of the compressive stress reflecting the yield curve of the material at increasing temperature. The samples with a high tensile preload expand such that the tensile stress is reduced as the temperature is raised. At a temperature of about 660°C, the stress changes from tensile to compressive. At a temperature just above the onset of the ferrite-to-austenite transformation, the o-T curve for the preloaded samples reaches the o-T curve for the sample with no preload and follows this curve very closely throughout the experiment — Fig. 10. The effect of preloading on the shape of the o-T curve is negligible for temperatures above the Acl temperature, i.e., the phase transformation relaxes the effect of different initial stresses, and the final stress level is very similar in the three different cases.

**Multiple Cycle Experiments**

The measured temperature cycle for the sample with first peak temperature of 1210°C and second peak temperature of 771°C is shown in Fig. 11. Similar temperature-time curves were also measured for the experiments characterized by a first peak temperature of about 1200°C and second peak temperatures of 1024°C, 1114°C, and 1221°C, and cooling times Δt_k/5 of about 15 s, respectively. The o-T curves for the first cycle evolves in the same manner as the o-T curves for the single-cycle experiments. When the cooling is interrupted by a new heating cycle, the second o-T cycle starts at a high tensile stress level, typically 400–250 MPa at 150°C, which is approximately the same tensile stress level as the single-cycle experiments starting in tension — Fig. 10. Upon further heating, the o-T curve of the second cycle meets the o-T curve of the first cycle around the Acl temperature and both curves follow the same path until the peak temperature of the second cycle is reached. During cooling, the o-T curve of the second cycle reaches the yield stress for austenite and follows this curve until transformation of austenite commences, i.e., a similar be-
behavior as obtained after the first cycle. Compared to the first cycle, the austenite-
to-ferrite transformation occurs at lower temperatures as the second-cycle peak
temperature increases, reflecting the in-
crease in hardenability as a result of in-
creased grain growth at higher peak tem-
peratures. After completion of the
transformation, the tensile stress increases
rapidly to a residual stress level of 450–480
MPa when the experiment is finished. An
example of a o-T curve for a double-cycle
experiment is shown in Fig. 12.

One experiment was performed using
triple thermal cycles, the o-T curve for this
experiment is shown in Fig. 13. Here, the
first and the second temperature cycle had
peak temperature of around 1200°C and
the measured o-T curve for the two first
cycles is very similar to the o-T curve for
the double-cycle experiment using peak
temperatures of 1200°C. The third cycle,
having a peak temperature of 769°C be-
haves very similarly to the last cycle of the
double-cycle experiment with a peak tem-
perature of 771°C. Thus, the effect of mul-
tiple cycles on the shape of the o-T curve
and on the final stress level is low, proba-
bly because of relaxation of strains during
the phase transformations.

Relation with Base Metal Strength Level

The general rule of thumb is that the
welding residual stresses are of the same
order of magnitude as the base metal yield
strength. This may be true as long as the
solid-state phase transformations do not in-
fluence the development of residual
stresses. Practical experience based on the
Satoh testing has demonstrated that the ex-
tent of phase transformation influence de-
pends on the steel transformation behavior,
i.e., its hardenability. In the present case,
phase transformations cause substantial
changes in the residual stress buildup. The
presently examined X70 pipeline steel has a
yield strength of 581 MPa (Table 1). Resid-
ual stresses in the range from 433 to 499
MPa, corresponding to 75–86% of the base
metal yield strength, were measured. Simi-
lar previous examinations (Ref. 22) have re-
vealed that the residual stress of conven-
tional C-Mn steel with base metal yield
strength of 398 MPa was found to be 465
MPa at its maximum in Satoh testing, which
is 117% of its yield strength. For QT steel
with a yield strength of 780 MPa, the maxi-
method residual stress was 582 MPa, which
is only 75% of the R<sub>0.2</sub> value (Ref. 23). The
most remarkable deviation from the yield
strength level has recently been reported
from Satoh testing (Ref. 24) and real weld
measurements (Refs. 25, 26) for super-
martensitic stainless steel, where the
martensite transformation takes place at
very low temperatures, typically within the
range of 180–220°C. This prevents exten-
sive buildup of residual stresses after com-
pletion of the phase transformation result-
ing in residual stresses being as low as about
100 MPa.

Comparison with Measurements Made on
Real Welds

Although the Satoh test does not re-
place real weldments, it provides a quick
and inexpensive way to evaluate the residual stress potential in the HAZ by weld simulation. In a real weld, the buildup of residual stresses is obviously much more complex since the joint configuration and geometry will influence the restraint intensity, and hence the residual stresses. Moreover, in a real weld the residual stress distribution is important. In a pipeline, welding residual stresses in different directions will develop, e.g., hoop stresses and axial stresses. With either bending or tension forces acting on the pipeline, it is most relevant to compare residual stress levels in the Satoh test with the maximum axial stresses resulting from girth welding. Data from girth welding of X70 pipeline have recently been published using neutron diffraction measurements (Ref. 27). Here, axial tensile stresses in the range of 269–486 MPa were measured. Actually, the present final stresses measured in the Satoh test fall within the scatter band for the axial stresses in the real girth weld. The weld simulation experiments gave a scatter from 433 to 499 MPa, depending on the peak temperatures and cooling rates employed. Good correlation between maximum residual stresses found in the Satoh test and maximum values measured in real welds have previously been reported for C-Mn and QT steels (Ref. 15).

**Summary and Conclusions**

The forces caused by the constrained expansion and contraction of X70 pipeline steel specimens, subjected to simulated weld thermal cycles, have been measured by means of Satoh testing. Based on the conducted work, the following main conclusions can be drawn:

- Phase transformations cause substantial changes in the residual stress buildup for the studied X70 pipeline steel. Residual stress of 433 to 490 MPa has been recorded using the Satoh testing method. These stresses are 75–85% of the base metal yield strength.
- X70 steel samples with low austenite transformation temperature may build up higher residual stress than samples with higher austenite transformation temperature, if the transformation product in the first case has higher yield strength and the transformation product in the second case reaches its yield limit.
- Samples with peak temperatures of around 1350°C reach higher final stress than samples with peak temperatures of 1200° and 1100°C. This is probably caused by increased hardenability as a result of enhanced grain growth at higher temperatures.
- In Satoh-type experiments, the effect of preloading on the shape of the α-T curve disappears at temperatures above the A_cert temperature, i.e., the phase transformation relaxes the different initial stresses and the final stress level is very similar for samples starting in high compression, high tension or zero stress.
- The effect multiple cycles on the shape of the α-T curve and on the final stress level is low, probably because of relaxation of strains during the phase transformations.

**Acknowledgment**

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**References**

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