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On the cover: A metal grinder works safely in the 3M CAM Center while wearing the company’s protective coveralls, respirator, hearing, and eye protection. (Photo courtesy of 3M Co.)
Let’s Make Welding Qualification Easier

Welding qualification is inevitable in our industry, and there are distinct and extensive rules existing for both procedure and performance qualification. I’m sure you have wondered, as I have, why there are so many different rules and requirements to establish initial qualification as well as to identify variables and limitations for requalification. Does it need to be so complex? I don’t think so.

Welding qualification is a monster we have created. All done by volunteers, just like you and me, with best intent, who have developed an extremely complicated system that is difficult to understand and use. Committees have developed from scratch, or have borrowed, information that is specific to and appropriate for their application without considering the big picture and the need for uniformity and consistency. Time has aided this process, allowing each group’s members to solidify their approach, being only concerned about their respective “world” and not being interested or involved with the rest of the industry.

The American Welding Society initiated a process years ago to consolidate procedure and performance qualification into one standard. Howard B. Cary, AWS past president 1980-1981, wrote a Welding Journal editorial titled “Why Not the Ultimate! One Welding Qualification Standard.” In his editorial, Cary said the following:

“For years, ASME and AWS have recognized that there is a great need technically and economically to have a single document concerning welding qualification requirements. The Board of Directors of AWS should be complimented for taking action on this matter. In April 1978, they directed that a committee be established to develop a standard which would consolidate, standardize, and simplify (to the extent practical) all AWS welding procedure and performance qualification requirements.”

The group established back then is the B2 Committee, which is currently responsible for the following AWS documents: B2.1, Specification for Welding Procedure and Performance Qualification; B2.2, Specification for Brazing Procedure and Performance Qualification; B2.3, Specification for Soldering Procedure and Performance Qualification; and B2.4, Specification for Welding Procedure and Performance Qualification for Thermoplastics. These specifications are the AWS-recognized “standards” for procedure and performance qualification. They are referenced by most application codes within AWS, and qualifications conducted according to the requirements of these B2 specifications are normally usable by those codes.

So, if we have these documents available, why is the system still so complicated? I believe it’s because not enough people are informed about the B2 documents or, for some reason, are resistant to their use. I can assure you that use of these standards provides substantial savings to industry. Welders/welding operators and procedures can be qualified to one standard for welding the same materials using the same welding processes for a number of different welding applications such as welding of machinery, pressure vessels, piping, and structures.

Individual employers are always responsible and accountable for the welding their organizations perform. No code, standard, or specification relieves the employer of this responsibility. Given the variety of work in the industry, it is only sensible that the more one standard is used, the more consistent and cost effective the work will become. I realize it is often difficult to break away from practices that have become the norm and begin using a new tool, but the documents provided by the AWS B2 Committee are tools that will prove themselves once put to use.

AWS B2.1, Specification for Welding Procedure and Performance Qualification, is the foundation for AWS Standard Welding Procedures as well as the most extensive listing of base materials grouped for welding qualification in existence. Methods are provided to qualify procedures via the standard plate groove/fillet test weldment as well as prototype or simulated service test weldments. The purpose is to provide a method of qualification that is sound and defendable whether you are welding fence posts or nuclear reactors or anything in between.

I volunteered for the B2 Committee in 1987 because I believed in its purpose and goals, as well as in the people who give of their time and knowledge to serve on it. Now, 24 years later, I still believe there is a great need technically and an economic benefit to having a single document concerning welding qualification requirements. Become informed and put the B2 documents to the test. I think you will like the results.

Jeff J. Fluckiger
Chair, AWS B2 Committee on Procedure and Performance Qualification
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President’s Jobs Council Urges Manufacturing Skills Training

One of the most important steps the United States can take to increase employment is to train workers in advanced manufacturing skills, according to the President’s Jobs and Competitiveness Council. In a report issued earlier this summer, the council urged businesses to form partnerships with community colleges, vocational schools, and others to match career training with real-world hiring needs. There are more than two-million manufacturing jobs in the United States, the council states, that are vacant due in part because employers cannot find workers with the necessary skills.

The President’s Council on Jobs and Competitiveness, whose members are business leaders appointed by the White House, provides nonpartisan advice to the president on strengthening the economy and promoting U.S. competitiveness.

Office of Management and Budget: Benefits of Regulation Outweigh Burdens

The U.S. Office of Management and Budget (OMB) has released its annual report on the costs and benefits of major federal regulations and, once again, has concluded that the benefits far outweigh the costs. According to OMB, the estimated annual benefits of major federal regulations from Oct. 1, 2000, to Sept. 30, 2010, for which agencies estimated and monetized both benefits and costs, are in the aggregate between $132 and $655 billion, while the estimated annual costs are in the aggregate between $44 and $62 billion.

While noting that the analysis has “significant limitations,” in particular quantifying the impacts of federal rules, OMB nevertheless urged that the overall conclusion is correct.

The study is available at www.whitehouse.gov/omb.

SEC Issues Final Whistleblower Rules

The U.S. Securities and Exchange Commission (SEC) has issued its final rule regarding employee corporate whistleblowing. This rule implements the Dodd-Frank Wall Street Reform and Consumer Protection Act, which added a new whistleblowing component.

Under the final rules, the SEC will pay an award of up to 30% to a whistleblower who voluntarily reports to the SEC original information that leads to a successful enforcement action in which the SEC’s monetary sanctions exceed $1 million. In addition, there are substantive workplace protections to prevent retaliation to whistleblowers.


Patent Reform Bill Moves Forward

The U.S. House of Representatives has approved the America Invents Act (H.R. 1249). Similar legislation was adopted by the Senate earlier this year, and therefore, the two bills must now be reconciled. The core of the legislation is to move the United States from a “first to invent” standard for a patent to a “first to file” standard. This would make the U.S. patent system consistent with most other countries, and is designed to simplify the patent application system and reduce litigation regarding which party first invented a particular process. Concerns have been expressed, however, that a “first to file” approach favors larger companies who have greater financial resources to file multiple patent applications on possible new inventions.

The president has stated publicly that he would sign the legislation.

Complementary Initiatives Introduced to Fight Government Waste

By presidential executive order, a new body — the Government Accountability and Transparency Board — has been created with a mission to provide strategic direction for enhancing the transparency of federal spending and advance efforts to detect and remediate fraud, waste, and abuse in federal programs. The 11-person board will be comprised of agency officials appointed by the president.

In addition, the Digital Accountability and Transparency Act (DATA) has been introduced in the House. This bill also would establish a board — the Federal Accountability and Spending Transparency (FAST) Board — and its mission would be to monitor grants, contracts, loans, and internal agency expenses and make these data available to the public via a Web site.

OSHA Proposing Revised Injury, Illness Reporting Requirements

The Occupational Safety and Health Administration (OSHA) has issued a Notice of Proposed Rulemaking regarding updating and revising record keeping and reporting requirements for work-related injuries and illnesses.

The new proposed reporting requirements would revise OSHA’s current regulation that requires an employer to report to OSHA, within eight hours, all work-related fatalities and inpatient hospitalizations of three or more employees.

Under the revised proposal, employers would be required to report to OSHA any work-related fatalities and all inpatient hospitalizations within eight hours, and work-related amputations within 24 hours. Reporting amputations is not required under the current regulation.


SBA Reports More Federal Contracts for Small Businesses

The federal government awarded nearly $100 billion in federal contracts to small businesses in fiscal year 2010, according to the U.S. Small Business Administration (SBA). Small businesses won a record $97.95 billion in federal contracts, the SBA said, which is 22.7% of eligible contracting dollars. This marks the largest single-year increase in more than five years, and is a significant improvement over fiscal year 2009, when 21.9% of contracting dollars were awarded to small businesses. This is the second consecutive year of an increase in federal prime contract dollars to small businesses, after four years of decline.

Contact the AWS Washington Government Affairs Office at 1747 Pennsylvania Ave. NW, Washington, DC 20006; e-mail lwebster@wc-b.com; FAX (202) 835-0243.
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Melrose Makes Possible Offer for ESAB’s Parent Company

Recently, the board of Melrose PLC, London, UK, confirmed it made a preliminary approach to the board of Charter International plc, Dublin, Ireland, the owner of welding and cutting company ESAB, with a view to entering into discussions about a possible offer for a value of 840 pence per share for each Charter share.

Charter confirmed it received a “highly preliminary, unsolicited proposal” from Melrose regarding a possible 840 pence per share equity and cash offer for the company, which is conditional on, among other things, financing and due diligence. Its board reviewed the proposal with advisers and rejected it, citing the offer as “opportunistic and substantially undervalues the company and its prospects.”

As of press time, Charter’s board also confirmed receiving an increased proposal from Melrose in relation to a possible 840 pence a share and cash offer for the company, which is conditional on, among other things, financing and due diligence. It’s considering this proposal and a further announcement will be made in due course.

In addition, Michael Foster, chief executive, has tendered his resignation to Charter’s board, which has now started a process to find a replacement who will be recruited from outside the group. Lars Emilson, chairman, will assume executive responsibilities in the interim period.

In its financial year ended December 31, 2010, Charter generated an adjusted profit before tax of approximately $236.32 million.

Fronius Announces Plans for New U.S. Headquarters

Fronius, a developer and manufacturer of battery-charging systems, welding technology, and solar electronics, plans to launch its U.S. headquarters in Portage, Ind., in the third quarter of 2012. The facility will tentatively employ up to 512 people by the end of 2016 in a variety of capacities, including technology positions, production roles, and office administration jobs.

Indiana Governor Mitchel E. Daniels and Portage Mayor Olga G. Velazquez joined company executives, employees, and other dignitaries in northwest Indiana at a recent ceremony on the future site of the Fronius U.S. headquarters.

Thomas Herndl, member of the management board for the manufacturing department of Fronius, believes this expansion reflects the goals of the organization.

Some employees will transfer from the company’s current Michigan-based office, which will continue to support the surrounding regions with sales, service, and application support.

IPC Midwest to Hold First Hand Soldering Competition

The Association Connecting Electronics Industries® recently announced the first of what is to be an annual IPC Midwest Hand Soldering Competition, Sept. 21–22, at the Renaissance Schaumburg Hotel and Convention Center, Schaumburg, Ill. Held in conjunction with the IPC Midwest Conference & Exhibition, it will require competitors to build a functional electronics assembly within a 30-min time limit.

Competition entries will be accepted until August 30. Participants will be notified of entry in early September. For more information, visit www.IPCMidwestShow.org.

Assemblies will be judged on soldering in accordance with IPC-J-STD-001, Requirements for Soldered Electrical and Electronic Assemblies; the speed at which the assembly was produced; and overall electrical functionality of the assembly.

The winner will receive a $500 prize, and the two runners up will get $250 and $100 awards. OK International/Metcal is the grand sponsor of the competition.
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SkillsUSA Recognizes Welding Winners

Winners of the annual SkillsUSA welding championships were recently announced at the award session of the 47th SkillsUSA National Leadership and Skills Conference. The event took place June 20–24 in Kansas City, Mo.

The high school welding winners were as follows: Tim Saxton, Cambridge, Minn. (gold); Kaleb Parsch, Attica, Mich. (silver); and Evan Vogler, Petersburg, Ind. (bronze). For the welding college/postsecondary category, the winners were Spartak Matveyenko, Sacramento, Calif. (gold); Blake Parks, Torrington, Wyo. (silver); and Micah Hoover, Williamsport, Pa. (bronze).

These welding competitors received contest drawings and a set of welding procedure specifications. All drawings, welding symbols, and welding terms conformed to the latest edition of the applicable American Welding Society (AWS) standards. Contestants were tested on various aspects of welding, including measuring weld replicas, using weld measuring gauges; laying out a plate and using oxyacetylene equipment to cut several holes that were checked for accuracy and quality; gas metal arc welding on steel to make welds in various positions using pulse transfer; and using a combination machine capable of providing the correct welding current for shielded metal arc and gas tungsten arc welding. Competitors completed the steel project and welded a stainless steel project in various positions using a variety of filler metals.

Judges were provided for the contest by the AWS Kansas City Section. Contestants were judged while assembling and welding the project. Certified Welding Inspectors judged the completed project.

Winners were announced in the welding fabrication and welding sculpture categories, too. For more details, visit www.skillsusa.org.

In addition, Brad Clink of Washtenaw Community College, Ann Arbor, Mich., won the SkillsUSA WorldTeam welding competitor spot. For being the US Open Weld Trials Team USA welder, following the WorldSkills International Competition he will participate at this October in London, England, he will receive the Miller Electric WorldSkills Competition Scholarship consisting of up to $10,000 per year for a period of four consecutive years (total maximum $40,000); up to $1000 in AWS publications; a four-year complimentary full AWS membership; and an AWS certification to which he qualifies at the trials.

“I started doing the SkillsUSA welding competition because I knew it would give me a chance to get a jump-start on my welding career and put me a step or two ahead from where I would be in life without competing,” Clink said.

He competed with Alex Pazkowski, also from Washtenaw Community College, along with Zack Brown of Leakesville, Miss., representing Greene County Vo-Tech.

Materials Testing Show to Host ‘Hall of Fame’ for Nondestructive Examination

The British Institute of Non-Destructive Testing (BINDT) is looking for the person or event making the single biggest contribution to nondestructive examination and condition monitoring.

The institute invites professionals from around the world to nominate people and events that have had the greatest influence on the industry’s development. They will be commemorated in a “hall of fame” at Materials Testing 2011, the biannual exhibition taking place September 13–15 in Telford, UK.

To enter, name a person (living or deceased), an event, or both, along with a brief explanation as to what you believe they contributed to the industry and why it was so important.

Contributions may be sent to joy@lavender-ndt.com. All comments will be collated, and the institute will set up a panel to discuss contributions. A special award will be made by BINDT President-Elect Steve Lavender at the 50th annual dinner.
Thermadyne Consolidates New Hampshire Manufacturing Operations

Thermadyne Holdings Corp., St. Louis, Mo., will be relocating the manufacturing operations of Thermal Dynamics, its wholly owned subsidiary and manufacturer of plasma cutting and welding equipment in West Lebanon, N.H., to its other North American facilities. Engineering, technical services and returned goods functions, and a small assembly operation will remain at the West Lebanon location. The company expects to have substantially completed these activities by December 31. The consolidation is expected to impact approximately 100 employees.

Coleman Cable Continues Expansion of Product Offerings and Capabilities

Coleman Cable, Inc., Waukegan, Ill., a manufacturer of electrical, industrial, and electronic wire and cable products including welding cables, completed several acquisitions in the second quarter of 2011.

Included are the assets of The Designers Edge, a designer and distributor of specialty lighting products internationally; Technology Research Corp., a cost-effective engineered solutions maker for applications involving power management and control, intelligent battery systems technology, and electrical safety products; and the assets of First Capitol Wire & Cable as well as Continental Wire & Cable, manufacturers of custom industrial wire and cable products used across many commercial, utility, and industrial end-markets.

PFERD Inc. and PFERD Milwaukee Brush Co. Make Operations Upgrade Investment

The abrasives and brush manufacturer has moved its U.S. production and distribution operations to Milwaukee, Wis. At the ribbon cutting ceremony (front row, from left) are Milwaukee Mayor Tom Barrett; Sam Birel, vice president of operations, PFERD Milwaukee Brush Co.; and (back row, from left) Jim Rueggeberg, CEO August Rueggeberg GmbH & Co. KG; Joern Bielenberg, CEO August Rueggeberg GmbH & Co. KG; Robert Puente, Alderman Dist. #9, Milwaukee; and Gene Huegin, president, PFERD Milwaukee Brush Co.

PFERD, Inc., the American subsidiary of August Rüeggeberg GmbH and Co. of Marienheide, Germany, has completed its consolidation of all U.S. production and distribution operations into a 100,000-sq-ft facility in Milwaukee, Wis.

The building was purchased by the company in January, and all production equipment and inventory have been moved to this location and operating for several weeks. Previously, Advance Brush products had been in Menomonee Falls, Wis., while PFERD distribution operations and production work had been handled at its headquarters in Leominster, Mass.

ABICOR® Binzel’s long life Omega consumables reduce direct costs by an average of 60% over competitive brands. Field data shows this as well as providing an average annual spend savings of $60,000. Typical payback on our LW and Omega torch models is less than 3 months.

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According to PFERD President Gene Huegin, this facility means its distributors will have one-order, one-shipment, one-invoice service, and the company’s inventory of abrasive tools and brushes is more centrally located for distribution purposes.

PFERD Executive Sam Birel led all details of the consolidation move and will remain as vice president, operations, in charge of the new facility. “This is our permanent home, and we equipped and stocked it the way we know will enable us to meet the abrasive and brush product needs of the metalworking, welding, and construction markets well into the future,” Birel said.

High-Speed Rail Awards Total $2 Billion

U.S. Transportation Secretary Ray LaHood recently announced $2 billion in high-speed rail awards. The historic investment is expected to create tens of thousands of jobs.

The Department’s Federal Railroad Administration selected 15 states and Amtrak to receive $2.02 billion for 22 high-speed intercity passenger rail projects as part of a nationwide network that will connect 80% of Americans to high-speed rail in 25 years.

These rail dollars will make an unprecedented investment in the Northeast Corridor, with $795 million to upgrade some of the most heavily used sections of the corridor; provide $404.1 million to expand high-speed rail service in the Midwest; boost U.S. manufacturing through a $336.2 million investment in locomotives and rail cars for California and the Midwest; and continue laying the groundwork for the nation’s first 220-mph high-speed rail system in California with a $300 million investment.

Huys Industries Opens New Facility

Huys Industries has recently opened Huys Electrodes, Inc., Telford, Pa., in a 15,000-sq-ft building to manufacture resistance welding consumables for the automotive, aerospace, and electronics industries. Two cold-forming machines, supported by a shop and related presses, CNC lathes, and milling equipment, will supply 10 million electrodes per annum for markets in North America, Europe, and Asia. One of the first products to be made will be the company’s new patented ParaCap™ electrode.

General Manager Barry Clymer, with more than 30 years of experience in cold forming copper electrodes, has hired six engineers and proficient, experienced workers. Huys Industries Pres-
ident Nigel Scotchmer noted future expansion plans include an electrode coating facility and a R&D lab in 2012.

“Huys’ success and leadership in software simulation in resistance welding with SORPAS® software, and the increasing demand for the difficult welding of thinner, stronger, and more advanced steels and coatings, is providing a unique opportunity to expand in the USA,” Scotchmer said.

**Bodycote, Rolls-Royce Renew Contract**

At the 49th International Paris Air Show, thermal processing specialist Bodycote signed a 10-year renewal contract with Rolls-Royce to provide thermal processing services in the UK. It involves direct support from Bodycote’s on-site facility within the boundaries of the Rolls-Royce Precision Casting facility in Derby and five additional UK locations. The company will provide heat treatment, hot isostatic pressing, thermal spray coatings, and metal joining, including brazing and electron beam welding.

**First Gerald R. Ford-Class Carrier Gets Superlift toward Completion**

The Gerald R. Ford (CVN 78), the lead ship in the new class of U.S. Navy supercarriers, took a step toward completion as Huntington Ingalls Industries, Newport News, Va., erected a 945-ton superlift near the stern of the ship. It’s being built using modular construction where smaller sections of the ship are welded together. These superlifts are preoutfitted and lifted into the construction dry dock with the shipyard’s 1050-metric-ton crane.

The superlift erected on the Gerald R. Ford has rooms for a diesel generator, pump, and oily water waste pump; 16 complete tanks; and 18 partial tanks that will be completed when it’s welded to the rest of the ship. The superlift is assembled from 18 smaller structural units supplied by the steel fabrication and assembly division. It’s one of 162 superlifts comprising the ship. Christening will occur in 2013 with delivery to the U.S. Navy in 2015.

**OSHA Directive: Homebuilders Can No Longer Fall Short in Safety Knowledge**

Fall protection standards are tightening for homebuilders nationwide, and Minnesota is enforcing greater compliance before the national deadline.
“The new fall-protection compliance deadlines set by both the Occupational Safety and Health Administration (OSHA) and the Minnesota Department of Labor and Industry are extremely tight,” said Benjamin Mangan, president of MANCOMM, a national safety and compliance publishing company.

On June 9, OSHA announced a three-month phase-in period to allow residential construction employers to come into compliance with regulation 29 CFR 1926.501(b)(13), requiring homebuilders to provide residential construction workers with fall protection. Nationally, the phase-in period runs June 16 to Sept. 15.

The Minnesota Department of Labor and Industry stepped up the deadline in their state, stating “Effective June 16, 2011, employers must follow 29 CFR 1926.501(b)(13), which states each employee engaged in residential construction activities six feet (1.8 m) or more above lower levels shall be protected by a guardrail system, safety net system, or personal fall-arrest system unless another provision in paragraph (b) of this section provides for an alternate fall-protection measure.”

Virginia Veterans Agency Recognizes Manufacturing Skill Standards Certification

The Virginia Department of Veterans Services’ endorsement of the Manufacturing Skill Standards Council (MSSC) certifications assists veterans reentering the workforce. This decision, applicable to vets in all 50 states, allows retired military personnel to be reimbursed for MSSC certification testing costs nationwide.

The Department of Labor reported in April that 10.9% of post-9/11 veterans are currently unemployed. Among younger vets, ages 18–24, unemployment is almost 27%. The recent recognition of the council’s credentialing system will put veterans into manufacturing and supply chain logistics career pathways.

Steel Industry Project Provides Lightweight, Reduced Carbon Footprint Vehicle Options

The Steel Market Development Institute, Detroit, Mich., in collaboration with WorldAutoSteel, revealed the results of a three-year program to develop engineered, steel-intensive designs for electrified vehicles that reduce greenhouse gas emissions over their entire life cycle.

The FutureSteelVehicle program features steel body structure designs that reduce mass by more than 35% over a benchmark vehicle and reduce total life cycle emissions by nearly 70%. This is accomplished while meeting a list of global crash and durability requirements, enabling five-star safety ratings and avoiding high-cost penalties for mass reduction.

The program developed advanced high-strength-steel body structures for four proposed 2015 to 2020 model-year vehicles as follows: battery electric and plug-in hybrid electric for A-/B-class vehicles; and plug-in hybrid electric and fuel cell for C-/D-class vehicles. In addition, it brings more advanced steel and steel technologies to its portfolio, including more than 20 new grades of materials expected to be commercially available in 2015 to 2020.

Industry Notes

• The welding program at Columbia Basin College, Pasco, Wash., received a $30,000 donation from Bechtel National. The com-
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Tony Anderson, Conference Committee Chair

The Aluminum Designation System & Characteristics of Aluminum Alloys
Mark Burke, Indalco Alloys

Aluminum Welding Metallurgy
Bruce Anderson, MAXAL International

Metal Preparation for Aluminum Welding
Frank Armaro, The Lincoln Electric Co.

Filler Alloy Selection Primary Characteristics
Tony Anderson, ITW Global Technology Center

Gas Metal Arc Welding of Aluminum Alloys
Mark Burke, Indalco Alloys

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Aluminum Weld Discontinuities: Causes and Cures
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Overview of Solid-State Welding Processes for Aluminum
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John Hinrichs and Chris Smith, Friction Stir Link Inc.

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Welding Aluminum for Marine Applications
Jerry Mrgain, AlcoTec Wire Corp.

The Functionality of Feeding Aluminum Wire in GMAW Systems
David B. Veverka, ESAB Welding and Cutting Products
Q: How does heat from arc welding affect the strength of the weld’s heat-affected zone, and does the heat from welding affect the strength of both heat-treatable and nonheat-treatable alloys?

A: To understand the effect of the heat from arc welding on the strength of a welded joint made in aluminum, it’s necessary to first understand how aluminum base alloys obtain their strength.

How Aluminum Alloys Obtain Their Strength

Alloying

Pure aluminum has a very low strength, and for this reason, would seldom be selected for use in a structural application. The addition of alloying elements to aluminum is the primary method used to produce a variety of different materials with improved strength, which are functional in a wide variety of structural applications. Further to alloying, aluminum alloys are generally subjected to work hardening or heat treatment, each of these processes being designed and conducted to enhance the material’s strength.

Work Hardening

Work hardening, or strain hardening as it’s also called, can be applied to both heat-treatable and nonheat-treatable material; however, it’s used extensively to produce the strain-hardened tempers in the nonheat-treatable aluminum alloys.

The process involves a change of shape
brought about by the input of mechanical energy. As deformation progresses, the material becomes stronger but harder and less ductile. The strain-hardened temper of full-hard material, H18 for example, is usually obtained with a cold work equal to about a 75% reduction in area.

It’s important to understand that the full effect of strain-hardening on the non-heat-treatable alloy can be removed by heating the base material to its annealing temperature for a very short time period.

Heat Treatment

Solution heat treatment and precipitation hardening is the most common method of strengthening the heat-treatable aluminum alloys.

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**Fig. 1** — Hardness profiles across gas tungsten arc welds in three different alloys.

**Fig. 2** — Typical properties of 6061-T6 as-welded with three different heat inputs and 5083-H321 as-welded with high or low heat input. Unlike the heat-treatable alloys, variation in the heat input has an insignificant effect on the HAZ strength of the nonheat-treatable alloys.
Solution heat treating is achieved by heating a material to a suitable temperature (around 990°F), holding at that temperature for a long enough time to allow the constituents to enter into a solid solution, and then cooling rapidly to hold the constituents in a solution. This process is usually followed by precipitation hardening, also termed artificial aging, which is achieved by reheating the alloy to a lower temperature (around 320°F) and holding it at this temperature for a specified time (up to 18 hours).

The result of these heat treatments is to produce a metallurgical structure within the material that provides superior tensile strength. During the artificial aging procedure, if the material is held at a temperature for too long or the temperature used is too high, the material can become overaged, resulting in a decrease in tensile strength.

It's important to recognize that the precipitation hardening process is both time and temperature dependent. This method of strengthening is only used on the heat-treatable aluminum alloys.

**The Effect of Arc Welding on the Heat-Affected Zone**

To make a welded joint using the arc welding process, the base material must be melted. During the melting process, heat is transferred through conduction into the base material adjacent to the weld. Typically, the completed weldment can be divided into three distinct areas: the weld metal, the heat-affected zone (HAZ) adjacent to the weld that has been affected by the welding operation, and the base material beyond the HAZ, which has been unaffected by the welding operation.

Because the HAZ will experience significant cycles of heating and cooling during the welding operation, its properties can change significantly from those of the original material before welding.

The effects of welding heat upon an aluminum base alloy vary with the distance from the weld and may be divided roughly into areas reflecting the different temperatures reached by the metal. The length of time at each temperature is also significant for the heat-treatable alloys. The width of the HAZ and the degree of metallurgical change in the heat-treatable alloys can be dependent on the thickness and geometry of the joint, the welding process used, preheat and interpass temperatures utilized, and any other criteria that can influence the overall heat input during the welding operation.

The HAZ in welds made with the inert gas shielded processes seldom extends more than ½ in. (12.7 mm) from the weld, but for design purposes, it's assumed to be 1 in. (25.4 mm) wide on each side of the weld.

**Nonheat-Treatable Alloys**

During welding of these materials, there will be an area within the HAZ that reaches the annealing temperature of the base material, typically 650°F (345°C). When subjected to this temperature, recrystallization of the material occurs very rapidly in the HAZ.

As a result, the HAZ in the nonheat-treatable, strain-hardened materials will come close to the fully annealed condition of the alloy with the appropriate decrease in strength and increase in ductility. Time at the annealing temperature and cooling rate are not significant factors in the annealing of these alloys.

For designs that are based on ultimate tensile strength, the minimum annealed strength of the alloy is used for the transverse tensile strength of butt joints in nonheat-treatable alloys. This is an important concept that designers and engineers should recognize.

Regardless of the base material's starting temper, the HAZ of the weld will have tensile properties of the annealed “0” temper. Because of this condition, it's sometimes convenient to fabricate with the nonheat-treatable alloys in the “0” temper. In fact, welding of “0” temper nonheat-treatable alloys is really the only time we can produce a weld as strong as the base material.

In most other cases, the weld and/or HAZ will be weaker than the starting material. The popularity of the higher-strength 5xxx series alloys (such as 5083, 5086, and 5456 for welded structures) is due to their high-annealed strengths and good ductility — Table 1. In general, the mechanical properties of these alloys are much less affected by the base metal temper and other factors, such as metal thickness, than are the heat-treatable alloys.

Welds in nonheat-treatable alloys have excellent ductility. They are capable of withstanding extensive deformation prior to failure due to their ability to redistribute stress. The higher-strength members of the 5xxx series are particularly good in this regard because of the relative uniformity of strength and ductility across the weld zones.

**Heat-Treatable Alloys**

In heat-treatable alloys, the HAZ created adjacent to the fusion zone results in a local degradation of the base metal properties. The microstructure in this zone is modified by the elevated temper-
atures it experiences during welding.

In these precipitation-hardenable alloys, the HAZ represents either dissolution or growth of precipitates. In the 2xxx series it represents dissolution, while in the 6xxx series it’s primarily a growth of precipitates — Table 2. Although the nature of these HAZs may differ, they are all diffusion controlled and thermally dependent. Whichever mechanism is operating, the end result is the same. The HAZ is weaker, often significantly, than the adjacent base material. A microhardness survey across the weld is a common means of determining the width and extent of the HAZ.

Microhardness profiles for gas tungsten arc welds in three aluminum alloys are shown in Fig. 1. The hardness profile for 2219-T87 exhibits dissolution of precipitate. The strengthening phase is an intermediate phase and, near the fusion zone where higher temperatures are experienced, there is greater dissolution of strengthening phases. This results in a gradual decrease in hardness in this zone as observed in Fig. 1.

The hardness profile for Alloy 6061-T6 is typical of all 6xxx series alloys. The HAZ is governed by a growth-like transformation of precipitate to form non-strengthening phases. Transformation is most rapid while the metal is in the temperature range between 800° and 550°F (427° and 288°C). The lowest points on the hardness profile for this alloy represent metal that has experienced temperatures in this range.

Closer to the fusion zone where the temperatures have been higher, the precipitate is dissolved into a solid solution and reprecipitated during cooling. The nonheat-treatable Alloy 5456 in Fig. 1 is also shown to have a reduction in strength within the HAZ but not as significant as the heat-treatable alloys.

Figure 2 illustrates the significance of heat input during welding on the heat-treatable Alloy 6061-T6. We can clearly see a significant reduction in the strength of the HAZ in Alloy 6061 as heat input is increased. In the same chart, we can see that the nonheat-treatable Alloy 5083 has been considerably less affected in terms of tensile strength reduction in its HAZ.

Summary

Dependent on the particular aluminum alloy type and its temper, there can be a significant difference between the tensile strength of the HAZ and the unaffected area of the welded component.

As can be seen in Tables 1 and 2, the reduction in tensile strength of the HAZ in the heat-treatable alloys is more significant than that of the nonheat-treatable alloys. The reduction in tensile strength of the HAZ in the heat-treatable alloys is more susceptible to welding conditions and can be reduced below the required minimum requirement if excessive heating occurs during the welding operation.

Acknowledgment

I would like to thank the Aluminum Association for permission to use information from Welding Aluminum: Theory and Practice available at the www.aluminum.org bookstore.
This double-barreled two-day conference in Charlotte will be something a little different in AWS conferences.

**Day one** will be all about the newer corrosion-resistant alloys and will cover such materials as the growing body of duplex stainless steels, the nickel-base alloys, and titanium. The duplex grades are beginning to replace the austenitic stainless steels in some instances, so there is much to learn in terms of how to weld these grades. Newer is the introduction of less expensive duplex alloys, so much needs to be learned here as well. There's a new titanium alloy which could very well replace the popular 6Al-4V grade. It, too, will be on the program. Cladding is also playing an increasingly important role in the whole matter.

**Day two** will be devoted to another hot topic in welding, the new chrome-moly steels such as the 91, 92, and 911 grades. There are benefits here, but there is still much to learn. It's a market cut out for the low-hydrogen consumables. Fabrication is tricky. Great attention must be paid to heat treat and dissimilar metal welding. Although not new but still a problem to many, there will even be discussion on that old nemesis, to some, 4130.

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Welcome Remarks
Robert Irving, Conference Chairman

The Many Versions of Duplex Stainless Steel – From Lean to Hyper
Gary Coates, Nickel Institute

What's Next After 2205 Duplex Stainless Steel?
Gary M. Carinci, TMR Stainless

Applications for 16-8-2 Stainless Steel Weld Metal
William F. Newell, Jr., Euroweld Ltd.

Hastelloy® Alloys: Solutions to Severe Wet Flue Gas Desulfurization Environments
Henry J. White, Haynes International

Material and Process Considerations for Corrosion-Resistant Weld Overlay
Ben Fletcher, Chicago Bridge & Iron Co.

Super Duplex Welding
David Riley, Westinghouse

Welding of ATI 425® Alloy
Luis J. Ruíz-Aparicio, ATI Allegheny Ludlum

Additive Manufacturing of Corrosion-Resistant Alloys and AMC
Ian D. Harris, Edison Welding Institute

A Highly Corrosion-Resistant High-Molybdenum Alloy
Samuel D. Kiser, Special Metals WPC

P91 and Beyond
William F. Newell, Jr., Euroweld Ltd.

Life Management of Creep Strength Enhanced Ferritic Steels
Kent Coleman, EPRI

The First Commercial Use of Filler Metal EPRI P87 in AEP’s Turk Plant
John A. Siefert, Babcock & Wilcox Research Center, and Dave Bauer, Babcock & Wilcox Power Generation Group

Use of Welding Program Management Software for Power Plant Construction Applications
Shane Findlan, Shaw Power Group

Variability in Field Post-Weld Heat Treatment
Kent Coleman, EPRI

Experience with the Welding of Grade 23 and 24, including a New Approach to Dissimilar Chromium-Molybdenum Welds
Russel Fuchs, Bohler Welding Group

The Benefits of Using Flux in the Development of New Weld Metals for Use on P91 Steel
Brian Gaal, Electrode Engineering

Tubular Wire Alternatives for P91 and P92 Chrome-Moly Steels
Keith Packard, Hobart Brothers Company
Q: My question is, how does one make a selection of active brazing filler metal? We are planning to braze a shaped porcelain dielectric ring with a 1.5-in.-diameter stainless steel tube. Due to the number of parts to be brazed every day, we have to design a stable process and simple inspection at lowest possible production costs. There are many active brazing alloys (ABAs) on the market, and they have different amounts of titanium as an active component. Some ABAs contain 1.25 wt-% titanium, while others have up to 4.5 wt-% titanium. If I understand correctly, these ABAs differ in their reaction with steel and ceramics, and probably the quality of the brazing will be different, too. The Ceramics Chapter of the Brazing Handbook only points out that titanium promotes wetting of ABA on ceramics, with no data to compare ABA fillers.

A: Selection of active brazing filler metals depends on the type of base material, preferential brazing temperature, and application. Dr. Toshi Oyama of WESGO Metals Corp., the company that invented and manufactures active brazing alloys (ABAs), considers that a rule of thumb is to braze at the temperature and time such that a uniform reaction zone is formed on the alumina. After that, there will be more reaction with the metals, and the thickness of the reaction zone increases, which will decrease joint strength.

Despite the fact these materials have a long history and have been used since the 1950s, professionals still make the selection of ABAs experimentally when setting up a new production line. The activity of the ABA and quality of the brazed joints depend not only on the content of active component (mostly titanium) but also on:

1. The nature and manufacturing method of base materials: ceramics, and especially, carbon composites;
2. Surface preparation of the base materials;
3. Vacuum grade of the furnace chamber;
4. Brazing temperature and holding time; and even
5. The form of the applied ABA (foil, paste, metallization).

For example, we have a contradictory experience in our company practice: The brazing filler metal Ticusil®, containing 4.5 wt-% titanium, provides sound quality brazing of most carbon-carbon composite.
parts, while CusilABA®, which contains 1.75 wt-% titanium, works better for brazing some types of graphite. The TiBraze®375 filler metal containing 37 wt-% titanium was successfully used for brazing sintered silicon carbide, which has a graphite-spoiled surface, but exhibited insufficient wetting on graphite.

However, the great experience in ceramic brazing accumulated by the industry allows making a priori correct selection of ABA in many standard situations, such as brazing of small-size alumina-to-alumina parts or alumina-to-stainless steel parts. For such applications, there is also a general approach for selection of ABA with different content of the active component that says: Greater content of active component (let’s say, Ti or Zr) results in better wetting of ceramics, but also in the formation of a thicker reaction layer at the interface between joint metal and base material — Fig. 1. In other words, increasing the titanium content in ABA plays a positive role for wetting the ceramic surface, but on the other hand, it plays a negative role in the strength of brazed joints due to brittleness of the intermetallic layer at the joint interface, as well as partial loss of plasticity of joint metal at high percentage of titanium. Figure 1 also shows that 1% or a little more of Ti already provides a satisfactory wetting of ceramic.

We also have to remember that increasing brazing temperature may result in greater residual stresses in the brazed joint due to the mismatch in coefficients of thermal expansion between ceramics and base metals. By the way, it may be important in your case, because you braze the steel tube inside the alumina ring, and significant residual stresses appear during cooling due to faster thermal contraction of steel inside the ceramic ring. From this point of view, I recommend that you apply low-titanium ABA such as CusilABA® (containing 1.75% Ti with a brazing temperature of 830°C) or IncusilABA® (containing 2.5% Ti with a brazing temperature of 720°C–750°C).

Mizuhara and Mally (Ref. 1) studied the effect of titanium content on the strength of alumina joints brazed with Ag-Cu-Ti active filler metals. They found that with increasing Ti content, the peel strength went up to a maximum at 2.5 wt-% Ti, and then dropped with a further increase in titanium, when brazing 97.6% alumina specimens. The maximum strength of 99.5% alumina brazed specimens was reached at 2 wt-% Ti (Ref. 1). The loss in strength of brazed joints at 3 and 4% Ti was explained by lower ductility of the joint metal. Due to these highly reliable experimental results, we also can accept that maximal strength of alumina brazed joints is reached at 2–2.5 wt-% Ti in traditional silver-based ABAs.

The effects of brazing temperature and holding time on the strength of ceramic-to-ceramic or ceramic-to-metal joints are not so clear. The problem is that ceramic brazed joints are very sensitive to the microstructure of joint area, specimen’s design and manufacture, as well as the testing technique. Therefore, the mechanical properties of ceramic joints with similar brazing materials measured by different companies can be significantly distinct from each other.

The general approach is: Higher brazing temperatures and longer holding times, on the one hand, may result in improved wetting and spreading of the filler metal that provides good formation and higher strength of brazed joints. But, on the other hand, the higher brazing temperature and longer holding time may result in more active reaction of the base ceramic material with brazing alloy, and consequently, in the formation of brittle reaction components in the joint microstructure, which causes lower strength.

Because of this, I recommend you perform in-house testing (if necessary) of your brazed joints that are manufactured the same way but using competitive filler metals containing different amounts of titanium, then use the data obtained from these tests for comparison purposes. The shear strength of alumina-to-stainless steel joints may vary from 70–80 to 250–300 MPa.

Acknowledgment

The author thanks Dr. Toshi Oyama, WESGO Metals, for his valuable comments and discussion of this brazing problem.

Reference

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Advancements in CO₂ Shielded Gas Metal Arc
Bill Guest, OTC-Daihen Inc.

Computed Radiography
R.W. Kruzic, Chicago Bridge & Iron Co.

Quality Assurance in Field Heat Treatment
Gary Lewis, Superheat FGH

DeltaSpot — Resistance Spot Welding with Process
Stefan Mayr, Fronius USA LLC

Reciprocating Wire Feed Systems for Plate Products
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Karma Slusarshuk, WearSox

Cladding Wear Surfaces on Non-Magnetic Drill Collars
Joe L. Scott, Devasco International, Inc.

Automated Back Gouging of Thick Plate Weld Joints for DDG 1000 Construction
Bruce Horn, Concurrent Technologies Corp.

A New Hybrid Laser Arc Welding Center Opens Up
Doug Zoller, American Tank & Fabricating Co.

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Understanding Weld Cracking in Steels
Joseph C. Bundy, Hobart Brothers Co.

Crack Avoidance in Creep Strength-Enhanced Ferritic Steels
William F. Newell, Jr., Euroweld Ltd.

Hot Cracking in Austenitic Stainless Steels
Damian J. Kotecki, Damian Kotecki Welding Consultants

How to Prevent Cracking When Welding Aluminum Alloys
Tony Anderson, ITW Global Welding Technology Center

How to Prevent Cracking When Welding Aluminum Alloys

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Hydrogen Induced Cracking in Welding High Performance Steels
Yoni Adonyi, LeTourneau University

Investigation of Weld Metal Cracking in a Hydrotreater Vessel
Robert W. Warke, LeTourneau University

Preventing Cracking in Nickel-Base Alloys
Donald J. Tilack, Tillack Metallurgical Consulting, Inc.

Phased Array Ultrasonics for Detecting and Sizing Cracks in Welds
Michael Moles, Olympus NDT

Pressure Vessel Crack Prevention in Weld Repairs and Alterations
James T. Worman, The National Board of Boiler and Pressure Vessel Inspectors

National Welding Education Conference

Tues., Nov. 15 • 9:00-4:00
$149 members/$149 nonmembers

Presented by the National Center for Welding Education and Training (Weld-Ed), this conference is designed to bring together educators for professional development and networking opportunities. Weld-Ed’s focus is on the preparation of welders, welding technicians, and welding engineers to meet the needs of industry. This conference will include presentations on topics such as Weld-Ed accomplishments in the last year, the partnership between Weld-Ed and AWS, welding industry workforce needs, recruitment tips and tools for educators, competency models, externship programs for educators, tips on partnering with other secondary and post-secondary schools, welding education trends, curriculum, materials science education and applications, distance learning updates, new technology applications, and presentations from welding educators who will share their best practices.

What’s New in Power Sources

Wed., Nov. 16 • 8:30-4:00
$345 members/$480 nonmembers

The latest welding machines are equipped with greatly improved capabilities, including multi-process operation. Meet the experts and understand the relative benefits of emerging power source technologies, for example, transformer-rectifiers and inverters. The experts will be on hand to compare these innovations.

Modern Power Source Technology That Drives Process Improvement
Todd McEllis, Miller Electric Mfg. Co. and ITW

AC Pulse GMAW for Aluminum, Mild and Stainless Steels
Phil Mosquera, OTC-Daihen Inc.

Advances in Production Monitoring
Bruce Chantry, The Lincoln Electric Co.

Advanced GMA Welding
Wesley Doneth, Fronius USA LLC

High Performance GMAW - New Machines. New Techniques Will Provide a Boost in Performance
Paul Blomquist, Applied Thermal Sciences, Inc.

WeldScore - Embedded Weld Data Quality Monitoring

Gold Track VI
R. W. Kruzic, Chicago Bridge & Iron Co.

Controlled Short Circuit GMAW Process Competes Favorably with SMAW, GTAW
Jim Cuhel, Miller Electric Mfg. Co.
AWS Professional Program

Pick and choose between concurrent sessions on the latest in welding research and commercial developments. Pay by the day or register for the entire four-day program.

Mon., Nov. 14

SESSION 1: International Trends in Welding Research
Chair: Stephen Liu, Colorado School of Mines
State of the Welding Related Industries and Trends of Welding Research & Development in Singapore by Ang Chee Pheng, President of the Singapore Welding Society ......................................................... 8:00
International Topics in Welding Research ................................................................. 9:00

SESSION 2: NSF I / UCRC Sponsored
Chair: Stephen Liu, Colorado School of Mines
Separating the Good Welds from the Bad Welds by John P. H. Steele, Colorado School of Mines ................................................................. 2:00
Development of a High-Chromium Nickel-base Filler Metal with Improved Weldability for Nuclear Power Plant Construction and Repair Applications by Adam T. Hope, Eric Fusner and John C. Lippold, The Ohio State University, and Steve L. McCracken ......................................................... 2:30
Weldability of ASS61+0.5Cu and Its Nanocomposites by Dake Wang, Hongseok Cho, Xiaochun Li and Sindo Kou, University of Wisconsin ........ 3:00
Welding of Stainless Steel-Effect of Sulfur on Weld Pool Phenomena by Sindo Kou, University of Wisconsin, C. Limmaneenvichit, King Mongkut's University of Technology-Thonburi, and P.S. Wei ......................................................... 3:30
Newly Developed Low Transformation Temperature (LTT) Welding by Tania Alghamdi and Stephen Liu, Colorado School of Mines ....................... 4:00
Weld Solidification Behavior of Ni-base Superalloys for Use in Advanced Supercritical Coal-fired Power Plants by David Tung and John C. Lippold, The Ohio State University ......................................................... 4:30

SESSION 3: Solid-State Processing
Chair: Yoni Adonyi, LeTourneau University
Friction Stir Welding of ISO 5183 X80M Steel by Antonio J. Ramirez, Taliana F. C. Hermenegildo and Tiago F. A. Santos, Brazilian Synchrotron Light Laboratory, and Conrado R. M. Afonso and Ricardo R. Marlinho, Federal University of Rio Grande ....................... 2:00
Adaptation of Al-to-Steel FRW-1 to Thick Sections by Wendell L. Johnson and Jerry E. Gould, Edison Welding Institute ......................................................... 2:30
Solid-State Welding of High Performance Steels by Nathan Dix, Josh Hammond and Yoni Adonyi, LeTourneau University ......................................................... 3:00
Friction Stir Welding of Lean Duplex Stainless Steel by Tiago F. A. Santos, Marina Magnani and Antonio J. Ramirez, Brazilian Synchrotron Light Laboratory ......................................................... 3:30
Susceptibility of Carbon Steel Welds to Hydrogen Embrittlement by Wei Zhang, Zhili Feng, John Wang and Larry Anovitz, Oak Ridge National Laboratory ......................................................... 4:00
Mechanical and Microstructural Evaluation of Friction Stir Processed Diffusion Bonded Magnesium and Magnesium Metal Matrix Composites by Scott Gordon and Stephen Liu, Colorado School of Mines ......................................................... 4:30

Tues., Nov. 15

SESSION 4: Shipbuilding
Chair: Maria Posada, Naval Surface Warfare Center-Carderock Division
Fracture Toughness of Welded NUCu-140 by Brett Leister, John DuPont and Jeffrey Farren, Lehigh University ......................................................... 8:00
Microscopy of Friction Stir Welded Ti Alloys by Sal Nimer and Marc Zupan, UMBC-University of Maryland, and Jennifer Wolk, Naval Surface Warfare Center-Carderock Division ......................................................... 8:30
Automated Welding Technology for VCS Submarines by Nancy C. Porter and Steve Massey, Edison Welding Institute, and Ned Kaminski, General Dynamics Electric Boat ......................................................... 9:00
Ultrasonic Impact Treatment of Aluminum 5456 Plate and Welds by Kim N. Tran and Caroline Scheck, Naval Surface Warfare Center Carderock Division, Lourdes Salamanca-Riba, University of Maryland – College Park, and Marc Zupan, University of Maryland – Baltimore County ......................................................... 9:30
Understanding the Effect of Tool Design in Friction Stir Welding of HSLA-65 Steels by David Lammlein and Maria Posada, Naval Surface Warfare Center – Carderock Division ......................................................... 10:00
Fusion Welding Repair of 5xxx Series Aluminum Friction Stir Welds by Maria Posada, Naval Surface Warfare Center – Carderock Division ......................................................... 10:30
Underwater Friction Stir Welding of HY80 Steel by Terry R. McNelley, Sarath K. Menon, Garth W. Young and William C. Stewart, Naval Postgraduate School, and Murray W. Mahoney, Consultant ......................................................... 11:00
Nondestructive Testing False Positives on Friction Stir Weld Applications by Bruce H. Halverson, Marinette Marine Corporation ......................................................... 11:30

SESSION 5: Arc Welding Processes
Chair: Daniel Hartman, Manufacturing Behavioral Science
Double Electrode GMAW with One Welding Power Supply by Jinsong Chen, Adaptive Intelligent Systems, and Yi Lu and YuMing Zhang, University of Kentucky ......................................................... 8:00
Submerged Arc Welding of High Strength Steel by Cold Wire Feed by Biswajit Basu, Naval Materials Research Laboratory, India, R. Rahul and E. Jeevansas, National Institute of Technology, India, and S. Jerome and Arun Kumar Shah, Panipat Institute of Engineering Technology ......................................................... 8:30
Welding of Welding Arc Interruptions in Tandem Pulsed GMAW by Ruham Pablo Reis, Federal University of Rio Grande ......................................................... 8:00
Study of Silicate Islands in GMAW by Richard Derrien, Stephen Liu, and Erik Lord, Colorado School of Mines ......................................................... 9:30
Full Penetration Welding Using Laser Enhanced GMAW by Yi Huang and YuMing Zhang, University of Kentucky ......................................................... 10:00
Submerged Arc Welding Line Pipe with Three Electrodes by Stephen Kenny, University of Alberta ......................................................... 10:30
Residual Stress Analysis in Machining of Duplex Welds by Carolina Payares-Aspino and Patricio Muñoz-Escalona, Universidad Simón Bolívar, and Anamels Sanchez, Fundación Instituto de Ingeniería ......................................................... 11:00
Selection of Welding Consumables for Metal Arc Welding Under Oil (MAW-UO) by Hamad H. Almustaneer, Stephen Liu, and David L. Olson, Colorado School of Mines ......................................................... 11:30
Droplet Heat Content in Nickel Sheathed WC-Cored GMAW Wires by Kevin Scott and Patricio Mendez, University of Alberta ......................................................... 12:00

SESSION 6: NSF I / UCRC Sponsored
Chair: John DuPont, Lehigh University
Corrosion Behavior of Nickel Based Alloy Coatings by Andrew W. Stockdale and John DuPont, Lehigh University ......................................................... 2:00
Thermal Stir Welding of Steel by Feng Pan and Shindo Kou, University of Wisconsin, and R.J. Ding, Marshall Space Flight Center ......................................................... 2:30
Preventing Dissimilar Metal Weld Failures by Gregory J. Brentrup, John DuPont, Brett M. Leister, Brett S. Snowden, and Joachim L. Giesenfeld, Lehigh University ......................................................... 3:00
Hot Bending of Armor Alloys by Nicholas A. Kulman and Bolan T. Alexandrov, The Ohio State University ......................................................... 3:30
Stress Rupture Evaluation of Steel Welding Consumables by Chai Xiao and Shindo Kou, University of Wisconsin ......................................................... 4:00
Laser Impact Welding by Huimin Wang, The Ohio State University ......................................................... 4:30

SESSION 7: Weld Modeling
Chair: Zhili Feng, Oak Ridge National Laboratory
Surface and Interface Phenomena in Thermoelectric Element Welding by Ithamar Glumac, Ben Sokolove, and Yoni Adonyi, LeTourneau University ......................................................... 2:00
A Computational Modeling Tool for Welding Repair of Irradiated Materials by Zhili Feng, Oak Ridge National Laboratory, and Eric Willis and Ken Wolfe, Electric Power Research Institute ......................................................... 2:30
3D Weld Pool Surface Characterization by XueWu Wang, YuMing Zhang and WeiJie Zhang, University of Kentucky ......................................................... 3:00
Modeling and Microstructure Evolution Analysis of Friction Stir Processed of Magnesium Alloy by Zhenzhen Yu, Wei Zhang and Zhili Feng, Oak Ridge National Laboratory, and Hahn Choo, University of Tennessee ......................................................... 3:30
Examination of Cross Tension Test for DP Steels by Murali Tumuluru and David J. Radakovic, U.S. Steel .................................................. 4:00

Modeling and Control of Droplet Development in Laser Enhanced GMAW by Yan Shao and YuMing Zhang, University of Kentucky ........................................ 4:30

Wed., Nov. 16

SESSION 8: Laser Materials Processing
Chair: Tom Lienert, Los Alamos National Laboratory

Characterization of a Materials Processing Laser by T.J. Lienert, J.O. Sutton, M.S. Pitch and P. Burgardt, Los Alamos National Laboratory .......................... 8:00

Issues with Laser Welding Through a Fused Silica Window by T.J. Lienert, J.O. Sutton, M.S. Pitch, R.T. Forayth and P.A. Papin, Los Alamos National Laboratory ........................................ 8:30

Reducing Alloying Element Vaporization from Stainless Steel Weld Pools Produced by Pulsed Laser Welding by T. DebRoy, Penn State University, and T.J. Lienert, Los Alamos National Laboratory ........................................ 9:00

Properties Variation in Stainless Steel Laser Welds by Charles V. Robino, Brad L. Boyce and Corbett C. Bataille, Sandia National Laboratories .................. 9:30

Modeling of Laser Spot Micro-Welding of Silicon by Ashwin Rehgan, Penn State University ................................................................. 10:00

Scaling Thermocapillary Weld Pool Shape by Peng S. Wei, C.L. Lin and H.J. Liu, National Sun Yat-Sen University, and T. DebRoy, Penn State University ........................................ 10:30

Comparing Laser and Resistance Interconnection Welds by Gerald A. Knorovsky, Danny O. MacCallum and Louis A. Malizia Jr., Sandia National Laboratories ................................. 11:00

SESSION 9: Filler Metals, Overlays and Repair
Chair: Patricio Mendez, University of Alberta

Welding Fume Study for Certain SMAW Electrodes Used in the Mining Industry by Kin-Ling Sham and Stephen Liu, Colorado School of Mines ........................................ 8:00

Analysis of Molten Surface End Face of Al-Mg Filler Metal Alloy and Welding Fume Study for Certain SMAW Electrodes Used in the Mining Industry by J.O. Sutton, M.S. Piitch, R.T. Forsyth and PA. Papin, Los Alamos National Laboratory ........................................ 8:30

New Self-Shielded Flux Cored Electrode by Wesley Wang and Stanley Ferrero, ESAB ................................................................. 9:00

Reduction of Cr(VI) in Stainless Steel Welding Fume by Tetsunao Ikeda, Hiroshi Sugahara and Hirotsa Watanabe, Kobe Steel, Ltd / Kobelco Welding of America ........................................ 9:30

Depositing Ni-WC Wear Resistant Coatings with Hot-Wire Assisted GTAW by Stuart Guest, Adrian Gerlib and Patricio Mendez, Canadian Center for Welding and Joining, University of Alberta ........................................ 10:00

Weal Performance of Welded Hardbanding Materials by Dan Danks, Abbe Doren and Joe Scott, Wear & Friction Resources ........................................ 10:30

Structure and Properties of FBW Rail Repairs by David Workman and Jerry E. Gould, Edison Welding Institute ........................................ 11:00

Combating Corrosion by Weld Overlay - A Unique Experience by J. V. D. Mury, QatarGas Operating Company Limited ........................................ 11:30

SESSION 10: Sensing and Control
Chair: YuMing Zhang, University of Kentucky

Computation of GMAW Pool Surface from Laser Reflection by Xiaojl Ma and YuMing Zhang, University of Kentucky ........................................ 2:00


Analytical Computation of GTAW Weld Pool Surface by Zhenhui Wang, University of Kentucky ........................................ 3:00

Temperature Measurement of Low-Carbon Steel TIG Welding Heat Affected Zone Using Fiber Bragg Grating by Yulong Li, Harbin Institute of Technology, and Zhichao Jiang, Yang Feng, and Hua Zhang, Nanjing University ........................................ 3:30

Machine-Human Cooperative Control of Welding Process by Weijie Zhang and YuMing Zhang, University of Kentucky ........................................ 4:00


Adaptive Fill Algorithm in Varying Weld Groove by Yong-Baek Kim, Jeon-Goo Kim, Hyeong-Soon Moon and Ji-On Kim, Hyundai Heavy Industries ........................................ 5:00

SESSION 11: Joining Metallurgy
Chair: Suresh Babu, The Ohio State University

Ultrasonic Soldering for Dissimilar Material Joining by Shankar Srinivasan, Edison Welding Institute ........................................ 2:00

Au-Al Intermetallic Formation in a Resistance Weld by Donald F. Susan, Gerald A. Knorovsky and Paul T. Vianco, Sandia National Laboratories 2:30

Constitution Diagram for Dissimilar Metal Welds by Eijah K. Gould, BP America, and John C. Lippold and Bolan T. Alexandrov, The Ohio State University ........................................ 3:00

Weld Behavior of Ultra-High Strength E3gln Steel by Daniel H Bechetti Jr, and John N. DuPont, Lehigh University ........................................ 3:30

Advanced Brazing Technologies for Nuclear Fuel Cladding by Edward D. Herderick, Kirk Cooper and Nate Ames, Edison Welding Institute ................................. 4:00

Microstructure of Alloy 625 Weld Overlay by Cleiton Carvalho Silva, Conrado R. M. Afonso, Hlilo Cordel de Miranda and Jesusdo Pereira Farias, Federal University of Cearak, and Antonio J. Ramirez, Brazilian Synchrotron Light Laboratory ........................................ 4:30

Effect of Ti on Toughness of 700 MPa Weld Metal by Hee Jin Kim and Jun Seok Seo, Korea Institute of Industrial Technology, and Changhee Lee, Hanyang University ........................................ 5:00

Thurs., Nov. 17

SESSION 12: Materials Weldability
Chair: Boian Alexandrov, The Ohio State University

Application of Cold Cracking Tests for Determining the Preheating Temperature in High Strength Steels by Mónica Zalazar, Universidad Nacional del Comahue, and Eduardo Asta, ESAB Argentina ........................................ 8:00

Hydrogen Assisted Cracking in Dissimilar Metal Welds by Bolan T. Alexanrov, Jeffrey M. Rodelas and John C. Lippold, The Ohio State University, and Shuo Shi, Shell International Exploration and Production 8:30

Impermeable Low Hydrogen Covered Electrodes by Alejandro Queiroz Braacarense, Claudio Turani, Ezqueel Cabies Pereira Pesso, and Ivaniza Felizardo, Federal University of Minas Gerais ........................................ 9:00

Characterization of Grade 91 Steels to Tempering by Daniel Saltzman, Bolan T. Alexandrov and John C. Lippold, The Ohio State University ................................. 9:30

Development of Welding Technology for Bicycle Frame by Mok-Young Lee and Woong-Seong Chang, PIST, and Norman Zhou, University of Waterloo ........................................ 10:00

Effect of Oxide/Ferrite Phase on the Toughness of SSDS by Kim Daee Joo, Bae Sang Decok and Chol Jun Tae, Hyundai Heavy Industries ........................................ 10:30

SESSION 13: Industrial Technology
Chair: Joe Scott, Devasco International

Automated Narrow Gap GTAW by Barbara K. Henon, Arc Machines, and Jonathan T. Saktin, Arc Applications ........................................ 8:00

Green Stud Welding Technologies Save Energy and Labor by Chris Hsu, Nelson Stud Welding ........................................ 8:30

Welding 4130 Steels for Oilfield Equipment by Joe Scott, Devasco International, and David R. Berridge, CRA Technologies ........................................ 9:00

Arc Welding Ultra HSLA Steels by Joe Scott and Tomas Breshears, Devasco International ........................................ 9:30

Increase Joint Success with an Internal Groove by Larry Zitzer, Marve Harker and Kyle Kofford, Idaho National Laboratory ........................................ 10:00

Product and Process Comparisons of Welding Fumes by Stanley E. Ferree and Frank Lake, ESAB ........................................ 10:30

Mechanization of Short Welds in Heavy Fabrications by Steve Massey and
Thermal Spray Technology: High-Performance Surfaces

Wed., Nov. 16 • 9:00-4:45
$345 members/$480 nonmembers
The third joint conference of AWS and the International Thermal Spray Association (ITSA) will introduce the thermal spray process and its uses to new potential users with morning and afternoon sessions focusing on actual applications and new developments in thermal spray technology.

RWMA Resistance Welding School

Wed., Nov. 16 (7:45-5:30) — Thurs., Nov. 17 (8:00-3:45)
$475 members/$695 nonmembers
This intensive two-day course covers the basics of resistance welding. The school is designed to give operators, production supervisors, engineers, and others the opportunity to study, better understand, and further their knowledge in the theory, applications, and equipment used in the resistance welding process.

Keep up with all the AWS events at FABTECH with the free mobile app installed on your smart phone, with maps, schedules, alerts, networking tools, and much more.

www.aws.org/show
AWS Exam and Preparation Events

D1.5 Bridge Code Clinic
Mon., Nov. 14 • 8:00-12:00
$175 members/$310 nonmembers
Prepare for the Bridge Code exam option for CWI certification or endorsement.

D15.1 Railroad Code Clinic
Mon., Nov. 14 • 1:00-5:00
$175 members/$310 nonmembers
Prepare for the Railroad Code exam option for CWI certification or endorsement.

ASME Section IX Code Clinic
Tues., Nov. 15 • 8:00-5:00
$345 members/$480 nonmembers
Prepare for the ASME Section IX, B31.1 & B31.3 exam option for CWI certification or endorsement.

D1.1 Road Map
Tues., Nov. 15 • 8:00-5:00
$345 members/$480 nonmembers
Prepare for the D1.1 exam option for CWI certification or endorsement.

Advanced Visual Inspection Workshop
Tues., Nov. 15 - Wed., Nov. 16 • 8:00-5:00
$550 members/$685 nonmembers
Prepare for Part B of the CWI or recertification exam.

Certification Examination
Thurs., Nov. 17 • 7:00- 6:00
Take your exam to certify as a CWI, CWE, CWS, CWSR, SCWI, CWEng, or test for endorsements. Advance application is required to take exams. Call 1-800-443-9353 ext. 273, or go to http://www.aws.org/certification for details on certification and registration requirements.

Other Seminars

Metallurgy Applied to Everyday Welding
Mon., Nov. 14 • 8:00-5:00
$345 members/$480 nonmembers
Improve your understanding of the science behind good welding.

The Why and How of Welding Procedure Specifications
Wed., Nov. 16 • 8:00-5:00
$345 members/$480 nonmembers
A valuable seminar on qualifying and following procedures.

Free AWS Events at FABTECH

Professional Welders Open Competition
Mon., Nov. 14 — Wed., Nov. 16
Watch contestants compete for hard cash and the title of best welder in America. Awards presented Thurs., Nov. 17 at 11 a.m.

Free Seminar Sample Sessions
Attend a special one-hour portion of an AWS exam seminar.
Mon., Nov. 14
Certified Welding Sales Rep .................................................. 1:00-2:00
Certified Welding Inspector ................................................... 2:00-3:00
Tues., Nov. 15
Certified Welding Supervisor ................................................. 8:00-9:00
Certified Radiographic Interpreter ........................................ 9:00-10:00

IIW and 2012 Annual Assembly Session
Mon., Nov. 14 • 11:30 -1:00
Everything you wanted to know about the American Council of the International Institute of Welding (IIW) and the 2012 IIW Annual Assembly in Denver. Light lunch and refreshments will be provided.

Thermal Spray Basics: Putting Coatings to Work
Tues., Nov. 15 • 1:00 – 5:00
Presented by the International Thermal Spray Association (ITSA), this intro to the benefits of thermal spraying will cover processes, equipment, applications, and industry usage.

Education Annual Program
Valuable free programs for educators and trainers are held every day of the show.

Career Counselor & Welding Educator Workshop
Mon., Nov. 14 • 10:30 – 5:00
Representatives from AWS, the welding industry and trade unions will make short presentations on career paths, scholarships and job outlook. A walking tour of exhibits on the show floor will highlight high-tech topics in welding related to the most rewarding career opportunities.

Topics in Welding Education
Mon., Nov. 14
Using Practical Welding Metallurgy Object Lessons .................. 8:00-9:00
Common Errors in Applying AWS A2.4 Welding Symbols .......... 5:00-10:00

Lectures in Welding Education
Tues., Nov. 15
Plummer Memorial Award Lecture ........................................... 10:30-12:00
Adams Memorial Membership Award Lecture ........................ 1:30-2:30
Howard E. Adams Memorial Instructor Membership Award Lecture .................................................. 2:30-3:30
Panel Discussion with Award Recipients ................................. 3:30-5:00

Educators’ Program
Wed., Nov. 16
Writing Engaging Lesson Plans Workshop .......................... 9:00-10:00
Complying with National and State Standards ......................... 11:00-12:00
E-learning on a Budget: Introducing Interactive Tools in the Classroom .................................................. 1:00-2:00
Recruiting Students into Welding Programs .......................... 2:00-3:00
Techniques for Developing Accurate and Fair Welding Assessments ............................................. 3:00-4:00
Developing a Welding Curriculum ...................................... 4:00-5:00

Thurs., Nov. 17
Project and Community Based Curriculum Design ................. 9:00-10:00
Structuring the Welding Shop Experience .............................. 10:00-11:00
Implementing the SENSE Program ..................................... 11:00-12:00

FROM START TO FINISH

November 14-17, 2011
McCormick Place • Chicago
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American Welding Society®
Advancements in protective equipment for the head keep welders safer and more comfortable

BY BILL GARDNER AND ERIC SOMMERS

The head is the body's command center and the gateway to respiratory health. No other part of the human body affects how we go about doing our job — or how we feel about it — more than the head. For that reason, equipment manufacturers have gone to extra lengths to design products that not only keep welders safer, but also enhance comfort and make it easier to do their jobs. This article looks at personal protective equipment (PPE), specifically head protection, that is making welding safer and more comfortable every day.

As a side note, all technologies discussed in this article should meet or exceed requirements put forth by the Occupational Safety and Health Administration (OSHA), the American Welding Society (AWS), the American National Standards Institute (ANSI), and the National Institute for Occupational Safety and Health (NIOSH), with the exception of the heat stress relief products, which are designed more for a welder's comfort and are not regulated.

Safety Glasses

Unfortunately, despite regulations, it is common to find welders not wearing safety glasses underneath their welding hoods. Many believe them to be redundant to the welding helmet or too cumbersome to wear in conjunction with a helmet. While modern welding helmets do a decent job of preventing hazards from reaching the eyes, there is still no substitute for primary eye protection such as a pair of safety glasses.

This is especially critical since welders spend significant portions of their day with the hood up when between welds, preparing welds, and moving completed parts out and new parts in. Rather than putting on a pair of safety glasses every time a welder flips up the helmet, the only way to ensure consistent protection at all times is to wear safety glasses throughout the day.

Many traditional safety glasses are uncomfortable, fit poorly, and tend to slide around your face as you work. Big, bulky glasses tend to also let debris in even when the welder is wearing them properly. Welders can now find reasonably priced options that offer form-fitting orbital eye coverage, rubber ear pads, and soft foam eye guards that keep out dust and perspiration — Fig. 1. These features ensure that
Fig. 1 — Reasonably priced safety glasses that offer form-fitting orbital eye coverage, rubber ear pads, and soft foam eye guards that keep out dust and perspiration are now available. These features ensure that the glasses grip tightly to the face, keep out airborne hazards, and provide comfort and protection throughout the day.

Fig. 2 — For heavy industrial applications where welders are consistently welding at high amperages (300+ amps) for long periods of their workday, a helmet with a reflective color, such as silver, should be considered. This will help reflect radiant heat and keep the welder cooler throughout the day.

the glasses grip the face tightly, keep out airborne hazards, and provide comfort and protection throughout the day. Clear glasses are fine for welding as the helmet will provide protection from the arc, but glasses up to shade level five should be kept available for plasma and oxyfuel cutting.

**Heat Stress Relief**

A new category of welding PPE, addressed by products such as Miller’s CoolBand™ and CoolBelt™, are designed for heat stress relief. Welders in heavy-duty, intensive welding applications were looking for ways to reduce temperatures under the hood and were going to the extent of buying complete respiratory systems to provide air circulation inside the welding helmet even if their application did not present any respiratory health hazards. New products have been designed to reduce temperatures under the hood without going to the expense of buying a complete respiratory system.

Options include a headgear cooling system featuring both downward and upward air vents that provide a constant flow of air over the welder’s face and lower the temperature in the hood by as much as 8°F. A belt-mounted product is also available. The belt-mounted system features a hose that pumps air up into the welder’s helmet, offers multiple air speeds and directional air controls, and lowers the temperature in the welder’s helmet by as much as 17°F.

In addition to lowering temperatures, these heat stress relief systems solve another major pain point: fogging of safety glasses and the inside of the helmet lens in hot conditions. By circulating air and reducing the welder’s perspiration, moisture is removed from the helmet and lens fogging is reduced. This improves comfort and productivity because welders spend less time wiping glasses and lenses, and im-
Fig. 3 — New helmets feature ANSI-approved clear grinding shields. This allows welders to keep their helmets down, flip up the visor, and have a clear 180-deg view of the workpiece and the surrounding areas while grinding.

Fig. 4 — The most recent hexavalent chromium standard has driven many manufacturers and fabricators who handle stainless steel to provide powered air-purifying respirators (PAPR) to protect their employees.

proves safety because it reduces fogging of the safety glasses, which was a deterrent to wearing safety glasses in the past.

**Autodarkening Welding Helmets**

The greatest recent advancement in autodarkening helmet technology involves the electromagnetic detection of the weld. Historically, welding helmets would only use optical sensors that picked up the light of the weld. By adding magnetic sensors that pick up on the magnetic field of the arc, helmets now respond more consistently than ever to further protect a welder’s sight. It especially improves performance when welding outside on sunny days. The lens won’t darken until an arc is struck, regardless of sunlight. This substantially improves detection when welding outside and eliminates these issues, which were common with older welding helmets.

Helmet manufacturers have also been able to add greater functionality to helmets without increasing their weight. Helmets today don’t weigh any more than the old passive helmets used years ago, even with advancements such as larger liquid crystal display (LCD) panels and customizable settings such as adjustable sensitivity, various shade options and delay controls. Premium helmets should feature the ability to respond within 1/20,000th of a second for optimal protection, especially in applications involving heavy tacking where a welder strikes a greater amount of arcs throughout the day (see lead photo). Larger LCD panels improve the welder’s view of the workpiece, peripheral vision, and overall awareness of the surroundings.

For heavy industrial applications where welders are consistently welding at high amperages (300+ amps) for long periods of their workday, a helmet with a reflective color, such as silver, should be considered — Fig. 2. This will help reflect radiant heat and keep the welder cooler throughout the day.

Helmet manufacturers have made helmets more comfortable by adding padding and improved balance to the design. Balance is one of the most important features to take notice of when trying on a helmet. A helmet with proper balance will reduce fatigue on the neck throughout the day and will make the helmet feel lighter.

Conventional wisdom may say that a smaller helmet will be more comfortable throughout the day because of reduced weight, but these designs pose a problem: They leave the neck unprotected and typically don’t feel much lighter than a properly balanced larger helmet. These smaller helmets often require a bib to be attached to properly protect the skin from spatter and UV light emitted by the arc. Look for helmets with a shell that extends down to the neck to give complete coverage. If you do use a smaller helmet, make sure you weld with your welding jacket fully zipped to protect your neck.

In shops where overhead cranes are used, or there is a risk of falling objects, a
hardhat is required and should be worn at all times. Most helmet manufacturers make an easy-to-install hard hat adapter that allows you to use your existing helmet with a hard hat. If you perform a lot of grinding work, also look for new models that feature an ANSI-approved clear grinding shield — Fig. 3. This allows welders to keep their helmets down, flip up the visor with the autodarkening lens, and have a clear 180-deg view of the workpiece and the surrounding areas.

**Powered Air-Purifying Respirators**

The most recent hexavalent chromium standard has driven many manufacturers and fabricators who handle stainless steel to provide powered air-purifying respirators (PAPR) to protect their employees — Fig. 4. However, more companies are looking at their safety initiatives and are outfitting their workforce with respiratory protection ahead of potential regulations. More than a way to keep safety numbers in check, these companies see this strategy as a way of staying in front of their insurance companies and lessening long-term liability.

The main reason to outfit welders with PAPR units is to protect them from harmful particulate created by the use of certain base and filler metals. In addition to hexavalent chromium, companies should be monitoring particulate levels in applications involving manganese, galvanized steels, and exotic alloys. Certain cleaners and degreasers also may emit harmful fumes/particulate.

Powered air-purifying respirators have become less intrusive in recent years, with battery weight being substantially reduced and designs introduced that evenly distribute the added weight across the welder’s back and shoulders — Fig. 5. A PAPR uses a blower (often positioned on a welder’s back along the waist) to pass contaminated air through a high-efficiency particulate air (HEPA) filter to remove contaminants and supply purified air in a sealed welding helmet. A HEPA filter is rated for removing at least 99.97% of airborne particles 0.3 micrometers in diameter.

In addition to removing contaminants, the flow of air cools the welder’s face similar to heat stress relief products, making the environment more comfortable. The fact that the PAPR seals the helmet with a cloth hood also keeps out contaminants from entering the helmet’s environment. This helps keep the welder’s face clean and comfortable. Some companies have even deployed these systems as another method of eye protection. When matched with a helmet with an integrated clear grinding shield, such as Miller’s PAPR with Titanium 94001™ autodarkening welding helmet, a system is created that completely seals the environment and never needs to be flipped up, even when grinding. Completely eliminating exposure is one of the best ways to ensure safety.

**Other Accessories**

While items like beanies and welding caps are not required in all facilities, these products do a nice job of keeping workplace dust out of the welder’s hair and scalp. Another often-overlooked piece of safety apparel is earplugs. Earplugs not only protect hearing, but they keep airborne contaminants — even spatter in some applications — from entering the ear canal.

**Job One: Safety**

While some of these more advanced technologies may seem excessive in certain welding applications, each carries out an important task in protecting the welder’s health, senses, and comfort — all of which start with the head. In many cases, the cost of a system like a PAPR is substantially less than the cost of a welding-related injury or illness and the associated loss in productivity.

Prevention is the best medicine, and in this case, that means outfitting your staff with the tools to make sure they not only return to do their job each day, but that they feel good about doing it.
Some of the costs of welding variables can be managed to improve the overall cost. For example, for a given application, some processes are more economical than others. Correct joint design can decrease the required amount of filler metal. Economies can be achieved by careful preassembly and fitting. Automated welding can be implemented to produce lower per-piece cost. All of these factors can be planned for maximum efficiency. However, sometimes costs are “hidden” in operations that are not known or anticipated. This article discusses the manageable costs and addresses some of the unforeseen costs.

**Manageable Costs**

Manageable costs include factors such as joint design, weldment design, mistake-proofing layouts and fitups, process selection, eliminating operations, production planning, welding procedures, supporting activities, and field welding. These are explained below.

**Joint Design**

As the fundamental factor in welding cost is the weight of deposited metal, all other welding costs can be related to this variable. Therefore, any change that results in a decrease of deposited metal will also reduce each welding cost item.

Deposited metal weights can be reduced in several ways. The simplest is to reduce the cross-sectional area of the joint by decreasing the root opening, using a root face on groove welds, decreasing the root opening, using a root face on groove welds, decreasing the groove angle, or using double-V or U-grooves, as shown in Fig. 1.

To achieve a reduction in cross section, the parts must be cut and fit accurately so that the overall dimensions meet the requirements of the assembly. If the groove angle is too small or the root face is too wide, the possibility of incomplete joint penetration or other unacceptable weld discontinuities may be increased. Defective welds are very costly because they must be removed and the joint must be rewelded. Changes in groove geometry should be carefully analyzed and tested before being implemented to ensure that overall dimensions meet the specification requirements and that weld quality will be acceptable.

**Weldment Design**

A source of cost reduction lies in the redesign of weldments to take full advantage of the accuracy of computer-controlled thermal machining centers and their ability to produce complex geometry inexpensively. Improved design eliminates the need for layout, improves quality, and makes operations mistake-proof. Weld quality improves when the quality of the components of the assembly improves. Welding speed increases with joint consistency, and weld automation becomes possible. Thermal machining centers can revolutionize manufacturing operations by improving weld joint design and eliminating operations (e.g., manual layouts). Hole patterns, alignment marks, protrusions, slips, or slots can easily be added. Some machines, particularly lasers, can etch layout patterns. All these features save tremendous time with respect to downstream processes.

Weld root openings are often 50 to 100% of the material thickness. Controlling the size of root openings is an efficient method to improve weld penetration and consistency and thus increase weld quality. A consistent root opening can be created by designing standoffs into workpieces. Weld standoffs are used to increase weld penetration and a travel speed. They also reduce weld joint preparation time when they can eliminate the beveling on workpieces, which is an expensive, labor-intensive operation. The use of computer-numerical control (CNC) thermal machining to create these standoff features generates a cost reduction because the cost of incorporating this feature into the component is less than the savings realized from the improvement.

Figure 2 demonstrates the manner in which standoffs increase consistency and weld quality and reduce setup time in welding operations, thus yielding significant cost reductions.

Figure 3 illustrates the manner in which weld length and spacing for intermittent welds can be designed into workpieces, thereby reducing or eliminating layout and measurement time. The addition of weld-locating features of the correct length and spacing clearly conveys the design requirements to the welder. Large cost reductions are achieved by eliminating preweld layout, postweld inspection measurements, and overwelding.

Figure 4 shows the manner in which a slot incorporated into the design indicates the weld location and length to the welder and the inspector.

**Mistake-Proofing**

A goal of all manufacturing concerns is to make manufacturing operations mistake-proof. Mistake-proofing reduces scrap costs and boosts efficiency. Figure 5 presents an example of the cutting of slots and tabs to allow for quick fitup operations. If multiple noninterchangeable components are to be welded, differently keyed patterns can be used to create an assembly that, in effect, inspects itself because it cannot be assembled incorrectly. Self-inspecting workpieces can eliminate steps in the inspection process, thus reducing costs.

**Process Selection**

Each welding process in commercial use has areas of application providing economic advantages. These areas are broad and overlap considerably, especially with respect to the consumable electrode arc welding processes. Many fabricators have production capacity for several welding processes. Choosing the most efficient welding process for each application is vital to minimizing welding costs. The characteristics and advantages of the consumable electrode are shown in Table 1.

The selection of the best welding process for a given application depends on the requirements of the job. To a degree, the processes an enterprise chooses determine the type of products that can be produced competitively. The optimum process is that which fabricates weldments at the lowest cost while producing accept-
able quality at high deposition rates and with high operator factors.

When large quantities of weld metal are required, the operator factor normally increases with increasing mechanization, as shown in Fig. 6.

The submerged arc welding process is the most efficient fusion welding process in plate and structural work such as shipbuilding, bridge building, and pressure vessel fabrication, assuming the workpieces can be properly positioned and the equipment accurately guided. However, when welds must be made out of position or when several short welds are required on many pieces involving frequent moves of the welder or the workpiece, a flexible process such as shielded metal arc welding, gas metal arc welding, or flux cored arc welding should be employed. The optimum process is selected based on a compromise between welding speed (deposition rate), versatility (all-position), and portability (operator factor).

Eliminating Operations

High-accuracy thermal machining centers can be used to eliminate many downstream operations. Machining operations as well as forming operations can be simplified and combined into all-inclusive work cells, saving time and money by reducing the number of workers handling the workpieces.

Lasers are capable of eliminating most drilling operations, including the drilling required before tapping. This eliminates the layout step. The tapping can be performed anywhere in the shop at the time of fabrication, welding, or assembly.

Production Planning

Maintaining production schedules is vital to controlling manufacturing costs in general and welding costs in particular. Therefore, the materials should be delivered in a timely manner, and appropriate equipment should be in place. The following guidelines can help prevent work delays:

1. The proper equipment for the specified welding process must be provided and set up;
2. The welding materials specified in the applicable welding procedures should be readily available at the job site;
3. Workpieces should be accurately positioned and aligned using fixtures whenever possible, and the fitup should be inspected before welding;
4. Fixtures and positioning equipment should be utilized whenever possible, as welding in the flat position greatly increases efficiency and reduces costs;
5. Power tools should be provided to remove slag and finish the weld surfaces; and
6. Work must be supervised to verify that procedures are followed, consumables are not wasted, and the workmanship is satisfactory.
Welding Procedures

Welding procedures are written instructions for shop personnel to follow in fabricating production weldments. The procedures should be thoroughly tested to verify that weldments of the desired quality are produced when the procedures are followed.

Project supervisors should select welding procedures from a portfolio of qualified procedures that best meet the requirements of the job. When selecting the welding process, the following should be considered: production quality, manufacturing schedule, and manufacturing cost.

Supporting Activities

Production welding is normally preceded by preassembly, cleaning, and fitting. It is often followed by cleaning, machining, or painting, or all of these. Cost control is a cooperative effort, and the support of all departments is required. Implementing the following guidelines will help reduce overall manufacturing costs:

1. Workpieces should be prepared as accurately as needed, particularly those that are bent or formed to shape;
2. Workpiece preparation should entail shearing or blanking whenever possible, as these techniques may be more economical than thermal cutting if the shapes are simple;
3. All cut workpieces should be accurately and clearly marked with the job and workpiece identities;
4. Delivery of materials should be scheduled so that all components of an assembly are available as needed at the fitting area;
5. All workpieces should be inspected for accuracy before they are delivered to the fitting area;
6. Workpieces must be accurately fitted;
7. Automated or robotic equipment should be used when available and suited to the job;
8. Excessive use of temporary welded restraints or other fitting aids that have to be removed by gouging and grinding should be avoided;
9. Tack welds should be placed in grooves or in fillet locations and should be small enough to be consumed by the production weld;
10. After welding, all slag, spatter, and other matter should be removed from the weldment; and
11. The assembly should be inspected after each operation prior to dispatching the assembly to the next operation.

Field Welding

When a welding project combines weldments made in the shop and in the field, it is important to plan to make as many of the welds as possible within the controlled setting of the shop. Consider-
ing the many complex conditions and unknown variables encountered in field welding, the number of rejected welds and rework may be greatly reduced by performing the appropriate welds in the shop.

**Unforeseen Costs**

One of the most frustrating outcomes of a job occurs when the costs have been estimated, the order has been received, and the product has been built, only to have the cost of the job ultimately exceed the estimate. This is especially frustrating when no clear cause can be assigned to the cost overrun. Often the problem results from failing to identify all the factors affecting cost, especially those that are not direct material or labor costs. Sometimes costs are hidden in operations that were not foreseen. This section explores various factors that can affect cost.

**Quality Factors**

Quality issues must be recognized as a factor in the management of welding and cutting costs. The cost of quality can be calculated and included in the cost estimate provided hidden steps or unnecessary operations are identified and evaluated.

The cost of quality is not always immediately obvious. It may be found in the scrap bin or in an unexpected repair job that occurs when a workpiece is not cut or welded according to the specifications. It may be hidden in the "built-in" rework that occurs as a result of having to manufacture weldments that are beyond the performance capabilities of the fabrication or welding equipment.

A typical example of hidden quality costs would be weld joint preparation in which the oxyacetylene cut quality is so poor that extra grinding is required in a rework operation to bring the workpiece into compliance with the dimensions, tolerances, or surface finish requirements. Another example would be the welding of a multipass joint in which grinding is required to prevent incomplete fusion. Both the grinding and the metal removal and replacement require additional time and materials to complete the weld.

The production department supervisor is usually aware of these conditions and takes the appropriate corrective action. Nevertheless, the lost time and additional labor and material are not identified and may become part of regular shop practice without the estimator’s knowledge. If the costs incurred in the additional procedures have not been factored into the cost estimate, the estimate will be low.

Poor workmanship also adversely affects welding costs. The cost of weld repairs can total two to three times that incurred to fabricate the original weld. Not only do repairs involve expenses for time, labor, and materials, but valuable shop space is also lost and the overall production schedule is delayed. Poor quality work may adversely affect the reputation of the manufacturer, which may ultimately be detrimental to future sales.

**Overwelding**

Another unforeseen cost, overwelding, results from inaccurate cutting and fitting, poor supervision, insufficient training, or lack of confidence in the strength of the weld as specified. Two joint configurations that often result in overwelding are complete- or partial-penetration welds in T-joints produced in the horizontal position and butt joints fabricated between plates of unequal thickness.

Overwelding significantly contributes to excessive welding cost. The increase in weld cross section as a result of overwelding is shown in Fig. 7. The weld detail is shown in Fig. 8A, the desired weld is illustrated in Fig. 8B, and the common overwelded condition is represented in Fig. 8C. Figure 9 illustrates the potential overwelding of a transition butt joint. Figure 10 illustrates the effect of poor fitup on the weld cross section.

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**Correction**

In the editorial that ran on page 4 of the July *Welding Journal*, Nigel Scotchmer was incorrectly identified as chair of the AWS International Standards Activities Committee (ISAC). Walter J. Sperko is chair of ISAC. Scotchmer is chair of the AWS Cl Committee on Resistance Welding and is a member of ISAC. The *Welding Journal* regrets the error.
Ten Tips for On-the-Job Welding Safety

It’s important for welders to follow safety procedures and wear personal protective equipment (PPE) at all times — see lead photos.

The many hazards welders are exposed to include hot materials; the intense light created by an arc; sparks; spatter; radiation (infrared, ultraviolet, and blue light); slag; fumes and gases; and electric shock. Therefore, paying attention to your surroundings and wearing the right gear are necessary while welding.

This article presents key areas for welders to focus on to improve on-the-job safety.

**OSHA Requirements**

The Occupational Safety & Health Administration (OSHA) mandates the use of personal protective equipment to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective in reducing these exposures to acceptable levels.

Employers are required to determine if PPE should be used to protect their workers. If so, they must implement a program that addresses the hazards present; the selection, maintenance, and use of
How welders can stay protected while working, including the types of personal protective equipment that should be worn

BY KRISTY GIEBE

Ten Guidelines for Welding Safety

1. Face Protection

Welders are subjected to many eye and face hazards. Therefore, proper selection and consistent use of eye and face protection are vital to avoid injury. Helmets are a crucial element of protection, so it’s essential to wear a helmet with a filter lens and cover plate that complies with ANSI Z87.1, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices, for protection from radiant energy, flying sparks, and spatter.

In addition, whenever radiation or flying particles and spatter are hazards, select welding helmets that protect the face, forehead, neck, and ears. Extra protection may be needed for overhead welding positions.

2. Head Protection

Welders should also choose helmets that are made of lightweight materials to increase comfort. When wearing a welding helmet over a hard hat, make sure to select a helmet that can properly accommodate the hard hat and works with the helmet as a cohesive system.

3. Filter Shades

Make sure to select the appropriate filter shade based on the welding process.
Injury Statistics and Ways for Welders to Stay Safe

According to the Occupational Safety & Health Administration (OSHA), welding, cutting, and brazing are hazardous activities that pose a unique combination of both safety and health risks to more than 500,000 workers in a wide variety of industries. The risk from fatal injuries alone is more than four deaths per thousand workers over a working lifetime.

Also, work-related injuries are higher than in other occupations, according to the U.S. Department of Labor’s Bureau of Labor Statistics, which points to welding torches as the source for 1200+ eye injuries per year.

To help welders stay safe while working, the following personal protective equipment tips are presented in this article: wear protection for your face, head, eyes, ears, feet, hands, and body; choose a welding helmet with an autodarkening filter; and use ventilation, but if this is not adequate or practical, wear an approved respirator.

and current. As the current increases, so should your filter shade to offer the proper level of protection and comfort.

Selecting a welding helmet with an autodarkening filter allows the welder to quickly and easily increase or decrease the filter shade and enables him or her to leave the helmet in the down position, offering additional protection from flying hazards.

Also, it’s important to select a helmet that sits comfortably on the top of the head and remains “locked in” if in the up position. Look for head gear with multip- ple adjustment points that allow the welder to create the most comfortable position for each welding task while maintaining a good field of vision.

4. Choosing Eye Protection

Select the proper eye protection for the job. Eye and face protectors for welding and related tasks, such as grinding and chopping, should comply with the requirements of ANSI Z87.1.

Depending on the specific work task, appropriate eye/face protection may include safety glasses with side protection, such as side shields or wraparound frames, goggles, face shields, welding helmets, curtains, or a combination of these. It’s important to wear safety glasses or goggles under a welding helmet. Make sure eye protection devices are not damaged or missing parts, and be certain they fit properly and comfortably.

Above all, keep eye and face protectors in place whenever the hazards are present. Not using them is the main cause of eye injury.

5. Hearing Protection

In welding, cutting, and allied operations, noise may result from the process, power source, or other equipment. If engineering methods fail to reduce noise to acceptable levels, devices such as ear muffers or ear plugs should be worn to protect hearing.

Hearing protection is only effective when employers and employees understand how to appropriately select, wear, and care for these items. According to the National Hearing Conservation Association, the most important factor in hearing protector selection is finding a comfortable device that an employee will wear correctly 100% of the time that he or she is exposed to harmful noise.

Choose a hearing protection device that offers the appropriate noise reduction rating and does not interfere with other PPE.

6. Foot Protection


Wear leather, steel-toed, high-topped boots in good condition. In heavy spark or slag areas, use fire-resistant boot protectors or leather spats strapped around your pant legs and boot tops to prevent injury and burns. Do not wear pants with cuffs. Wear the bottoms of your pants over the tops of your boots to keep out sparks and flying metal.

7. Hand Protection

Always wear dry, hole-free, insulated welding gloves in good condition to protect hands from burns, sparks, heat, cuts, scratches, and electric shock. ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes, requires all welders to wear protective flame-resistant gloves, which should provide the heat resistance and general hand protection needed for welding.

8. Body Protection

Choose oil-free, heavy, nonsynthetic clothing (such as wool or cotton) that allows freedom of movement and covers all areas of exposed skin. Wear long-sleeved shirts and button the cuffs, pockets, and collar. Wear heavy, durable long pants without cuffs. Keep clothing dry to reduce the possibility of electric shock. Wear leather aprons, leggings, capes, and sleeves as needed for the application.

9. Protecting against Fumes and Gases

Many welding, cutting, and allied processes produce harmful fumes and gases. Ventilation can be used to control overexposures to fumes and gases during welding and cutting. Other ways to avoid these hazards are to keep your head out of the fumes, and reposition the work, your head, or both to keep from breathing the fumes. A technically qualified person should evaluate the exposure to determine if the ventilation is adequate.

10. Respiratory Protection

When ventilation is not adequate or practical, an approved respirator should be worn. Powered air-purifying respirators are particularly useful for welding environments, as these use a blower to force the ambient air through air-purifying elements to the inlet covering, so welders are breathing filtered air, not weld fumes.

Conclusion

During welding jobs, welders can reduce risks by always wearing protective clothing and equipment suitable for a particular task; using proper head, face, and eye protection; avoiding breathing the air in the fume plume directly above the arc; and keeping the work area clean and free of hazards.

Additionally, workers should be alert, aware, and focused on the job, as well as obey safety rules and regulations. Following these guidelines and the ten recommendations listed above should improve on-the-job welding safety.

Acknowledgment

The author would like to acknowledge the American Welding Society as a source of content for this article.
If you always call it quits when you’re faced with a task that seems impossible, you’ll never achieve great things. This is the crucial point where we simply keep going. As a worldwide technological leader and European market leader, we work day-in, day-out, on realizing our vision: to «decode the DNA of the arc». So as to make impossible weld-joints possible – like steel to aluminum. Today we can say with complete conviction: We have full mastery of the arc. A mastery which ensures higher welding speeds, zero spatter and excellent gap bridgeability. Since 1950, this is how we have kept coming up with innovative total systems for arc welding and resistance spot-welding. Want to know more? Check out www.fronius-usa.com
Keeping Stud Welding Shop Floor Costs in Check

Energy use, welding machinery design, and operational planning all play a role in a manufacturer’s day-to-day operating costs

BY DOUG PHILLIPS

Controlling costs is an essential part of running any business. It can make all the difference between profit and loss or maximizing profit within a business. In short, keeping a firm handle on the costs incurred during day-to-day operations has a substantial impact on the performance of any business, affecting share price, the value of a business when it comes up for sale, or even freeing resources to invest in new technologies, salaries, and job creation.

With increasing competition from overseas, the pressure to control costs, particularly in western weld shops, has never been so great. Commoditized products can easily be produced at any location and quickly shipped to customers around the globe. Similarly, assembly work can also be outsourced to lower cost economies with relative ease. With western manufacturers facing greater regulation and employment costs than their counterparts in emerging markets, the pressure to control shop-floor costs has never been greater.

So, which areas should U.S. weld shops be looking at to control their costs and ensure they’re able to compete in what are challenging global markets? This article explores some of the options, including energy use, welding machinery design, and operational planning.

First and foremost, it’s essential to focus on shop-floor costs as a key business area. It’s incredibly easy to get caught up in the day-to-day challenges of assembly, people management, and production schedules to the detriment of time spent reviewing operations and planning strategically for the way ahead. Cost management reaches across every area of the business so it needs to be tackled at every level, not viewed as an isolated area of focus when times are tough.

Energy

Currently, one of the biggest challenges facing every manufacturing and

welding business is the seemingly relentless increase in energy prices.

All welding technologies require significant energy expenditure, but there are steps that every weld shop can take to mitigate the impact of these price rises on their business.

Businesses should make sure that welding equipment is switched off wherever possible, when it is not in use.

Many automotive assembly plants leave their assembly machines switched on between shifts to save downtime when the new shift arrives. Other fabricators are known to leave machines switched on overnight to avoid the need to carry out preproduction weld qualification tests after cycling power.

These decisions are born out of a desire to improve efficiency in the assembly process, but rising energy prices mean it may actually be more cost efficient to review these policies.

Where time is tight or turning machinery off altogether is not an option, weld shops should consider choosing welding equipment that offers the option of switching to idle mode when it is not in use.

Equipment manufacturers have developed new technologies that use significantly less energy when set to idle, allowing customers to make real cost savings without impacting the efficiency of their assembly line when short breaks occur.

For example, a traditional stud welding machine may use up to 113 W of power, plus 50 W more to power the gun and feeder, even when they are not in use. By using fewer, more energy-efficient tooling, these figures can be reduced to 7.5 W to power the machine, with no additional energy required to power the gun and feeder when they are in sleep mode.

Equipment Choices and New Technologies

Energy

When attempting to reduce costs, weld shops should look at the design of the equipment they are using. The total energy required for any welding job is directly linked to the welding arc energy required and power conversion efficiency. Therefore, if you consistently select equipment with improved energy efficiency during the procurement process, future energy costs can be significantly reduced.

Compressed air is the most expensive form of energy for welding applications and is frequently used across the automotive industry in particular. A number of equipment manufacturers, including Nelson Stud Welding, have been working with automotive customers to develop new, airless welding technologies that can reduce energy requirements while maintaining and even improving the quality of the welding process itself.

Inverter stud welding machines offer another energy-efficient alternative for many weld shops, particularly when compared with welding technologies that require line frequency transformer and rectifier topology, which has a poor energy conversion rate and high idle power.

Previously, the range of applications that could make use of inverter stud welding technology was limited, but recent improvements mean it is now available to a wider range of sectors, including the automotive and shipbuilding industries — Fig. 1.

Benefits of inverter technology include reduced input energy requirements, lower installation costs, and greater efficiency along the assembly line because of the flexibility and portability of the equipment — Fig. 2.

In addition, inverters waste less energy in the form of heat than do traditional welding technologies. This means weld shops do not need to use cooling fans as much, which saves energy, reduces the amount of dirt blown into the welding machines, and reduces the frequency of maintenance work and downtime experienced on the shop floor.

Weld Quality

Aside from energy consumption, one of the greatest, manageable shop-floor costs is the cost of eliminating or correcting weld defects.

The occurrence of weld defects has a significant impact on shop floor costs, requiring assembly schedules to be adjusted and additional time and resources to be spent correcting defects or even scrapping parts.

The very nature of some welding techniques makes accounting for some level of weld defects an inevitable part of the assembly process. However, while this can be mitigated to some extent through investment in staff training to improve welders’ skills, it is ultimately an expensive solution, requiring regular time out of the business and increased salaries for more-experienced workers.

Depending on the nature of the welding work to be undertaken, there are a number of alternatives weld shops can consider to reduce the incidence and associated costs of weld flaws.

For example, fabricators using the drawn arc stud welding process could consider investing in plunge current waveform technology.

By way of explanation, here are the steps utilized in the drawn arc stud welding process:

- Push the stud against the workpiece to make contact.
- Start a low pilot current and lift the stud to draw a small pilot arc current.
- Increase current to the welding current level for a set time to melt the stud and the workpiece.
- Plunge the stud back into the workpiece to extinguish the arc and complete the weld.
- Turn off the welding current and remove the weld tool.

The synchronization of current turnoff and stud plunge is always guesswork and is, therefore, a common source of weld defects. If the current is shut off too soon, cold welds result; if it’s left on too long, energy is wasted and cables and connectors can overheat, causing downtime. However, shutting off the current when a short-circuit is detected also risks prematurely turning off the heat, which can lead to a sticker weld. By using plunge current waveform technology, fabricators can reduce the frequency of weld flaws while also limiting unscheduled downtime and reducing energy bills.

The technology uses the current waveform from an inverter controlled by a digital signal processor that can be choreographed with the stud’s motion during the plunge element of the process. This reduced plunge current saves electricity, reduces cable and connector wear by removing excessive heat, and, most importantly, compensates for process variation due to the mechanical motion of the gun. The reduced plunge current keeps the weld pool warm reducing the risk of cold...
plunge, and can result in a 9% reduction in energy usage. Alternatively, inverter stud welding technology can also be used for some applications as the technology eliminates the characteristic weld spike during the stud welding process that is a source of damaging weld spatter.

Designing Efficient Assembly Lines

Ensuring assembly lines are as efficient as possible might seem like the obvious place to start when it comes to controlling shop-floor costs, but it is an area that is surprisingly overlooked on a day-to-day basis, simply because “things have always been done this way.”

Efficiency within the assembly line is reliant on a number of variables including project scheduling, staff availability, and a fabricator’s ability to invest in the latest, flexible technologies.

Weld shops should regularly review their project schedules to see if there might be ways to maximize efficiencies along the line.

Monthly reviews can identify groups of projects that fit into “families” using similar assembly patterns or customer order patterns that can both be used to identify small changes that can make a big difference in cell design and assembly efficiency.

Reviewing processes — from design and part ordering to assembly and customer shipping requirements — can also provide an opportunity for site managers to identify bottlenecks in the process, their causes and potential solutions in terms of optimum inventory levels, assembly layouts, and staffing requirements.

Choice of welding technologies can also have a significant role to play, increasing the efficiency of any production line.

For example, a new welding solution for an automotive client to improve the productivity of its assembly line was recently developed. The line needed to weld an assortment of fasteners of varying shapes, which was proving problematic as traditional stud welding heads can only cope with one stud type at a time. Working closely with the customer’s team, a new piece of equipment was developed utilizing a new gripper and intelligent stud feeding system that could manage a variety of stud sizes while delivering fast cycle times. It was designed to integrate into the customer’s existing stud welding systems, so other components such as feeders and welding machines didn’t need to be replaced, and it also prevented compressed air escaping through leaks, resulting in a 15% saving on the cost of compressed air.

Other equipment solutions that can improve efficiency, and therefore reduce cost on the shop floor, include using lightweight, portable stud welding machines — Fig. 3. Capable of operating in tight spaces and at difficult angles, these welding machines can be operated by a single employee after just two to three hours of training. This means that a single operator can take responsibility for a variety of aspects of an assembly project, rather than being limited to a single assembly station, improving weld efficiency and reducing shop-floor staffing and training costs.

Conclusions

While there will always be external factors that threaten to add cost to fabricators’ businesses, there is a whole host of steps everyone can take to manage those costs that remain within our control, thereby mitigating the impact of external factors.

From energy prices to equipment design, staff training to assembly line efficiency, the challenge is to make the time to focus on these issues and ensure steps are taken across every area of the business at an early stage to maximize efficiencies.

Manufacturing is an increasingly challenging industry, with global economic challenges and increasing international competition placing new pressures on western weld shops. But, with careful planning and alertness to change and opportunity, American fabricators can continue to be market leaders in this field, delivering high-quality, complex assemblies within tight timescales to customers around the world. ♦
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Certification Program Emphasizes Safe Use of Robots

BY VERN MANGOLD

The AWS Certified Robotic Arc Welding program stresses technical competency and safety

Welding personnel who achieve CRAW status demonstrate they possess the technical knowledge to perform robotic arc welding tasks in a safe, efficient, and economical manner.

The use of industrial robots to perform arc welding processes is relatively new in the world of manufacturing technology. Industrial robots turn 50 years old this year, and the process of robotic arc welding has existed in rudimentary form since 1972. A slightly more mature process is robotic resistance welding, casually known as spot welding. Spot welding is typically used to join sheet metal structures, and robots have successfully welded automobile bodies together since 1965. Robotic arc welding only became a reality when improvements in the servo and computer technologies robots use and the ability of robots to move in a continuous, variable, and controlled fashion were perfected. Computer-enabled servo control technologies allowed machines, for the first time, to duplicate the dexterity and precision of human hand motion.

Due to the natural evolution of manufacturing science, the development of the robotic arc welding process was created first, and the practical application of the technology to manufacturing tasks followed. Of course, the promise of robotic arc welding would never be realized fully if the technology could not be used in a safe manner. By trial and error, the robotic arc welding process gradually developed until today when it is considered a mature and prime manufacturing process technology.

In 1985, the American Welding Society (AWS) Technical Activities Committee added a new technical machinery committee to the family of technical committees under its purview. The leadership of John Hinrichs, a past AWS director-at-large and former executive at A. O. Smith Automotive Products Co. (later Tower Automotive), was instrumental in bringing robotic arc welding to AWS’s attention. Hinrichs leveraged both his extensive experience with arc welding robots and his contacts within industry to convince the AWS to become actively involved in the safe and efficient application of the new robot arc welding technology. At Tower Automotive, Hinrichs’s engineers developed techniques and manufacturing protocols for arc welding robots, which became the foundational information and benchmark for the new committee. Since its inception, the committee has published four successful AWS/ANSI

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For more information concerning the AWS Certified Robotic Arc Welding program, contact the AWS Certification Dept. at (305) 443-9353, ext. 273, or visit www.aws.org. You can also contact any of the Approved Testing Centers identified in this article.
robot standards as well as technical reports and other tools that continue to enhance and augment the safe application of arc welder robots.

The new group was designated D16, Committee on Robotic and Automatic Welding. The first task it addressed was development of an arc welding robot system safety standard. D16.1, Specification for Robotic Arc Welding Safety, became an ANSI-approved standard in 2001.

The Industrial Robot

From the earliest introduction of continuous-path articulated robots, the process of continuous-path arc welding has been considered a natural extension of the use of robots in the manufacture of automotive and other transportation-related products. Resistance welding of car bodies provided the predecessor technology that was fundamental for the introduction and eventual acceptance of equipment supplied by companies seeking better methods of arc welding steel and aluminum structures. Although the technological developments ushered in a new opportunity to create robotic arc welding applications, additional developments were required to make the applications commercially viable and acceptable to the general industrial manufacturing community. The missing element in this process was standardization and harmonization of the language and specifications used by industrial robot integrators, suppliers, and end users.

Today, industrial arc welding robots are clearly valuable tools in the welding engineer’s tool box. In certain industries, almost without exception, product designers who create metal products consider the design of new products and revisions to existing product designs to incorporate robotic arc welding processes. The use of hand arc welding processes in the production of automotive and transportation products is virtually nonexistent in factories both small and large and foreign or domestic. In addition to the manufacture of automotive and transportation products, arc welding robots are considered critical to the production of a wide variety of commercial and industrial products ranging from submarines to small appliances.

Fig. 1 — Typical small parts robotic arc welding work cell from AWS D16.3, Risk Assessment Guide for Robotic Arc Welding.

Safety First

It is significant that the D16 Committee has produced standards that address the technical needs of the welding industry in the logical areas of business productivity and efficiency. The committee first produced D16.2, Guide for Components of Robotic and Automatic Arc Welding Installations, in 1998, and the Do’s and Don’ts technical report and pocket robotic arc welding guide in 1999. But D16.1, Specification for Robotic Arc Welding Safety, remains the most important publication the D16 Committee has produced. The D16.1 standard provides comprehensive directions and information necessary for the safe use of robotic arc welding technology.

Safety Considerations for Arc Welding Robot System Integrators

Unlike other welding process tools, an industrial robot does not operate in a stand-alone or nonintegrated environment. Robots are only useful if they are integrated with a computer-controlled manufacturing process. The term “system” is very broad and inclusive. Systems are not simply elaborate manufacturing production cells consisting of numerous robots and all manner of ancillary and peripheral equipment. An arc welding robot system can be as basic as a robot positioned along an indexing conveyor awaiting a signal to advance forward to produce a specific welding operation. Even simple systems must be integrated electronically with other process equipment, thereby changing the safety paradigm.

In reality, if a robot is not integrated into a manufacturing system, no arc welding robot system safety standard is required. Practical applications of industrial robots that do not require integration are reduced to noncontact inspection processes that rely on the robot machine equipped with embedded machine vision and other sophisticated sensory systems. Arc welding with robots is not an example of those types of applications.

To understand the unique safety requirements of arc welding robot systems, we need to study the industry-accepted definitions of robots and robot systems. The key definitions and nomenclature associated with arc welding robots have been harmonized by the Robotic Industries Association and the AWS. The following definitions are from AWS D16.1:

Industrial Robot (Robot): An automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes.

Industrial Robot System (Robot System): An industrial robot combined with ancillary and peripheral equipment necessary to perform a production arc welding process. The robot is electrically interfaced to the ancillary and peripheral equipment.

Robots differ from other manufactur-
ing process capital equipment due to their unique capability to react to the manufacturing environment. The robots are integrated directly with other equipment and devices. The ability of the robot to change processes, operations, and functions autonomously without any manner of human involvement or direct control is a control feature welcomed by the end user.

Why is the difference between arc welding robots and tele-operated machines important? A robotic arc welding system will create a schedule of safety hazards that change as the application changes and the sensory input system dictates. The arc welding industry reports very few serious lost-time injuries that involve the collision or direct interaction of robots and humans. The overwhelming number of serious injury accidents and fatalities can be directly attributed to the interaction of personnel to hazards that involve the robot system's ancillary and peripheral equipment. Robots typically do not strike humans but robot-controlled systems that are not properly designed or deployed can potentially cause all manner of nonrobot collision-related accidents.

The Certified Robotic Arc Welding Program

In keeping with the longstanding AWS tradition of emphasizing safety, the D16 Committee developed the Specification for the Qualification of Robotic Arc Welding Personnel (D16.4). Subsequently, the QC19 Certification Project Team Task Force developed the QC19, Specification for AWS Certification of Robotic Arc Welding Personnel. The program has many similarities to the AWS Certified Welding Inspector (CWI) program. For example, to earn Certified Robotic Arc Welding (CRAW) credentials, the candidate must pass both a closed-book written examination and a hands-on welding performance examination.

So how does the CRAW program benefit employers and workers? Employers benefit through knowing that welding personnel who have earned the certification will demonstrate the requisite level of technical knowledge required to perform robotic arc welding tasks in a safe, efficient, and economical manner. It also signifies that the CRAW Operator or Technician has demonstrated the capability of working with various codes, standards, and specifications. Since proof of active practice or reexamination is required every three years, certification also signifies that the CRAW Operator or Technician is current with the welding industry. In addition, candidates who are successful in achieving the certification earn the right to carry the CRAW credential with pride and to advertise their achievement on their professional résumés.

Robot system safety involves the combination of two different manufacturing sciences and processes: gas metal arc welding and robot system design. The combined safety considerations must be addressed to effectively use arc welding robots safely and productively. The CRAW program validates the safe application of arc welding robots by testing individuals on the physics of the welding process and the programming and operation of sophisticated industrial robots.

There are two levels of AWS-sanctioned CRAW certification: Certified Technician (CRAW-T) and Certified Operator (CRAW-O).

Requirements

AWS D16.4:2005, Specification for the Qualification of Robotic Arc Welding Personnel, sets the education and experience requirements for taking the CRAW examination as follows:

To become CRAW-T certified, candidates must have a minimum of 3000 hours of three-year's arc welding experience with all relevant processes, have a two-year associate's degree in welding/robotics/electrical or equivalent, and hold current CWI (Certified Welding Inspector) certification.

CRAW-O candidates must have a minimum of 2000 hours or two years of arc welding experience, and a combination of training and work experience that equals three years.

In addition, candidates must comply with all the other requirements set forth in AWS D16.4, as well as those in AWS QC19, Specification for AWS Certification of Robotic Arc Welding Personnel. QC19 can be downloaded for free from the site www.aws.org/certification/CRAW.

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<tr>
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The distinctions between manual welding environments and the environment created by the presence of an automatic, self-starting, and adaptive robot arc welding system are addressed in both D16.1 and D16.2. Robot systems have all of the potential hazards encountered in manual arc welding, along with some that are unique to robot systems. Successful CRAW candidates must first understand the fundamentals of the arc welding system, then demonstrate their knowledge of the unique robot system hazards and the accepted methodologies for their mitigation. These hazards are as follows:

**Arc-Welding-Specific Hazards**
- Ultraviolet radiation
- Sparks and spatter
- Hot surfaces
- Electrical shock
- Effluent.

**Robot-Specific Hazards:**
- Automatic self start
- Singularity
- Collision
- Variable pinch points
- Single point of control issues
- Training and observation personnel protection
- Robot program verification
- Forced outputs and system testing.

While the CRAW program addresses every aspect of arc welding robot safety, it is not limited only to arc welding safety. It is designed to assist arc welding robot integrators in complying with prevailing regulations and voluntary industry standards. The CRAW certification includes a performance test that demonstrates the candidate's understanding of robot programming and control of welding process parameters.

CRAW certification requires that the candidate provide specific personal information that includes, but is not limited to, documentation of work and academic ex-
perience, satisfactory completion of a written, closed-book examination combined with a practical hands-on performance test. The examination tests the candidate’s knowledge of welding processes, welding procedures, destructive and nondestructive tests, welding terms, definitions, symbols, inspection procedures, safety, quality assurance and responsibilities, weld procedure development, and welding application performance validation.

Selected AWS welding standards serve as the principal reference documents for candidates who are pursuing CRAW certification. The documents are also used by AWS and the D16 Committee to formulate written examination questions and to subsequently validate the answers provided by the candidate. In addition to ANSI/AWS standards, other ANSI standards must also be considered as documents to be studied by the candidates.

Table 1 lists the topics to be included in the written examination and how the questions are weighted.

The performance test requires the candidate demonstrate robotic arc welding programming skills. The actual weld production and posttest inspection will determine the skill and knowledge level of the candidate. The written performance examination tests the candidate’s knowledge of general robot and arc welding technology. The objective performance test is described in AWS QC 19. The GMAW process is used to produce the welded coupon (Fig. 2) and the candidate must demonstrate knowledge of the process during the system inspection and, subsequently, through the actual performance examination. While it is preferred the performance examination be completed and passed on the same day that the written examination is proctored, it can be completed and passed three months prior to or after the written exam. The welding coupon is a standard performance examination device that is supplied to the candidate in a tack welded condition by the CRAW examination proctor.

Following are the five performance examination topics.
- Identification of components and demonstration of use,
- Procedure and welding process setup,
- Robot programming of test piece,
- Welding of test piece,
- Weld quality assessment.

Candidates for the CRAW certification program do not need an employer or other commercial organization to sponsor them. Individuals with the requisite qualifications can apply to any authorized AWS Approved Testing Center (ATC) and, if accepted, can sit for the written and performance examinations. The candidate is responsible for all fees and costs associated with the CRAW program.

Potential candidates who seek to pursue CRAW certification are responsible for studying and reviewing the referenced CRAW materials and the relevant ANSI standards and other documents that govern both the written examination and the procedures and requirements of the performance test. The list of reference documents is available in AWS QC19, which can be downloaded at www.aws.org/certification/docs/QC19.pdf.

Code of Professional Conduct

CRAW-O and CRAW-T certified professionals, regardless of any other AWS certification level achieved, agree, by affixing their signature to the application for certification, to be bound by a code of professional conduct contained in the AWS Code of Ethics. Compliance with the code includes the requirement that the CRAW-certified professional will perform his or her required welding tasks at all times with a concern for public safety.

What’s Next

Future CRAW activities include the prospect for a new program that addresses the application of gas tungsten arc welding (GTAW). The GTAW application presents unique safety hazards for the welding process engineer to evaluate and consider. A CRAW program designed with this application in mind can be a valuable tool for improving both the safety and acceptance of robotic GTAW applications. CRAW certification represents one of the many ways that AWS reaches out to industry to train and encourage manufacturing professionals to apply advanced safety standards, procedures, and practices in the design of arc welding robot systems. The U.S. robotic arc welding industry is very safe and will continue to become safer as the CRAW program propagates into more manufacturing operations.

Where You Can Go to Become Certified

Currently, six organizations have achieved AWS Approved Testing Center (ATC) status — Fig. A. All six entities are deeply involved in both the science and the business of applying robots to arc welding applications.

Each CRAW-authorized ATC is free to customize its CRAW training program. Each of the current ATCs offers a variety of training and orientation packages that are designed to assist all candidates regardless of their background and experience. Following is a brief description of the ATCs and their offerings.

1. OTC Daihen, Inc., Tipp City, Ohio (www.daihen-otc.com). The company, a division of the Daihen Corp., Osaka, Japan, is the most recent ATC — Fig. B. It has been active in the arc welding market in the United States for more than 30 years. OTC DAIHEN, initially known as OTC America (Osaka Transformer Co.) set up its first office in Charlotte, N.C., in 1979. Originally, the company only supplied welding equipment for other Japanese transplant companies, but soon entered the U.S.-based Japan-
ese automotive market as a provider of gas metal arc welding equipment and systems.

In the late 1970s, OTC Japan developed its first generation of dedicated arc welding robots, and the company entered the robot business in America in 1983. In recent years, the company launched its Dynamic Robotics Div. and moved the U.S. headquarters to Tipp City, Ohio.

2. ABB, Inc., Auburn Hills, Mich. (www.abb.com/robotics). ABB became the first AWS Approved Testing Center specifically established for Certification of Robotic Arc Welding (CRAW) personnel. ABB offers a prep course to prepare for the certification exam, in addition to providing the personnel, facilities, and procedures to administer the certification testing for AWS. The CRAW and all of ABB’s robotic welding courses are led by Keith Lloyd, CWI, CWE, CRAW-T, and ABB senior training instructor.

ABB offers a state-of-the-art training laboratory — Fig. C. “We can support the training needs of customers who have older ABB welding technology, in addition to those who have our most current welding solutions, which makes ABB a prime location for the CRAW,” Lloyd said. The welding lab is equipped with a two-station manual weld booth, two IRB140 compact weld cells, one FlexArc 250R, and three FlexArc USCs with IRB 1410 robots.

At the main training center in Auburn Hills, more than 45 courses in programming, electric service (troubleshooting), mechanical/preventive maintenance, software, processes, and customized courses on a variety of ABB robots are offered. All courses provide classroom instruction combined with hands-on learning.

ABB Robotics is a supplier of industrial robots, robot software, peripheral equipment, modular manufacturing cells, and service for tasks such as welding, handling, assembly, painting and finishing, picking, packing, palletizing, and machine tending.

3. Milwaukee Area Technical College (MATC), Milwaukee, Wis. (www.matc.edu). The college, within its two-year associate degree program for welding technology, offers an in-depth curriculum addressing the topics of the CRAW written exam. Two semesters of robotic study provide students with the necessary skills and knowledge to succeed in industry as CRAW-credentialed manufacturing professionals. MATC is exploring an Advanced Technical Certificate aimed at specific training targeting those already in industry who wish to become AWS certified to CRAW-O or CRAW-T. Contact Larry Gross at grossl1@matc.edu for more information.

4. Genesis Systems Group, Davenport, Iowa (www.genesis-systems.com). In business since 1983, the company’s expertise is in the design, manufacture, and implementation of robotic welding systems. With more than 3000 robotic welding system installations, Genesis has work cells located in more than 40 states and 12 different countries. The company has the CWI and CRAW personnel on hand to help candidates achieve their CRAW-O and CRAW-T certification goals.

Fig. B — Larry Barley, the OTC-designated CRAW-T examination proctor, stands in front of the new OTC CRAW work cell. Barley recently earned CRAW-T status; he became an AWS CWI more than 20 years ago. This robot system is an integral component of the OTC-designed CRAW cell.

Fig. C — ABB’s state-of-the-art weld lab includes several robotic weld cells. The center offers more than 45 courses that combine classroom instruction with hands-on learning.
As one of the first AWS ATCs, the company's training department has developed a four-day intensive class designed to help students master the skills needed to obtain this elite national certification. Major topics include welding processes, metallurgy, discontinuities and defects, visual inspection, welding symbols, destructive and nondestructive testing, and safety. The state-of-the-art training facility has five complete welding cells with FANUC robots, which allow students to utilize hands-on practice for the practical part of the test and to enhance their robot skills. The practical test is processed on site. The class is four days, Monday through Thursday, with the CRAW test held on Friday.

Genesis is offering an additional CRAW class October 10. In addition, the company offers multiple robotic training classes, including basic, advanced, maintenance, and FANUC WeldPro at its Davenport, Iowa, facility.

5. The Lincoln Electric Co., Cleveland, Ohio (www.lincolnelectric.com). The Automation Center at Lincoln Electric’s world headquarters in Cleveland is an AWS ATC for training and certification testing for the CRAW program, which allows welding personnel employed in various industry segments including education, to measure themselves against an industry standard. It also signifies the individual has demonstrated the capability of working with various codes, standards, and specifications.

Each program (CRAW-O and CRAW-T) has several levels and is based on knowledge of robotics, welding experience, and education. The student is required to take a comprehensive written examination, two-hour practical examination, and demonstrate the ability to perform a proper robotic weld from a schematic drawing. AWS sets the requirements, and certification must be renewed every three years.

Prerequisites for the Lincoln Electric CRAW program include submitting an application to AWS along with the appropriate fees. For any questions relating to the CRAW certification process or schedule of classes, contact Lincoln Electric Automation at (888) 935-3878 or e-mail automation@lincolnelectric.com.

6. Wolf Robotics, LLC, Ft. Collins, Colo. (www.wolfrobotics.com). As an ATC, Wolf Robotics conducts periodic training and testing of individuals for the CRAW-T program. Certification testing for CRAW-T and CRAW-O is conducted at its facility on scheduled dates. Students have to pass a two-hour closed-book written exam with about 130 questions on welding fundamentals and robotic arc welding systems that includes welding processes and procedures, robot programming, safety, and other welding-related subjects. An additional two-hour welding performance test is also required to test the student on robotic arc welding cell operation. A weld test piece is presented to the student along with an engineering weld drawing. The student is required to read and decipher weld symbols then program the robot to weld the part according to instructions.

The welding performance test is conducted and evaluated by a CRAW-T instructor. The written test is administered by authorized AWS personnel and results are returned in 1–2 weeks. In preparation, Wolf Robotics offers an optional three-day training seminar that includes two days of review for the written portion and one day of hands-on practical training using Wolf lab robots.
The American Welding Society and Weld-Ed will conduct a major roundtable on solutions to the problem of developing an adequate welding industry workforce. You are encouraged to attend.

The program will begin in the morning with a Facilitated Executive Dialogue that will focus on developing a set of recommendations for industry, education, and government to drive action to improve the development of the future workforce.

The following topics will be among those addressed during this session:

- Challenges faced by employers in recruiting, training, and retaining welders and other welding professionals
- Challenges faced by educators in recruiting, educating, and retaining students in welding-related programs
- Organizational impacts from new technologies, advancements in welding, and globalization
- Creative solutions and partnerships to educate and hire the right people

Continental breakfast and lunch will be served.

After lunch, a working session on Development of Solutions/Pilot Projects will include participants from the morning executive roundtable and audience. Participants will develop ideas and frameworks for pilot projects that address challenges heard in the morning dialogue. Participants are encouraged to offer ideas and suggestions, and to commit their organizations to participate in pilot projects.

A final report will be issued by the American Welding Society with recommendations for industry, education, and government. These recommendations will drive action and create a series of projects that address key challenges to recruiting, educating, and retaining a skilled welding industry workforce.

Reserve your place at this event by registering at www.aws.org/roundtable or calling (800) 443-9353 ext 212.

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August 15 - 18 ♦ November 14 - 17

Arc Welding Inspection & Quality Control
September 26 - 30 ♦ November 28 – December 2

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China Aerospace & Aviation Technology Show (CAATS), Nov. 1–5. SNIEC, Shanghai, China; www.caats.aero/.


♦ FABTECH. Nov. 14–17. McCormick Place, Chicago, Ill. This exhibition is the largest event in North America dedicated to showcasing the full spectrum of metal forming, fabricating, tube and pipe, welding equipment, and myriad manufacturing technologies. Contact American Welding Society, (800/305) 443-9353, ext. 264; www.fabtechexpo.com or www.aws.org.


♦ 5th Int’l Brazing and Soldering Conf. April 22–25, Red Rock Casino Resort Spa, Las Vegas, Nev. A joint activity of the American Welding Society and ASM International®, it will bring together scientists and engineers from around the world who are involved in the research, development, and application of brazing and soldering. www.asminternational.org/IBSC.


Educational Opportunities


Certified Welding Supervisor Preparation with Exam. Two-week-long class beginning Sept. 1. Hobart Institute of Welding Technology, Troy, Ohio; www.welding.org; hiwt@welding.org; (800) 332-9448.

Fundamentals of Brazing Seminar. Sept. 27–29, Crowne Plaza Irvine, Orange County, Calif. For designers, processing, manufacturing, and quality engineers, managers, production supervisors, and brazing operations personnel with all levels of brazing experience. Lucas-Milhaupt, www.lucasmilhaupt.com; (800) 558-3856.


Art Using Welding Technology Classes and Workshops. Miami, Fla. With artist and sculptor Sandra Garcia-Pardo. Meet the artist at www.sandragarciaart.com; (786) 547-8681.

ASM Int’l Courses. Numerous classes on welding, corrosion, failure analysis, metallography, heat treating, etc., presented in Materials Park, Ohio, online, webinars, on-site, videos, and DVDs; www.asminternational.org. search for “courses.”


Basics of Nonferrous Surface Preparation. Online course, six hours includes exam. Offered on the 15th of every month by The Society for Protective Coatings. Register at www.sspc.org/training.

— continued on page 98
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PROFESSION: Welder
COMPANY: TQ Constructors, Inc.

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### Certified Welding Inspector (CWI)

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<td>Miami, FL</td>
<td>Sept. 18–23</td>
<td>Sept. 24</td>
</tr>
<tr>
<td>New Orleans, LA</td>
<td>Sept. 18–23</td>
<td>Sept. 24</td>
</tr>
<tr>
<td>Tulsa, OK</td>
<td>Oct. 16–21</td>
<td>Oct. 22</td>
</tr>
<tr>
<td>Long Beach, CA</td>
<td>Oct. 16–21</td>
<td>Oct. 22</td>
</tr>
<tr>
<td>Newark, NJ</td>
<td>Oct. 16–21</td>
<td>Oct. 22</td>
</tr>
<tr>
<td>Nashville, TN</td>
<td>Oct. 16–21</td>
<td>Oct. 22</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>Oct. 23–28</td>
<td>Oct. 29</td>
</tr>
<tr>
<td>Roanoke, VA</td>
<td>Oct. 23–28</td>
<td>Oct. 29</td>
</tr>
<tr>
<td>Cleveland, OH</td>
<td>Oct. 23–28</td>
<td>Oct. 29</td>
</tr>
<tr>
<td>Detroit, MI</td>
<td>Oct. 23–28</td>
<td>Oct. 29</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Oct. 23–28</td>
<td>Oct. 29</td>
</tr>
<tr>
<td>Atlanta, GA</td>
<td>Oct. 30–Nov. 4</td>
<td>Nov. 5</td>
</tr>
<tr>
<td>Dallas, TX</td>
<td>Nov. 6–11</td>
<td>Nov. 12</td>
</tr>
<tr>
<td>Sacramento, CA</td>
<td>Nov. 6–11</td>
<td>Nov. 12</td>
</tr>
<tr>
<td>Spokane, WA</td>
<td>Nov. 6–11</td>
<td>Nov. 12</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>Exam only</td>
<td>Nov. 17</td>
</tr>
<tr>
<td>Syracuse, NY</td>
<td>Dec. 4–9</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Dec. 4–9</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>Houston, TX</td>
<td>Dec. 4–9</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>Reno, NV</td>
<td>Dec. 4–9</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>Dec. 4–9</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>St. Louis, MO</td>
<td>Exam only</td>
<td>Dec. 10</td>
</tr>
<tr>
<td>Corpus Christi, TX</td>
<td>Exam only</td>
<td>Dec. 31</td>
</tr>
</tbody>
</table>

### Certified Welding Supervisor (CWS)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami, FL</td>
<td>Sept. 12–16</td>
<td>Sept. 17</td>
</tr>
<tr>
<td>Norfolk, VA</td>
<td>Oct. 17–21</td>
<td>Oct. 22</td>
</tr>
</tbody>
</table>

CWS exams are also given at all CWI exam sites.

### Certified Radiographic Interpreter (CRI)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago, IL</td>
<td>Sept. 12–16</td>
<td>Sept. 17</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>Oct. 17–21</td>
<td>Oct. 22</td>
</tr>
<tr>
<td>Allentown, PA</td>
<td>Nov. 7–11</td>
<td>Nov. 12</td>
</tr>
</tbody>
</table>

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

### Certified Welding Sales Representative (CWSR)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami, FL</td>
<td>Aug. 24–26</td>
<td>Aug. 26</td>
</tr>
<tr>
<td>Indianapolis, IN</td>
<td>Sept. 21–23</td>
<td>Sept. 23</td>
</tr>
</tbody>
</table>

CWSR exams will also be given at CWI exam sites.

### Certified Welding Educator (CWE)

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

### Certified Robotic Arc Welding (CRAW)

<table>
<thead>
<tr>
<th>WEEK OF</th>
<th>LOCATION</th>
<th>CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept. 19</td>
<td>OTC Daihen, Inc., Tipp City, OH</td>
<td>(937) 667-0800</td>
</tr>
<tr>
<td>Sept. 19</td>
<td>Wolf Robotics, Ft. Collins, CO</td>
<td>(970) 225-7736</td>
</tr>
<tr>
<td>Oct. 24</td>
<td>Lincoln Electric Co., Cleveland, OH</td>
<td>(216) 383-8542</td>
</tr>
<tr>
<td>Oct. 31</td>
<td>OTC Daihen, Inc., Tipp City, OH</td>
<td>(937) 667-0800</td>
</tr>
<tr>
<td>Nov. 7</td>
<td>ABB, Inc., Auburn Hills, MI</td>
<td>(248) 391-8421</td>
</tr>
<tr>
<td>Dec. 12</td>
<td>OTC Daihen, Inc., Tipp City, OH</td>
<td>(937) 667-0800</td>
</tr>
<tr>
<td>On request</td>
<td>MATC, Milwaukee, WI</td>
<td>(414) 297-6996</td>
</tr>
</tbody>
</table>

### Certified Welding Engineer (CWEng)

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

### Senior Certified Welding Inspector (SCWI)

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

### International CWI Courses and Exams

Please visit [www.aws.org/certification/inter_contact.html](http://www.aws.org/certification/inter_contact.html).

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Important: This schedule is subject to change without notice. Please verify your event dates with the Certification Dept. and confirm your course status before making your travel plans. For information, visit [www.aws.org/certification](http://www.aws.org/certification), or call (800/305) 443–9353, ext. 273, for Certification; or ext. 455 for Seminars. Apply early to avoid paying the $250 Fast Track fee.
Proper sizing of cable for welding equipment is essential for safety, longevity, and quality welds.

CCI understands the demands of the welding industry. Excelene® cables are manufactured to the highest performance standards.

Don’t settle for undersized cables:

- Undersized cables have as much as 31% less copper
- Undersized cables produce up to 33% more electrical resistance
- More resistance creates excessive heat and wear while in use
- Undersized cables can reduce the lifespan of your equipment
- Undersized cables can reduce the quality and integrity of weld joints

CCI’s Excelene® meets or exceeds the rigorous demands for voltage drop and overall performance for the welding industry.

CCI — Power with the best.™

For Info go to www.aws.org/ad-index
The AWS Foundation is pleased to announce recipients of the 2011 workforce development grants.

The Foundation is awarding a total of $79,704 to five projects. Many applications were received, and five outstanding projects were chosen to receive funding. We will recognize one recipient each month in upcoming issues of the Journal. These awards are made possible by the Miller Electric Mfg. Company, Hobart Brothers Company, Hobart Institute of Welding Technology, OKI Bering, and Bohler Thyssen Welding USA.

We would like to recognize Fulton County Area Technical Vocational School and Mellott Company, Pennsylvania.

This project will provide welding skill upgrade training to ten Mellott Company employees who will complete AWS certifications. Additionally, three welding students will be selected and will receive welding training, complete AWS certifications and be hired by Mellott Company upon successful completion of the program.

Pictured, from left to right are Don Howard, District 7 Director; Elisa Ramsey, Fulton County School District; Jonas Smith, Mellott Company; Bobby Cross, Mellott Company; Allan Spade, Mellott Company; and Joseph Bart Sickles, Johnstown/Altoona Section Chairman.

Welding for the Strength of America
The Campaign for the American Welding Society Foundation
AWS Foundation Awards Workforce Development Grants

The AWS Foundation has awarded five workforce development grants for a total of $79,704.

A $12,850 grant was awarded to Regional Technical Education Center (RTEC) and Kolberg-Pioneer, Inc. (KPI), Yankton, S.Dak., to recruit, train, and AWS-certify ten employees; $18,394 to Fulton County Area Technical School and the Mellott Co., Pennsylvania, to upgrade welder skills for ten employees; $10,500 to Pittsburgh Public Schools, American Bridge Co., Boilermakers Local 154, Local 66 International Union of Operating Engineers, and Safety Guard Steel Fabricating Co., Pennsylvania, to train ten high school seniors; $19,095 to Henderson Community College and Pittsburgh Tank & Tower Co., Ohio Valley Marine Services, Inc., and Alliance Coal, LLC, Kentucky, to train 34 employees; and $18,865 to Vermeer Corp., Iowa, to train 55 new-hires in a three-week program.

Receiving the RTEC grant were Josh Svatos, RTEC general manager and vice chair of the AWS Siouxland Section; Nick Morrison, Section member; Section Chair Kelly Kleinwolterink; Bob Olson, CWI/CWE and long-time Section member; Mark Luchtel, KPI manufacturing manager; and Rhonda Kocer, KPI human resources manager. Kevin Schurman, a recent graduate of Yankton High School, is the first recipient of an AWS Welder Workforce Development Scholarship.

Mellott Co. has agreed to contribute $7150 to the AWS Foundation grant money to provide welding skill upgrade training to ten of its employees including two welding supervisors. The supervisors will prepare for and take the AWS Certified Welding Supervisor exam. The remaining employees will complete a D1.1 qualification then be hired by Mellott Co. AWS District 7 Director Don Howard and AWS Johnstown/Altoona Section Chair Joseph Bart Sickles presented the grant to Fulton County School District representative Elisa Ramsey, and Mellott Co. representatives Jonas Smith, Bobby Cross, and Allan Spade.

Shown at the AWS Foundation grant presentation to the Fulton County VoTech Student Chapter and Mellott Co. are (from left) District 7 Director Don Howard, Elisa Ramsey, Jonas Smith, Bobby Cross, Allan Spade, and Joseph Bart Sickles, chair, Johnstown/Altoona Section.

Pictured receiving the RTEC grant are (from left) Josh Svatos, Nick Morrison, Kelly Kleinwolterink, Bob Olson, Mark Luchtel, and Rhonda Kocer.

Shown (from left) are Mark Luchtel, KPI manufacturing manager; scholarship awardee Kevin Schurman; Bob Evans, Yankton High School metals instructor; and Josh Svatos, vice chair, AWS Siouxland Section, and RTEC general manager.

AWS was approved as an accredited standards-preparing organization by the American National Standards Institute (ANSI) in 1979. AWS rules, as approved by ANSI, require that all standards be open to public review for comment during the approval process. The review expiration date is shown. Draft copies may be ordered from Rosalinda O’Neill, roneill@aws.org; (305) 443-9353, ext. 451.

ISO Draft Standards for Public Review
Copies of draft International Standards are available for review and comment from your national standards body, which in the United States is ANSI, 25 W. 43rd St., 4th Fl, New York, NY 10036; (212) 642-4900. Send comments regarding ISO documents to your national standards body. In the United States, if you wish to participate in the development of International Standards for welding, contact Andrew Davis, adavis@aws.org; (800/305) 443-9353, ext. 466.

Technical Committee Meetings
All AWS technical committee meetings are open to the public. Persons wishing to attend a meeting should contact the staff secretary of the committee as listed below at AWS, 550 N.W. LeJeune Rd., Miami, FL 33126; telephone (305) 443-9353.


D8 Committees Work on Auto Weld Test Methods

The D8 Committee on Automotive Welding and D8D Subcommittee on Automotive Resistance Spot Welding met May 17 at RoMan Engineering Services in Livonia, Mich. The business included voting on D8.9M, Recommended Practices for Test Methods for Evaluating the Resistance Spot Welding Behavior of Automotive Sheet Steel Materials. The volunteers working on the committee are Chair Dan Galiher, Hongyan Zhang, Tom Morissett, Bill Qualls, Jim Dolfi, Bill Brafford, Elliot Biro, Nigel Scotchmer, Frank Hunt, Dennis Kolodziej, Secretary Efram Abrams, John Bohr, Don Maatz Jr., Menachem Kimchi, Joseph Beckham, Tom Sparschu, Eric Pakalnins, Justin Hunt, and Murali Tumuluru.

C1 Committee Ballots Recommended Practices for Resistance Welding

The committee volunteers include Chair Nigel Scotchmer, Menachem Kimchi, Murali Tumuluru, Cameron Davidson, Charles Albright, Bill Qualls, Tyler Alexander, Bernie Bastian, John Bohr, Bill Brafford, Bob Cohen, Kurt Hofman, and advisers Mike Hebert, Wladyslaw Jaxa-Rozen, and Bruce Kelly. The staff secretary is Efram Abrams.

The committee is currently seeking new members. To learn more about serving on this committee, contact Efram Abrams, eabrams@aws.org; (800/305) 443-9353, ext. 307.
Five Technical Documents Released

Resistance Welding Pocket Handbook
The 48-page Resistance Welding Pocket Handbook contains basic information on resistance welding including important do's and don'ts; common weld defects and their probable causes; and various charts including sample weld schedules. The publication is a joint effort of the AWS J1 Committee on Resistance Welding Equipment and members of the Resistance Welding Manufacturing Alliance (RWMA). The list price is $44, $33 for AWS members. To purchase, call (888) 935-3464, or visit www.aws.org/standards.

Surfacing Electrodes Specification Updated
The revised A5.21M:2011, Specification for Bare Electrodes and Rods for Surfacing, has been published. The 40-page document prescribes the requirements for the classification of bare electrodes and rods for surfacing. All electrodes and rods now classified in accordance with A5.21:2011 are uncoated. The document is the first of the A5.21 specifications to make use of both U.S. Customary Units and the International System of Units (SI). The publication was prepared by the A5 Subcommittee on Filler Metals and Allied Materials. The list price is $52, $39 for AWS members. To purchase, call (888) 935-3464, or visit www.aws.org/standards.

Orbital Machine Pipe Welding Guide
The American Welding Society has released the first edition of AWS D10.14M/D10.14:2010, Guide for Multipass Orbital Machine Pipe Groove Welding. The 76-page guide, prepared by the D10 Subcommittee on Piping and Tubing, will benefit readers wishing to familiarize themselves with the processes typically used to weld pipe in power-generation and chemical processing plants, and cross-country and offshore transmission pipelines. The list price is $76, $57 for AWS members. To purchase, call (888) 935-3464, or visit www.aws.org/standards.

New Standard Details Gases for Fusion Welding
Just released, the first edition of AWS A5.32M/A5.32:2011 (ISO 14175:2008 MOD), Welding Consumables — Gases and Gas Mixtures for Fusion Welding and Allied Processes, classifies and designates various gases and gas mixtures used in fusion welding according to their chemical properties and metallurgical behavior as the basis for correct selection by the user, and to simplify the qualification procedures. The publication was produced by the A5 Subcommittee on Filler Metals and Allied Materials. The list price for the standard is $52, $39 for AWS members. To purchase, call (888) 935-3464, or visit www.aws.org/standards.

D1.4 Reinforcing Steel Standard
The recently revised edition of the AWS D1.4M:2011, Structural Welding Code — Reinforcing Steel, has been published, superseding the 2005 edition. The 84-page document covers welding of reinforcing steel for most reinforced concrete applications including precast concrete components. Figures are included to clearly illustrate important welding considerations: Unacceptable weld profiles, effective weld sizes, details of joints of anchorages, base plates, and inserts. The standard was prepared by the D1 Committee on Structural Welding. The list price is $116, $87 for AWS members. To purchase, call (888) 935-3464, or visit www.aws.org/standards.

AWS Launches Its First Online Certification Program
The American Welding Society launched its first-ever online certification program for welding sales professionals this spring. The certification serves to recognize experience, knowledge, and excellence in welding sales expertise. “The AWS Welding Sales Representative Certification sets apart the elite sales professionals from the rest of the pack,” said Cassie Burrell, AWS deputy executive director. “Being able to take the course and test online will make it more convenient for sales reps to obtain the certification and will show their commitment to help customers find new solutions and ways to improve their welding quality and productivity, as well as help provide a safer workplace,” Burrell added.

New AWS Supporters

Sustaining Members
Guam Industrial Services, Inc.
dba Guam Shipyard
Bldg. 20, Connavar
PO Box 13010, Naval Activities
Santa Rita, 96915, Guam
Representative: Bobby Altizer
Guam Industrial Services, Inc., dba Guam Shipyard, is a full-service ship repair, maintenance, and industrial service company serving the western Pacific area. It is the premier provider of steel fabrication, welding, machining, preservation, and quality assurance stands in the region.

Pearl Abrasives Co.
6210 S. Garfield Ave.
Commerce, CA 90040
Representative: Ted Skaff
Pearl Abrasives Co. supplies bonded abrasives, coated abrasives, wire brushes, diamond blades, cup wheels, core bits, polishing pads, and a complete line of tile and masonry saws and surface-preparation equipment. It also carries dust-containment products, the Tuscan Leveling System, and the new Roto Wedge.

Steelmax Tools LLC
6200 S. Troy Cir., Ste. 110
Centennial, CO 80111
Representative: Peter Smith
www.steelmax.com
Steelmax designs, imports, and wholesale metal-fabrication tools, including saws, magnetic drills, plate and pipe bevelers, grinders, and welding and cutting automation equipment. It also supplies the consumables to support the tools.

Affiliate Companies
AWD Sales & Service, Inc.
422 N. 1100 W., Payson, UT 84651

Baker Iron Works, Inc.
PO Box 145, Solana Beach, CA 92075

Bolster Engineering Solutions
B 259 Old Minal Residency J K Rd.
Madhya Pradesh, Bhopal 462023, India

Dant Clayton Corp.
1500 Bernheim Ln., Louisville, KY 40210

Dimension Plumbing & Heating, Inc.
1985 N. Broadway, Rochester, MN 55906

MMW Plumbing Heating & Air, Inc.
87 N. Fannin St., Amarillo, TX 79106

Monarch Residential Vaults & Ironworks LLC
PO Box 1541, Durango, CO 81302

Petroleo Brasileiro SA Petrobras
Ave. Republica Chile 65
Rio de Janeiro, 20031-912, Brazil

Phoenix Products
1727 Bennett St., Jacksonville, FL 32206

Precitech Global Co. Ltd.
21 Tony Ile St. Obagi, Onela, Rivers State
Port Harcourt 510103, Nigeria

S. L. Shaw Co., Inc.
PO Box 67, Bakersfield CA 93302

The Bratton Corp.
2801 E. 85th St., Kansas City, MO 64132

Van Linda Iron Works, Inc.
3787 Boutwell Rd.
Lake Worth FL 33461

Supporting Companies
L & M Ethanol Maintenance Contracting, Inc.
2354 170th St.
Ft. Dodge, IA 50501

Taylor Press Products
13675 N. IH 35, PO Box 737
Jarrell, TX 76537

Educational Institutions
Auto Diesel Institute of Michigan
Baker College of Owosso
1020 S. Washington St.
Owosso, MI 48867

Honorary Meritorious Awards

The deadline for submitting candidates for these awards is December 31 prior to the year of the awards presentations. Send candidate materials to Wendy Sue Reeve, wreeve@aws.org; 550 NW LeJeune Rd., Miami, FL 33126.

William Irrgang Memorial Award
This award is given to the individual who has done the most over the past five years to enhance the Society’s goal of advancing the science and technology of welding. It includes a $2500 honorarium and a certificate.

Natl’l Meritorious Certificate Award
This award recognizes the recipient’s counsel, loyalty, and dedication to AWS affairs, assistance in promoting cordial relations with industry and other organizations, and for contributions of time and effort on behalf of the Society.

George E. Willis Award
This award is given to an individual who promoted the advancement of welding internationally by fostering cooperative participation in technology transfer, standards rationalization, and promotion of industrial goodwill. It includes a $2500 honorarium.

Honorary Membership Award
This award acknowledges eminence in the welding profession, or one who is credited with exceptional accomplishments in the development of the welding art. Honorary Members have full rights of membership.

Int. Meritorious Certificate Award
This honor recognizes recipients’ significant contributions to the welding industry for service to the international welding community in the broadest terms. The award consists of a certificate and a one-year AWS membership.
Nominate Your Candidate for the M.I.T. Prof. Masubuchi Award

Todd A. Palmer, assistant professor, The Pennsylvania State University, tapl03@psu.edu. Sponsored by the Dept. of Ocean Engineering at Massachusetts Institute of Technology (M.I.T.), this award includes a $5000 honorarium.

Nominations Sought for National Officers

AWS members who wish to nominate candidates for President, Vice President, and Director-at-Large on the AWS board of directors for the term starting Jan. 1, 2013, may:

1. Send their nominations by Oct. 4, 2011, to Gricelda Manlich, gricelda@aws.org c/o John C. Bruskotter, chairman, National Nominating Committee, or

2. Present their nominations in person at the open session of the National Nominating Committee meeting scheduled for 2:00 to 3:00 PM, Tuesday, Nov. 15, 2011, at McCormick Place, Chicago, Ill., during the FABTECH show. Nominations must be accompanied by biographical material on the candidate, including a written statement by the candidate as to his or her willingness to serve if nominated and elected, letters of support, plus a 5- x 7-in. color portrait. Note: Persons who present their nominations at the show must provide 20 copies of the biographical materials and written statement.

District 16 Director Nominated

Dennis Wright, an AWS Distinguished Member, has been nominated to serve the last year of David Landon’s term as District 16 director, beginning Jan. 1, 2012, and to continue to serve the following full three-year term. Landon will leave that post Jan. 1 to begin serving as an AWS vice president.

Wright owns his own business, Wright Welding Technologies, where he conducts inspections, qualifies welders, and prepares welding procedures. He also works in the general job shop at Zephyr Products, Inc., Leavenworth, Kan., where he earned his CWI and CWE. The company has an ongoing program of training state penitentiary inmates as welders using the AWS SENSE program. The welders are qualified to D1.1, D1.2, D1.3, and D1.6. In addition, he serves on the National SkillsUSA for welding and the Johnson County Community College Advisory Board for welding.

During his 8½-year tour in the U.S. Navy, he worked on repair ships performing welding, brazing, pipefitting, and sheet metal work. He welded HY80 plate in all positions on submarines, and was qualified to weld aluminum on aircraft. Before leaving the Navy, he served as a journeyman welder/fitter in a San Diego shipyard.

He has experience with Allis Chalmers as a welding supervisor and was in charge of all three weld shops at Libby Corp. building aluminum generator sets. Wright has been published in Welding Journal, Welding Handbook, and Welding Design and Fabrication.

District Directors Present Awards

The District Director Award provides a means for District directors to recognize members who have volunteered their time and skills to the affairs of their Section and/or District.

District 1 Director Tom Ferri nominated: Geoffrey Putnam, Green & White Mils.; and Douglas Desrochers, Central Massachusetts/Rhode Island.

District 2 Director Harland Thompson nominated: James Dolan, New Jersey; Frank Simone, Philadelphia; Dominick Colasanto, New York; and Brian Cassidy, Long Island.

District 5 director George Fairbanks nominated: Paul Hebert, John Pajak, Mike Skill, Buddy Delaune, O.M. (Tibb) Dickson, Bruce Halilla and family, and John Bruskotter, New Orleans; Dale Delaville, Davis Rayborn, Gary Owens, Markkevin Spencer, Cal Pepper, and Jeff Knight, Baton Rouge; and Howard Stevens, Jim Cooley, and Roy Ledford, Birmingham.

District 14 Director Robert Richwine nominated: Bennie Flynn, Gary Tucker, Gary Dugger, Tony Brosio, Richard Alley, Josiah Miller, and David Jackson, Indiana; Tim Pinson and Alan Mattox, Lexington; Joseph Kent, Louisville; Victor Shokey and Tully Parker, St. Louis; and John Durbin and Gary Marx, Tri-River.

District 16 Director David Landon nominated John Kirke, Nebraska Section, for his life-long dedication to inspiring students in the field of welding.

Section Membership Awards

The Atlanta Section, District 5, earned the Henry C. Neitzel National Membership Award for the greatest net numerical increase in membership for the year 2010–2011.

The Drake Well Section, District 10, earned the Henry C. Neitzel National Membership Award for the greatest net percentage increase in membership for the year 2010–2011.

Next to the District number listed below is the name of the Section that achieved the greatest percentage increase in membership for the year.

1 — Central Mass/Rhode Island
2 — Long Island
3 — York Central Pennsylvania
4 — Triangle
5 — Atlanta
6 — Niagara Frontier
7 — Wheeling
8 — Holston Valley
9 — Mobile
10 — Drake Well
11 — Saginaw Valley
12 — Racine–Kenosha
13 — Blackhawk
14 — Mississippi Valley
15 — Arrowhead
16 — Mid-Plains
17 — Oklahoma City
18 — El Paso
19 — Spokane
20 — New Mexico
21 — California Central Coast
22 — Fresno

Membership and District Director Awards Announced
District 2 conference attendees are from left (front row) Thomas Colasanto III, Jesse Provler, Brian Cassidy, Herb Browne, and District 2 Director Harland Thompson; (standing) Bob Waite, Dominick Colasanto, Thomas Colasanto, Ken Stockton, Rob Saltzstein, Michael Chomin, Kenneth Temme, Jim Dolan, Tom Gartland, Gus Manz, and Al Fleury.

District 1
Thomas Ferri, director
(508) 527-1884
thomas_ferri@thermadyne.com

CONNECTICUT
JUNE 18
Activity: The Section held a testing session for CWI, CWE, SCWI, CWSR, and CWI 9-year recertification candidates at the Sheraton at Bradley International Airport in Windsor Locks, Conn. Russ Norris was test supervisor, assisted by Nissa Norris and Tim Kinnaman.

MAINE
May 24
Speaker: Jon Theberge, welding instructor
Affiliation: Seacoast School of Technology
Topic: The SENSE study program
Activity: The Section held its biannual craft committee meeting to discuss welding class projects and the move to the SENSE program next year. The event was held at Seacoast School of Technology in Exeter, N.H.

District 2
Harland W. Thompson, director
(631) 546-2903
harland.w.thompson@us.ul.com

District 2 Conference
JUNE 4
Activity: Harland Thompson, District 2 director, held the conference at Pantagis Renaissance in Scotch Plains, N.J. Attending were Thomas Colasanto III, Jesse Provler, Brian Cassidy, Herb Browne, Bob Waite, Dominick Colasanto, Thomas Colasanto, Ken Stockton, Mike Chomin, Kenneth Temme, Jim Dolan, Tom Gartland, Gus Manz, Al Fleury, and Rob Saltzstein, AWS staff representative.

District 3
Michael Wiswesser, director
(610) 820-9551
mike@welderinstitute.com

Shown at the Maine Section meeting are (from left) Russ Norris, presenter Jon Theberge, Mark Stock, Adam Fallon, and Paul Plourde.

Russ Norris (left), Nissa Norris, and Tim Kinnaman supervised certified welding inspector testing for the Connecticut Section.
Shown at the Lancaster Section board meeting are from left (seated) John Boyer and John Ganoe, (standing) David Watson, Brian Gross, Joe Young, Tim Siegrist, Mike Sebergandio, Robert Blauser, and Justin Heistand.

Merilyn McLaughlin was recognized for her 22 years of service to the Reading Section.

Thomas Davenport received a Reading Section scholarship to continue his welding studies at LeTourneau University.

LANCASTER
JUNE 1
Activity: The Section held its annual board and reorganization meeting at Graystone Bank Community Room in Mountville, Pa. The incoming slate of officers were elected, and students chosen to receive District scholarships. John Ganoe was nominated for the Section instructor of the year award. Attending the meeting were David Watson, Brian Gross, Joe Young, Tim Siegrist, Mike Sebergandio, Robert Blauser, Justin Heistand, John Boyer, and John Ganoe.

READING
APRIL 28
Activity: The Section held its awards banquet at Lancaster County Career & Technology Center in Mt. Joy, Pa. Merilyn McLaughlin was presented a statue in appreciation for her 22 years of dedicated service to the Section. On behalf of outgoing Section Chair Daniel Milan, Michael Torres received his chairman’s appreciation certificate from Mike Wiswesser, District 3 director. Thomas Davenport received a $750 scholarship toward his LeTourneau University tuition. The following students were recognized as the most outstanding graduates of their respective schools’ welding programs: Travis Chavous, David Huey, Travis Laverty, and Kraig Howe.

WASHINGTON, D.C.
MAY 21
Activity: The Section hosted its 15th annual picnic at Tom Jacobs’ Fish Farm in Cooksville, Md.

NORTH FLORIDA
MAY 24
Activity: The Section met with members of the local chapter of ASNT for a presentation on phased array ultrasonic testing
District 5 conference attendees are (from left) Curtis Warren, Vicki Pinsky, Gilly Burrion, David Ennis, Jennifer Skyles, Al Sedory, AWS Vice President Nancy Cole, Alan Shissler, District 5 Director Steve Mattson, AWS Past President Bill Meyers, and Carl Matricardi.

Shown at the North Florida Section program are (from left) Jason Chapman, Kurt Krueger, Eric Blackwell, John Taylor, Doug Yates, and presenter Keith Erk.

technology. Keith Erk from Olympus conducted the demonstrations. This North Florida Section event was held at Tulsa Welding School in Jacksonville, Fla.

District 6
Kenneth Phy, director
(315) 218-5297
KAPhyInc@gmail.com

SYRACUSE
JUNE 1
Activity: The Section met at Haun Welding Supply in Syracuse, N.Y., for a demonstration of the VRTEX™ 360 virtual reality arc welding trainer. Dale Kapuscinski, a district manager for Lincoln Electric Co., conducted the program.

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

COLUMBUS
APRIL 21
Speaker: Tom Ramsay, computational methods group leader

Activity: The Columbus Section regularly meets with the local chapters of ASM International, ASME, AIAA, SWE, and NACE. Each organization takes a turn hosting a meeting during the year. This program was held at Arlington Banquets in Columbus, Ohio, for 40 attendees.

May 4
Speaker: John Anderson Jr., curator for aerodynamics
Affiliation: National Air and Space Museum

Shown during the Atlanta Section tour are (from left) District 5 Director Steve Mattson, Carl Matricardi, presenter Wayne Blamire, and Chairman David Ennis.

At the Syracuse Section program, Eric Marden (left) tries his hand welding virtually as Dale Kapuscinski adjusts the controls.
Chattanooga Section members and guests are shown at the annual fish fry fund-raising outing in May.

Winning team members at the Columbus Section golf tournament are (from left) John Lawmon (captain), Rick Cippichio, Jim Christopher, and Bob Licka.

Andre Odermatt discussed the history of welding for Dayton Section members.

Ben Finney (right) receives his past chairman’s certificate from Chris Anderson at the Dayton Section program.

Jason West (left) and Matt Jennings fried the fish and hush puppies for the Chattanooga Section’s event.

Briggs Smith (left) and Joe Livesay, District 8 director, feasted at the Chattanooga Section’s fish fry outing.

Topic: Breaking the sound barrier: Aerodynamic breakthroughs that made it possible
Activity: Following Anderson’s presentation, members of the Columbus Section and local technical societies held a question and answer session with the speaker. This program was held at Arlington Banquets in Columbus, Ohio, for 59 attendees.

June 9
Activity: The Columbus Section held its annual golf outing and social event at the Players Club at Foxfire Golf Club in Lockbourne, Ohio. Nine teams participated in the event that raised $1100 for the Section’s scholarship fund. John Lawmon was the winning team captain with teammates Rick Cippichio, Jim Christopher, and Bob Licka. The awards-presentation banquet was held in the clubhouse.

DAYTON
May 10
Speaker: André Odermatt, president
Affiliation: Hobart Institute of Welding Technology (HIWT)
Topic: The history of welding
Activity: Ben Finney received an award in appreciation of his services as chairman from Chris Anderson, scholarship chair. The meeting was held at HIWT in Troy, Ohio.

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

CHATTANOOGA
May 20
Activity: The Section hosted its annual fish fry fund-raising event at Camp Columbus in Hixson, Tenn. Joe Livesay, District 8 director, attended the outing.

GREATER HUNTSVILLE
February 15
Speaker: Cindy Wiggly, director
Affiliation: Marshall Technical School
Topic: The local needs for skilled metal trade workers
Activity: The Greater Huntsville Section members and welding students enjoyed a meal sponsored by the Marshall Technical School’s welding department.

APRIL 22
Activity: Joe Smith, welding instructor at Marshall Technical School, coordinated a welding contest for 44 high school welding students from five counties. The winners in the advanced level were Nathaniel Chester, Jason Ward, and Justin Green. Winners in the first-year category were Justin Douglas, J. D. Moore, and Jordan Forster.

NORTHEAST TENNESSEE
APRIL 5
Activity: The Section held a students’ day program at Tennessee Technology Center in Knoxville, Tenn., for about 80 attendees. Students toured the facility to learn about the importance of welding. Autodarkening hoods, welding gloves, and other prizes were donated by Praxair, Holston Gases, Airgas, A-Welders, and South Doyle High School. Jeff Hankins presented the opening talk.

WEST TENNESSEE
APRIL 15
Activity: The Section hosted a students’ day welding and oxyfuel cutting contest for postsecondary students at Tennessee Technology Center in Jackson, Tenn. Fifty-eight students from five local technology training centers participated in the event. Judging the activities was Eddie Harper, a CWI and a district sales manager for Harris Products Group.

District 9
George Fairbanks Jr., director
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fits@bellsouth.net

District 10
Richard A. Harris, director
(440) 338-5921
richaharris@windstream.net

NW PENNSYLVANIA
MAY 19
Speaker: Harry Sadler
Affiliation: The Lincoln Electric Co.
Topic: Welding codes
Activity: Richard Harris, District 10 director, presented the Section Educator Award to Jesse McIntosh of the Tri State Business Institute. Section Treasurer Marty Siddall received the Section Meritorious Award and the District Director Award for his contributions to the Section. The event was held at Tri State Business Institute in Erie, Pa.

Marty Siddall (left) receives his awards from Richard Harris, District 10 director, at the Northwestern Pennsylvania Section meeting.

Jeff Hankins opened the students’ day program sponsored by the Northeast Tennessee Section.
District 11 representatives are shown at their District conference in June.

District 11
Robert P. Wilcox, director
(734) 721-8272
rmwilcox@wowway.com

District 11 Conference
JUNE 10
Activity: The Central Michigan Section sponsored the event at Lansing Community College in Lansing, Mich. Attending the meeting were Don DeCorte, an AWS director-at-large; Robert Wilcox, District 11 director; and Rob Saltzstein, AWS staff representative.

DETROIT
APRIL 30

NORTHWEST OHIO
APRIL 7
Speaker: Karl Hoes, welding instructor
Affiliation: The Lincoln Electric Co.
Topic: Materials and processes used for welding competition vehicles
Activity: This was the Section’s 15th annual Lincoln Electric motorsports welding night event. Featured was a hands-on demonstration of virtual arc welding training equipment. The five highest scorers won a welding helmet. The Lincoln demonstration truck was on site for demonstrations. Charlie Stewart made a presentation on the proper methods for oxyacetylene cutting. Thirty competition vehicles were on display including models from the Universities of Toledo, Northwest Ohio, and Bowling Green State. More than 1500 visitors attended the event.
Shown are the attendees at the District 12 conference held in Manitowoc, Wis.

Bill Dawson addressed the Madison-Beloit Section meeting.

District 12

Daniel J. Roland, director
(715) 735-9341, ext. 6421
daniel.roland@us.fincantieri.com

District 12 Conference
MAY 20
Activity: The District 12 conference was held in Manitowoc, Wis., conducted by Dan Roland, District director. Attending were Director-at-Large Sean Moran and Jeff Weber, AWS staff representative.

MADISON-BELOIT
APRIL 20
Activity: Section members and students from Madison Area Technical College toured Pro Metal Works, Inc., and its subcontracting company Service Welding LLC. Section Treasurer Bill Dawson, owner of Service Welding, conducted the tour and later gave a presentation at the dinner held at Sunset Grill in Deforest, Wis.

MILWAUKEE
MAY 23–25
Activity: The Section cosponsored the biannual National Robotic Arc Welding Conference and Exhibition with the AWS D16 Committee, FMA, John Deere, and the Milwaukee Area Technical College (MATC). The talks were presented at the college and Clarion Hotel & Conference Center. Highlights included tours of John Deere Corp. and Miller Electric Corp. Dean Elkins, senior general manager at Motoman, Inc., and chairman of the Robotic Industries Association, was the keynote speaker. He discussed the 50 years of robotic automation and the future of American industry. Attending were Jeff Noruk, president, Servo-Robot; and John Hinrichs, chairman, Friction Stir-Link. Milwaukee Section scholarships were awarded to Kyle Krause, Ron Noval, Scott Kitzman, Mark Weinfurter, Larry Love, and Alicia Addams.

Madison-Beloit Section members and area welding students are shown during their tour.

The Milwaukee Section scholarship winners are (from left) Kyle Krause, Ron Noval, Scott Kitzman, Mark Weinfurter, Larry Love, and Alicia Addams.

Shown at the Milwaukee Section-sponsored National Robotic Arc Welding Conference are (from left) Jeff Noruk, John Hinrichs, and speaker Dean Elkins.
District 14 conference participants included (from left) John Durbin, Gary Marx, Tony Brosio, Tully Parker, Coy Hill, Joe Kent, Gary Tucker, Joyce Kent, Dru Harmas, Bennie Flynn, District 14 Director Bob Richwine, and James Mattox.

St. Louis champion golfers include (from left) A Flight team: A. Thomas, B. Garner, L. Miller, and W. Ford; B Flight team: D. Laroue, S. Cordevani, and D. Baumer; and C Flight team: M. Meyers, A. Schumann, T. Standfield, and J. Gladish.

Shown at the Indiana Section’s tour of Indianapolis Motor Speedway are (from left) Tony Brosio, District 14 Director Bob Richwine, Tom Simpson, and Guy Blanchard.

Tully Parker (right) received the District Meritorious Award from Bob Richwine, District 14 director, at the District conference.

Presenter David Thayer (left) is shown with Craig Tichelar, Chicago Section chair.

District 13
W. Richard Polanin, director
(309) 694-5404
rpolanin@icc.edu

CHICAGO
May 11
Activity: The Section members, led by Chair Craig Tichelar, visited the Lincoln Electric Co. facility in Bolingbrook, Ill., to learn about its customer training operations. David Thayer discussed the program and guided the tour.

District 14
Robert L. Richwine, director
(765) 378-5378
bobrichwine@aol.com

District 14 Conference
June 4
Activity: The Tri-River Section hosted the event at Ivy Tech Community College in Evansville, Ind. Tully Parker received the District Meritorious Award from Bob Richwine, District 14 director. The District presented $8100 in scholarships. The AWS staff representative was Monica Pfarr, corporate director, AWS Foundation, Inc., Solutions Opportunity Squad.
George Young (white shirt) presented a seminar on explosion welding for the Black Hills Student Chapter members.

Black Hills Student Chapter members worked with Michael Prugh (white shirt) to build this custom-designed motorcycle.

INDIANA
MAY 20
Activity: The Lincoln Electric Co. invited the Section members for a tour of Gasoline Alley at the Indianapolis Motor Speedway.

ST. LOUIS
JUNE 6
Activity: The Section hosted its annual golf outing and scholarship fund-raising event at Fox Creek Golf Course in Edwardsville, Ill. The members on the three teams with the lowest scores included A. Thomas, B. Garner, L. Miller, W. Ford, D. Laroue, S. Cordevant, D. Baumer, M. Meyers, A. Schumann, T. Standfield, and J. Gladish.

Black Hills Student Chapter
Activities: During the year, the Student Chapter recruited 20 new members, held two meetings, four workshops, and toured HS Precision in Rapid City, S.Dak. The workshops included seminars on explosion welding presented by George Young, friction stir welding fundamentals, and work with motorcycle designer Michael Prugh on a custom motorcycle used in the 2010 Legends Ride event held in Sturgis, S.Dak. They also participated in the ASM Materials Camp, and performed community service by renovating the metal entrance gates to the Rapid City Storybook Island children’s park.

IOWA
MAY
Activity: The Vermeer Corp. was recently awarded a Workforce Development Grant from the AWS Foundation for the training of 55 new welders. Rich Kacmarynski, Vermeer Corp. training and development specialist, accepted the award from Chair Rick Guffey and Dave Landon, District 16 director.

District 16
David Landon, director
(641) 621-7576
dlandon@vermeermfg.com

KANSAS
JUNE 15
Activity: For the last activity of the 2010–2011 season, 22 Section members
Participating in the April 28 Central Arkansas program were (from left) Chair Dennis Pickering, Michael Dugan, presenter Jimmy Brewer, and George Seahorn.

Shown at the Rio Grande Valley program are (from left) District 18 Director John Bray, Hector Rendon, Israel Garza, Chair Ray Rivera, and Richard Salinas.

Judges in the Utah SkillsUSA welding competition are (from left) Bob North, Michelle Nicholson, Red Anderson, Rex Hardman, Mike Ramstetter, and Stuart Talbot.

and guests enjoyed a picnic dinner together before attending the Wichita Wingnuts baseball game at Lawrence-Dumont Stadium in Wichita, Kan.

**District 17**

J. Jones, director
(940) 368-3130
jjones@thermadyne.com
Awardees at the Colorado Section program are (from left) Steve Unrein, James Corbin, John Steele, Jesse Grantham, Tom Kienbaum, Dean Mitchell, and David Murphy.

CENTRAL ARKANSAS
APRIL 20
Activity: The Section members manned a booth at the SkillsUSA competitions held in Hot Springs, Ark. AWS memberships were awarded to the students who placed in the welding competition. Chairman Dennis Pickering presented a Distinguished Service certificate to Jimmy Brewer of the United Assoc. of Plumbers and Pipefitters Local #155 for his contributions to the Section’s activities.

APRIL 28
Speaker: Jimmy Brewer
Affiliation: United Assn. of Plumbers and Pipefitters Local #155
Topic: The American Welding Society
Activity: Following the talk, Brewer presented a demonstration of an orbital welding machine. The program was held at the University of Arkansas in Fort Smith, Ark. Participating were Chair Dennis Pickering, Michael Dugan from the University of Arkansas at Ft. Smith, and George Seaborn from the United Assn. of Plumbers and Pipefitters Local #29.

District 18
John Bray, director
(281) 997-7273
sales@affiliatedmachinery.com

RIO GRANDE VALLEY
JUNE 8
Activity: This new Section nominated its incoming slate of officers. Named were Ray Rivera, chairman; Richard Salinas, secretary and treasurer; and Hector Rendon, educational representative. District 18 Director John Bray presented Israel Garza the District Educator Award. The program was held at Longhorn Cattle Co. Barbecue and Steak House in San Benito, Tex.

SAN ANTONIO
MAY

District 19
Neil Shannon, director
(503) 201-5142
neilshnn@msn.com

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

COLORADO
MAY 12
Speaker: Brian Heft
Affiliation: Petrogen, Inc.
Topic: Features of the Petrogen cutting torch system
Activity: The Section held its election of its board members. Awards were presented to Steve Unrein, David Murphy, and Tom Kienbaum for Section Meritorious Awards; James Corbin, Section Private Sector Instructor Award; Lynn Sturgill, District Private Sector Instructor Award; John Steele, District Educator Award; Jesse Grantham, District CWI Award; Ruben Vinton, Section Educator Award; and Dean Mitchell, Section CWI and Section Chairman Awards.

District 21
Nanette Samanich, director
(702) 429-5017
nan07@aol.com

District 22
Dale Flood, director
(916) 288-6100, ext. 172
d.flood@tritool.com

International Section

SAUDI ARABIA
Calendar
The 14th Middle East Corrosion Conference & Exhibition is scheduled for Feb. 12–15, 2012, at Gulf International Convention Center Gulf Hotel, Kingdom of Bahrain. Contact Dr. Moufaq Jafar, Chair, technical committee, moufaq.jafar@aramco.com; or visit www.mecconline.org.
Congratulations to the top recruiters Eleanor Ezell for Individual Members and Michael Pelegrino for Student Members in the 2010–2011 MGM campaign. Listed below are the May 31, 2011, standings.

For complete campaign rules and prize list, see page 81 of this Welding Journal, or visit www.aws.org/mgm. Call the Membership Department, (800) 443-9353, ext. 480, regarding your member-proposer point status.

**Winners Circle**

Listed are the sponsors of 20 or more Individual Members/year, since June 1, 1999. The superscript denotes the number of years the member earned Winners’ Circle status.

E. Ezell, Mobile 8
J. Compton, San Fernando Valley 7
J. Merzthal, Peru 2
G. Taylor, Pascagoula 2
J. Taylor, Pascagoula 2
B. Chin, Auburn 1
S. Esders, Detroit 1
M. Haggard, Inland Empire 1
M. Karagoulis, Detroit 1
S. McGill, NE Tennessee 1
B. Mikeska, Houston 1
W. Shreve, Fox Valley 1
T. Weaver, Johnstown/Altoona 1
G. Woomer, Johnstown/Altoona 1
R. Wray, Nebraska 1

**President’s Guild**

Sponsored 20 or more new members

E. Ezell, Mobile 28

**President’s Roundtable**

Sponsored 9–19 new members

G. Kirk, Pittsburgh 17
M. Pelegrino, Chicago 15

**President’s Club**

Sponsored 3–8 new members

M. Tryon, Utah 8
T. Crane, Drake Well 7
J. Daubert, Northern New York 6
C. Simmons, Atlanta 6
D. Wright, Kansas City 6
H. Rosario, Central Texas 5
T. Barber, San Fernando Valley 4
R. Dawson, Western Carolina 4
J. Drolon, Kansas City 4
D. Evancezyk, Louisville 4
J. Hope, Puget Sound 4
J. Hopwood, Iowa 4
D. Steyer, Niagara Frontier 4
W. Sturge, New York 4
G. Bish, Atlanta 3
H. Cable, Pittsburgh 3
C. Crompton, Florida W. Coast 3
P. Ellenbecker, Fox Valley 3
M. Haggard, Inland Empire 3
R. Hutchinson, Long Bch/Oc. Cty 3
D. McCuaied, Pittsburgh 3
F. Oravets, Pittsburgh 3
W. Sartin, Long Bch/Oc. Cty 3
G. Seese, Johnstown-Altoona 3

**President’s Honor Roll**

Sponsored 2 new members

M. Allen, Charlotte
D. Berger, New Orleans
J. Carney, W. Michigan
J. Fox, NW Ohio
R. Fuller, Florida W. Coast
J. Gerdink, Northwest
G. Hamilton, Houston
J. Hill, Nebraska
A. Holt, St. Louis
J. Kline, Northern New York
A. Laubs, Lakeshore
R. Marslender, New Jersey
F. Nguni, New Jersey
T. Palmer, Columbia
B. Severson, Iowa
G. Siepert, Kansas
R. Wahrman, Triangle
W. Wall, Auburn
D. Wantz, York-Central Pa.
G. Watry, Madison-Beloit
S. Witkowski, Houston
G. Scherer, Wyoming 14
R. Wahrman, Triangle 14
M. Arand, Louisville 13
R. De Luna, Cuatitlan Izcalli 13
C. Dommel, NW Ohio 13
G. Watry, Houston 13
B. Wenzel, Sacramento 13
R. Boyer, Nevada 12
J. Daughtery, Louisville 12
J. Goodson, New Orleans 12
W. Harris, Pascagoula 12
J. Boyer, Lancaster 11
D. Porter, Nashville 11
J. Tiberger, Boston 11
R. Metheney, Stark Central 10
K. Rawlings, Columbia 10
R. Young, Iowa 10
A. Badeaux, Washington, D.C. 9
C. Kipp, Lehigh Valley 9
D. Kowalski, Pittsburgh 9
G. Putnam, Green & White Mts. 9
C. Renfro, Chattanooga 9
G. Siepert, Kansas 9
S. Ulrich, St. Louis 9
V. Covey, Central Texas 8
A. Duron, New Orleans 8
T. Green, Central Arkansas 8
M. Kacker, Milwaukee 8
T. Moore, New Orleans 8
R. Beluzzi, New York 7
K. Kears, Northern Michigan 7
D. Ketler, Willamette Valley 7
J. Kline, Northern New York 7
A. Perazzone, Arizona 7
J. Johnson, Madison-Beloit 6
S. Silverstein, Milwaukee 6
H. Thompson, Long Island 6
S. Colton, Arizona 5
J. Gerdink, Northwest 5
R. Ledford, Birmingham 5
J. Moyer, San Francisco 5
J. Morash, Boston 5
T. Smeltzer, San Francisco 5
B. Suckow, Northern Plains 5
B. Benyon, Drake Well 4
W. Galvery, Long Bch/Oc. Cty 4
A. Holt, St. Louis 4
S. Mackenzie, Northern Michigan 4
C. Warren, N. Central Florida 4
D. Aragon, Puget Sound 3
R. Bass, Tulsa 3
R. Chase, L.A./Inland Empire 3
B. Clark, Iowa 3
J. Fitzpatrick, Arizona 3
R. Harris, Spokane 3
R. Hilty, Pittsburgh 3
J. Hope, Puget Sound 3
J. Mahoney, N. Central Florida 3
J. Mahoney, Central Florida 3
S. Miner, San Francisco 3
F. Pruitt, Greater Huntsville 3
G. Rolla, L.A./Inland Empire 3
J. Seitzer, York-Central Pa. 3
C. Shipp, San Diego 3
J. Sullivan, Mobile 3
The company has redesigned its MIG Tips electronic newsletter to offer more links to valuable welding information, and options for sharing on social media sites, such as Twitter and Facebook. The free quarterly publication provides the latest news on the company’s welding products and includes welding basics, practical advice for improving productivity and quality in the welding operation, and information on industry events. To subscribe to the newsletter, visit the Web site shown.

Bernard Welding Equipment
www.bernardwelds.com/migtips_signup.php
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Steel Bumper Manual Revised

The just-released fourth edition of the Steel Bumper Systems for Passenger Cars and Light Trucks Product Manual is intended to increase the reader’s knowledge of bumper systems and help overcome engineering challenges of passenger car and light truck bumper systems. It offers an overview of an automotive component system, which has undergone significant change in recent years. The information provided is aimed at automotive industry design, manufacturing, purchasing, and safety-related staffs; and steel industry sales and marketing groups. The emphasis is on materials, design, manufacturing, government regulations, and cost. The 190-page PDF has numerous photographs, graphics, charts, and tables, some in full color. The manual can be downloaded free from the Web site shown.

Steel Market Development Institute
www.autosteel.org
(248) 945-4777

API 1104 Pipeline Standard Released

API STD 1104, Welding of Pipelines and Related Facilities, Rev. 20, covers the gas and arc welding of butt, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, and nitrogen. Where applicable, it covers welding on distribution systems. It applies to welding both in-service and new construction. The welding may be done by a shielded metal arc, submerged arc, gas tungsten arc, gas metal arc, flux cored arc, plasma arc, oxyacetylene, or flash welding process or by a combination of these techniques. This standard also covers the procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing, as well as the acceptance standards to be applied to production welds tested to destruction or inspected nondestructively. The 84-page standard may be purchased in hard copy or PDF for $286. Order online or call.

IHS Standards Store
http://global.ihs.com
(877) 413-5184

— continued on page 92
World Class Benefits for Your World Class Members

NEW FOR 2011

World Class Benefits has five new enhancements to your association’s member benefits program. Here is a brief summary of each plan:

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<th>Plan</th>
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<td>CoreHealth Insurance</td>
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<td>- Business class upgrade discount for experienced welding professionals</td>
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For More Information Call 800-955-0418 or e-mail info@wwins.com
NFPA Standard Addresses Fire Prevention

NFPA 51B: Standard for Fire Prevention during Welding, Cutting, and other Hot Work, provides vital requirements for anyone who manages, supervises, or performs hot work, including outside contractors and property managers. The provisions apply to welding and allied processes, heat treating, grinding, thawing pipe, power-driven fasteners, hot riveting, and similar applications producing a spark, flame, or heat. New requirements are listed for approved welding blankets, pads, and curtains, and updated permit information. The 18-page, soft-bound or PDF document lists for $32, $28 for NFPA members.

National Fire Protection Assn.
www.nfpa.org/index.asp
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Laser Product Guide for Photonics Research

The Resource Catalog for photonics research products and related applications includes products from all of the company’s brands, including Corion®, New Focus™, Oriel® Instruments, Richardson Gratings™, and Spectra-Physics® Lasers. It is designed as a learning resource and product guide for optoelectronics engineers, universities, and photonics researchers. The free guide features 1632 pages and highlights 2440 new products. In addition, there are more than 200 pages of technical and application notes, plus instructive reference information, definitions and characteristics for tunable diode...
Know an individual, company, educator, or educational facility that exemplifies what welding is all about? Nominate them for the

9th Annual

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- **Large Business** (200 or more employees)
- **Small Business** (less than 200 employees)
- **Distributor** (welding products)
- **Educator** (welding teacher at an institution, facility, etc.)
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For more information and to download the PDF nomination form online, visit www.aws.org/awards/image.html or call 800-443-9353.
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Ninth Edition, Volume 1, Welding Science and Technology

Presents the latest developments in the basic science and technology of welding, and general descriptions of processes, continues with chapters on the physics of welding and cutting; heat flow; welding metallurgy; design; test methods; residual stress; welding symbols; tooling and positioning; monitoring and control; mechanical, automated, and robotic techniques; economics; weld quality; inspection; qualification and certification; welding codes and standards; and safe practices. 932 pages, 17 chapters, 2 appendices, 530 illustrations, 168 tables, hardbound. 8" x 10", (2001).

WHB-1.9 $192 nonmembers/$144 members


Presents comprehensive information on welding and related processes. Contains detailed information on arc welding power sources; shielded metal arc, gas tungsten arc, gas metal arc, flux cored arc, submerged arc, and plasma arc welding processes. Includes chapters on electron beam welding, stud welding, oxyfuel gas welding, brazing, soldering, oxygen cutting, and arc cutting and gouging. 736 pages, 15 chapters, 260 line drawings, 100 photographs, 448 tables, hardbound. 8" x 10", (2004).

WHB-2.9 $192 nonmembers/$144 members


Over 600 pages of comprehensive information on solid-state and other welding and cutting processes. The book includes chapters on resistance spot and seam welding, projection welding, flash and upset welding and high-frequency welding. In addition to a chapter on friction welding, a new chapter introduces friction stir welding. The most recent developments in beam technology are discussed in the greatly expanded chapters on laser beam welding and cutting and electron beam welding. A diverse array of processes are presented in chapters on the ultrasonic welding of metals, explosion welding, diffusion welding and diffusion brazing, adhesive bonding and thermal and cold spraying. The last chapter covers various other welding and cutting processes, including modernized water jet cutting, 669 pages, 15 chapters, 3 appendices, 438 illustrations, 59 tables; hardbound. 8" x 10", (2007).

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Extensively revised and updated from the eighth edition, this comprehensive volume had more than 50 experts in materials and materials applications assure its accuracy and the currency of its content. It is a great reference source for engineers, educators, welding supervisors, and welders. Covers carbon and low-alloy steels; high-alloy steels; coated steels; tool and die steels; stainless and heat-resisting steels; clad and dissimilar metals; surfacing; cast irons; maintenance and repair welding; and underwater welding and cutting. Includes more than 500 tables, charts, and photos. 779 pages, 10 chapters; hardbound. 8" x 10", (2011).

WHB-4.9 $192 nonmembers/$144 members


Covers nonferrous metals, plastics, composites, and ceramics; specialized topics on maintenance and repair welding; underwater welding and cutting. Includes applications of the specific metals and processes, weldability, safety practices. Best copy available, 538 pages, 10 chapters, softbound. 8½" x 10"/. (1996).

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Norris Cylinder Designates Marketing VP

Norris Cylinder Co., headquartered in Longview, Tex., has appointed Victor Palzes vice president of sales and marketing for both the Huntsville, Ala., and Longview locations. Previously, Palzes served in a similar position for eleven years with Genstar Technologies.

Toshiba Imaging Appoints National Sales Manager

Toshiba Imaging Systems Division, Irvine, Calif., a provider of high-definition camera technology for industrial, machine vision, diagnostics, military, microscopy, and broadcast applications, has named Gary Pitre national sales manager. Prior to this appointment, Pitre served as Eastern regional sales manager for Toshiba America Information Systems — Imaging Systems Division since 2006.

CenterLine Appoints USA Representative

CenterLine (Windsor) Ltd., Windsor, Ont., Canada, a provider of welding, metal forming, and cold spray products and services for the automotive, mass transit, aerospace, and defense industries, has named Stuart Rogers southeast U.S.A. manufacturer’s representative. Prior to joining the company, Rogers worked eight years as an independent manufacturer’s representative for two European welding equipment suppliers.

FMA Names President

The Fabricators & Manufacturers Assn., Infl (FMA), Rockford, Ill., has announced the retirement of Gerald M. Shankel as president and CEO, effective Oct. 1. Edward S. Youdell, group publisher for FMA Communications, Inc., was named to succeed him in the post. Shankel, who served in the position since 2002, will serve as president emeritus until he leaves the organization at the end of the year.

Doncasters Names Chair

Doncasters Group Ltd., Staffordshire, UK, a precision engineering group wholly owned by Dubai International Capital, has appointed Tariq Jesrai chairman, effective immediately. Jesrai previously served as CEO of McKechnie Aerospace.

ARC Specialities Hires Sr. Welding Engineer

ARC Specialties, Inc., Houston, Tex., a supplier of automated and robotic welding systems, has appointed Dave Hebble senior welding engineer. Hebble previously was a field application engineer at ESAB, specializing in process and application development for multiwire submerged arc welding, plasma cutting, and gouging.

ASQ Announces Officers for 2012

The American Society for Quality (ASQ), Milwaukee, Wis., has announced the following slate of officers for the 2012 term beginning July 1, 2011. James J. Rooney, chair; John Timmerman, chair-elect; William B. McBee, treasurer; E. David Spong, past chair; and newly elected board members Joanne D. Mayo and Kathleen Goonan. Due to the society’s change from a fiscal year to a calendar year, the incoming officers will serve 18-month terms, ending Dec. 31, 2012.

Insteel Names Board Member

Insteel Industries, Inc., Mount Airy, N.C., a manufacturer of welded steel wire reinforcing products for concrete construction applications, has appointed Duncan S. Gage to serve on the audit com-
committee of its board of directors. Gage currently serves as president and CEO of Giant Cement Holding, Inc.

**Eriez® Names Director of North American Sales**

Eriez®, Erie, Pa., has promoted Dave Heubel to the newly created position of director — North American sales. The promotion comes as a result of the company’s announcement that it is combining its U.S. and Canadian sales organizations into a consolidated North American sales team. With the company since 1990, Heubel previously was national sales manager for the U.S. light and heavy industry markets.

**AMT Names Automotive Account Manager**

Applied Manufacturing Technologies (AMT), Orion, Mich., has appointed Richard Saro automotive account manager. He joins the Automotive Engineering Group to support and partner with new and existing customers to develop innovative automation solutions. Prior to joining the company, Saro held key global program and project management positions at Rockwell Automation and Comau Pico, Inc., working with Daimler, Ford, and General Motors.

**PAS Technologies Names Key Account Manager**

PAS Technologies, Inc., Kansas City, Mo., a supplier of repair and overhaul solutions for the aerospace and industrial markets, has named Paul Goodrum key account manager to lead the company’s strategy with Rolls-Royce and its key first-tier suppliers. Goodrum has more than 30 years’ experience in the aerospace business, most recently as technical sales manager at Dunlop Aircraft Tyres, Ltd.

**Joining Technologies Taps Engineering Manager**

Joining Technologies, Inc., East Granby, Conn., a supplier of precision fusion processes, laser and electron beam welding, and weld system design and integration, has promoted Salay Stannard to materials engineering manager. Since 2009, Stannard served the company as a process development engineer, concerned with laser welding of medical, aerospace, and defense components.

**European Laser Institute Confirms Chair**

The European Laser Institute, Aachen, Germany, representing 31 association members from 14 European countries, has reelected Stefan Kaierle chair of its executive board for an additional two years. The institute also works in close collaboration with the Laser Institute of America.

**RMT Robotics Appoints Customer Care Manager**

RMT Robotics®, a Cimcorp Oy company and supplier of robotic gantry material handling systems, has named Dave Barker customer care manager. Prior to joining the company, Barker served 12 years at Automated Tooling Systems, most recently as manager of technical services.

**SME Inaugurates Awards for Educators**

The Student Relations Committee of the Society of Manufacturing Engineers (SME), Dearborn, Mich., has awarded its inaugural Faculty Advisor Professional Development Award to four educators committed to the next-generation of manufacturing professionals. The awardees are Christopher Gallagher, Bahram Aslabanpour, Ross Monroe, and Daniel Kandray. Gallagher is with Olympic College, Bremerton, Wash.; Aslabanpour serves Texas State University, San Marcos, Texas; Monroe works at Edmonds Community College in Lynnwood, Wash.; and Kandray is with the University of Akron, Akron, Ohio. This annual award recognizes the service of faculty advisors to SME and its student chapters in advancing manufacturing knowledge, education, and the society’s strategic plan. It includes awards of up to $2000.

**Obituaries**

**Frederick Schulze**

Frederick Schulze, 78, died June 10 in Florence, S.C. An AWS member from 1976 to 1995, he served with the South Carolina Section. Well known in the welding industry, Schulze worked for International Rectifier, Harrischfeger (A. O. Smith), Miller Electroic, ESAB, and retired as president of Basler Electric Co. He earned the rank of Eagle Scout and the Order of the Arrow in the Boy Scouts of America, and served as a sergeant first class in the U.S. Army. He enjoyed yachting with his family and numerous hobbies. He is survived by his wife of 56 years, Judith, two sons, two daughters, a brother, a sister, and eight grandchildren. Memorials may be made to McLeod Hospice House, 1203 E. Cheves St., Florence, SC 29506; or The American Diabetes Assn., 2711 Middleburg Dr., Ste. 108B, Columbia, SC 29204.

**Joe Alvarez Jr.**

Joe Alvarez Jr., 68, died June 14 at his home in Pearland, Tex. He was a co-owner with Jerry Koza of several companies, including Profax, Associated Equipment Co., Southern Welding Systems International, Associated Welding Supply, and Affiliated Machinery, Inc., all located in Pearland, Tex.; Tempil in South Plainfield, N.J.; Lenco NLC, Inc., in Jackson, Mo.; and Independent Welding Wholesale Co., in Sydney, Australia. He served in the U.S. Navy as a cryptologist from 1962 to 1968. He is survived by his wife, Sandy, two daughters, his parents, and other relatives, all residing in Pearland. Memorials may be made to the Brain and Spine Center, MD Anderson, www.mdanderson.org.

**Seabury Waring Jr.**

Seabury Bassett Waring Jr., 56, died June 26 at his home in Rumford, R.I. He was a self-employed welding engineer and an AWS Certified Welding Inspector for many years. An AWS member since 1989, he held the post of certification chair for the Boston Section for many years. He was an alumnus of The Ohio State University and Moses Brown School, and a member of ASNT and other technical societies. He is survived by his wife, Sheila Marie Vierra, a daughter, a son, and six grandchildren.
NEWS OF THE INDUSTRY
— continued from page 14

company is building the Hanford Waste Treatment Plant and is in need of welders for its construction. According to welding instructor Chris Mitchell, the money was used to buy four track torches, a vertical belt sander, and five welding machines.

• Airgas, Inc., Radnor, Pa., has completed the acquisition of ABCO Gases, Welding and Industrial Supply Co., Inc., Waterford, Conn., and aligned its 12 regional companies into four new divisions, including North, South, Central, and West.

• J M Eagle, a plastic pipe manufacturer, was honored by the U.S. Environmental Protection Agency for achieving energy-efficiency goals at its facilities in Hastings, Neb.; Wharton, Tex.; Butner, N.C.; and Stockton, Calif.

• GRT-Mars, Inc., President Geoff Engelstein recently announced the contract manufacturing and engineering company in Mountainside, N.J., will be changing its name to Mars International, Inc., and its Web site address to www.marsint.com.

• Genesis Systems Group, LLC, Davenport, Iowa, and ICESA Modicon, San Juan del Rio, Queretaro, Mexico, have formed a joint venture enterprise. Genesis-ICESA Systems will share its knowledge with local support and use resources from both companies to become a robotic systems integrator in Mexico.

• Hayden Corp., a Massachusetts-based thermal spray coating company, has an improved site at www.haydencorp.com. It features expanded content and the Hayden Learning Center with presentations, video clips, and an interactive applications guide.

• Magnum Pv, Brampton, Ont., Canada, has partnered with Schmid Technology Systems GmbH to establish a 72-MW solar PV panel manufacturing line. At the system’s center is an automated tabber stringer with contactless resistance soldering.

• The Knight School of Welding moved into a new 20,000-sq-ft building in Louisville, Ky. According to Executive Director Dave Tofaute, Owner Melvin C. Hobbs was looking for a permanent location to house the school to earn accreditation as a testing facility through the American Welding Society.

• The Aluminum Association has three new members — Harsco Metals, Harrisburg, Pa.; Reliant Aluminum Products, High Point, N.C.; and PLS Logistics Services, near Pittsburgh, Pa.

• South Carolina Gov. Nikki Haley, the South Carolina Dept. of Commerce, and Alliance Pickens announced metalworking firm VCI-SC Inc. will establish a facility in Pickens County. The $2 million investment is expected to generate 50 new jobs.

• Star Safety & Security Consultancy SSSC, an inspection, testing, and certifying company, also an AWS Educational Institution member, has started its operation in Abu Dhabi, UAE.

• Hobart Brothers Co. and ITW Food Equipment Group, Troy, Ohio, have each donated $10,000 to the Overfield Early Childhood Program to support the school’s annual fund.

• Dynamic Fabrication, Inc., Santa Ana, Calif., a contract metalworking firm, is celebrating its 30th anniversary. The company’s president and founder is Mike Kartsonis.

• Saint-Gobain Technical Fabrics has recently changed its company name to Saint-Gobain ADFORS, meaning to “add reinforcement” to your building or product.

• The International Association for Continuing Education and Training has recertified Motoman Robotics, a division of Yaskawa America, Inc., as an Authorized Provider under the new ANSI/IACET 1-2007 Standard.

• The Lincoln Electric Co. was recently honored by Cleveland-based Inside Business magazine with the Manny Award in the New Product Development category for the VRTEX® 360 virtual reality arc welding trainer.

Consumables: Care and Optimization. Free online e-courses on the basics of plasma consumables for plasma operators, sales, and service personnel; www.hyperthermcuttinginstitute.com.

Crane and Hoist Training for Operators. Konecranes Training Institute, Springfield, Ohio; www.konecranesamericas.com; (262) 821-4001.


EPRI NDE Training Seminars. Training in visual and ultrasonic examination and ASME Section XI. Sherryl Stogner (704) 547-6174; sstogner@epri.com.

Environmental Online Webinars. Free, online, real-time seminars conducted by industry experts. For topics and schedule, visit www.augustmack.com.

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Hellier NDT Courses. Hellier, 277 W. Main St., Ste. 2, Niantic, CT 06357; (860) 739-8950; FAX (860) 739-6732.


INTEG Courses. Courses in NDT disciplines to meet certifications to Canadian General Standards Board or Canadian Nuclear Safety Commission. The Canadian Welding Bureau; (800) 844-6790; www.cwbgroup.org.


NACE Int'l Training and Certification Courses. National Assoc. of Corrosion Engineers; (281) 228-6223; www.nace.org.


NDT Courses and Exams. Brea, Calif., and customers' locations. Level I and II and refresher courses in PA, UT, MP, radiation safety, radiography, visual, etc. Test NDT, LLC; www.testndl.com; (714) 255-1500.

Online Education Courses. Topics include Introduction to Die Casting ($99), Metal Melting and Handling ($99), Product Design ($59), Energy Training ($19), Cross Training ($19), Managing Dust Hazards ($19), Safety (free), North American Die Casting Assn., www.diecasting.org/education/online; or call (847) 808-3161.


Protective Coatings Training and Certification Courses. At various locations and online. The Society for Protective Coatings; (877) 281-7772; www.spc.org.

Robotics Operator Training. Presented by ABB University at 13 locations nationwide. For course titles and locations: www.abb.us/abbuniversity; (800) 435-7365, opt. 2, opt. 4.


Servo-Robot Training Seminars. Two-day seminars held throughout the year at Servo-Robot, Inc., near Montreal, Canada. Seminars include tutorials and hands-on practical training. For seminar schedule and costs, e-mail request to info@servorobot.com.


SSPC Training and Certification Courses. Courses in protective coatings, abrasive blasting, paint inspector, bridge coatings inspector, surface preparation, NAVSEA inspector, and many others. The Society for Protective Coatings; www.spc.org.

Thermadyne® Distributor Training. Year-around training at Denton, Tex.; West Lebanon, N.H.; Bowling Green, Ky.; and Chino, Calif.; (940) 381-1387; trainingteam@thermadyne.com.


Welding Introduction for Robot Operators and Programmers. This one-week course is presented in Troy, Ohio, or at customers' locations. Hobart Institute of Welding Technology; (800) 332-9448, ext. 5603; www.welding.org.

Welding Skills Training Courses. Courses include weldability of ferrous and nonferrous metals, arc welding inspection, quality control, preparation for recertification of CWIs. Hobart Institute of Welding Technology; (800) 332-9448; www.welding.org.

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All about Welding Nozzles

Tips are offered for determining the best nozzle design for a given application, along with maintenance advice that can measurable impact quality and productivity.

BY DAVID BELLAMY AND JEFF WELLS

Like other gas shielded metal arc (GMAW) gun consumables, nozzles are often an overlooked component in the welding operation — Fig. 1.

However, knowing how to select the best nozzle for a given welding application can have a measurable impact on the quality, productivity, and overall cost of the welding operation. That's because the nozzle is responsible for directing the shielding gas to the weld pool and protecting it from contamination. Without proper gas flow, the weldment is prone to a number of problems, including excessive spatter and porosity that can ultimately lead to downtime for rework. Plus, using the wrong nozzle for an application may cause overheating that leads to premature consumable failure.

For these reasons, it is important to select the right shape and style of nozzle, as well as the right material for each application. Also, knowing how to store and handle nozzles properly can go a long way in helping keep the welding operation up and running. Consider these tips.

What Are the Best Nozzle Shapes, Styles, and Materials?

When selecting a nozzle, the goal is to find one that provides the best joint access for the application and allows for the proper gas flow to the weld pool. Keep in mind that nozzles with smaller inside diameters may be more prone to collect spatter, so it is better to use a nozzle with the largest possible inside diameter to ensure greater gas flow.

Nozzles are available in several shapes, including straight, bottleneck, and short or long tapers. Straight nozzles typically have larger inside diameters (e.g., ½ in.), but the joint access is not as good. Bottleneck nozzles can improve this situation, particularly for automated welding applications. A common inside diameter for a bottleneck nozzle is ½ in.

Semiautomatic applications often use short and long taper nozzles, although the former are also common in automated welding. Note, that long taper nozzles typically have smaller inside diameters and thus may collect spatter more readily. When possible, use a short taper nozzle to minimize this problem.

Each nozzle shape is usually available in standard and heavy-duty styles, and in slip-on or thread-on varieties. Heavy-duty nozzles have thicker walls, as well as thicker insulators, and are designed for use in high-current applications ranging
Nozzles are typically available in brass or copper, although chrome-plated nozzles are also available. Brass nozzles tend to resist spatter well and are good for lower-current applications (100 to 300 A), whereas copper nozzles are better for high-current applications (above 300 A) and for those with longer arc-on time.

Water-cooled nozzles are also available for high-current applications. These circulate coolant around the nozzles and tend to be much more expensive.

From the Nozzle to Contact Tip

The relationship between the nozzle and contact tip can have a significant impact on weld quality and should be selected carefully for each application. Generally, welding operators maintain a recessed or extended contact-tip-to-nozzle relationship. A recessed contact tip offers better gas coverage, but it also shortens the electrode extension. As a result, this contact-tip-to-nozzle relationship offers less accessibility to the joint. Conversely, an extended contact-tip-to-nozzle relationship allows the welding operator greater access into confined areas or joints. In this scenario, however, the shielding gas coverage may not be as good as compared to a recessed contact tip. Typically, an extended contact tip is used in automated applications, but it can also be used in the semiautomatic process. In these applications, there is an increased chance of the welding operator touching the contact tip to the workpiece because of the extension, which could damage the consumable and also cause poor weld quality.

The welding operator will need to weigh these advantages and disadvantages to determine whether a recessed or extended contact tip will provide the better welding performance for the job.

Tips for Making Your Nozzles Last Longer and Perform Better

As with any front-end consumable, handling, storing, and maintaining the nozzle properly helps ensure good welding performance and longevity. Selecting higher-quality nozzles can help, too.

Look for nozzles that have a smooth surface finish and edges, as these resist spatter buildup compared to nozzles that have an uneven surface or burrs on the edges. Heftier nozzles are more desirable than lighter or thinner ones since they tend to resist heat better. Also, consider purchasing nozzles that feature a brass insert, which helps maintain the inner diameter of the nozzle, and prevents the nozzle from rocking and wearing prematurely. The addition of a high-temperature fiberglass insulator can also help extend nozzle life — Fig. 2. Finally, look for heavy-duty crimping on the nozzle. The crimping holds the layers together and is an indication that the nozzle will last longer.

When storing nozzles, keep them in their original packaging, usually a small plastic bag. Removing them from that packaging and placing them in a bin can lead to scratches or dents that allow spatter to adhere and will ultimately shorten the life of the nozzle. Use gloves when handling nozzles or replacing nozzles to prevent dirt, oil, or other contaminants from adhering to them and inadvertently entering the weld pool.

Periodically inspect the nozzle for spatter buildup and clean it using the tool recommended by the manufacturer as needed and/or consider using an anti-spatter compound to protect against spatter — Fig. 3. To apply the antispatter, dip approximately the front inch and a half of the nozzle into the antispatter compound. Avoid submerging the nozzle in the compound, as it can saturate the fiberglass insulator inside and cause it to fail prematurely.

Finally, never use the nozzle to chip away spatter. It can dent or misshape the nozzle, requiring it to be replaced.

As with any front-end consumable, nozzles play an important role in maintaining good weld quality and can have a measurable impact on productivity and costs, too. Take the time to select the right one for each application then maintain it properly. Doing so can minimize downtime and keep your welding operation running smoother.

The goal is to find a nozzle that provides the best joint access for the application and allows for proper gas flow to the weld pool.
Building a Backyard Bridge: One Father’s Journey from Start to Finish

A home project that enables easy access to a fish pond pays off in a big way

Reynold DeChant, Cleveland, Ohio, looks for challenges in life. Recently, he decided to build a bridge in his backyard to better access the fish pond.

“I thought a welding project would be just the ticket to satisfy the need,” DeChant said. Not only would building a bridge give him a sense of pride, but DeChant also figured he could get approval from his wife by explaining that it was for their three daughters.

Goals for the bridge design included the following: It had to be long enough to span the creek for easy access to the fish pond, let his children safely feed the fish, require a decent amount of welding, and look great in the yard.

Sketching a Bridge Design to Follow

DeChant looked for plans online, but nothing seemed right, so he sketched his dream bridge. I would be 12 ft long, 3 ft wide, and feature a variety of materials — Fig. 1.

Material Selection Takes Shape

After being satisfied with the bridge design, he bought the required materials. “My buddy talked me into going lengthwise with the composite boards for the bridge deck because they bend to shape. Taking that advice was probably the best decision I made. I had the tubes rolled

Information courtesy of The Lincoln Electric Co. (www.lincolnelectric.com), Cleveland, Ohio.

Fig. 1 — Reynold DeChant created this artistic bridge rendering, complete with dimension and material details, as a plan for a bridge to go over the creek in his yard.
to 1-ft rise at the 6 ft length, and the boards fit nicely,” DeChant said.

As labeled in Fig. 1, the additional materials included flat stock, wood deck and cap, cables, tube steel, and a triangle gusset.

**Fabrication Work Details**

DeChant’s garage floor provided a level surface suitable for welding. He used The Lincoln Electric Co.’s Power MIG® 140C wire feeder welding machine and SuperArc® L-56 gas metal arc wire.

“The vertical welds on the handrail posts were the most difficult. I ended up heating the stock and doing a weave weld. I reinforced the three, 3-in. squares with gussets,” DeChant said.

Afterward came priming, painting with an industrial-grade gloss black color, and drilling the board holes into cross members. He also used ½-in., zinc-coated carriage bolts and the kids’ pool noodle toys to cover the brackets’ sharp edges.

However, it was difficult to get the bridge out of the garage. Three neighbors helped DeChant lift and move it to the creek.

Once in place, he poured the footers, using a floor jack to lower the cross member into the concrete. He used the third, 3-in. square for the fish food dispenser. The wrought iron fence keeps the kids from falling in the water — Fig. 2.

**Pleasing End Result**

“Overall, designing and building the backyard bridge was a fun and valuable learning experience. The wife and kids love it, and at least for awhile, Dad is enjoying the fruits of his labor,” DeChant concluded.
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- Gary Bourn, Florida Gas Welding Supply

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Closely tied to the American Welding Society, the college offers an exceptionally well-rounded education in D1.1 structural and API pipe welding skills.

BY HOWARD M. WOODWARD

Lincoln College of Technology, located in Grand Prairie, Tex., is a career education school offering training programs designed to emphasize hands-on learning skills and prepare graduates to enter the workforce with confidence. With a campus in the mid-cities area of Dallas/Fort Worth, the college welcomes students from across the state of Texas.

Lincoln College of Technology is accredited by the Accrediting Commission of Schools and Colleges of Technology, and approved and regulated by the Texas Workforce Commission. The Lincoln campus offers many years of experience assisting students in the pursuit of personal and professional goals, and has financial aid representatives to help applicants with federal and state grants, student loans, or other funding arrangements. Unlike many colleges with only two starting times per year, all Lincoln programs are on an ongoing basis throughout the year.

The Skilled Trades campus offers training in welding technology, air-conditioning, refrigeration, and heating (HVAC) technology, and other trades.

Three different class schedules are offered with students attending as early as 7:00 AM and as late as 11:00 PM depending on their preferences and needs. This scheduling flexibility accommodates a wide demographic of students. Lincoln's students include recent high school graduates as well as working adults wishing to improve or enhance their skills or prepare for new careers.

The Dallas-Ft. Worth Metroplex has diverse opportunities for welders. The community offers careers for qualified graduates in well-paying areas such as advanced robotics, aerospace, construction, and the energy industries. The college provides graduates with the basic foundation needed to succeed in these welding professions.

The Welding Technology Program

The welding technology program prepares students to launch careers as structural and pipe welders. Students develop key fundamental skills during the initial courses and learn to apply these skills using different and more complex welding procedures. The welding procedures include shielded metal arc welding (SMAW), gas metal arc welding (GMAW), flux cored arc welding (FCAW), and gas tungsten arc welding (GTAW). Using each of these procedures, students learn to weld pipe and plate in various positions including flat, horizontal, vertical, and overhead. Students also learn various metal cutting and preparing techniques.

Donnie Williams, supervisor of the Welding Technology Department, said, “We certify to the AWS D1.1 (Structural Welding Code — Steel), and it is taught extensively in every course. The school has all current code revisions as part of the quality control program. API 1104 and ASME Section 9 are presented and taught in the pipe classes.”

Upon successful completion, the graduate should possess the working knowl-

HOWARD M. WOODWARD (woodward@aws.org) is associate editor of the Welding Journal.
edge and skills to qualify as a structural and pipe welder using any of the four processes in construction, fabrication, or plant maintenance work settings. Students should be able to complete prequalification tests for construction or fabrication related projects.

The American Welding Society (AWS) qualification helps make Lincoln graduates marketable and versatile as they enter the welding workforce and is a goal for many students. This important qualification test has been integrated into the programs to create a welding technology curriculum that incorporates all essential industry qualifications while providing students with ample opportunities for hands-on experience.

The program includes 960 instructional hours, through which students earn 34.5 semester credit hours. Most classes involve 30 lecture hours and 90 lab/shop hours for four semester credits. Students typically complete the program in approximately 43 weeks (including holidays and scheduled breaks). The program has recently been updated to include basic fabrication and enhanced blueprint-reading instruction.

The Welding Faculty

Both Donnie Williams and Paul Zimmerman, the night supervisor, are AWS Certified Welding Inspectors (CWIs) and Certified Welding Educators (CWEs).

The staff employs nine full-time welding instructors and two Certified Weld Inspectors, with a combined experience of more than 300 years. Each instructor is required by the state to have at least five years of experience to be employed by an educational institution. Some of the instructors, including supervisors, have as much as 30 years of valuable industry experience to share with their students — Fig. 1.

The skill sets and experience represented by Lincoln’s welding faculty encompass the manufacturing, oil and gas, shipbuilding, aerospace, nuclear power, defense, ironworking, and millwright trades. In addition, five members of the welding staff were once self-employed as rig welders. With this range of experience, the welding faculty and staff are uniquely qualified to competently answer their students’ questions and to guide them into a career path best suited to their personal interests, goals, and talents.

Williams said, “For someone who has paid his dues in this industry, it is rewarding for me to be able to help someone currently in the situation I was in years ago. It is especially rewarding when a student or graduate tells me that their life has been changed because of knowing me and by coming to Lincoln.” Williams noted, “The aim of Lincoln’s Welding Technology program is two-fold. We are not only educating the next-generation of welding professionals; we are also nurturing the next-generation of AWS leadership.”

Zimmerman commented, “It is nice to give back to the trade that has kept me fed for 30 years.”

The Welding Facilities

Lincoln’s Grand Prairie campus features a welding lab with 75 welding machines. The facility employs a full-time lab technician, and the equipment is serviced by Airgas on a maintenance contract. The equipment is predominately Lincoln Electric Co. multiprocessors. For diversity, Miller Syncrowaves have been added for the students to work with. Complementing the welding lab instruction, the college uses six classrooms well-equipped with computers and video projectors.

In addition, all students are provided with everything they need to successfully complete the program. This includes their steel-toed boots, tools, and welding hoods, all of which are included in the cost of tuition.

What Welding Tech Graduates Say

Students who have successfully completed the Welding Technology program have gone on to get successful careers in the field. Brady Cherry, a 2010 graduate and former student and AWS Student Chapter board member, was hired by an area heavy-equipment manufacturer. He said, “After hours and hours of practicing and tutoring, I was able to pass the 6G SMAW qualification. Now, I have a good job making good money with outstanding benefits.”

Kameron Bircher, a 2010 graduate and special achievement award winner commented, “Lincoln College of Technology helps to make masters of their students in all welding processes and positions. Welding is like our bodies; if your heart is not in it, it won’t work.”

Fourth term student Leon Morris adds, “I’ve just passed my 4G FCAW qualification, and my future looks good. When I
came to Lincoln, I didn’t know anything about welding, but all of that is changing.”

Lincoln’s Ties with AWS

Lincoln College of Technology maintains strong ties to the American Welding Society. The college runs the only AWS Student Chapter in the North Texas area. Donnie Williams and Phil Harris serve as vice chair and secretary, respectively, of the AWS North Texas Section and also are advisors to the Student Chapter. Their support has helped make the Student Chapter a vital addition to welding students’ educations. The Student Chapter’s activities closely mirror what is occurring at the AWS North Texas Section level, plus the Student Chapter includes projects to benefit local nonprofit organizations, giving interested students the chance to get involved with the community.

Last year, Lincoln’s AWS Student Chapter welded ornate handrails for Christian Community Action, a nonprofit organization helping underprivileged people in the area — Fig. 2. Each year, the AWS Student Chapter holds a membership drive featuring special activities. This year, Airgas sponsored a cookout for the students that included a demonstration of ultrasonic weld examination performed by Doug Post, an independent welding consultant — Fig. 3. That event convinced 25 welding students to join the Student Chapter.

Career Services

Lincoln College of Technology’s Career Services Department assists students with career placement upon graduation. Throughout each student’s career training at the college, Career Services works to help ensure optimal preparation for job placement. This involves guidance on effective résumé writing, the online job search and application process, and how to best present skills and qualifications during a job interview and when interacting with potential employers. The Career Services Department has an ongoing relationship with local members of the welding industry. The vendors periodically host open house events to establish and strengthen relationships between the industry and the student body. Employers are encouraged to participate in classroom presentations about their company, their hiring practices, and what to expect when starting in the industry.

Life in the Area

There is no shortage of extracurricular activities at the college or in the surrounding area. Often the school holds student-appreciation events and car shows.

In addition, the North Texas area offers everything from sports, including the Dallas Cowboys, Dallas Mavericks, and the Texas Rangers, to fun for the entire family at Six Flags.

Last season, the mid-cities area hosted major league baseball’s World Series and the National Football League’s Super Bowl. It is also proud to have the reigning 2011 NBA Champions, the Dallas Mavericks, to support. Every major sports venue is represented in the area.

The Fort Worth stock show and rodeo is one of the biggest PRCA rodeos in the country. This is held at the Will Rodgers coliseum in January.

Dallas has just completed a new grand opera house, and the Bass Hall in Fort Worth hosts the Van Cliburn piano competition.

Where to Learn More

The college maintains an excellent Web site with a wealth of interesting information. Visit the site to learn all the details about the college’s history, educational offerings, counseling services, scholarships, living accommodations, part-time jobs, other training locations, forms, and online training opportunities. You can also make an appointment to talk to a counselor or visit the campus for a tour of the facilities and meet the faculty.

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Grand Prairie, TX 75052
www.lincolntech.edu

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DonaldWilliams@lincolntech.com
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“Networking with other distributors allows an opportunity for members to gain different perspectives and lessons-learned on addressing a variety of issues associated with ownership (i.e., operations, sales, suppliers, etc.).”
Flux Cored Arc Weld Quality

The quality of welds that can be produced with the flux cored arc welding (FCAW) process depends on the type of electrode used, the method (gas-shielded or self-shielded), condition of the base metal, weld joint design, welding conditions, and the competency of the welder/welding operator.

The welding method may influence the impact properties of mild steel weld metal. Some self-shielded electrodes are highly deoxidized types that may produce weld metal with relatively low notch toughness. Other self-shielded electrodes have excellent impact properties. Gas-shielded and self-shielded electrodes are available that meet the Charpy V-notch impact requirements of specific classifications of the AWS filler metal specifications. Notch toughness requirements should be considered before selecting the FCAW method and the specific electrode for an application.

A few FCAW mild steel electrodes are designed to tolerate a certain amount of mill scale and rust on the base metals. Some deterioration of weld quality should be expected when welding dirty materials. When these electrodes are used for multipass welding, cracking caused by accumulated deoxidizing agents in the weld metal may occur.

In general, sound flux cored arc welds can be produced in mild and low-alloy steels that will meet the requirements of several construction codes. If particular attention is given to all factors affecting weld quality, meeting code requirements can be assured.

When less stringent requirements are imposed, the advantages of higher welding speeds and currents can be realized. Minor discontinuities may be permitted in such welds if they are not objectionable from the standpoints of design and service.

Flux cored arc welds can be produced in stainless steels with qualities equivalent to those of gas metal arc welds. Welding position and arc length are significant factors when self-shielded electrodes are used. Out-of-position welding procedures should be carefully evaluated with respect to weld quality. Excessive arc length generally causes increased nitrogen pickup in the weld metal. Because nitrogen is an austenite stabilizer, absorption of excess nitrogen into the weld may prevent the formation of sufficient ferrite and thus may increase susceptibility to microfissuring.

Several types of discontinuities can result from improper procedures or practices. Although many of the discontinuities are innocuous, they adversely affect the weld appearance. Table 1 shows these discontinuities along with their causes and remedies.

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<th>Problem</th>
<th>Possible Cause</th>
<th>Corrective Action</th>
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<td>Porosity</td>
<td>Low gas flow</td>
<td>Increase gas flowmeter setting. Clean spatter-clogged nozzle.</td>
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<td></td>
<td>High gas flow</td>
<td>Decrease to eliminate turbulence.</td>
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<td></td>
<td>Excessive wind drafts</td>
<td>Shield weld zone from draft or wind.</td>
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<td></td>
<td>Contaminated gas</td>
<td>Check gas source. Check for leak in hoses and fittings.</td>
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<td></td>
<td>Contaminated base metal</td>
<td>Clean weld joint faces.</td>
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<td></td>
<td>Contaminated welding wire</td>
<td>Remove drawing compound on wire. Clean oil from rollers. Avoid shop dirt. Rebake welding wire.</td>
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<td></td>
<td>Insufficient flux in core</td>
<td>Change electrode.</td>
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<td></td>
<td>Excessive voltage</td>
<td>Reset voltage.</td>
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<tr>
<td></td>
<td>Excess electrode stickout</td>
<td>Reset stickout and balance current.</td>
</tr>
<tr>
<td></td>
<td>Insufficient electrode stickout (self-shielded electrodes)</td>
<td>Reset stickout and balance current.</td>
</tr>
<tr>
<td></td>
<td>Excessive travel speed</td>
<td>Adjust speed.</td>
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<tr>
<td>Incomplete fusion or penetration</td>
<td>Improper manipulation</td>
<td>Direct electrode to the joint root.</td>
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<tr>
<td></td>
<td>Improper parameters</td>
<td>Increase current. Reduce travel speed.</td>
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<tr>
<td></td>
<td>Improper joint design</td>
<td>Decrease stickout. Reduce wire size.</td>
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<tr>
<td></td>
<td>Excessive joint restraint</td>
<td>Increase travel speed (self-shielded electrodes).</td>
</tr>
<tr>
<td>Cracking</td>
<td>Improper electrode</td>
<td>Increase root opening. Reduce root face.</td>
</tr>
<tr>
<td></td>
<td>Insufficient deoxidizers or inconsistent flux-fill in core</td>
<td>Reduce restraint. Preheat. Use more ductile weld metal.</td>
</tr>
<tr>
<td>Electrode feeding</td>
<td>Excessive contact tip wear</td>
<td>Check formulation and content of flux.</td>
</tr>
<tr>
<td></td>
<td>Melted or stuck contact tip</td>
<td>Check formulation and content of flux.</td>
</tr>
<tr>
<td></td>
<td>Dirty wire conduit in cable</td>
<td>Reduce drive roll pressure.</td>
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</table>

CAN WE TALK?

The Welding Journal staff encourages an exchange of ideas with you, our readers. If you’d like to ask a question, share an idea or voice an opinion, you can call, write, e-mail or fax. Staff e-mail addresses are listed below, along with a guide to help you interact with the right person.

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American Welding Society
Analysis of Spot Weld Growth on Mild and Stainless Steel

Nugget growth by varying current and weld time was analyzed in joining mild steel, austenitic stainless steel, and dissimilar steels

BY A. ARAVINTHAN AND C. NACHIMANI

ABSTRACT

Resistance spot welding (RSW) is an important technology in various industries for joining two or more metals. Joining dissimilar base metals has become very common among mechanical assemblies. Hence, this experiment was carried out to analyze the growth of a spot weld in a mixed joint of mild and 302 austenitic stainless steels. Basically, the growth of a spot weld is determined by its parameters such as current, weld time, electrode tip, and force. However, other factors such as electrode deformations, corrosion, different thicknesses, and material properties also affect the weld growth. This investigation was intended to analyze only the effects of nugget growth on mild steel, stainless steel, and mixed steels with respect to the variation of current and weld time. As such, the force and the electrode tips were constant throughout the experiments. The welded samples were all equal size and underwent tensile, hardness, and metallurgical testing to characterize the formation of weld nuggets. The tensile tests showed significant relationship between differing current increments and sufficient weld time to attain a proper weldment. The hardness distributions were measured from the unwelded area on one side of the sample and moved through the regions of the heat-affected and fusion zones and ended at the unwelded area on the other side. The hardness was altered due to heat treatment, and the metallurgical views support this phenomenon.

Introduction

The spot welding process joins two or more metal sheets together through fusion at a certain point (Ref. 1). It is a simple process that uses two copper electrodes to press the work sheets together and force high current to pass through it. The growth of the weld nugget is, therefore, determined by its controlling parameters such as current, weld time, electrode tips, and force (Ref. 2). In this experiment, the current and weld time were varied to see the weld growth, while the electrode tips and force remained constant. The entire work was carried out to observe the weld growth in mild steels joints, stainless steels joints, and both steels in a mixed joint for the same current and weld time (Ref. 3).

Experimentation

In this experiment, a JPC 75-kVA spot welding machine was used. The machine was capable of joining up to 5-mm-thick base metals for various materials. It uses a pneumatic-based electrode actuation system to produce up to 15 kN of force, and a current range varying from 1 to 25 kA. However, this experiment used only a constant of 3 kN of force for the entire weld schedules at increments of 6, 7, and 8 kA. The weld time was varied from 10 to 20 cycles with 5 as the interval. The electrode tips were 0.5 mm² in the round area. The base metals for these experiments were mild steel and 302 austenitic stainless steel (Table 1). Initially, a weld schedule (Table 2) was developed to accomplish these experiments. A standard size (200 × 25 × 1 mm) for the base metals was prepared (Fig. 1) and welded according to the weld schedule as lap joints. The first category was only the mild steel joints, whereas, the second category was only 302 austenitic stainless steel. The third category was mixed base metals of mild and 302 austenitic stainless steels. A total of 200 pairs of welded samples were developed for tensile, hardness, and metallurgical tests (Refs. 4, 5).

Results and Discussion

Hardness Test

The hardness of the welded areas for the mild steel seemed to be higher than the stainless steel and the mixed steels (Ref. 6). Forty-five pairs of samples were analyzed and found that the average of unwelded areas was 54 HRB, and the average of welded areas was 98 HRB. The hardness increment was 44 HRB (81%). These hardness increments were surmized to be the result of heat treatment due to high thermal conductivity and low resistivity of the materials (Ref. 7). Figure 2 shows the hardness of the mild steels.

The hardness of 302 austenitic stainless steels did not change very much as compared to mild steels. This was because of the nature of the material. The heat treatment effect is not supported by the chromium composition of the material (Ref. 8). The effect was reduced by the thermal conducting factors as well as the electrical resistance. The average of unwelded area was 75 HRB and the average of welded area was 85 HRB. The average increment (13%) was only 10 HRB. The results are graphically shown in Fig. 3.

KEYWORDS

Dissimilar Steels
Pull Test
Resistance Spot Welding
Spot Weld
Stainless Steel
Weld Nugget
Weld Hardness

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The final test on hardness was carried out on the dissimilar metal welded sheets. One side of the material was mild steel and the other side was stainless steel, as shown in Fig. 1. The hardness increased slightly on both sides of the weld compared to the mild and stainless steels categories. For instance, the mild steel hardness was found to be 54 HRB at the unwelded areas, whereas, the welded region was 100 HRB. It has increased slightly compared to the mild steel category of 98 HRB. The stainless steel side also increased almost to the mild steel values (101 HRB). It increased from 75 to 101 HRB. Although it fluctuated slightly up and down, the values remained in the region of deviation. The hardness values are plotted against each other in Fig. 4.

### Table 1 — Chemical Composition of Mild Steel and 302 Austenitic Stainless Steel

<table>
<thead>
<tr>
<th>Element</th>
<th>Maximum wt-%</th>
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<tbody>
<tr>
<td>C</td>
<td>0.23</td>
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<tr>
<td>Mn</td>
<td>0.90</td>
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<tr>
<td>P</td>
<td>0.04</td>
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<tr>
<td>S</td>
<td>0.05</td>
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</table>

**Mild Steel**

<table>
<thead>
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<th>Element</th>
<th>Maximum wt-%</th>
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<tr>
<td>C</td>
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<tr>
<td>Cr</td>
<td>17–19</td>
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<tr>
<td>Ni</td>
<td>8–10</td>
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<tr>
<td>Mn</td>
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</tr>
<tr>
<td>Si</td>
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</tr>
<tr>
<td>S</td>
<td>0.03</td>
</tr>
<tr>
<td>P</td>
<td>0.04</td>
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</table>

**302 Austenitic Stainless Steel**

<table>
<thead>
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<th>Element</th>
<th>Maximum wt-%</th>
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<tbody>
<tr>
<td>C</td>
<td>0.15</td>
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<tr>
<td>Cr</td>
<td>17–19</td>
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<td>S</td>
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<td>P</td>
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### Table 2 — Weld Schedule

<table>
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<tr>
<th>Samples Number</th>
<th>Material(a)</th>
<th>Electrode Tips (mm²)</th>
<th>Force (kN)</th>
<th>Current (kA)</th>
<th>Weld Time (Cycle)</th>
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<tr>
<td>1–5</td>
<td>MS &amp; SS</td>
<td>0.5</td>
<td>3</td>
<td>6</td>
<td>10</td>
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<tr>
<td>6–10</td>
<td>MS &amp; SS</td>
<td>0.5</td>
<td>3</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>11–15</td>
<td>MS &amp; SS</td>
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<td>3</td>
<td>7</td>
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<tr>
<td>16–20</td>
<td>MS &amp; SS</td>
<td>0.5</td>
<td>3</td>
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<td>15</td>
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<td>21–25</td>
<td>MS &amp; SS</td>
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<td>3</td>
<td>8</td>
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<td>26–30</td>
<td>MS &amp; SS</td>
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<td>3</td>
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<td>31–35</td>
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<td>36–40</td>
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<td>41–45</td>
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(a) MS – Mild Steel; SS – Stainless steel

### Tensile Test

The strength of the welded samples was tested using tensile peeling methods for the mild steel, stainless steel, and mixed steels. Figure 5 shows the tensile strength with respect to increments of current and weld time.

Tensile test results showed that when welding current and weld time were increased, the strength was also increased as reported in the literature (Refs. 4, 5).
However, the experiments were not conducted beyond the expulsion limit to see the extreme cases. It was conducted to see the weld nuggets growth, and therefore, the weld schedule was limited to a few steps from poor welds to sound welds. The weld experiments from numbers 1 to 2 and 2 to 3 have shown strength increments due to current increments from 6 to 7 and 7 to 8 kA, respectively. Similar results were also noticed for weld time increments. Thus, the strength from experiments 1 to 4 and from 4 to 7 have shown increments in strength due to the increments of weld time from 10 to 20 cycles. The experiments that followed also showed the same principles of increase and decrease when the parametric changes occurred — Fig. 5.

This was because an increase in current and weld time caused the weld diameter to

![Graph of Tensile Strength vs. Current and Weld Time]

**Fig. 5 — Tensile test results.**

<table>
<thead>
<tr>
<th>Mild Steels Samples</th>
<th>Stainless Steels Samples</th>
<th>Dissimilar Steels Samples</th>
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<td><img src="image2" alt="Button Pullout" /></td>
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<td><img src="image4" alt="Tear at the edge of one side" /></td>
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<td><img src="image8" alt="Tear at the edge of both sides" /></td>
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**Fig. 6 — Tensile tested samples of mild, stainless, and dissimilar steels.**
increase, and therefore the weld strength increased. The amount of heat generated at the weld interface increased as the weld current and weld time increased. The weld zone expanded radially and once cooled then formed a weld nugget. The stainless steel welds seemed to have higher tensile strength compared to the other two types of joints, since the breaks happened at the border of the spot weld (torn from edge of the nuggets), which was expected by the materials properties. However, some cases showed button pullout when the weld was moderately weak (Refs. 6, 7). In the mixed steel joint, the mild steel side was broken first. Besides, the improper joint was noticed in the weakest weld only. Figure 6 shows three types of common breaks that happened during tensile testing. If a com-

<table>
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<th>Mild Steels Macrograph</th>
<th>Stainless Steels Macrograph</th>
<th>Mixed Steels Macrograph</th>
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<tr>
<td>Width of FZ = 3.274 mm (6kA)</td>
<td>Width of FZ = 4.428 mm (6kA)</td>
<td>Width of FZ = 4.265 mm (6kA)</td>
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<td>Width of FZ = 3.524 mm (7kA)</td>
<td>Width of FZ = 4.606 mm (7kA)</td>
<td>Width of FZ = 4.344 mm (7kA)</td>
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<tr>
<td>Width of FZ = 3.738 mm (8kA)</td>
<td>Width of FZ = 4.839 mm (8kA)</td>
<td>Width of FZ = 4.446 mm (8kA)</td>
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</tbody>
</table>

Fig. 8 — Nugget cross section of mild, stainless, and dissimilar steels.
comparison study of strength between categories is considered, then the mild and stainless steels have created upper and lower strength bands and the dissimilar joints almost fall between these two.

**Macrograph Views**

Metallographic samples were produced using standard procedure with an optical microscope. It was taken to measure the exact weld nugget diameters rather than seeing the mixture of chemical properties. A typical macrostructure for mild steel, stainless steel, and mixed steels shows three distinct structural zones — Fig. 7.

The different areas are described below.

1) **Fusion zone (FZ).** Zone that undergoes complete melting and resolidification during weld cycle with a coarser grain. The width of the zone is equivalent to the weld nugget diameter.

2) **Heat-affected zone (HAZ).** Zone that undergoes microstructural alteration during the weld cycle. The grains were finer than in the FZ.

3) **Base metal (BM).** Area that is not affected during the weld cycle, and the grains remain the same.

The macrograph was developed to see the exact diameter of nuggets, and it showed three distinct structural zones as mentioned previously (Refs. 4, 7). As for mild steel, the fusion zone was made of coarser grains and the HAZ was finer grains. However, the HAZ was higher due to better thermal conductivity and higher electrical resistivity as compared to stainless steel. In contrast, the stainless steel had a lower HAZ and therefore the fusion zone seemed to be higher as compared to mild steel for the same weld schedule (Refs. 9, 10). The dissimilar welds showed asymmetrical views when both materials were concerned. The mild steel side was shorter in length as compared to stainless steel with different HAZs. Figure 8 shows the comparison of weld zones for mild, stainless, and dissimilar steels.

The average diameter of five samples was considered to characterize the weld diameter growth for three different currents and three different weld times. In mild steel, the result showed that the incremental from lowest weld schedule to highest was 2.240 mm, in stainless steel it was 1.072 mm, and in the dissimilar steels it was 0.494 mm. As such, the mild steel seemed to have the highest nugget growth compared to the other two types of joints — Fig. 9.

**Conclusions**

This project investigated spot weld nuggets’ growth in mild steel, stainless steel, and dissimilar steels, all with a 1 mm thickness. The investigation concludes the following:

1. Hardness of the welded zone is greater than the hardness of the unwelded zone for all three joints.
2. The increase in hardness between the unwelded zone and welded zone was greater in mild steel compared to stainless steel because of the better thermal conductivity and lower electrical resistance.
3. The increase in current or weld time does not influence the increase in hardness distribution in the welded region. It fluctuated without relationship.
4. Stainless steel seems to have higher weld strength compared to mild steel and the mixed welds due to the nature of the material’s hardness. The pull out breaks occurred at the border of the weld (tear from edge) in most cases. Button pull out was noticed for poor welds.
5. Strength of the mixed weld (mild steel and stainless steel) is almost similar to the strength of pure mild steel welds.
6. The diameter of the nugget in stainless steel is bigger than the diameter of nugget in mild steel for the same current and weld time because stainless still has lower thermal conductivity and higher electrical resistance as compared to mild steel.
7. The heat imbalance in the dissimilar joints caused the asymmetrical shape of weld nuggets.
8. Mild steel seemed to have the highest nugget growth rate as compared to the other two types of joints.

**References**

Welding Sequence Definition Using Numerical Calculation

Three calculations were made with different welding sequences and clamping conditions to predict distortion after pipe welding

BY PRIMOŽ MRVAR, JOŽEF MEDVED, AND SEBASTJAN KASTELIC

ABSTRACT

The welding simulation for a pipe in a hydropower plant was made due to very large dimensions. The pipe is 5.5 m in diameter. The main aim was to predict the welding sequence that will cause no deformation after welding because machining the pipe at the construction site is almost impossible. For achieving distortion in the desirable limits, the welding process was simulated with the finite element program Sysweld. The macro weld deposit methodology was used to minimize the calculation time. Two different finite element models (FEM) were made. Three different welding sequences and clamping conditions were calculated to reduce distortion. The calculation of microstructure constituents in the virtual complex geometry of joints was also analyzed.

Introduction

Welding is an important process and has a very important part in industry, especially in the automotive, maritime, and energy sectors. Although welding has many advantages, it also has some disadvantages such as thermal expansion and shrinkage or microstructural transformations, which cause stresses. All these processes have a main influence on the distortion during and after welding. With knowing all these properties and welding parameters, it’s possible to predict the final distortion. Accurate prediction of the distortion is important when distortion on some unique, large parts has to be predicted. To achieve the deformation in the desirable limits, changes in welding parameters can be made, such as welding sequence and clamping of the welded parts. When changing some welding parameters of complex parts, with a large number of beads or multipass welding, etc., it’s not easy to predict the distortion after welding (Refs. 1, 2).

When the welding procedure is planned, it’s now possible to predict the distortion with numerical calculation. Distortion and residual stresses with plastic history of welded components can be calculated with numerical simulation, taking into account all relevant physical phenomena. Therefore, planning or making the optimization can be done virtually, and when results are acceptable, the transfer of new technology in practice can be made with minimum prototyping.

Designing the welding fabrication with the computer to minimize or control distortion can significantly reduce fabrication costs. Controlling residual stress can significantly enhance the structure’s service life.

With proper modeling, considering the distortion, elimination of expensive distortion corrections can be done; the reduction of machining requirements can be made; the minimization of capital equipment cost can be expected; quality improvements can be made; and premachining concepts can be used. Modeling — considering residual stress control has influence on weight reducing and maximisation of fatigue performance — can lead to quality enhancements and minimize cost of service problems (Ref. 3).

For getting all these data with numerical calculation, the consideration of all main physical effects, which accrues at welding, has to be taken into account. This numerical calculation is based on coupled thermo-metallurgical analysis. All results are calculated with a modified heat convection, shown in Equation 1.

\[
\left( \sum_{i} C_{i} \right) \frac{dT}{dt} + \sum_{i,j} L_{ij}(T)A_{ij} = Q
\]

\[
\begin{align*}
\text{P} & \quad \text{phase proportion} \\
\text{T} & \quad \text{temperature} \\
\text{t} & \quad \text{time} \\
\text{i, j} & \quad \text{phases} \\
\text{C} & \quad \text{mass density} \\
\text{C} & \quad \text{specific heat} \\
\text{Q} & \quad \text{thermal conductivity} \\
\text{Q} & \quad \text{heat sources} \\
L_{ij}(T) & \quad \text{latent heat of } i \rightarrow j \text{ transformation} \\
A_{ij} & \quad \text{proportion of phase } i \text{ transformed to } j \text{ in time unit}
\end{align*}
\]

Numerical simulation was used for the prediction of final distortion after welding a pipe and flange for a hydropower plant. The welded construction is shown in Fig. 1. The pipe’s diameter is 5.5 m, and the flange is 140 mm thick. Making the pipe and flange is not the issue in this paper. The pipe and flange were welded and then machined in the workshop to the desirable dimensions. The problem occurred due to the transport reasons. The pipe will be used in a reversible hydropower plant whose location is high in...
Table 1 — Welding Parameters

<table>
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<tr>
<th>Electrode</th>
<th>Current type/polarity</th>
<th>Electrode size</th>
<th>Current</th>
<th>Voltage</th>
<th>Welding speed</th>
</tr>
</thead>
</table>

In the Alps, about 2000 m above sea level. The transport of 5.5-m pipe by the road is not possible because the tunnels are too small. Transporting the already welded pipe and flange together by helicopter is not possible because the pipe with flange is too heavy for transport by a helicopter at 2000 m above sea level. Therefore, the pipe and flange are to be transported separately by a helicopter to the hydropower plant location.

The aim of the numerical calculation was to predict the distortion after welding and to determine the welding sequence of the welding to have the distortion in the tolerance, so the welding will be done without machining after welding. The heat input was defined with macro bead deposit methodology (MBD). This method is convenient for calculating very large structures, where the main aim is deformation (Ref. 4).

Preparing the FEM Mesh for Calculation

For this calculation, two different finite element models (FEM) were made. The finite element mesh for the calculation is shown in Fig. 1. Only half of the model is meshed because the symmetry was taken into account. The model has 46237 elements.

Three simulations with different welding sequences and clamping conditions were made. The sequence and FEM for the first and second calculations are shown in Fig. 2A. Welding started on the inner side of the pipe with six beads and continued with the rest ten beads on the outer side of the pipe. The difference between the first and second sequence was in clamping and preheating. For the first calculation, the reinforcement was not included, and the preheating was not defined. For the second calculation, the welding sequence was not changed; only the reinforcement was taken into account, and the preheating was 150°C.

For the third calculation, the sequence and mesh were changed. Welding started on the inner side of the pipe with six beads; welding continued with eleven beads on the outer side of the pipe. After this, four beads on the inner side were made and at the end, nine beads on the outer side of pipe were made. The mesh and sequence are presented in Fig. 2B. For the third sequence, the reinforcement was also taken into account, and the preheating was 150°C.

Heat Input Definition

The defining of heat input is based on the real welding parameters that are presented in Table 1. These parameters are also important when preparing mesh. From electrode size and welding speed, the volume of deposited material for each bead is determined. The energy input is defined by welding current, voltage, and welding speed.

The heat input definition was made based on the pipe size and welding parameters. The method used in this particular case is the cooled MBD method. The heat is transferred into the weld instantaneously in one or several macro steps. The real weld trajectory is divided into several macro sections. It's deposited in the structure before the computation starts and released following the definition of the macro time steps. The energy/length transferred into the structure is the same as in the real process, but it occurs in another time frame.

The MBD methodology is, to a certain extent, a coarser step-by-step method (Ref. 4). The alternative is transient welding (step-by-step methodology) (Ref. 5).
The heat source is transferred from the torch to the workpiece along a weld interface. It has the same speed as the real welding heat source and provides the same energy/length as in the real process (Refs. 4, 6, 7). The transient method is convenient for weld quality analysis where only a local area around the weld is modeled (Refs. 8, 9). In this case, the mesh is denser, and the time for calculating a construction this size is not acceptable.

For comparison, calculation of a butt joint with three beads for both methods was made. The plate dimensions were 400 x 150 x 10 mm. The finite element mesh for both methods is shown in Fig. 3. The plates were clamped at left and right edges. For MBD technology, each bead was divided into two macro segments — Fig. 3B. The calculation time for the transient method with 7304 elements was 210 min and 45 min for the MBD method with 2020 elements. These calculation times were obtained with Sysweld 2009.1 on a 2.2-GHz CPU with 2 GB of RAM. Deformation calculated with the MBD method was higher. Maximum bending with the transient method was 2.1 and 2.9 mm with the MBD method.

Due to reasonable calculation time, the heat input was defined with the MBD method. The calculation for the third sequence took two days and 22 h. The heat input for each bead on the calculated pipe half was defined in ten macro steps. In the definition of heat input, it’s also taken into account that two welders are welding simultaneously on the pipe half (four welders on the whole pipe). The influence of two welders welding simultaneously on the calculated pipe half can be seen in Fig. 4A where the start of two macro steps is at the same time. The macro step size is shown in detail — Fig. 4B.

### Mechanical Properties Definition

The base material of the pipe and flange is 355 stainless steel with the chemical composition presented in Table 2. For good numerical results, precise thermal and material properties of the used material must be taken. All these properties must be measured as a function of temperature and phase. For welding the yield stress, thermal strains, Young's modulus, Poisson’s ratio, strain hardening, density, thermal conductivity, and latent heat must be known. Yield stress as a function of temperature and phase is presented on a graph in Fig. 5.

For calculating microstructural constitutions, the digitalized CCT diagram is needed. The used diagram is presented in Fig. 6.

### Results

With all these data, several results can be obtained after welding. In this case, determining deformation after welding is the main purpose. Beside the deformation, a very important result is also stress and the microstructure in the welding area after welding.

Deformation of the flange after welding with the third sequence is about 3.8 mm. The deform shape of the pipe is presented in Fig. 7. The effect of different welding sequences and clamping condi-
tions on deformation can also be seen in Fig. 7A–C. The deformed shape is multiplied by factor 10, so the deformed shape can be visible. Maximum deformation after welding with the first sequence in the flange area is 7.7 mm. The deformation in the second calculation was 6.3 mm, and after welding with third sequence, the deformation was 3.8 mm.

Beside the deformation, distribution of stresses in the heat-affected zone are calculated. It's shown that there is small compressive stress in the area where the first beads were made — Fig. 8A–C. The highest tensile stress accrues on the surface at the inner side of the pipe and below the surface of last beads welded on the outer side of the pipe.

The results that are presented in Figs. 9 and 10 show the microstructure after welding in the heat-affected cone. Presented in Fig. 9A–C is the bainite distribution in the welding area. The amount of bainite at the welding area in Fig. 9A is 70 vol.-%, but in Fig. 9B and C, the amount of bainite is 90 vol.-%. On the border between the base material and welded beads is an increased amount of martensite phase, up to 80 vol.-% in Fig. 10A where the preheating was not defined, and between 10 and 20 vol.-% in Fig. 10B and C where the preheating was 150°C. This is the result of a higher cooling rate on the border with a base material when the preheating was not defined.

Conclusions

For distortion prediction after unique pipe welding, three calculations were made with different welding sequences and clamping conditions. The deformation after the third calculation is acceptable. For further deformation reduction, another calculation with a change in the welding sequence could be made, but the obtained results are suitable for now.

The peak values of stresses are relatively high for this material, but these peaks cover very small areas. Also, these values should be moderated with some simple test welding with similar conditions. The test welding should be simulated as well, so that we can compare if these stresses will cause some cracks or not.

The amount of martensite phase on the border with a base material could be reduced with a higher preheat temperature, but this higher temperature will be hard to reach due to the flange’s large heat capacity. Also, the tendency for crack formation is relatively low because the area with a higher portion of martensite is not at the same place as the area with a high value of calculated stress.

References

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<th>Month</th>
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| January    | • 2011 FABTECH Review  
| February   | • Preventing Weld Failures  
| March      | • Maritime Construction  
             • Do-It-Yourself Projects  
             • Bonus: The American Welder                                    | Jan. 23           | Feb. 1               |
| April      | • Update on Power Sources  
             • Training for a Welding Career                                    | Feb. 17           | March 1              |
| May        | • Welding Structural Steel  
             • New Faces in Welding                                             | March 21          | April 3              |
| June       | • Considerations for Welding Pipe and Tube  
             • Fabricating for Underground Projects  
             • Bonus: The American Welder                                    | April 20          | May 1                |
| July       | • Welding for the Food Processing Industry  
             • Brazing and Soldering Today                                      | May 23            | June 1               |
| August     | • Personal Protection and Safety on the Job  
             • Oxyfuel and Plasma Cutting                                      | June 22           | July 2               |
| September  | • Weld Inspection  
             • Bonus: The American Welder                                      | July 23           | Aug. 2               |
| October    | • 2012 FABTECH Preview  
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