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WELDING Journal

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WELDING *Journal*

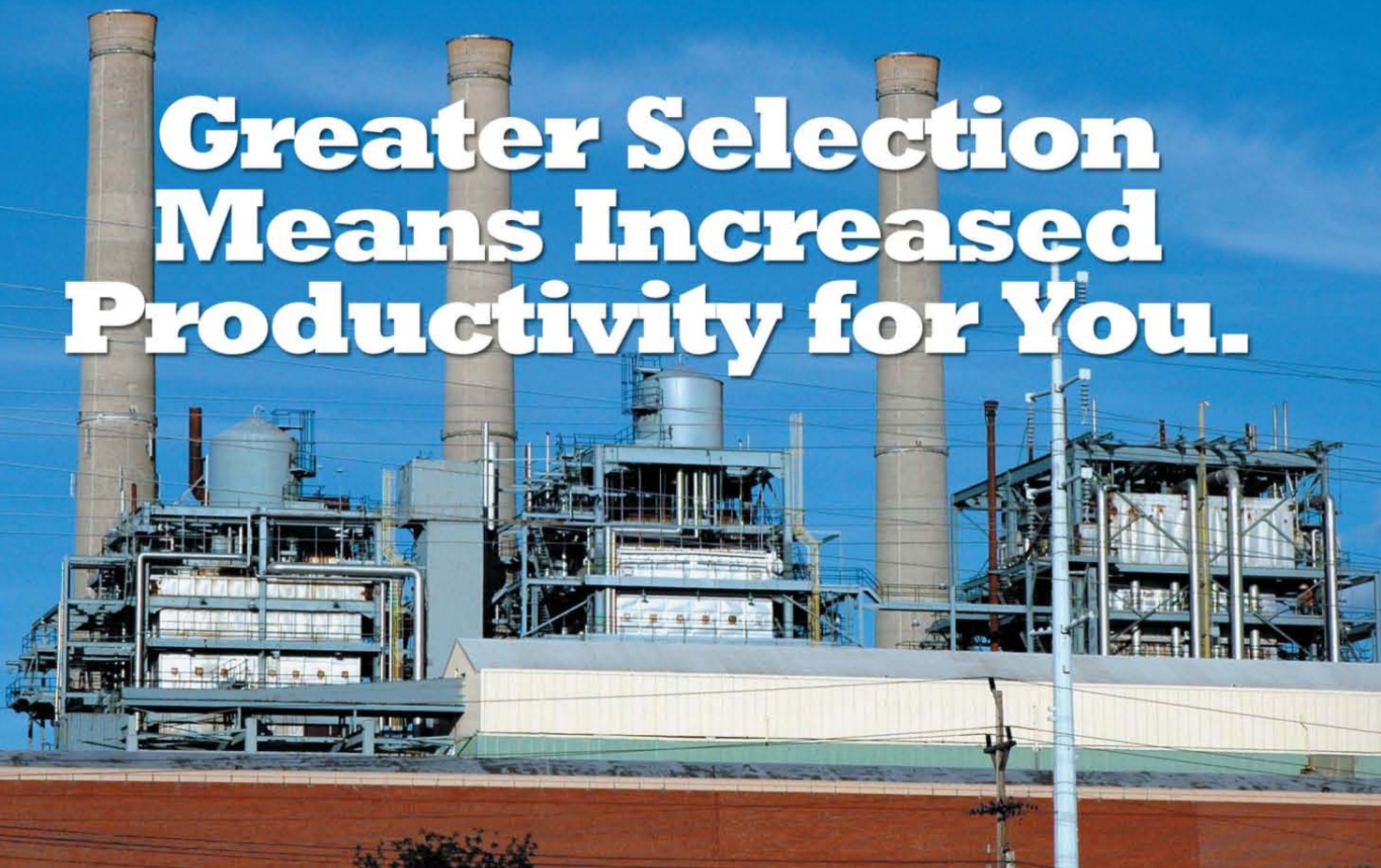
May 2009



- **Future Nuclear Plants Will Depend on Welding Technology**
- **Processes and Preparation Are Keys to Pipe and Tube Welding**

PUBLISHED BY THE AMERICAN WELDING SOCIETY TO ADVANCE THE SCIENCE, TECHNOLOGY, AND APPLICATION OF WELDING AND ALLIED JOINING AND CUTTING PROCESSES, INCLUDING BRAZING, SOLDERING, AND THERMAL SPRAYING

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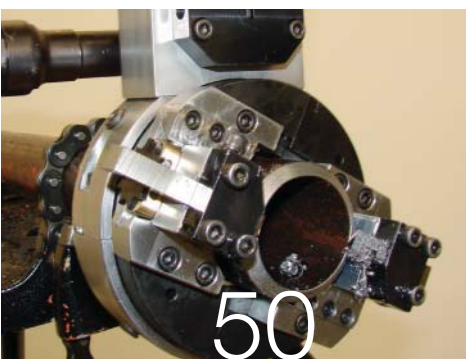
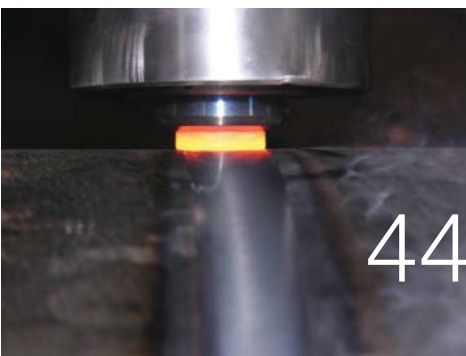
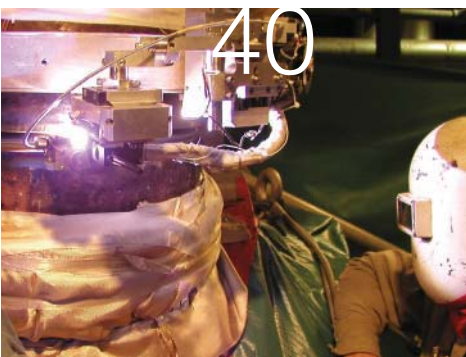
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PRESS TIME

NEWS

SkillsUSA Offers Online Welding Assessment

SkillsUSA, Leesburg, Va., introduced a new online, technical assessment to help candidates prove entry-level welding proficiency at www.workforcereadysystem.org.

The Welding Skill Connect Assessment evaluates entry-level knowledge and skills in flux cored arc welding, gas tungsten arc welding, oxyfuel cutting, and shielded metal arc welding through interactive questions. Videos and animations enable a more accurate evaluation of practical knowledge. These are hosted on the patented LearnMate system. Also, SkillsUSA created an employability assessment to evaluate soft skills.

Industry experts participating in its development came from various organizations including the American Welding Society.

All assessments align with Perkins IV accountability measures as issued by the U.S. Department of Education. Additionally, each assessment was developed with industry and education leaders working together to identify the appropriate criteria and testing methodology. Once developed, they were evaluated by psychometricians for reliability in comparison to field test data before becoming available for purchase.

Each assessment consists of approximately 50 items and takes about an hour to complete. Items are delivered randomly from an item bank, as are the possible answers to each question according to the assessment blueprint defined. Assessments cost \$5 for SkillsUSA members or \$20 for nonmembers.

Florida Power & Light Proposes Natural Gas Pipeline

Florida Power & Light Co. has filed a proposal with the Florida Public Service Commission for the construction of a new underground natural gas pipeline in Florida. It is planned for construction in the eastern portion of the state from Palm Beach County to Bradford County and will be approximately 300 miles in length.

The Florida EnergySecure Line is expected to deliver the following four benefits: an increase in the supply of clean natural gas to meet planned needs; diversification of the source of natural gas production beyond offshore Gulf of Mexico sources to other on-shore sources; addition of a third major natural gas pipeline route into the Florida peninsula to help protect access to the supply of natural gas and the electric generation it supports in the event any of these routes are disrupted; and creating demand for 7500 jobs, including 3500 construction jobs, as well as generation of more than \$400 million in additional property taxes across 14 counties over the lifetime of the project, according to an economic impact analysis.

The company's proposal calls for this line to enter into service as early as 2014. Plus, the project is expected to provide an opportunity for Florida companies to participate in fabrication, supply, and construction support roles.

Shaw Renews Nuclear Maintenance Contract with Entergy

The Shaw Group Inc., Baton Rouge, La., recently announced the Maintenance Division of its Power Group has renewed an existing contract with Entergy Nuclear, a subsidiary of Entergy Corp. Nuclear maintenance services will be provided to 11 nuclear units at nine power stations. Shaw's scope of work includes routine maintenance/modifications, refueling outage services, and capital construction. The value of this six-year contract was not disclosed.

John Wood Community College Board Approves Grant Submission for Welding Equipment

The board of trustees for John Wood Community College, Quincy, Ill., has authorized the submission of a grant application for funds to purchase more equipment for a welding lab as part of the college's new Workforce Development Center. The \$40,000 grant is being submitted to the U.S. Department of Agriculture.

College officials are hopeful the first welding classes will be offered by early summer. The total cost to establish the welding lab will be approximately \$80,000. In addition, the college has already received gifts and pledges from local manufacturing firms totaling more than \$25,000 in cash and equipment.

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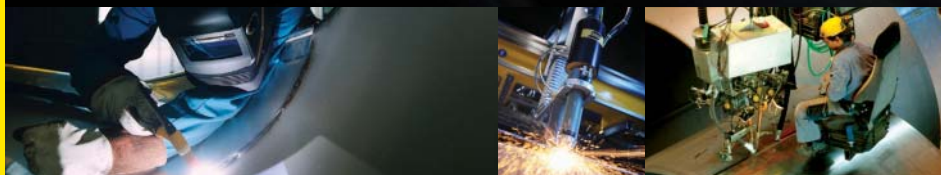
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EDITORIAL

A Bulletproof Way to Make Successful Spot Welds

Let's say you are hired to operate a complex computer-controlled machining center. You have no training on this system, have never worked with any similar equipment, don't know anything about machining, and the company does not offer any training. To make matters worse, you don't have an instruction book on the equipment and have no idea how to read drawings.

So you come to your first day of work and stare at the control panel for a clue. A box of 5000 parts to be machined is rolled into the department with a set of detailed drawings. In desperation, you ask one of the operators in the department for help and he shows you what he remembers from jobs that have been run over the years. You push buttons and make random settings until the machine starts to work, and you hope usable parts will be produced.

Sound crazy? Of course it is. *But that is exactly how most spot welding machines are set up.*

As a result, millions of spot welds are made every day that range widely in quality and consistency. In addition, lack of knowledge about the resistance welding process can lead to excessive electrode dressing, unacceptable weld indentation, and danger to the operator from metal expulsion (flash). And setup time for new jobs that should take just a few minutes ends up taking ½ hour or more.

It turns out that a lot of knowledge about this process is readily available. Resistance welding is not a "black art" but can actually be done by the numbers. Unfortunately most people in our industry are unaware of how easy it is to find information and education on this process.

Resources. There are very good texts available that cover the entire subject. One of the best is the *Resistance Welding Handbook* Edition 4 available through the Resistance Welding Manufacturing Alliance (RWMA) at www.rwma.org. The book includes proven welding schedules for a large range of metals and processes including spot, projection, and seam welding. I would also recommend RWMA Bulletin 5, which covers all of the process names and types of welding sequences.

Great Career Path. If you are interested in an education that includes a good base of resistance welding knowledge, Ferris State University offers an extensive curriculum combining classroom and hands-on education in its two-year associate Welding Technology and four-year BS Welding Engineering Technology programs (www.ferris.edu). The university reports that 100% of the students from these programs find jobs in this industry immediately after graduation.

RW School. An excellent two-day school on resistance welding is operated by the RWMA (www.rwma.org). This course includes a copy of the RWMA *Handbook* as well as some hands-on experience. This Emmet A. Craig resistance welding school is held one or two times a year in various cities and has limited enrollment.

In-Plant Training. Several companies offer in-plant training schools. These seminars can be customized to focus on the particular type of resistance welding being done in your facility. There are also companies that specialize in establishing welding schedules for unusual part configurations or more difficult-to-weld metals. This is especially important today when new metal alloys (HSLA, dual-phase, etc.) are being introduced into industry. For a list of companies that provide these services, contact me at roger@unitrol-electronics.com.

Professional RW Technician. Being a resistance welding technician can lead to a secure future. The RWMA is just completing the design of a program that will offer training, testing, and certification for several RW technician levels. This will be run in a similar manner to the AWS arc welding certification program. Having this certificate can be the key to getting a good quality job and offers opportunities for both young people entering the workforce as well as those looking for retraining. Information on many of the resources I have mentioned is available on the RWMA pages of the AWS Web site at www.aws.org.

Going back to our poor computer-controlled machine center guy, think of how successful he would be if he were trained on the equipment, understood the technology, and had access to documentation. The same success can be achieved in the resistance welding department with basic knowledge of the process, use of readily available welding schedules, and access to quality textbooks.



Roger B. Hirsch
Chair, RWMA



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“NO SHORTCUTS”

It's part discipline, part pride and all passion that fuels Shane 'Cajun' Guidry, a native of New Orleans, Louisiana. "If you take pride in your work, then welding is for you," he says. "Because every weld you make is your signature." Shane's passion for welding runs deeper than your average metalworker.

His work has brought him from Russia to the 40-below temperatures of Alaska. Today he works as an AWS Certified Welding Inspector, where his 'no shortcuts' attitude has made him a reliable team member. "For every weld I inspect, I pretend a member of my family will depend on it," he says.

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While in Alaska, Shane used Tweco arctic cables on an exploratory drilling site. He said, "Even after dropping them seven stories down, they came up clean and ready to go again."

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NEWS OF THE INDUSTRY

Zachry Offers Free Training at its New Houston Welding Academy

Zachry, an engineering, construction, and maintenance provider, opened the Houston Regional Craft Employment and Development Center on March 18. It serves the greater Houston, Tex., area by offering free welding training along with job opportunities to those interested in joining the company's nearly 20,000 employees across the country.

The Zachry Academy is housed at the 30,000-sq-ft building. This academic and hands-on learning center is designed to instruct first-time craft workers in the welding, electrical, pipe, millwright, and instrumentation trades. Bill Cherry, the first and only person to receive a Master Craft Instructor in Welding certificate from the National Center for Construction Education and Research, is the welding manager. Continuing education for existing employees is provided, too.

"Even though the economy is in a downturn, we are preparing ourselves for the future as well as providing improved industry employment and training capabilities," said Steve Hoech, senior vice president of employee relations.

Students receive academic and practical training in welding through an on-site instructor, educational materials, and on-the-job simulations — all of which are free to participants. Specifically, they learn the facets of industrial welding and company standards including shielded metal arc welding (SMAW) on plate/pipe along with gas tungsten arc welding (GTAW) on pipe.

Its goal is to train qualified welders who will function safely and productively on Zachry job sites. According to Greg Sizemore, senior craft development manager, this program is an "open entry and open exit," meaning although the training consists of approximately 300 hours, the students are trained until the instructors believe in their abilities and are confident with their level of knowledge and performance. A test must be completed to graduate from the program and move on to employment. Cherry administers this to ensure proficiency in structural welding.

The facility further includes computer kiosks, online capabilities, and necessary equipment. The selective-enrollment program conducts training during the day, while employed craft workers may gain certifications and upgraded training during evening hours. Once an employee has successfully upgraded their skills, they are given the opportunity to perform those on their current and succeeding assignments.

The lab contains 25 welding booths. Twenty booths are dedicated to SMAW and GTAW. Four booths have multiprocess machines capable of gas metal arc welding (GMAW), flux cored arc welding, GTAW, SMAW, and gouging. Other equipment includes a plasma arc cutting machine and machines for aluminum GTAW and GMAW.

"It's all about the people," said Tammy Prescher, director of craft employment and development. "The new Houston facility is part of Zachry's continuing effort to boost investments in our company, our craft workers, and our community."

The program is still growing, and Zachry would like to continue training and employing structural welders from the Houston area, as the industry is lacking in experienced welders nationwide, according to Glen O'Mary, craft development manager and academy manager. "We want to get people in on the ground floor, and we want to do it right. At the cost of the company, we are putting people to work," he said. O'Mary hopes this training will continue indefinitely, and there is a possibility of program expansion due to the shop's large configuration.

Applicants must go through an initial screening and attend an on-site interview. Approximately ten students are chosen in each training group. Upon successful completion, students are prepared to enter the workforce as structural welders. Those showing welding proficiency will be given an employment offer on one of the nationwide company job sites. Applications will be accepted from May 1–29 for its second session. Individuals interested in completing the training program may visit www.zhi.com and click on the Zachry Academy link.



Bill Cherry is the welding manager at Zachry's new Houston Regional Craft Employment and Development Center. Free welding training is provided here for students who get accepted in the company's training program. (Photos courtesy of Dan Payton.)



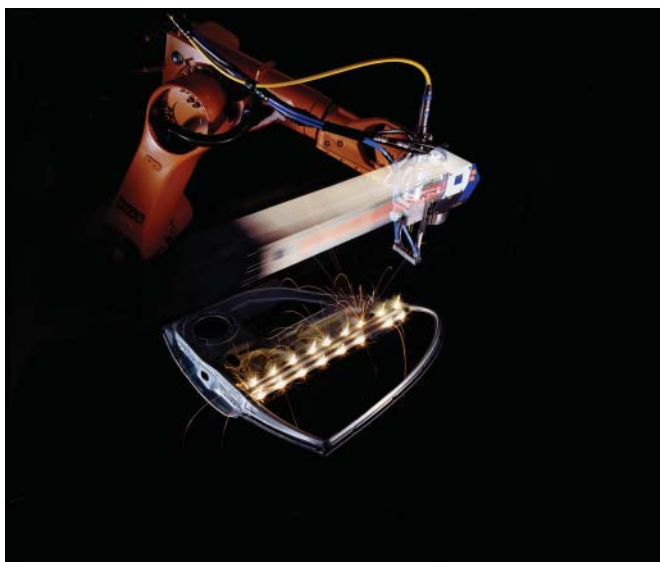
A Zachry Academy welding student tests on 2-in. Schedule 10 (0.109-in.-wall) stainless steel pipe coupons with gas tungsten arc welding using ER-308 filler metal in the 6G position with argon purge and shielding gas.

URS Joint Venture Awarded Nuclear Component Replacement Contract

URS Corp., San Francisco, Calif., recently announced SGT LLC, a 50-50 joint venture between URS's Washington division and AREVA NP Inc., has been awarded a contract by Tennessee Valley Authority. Project management, engineering, and construction services are to be provided for the replacement of four steam generators at the Sequoyah Nuclear Power Plant Unit 2 in Tennessee. The 4-year contract has a maximum value of \$130 million. Engineering and planning activities will begin immediately with installation scheduled for fall 2012.

In addition, the replacement services will include management and outage planning, design engineering, construction and craft management, and rigging and handling of the old and new steam generators. SGT will be responsible for large-bore pipe cutting and welding, heavy haul transportation, and fit-up metrology. Each generator is more than 67 ft long and weighs nearly 350 tons.

TRUMPF Receives Daimler Key Supplier Award



Daimler AG honored TRUMPF with its Key Supplier Award in the Innovation category recently in Stuttgart, Germany, as part of its Key Supplier Meeting and the 2009 Daimler Supplier Awards Ceremony. In doing so, the automobile manufacturer acknowledged TRUMPF's contribution to the development of the robot-driven laser welding system RobScan (as seen above). This consists of a programmable focusing optics and scanner optics for laser welding integrated into a robotic arm. Also, mirrors position the laser beam on each area within the processing field quickly. Spot and seams can be welded without having to move the workpiece or the focusing optics. The center of this process at Daimler are TRUMPF disk lasers from the TruDisk Series.

Gene Haas Foundation Funds Machining Technology Scholarships

The Gene Haas Foundation has provided a \$200,000 grant to the SME Education Foundation, Dearborn, Mich., to assist qualified students interested in machine operation and maintenance courses.

High school seniors, graduates, or GED recipients are eligible for a one-year scholarship, ranging from \$1000 to \$5000. Ap-



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plicants may download the scholarship application at www.smeef.org/cgi-bin/get-file.pl?/downloads/foundation/haas_machine_application.doc and submitting it to the SME Education Foundation for processing.

Component Engineers and New England Welding Combine Capabilities for Project



The process of making Dallas Area Rapid Transit light rail door frames requires certified welding in one of many precision weld fixtures built by New England Welding. Component Engineers is helping with this manufacturing job. (Photo courtesy of New England Welding.)

Component Engineers Inc. (C.E.I.), Wallingford, Conn., and New England Welding, Inc. (N.E.W.), Avon, Mass., are collaborating to complete the metal fabrication of lightweight aluminum door panels for Dallas Area Rapid Transit (DART) superlight rail vehicles in Dallas, Tex. DART is a Dallas-based public transit system providing public transportation by train and bus throughout Dallas and 12 nearby metropolitan areas.

N.E.W. has expertise in door assembly and intricate welding to strict requirements, while C.E.I. is proficient in engineering, design, and fabrication of demanding metal stampings. In this case, large forming dies shape the aluminum to the exact specifications of the customer.

Lincoln Electric Starts Green Initiative Awareness Program

The Lincoln Electric Co.'s Green Initiative Awareness Program upholds the company's initiatives to reduce the environmental impact of its manufacturing processes and products. This investment in technological advancement for its welding products has resulted in lower environmental impacts and underlines its support to creating products that help reduce welding costs and adhere to environmental standards.

To help identify these products, the company is labeling them with a new "Green Initiative" logo stating the green advantage. A Web site has also been created at www.lincolnelectric.com/green.

Rogue Community College's Welding Classes Provide Job Opportunities

In Jackson County, Ore., Rogue Community College's (RCC) welding classes and a fully equipped shop are up and running.



Tom Boyd (left) and Jesse Holcomb (right), both Jackson County, Ore., residents, are learning industrial welding skills from Rogue Community College's (RCC) instructor Todd Giesbrecht (center). Currently, RCC welding classes are offered in White City and Grants Pass, Ore. (Photo courtesy of Rand Hill, RCC.)

The college began offering its Welding Technology program winter term at the U.S. Department of Veteran's Affairs Rehabilitation Center and Clinics, White City, Ore. Welding has long been offered on the Redwood Campus, Grants Pass, Ore., and many Jackson County students are taking classes at both sites.

This expansion is in response to requests by an industry advisory committee, according to Jeanne Howell, RCC associate dean of Workforce Training. Much of the region's manufacturing and industrial base is located in the White City area.

"It is truly open entry," said Todd Giesbrecht, a recently hired instructor. "I really like my trade and teaching. I like seeing people come in without a lot of knowledge and leave with the competency level to get a job. I enjoy seeing graduates who have jobs and are supporting their families."

Long term, job prospects for welders are good, Howell added. According to an Oregon Employment Department forecast, the need for welders — both regionally and statewide — ranks near the top through the year 2016, with more than 2100 projected openings in Oregon and more than 120 locally for welders, solderers, cutters, and brazers.

Jackson County students, such as Talent resident Jesse Holcomb and Tom Boyd of Shady Cove, are taking welding classes at both RCC sites. Holcomb has been building tables and racks for the new shop; he hopes to remain in the Rogue Valley after finishing the program. Boyd, laid off after working 12 years in a local lumber mill, is attending college under the Federal Trade Adjustment Act. "I'd been a welder's helper in the oilfields, and I always wanted to be the welder. When I got a chance for school, I jumped on it," Boyd said.

The Aluminum Association Sets up Building and Construction Committee

The Aluminum Association, Arlington, Va., has established the Building and Construction Committee for its membership. This group, which became active in March, is led by newly elected chairman Eddie Bugg, director of sustainable solutions at Kawneer Co., Alcoa.

Created to support the association's Sustainability Working Group, it will aid sustainability messaging through end-of-life recycling rates and use-phase environmental benefits of aluminum in building and construction applications. Founding members include Alcoa, Hydro Aluminum North America, Indalex Aluminum Solutions, Jupiter Aluminum Corp., Novelis Inc., Nichols Aluminum, and Rio Tinto Alcan.

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Technical College Enrollment Increases in Georgia and Louisiana

Enrollment is up at two technical college systems, showing just how important various types of skills are to meet future work opportunities and needs.

In winter quarter 2009, the 33 Technical College System of Georgia colleges enrolled 88,294 students, representing a 9.4% system increase over the same time last year.

Plus, enrollment has risen at colleges within the Louisiana Community and Technical College System, and the schools are serving as an essential part of the solution to address the state's current economic situation. Based on 14th day class credit enrollment figures, system-wide, enrollment is up by 12.8%, from 51,798 students in spring 2008 to 58,426 students in spring 2009.

Nuts, Bolts & Thingamajigs Foundation to Join Forces with FMA

The Nuts, Bolts & Thingamajigs Foundation (NBTF), founded by actor, director, and producer John Ratzenberger, is collaborating with the Fabricators & Manufacturers Association (FMA) Foundation to create one charitable organization called Nuts, Bolts & Thingamajigs, The Foundation of the Fabricators & Manufacturers Association, Int'l (NBT), based in Rockford, Ill.

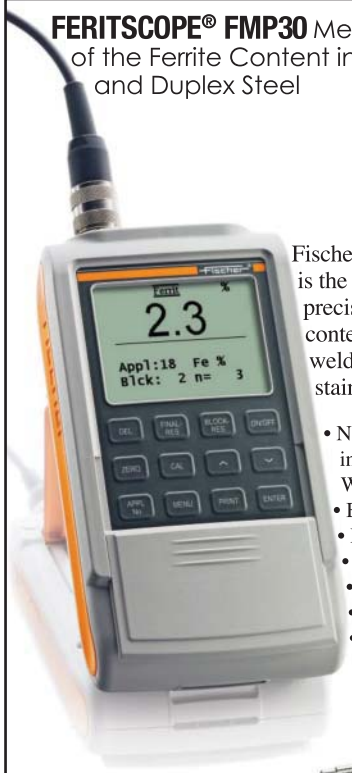
Directing the new organization will be former FMA Foundation executives Gerald Shankel and Terrence Egan, serving as president and director, respectively. Ratzenberger will continue to serve on the governing board and lead the foundation's national public policy and media campaigns.



A new entity, Nuts, Bolts & Thingamajigs, The Foundation of the Fabricators & Manufacturers Association, Int'l (NBT), is intended to inspire America's youth to consider careers in manufacturing. As pictured above, John Ratzenberger (center) oversees a young student operating a drill press at the Women of Today's Manufacturing/Techworks summer camp in Rockford, Ill.

— continued on page 103

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INTERNATIONAL

UPDATE

GE Oil & Gas to Supply Large Reactors to Italian Refinery

GE Oil & Gas recently received a major contract to supply Italian energy company Eni S.p.A. with what it believes to be the largest refinery reactors of their type ever manufactured. The reactors will be a critical part of Eni's project to boost production at its refinery in Sannazzaro, Italy. Financial terms of the contract were not disclosed. Heavy-wall reactors are used for high-pressure and high-temperature refinery processes including hydrocracking, hydrotreating, and desulfurization.

GE's components production facility in Massa, Italy, will manufacture the heavy-wall, slurry reactors, which will weigh approximately 2000 tons each. It will utilize advanced manufacturing techniques such as welding of Cr-Mo-vanadium materials, which resists corrosion in refineries and other harsh environments.

Due to their size, and the refinery's location in a densely populated area, the units cannot be delivered completely assembled. Forged rings for the reactors will be welded at GE's Massa facility, then delivered to the refinery on specially designed trucks. GE will set up a temporary facility to complete construction on site. The two reactors are scheduled for delivery early in 2011, with commercial operation in 2012.

They will be the centerpiece of a new process designed to produce more middle distillates from each barrel of feedstock. A proprietary process called Eni Slurry Technology enables increased efficiency in unconventional oils, heavy oils, and residues distillation. The process produces no residues, unlike other heavy oil cracking processes.

Linde Group and Samsung Engineering to Build Ethylene Plant in India

A contract valued at about \$1.3 billion to build a turnkey ethylene plant in Dahej, India, has been awarded to The Linde Group and Samsung Engineering, Korea. The plant will be the largest of its kind in India and one of the largest ethylene plants in the world.

OPAL, a subsidiary of the state-owned Oil and Natural Gas Corp., commissioned the plant, which is part of a new petrochemical complex being built in the Indian state of Gujarat. It is expected to produce 1.1 million tons of ethylene, 400,000 tons of propylene, 150,000 tons of benzene, and 115,000 tons of butadiene per year. These products are used as source materials in the plastics industry.

Strategic Marine Opens Shipyard in Vietnam

Strategic Marine recently held the official opening of its \$18 million shipyard in Vietnam. Company Chairman Mark Newbold told the several hundred dignitaries and guests attending the grand opening that the Vietnamese yard had already won more than \$68.3 million in orders. The 33.6-acre yard has the capability of constructing large steel and aluminum vessels.

He also announced the company had pioneered and funded an apprenticeship program, a first by any company in Vietnam, which would see 55 Vietnamese workers undertake a two-year course in a range of specialized shipbuilding skills. "This scheme is expected to boost the national government's plans to expand and modernize its shipbuilding industry, while helping us to upgrade skill levels," Newbold said.

He said the shipyard, located in the Dong Xuyen Industrial



Strategic Marine directors and delegates cut the ribbon to officially open the shipyard.

Zone in Ba Ria Vung Tau province, could not have been built without the support of the Vietnamese authorities and local businesses, "and the sheer hard work of the yard's 1100 employees."

To date, the facility has completed construction of the 103- x 50-m steel pontoon base for the Australian Marine Complex's floating dry dock, which was shipped to western Australia late last year.

The yard has nearly 5 acres of machinery and workshop space, including five large fabrication workshops, five specialist workshops, a 1.2-acre stores area, and a 16,000-sq-ft paint shop.

Magnatech Building New Orbital Welding System Center in The Netherlands



An architectural rendering of the Magnatech facility under construction in The Netherlands.

Magnatech International is constructing a 16,400-sq-ft facility in Dronten, The Netherlands. It will be used as a distribution center for the company's line of orbital pipe welding systems. The building is expected to be completed in late summer.

"With our rapid expansion in all areas of mechanized pipe welding, particularly in the pipeline industry, we need space for customer demonstrations, training, and service," said Wyn Wijnholds, company president.

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American Welding Society

Friends and Colleagues:

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

For specifics on the nomination requirements, please contact Wendy Sue Reeve at AWS headquarters in Miami, or simply follow the instructions on the Fellow nomination form in this issue of the *Welding Journal*. Please remember, we all benefit in the honoring of those who have made major contributions to our chosen profession and livelihood. The deadline for submission is July 1, 2009. The Committee looks forward to receiving numerous Fellow nominations for 2010 consideration.

Sincerely,

Nancy C. Cole
Chair, AWS Fellows Selection Committee



CLASS OF 2010 FELLOW NOMINATION FORM

(please type or print in black ink)

DATE _____ NAME OF CANDIDATE _____

AWS MEMBER NO. _____ YEARS OF AWS MEMBERSHIP _____

HOME ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____ PHONE _____

PRESENT COMPANY/INSTITUTION AFFILIATION _____

TITLE/POSITION _____

BUSINESS ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____ PHONE _____

ACADEMIC BACKGROUND, AS APPLICABLE:

INSTITUTION _____

MAJOR & MINOR _____

DEGREES OR CERTIFICATES/YEAR _____

LICENSED PROFESSIONAL ENGINEER: YES _____ NO _____ STATE _____

SIGNIFICANT WORK EXPERIENCE:

COMPANY/CITY/STATE _____

POSITION _____ YEARS _____

COMPANY/CITY/STATE _____

POSITION _____ YEARS _____

SUMMARIZE MAJOR CONTRIBUTIONS IN THESE POSITIONS:

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

SEE GUIDELINES ON REVERSE SIDE

SUBMITTED BY: PROPOSER _____ AWS Member No. _____
Print Name _____

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

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

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

SUBMISSION DEADLINE July 1, 2009



American Welding Society

Fellow Description

DEFINITION AND HISTORY

The American Welding Society, in 1990, established the honor of Fellow of the Society to recognize members for distinguished contributions to the field of welding science and technology, and for promoting and sustaining the professional stature of the field. Election as a Fellow of the Society is based on the outstanding accomplishments and technical impact of the individual. Such accomplishments will have advanced the science, technology and application of welding, as evidenced by:

- * Sustained service and performance in the advancement of welding science and technology
- * Publication of papers, articles and books which enhance knowledge of welding
- * Innovative development of welding technology
- * Society and chapter contributions
- * Professional recognition

RULES

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

NUMBER OF FELLOWS

Maximum of 10 Fellows selected each year.

AWS Fellow Application Guidelines

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

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

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

Supporting Letters

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

Return completed Fellow nomination package to:

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

Telephone: 800-443-9353, extension 2933

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LETTERS TO THE EDITOR

Readers Question Article on Fillet Weld Measurements

We are writing with our areas of concern about an article in the February 2009 *Welding Journal*. The article is "How to Accurately Measure Fillet Welds," by Joe Pavilanis.

The article states that "Woolf Aircraft needed a tool . . . traceable to NIST . . . therefore, the company developed an inspection tool/system that it can use to measure a leg length, as well as the actual weld throat." According to AWS A3.0:2001, *Standard Welding Terms and Definitions* (see Fig. 25A, B), convex fillet weld and concave fillet weld on page 83, it is impossible to measure the actual throat with the mentioned tool. As illustrated below, the actual throat in a convex weld is measured from the weld root (point at which weld metal intersects the base metal and extends farthest into the weld joint) to the most convex portion of the weld. In addition, for a concave weld the actual throat is measured from the weld root (point at which weld

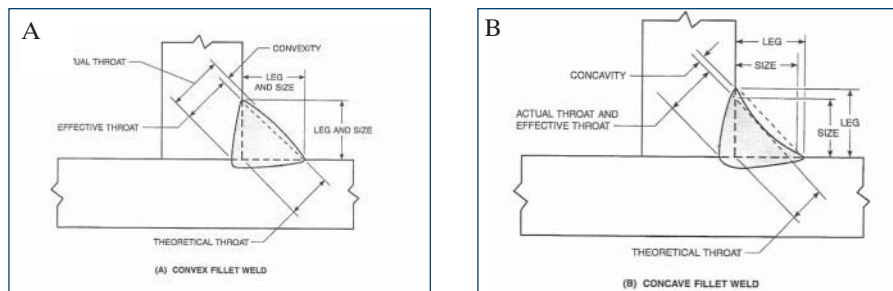


Fig. 25 — Weld sizes.

metal intersects the base metal and extends farthest into the weld joint) to the most concave portion of the weld. Because you cannot see the weld root without cutting a piece out and etching it, we believe the author may be referring to the theoretical throat.

Figure 5 of the article states, "By knowing the actual throat reading, we also know the actual leg length of this side of the triangle." We are suggesting that this also is incorrect according to AWS A3.0:2001. In a convex weld, the leg size is determined

by measuring from the joint root to the toe of the weld. If the horizontal leg measurement equals the vertical leg in measurement, this will give you fillet weld size. If the leg measurements are different, you use the length of the shortest leg. We believe the author may be referring to the theoretical throat. In a concave fillet weld the leg is still measured the same way only in this case, the leg of the fillet weld will

— continued on page 103

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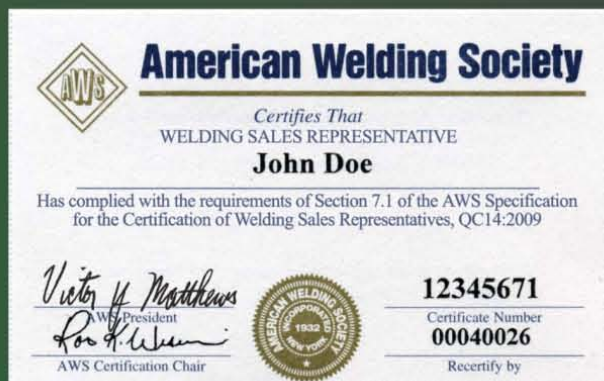
the sales of welding equipment, cutting equipment, and supplies and other related services; OR at least two years' of the same experience *PLUS* a training certificate of completion for welding processes.

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seminar fulfills this training certificate requirement...so by taking the seminar, a sales representative with between two and five years' relevant experience would be qualified to take the exam.

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STAINLESS

Q&A

Q: I need to make a series of lap fillet welds of 304L stainless steel, ½ to ¾ in. thick, on mild steel sheet and plate that are anywhere from ¼ to ½ in. thick. In every case, the stainless steel thickness will be less than or equal to the mild steel thickness. I am considering making these welds by GTAW without filler metal. Is this an acceptable approach?

A: Depending upon how long the welds are, there can be significant risks in this approach. An autogenous weld (no filler metal) will be composed entirely of a mixture of the two base metals. In an autogenous lap fillet weld, as sketched in Fig. 1, the majority of the weld metal composition comes from the overlapping piece, which, from your description, would be the 304L stainless steel piece. It would be reasonable to assume that the fused metal will be somewhere between 60 and 90% stainless steel, with the remainder being mild steel. If the welding is done manually, as I expect, the dilution is likely to vary all across that range, so we need to consider all of the possible compositions in that range.

For estimating fusion zone solidification mode and microstructure, only the carbon, chromium, nickel, and nitrogen contents are of interest. The 304L stainless composition might typically be 0.02% C, 18.5% Cr, 10.5% Ni, and 0.03% N, with a calculated Ferrite Number (FN) of about 4, and solidification in the primary ferrite mode. It is very common for steel producers to aim for about 4 FN in 304L base metal. The mild steel composition might typically include 0.15% C, with no significant chromium, nickel, or nitrogen. There are two concerns: what will be the solidification mode of the fusion zone, and what will be the alloy content (austenite stability) of the fusion zone. The solidification mode bears directly on the likelihood of solidification cracking in the weld metal. The austenite stability bears directly on the likely mechanical properties of the fusion zone and the possibility of cold cracking.

Given that the fusion zone is expected to consist of 60 to 90% 304L stainless, the composition range of the fusion zone can be easily calculated, as is shown in Table 1. The chromium equivalent (Cr_{eq}) and nickel equivalent (Ni_{eq}) for each composition, calculated according to the WRC-1992 Diagram (Fig. 2), are also included in Table 1. The actual fusion zone composition is likely to vary between the 60% and 90% 304L limits.

Figure 2 has been slightly modified from its original published form to em-

BY DAMIAN J. KOTECKI

phasize the dashed line that forms the boundary between the region labeled “AF” (in which solidification occurs in the primary austenite mode and in which solidification cracking is quite likely) and the region labeled “FA” (in which solidification occurs in the primary ferrite mode and in which solidification cracking is highly unlikely). Then the locus of all possible fusion zone compositions for the case of an autogenous GTA weld between typical 304L and mild steel has been added to the WRC-1992 Diagram. The locus of all possible fusion zone compositions is marked as “mild steel” on the lower-left end and “304L” on the upper-right end, to indicate where those compositions lie. Then the composition corresponding to a fusion zone of 90% 304L and the composition corresponding to 60% 304L are indicated on this locus of all possible compositions in Fig. 2. Compositions between these two dilutions will lie between these two points on the WRC-1992 Diagram.

From Fig. 2 it can be seen that the point labeled “90%” is barely inside the region of primary ferrite solidification, which would indicate that solidification cracking

of such a composition would be highly unlikely. However, traversing slightly downward and to the left (less 304L and more mild steel in the fusion zone) along the locus of all possible fusion zone compositions would cross over into primary austenite solidification at slightly less than 90% 304L. For such compositions, solidification cracking becomes a distinct possibility.

Furthermore, it can be seen that the locus of all possible fusion zone compositions crosses the shaded region labeled “Martensite Boundary @ 1% Mn” at

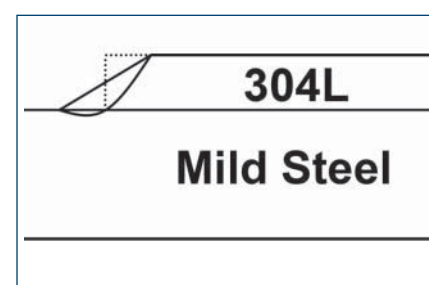


Fig. 1 — Sketch of autogenous GTAW lap joint of 304L on mild steel.

Table 1 — Typical Composition of Mild Steel and 304L Stainless, and Diluted Fusion Zone

	Mild Steel	304L Stainless	90% 304L	60% 304L
C	0.15	0.02	0.033	0.072
Cr	—	18.50	16.650	11.100
Ni	—	10.50	9.450	6.300
N	—	0.03	0.027	0.018
Cr_{eq}	0.00	18.50	16.65	11.10
Ni_{eq}	5.25	11.80	11.15	9.18

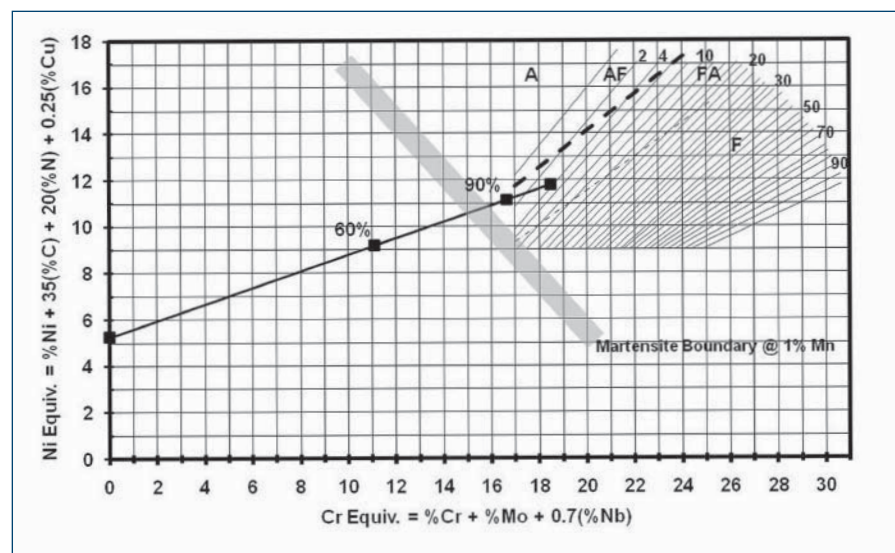


Fig. 2 — WRC-1992 Diagram with typical 304L and mild steel. The boundary between the AF and FA solidification modes is emphasized as the heavy dashed line.

slightly less than 90% 304L. Compositions below and to the left of this boundary are predicted to transform to martensite. Compositions within the shaded boundary may or may not transform to martensite — there is a degree of uncertainty in the precise location of the boundary, which is the reason it is shown as a shaded region rather than a distinct line. If the fusion zone transforms extensively to martensite, it will be brittle and could be subject to cold cracking. This is where the weld length issue comes in — the longer the weld is, the more likely that occurrence of cold cracking becomes due to greater longitudinal restraint. The GTAW process normally produces very little diffusible hydrogen, so the tendency to cold cracking of martensite is likely to be low, but not negligible.

In conclusion, it is feasible to do what you propose, but it is not without risk. Probably the greatest risk is of crater cracking if the fusion zone solidifies in the primary austenite mode. To combat that, I suggest that you train your welders to employ current downslope control and run the arc up on the 304L when terminating each weld, as this can minimize crater cracking tendencies. You also need to assess the mechanical property requirements of the joints. In particular, is ductility necessary in the fusion zone? If not, then you can probably accept some martensite in the fusion zone, but you should also take into account the possible consequences of a failure in case a given weld cracks or fractures. You should also recognize that it is difficult, in an autogenous GTAW procedure, to get a fillet weld throat large enough to make the weld strength equal the 304L base metal strength without a lot of penetration into the mild steel, so the load-bearing ability of the fillet is likely to be limited. Finally, I suggest that you plan for extensive visual examination of the joints to look for cracks and any evidence of excessive penetration into the mild steel.

DAMIAN J. KOTECKI is president, Damian Kotecki Welding Consultants, Inc. He is a past president of the American Welding Society, currently treasurer and a past vice president of the International Institute of Welding, and a member of the AWS ASD Subcommittee on Stainless Steel Filler Metals, and the AWS D1K Subcommittee on Stainless Steel Structural Welding. He is a member and past chair of the Welding Research Council Subcommittee on Welding Stainless Steels and Nickel-Base Alloys. E-mail your questions to Dr. Kotecki at damian@damiankotecki.com, or send to Damian Kotecki, c/o Welding Journal, 550 NW LeJeune Rd., Miami, FL 33126.

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WELDING JOURNAL 25

POINT OF VIEW

Building Momentum for Long-Term Jobs

BY CHRISTINE TODD WHITMAN



Christine Todd Whitman served as governor of New Jersey and head of the U.S. Environmental Protection Agency before becoming cochair of the Clean and Safe Energy Coalition.

During my tenure as New Jersey's governor, I learned a great deal about labor markets. One lesson was that worker shortages often point to a perception problem.

We know from talking to high school kids that such is the case with welding and other highly skilled trades. More than a third of American high school students recently surveyed about their employment plans said they were not pursuing a career as a skilled tradesman because they didn't believe there would be enough opportunities or they didn't know enough about such options.

We can blame these perceptions in part on the contraction of the U.S. manufacturing sector over the past decade and the rise in service-related office jobs. But all of that is in the rearview mirror.

The reality is that America's future rests largely on its ability to retool our energy infrastructure, and welders are going to be on the front lines of this transition for many years to come. The energy sec-

tor is in growth mode during one of the deepest recessions in our lifetime, and it won't be long until those entering the workforce benefit from opportunities in this sector.

To help stoke their interest, the nuclear energy industry has been conducting regional workshops to help get the word out about the widespread need for skilled tradesmen.

America is pushing for an expansion of its nuclear energy capabilities to meet an urgent need for large-scale electricity sources that don't pollute our air. By 2030, our country is going to need 20% more electricity than we use today. Meeting this demand will require investing \$1.5 trillion to \$2 trillion in capital investments, including power plants and transmission lines to move electricity to where it is needed.

Electric utility companies are under increasing pressure to derive more of their electricity supplies from clean energy sources. Nuclear energy is the only large-scale electricity source that is emissions-free, produces power around the clock, and is expandable today. Using nuclear energy plant technology developed in the United States and uranium fuel from domestic sources or friendly trading partners like Canada, it will also greatly reduce our dependence on foreign energy sources. For all of these reasons, utilities have filed permits to build 26 new reactors.

This pending wave of nuclear energy plant construction will provide tremendous opportunity for welders seeking long-term, high-paying positions. If all 26 plants now pursuing licenses are built, they would create up to 62,000 construction jobs. Each new reactor project will employ as many as 2400 construction workers at peak periods. In the southeastern part of the country, where many of these facilities will be built, energy producers predict they will need more than 115,000 skilled tradesmen, including 22,000 boilermakers and tube welders, and 38,000 pipefitters and combination welders, according to a report released by the Clean and Safe Energy Coalition, which I chair along with Greenpeace co-founder Patrick Moore.

Many companies already are hiring in anticipation of the building boom. Over

the past three years, the prospect of nuclear plant construction has created 15,000 jobs, including many in the manufacturing industry. Westinghouse, for example, announced last April that it added 3000 jobs in the past three years, and it expects to add 400 to 500 per year to meet expected demand from new nuclear plant construction.

Indirectly, economic benefits will spread to hundreds of suppliers of commodities and components manufacturers, spelling much-needed relief for local communities hard hit by the economic slowdown. Depending on its design, a new nuclear reactor could require up to 3 million cubic yards of concrete, 50,000 tons of reinforcing steel and related parts, as much as 150 miles of pipe, more than 11,000 valves, and as many as 2200 pumps.

These messages are resonating with attendees at regional workshops, but those attending these forums represent a sliver of the young Americans who are eager to find jobs. That's why I am extremely encouraged by the American Welding Society's proactive and innovative efforts to manage its workforce transition through programs like welding "boot camps" run by local colleges to gaining training grants. These efforts are clearly bearing fruit.

Welders were involved in the greatest engineering feats in our nation's history, from our railroads to our skyscrapers to our dams. Now, as we prepare to embark on yet another infrastructure challenge, they are being called on again.

At a time when many in our society are lamenting the decline of America's zeal for building infrastructure, this transformation will create an abundance of opportunities for Americans of all ages to leave their mark on America's rich landscape.

Growth industries aren't easy to come by these days. Those workers who stake their claim now can be secure in the knowledge that they will be needed for decades to come. ♦

CHRISTINE TODD WHITMAN is cochair of the Clean and Safe Energy Coalition (www.cleansafeenergy.org), a national grassroots coalition that promotes the economic and environmental benefits of nuclear energy.



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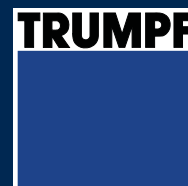
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TECHNOLOGY

ACGIH Intends to Reduce Respirable Manganese Limit

The American Conference of Governmental Industrial Hygienists (ACGIH) recently announced it intends to reduce the threshold limit value (TLV) – time weighted average (8-hour TWA) maximum exposure limit for respirable particulate manganese from 0.2 to 0.02 mg/m³. This is the TLV that applies to manganese compounds in welding fume. It is important to note that the Occupational Safety and Health Administration (OSHA) has not changed its legally mandated permissible exposure limit (PEL) for manganese, which remains 5.0 mg/m³ (ceiling limit).

This tenfold reduction in the TLV means that if you control exposure to welding fume based upon the ACGIH TLV, engineering controls will be essential in any area in which arc welding is performed and the use of respirators, up to air-supplied units, may be required depending upon an assessment by a qualified industrial hygienist. For additional information, visit www.aws.org for links to ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, AWS *Safety and Health Fact Sheets*, etc.

Because of the potential effect the reduction in TLV may have, it is important the welding community is aware of this development. All are encouraged to review the Notice of Intended Change documentation, which may be obtained from the ACGIH Web site at www.acgih.org, and consider what changes to their operations may be needed should this TLV be adopted. Additional details regarding the TLV development process is located on the ACGIH Web site at www.acgih.org/TLV/DevProcess.htm. The ACGIH invites public comment upon intended changes to TLVs, and the deadline for comments on this change is July 31, 2009. If you have information that may influence the ACGIH on this matter, you are urged to provide it by the above deadline.

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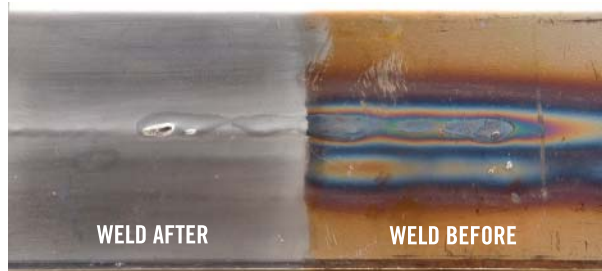
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August 3-14, 2009 – Yuba College, Marysville, CA

Participants will receive information on the growing need for welding technicians and a curriculum for use in training them. Weld-Ed staff will discuss the opportunities for attendees to create new AAS programs in welding technician education and/or to infuse welding and materials joining instruction into existing technician or technology programs. Attendees will also learn about Weld-Ed materials and services that are available for planning and implementing welding and materials joining education at their institutions. Participants will receive three semester credit hours on completion of the course.

Weld-Ed is a National Science Foundation ATE National Center of Excellence with the stated mission of promoting welding education and training and assisting secondary and post secondary schools around the country in developing and implementing educational programs that support the creation of welding and materials joining technicians.

Fee: \$500, participants are responsible for any travel, evening meals, and weekend lodging and meals.

For registration information, go to www.weld-ed.org/workshops, or call 440-366-7036.

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RWMA

Q&A

Q: My company is relatively new to resistance spot welding, and we are looking at efficiency improvements that would require running multiple part combinations on a single tool. With an eye toward minimizing potential changeover miscues, we would like to utilize a single welding electrode for all of our spot welds, if possible. Unfortunately, after a review of the many electrode combinations that might work, we came away slightly concerned about the wide variety available. Are there any rules or guidelines that could aid us in this endeavor?

A: This is a fairly common question within the industry as companies look to standardize and/or minimize the number of welding consumables, including electrodes, they stock for a given process. To help determine an answer, it will be helpful to consider the function of the electrode within the resistive welding process and then attempt to provide a few basic guidelines on proper selection.

The successful execution of any resistance welding operation, however simple or complicated, is dependent upon the proper functioning of the electrodes. The high level of development that has occurred (and is still occurring) with the various resistive joining processes has made it more evident than ever that good welding is a precision process. A properly designed welding machine includes a capable electrical system, robust mechanical system, and precise control system. The function of the electrodes is to conduct the current and withstand the high forces so as to maintain a uniform contact area, thus ensuring the proper relationship of current, time, and force required for a successful weld.

To answer your question regarding electrode selection and whether or not it is possible for one size to fit all, it is beneficial to start by discussing the basic parameters that affect every weld: current, time, and force. Other themes important to the discussion are electrode materials and contact face geometry. As you did not detail the specifics of the substrates involved, this discussion is generic in nature but should provide enough information on the selection of resistance spot welding electrodes to reach the correct conclusion for your particular application.

Weld Force. The force required for a particular weld influences many aspects of electrode design and construction, particularly the electrode taper size, body diameter, and cooling cavity to contact face distance. The welding operation subjects

BY DONALD F. MAATZ JR.

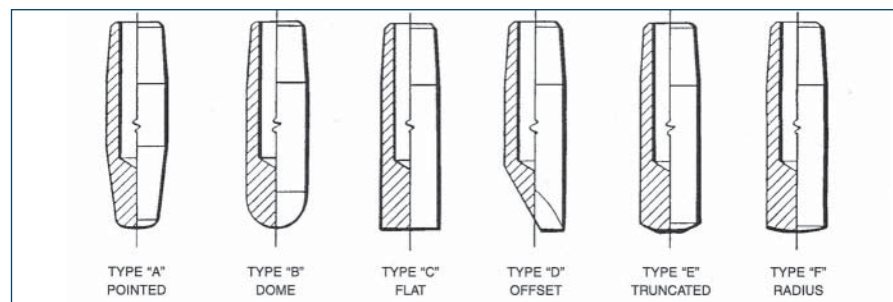


Fig. 1 — Standard spot welding electrodes. (Illustration courtesy of the RWMA.)

the electrodes to stresses that are often of considerable magnitude, and they must be capable of withstanding these stresses at elevated temperatures without excessive deformation. This is no easy task when one considers that many resistance spot welds are made between 500 and 1700 pounds. The majority of the electrode design requirements have been proven over time and subsequently incorporated as industry standards. Specifically, AWS D8.6, ISO-5821, and RWMA Bulletin 16 may be referenced for the recommended or standardized designs. The electrode design constraints mandated by force are a critical area where a compromise in the electrode selection process may occur. For example, if one application requires a higher weld force than another, the electrode selected must be capable of withstanding the greater force condition.

Weld Current and/or Weld Time. The secondary welding current and time required to achieve a spot weld are rarely, if ever, considered when selecting an electrode. The primary reason for this is that the vast majority of spot welding electrodes are cooled in some fashion, thus rendering them with excellent electrical and thermal capacities. This results in the required weld force being a much larger factor in electrode design selection than either current or time.

Electrode Material. An in-depth discussion on the proper selection of electrode materials should be left for another time as this is potentially a very application-specific area of resistance welding. There are many excellent sources of information on this topic and a good place to start is the *Resistance Welding Manual* or one of the many electrode suppliers listed in the RWMA Directory (files.aws.org/rwma/docs/webdir-09.pdf). One point to keep in mind is that electrodes generally have a higher thermal conductivity than that of the metals being welded, so for a starting point consider

electrodes constructed of RWMA Class-1 and Class-2 copper as these alloys compose the majority of the usage within the industry.

Electrode Geometry. The selection of the contact face geometry is the most critical aspect of electrode selection that must be considered. To help facilitate this selection, several aspects of the weld must be considered. These include the required weld size, substrate gauge, and surface quality requirements. One important physical characteristic to remember is that the contact face geometry, weld size, and substrate gauge should all trend in the same direction. More to the point, a welding process that attempts to utilize a larger contact face to weld both a thick and thin section will most likely struggle on the thin stack-up. This is a very important point to keep in mind when selecting the electrode for your application. Other items such as substrate type and coating, while important for determining the actual weld schedule (force, etc.) and influencing the potential life of the electrode, do not have the impact on achieving the initial weld that the required weld size, substrate gauge, and surface quality do.

Figure 1 illustrates six of the many standard electrode nose geometries available.

DONALD F. MAATZ Jr. is laboratory manager, RoMan Engineering Services. He is a member of the AWS Detroit Section executive committee, serves on the D8 and D8D Automotive Welding committees, is vice chairman of the Certified Resistance Welding Technician working group and of the RWMA Technical Committee. He is a graduate of The Ohio State University with a BS in welding engineering. This article would not have been possible were it not for the assistance of members of the RoMan team. Send your comments and questions to dmaat@romaneng.com, or to Don Maatz, c/o Welding Journal, 550 NW LeJeune Rd., Miami, FL 33126.

Each of these geometries has its own benefits and limitations, and supporters and detractors. Type A, B, and E geometries are most commonly used for general welding applications. Type C and F geometries are typically used where minimal surface marking is required. Type D geometry permits access in limited spaces. The following general guidelines should help with the selection process:

- **Type A.** Good general design. The selection of the contact face diameter is important so that it is compatible with the desired weld size and the substrate gauge. The design is able to support weld sizes larger than $4\sqrt{\text{GMT}}$ (governing metal thickness) when a properly sized contact face is utilized for a particular substrate gauge.
- **Type B.** Also a good general design. Type B will typically result in more indentation than Types A or E due to its spherical shape; it is not able to support very large weld sizes. As a rule of thumb, do not expect to sustain weld sizes larger than $4\sqrt{\text{GMT}}$. It is a good candidate for robotic dressing.
- **Type C.** Utilized for improved weld surface quality. Has the potential to wear quickly when welded on coated materials and should be dressed off-line in order to renew properly.
- **Type D.** Utilized when a weld has to be made close to an upturned flange or corner. The offset loading associated with the Type D design is hard on the electrode taper. The basic rules regarding Types A and E contact face diameters also apply to the Type D electrode contact face.
- **Type E.** Another good general design available in different rake angles. The 30- and 45-deg designs are the most popular. These designs are also a good candidates for robotic dressing. As with the Type A electrode, the selection of the contact face diameter is important so that it is compatible with the desired weld size and substrate gauge.
- **Type F.** Utilized for improved weld surface quality. May also be used when welding very thick stack-ups or aluminum, depending on the face radius specified. A properly sized Type F can support very large weld sizes ($>5.5\sqrt{\text{GMT}}$) when used with robust schedules and capable equipment. Also while possible, this geometry is not a good candidate for robotic dressing.

For further information on electrode selection, AWS C1.1:2000, *Recommended Practices for Resistance Welding*, may also be a beneficial reference.

So to attempt to answer your question: Are there industry standard electrode designs available that are very versatile and capable of welding many different stack-ups? The answer is yes if due considera-

tion is given to the required weld force and a suitable geometry is selected. However, even the best standard electrode can become unsuitable under a variety of circumstances. Another way to look at this problem is to think of the spark plugs in your car. While different types of spark plugs may work, there is most likely an optimal design that works best, but just as there is not a spark plug made that will allow my pickup truck to sit on the pole at the Indy 500, there is not a single elec-

trode capable of making all types of resistance spot welds. ♦

Acknowledgment

The author would like to thank the Resistance Welding Manufacturing Alliance (RWMA) for allowing the use of information from the *Resistance Welding Manual*, revised 4th Edition, to answer this question. This resource is available at www.rwma.org in the publication section.



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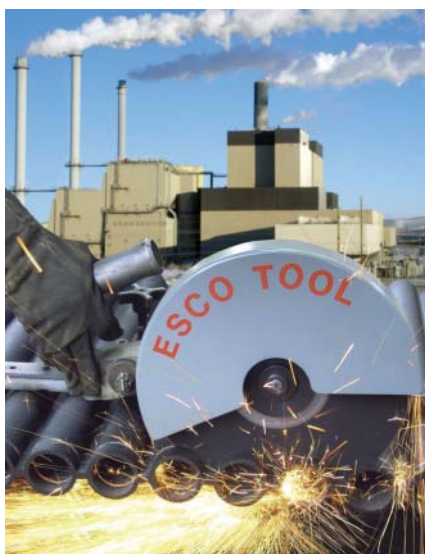
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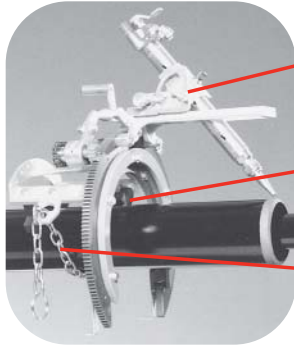
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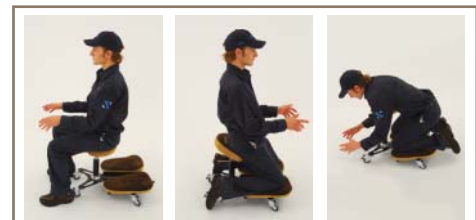
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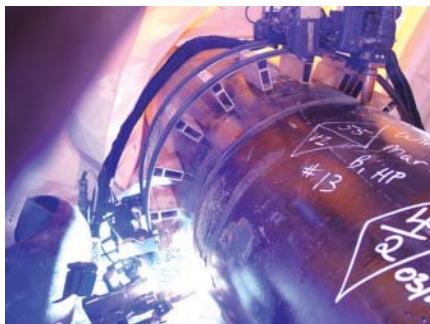
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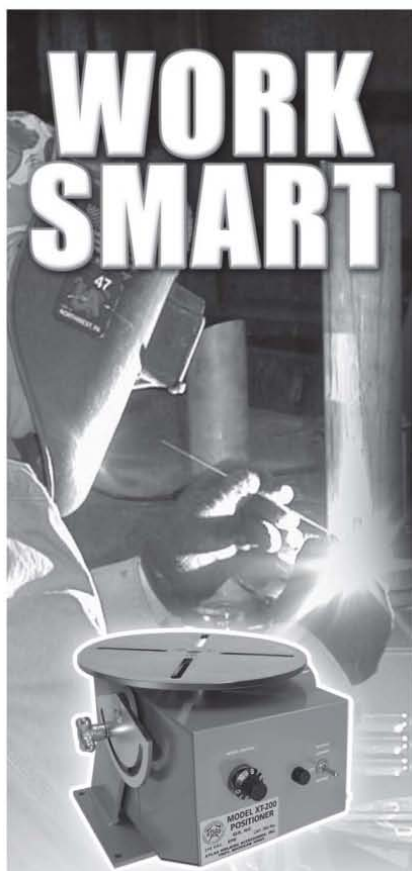
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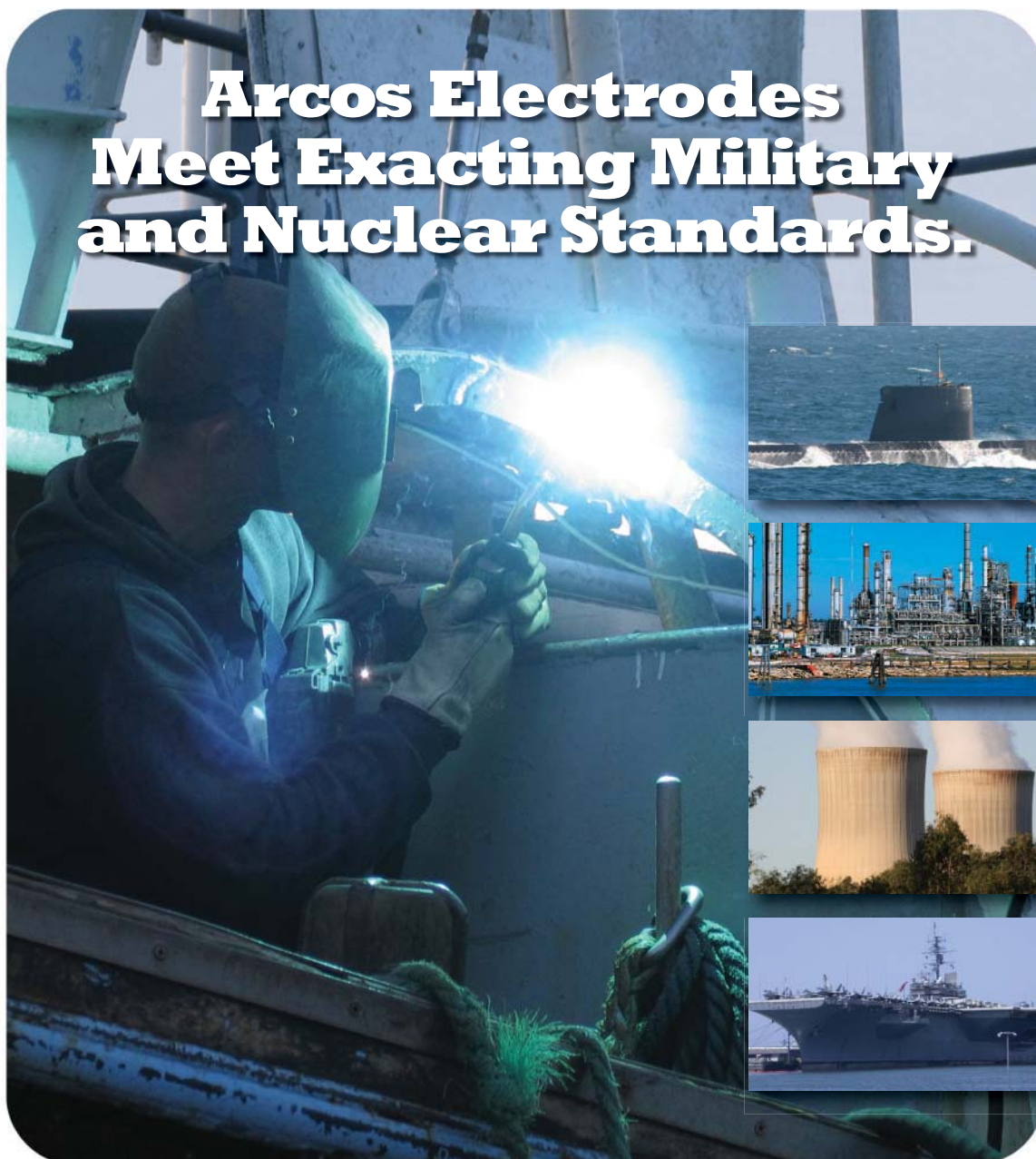
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Construction of the Olkiluoto Unit 3 nuclear power plant in Finland. (Photo courtesy of TVO.)



Welding for New Nuclear Power Plants: Building on Experience

Lessons learned from the existing fleet of nuclear plants provide the foundation for new welding guidelines aimed at reducing the risk of degradation mechanisms

BY STEVE McCracken, ERIC WILLIS, AND JEFFREY HAMEL

Pressures to meet the growing demand for reliable, around-the-clock electricity and to reduce greenhouse gas emissions have revived interest in nuclear power in the United States. Several U.S. utilities are actively planning to build advanced nuclear power plants, and these plants could come on line by 2016 or 2017. The Nuclear Regulatory Commission has received 17 applications to build 26 new U.S. nuclear reactors and expects applications for up to 7 more reactors by the end of 2010.

A key reason for the renewed interest in construction of new nuclear plants is the existing nuclear fleet's strong record of safe and reliable operation. In 2008, for example, U.S. nuclear power plants achieved an average 91% capacity factor, which indicates that plants were on line and generating electricity more than nine out of every ten hours.

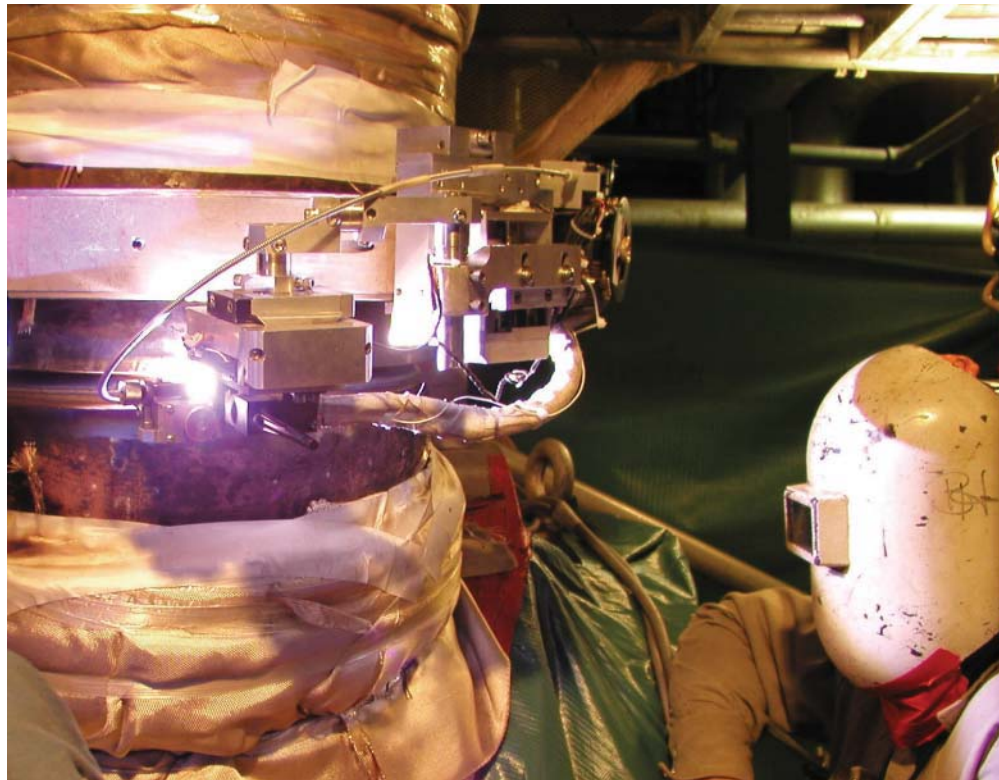
The welding community has contributed to this commendable fleet performance through technically sound welding practices supported by stringent engineering codes and standards, and will continue to contribute to the success of the next generation of nuclear plants. High-quality, reliable welds are critical to safe nuclear plant operation. Because of the safety significance of welds in many critical systems, structures, and components, the nuclear power industry must be confident in the quality and integrity of welded joints.

The next generation of nuclear power plants will likely have a design life of 60 years or more. Improved welding and fabrication practices will be essential in achieving this increased life expectancy and minimizing the potential for unexpected and costly repairs and maintenance.

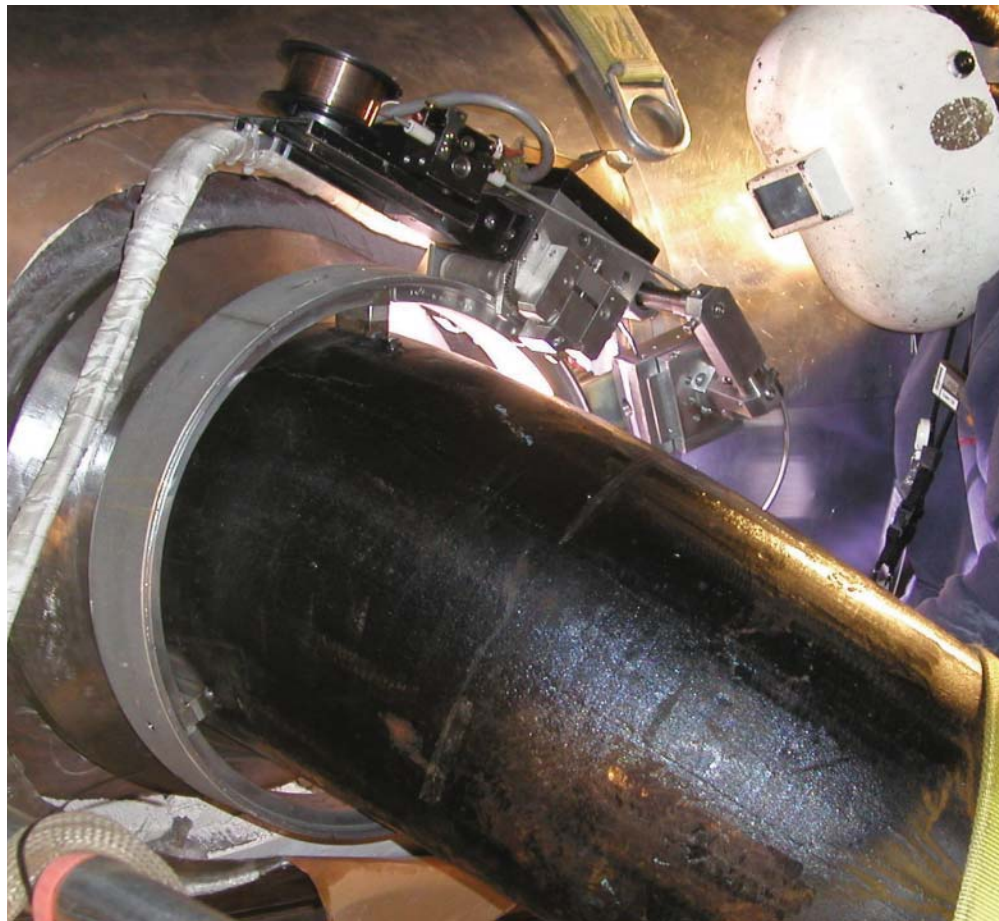
To ensure the reliability and longevity of future nuclear plants, the Electric Power Research Institute (EPRI) is working with utilities and equipment manufacturers to develop welding and fabrication "best practice" guidelines for new nuclear plant construction. Such guidelines will equip the welding community and utility engineers with practical tools for identifying and implementing the most efficient, timely, and cost-effective methods to reduce the risk of degradation mechanisms such as stress corrosion cracking.

As an independent, nonprofit research and development organization, EPRI

STEVE McCracken (smccracken@epri.com), *ERIC WILLIS* (ewillis@epri.com), and *JEFFREY HAMEL* (jhamel@epri.com) are senior project managers with the Electric Power Research Institute's Nuclear Program. More information on EPRI's Advanced Nuclear Technology Program can be found at www.epri.com/ant.



Machine gas tungsten arc welding of a closure joint on a 14-in.-diameter pipe.



Machine gas tungsten arc welding of a pipe-to-nozzle joint.



Vessel head clad welding.

does not attempt to advocate or dictate any particular process for reducing the risks inherent in welding and fabrication practices. Rather, the Welding and Fabrication Best Practices project aims to provide multiple ways of achieving risk-reduction goals, so users can choose among several options and select the most practical or cost-effective approach in a given situation.

The ongoing project includes the following key steps:

- Evaluate welding and fabrication practices in operating plants to identify lessons learned
- Identify the relative susceptibility of critical welds in new nuclear plant designs to known degradation mechanisms
- Develop a systematic process that identifies the key factors influencing the susceptibility of high-risk welds to degradation mechanisms

- Provide recommendations for reducing the propensity of welds to degradation mechanisms.

Learning from Experience

The 104 nuclear generating units now operating in the United States offer a wealth of information about welding and fabrication practices, materials failure, and component degradation. The lessons learned from the existing nuclear fleet can help the industry identify practices that contribute to failures, and apply improved practices to increase the reliability and extend the life of new nuclear plants.

In 2008, as a first step in the best practices project, EPRI assembled a team of welding and fabrication experts to survey welding and fabrication practices in nuclear plants and in other industries. The survey team reviewed and documented practices that contributed, or could contribute, to the premature failure of critical components.

The researchers confirmed that most

material failures in operating plants occur in or near welds. Root cause evaluations showed that many of these failures resulted from less than optimum welding, fabrication, or surface-conditioning practices. For example, residual stresses induced by welding and uncontrolled grinding on reactor coolant piping are known contributors to stress corrosion cracking. Weld repairs in particular can induce high weld residual stresses that increase susceptibility to cracking mechanisms. However, optimized welding and fabrication processes along with properly controlled repair practices can reduce susceptibility to known cracking mechanisms.

Closing the Gaps

Operating experience from the current fleet of nuclear power plants can be analyzed to identify and manage materials performance issues for advanced light water reactor designs currently being considered for new nuclear power plants. In many cases, evaluation of operating plant

issues and implementation of mitigation or management technologies can significantly reduce operating costs over the life of these new plants. Potential benefits include prevention of degraded conditions, more efficient and accurate inspections, and reductions in repair and replacement costs.

The EPRI Advanced Nuclear Technology Program has initiated a materials management matrix (MMM) initiative to meet this need. Among the key gaps identified through the MMM initiative is that currently there are no industry guidelines for new nuclear power plants plant fabrication and construction that identify practices that influence (positively or negatively) susceptibility to known degradation mechanisms.

Practical Information and Guidance

Building on the information matrix, the project team will meet with the original equipment manufacturer (OEM) for each new reactor design to review and document welding and fabrication practices. The team will then identify critical welds and assign a relative risk ranking to a known degradation mechanism. The risk ranking considers the influence of welding, machining, repair, and mitigation processes identified by the OEM and considers weld material, system service conditions, and operating experience. This information will be compiled in a Welding and Fabrication Addenda to the MMM for each new reactor design.

The team will also determine the welding, machining, repair, and mitigation factors that influence degradation mechanisms for specific materials. This information will be evaluated and documented in a Welding and Fabrication Critical Factors document. Utility engineers can use this report to identify specific processes or process parameters that can be implemented to reduce the identified susceptibility and risk. Together, these documents will enable users to identify welds with a high relative risk for degradation, and then systematically determine methods and ways to minimize and reduce susceptibility with specific welding and fabrication practices.

For example, the Welding and Fabrication Addenda to the matrix for a new pressurized water reactor design may rank the dissimilar metal nozzle-to-safe-end welds in the reactor coolant system high for relative risk to primary water stress corrosion cracking. A high relative risk ranking may be based on the critical nature of the system, materials, specific reactor design, service conditions, and on the influence of the welding, fabrication, and surface conditioning specified by the OEM.

The materials, design, and service conditions of the new reactors most likely cannot be changed. However, the welding, fabrication, or surface-conditioning processes can possibly be modified slightly or significantly to reduce the relative risk ranking of the dissimilar metal welds, which would increase the reactor coolant system life and reliability. For example, a number of processes have recently been developed to mitigate the tensile residual stresses that are produced by welding. These residual stress mitigation processes were not available during the construction of the original U.S. nuclear power plant fleet, but hold significant potential for application in the new fleet. For those cases where it is not cost effective or feasible to modify the welding process to reduce the residual tensile stresses, residual stress mitigation processes can be used to lower the propensity to degradation mechanisms. The Welding and Fabrication Critical Factors report will provide background information and specific guidelines on which processes or process parameters would effectively reduce the relative risk ranking.

The Payoff

Optimizing welding, fabrication, or surface-conditioning practices in the sus-

ceptible areas of critical components can significantly improve the life and reliability of new nuclear power plants, preventing forced shutdowns and reducing outage maintenance costs.

The best practices project is an ambitious collaborative effort to develop information and tools that will enable project participants to build reliability into new nuclear power plants. Working together, utilities, equipment manufacturers, vendors, and the welding community can seize the opportunity to apply improved welding and fabrication practices to ensure that new nuclear plants will operate reliably over their designed 60-year lifetimes. ♦

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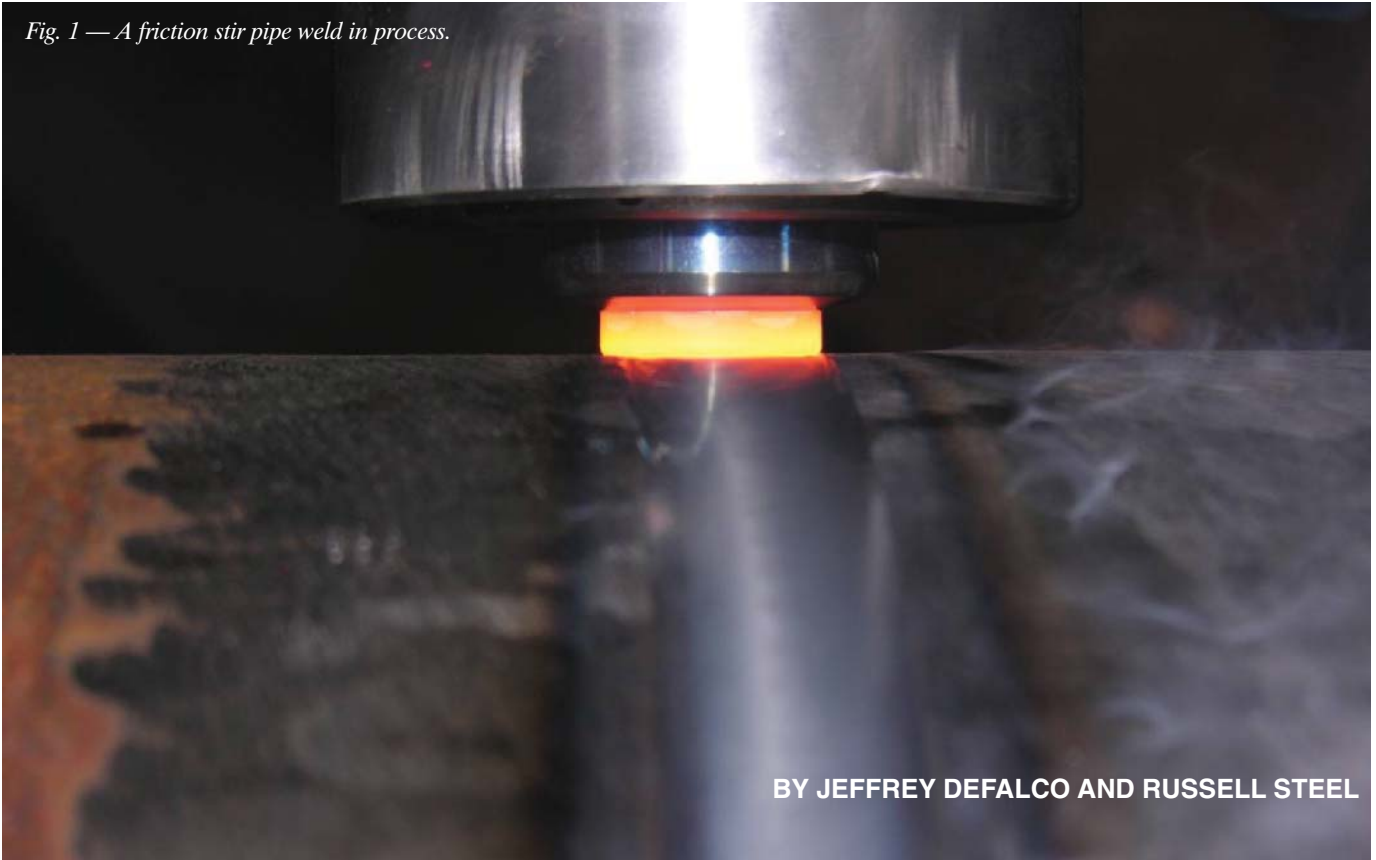
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Friction Stir Process Now Welds Steel Pipe

Fig. 1 — A friction stir pipe weld in process.



BY JEFFREY DEFALCO AND RUSSELL STEEL

The process offers tremendous advantages in productivity and cost savings for the pipeline industry

Friction stir welding (FSW) is a relatively new joining process that has exhibited many advantages over traditional arc welding processes, including greatly reducing distortion and eliminating solidification defects. Because melting does not occur and joining takes place below the melting temperature of the material, a very-high-quality weld can be created with low heat input, minimal distortion, no filler material, and no fumes. Friction stir welding is also highly efficient and more environmentally friendly than traditional welding methods.

For the pipeline industry in particular, FSW is advantageous because, compared to conventional fusion welding processes such as arc and laser beam welding, FSW is highly energy efficient, with reduction in energy usage of 60 to 80% not uncommon.

Friction stir welding offers better weld quality because it is immune to the welding defects caused by solidification in fusion welding. It offers high weld joint strength, is a highly productive method of welding, and can join dissimilar materials and composites.

Until recently, applications for FSW have been limited mostly to aluminum and other low-melting alloys, and because FSW equipment is not inherently portable, it was not applicable for on-site construction of large and complex structures such as pipelines, bridges, and refinery vessels. Recent technology breakthroughs in tool composition and technology, however, have increased FSW's joining capability to include high-strength steels and other high-melting-temperature materials. Also, portable equipment

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specific to FSW orbital welding can now perform girth welds in the field. This further enables this useful technology to be applied for pipe welding.

Friction stir welding of ferrous alloys is particularly useful in production environments where welding repair and direct costs are high. From a mechanical capability standpoint, FSW of up to ½ in. (12.7 mm) maximum on steels is very repeatable, and development is currently underway to expand this capability up to ¾ in. (19 mm). The world currently has an estimated 6200 miles (10,000 km) of onshore pipelines used to transport oil and gas, with capital expenditure estimated as exceeding \$16 billion. More than half of the world's undeveloped hydrocarbon reserves are remote from potential users, and very large pipelines, up to 56 in. (1.42 m) diameter are required to transport the fuel to market. The welding process used to make the site girth welds has a significant bearing on the total cost of the pipeline. FSW offers significant cost improvements over the current practice of using mechanized or automated gas metal arc welding (GMAW) processes.

The FSW process is relatively easy to control in the presence of adverse environmental conditions, and the weld parameters are robust. Because it is capable of single-pass welds, FSW saves time and reduces the pipeline welding logistics considerably. This equipment can also be operated by a nonwelder, which can save labor cost but, more importantly, addresses the current shortage of qualified welders.

The Friction Stir Weld Process

The FSW process was patented in 1991 by The Welding Institute (TWI) for use with low-melting-temperature materials such as aluminum, brass, and copper. FSW is a solid-state welding process in which a non-consumable tool is rotated along the interface between two materials to be joined. The tool consists of a protruding pin, which is plunged into the workpieces, and a larger concentric “shoulder” that is maintained on the surface of the joint. The concave surface of the shoulder produces a mixture of frictional heating and forging pressure. Frictional heating created by the shoulder and pin rotation in contact with the base material produces a local plasticized region around the tool. As the tool moves along the weld joint, the plasticized material is displaced. Under the heat and forging pressure of the tool, a fully consolidated metallurgical bond is produced — Figs. 1, 2.

Welding parameters for FSW consist of the travel speed of the tool with respect to the base material, the rotational speed of the tool, and the forging pressure ap-



Fig. 2 — Examples of friction stir welds.

plied by the tool. These parameters are governed by the tool geometry (i.e., shoulder and pin diameter), mechanical properties of the material to be joined (i.e., flow stress), and material thickness.

The process was originally limited to low-melting-temperature materials because initial tool materials could not hold up to the stress of “stirring” higher temperature materials such as steels, stainless steels, and nickel-based alloys. This problem was recently solved with the introduction of new tool material technology using very hard materials such as polycrystalline cubic boron nitride (PCBN), tungsten rhodium, and ceramics. The use of a liquid-cooled tool holder and telemetry system has further refined the process and capability — Fig. 3.

Tool materials required for FSW of high-melting-temperature materials requires high “hot” hardness for abrasion resistance, along with chemical stability and adequate toughness at temperature. Material developments are advancing rapidly in different tool materials, each material having specific advantages for different applications. Shown in Fig. 4 are tool profiles of a 6-mm pin tool before and after more than 100 ft of friction stir welding in A36 steel. Little tool wear is present, without tool fracture or cracking.

During the FSW process, microstructurally distinct regions are characterized much like those found in arc welds. These include the following (Fig. 5): A) the unaffected base material, B) heat-affected zone (HAZ), C) thermal mechanically affected zone (TMAZ), and D) the stir zone (SZ) or weld nugget. The SZ consists of



Fig. 3 — An example of the latest tool, tool holder, and telemetry system technology.

fine equiaxed grains. Recrystallization has occurred in order to relieve the high amount of plastic strain introduced by the FSW process. Adjacent to the SZ are the TMAZ and HAZ regions. The TMAZ is distinguished by an elongated plastically deformed grain structure. The HAZ, just as in an arc weld, is the region that has experienced an elevated thermal cycle but has not undergone any deformation.

An advancing and retreating side of the weld occurs with FSW. The side of the weld in which the tool rotation and the travel direction is in the same direction is considered the advancing side. The side of the weld in which the tool rotation is opposite to the travel direction is considered the retreating side. Distinct microstructural features are present in these



Fig. 4 — A new 6-mm pin tool (left) and one shown after more than 100 ft of weld in A36 steel.



Fig. 5 — Microstructural regions of a friction stir weld: A — Unaffected base metal; B — heat-affected zone (HAZ); C — thermal mechanically affected zone (TMAZ); D — stir zone (SZ).

areas depending upon the material being joined, FSW tool geometries, and the welding parameters. Also, because of impinging heat and mechanical variations between the advancing and retreating sides, different alloys can be joined together.

Weld Characteristics in FSW Steel Applications

Friction stir welding produces a refined microstructure compared to that of the original base metal. Materials such as stainless steels and nickel-based alloys exhibit a fine equiaxed grain structure on the order of 5–10 μm . This is typically the case with ferritic steels as well; however, ferritic steels undergo an allotropic phase transformation, and the resulting as-welded microstructure is quite unique and not fully understood. These microstructures are dependent upon the welding parameters selected. Excellent welds have been produced in API Grades X65, X80, and X100, along with traditionally unweldable L80 steels. Stringent pipeline qualifications require mechanical testing along with impact testing for specified toughness. Further tests, including crack tip opening displacement (CTOD), are required for strain-based

pipeline design. API Grade X65 steel $\frac{1}{4}$ -in.-thick girth welds have shown excellent mechanical properties, including overmatched weld and HAZ, and Charpy impact properties with significant improvements using FSW — Fig. 6.

Excellent CTOD tests have been reported in various API grades of steel with weld nuggets showing significantly higher values than that of the base metal, while some reports have shown unsatisfactory results while exhibiting high Charpy impact values. As the FSW technology develops for pipeline applications, a firm understanding of the effects of steel chemistry, welding parameters, and tool design is required for field implementation.

Traditionally nonweldable API Grade L80 used for well casings has also shown excellent weld properties with mechanical properties equivalent to the base metal and maintaining 21% elongation through the weld.

For example, in welding trials of API Grade X80 steel, a single weld pass was made at partial penetration due to the small amount of material available. Weld penetration was 0.187 in. (5 mm) of the full 0.787 in. (20 mm) thickness. The material exhibited excellent weldability, producing fully consolidated welds under parameters of 550 rev/min and 4 in. (100 mm)/min.

Advantages of High-Melting-Temperature FSW

The low heat input and lack of solidification defects in the weld provide friction stir welding with a number of important advantages over fusion welding. These include the following:

1. No filler metal is used, providing significant cost savings in materials
2. The process can be fully automated
3. The energy input is efficient as all heating occurs at the tool/workpiece interface
4. Minimum postweld inspection is required due to the solid-state nature and extreme repeatability of FSW
5. Depending on the target alloy, FSW is tolerant to interface gaps and requires little preweld preparation
6. No weld spatter needs to be removed
7. The postweld surface finish can be exceptionally smooth with very little to no flash
8. No solidification-related cracking, porosity, or oxygen contamination occurs
9. Little or no distortion is found in the base metal
10. No operator protection is required as there are no harmful emissions
11. Weld mechanical and fatigue properties are improved
12. The joint can be joined in a single pass

In addition, FSW offers these advantages over traditional welding methods in pipelines:

1. Single-pass welds reduce time and money related to weld schedules, consumables, and propensity of weld failures.
2. Lower consumable costs. New FSW tool material and geometry designs promise even longer tool life than currently promised.
3. Friction stir welding is a reproducible, machine tool welding process

where wire chemistry and power supply variances are not issues.

4. Does not require direct involvement/supervision, nor does the operator need to be a skilled welder.

5. Very low degrees of distortion, leading to greater precision in assembly and reduced rectification.

6. Reduce number of welding stations due to faster completion rates.

7. Fewer weld parameters to monitor, making it less cumbersome in the field.

8. All-position welding facilitating orbital or other out-of-position scenarios.

9. Has been used on many associative grades of steel up to API 5L-X100.

10. Significant economic advantages over current GMAW practices.

11. Able to perform full circumferential welds without stopping. Start and stop overlap quality is very high quality as the process will weld over itself.

12. Able to operate in the wide temperature swings inherent to global field operation without special modifications to the equipment.

13. Very low energy consumption, mostly related to driving the welding spindle

14. Promises to greatly reduce weld-related rework by further reducing field defects.

Beyond the Linear Weld

Until recently, FSW has been typically utilized in linear butt and lap joint configurations. To make this technology applicable for on-site applications, such as pipeline welding, a portable, rotating machine needed to be developed. In addition to the advantages mentioned earlier, FSW on pipe can be completed in a single out-of-position pass that is not affected by gravity. Load data and process parameters developed on flat plate were used to facilitate the design of rotary pipe welding fixtures and operation parameters.

This portable pipe welding machine was designed to be a field-ready, stand-alone machine that was capable of friction stir welding stationary pipe typical of that found in the assembly of a pipeline. This machine was designed to produce single-pass, complete joint penetration welds on 12 in. (305 mm) ID pipe with a wall thickness up to 0.5 in. (13 mm). The machine is designed to weld butt joints in pipe segments using a spindle head that traverses the joint with the FSW tool on the outside while an expandable mandrel supports the backside of the weld on the inside of the pipe.

In a typical linear weld, as welding occurs, specific loads act on the FSW tool. These consist of the force that opposes the travel direction of the weld (X axis load) and the force acting against the tool shoul-

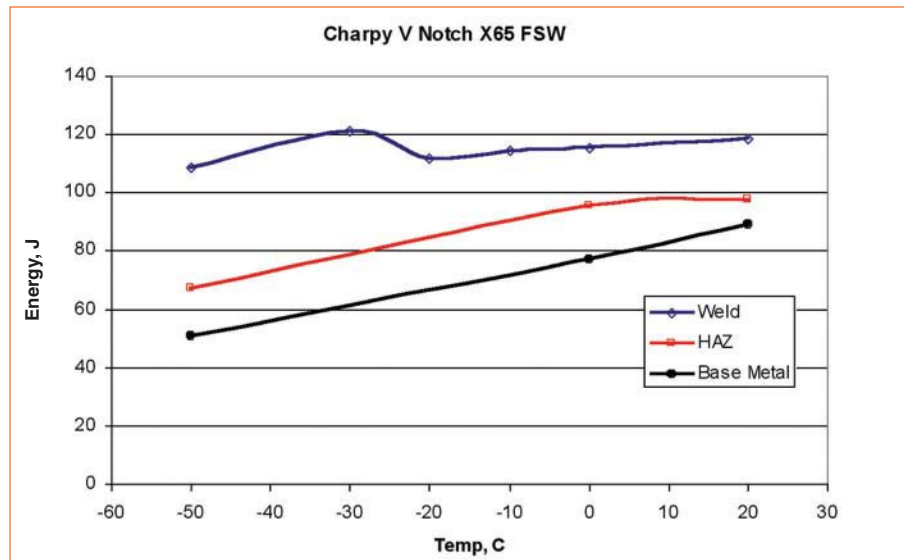


Fig. 6 — Results of Charpy V-notch tests on 1/4-in.-thick API Grade X65 steel.



Fig. 7 — An operator sets up the orbital FSW machine.

der (Z axis load). The tool depth into the plate is controlled through the Z axis load, which can be set to a specific value depending upon the tool design and material thickness. The X axis loads were monitored at various welding parameters on typical horizontal welds to establish important design criteria such as load capacities, tool holder concentricity requirements, tool offset parameters, and rigidity requirements of the system. This information was then extrapolated to suit a rotary application.

As one would expect, the portable orbital welding machine adds a W-axis to drive the spindle and FSW head assemblies circumferentially around the pipe. A clamping fixture clamps and holds the two segments of pipe together for butt-joint welding — Fig. 7. To provide the internal pipe support to prevent wall collapse due to the high pressures exerted by the FSW process, an internal, expandable anvil was designed.

An inherent problem with FSW is the presence of an extract hole after the weld is completed. On linear joints such as in plate, a run-off tab is often used. This tab is removed after the weld is completed. The same solution was used for removing the exit hole for pipe welding. For a full circumferential weld, a run-off tab was fixtured over a joined portion of the pipe

near the starting point of the weld after the weld had begun. The joint consists of the weld overlapping at the beginning and then moving off-axis on a run-off tab to complete the weld. After the weld is completed, the entire assembly unclamps for removal from the finished weld joint.

The FSW pipe machine is designed to function in a field environment and requires only one operator — Fig. 7. Additional people may be required to attach, detach, and move the machine to the next joint. This basic machine design can also be configured to weld pipe in a vertical position and for a variety of diameters. It can also be used for bead welds. Large-diameter pipes can also be retrofitted for multiple welding heads for increased productivity.

Technology Development

Friction stir welding is a technology in constant development. This technology becomes more and more attractive as the tool technology allows for thicker section welding. Currently the thickness is limited, but single-pass welding of API grades of steel is being developed for thicknesses up to 1 in. Tool designs needed for welding tubular geometries are more complex than those used for linear welding and the control systems needed require a higher

level of sophistication, such as control algorithms that vary parameters to maintain a specific tool temperature.

Trends in pipe development have moved toward the development of higher-strength steels for use in pipelines. These new high-strength grades provide cost savings; however, they also introduce difficulties in welding while using conventional welding methods. Although FSW has many advantages over its fusion welding counterparts, careful parameter development is needed to understand the essential variables that are required for friction stir welding in these special grades of steel.

Summary

Friction stir welding of out-of-position welds such as that involved for pipe welding offers tremendous advantages in productivity and cost savings for the pipeline industry. This disruptive technology has the potential to significantly alter the way this industry does business in the coming decades. ♦

Acknowledgments

The authors want to acknowledge the support provided by Dr. Zhili Feng of Oak Ridge National Laboratory by his providing the Charpy V-Notch results for X65.



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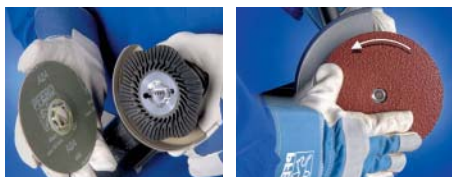
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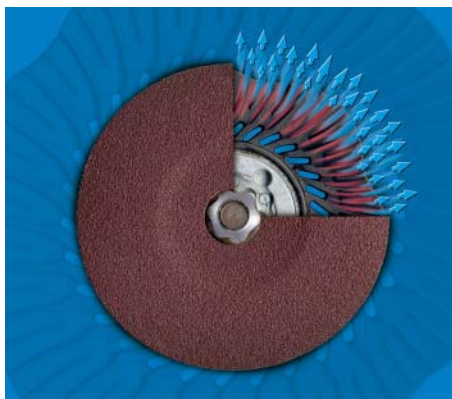
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Proper Preparation: The Key to Successful Pipe Welds

Properly machining the weld prep will enhance the efficiency of your welding operation and minimize defects and rework

BY MARK LESKA



Fig. 1 — Accessories are available as part of a complete machining system. Shown here is a counterbore module machining the inside surface of the weld prep area.

In today's economic, regulatory, and legal environment, proper weld prep procedures are more critical than ever to ensure your firm is producing high-integrity welds. To remain competitive, it's important that your welding throughput remains high, yet welders today are facing increasing headwinds caused by inexpensive imported materials and products, short staffing, and increasingly stiff welding regulations. Ultimately your failure to comply with these regulations, or producing marginal or substandard welds, can open your company up to substantial liability and legal issues.

Following are some of the challenges encountered in the welding sector today:

- An influx of inexpensive imported materials and tools
- The appearance of low-cost, low-quality tubing, pipe, and fittings
- Poor tolerances in wall thickness, out of roundness, and material composition
- Unflagging demand for reliable, skilled welders and trained new welding entrants
- More stringent welding codes, with ever-higher standards and specifications
- Specialized requirements for the power-generation field including nuclear, hydro, and coal, as well as petrochemical and refining
- Critical requirements for high-purity

environments in the aerospace, biopharmaceutical, semiconductor, and nanotechnology industries.

As a supplier of portable weld prep machine tools, E.H. Wachs believes the key to effective welding is in the weld preparation. Without it, even the most skilled welder using the most sophisticated welding equipment cannot produce the repeatable, high-integrity welds required for your bottom line.

To illustrate, automatic orbital welding is now being specified on many new projects. Depending on the type of orbital system required, it can involve a substantial capital investment that, if well managed, can produce a substantial return on investment. However, the consensus among today's manufacturers of orbital welding equipment is that users appear reluctant to properly prep (machine) the tube or pipe to be welded. This leads to a lack of success with this equipment, which is preventable by simply following the recommended prep procedures.

Often the welder will attempt to thermal (oxygen or plasma) cut and grind the desired bevel, either 30 or 37.5 deg. Hand grinding is often used after cutting as a shortcut or rough substitute for the proper weld prep. Compound bevels or the "J" bevel typically recommended by the manufacturers of automatic welding systems are impossible to produce without machining. In addition, thermal cutting has the major drawback of changing the metallurgical properties of the pipe in the area around the cut.

Regardless of whether the welds are being made manually or automatically, properly machining the weld prep will enhance the efficiency of your welding operation and minimize or totally eliminate defects and rework. By contrast, not tak-

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Fig. 2 — OD-mounted split frame machine tool with air drive shown simultaneously parting (cutting) and beveling a standard 37.5-deg weld prep. Note the lathe-quality finish ready for welding.

ing steps to properly machine the required weld prep can cause gaps and mismatches, and may result in either overwelding or poorly executed, unsuitable welds. In the best case this leads to increases in material spoilage and higher labor costs (due to reworking). In the worst case it can lead to contamination considerations or a catastrophic failure, all with high potential liability risks.

When looking for increased welding throughput, the weld prep is often overlooked as a likely place to create efficiencies. In fact, some may think of it as a production bottleneck. However, it offers a great opportunity for savings since a proper prep offers a substantial decrease in consumables and arc times. Portable machining equipment will consistently outperform hand grinding in labor costs and time savings as well. In addition, the consistency and repeatability of properly machined pipe and tube preps allow your welding team to move quickly without “customizing” each weld to an erratic prep. This is true regardless of whether your team is using manual or automated welding.

Choosing a Machine

Field-portable machine tools provide the capability to part (cut), bevel, and compound bevel and counterbore pipe, leaving a lathe-type finish that in years

past was only available in a well-equipped machine shop. When looking for the best machines for your organization, the following are important points to consider:

- Build quality and rigidity
- Size range and capabilities
- Speed of operation
- Feed rate
- Mounting system
- Tooling availability and quality
- Parts and service availability
- Rental options
- Amount of training needed for operation.

Portable machine tools mounted on either the outside or inside of the pipe are available, with a large range of sizes and capabilities suitable for most any tube, pipe, or fitting application. Inside diameter (ID) mounted machines are intended for pipe already cut to length. These utilize a mandrel and chuck assembly, and this mounting method offers the advantage of being automatically self centering. They can face, bevel, compound bevel, counterbore, and, with optional accessories, be used for flange facing — Fig. 1.

Outside diameter (OD) mounted machines include split frames that are designed to split in half for mounting to the outside of inline pipe, and can be used for parting, beveling, counterboring, and flange facing — Fig. 2. ♦



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Automation Optimizes Nuclear Component Fabrication

The new generation of nuclear power plants need to be welded with the latest generation of intelligent, automated welding systems

BY JEFFREY NORUK AND JEAN-PAUL BOILLOT

After a hiatus of almost 30 years, the U.S. nuclear industry is coming back to life.

Manufacturing structural components like pressure vessels, piping, tube sheets, pumps, valves, etc., needs to be done in a way far different than was in place in the past. Nowhere is this more important than in the welding production areas. Thirty years ago, more than 95% of the welding was done manually or in a mechanized fashion with operator control. Although the components produced worked, the productivity was far too low and the repair level way too high to be acceptable in today's leaner production environment. Now with the digital convergence of sensors, motion devices, welding equipment, "smart cameras," and other modules distributed over a network in the welding cell, one can achieve a much higher level of optimization. This article explains how things have improved and what is required to take advantage of this new technology.

Levels of Automation

A quick review of the levels of automation available for the arc welding processes is shown in Fig. 1. The shift to more intelligent machines begins when the device is either fully programmable (teach and play or offline programmed) and/or guided by an intelligent device like a laser vision system. Figure 2 shows laser vision joint tracking systems integrated to both a robot and a hard automation machine. This type of equipment is available and successfully used in general industry. It can be transitioned over to the welding

of nuclear power plant components with proper technology transfer and training. What is really necessary to achieve the required quantum leap in productivity, while at the same time maintaining excellent first-pass yield, is a systematic total quality approach to welding automation.

Figure 3 explains how one needs to approach this goal by measuring what happens before, after, and at the welding arc location. If one waits to inspect the welded part after it is completed, it is too late. Capabilities now available, which were just dreams 30 years ago when production of nuclear power plants was at its peak, include the following:

- Initial joint validation to make sure the component is fit up correctly per the approved procedure and, if not, the ability to prevent the start of the welding process until this is corrected.
- Real-time robust laser joint tracking to maintain perfect torch-to-joint alignment independent of the welding process.
- Continuous automated visual inspection pass by pass and layer by layer to find any unacceptable conditions before further welding is done thus preventing costly repairs or even the potential of scrapping an expensive part.
- Adaptive welding capability to compensate for joint variability thus minimizing wasteful overwelding and costly distortion. This capability can also help maintain correct heat input control so the metallurgical and mechanical integrity of the welded joint meets the design intent. Note these algorithms are the ones that were developed during the procedure development and qualification phase.
- Automatic postweld inspection capabil-

ity to measure the weld geometry and to detect defects in a much faster and more reliable manner than using human inspectors. This capability optimizes the component fatigue life and structural performance.

- The ability to have a variety of networked sensors that can monitor the welding system to ensure the welding procedure is being followed. These sensors can also aid in the programming and real-time monitoring of the welding process itself.
- Portable robots that can be programmed and operated from a distance due to the onboard sensor control thus potentially removing the operator from harmful and unsafe areas.
- Real-time digital communication between all components in the welding cell to facilitate high-speed closed-loop control.

Using the Systematic Total Quality Control Approach

All these new capabilities will allow one to get closer to the ideal optimized welding performance. Until now, the disconnect has been that the welding procedure was developed in a laboratory under perfect conditions and then when it was transferred to the production floor it was not successful due to all the variables in material, joint fitup, equipment, and personnel. By adding the right level of intelligence into the welding system, this limitation can be overcome to a great extent.

Specifically, the laser vision sensors can help develop the welding procedure more quickly because no longer does the

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welding engineer need to worry about trying to keep the wire in the joint or manually compensate for changes in his test plate geometry. This can all be managed automatically and the actual data stored so the same welding parameters can be repeated for subsequent tests. The exact effect of changes in welding parameters can also be immediately measured with the process monitoring and postweld inspection capabilities built into the system. This will ensure one is staying within the tolerance range allowed for heat input and for individual parameter (current, voltage) variations.

Success Stories Demonstrating the Systematic Total Quality Control Approach

Welding, Inspection, and Repair in Remote Applications

A laser vision joint-tracking system from Servo-Robot is an important component for the applications that require robotic operation developed by Idaho National Laboratory (INL), including the Yucca Mountain Nuclear Waste Closure System and the DOE Standardized Canisters (Refs. 1, 2). System designers realized early on the necessity of accurately mapping the trajectory of the weld to allow the robotic system to place the automated welding, inspection, and repair tools necessary for a completely remote operation. The integration of the joint-tracking system provides this as well as weld profile measurements of completed and partially filled weld joints important for process parameter decisions. The eyes of a visual inspector are also replaced with the profile measurements from the system's camera, validating workmanship and geometry requirements of the weld before other nondestructive examination (NDE) methods (leak, eddy current, and ultrasonic testing) are applied. Figure 4 offers an overview of the robotic welding system, and Fig. 5 shows a close-up of the laser vision camera system and the welding head.

Following are the key features of this system:

- The tracking system ensures the gas tungsten arc welding (GTAW) tungsten electrode and the cold wire feed are precisely maintained in the joint so that the resulting weld pool achieves optimum penetration, fusion, and soundness.
- The adaptive capability allows for the joint measurement to automatically call different preapproved weld schedules if features like the root opening,

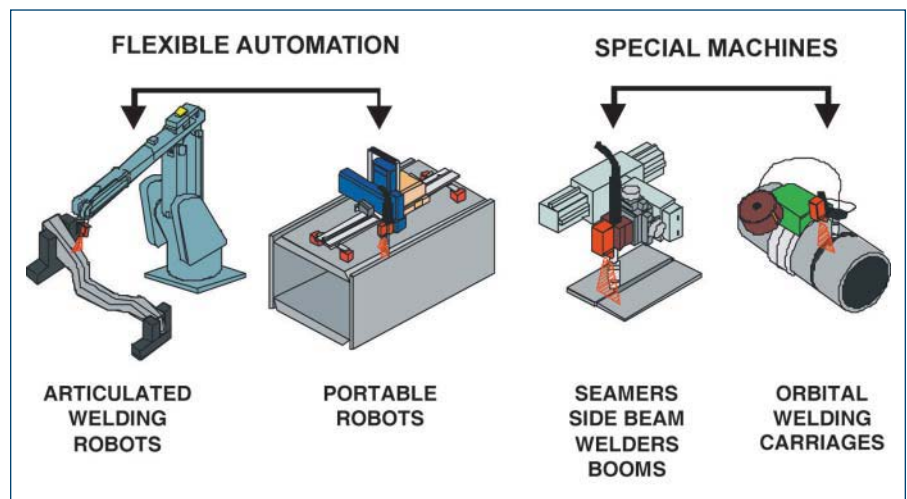


Fig. 1 — Level of arc welding automation.

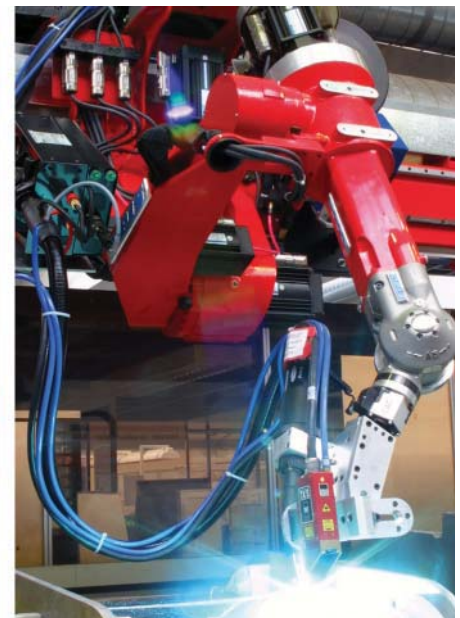


Fig. 2 — Laser vision controlled welding machines in hard and flexible automation.

mismatch, or area vary by more than the preset allowable values. Process parameters like current, travel speed, and wire feed speed can be changed.

- The postweld automated weld inspection is part of the overall NDE plan. The automated inspection done using the laser vision camera system not only can measure the critical weld geometry features such as leg size and convexity, but it can also find and measure defects like undercut and porosity and report if they are outside acceptable tolerance limits. In addition to go/no-go status, the system also provides a date and time stamp for all the results so statistical analysis can be done to determine if there is any significant trending information that could help troubleshoot reoccurring problems.

Intelligent Portable Robot

One advantage manual welders still maintain over most forms of automation is that they are extremely flexible with respect to the fact that the part to be welded can either be brought to them or they can go to the work. Automation used for nuclear power plants has historically been relegated mainly to the welding done in the fabrication plants and has not been used very much for the onsite installation itself. In fact, even inside the factory the limited portability of advanced programmable welding systems has required using the inflexible strategy of having to bring large components, such as complete modules, to the welding cell. Thus, the automation equipment carried to the part has been mainly “dumb” tractors having

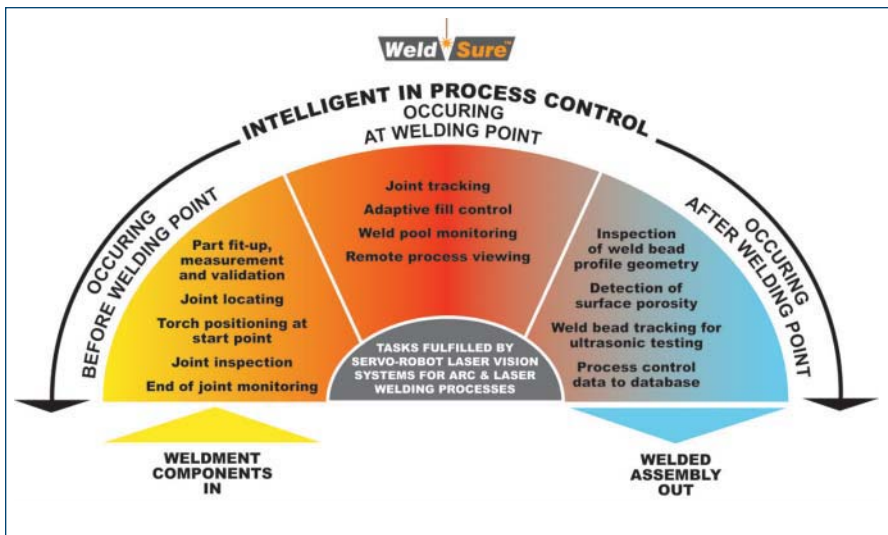


Fig. 3 — How laser vision ensures weld quality, minimizing waste and decreasing production costs.



Fig. 4 — Overview of the automated welding system. (Photo courtesy of INL.)

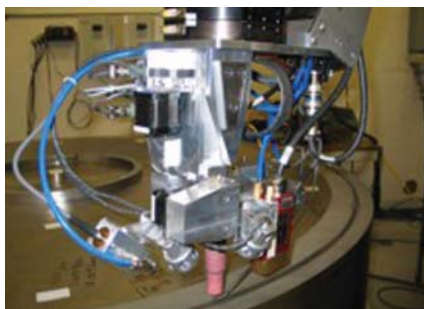


Fig. 5 — Close-up of the camera system and welding head. (Photo courtesy of INL.)



Fig. 6 — Portable welding robot with intelligent interactive teaching method.

no capability to be programmed or interfaced to sensors, thus greatly limiting their usefulness and increasing the cost of welding. The key differentiators separating a “dumb” welding tractor from a robot are as follows:

- Ability to teach and play back the path on the part by the welding operator himself
- No need for careful setup of the rail because the path is now programmed or alternatively a laser vision sensor takes control and adjusts for the deviation

- The ability to override the programmed path via the teach pendant and then save the modified values for subsequent passes
- Very precise motion control leading to more repeatability from weld to weld
- Precise coordination of the torch motion and welding parameters, e.g., during weaving the pulsing parameters can be synchronized precisely
- Simultaneous computer control of both the motion and welding process to en-

able intelligent process control such as when joint tracking and real-time adaptive control are used

- Robot welding program can be memorized and downloaded to other robots from the common database ensuring the latest correct welding parameters are being used
- Inspection of the welds for both defects (undercut and porosity) and geometry (leg size, convexity, entry angle, and toe radius) can be correlated to the exact position of the robot on the joint thus facilitating more efficient additional NDE or repair, if needed.

The operator interfaces with the portable robot via a teach pendant as shown in Fig. 6. The benefits of using a portable robot include the capability for the operator to do other tasks because he no longer needs to adjust the arc position on a continuous basis. In addition, a dramatic increase in travel speed is possible because it is not limited to the response time and skill of the operator. Plus, the perfectly placed wire or tungsten electrode will greatly improve weld quality and consistently achieve the product performance the product design engineer planned.

Narrow Groove Submerged Arc Welding

When welding heavy-walled pipe or a pressure vessel with a narrow groove, it is critical that the wire be positioned precisely in the root of the joint. The automated system employing a laser vision real-time tracking system shown in Fig. 7 will provide the exact offset information to maintain perfect cross-joint positioning as well as consistent standoff. This ensures the deep penetrating process will achieve the root pass quality that is required if one hopes to have a chance to achieve a sound weld. In addition, the built-in ability to measure the changing joint geometry (due to inconsistent fitup or part preparation) will provide the ability to change any of the welding parameters in real time to optimize the multipass weld placement. One can create multiple weld schedules and then the system will automatically select the correct one based on the strategy developed during the procedure development phase.

‘Near’ Future State

While tremendous capability is already in place and proven that it can be applied to the welding of all the critical and standard components inside a nuclear reactor, there are exciting new developments that will be available soon to add even another layer of “smart control” onto the automated welding systems. This new capa-

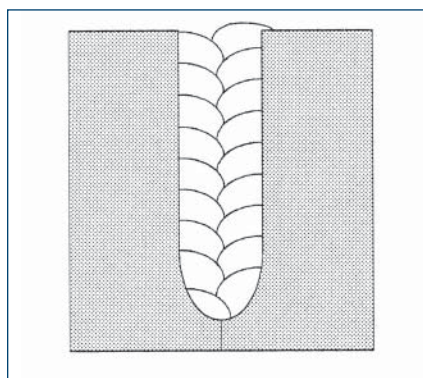
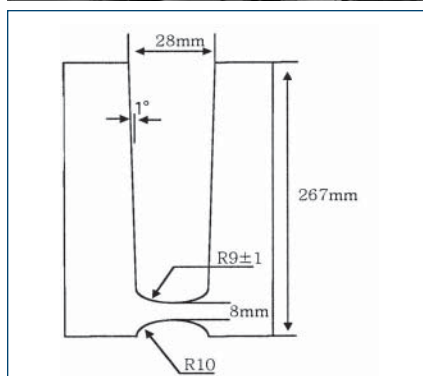


Fig. 7 — Joint tracking and adaptive control for narrow gap welding with the SAW process. (Photo and illustrations courtesy of Doosan Heavy Industries & Construction Co. Ltd.)

bility will optimize the process and remove the welder further from the potentially dangerous work area. These improvements will be primarily driven by the use of several sensors networked together to make immediate decisions as to what needs to be done to respond to changing conditions.

The concept here is that in addition to the normal laser vision, which essentially gives eyes to the welding automation, more sensors are employed to emulate the human welder. Right now a human welder uses his vision, hearing, tactile feeling, and even occasionally his smell to know if the welding is progressing correctly. Sensors needed to emulate the welder applicable to automated welding systems include the following:

- Automatic feedback of the actual torch work and travel angles with respect to the joint
- Automatic feedback as to exactly where

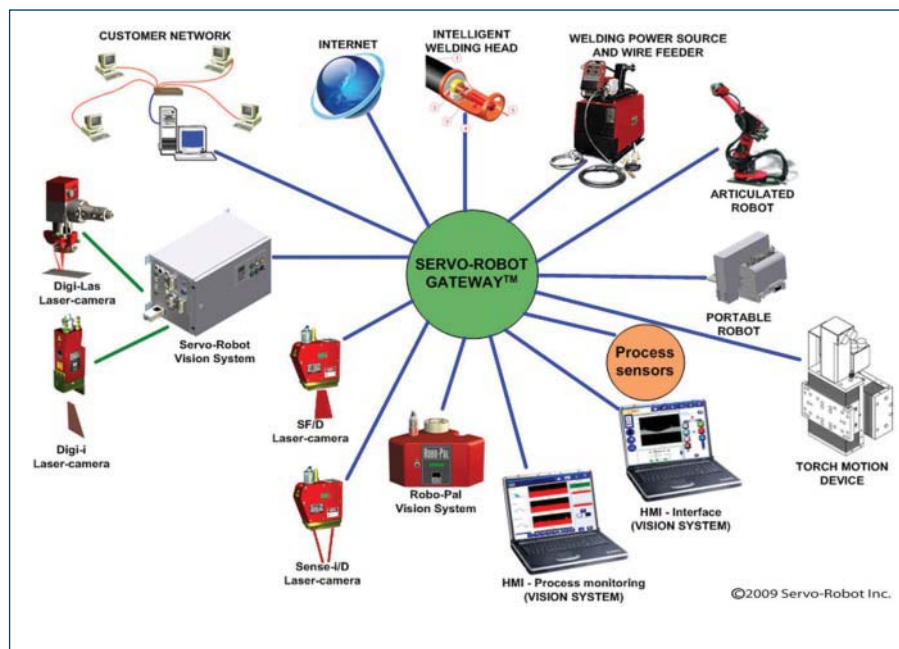


Fig. 8 — Ethernet welding gateway.

the robot is located in space (factory) (Note this is especially helpful for a portable robot.)

- Real-time monitoring of the health of the robot and the peripheral equipment including the sensors themselves
- Real-time optimization of the welding parameters by measurement of the weld deposit
- Weld pool and workpiece temperature monitoring
- Instant communication through Ethernet via a TCP/IP network — Fig. 8.

Conclusion

The reintroduction of nuclear power, along with the use of other alternative energy sources, will help put us on the path to energy independence. To achieve this in a timely and efficient manner, we need to use welding automation systems that are themselves efficient, flexible, and green in nature. Flexible self-teaching welding heads utilizing hybrid sensor technology can dramatically improve the productivity, quality, and safety associated with the various welding processes. Laser vision and other sensors can play a big role in achieving this goal thanks to the latest high-speed networked process control. ♦

References

1. Smartt, H. B., Watkins, A. D., Pace, D. P., Bitsoi, R. J., Larsen, E. D., McJunkin, T. R., and Tolle, C. R. 2006. Yucca mountain: Design of a welding and inspection system for waste package closure. *Proceedings 2006 International*

High-Level Radioactive Waste Management Conference, Las Vegas, Nev.

2. Larsen, E. D., Watkins, A. D., McJunkin, T. R., Pace, D. P., and Bisoi, R. J. 2006. Remote welding, NDE, and repair of DOE standardized canisters. *Proceedings 5th International Conference on NDE in Relation to Structural Integrity for Nuclear and Pressurized Components*, San Diego, Calif., pp. 929–942.

Correction

There were errors in the boxed item titled Tips for Proper Torch Usage that appeared on page 51 of the article by Jerry Arnold, Earl Miller, and Greg Mitchell in the April issue of *Welding Journal*.

The authors state these tips refer to hand-held torches for use only with MAPP® (which has been discontinued), MAP//PRO™, or propane gases.

In the Don't section where it said "don't reduce the flame," the article should have stated "Don't reduce the flame to the point where it is burning back inside the tip."

In the Dos section, the item that said "the acetylene regulator should always be turned full on" is wrong. The correct statement is as follows: "Remember that when using a TurboTorch hand torch with MAP//PRO that has a flow valve, you should always start with the flow valve in the full open position. If the flame is flaring after startup, slowly regulate the gas flow by closing the valve until the proper flame is obtained."

New Technology Doubles Contractor's Pipe Welding Output

A process change produces significant improvements in work quality and uniformity plus savings in time and reduced consumables inventories

BY NICK PETERSON

Darwin Terpstra and Mike Mackintosh (Fig. 1), engineering and production managers for Bel-Aire Mechanical, Inc., Phoenix, Ariz., often faced the familiar challenge to produce the highest-quality pipe welded product in the shortest amount of time, with minimal rework, using a labor force of various skill levels.

And, as with other supervisors in this position, they sought to overcome the limitations of the shielded metal arc welding (SMAW) process — including its relatively slow travel speed — by using gas metal arc welding (GMAW), which is faster and also easier for welders to master. Unfortunately, standard GMAW isn't ideally suited for pipe welding; its higher travel speed can be offset by the cleanup time required along with a 10% or higher rework rate.

Also, as is done in other pipe-fabrication shops, Mackintosh brings in additional welders when the workload demands it, thus creating a workforce with a diverse range of skill levels and operator styles. Each weld could look as unique as the welder's signature.

These challenges are not unique to Bel-Aire — all pipe fabricators must face them — and the company had done well, growing to be one of the top mechanical contractors in the state. In 2006, when Bel-Aire purchased a new building, Mackintosh and Terpstra took the opportunity to reevaluate the entire pipe welding operation. In addition to examining the work flow through the pipe shop and eliminating bottlenecks, they took a closer look at the GMA and SMA welding processes they had been using. Once they evaluated the new technologies and equipment that were available, they mothballed the exist-



Fig. 1 — Darwin Terpstra (left) and Mike Mackintosh take ten in the Bel-Aire weld shop.

ing welding equipment. In its place, they brought in welding systems that use a modified short circuit process for the root pass and an advanced pulsed spray transfer process for the fill and cap.

The result of this change allowed the shop to double its production. Three welders now do what formerly required six welders to accomplish. Moreover, the welders now were able to produce more uniform and nearly identical welds — Fig. 2.

The company now performs two distinctly different welding processes using the same welding machine, gas, and wire for the root, fill, and cap passes, thus re-

ducing the inventory of wires, gases, and other consumables. This has shortened training times and nearly eliminated weld rework all equating to considerable cost savings.

Mackintosh said, "Previous rework rates could be as much as 10%, depending on the application and testing parameters. Now, rework is no longer a factor."

Bel-Aire Gets Its Start

James Dinan and John Sapien founded the company in 1986 after recognizing a need for a mechanical contractor to provide both solid HVAC capabilities and pri-

NICK PETERSON (www.millerwelds.com) is a weld engineer for Miller Electric Mfg. Co., Appleton, Wis.

many contractor-related services. The company started off with the smaller jobs, and today, with more than 300 employees, it is actively involved in mechanical construction, renovations, upgrades, and re-models throughout Arizona. Its projects range from multimillion-dollar mission-critical facilities to turnkey, fast-track retrofits.

It excels in many areas, including building information modeling (BIM), which allows Bel-Aire's design department to create a virtual fly-through to ensure there will be no collisions with piping, plumbing, electrical conduits, sheet metal, and fire-protection systems. The company works with architects, engineers, and other contractors within a collaborative environment to provide a coordinated, collision-free model prior to fabrication.

Opportunity Knocks

"When Bel-Aire purchased its new facility, we were provided a great opportunity," Mackintosh said. "We were able to start over from the beginning. We had time, because the building wasn't quite ready for us to move into yet, and I had tremendous amount of support from Jim Dinan, our CEO, and John Sapien, our chairman. We took the opportunity to look at the entire work flow."

Some of the changes Mackintosh and Terpstra implemented included the addition of a computerized pipe cutting machine, which allows one operator in a few hours to equal the work previously done by two workers in eight hours.

"That was a tremendous change," Mackintosh noted. "We looked at everything needed to make a high-quality weld. We added a bead blaster to ensure that pipe and fittings were free of paint and other contamination. We made sure we had the proper bevels. The best welder in the world cannot overcome poor preparation."

One of the most significant changes came when Mackintosh replaced the existing SMA and standard GMA welding equipment with equipment that offered RMD™ (regulated metal deposition), a modified short circuit GMAW process optimized for root pass welding, and ProPulse™, an advanced pulsed GMAW process optimized for the fill and cap passes. These would change the nature of Bel-Aire's welding operations.

Out with the Old

The firm works in accordance to ASME Section 9. Prior to adopting the new processes, the company had been using SMAW, primarily 6010 electrodes, and standard GMAW processes. To get the advantages GMAW promised in other



Fig. 2 — The new technology yields uniform high-quality welds at twice the former productivity using operators with a wide range of skill levels.

applications, such as increased travel speed and less operator training compared to SMAW, Bel-Aire had acquired four 300-A GMAW machines.

"The GMAW equipment worked fine," Mackintosh said. "I'm sure they have their place, but not in the pipe world. The weld time was quicker than SMAW, but the time required to clean between passes offset those savings. With GMAW, we would occasionally have lack of fusion or inclusions, which could lead to leaks."

He added, "If you're not skilled with standard short circuit GMAW, the tendency is to trap inclusions or get porosity in the weld. Then you have to remove it, grind it until you have good material, and start over again. That's costly and time consuming." Including the time to discuss the issue with the inspector, reload the pipe into the positioner, grind down to good metal and reweld, reworking a weld could cost twice that of the original weld.

"With SMA or GMAW, if you put three welders under the hood, you'll have three completely different looking welds," said Mackintosh. "They would all be acceptable, but you could tell which welder was more experienced."

The issue, of course, wasn't with the

operators. They are skilled, trained welders. Nor was it with the equipment, which worked as well as the day it was manufactured. The issue was that the welding equipment and processes were not designed for pipe welding.

In with the New

The welding equipment Mackintosh brought in was specifically optimized for pipe welding.

The RMD modified short circuit transfer process precisely controls welding current during all phases of metal transfer to eliminate excess weld pool agitation. This results in a calm weld pool that is easier for the operator to manipulate and eliminates incomplete fusion, which occurs when molten metal splashes against the sidewall of the pipe and "freezes" on top if it. The process is highly tolerant of high-low misalignment because it has a faster-freezing pool that stays where it's put.

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The issue was that the welding equipment and process were not designed for pipe welding.

welding, the technology provides a much cooler weld pool that is ideal for out-of-position welds. The user only needs to adjust a few settings, and the result is shorter arc lengths and a more focused arc column. This provides a weld pool that is easier to control. Operators learn the process faster and make higher-quality welds with lower reject rates. The process also is more tolerant of contact tip-to-work-distance variations and provides improved fusion and fill at the toes of the weld, which helps to ensure quality welds are achieved on the first try with a lower overall heat input, that reduces interpass cooling time and weld cycle time. Mackintosh immediately saw the benefits.

"One of the first things I noticed was that welders don't have to be as highly skilled," Mackintosh stated. "After three or four hours of coaching, a less-skilled operator would be consistently producing high-quality welds. When the work load increases and we bring in new welders, I now can feel comfortable that the time to get up to speed will be short."

With both processes in one machine, using the same gas and wire, it eliminates the need to have separate machines, wires, or welding processes for root and fill passes. Operators only need to push a switch to change processes and utilize the preprogrammed parameters. One of the things Mackintosh has to teach experienced GMA welders is to not try adjusting the parameters. "We use the same RMD program on 2-in. pipe as we do on 24-in. pipe, and we use two programs for ProPulse, depending on the configuration," Mackintosh said. "I can assure our customers that each welder is using the same wire feed speed and voltage, and that all of the welds we make are of the same quality, and we'll have the same high quality for chilled water pipe as we do on process piping."

The new processes eliminate incomplete fusion, inclusions, and the other issues associated with using standard GMAW for pipe welding.

"Rework is now almost nonexistent," Mackintosh stated.

"With three welders welding all day long, I'm saving about 60 hours a week," Mackintosh noted. "On a 6-in. joint, time has decreased by 50%, and we're using half as many machines to do twice as much work." ♦



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CONFERENCES



12th Aluminum Welding Conference Toronto, Ont., Canada May 5 and 6

A panel of aluminum industry experts will survey the state of the art in aluminum welding technology and practice. You will also have the opportunity to network with speakers and other participants, as well as visit an exhibition showcasing products and services available to the aluminum welding industry.

Aluminum lends itself to a wide variety of industrial applications because of its light weight, high strength-to-weight ratio, corrosion resistance, and other attributes. However, because its chemical and physical properties are different from those of steel, welding of aluminum requires special processes, techniques, and expertise.

Shipbuilding Conference New Orleans, La. June 16 and 17

Welding is the most vital and fundamental manufacturing process in the construction of ships and metal hull boats. Keeping in tune with the progress of new innovative developments, as well as their potential value and impact to the industry is essential for those in the shipbuilding community. This conference will address the critical importance of welding in the shipbuilding industry by providing current information on new and emerging technologies being developed for shipbuilding applications. The conference will also provide opportunities for you to network informally with experts from academia and industry, as well as with your fellow participants. An exhibition showcasing products and services available to the shipbuilding industry will also be featured.

2009 FABTECH International & AWS Welding Show Conference Schedule Chicago, Ill.

Weld Cracking: 'The Heat-Affected Zone' Conference November 16

One of production welding's greatest moments, the construction of the Liberty ships during World War II, was accompanied by a new problem. Weld cracking was observed on some of these ships, and the reason for the cracking was a mystery. The cause has since been determined, but as new metals and alloys have come into use the problem comes back in different forms to haunt the welding metallurgist. A crack costs money, takes time to repair, and interrupts production. So where does one go for help? The experts will be at Weld Cracking VII. You will obtain answers to your current problems and will be better prepared to solve cracking problems in the future. You can also learn about the latest equipment including induction heating, a wireless heat-treat system, and portable X-ray diffraction equipment. The use of fracture mechanics will be explored. Descriptions will be given on the heat-affected zone and on the many types of cracks that accompany welding. Base materials covered will include various steels, the stainless steels, aluminum, and titanium.

New Developments in Thermal Spray Coatings, Processes, and Applications Conference November 16

This one-day event organized by the American Welding Society and the International Thermal Spray Association will introduce the process and its uses to new potential users with sessions focusing on actual applications and new developments in thermal spray technology. It will include a half-day tutorial on thermal spray fundamentals titled "What Is Thermal Spray" sponsored by the International Thermal Spray Association.

Welding of Chrome-Moly Steels Conference November 17

The welding of chrome-moly steel goes back to the days when tubing was oxyacetylene welded to make up the fuselages of the early prealuminum airplanes. It all required outstanding precision on the part of the welder, and even though the methods have changed, the welding of 4130 steel still requires utmost precision. The welding of chrome-moly steels requires great skills on all parties involved, and not just the welding: heat treatment and non-destructive examination are essential to a successful weld. The 2½ Cr-1 Mo steels are popular materials for boilers and pressure vessels. More recently, the modified 9 Cr-1 Mo steel is now widely specified in the electric utilities and is moving into the oil and gas industry. Conventional welding processes are all used effectively on 4130, 2½ Cr-1 Mo, and modified 9 Cr-1 Mo steels. Newer processes such as hybrid welding have also become popular.

AWS/DVS Electron Beam Welding Conference November 16 and 17

This event will include a two-day technical program and a half-day tutorial. Join scientists, engineers, and technical personnel from around the globe who are involved in the research, development, and application of electron beam welding.

Welding the Corrosion-Resistant Alloys Conference November 18

Interest in welding corrosion-resistant alloys is extraordinarily high. The reasons include the entry of the duplex stainless steels and other high-performance grades. Another is the unstable prices in nickel, molybdenum, and titanium. When the price of nickel hit the roof, many fabricators switched from 316 to 201 stainless because of the latter grade's lower nickel content. Research is feverish throughout the world in the development of new and cheaper methods of producing titanium. Will a lower-cost titanium make the metal more popular? The overall activity is intense. Cladding and strip overlay processes have become more popular means of protecting parts exposed to heavy corrosion. Duplex stainless is now being welded for over-the-road tankage. Newer processes, like friction stir welding and thermal stir welding, will be discussed. Keep abreast of this exciting new world in welding where corrosion-resistant alloys have taken center stage.

For more information, please contact the AWS Conferences and Seminars Business Unit at (800) 443-9353, ext. 455. You can also visit the Conference Department at www.aws.org/conferences for upcoming conferences and registration information.

AN OBSERVATION FROM THE AMERICAN WELDING SOCIETY

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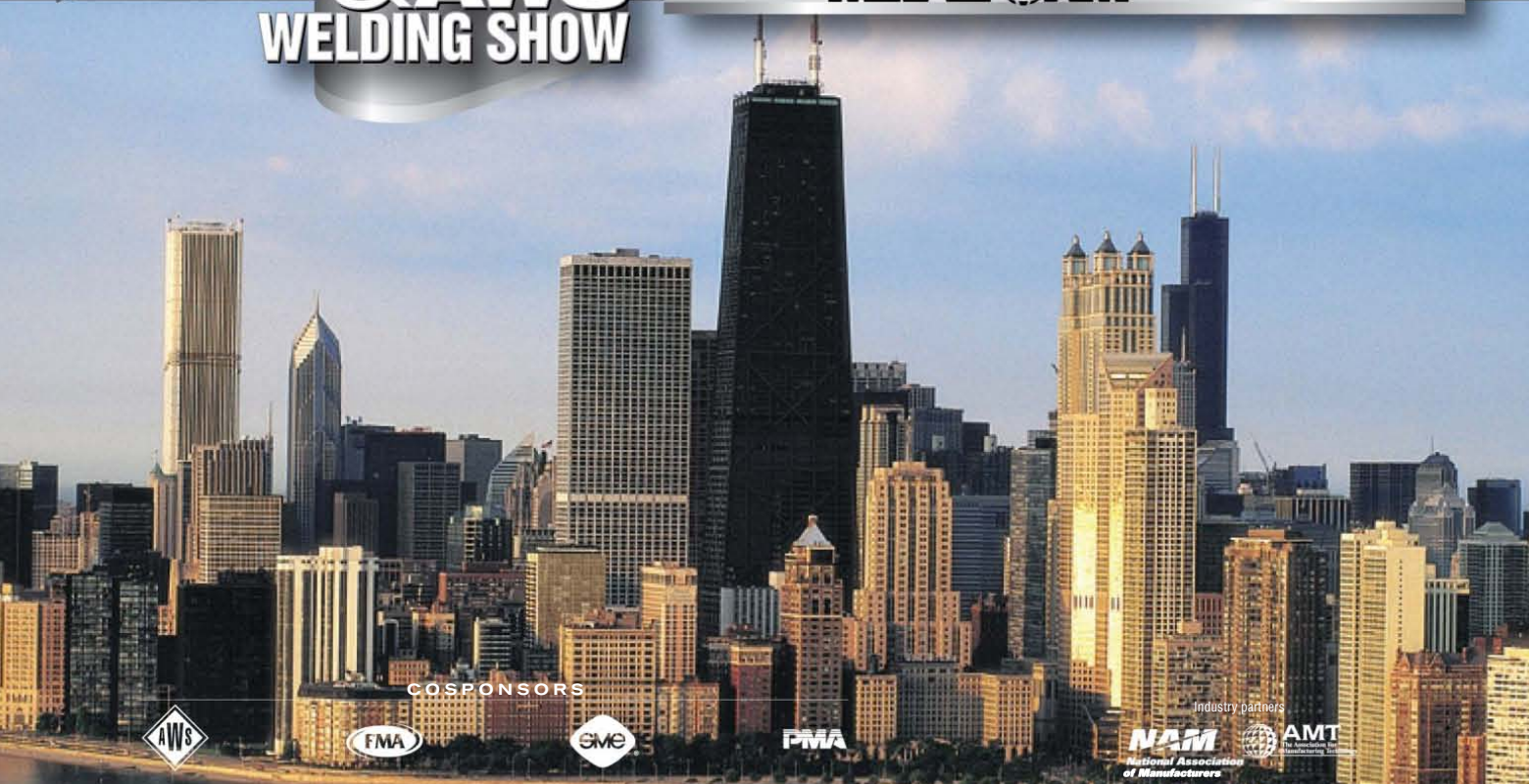
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High-Frequency Welding of Pipe and Tube

High-frequency welding offers a number of advantages. It can be used to weld a wide range of commonly used metals, including low-carbon and alloy steels, ferritic and austenitic stainless steels, and many aluminum, copper, titanium, and nickel alloys. It can produce welds at very high speeds and with high energy efficiency. Welds are produced with a very narrow and controllable heat-affected zone and with no superfluous cast structures, which often eliminates the need for postweld heat treatment. Oxidation and discoloration of the metal and distortion of the workpiece are minimal.

Induction Seam Welding

The predominant application of high-frequency induction welding is welding of continuous-seam pipe and tubing. The pipe or tube is formed from metal strip in a continuous-roll forming mill and enters the welding area with the edges to be welded slightly separated. In the weld area, the open edges of the pipe or tube are brought together by a set of forge pressure rolls in a V shape until the edges touch at the apex of the V, where the weld is formed. The weld point occurs at the center of the mill forge rolls, which apply the pressure necessary to achieve a forged weld.

An induction coil, typically made of copper tubing or sheet with attached water-cooling tubes, encircles the tube (the workpiece) at a distance equal to one to two tube diameters ahead of the weld point. This distance, measured from the weld point to the edge of the nearest induction coil, is called the V length. The induction coil induces a circumferential current in the tube strip that closes by traveling down the edge of the V through the weld point and back to the portion of the tube under the induction coil — Fig. 1.

Contact Seam Welding

The high-frequency contact welding process provides another means of welding continuous seams in pipe and tubing. The process is essentially the same as that for induction welding and is illustrated in Fig. 2. The major difference is that sliding con-

tacts are placed on the tube adjacent to the unwelded edges at the V length. With the contact process, the V length is generally shorter than that used with the induction process. This is because the contact tips can usually be placed within the confines of the forge rolls where the induction coil must be placed sufficiently behind the forge rolls, so that the forge rolls are not inductively heated by the magnetic field of the induction coil. Because of the shorter V lengths achievable with the contact process, an impeder is often unnecessary, particularly for large-diameter tubes.

Comparison of the Two Processes

High-frequency contact welding is a more efficient process than induction welding because of the shorter lengths and because there are no losses in the induction coil or the tube under it. For seam welding of large-diameter pipe, the contact process can use as little as half the power required by the induction process.

Induction welding has the disadvantage that it is strictly a continuous process and the roll form mill generally has an accumulator to ensure a continuous supply of strip to the mill. Large-diameter tube is often welded coil to coil, requiring the roll form mill to be rethreaded between each coil run. In this situation, contact welding is preferred because the strip does not have to be threaded through the tight induction coil each time a tube is produced.

The major disadvantage of the contact process is contact wear. This requires replacement of the contact tips at regular intervals, generally once every shift. In addition, when using the contact process under some conditions, arcing between the sliding contacts and the tube can occur. This may cause surface marking or “arc marks.” In applications such as the manufacture of pipe to API standards for oil and gas transport, any arc marks must be removed by grinding.

The choice between the two processes is often resolved by employing dual welding machines that allow operation with both the contact and induction processes. ♦

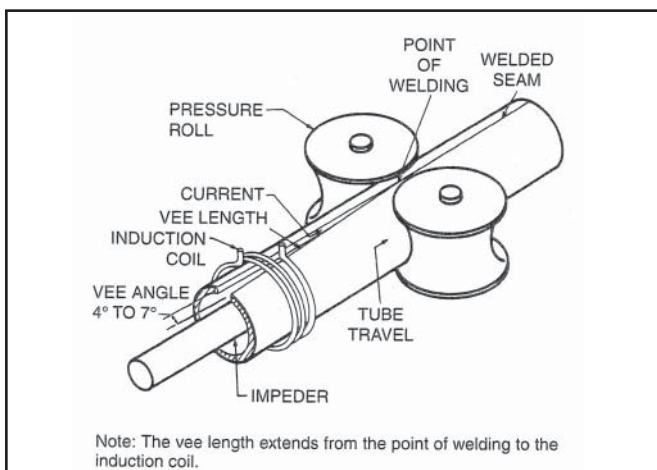


Fig. 1 — High-frequency induction seam welding of a tube.

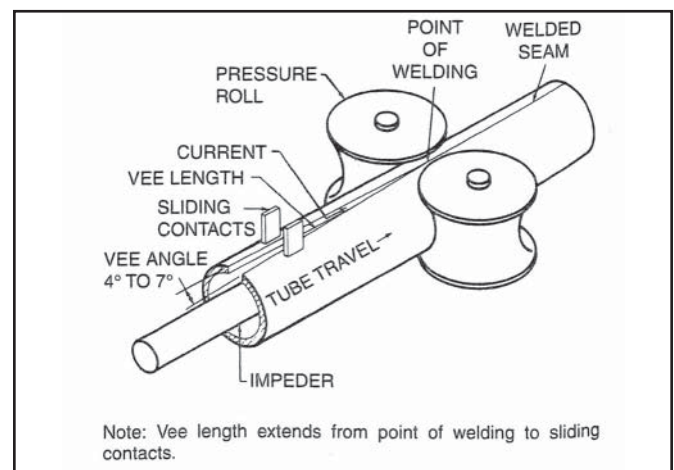
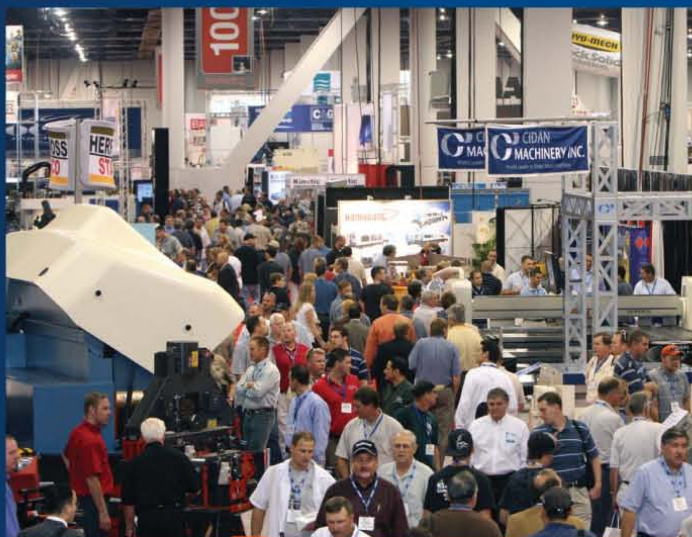


Fig. 2 — Joining a tube seam with high-frequency resistance welding using sliding contacts.

Excerpted from the *Welding Handbook*, Vol. 3, ninth edition.

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COMING EVENTS

NOTE: A DIAMOND (◆) DENOTES AN AWS-SPONSORED EVENT.

JOM-15, 15th Int'l Conf. on the Joining of Materials, and 6th Int'l Conf. on Education in Welding. May 3–6, Helsingør, Denmark. Organized by JOM Institute, supported by Dansk Metal, Danish Welding Society, DSL.FORCE Technology. Send e-mail inquiries to jom_aws@post10.tele.dk.

AISTech 2009, The Iron & Steel Technology Conf. and Expo and Asia-Pacific Partnership Technology Showcase 2009. May 4–7, St. Louis, Mo. Contact Association for Iron & Steel Technology www.iss.org.

Int'l Thermal Spray Conf. and Expo (ITSC). May 4–7, Flamingo Las Vegas Hotel, Las Vegas, Nev. Sponsored by ASM Int'l Thermal Spray Society, German Welding Society, and Int'l Institute of Welding. Visit www.asminternational.org/itsc.

Offshore Technology Conf. May 4–7, Reliant Center, Houston, Tex. Visit www.otcnet.org/2009.

◆ **12th Aluminum Welding Conf. and Expo.** May 5, 6, Toronto, Ont., Canada. Cosponsored by AWS and The Aluminum Assn. Contact American Welding Society, (800/305) 443-9353, ext. 229; visit www.aws.org.

Del Mar Electronics Show. May 6, 7, Del Mar Fairgrounds, San Diego, Calif. Visit www.vts.com.

◆ **Robotic Arc Welding Conf. and Expo.** May 11–13, Milwaukee Area Technical College, Milwaukee, Wis. Cosponsored by the

AWS Milwaukee Section and D16 Committee on Robotic and Automatic Welding. Includes tour of Caterpillar's facility in Aurora, Ill. Contact Karen Gilgenbach at karen.gilgenbach@airgas.com, or call (262) 613-3790.

RAPID 2009. May 12–14, Renaissance Schaumburg Convention Center, Schaumburg, Ill. Contact Society of Mfg. Engineers, (800) 733-4763, www.sme.org/rapid.

3rd Annual Training Within Industry Summit. May 12, 13, Mason (Cincinnati), Ohio. Visit www.twisummit.com.

Advanced Manuf. Expo. and Plant Maintenance & Design Engineering Show. May 19–21, Place Bonaventure, Montreal, Que., Canada. Contact Society of Mfg. Engineers, (800) 733-4763, www.sme.org.

EASTEC. May 19–21, Eastern States Exposition Grounds, W. Springfield, Mass. Contact Society of Mfg. Engineers, (800) 733-4763; or visit www.sme.org/eastec.

◆ **AWS Weldmex.** June 2–4, Cintermex Exhibition Center, Monterrey, Mexico. Colocated with Metalform Mexico, FABTECH Mexico, and COATech. Contact American Welding Society, (800/305) 443-9353, ext. 229; or visit www.aws.org.

Beijing-Essen Welding & Cutting Fair. June 2–5, Shanghai, China. Visit www.beijing-essen-welding.de.

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Emerging Technologies for High-Productivity Heavy Fabrication, EWI Workshop. June 3, 4, EWI, Columbus, Ohio. Visit www.ewi.org/events.

AeroMat® 2009 Conf. and Expo. June 7–11, Dayton Convention Center, Dayton, Ohio. Call ASM (800) 336-5152, ext. 0; visit <http://asmcommunity.asminternational.org/content/Events/aeromat09/> or e-mail customerservice@asminternational.org.

SME Annual Conf. June 7–9, Hyatt Regency Philadelphia, Philadelphia, Pa. Contact Society of Manufacturing Engineers, (313) 425-3069; www.sme.org.

♦ **Weld Cracking VII 'The Heat-Affected Zone' Conf.** June 9, 10, Columbus, Ohio. Contact American Welding Society, (800/305) 443-9353, ext. 229; or visit www.aws.org.

First Int'l Conf. on Welding Technologies. June 11–13, Gazi University, Ankara, Turkey. Visit www.icwet09.org.

♦ **6th Annual Charting the Course in Welding: U.S. Shipyards Conf.** June 16, 17, Sheraton Metairie Hotel, New Orleans, La. Contact American Welding Society, (800/305) 443-9353, ext. 229; or visit www.aws.org.

Western Manufacturing Technology Show. June 16–18. Northlands Park-AgriCom, Edmonton, Alb., Canada. Contact Society of Manufacturing Engineers, (800) 733-4763; or visit www.sme.org.

7th Int'l Expo on Electric Power Equipment and Technology and 6th Int'l Expo on Electrical Engineering, Electrical Equipment, and Contractors' Supplies. July 8–10. Shanghai Int'l Expo Center, Shanghai, PR, China. Visit www.2456.com/ep.



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Int'l Metallographic Society Annual Convention. July 26–30, Richmond, Va. Sponsored by ASM Int'l. Held during Microscopy and Microanalysis. Visit <http://imm2009.microscopy>.

Essen Welding Fair (Schweissen & Schneiden). Sept. 14–19, Essen, Germany. Visit www.messe-essen.de.

25th ASM Heat Treating Society Conf. and Expo. Sept. 14–17, Indiana Convention Center and RCA Dome, Indianapolis, Ind. Visit www.asminternational.org.

Asiamold — Int'l Trade Fair for Moldmaking and Tooling, Design, and Application Development. Sept. 16–18, Poly World Trade Centre Expo, Guangzhou, China. Visit www.asiamold-china.com.cn.

◆ **GAWDA Annual Meeting.** Sept. 20–23, Grand Hyatt Hotel, San Antonio, Tex. Sponsored by Gases and Welding Distributors Assn. Visit www.gawda.org.

Numerical Analysis of Weldability, 9th Int'l Seminar. Sept. 28–30, Graz-Seggau, Austria. Sponsored by Graz University of Technology, Austria Institute for Materials Science and Welding, and IIW Commission IX working group Mathematical Modeling of Weld Phenomena. Visit <http://iws.tugraz.at>.

SOUTH-TEC. Oct. 6–8, Charlotte Convention Center, Charlotte, N.C. Contact Society of Mfg. Engineers, (800) 733-4763; or visit www.sme.org/southtec.

◆ **Welding of Corrosion-Resistant Alloys Conf.** Oct. 6, 7, New Orleans, La. Contact American Welding Society, (800/305) 443-9353, ext. 229; or visit www.aws.org.

SNAME 2009 Annual Meeting and Expo. Oct. 21–23, Providence, R.I. Contact Society of Naval Architects & Marine Engineers. Visit www.snameexpo.com.

96th ASM Annual Meeting at MS 2009. Oct. 25–29, Pittsburgh, Pa. Coorganized by ASM Int'l, ACerS, and AIST. Visit www.matscitech.org.

The Aluminum Assn. Annual Meeting. Oct. 25–27, Charleston Place, Charleston, S.C. Visit www.aluminum.org.

National Robot Safety Conf. XXI. Oct. 26–29, Hyatt Regency, Dearborn, Mich. Contact Robotic Industries Assn. at ria@informz.net or ria@robotics.org.

ICALEO®, 28th Int'l Congress on Applications of Lasers & Electro-Optics. Nov. 2–5, Hilton in the Walt Disney World Resort®, Orlando, Fla. This conference is where researchers and end-users will meet to review state-of-the-art laser materials processing and project what lies in the future. Laser Institute of America's goal for ICALEO® is to bring both academic and industrial people together who may benefit from laser technology. E-mail Laser Institute of America at conferences@laserinstitute.org; or visit www.icaleo.org.

◆ **FABTECH International & AWS Welding Show** now including **METALFORM.** Nov. 15–18, McCormick Place, Chicago, Ill. This show is the largest event in North America dedicated to showcasing the full spectrum of metal forming, fabricating, tube and pipe, welding equipment, and technology. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

35th Int'l Symposium for Testing Failure Analysis (ISTFA). Nov. 15–19, San Jose, Calif. Visit www.asminternational.org.

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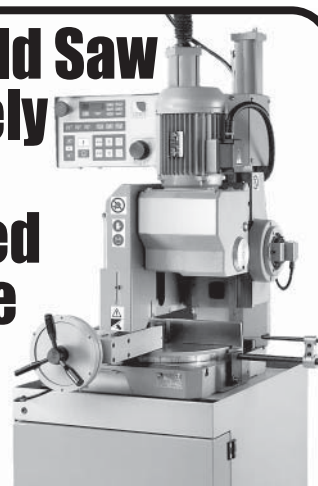
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◆ **Weld Cracking VII.** Nov. 16, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

◆ **Int'l Electron Beam Conf.** Nov. 16, 17, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

◆ **Welding Chrome-Moly Steels Conf.** Nov. 17, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

◆ **Welding Corrosion-Resistant Alloys Conf.** Nov. 18, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

9th Int'l Welding Conf. and Expo. Dec. 1-3, World Trade Center, Yekaterinburg, Russian Federation. Visit www.uv2000.ru.

◆ **Power-Gen Int'l.** Dec. 8-10, Las Vegas, Nev. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

21st World Energy Congress. Sept. 12-16, 2010, Palais des Congrès, Montreal, Que., Canada. Visit <http://montreal2010.ca>.

Educational Opportunities

ASME Section IX Course. June 1-3, Houston, Tex. Presented by Walter J. Sperko. Call ASME InfoCentral (800) 843-2763, or visit

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http://catalog.asme.org/Education/ShortCourse/BPV_Code_Section_IX_Welding.cfm.

Automotive Body in White Training for Skilled Trades and Engineers. Orion, Mich. A five-day course covers operations, troubleshooting, error recovery programs, and safety procedures for automotive lines and integrated cells. Contact Applied Mfg. Technologies, (248) 409-2000, www.appliedmfg.com.

Boiler and Pressure Vessel Inspectors Training Courses and Seminars. Columbus, Ohio. Call (614) 888-8320; visit www.nationalboard.org.

CWI/CWE Course and Exam. Troy, Ohio. This is a ten-day program. Contact Hobart Institute of Welding Technology, (800) 332-9448, www.welding.org/technical/schedule2008.html.

CWI/CWE Prep Course and Exam and NDT Inspector Training Courses. An AWS Accredited Testing Facility. Courses held year-round in Allentown, Pa., and at customers' facilities. Contact: Welder Training & Testing Institute, (800) 223-9884, info@wtti.edu; visit www.wtti.edu.

CWI Preparatory and Visual Weld Inspection Courses. Classes presented in Pascagoula, Miss., Houston, Tex., and Houma and Sulphur, La. Contact: Real Educational Services, Inc., (800) 489-2890, info@realeducational.com.

Environmental Online Webinars. Free, online, real-time seminars conducted by industry experts. For topics and schedule, visit www.augustmack.com/Web%20Seminars.htm.

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

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Introduction to Welding and Materials Joining Course. Training for high school, technical and community college instructors. June 15-26, Texas State T.C., Waco, Tex.; July 13-24, Pennsylvania College of Technology, Williamsport, Pa.; Aug. 3-14, Yuba College, Marysville, Calif. The \$500 fee includes hotel, two meals, and course materials. Visit Weld-Ed at www.weld-ed.org/workshops or contact Beth Plas at (440) 366-7036, bplas@lorainccc.edu.

AWS Certification Schedule

Certification Seminars, Code Clinics and Examinations

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

Certified Welding Inspector (CWI)

LOCATION	SEMINAR DATES	EXAM DATE
Nashville, TN	May 10-15	May 16
Jacksonville, FL	May 10-15	May 16
Baltimore, MD	May 10-15	May 16
Long Beach, CA	EXAM ONLY	May 30
Detroit, MI	May 31-Jun. 5	Jun. 6
Miami, FL	May 31-Jun. 5	Jun. 6
Albuquerque, NM	May 31-Jun. 5	Jun. 6
Spokane, WA	Jun. 7-12	Jun. 13
Oklahoma City, OK	Jun. 7-12	Jun. 13
Birmingham, AL	Jun. 7-12	Jun. 13
Hartford, CT	Jun. 14-19	Jun. 20
Pittsburgh, PA	Jun. 14-19	Jun. 20
Beaumont, TX	Jun. 14-19	Jun. 20
Corpus Christi, TX	EXAM ONLY	Jun. 20
Kansas City, MO	Jun. 21-26	Jun. 27
Knoxville, TN	EXAM ONLY	Jun. 27
Miami, FL	EXAM ONLY	Jun. 16
Fargo, ND	Jul. 12-17	Jul. 18
New Orleans, LA	Jul. 12-17	Jul. 18
Sacramento, CA	Jul. 12-17	Jul. 18
Phoenix, AZ	Jul. 19-24	Jul. 25
Orlando, FL	Jul. 19-24	Jul. 25
Milwaukee, WI	Jul. 19-24	Jul. 25
Cleveland, OH	Jul. 26-31	Aug. 1
Los Angeles, CA	Jul. 26-31	Aug. 1
Louisville, KY	Jul. 26-31	Aug. 1
Denver, CO	Aug. 2-7	Aug. 8
Philadelphia, PA	Aug. 2-7	Aug. 8
San Diego, CA	Aug. 9-14	Aug. 15
Miami, FL	Aug. 9-14	Aug. 15
Charlotte, NC	Aug. 16-21	Aug. 22
San Antonio, TX	Aug. 16-21	Aug. 22
Bakersfield, CA	Aug. 16-21	Aug. 22
Rochester, NY	EXAM ONLY	Aug. 22
Portland, ME	Aug. 23-28	Aug. 29
Salt Lake City, UT	Aug. 23-28	Aug. 29
Seattle, WA	Aug. 23-28	Aug. 29
Corpus Christi, TX	EXAM ONLY	Aug. 29
Pittsburgh, PA	Aug. 30-Sept. 4	Sept. 5
Houston, TX	Aug. 30-Sept. 4	Sept. 5
Minneapolis, MN	Aug. 30-Sept. 4	Sept. 5
St. Louis, MO	Sept. 20-25	Sept. 26
Miami, FL	Sept. 20-25	Sept. 26
New Orleans, LA	Sept. 20-25	Sept. 26
Anchorage, AK	EXAM ONLY	Sept. 26
Tulsa, OK	Oct. 4-9	Oct. 10
Long Beach, CA	Oct. 4-9	Oct. 10
Newark, NJ	Oct. 4-9	Oct. 10
Miami, FL	EXAM ONLY	Oct. 15
Portland, OR	Oct. 18-23	Oct. 24
Roanoke, VA	Oct. 18-23	Oct. 24
Cleveland, OH	Oct. 18-23	Oct. 24
Atlanta, GA	Nov. 1-6	Nov. 7
Dallas, TX	Nov. 1-6	Nov. 7
Sacramento, CA	Nov. 1-6	Nov. 7
Spokane, WA	Nov. 1-6	Nov. 7
Corpus Christi, TX	EXAM ONLY	Nov. 21
St. Louis, MO	EXAM ONLY	Dec. 5
Syracuse, NY	Dec. 6-11	Dec. 12
Reno, NV	Dec. 6-11	Dec. 12
Miami, FL	Dec. 6-11	Dec. 12

9-Year Recertification Seminar for CWI/SCWI

LOCATION	SEMINAR DATES	EXAM DATE
Sacramento, CA	May 4-9	NO EXAM
Pittsburgh, PA	Jun. 1-6	NO EXAM
San Diego, CA	Jul. 13-18	NO EXAM
Orlando, FL	Aug. 24-29	NO EXAM
Dallas, TX	Oct. 5-10	NO EXAM
Miami, FL	Nov. 30-Dec. 5	NO EXAM

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

Certified Welding Supervisor (CWS)

LOCATION	SEMINAR DATES	EXAM DATE
Columbus, OH	Jun. 1-5	Jun. 6
Minneapolis, MN	Jul. 20-24	Jul. 25
Philadelphia, PA	Aug. 31- Sep. 4	Sep. 5
Tulsa, OK	Oct. 5-9	Oct. 10
Long Beach, CA	Nov. 30-Dec. 4	Dec. 5

CWS exams are also given at all CWI exam sites.

Certified Radiographic Interpreter (CRI)

LOCATION	SEMINAR DATES	EXAM DATE
Miami, FL	Jun. 22-26	Jun. 27
Houston, TX	Jul. 27-31	Aug. 1
Miami, FL	Oct. 19-23	Oct. 24

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

Certified Welding Sales Representative (CWSR)

LOCATION	SEMINAR DATES	EXAM DATE
Miami, FL	Oct. 21-23	Oct. 23
Chicago, IL	Nov. 16-18	Nov. 18

CWSR exams will also be given at certain CWI exam sites. Call for details.

Certified Welding Educator (CWE)

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

Senior Certified Welding Inspector (SCWI)

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

Code Clinics & Individual Prep Courses

The following workshops are offered at all sites where the CWI seminar is offered (code books not included with individual prep courses): Welding Inspection Technology (general knowledge and prep course for CWI Exam-Part A); Visual Inspection Workshop (prep course for CWI Exam-Part B); and D1.1 and API-1104 Code Clinics (prep courses for CWI Exam-Part C).

On-site Training and Examination

On-site training is available for larger groups or for programs customized to meet specific needs of a company. Call ext. 455 for more information.

International CWI Courses and Exams

AWS training and certification for CWI and other programs are offered in many countries. For international certification program schedules and contact information, please visit http://www.aws.org/certification/inter_contact.html

For information on any of our seminars and certification programs, visit our website at www.aws.org/certification or contact AWS at (800) 443-9353, Ext. 273 for Certification and Ext. 455 for Seminars. Please **apply early** to save Fast Track fees. **This schedule is subject to change without notice.** Please verify the dates with the Certification Dept. and confirm your course status before making final travel plans.

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In addition to the formal sessions being presented, the conference will provide several opportunities for you to network informally with experts from academia and industry, as well as with conference participants. An exhibition showcasing products and services available to the shipbuilding industry will also be featured during this two-day conference.

For the latest conference and exhibitor information or to register for the conference visit our website at [www.aws.org / conferences](http://www.aws.org/conferences) or call 800-443-9353, ext. 455.

To secure tabletop exhibit space or for questions about exhibiting at the conference, please call 800-443-9353, ext. 223.

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SOCIETY NEWS

BY HOWARD M. WOODWARD

AWS Announces New Certification Program for Sales Representatives and Member Benefits for Welders

On March 10, the American Welding Society announced the inauguration of its certification program for welding sales professionals. The certification serves to recognize experience, knowledge, and excellence in welding sales expertise.

"The AWS welding sales representative certification will set apart the elite sales professionals from the rest of the pack," said Cassie Burrell, AWS deputy executive director. "It drives home the dedication that sales professionals have to their customers because it shows 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."

Sales professionals interested in being the best and most successful in the industry and who meet the program's requirements can take a two-hour exam to establish their credentials. Convenient examination sites are scheduled throughout the country. In addition, AWS offers three-day preparation seminars with the examination held on the afternoon of the third day. The seminar can be taken at certain AWS-scheduled sites, or at the workplace for groups of sales personnel.

The examination topics will establish the sales person's level of knowledge concerning five arc welding processes, brazing and soldering, cutting, safety in process and gas-cylinder handling, AWS filler metal classifications, shielding gas applications, welding terminology, ventilation, electrical requirements for power sources, and welding procedures and their qualification.

The optional seminar serves to prepare sales professionals for the exam and also to enhance professional knowledge, as candidates gain insight alongside their peers in a stimulating, interactive classroom environment. Those enrolled in the seminar will receive a study guide and valuable reference books that they can keep: *Welding Handbook* volumes 1 and

2, AWS A5.32/A5.32M-97(R2007), *Specification for Welding Shielding Gases*, and ANSI Z49.1:2005, *Safety in Welding, Cutting, and Allied Processes*.

Prerequisites for the AWS Certified Welding Sales Representative program include a high school diploma or equivalent and at least five years of experience in an occupational function in direct relation to the sales of welding equipment, cutting equipment, and supplies of other related services; or at least two years of the same experience plus a training certificate of completion for welding processes. Completion of the AWS Certified Welding Sales Representative seminar fulfills this training certificate requirement. Therefore, by taking the seminar, a sales representative with between two and five years of relevant experience would be qualified to take the exam.

Visit www.aws.org/certification/CWSR for more information and application forms. For information about applying for certification, call (800) 443-9353, ext. 273; call ext. 455 with questions about the exam-preparation seminar; and call ext. 219 for information about customized training and examination conducted at your workplace.

Major Membership Benefits for Welders Announced

Also in March, a new American Welding Society membership program was inaugurated that will empower welders who are AWS members to take advantage of instant discounts at dozens of Gases and Welding Distributors Association (GAWDA) member stores nationwide.

Welder members can also benefit from hefty discounts on insurance, welding books and training, and other services.

"AWS has negotiated on behalf of its 56,000 members so that welder members can receive significant discounts from par-

ticipating GAWDA member welding supply distributors," Burrell said. "We have also arranged access to AWS health insurance and dental plans, plus discounts on auto and home insurance for welders."

With the upcoming changes in the economy, many welders are moving into high-growth industries such as green energy and infrastructure. For their new job environments, welders often need to purchase new protective equipment. They also want to maintain their access to health care insurance. This new membership program addresses both of these needs, by providing the opportunity for savings on safety apparel, welding helmets, tools, and other gear, as well as access to customized insurance coverage.

As AWS members, welders also can attend the regular meetings of more than 200 local AWS chapters, called "Sections," where they can network to find the best career opportunities and share their expertise with others. Each local AWS Section works to improve the professionalism of its members while providing scholarships and mentoring to the next generation of welders in its community.

Welders who join AWS to receive these benefits will also receive a subscription to the monthly *Welding Journal* magazine and discounts on hundreds of welding books and educational programs.

Other benefits of joining AWS include up to an 87% discount on a choice from 28 welding books and CDs, access to the "Welders Exchange Bulletin Board" and "JobFind" on the AWS Web site, and members-only discounts on car rentals, cell phone plans, FedEx shipping, plus additional benefits.

The cost of a one-year AWS membership is \$80 plus a one-time initiation fee of \$12, but new members can save more by signing up for a two-year AWS membership for \$147. For more information on the AWS Welder Membership and to sign up, visit www.aws.org/membership or call (800/305) 443-9453, ext. 260.

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Dumfries, VA 22026

Soldadura de Arco S. De R.L. M.I.
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Colonia López Mateos
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Tazewell County Career and Technical Center
100 Advantage Dr.
Tazewell, VA 24651

Wylie High School
2550 W. FM 544
Wylie, TX 75098

Membership Counts

Member Grades	As of 4/01/09
Sustaining.....	518
Supporting.....	314
Educational.....	495
Affiliate.....	469
Welding distributor.....	44
Total corporate members.....	1,840
Individual members.....	50,577
Student + transitional members.....	5,502
Total members.....	56,079

Ridgway Earns AWS Student Chapter Member Award

Thomas Ridgway, Canton South High School Student Chapter, has been selected by Chapter Advisor **Art Baughman** to receive the AWS Student Chapter Member Award. Thomas, a member of the National Technical Honor Society, has served as the Student Chapter chairman for 2009, and as Chapter secretary. He designed and helped build fire pits for the Chapter's fund-raising event this year and also volunteered to help

build basement support poles with Habitat for Humanity.

The AWS board of directors established the Student Chapter Member Award to recognize AWS Student Members whose Student Chapter activities have produced outstanding school, community, or industry achievements.

This award also provides an opportunity for Student Chapter advisors, Section officers, and District directors to recog-

nize outstanding students, in addition to enhancing the image of welding within their communities.

To qualify for this award, the candidate must be a Student Member affiliated with an AWS Student Chapter. The criteria and application form can be downloaded from www.aws.org, Section Toolkit, Student Chapter page; or call the Membership Department (800/305) 443-9353, ext. 260, for complete information.

Candidates Sought for Prof. Masubuchi Award

November 2 is the deadline for submitting nominations for the 2010 Prof. Koichi Masubuchi Award, sponsored by the Dept. of Ocean Engineering at Massachusetts Institute of Technology. This award includes an honorarium of \$5000. It is presented each year to one person who has made significant contributions to the advancement of materials joining through

research and development.

The candidate must be 40 years old or younger, may live anywhere in the world, and need not be an AWS member. The nomination package should be prepared by someone familiar with the research background of the candidate. It should include the candidate's résumé listing background, experience, publications, honors, and awards, plus at

least three letters of recommendation from fellow researchers.

This award was established to recognize Prof. Koichi Masubuchi for his numerous contributions to the advancement of the science and technology of welding, especially in the fields of fabricating marine and outer space structures. E-mail your nominations to Prof. John DuPont at jnd1@lehigh.edu.

Tech Topics

ERRATA

AASHTO/AWS D1.5M/D1.5:2008 Bridge Welding Code

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

Page 262, Form L-3 — Procedure Qualification Record (PQR) for Qualification, Pretest, and Verification Results Change “Maximum Size Single Pass” to “Minimum Size Multiple Pass” in the “Macroetch” row.

Standards Reaffirmed by ANSI

A5.25/A5.25M-97 (R2009), *Specification for Carbon and Low-Alloy Steel Electrodes and Fluxes for Electroslag Welding*. 2/27/09.

C6.1-89 (R2009), *Recommended Practices for Friction Welding*. 2/27/09.

Standards for ANSI Public Review

B2.2/B2.2M:200X, *Specification for Brazing Procedure and Performance Qualification*. Revised — \$40. 5/18/09.

C4.2/C4.2M:200X, *Recommended Practices for Safe Oxyfuel Gas Cutting Torch Operation*. Revised — \$25. 3/16/09.

AWS was approved as an accredited standards-preparing body 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 above standards are open for public review until the dates shown. Draft copies may be obtained from R. O'Neill, ext. 451, roneill@aws.org.

ISO Standard for Public Review

ISO/DIS 10225, *Gas welding equipment — Marking for equipment used for gas welding, cutting, and allied processes*.

Copies of this draft standard are available for review and comment through your national standards body, which in the United States is ANSI, 25 W. 43rd St., 4th Fl., New York, NY 10036; (212) 642-4900. Any comments regarding ISO documents should be sent 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, ext. 466, adavis@aws.org.

Technical Committee Meetings

May 5–7, D17 Committee and Subcommittees on Welding in the Aircraft and Aerospace Industries. Cincinnati, Ohio. Call M. Rubin, ext. 215.

May 6, 7, A2 Committee and Subcommittees on Definitions and Symbols. Myr-

D14 Committees Meet at Lincoln

The D14 Committee on Machinery and Equipment and its D14E Cranes and Presses and D14I Hydraulic Cylinders Subcommittees held meetings March 10–12 to work on their documents at The Lincoln Electric Co. Training and Distribution Center in Bolingbrook, Ill. The meetings were hosted by **Keith Sheffer** and **Phil Bouchard**.



D14 Committee members are (from left) Larry Schweinegruber, Ed Yevick, Tom Landon, Chair Jerry Warren, Secretary Matt Rubin, Pat Mortale, Joe Campbell, and David Ashley.



D14E Subcommittee members are (from left) Ed Yevick, Chair David Ashley, Jerry Warren, Troy McMurtrey, Secretary Matt Rubin, and Joe Campbell.



D14I Subcommittee members are from left (front row) Ed Yevick, Don Murray, Robby Anderson, Joe Campbell, and Ron Stiglitz; (back row) Jerry Warren, Brian Rosenbloom, Jamie Slipke, Secretary Matt Rubin (hidden), Chris Hordyk, and Troy McMurtrey.

tle Beach, S.C. Call A. Alonso, ext. 299.

May 14, D16 Committee on Robotic and Automatic Welding. Milwaukee, Wis. Call M. Rubin, ext. 215.

B2.1 and D16.3 Updated

B2.1/B2.1M:2009, *Specification for Welding Procedure and Performance Qualification*, provides the requirements for qualifying welding procedures and the performance of welders and welding operators for manual, semiautomatic, mechanized, and automatic welding, in both U.S. customary units and SI (metric) units. Included are sample forms, new materials from Australian and New Zealand standards, new welding procedure specification and qualification variables with tighter restrictions, and updated filler metal groupings. Covered are qualification requirements for base metals, filler

metals, qualification variables, and testing requirements. The processes included are oxyfuel gas, SMA, GTA, submerged arc, laser beam, GMA, FCA, plasma arc, electroslag, electrogas, electron beam, and arc stud. The 298-page document lists for \$156; \$117 for AWS members.

D16.3M/D16.3:2009, *Risk Assessment Guide for Robotic Arc Welding*, identifies and evaluates potential safety hazards associated with robotic arc welding. Included are updated terminology and guidelines for describing, classifying, and documenting hazards to personnel and electromagnetic hazards in a robotic arc welding cell. Included is a sample risk assessment form, and recommendations for a training program. The document lists for \$52, \$39 for AWS members. To purchase, call WEX at (888) 935-3464, or visit www.aws.org/standards.

Member-Get-A-Member Campaign

Listed below are the people participating in the 2008–2009 AWS Member-Get-A-Member Campaign. For campaign rules and a prize list, see page 83 in this *Welding Journal*, and for complete campaign rules visit www.aws.org/mgm. The standings are as of March 17, 2009. If you have any questions regarding your member proposer points, call the AWS Membership Dept. (800/305) 443-9353, ext. 480.

Winner's Circle

Sponsored 20+ new members.

The superscript indicates the number of times the member has achieved Winner's Circle status since June 1, 1999.

J. Compton, San Fernando Valley⁷
E. Ezell, Mobile⁶
J. Merzthal, Peru²
G. Taylor, Pascagoula²
L. Taylor, Pascagoula²
B. Mikeska, Houston¹
R. Peaslee, Detroit¹
W. Shreve, Fox Valley¹
M. Karagoulis, Detroit¹
S. McGill, NE Tennessee¹
T. Weaver, Johnstown/Altoona¹
G. Woomer, Johnstown/Altoona¹
R. Wray, Nebraska¹
M. Haggard, Inland Empire¹

President's Guild

Sponsored 20+ new members.

S. Esders, Detroit — 22

President's Roundtable

Sponsored 9–19 new members.

E. Ezell, Mobile — 17
P. Betts, Mobile — 12

President's Club

Sponsored 3–8 new members.

L. Contreras, South Florida — 8
R. Ellenbecker, Fox Valley — 8
J. Compton, San Fernando Valley — 7
P. Shahoveisi, International — 7
D. Marquard, Cleveland — 6
R. Robles, Corpus Christi — 6
D. Wright, Kansas City — 6
C. Daon, Israel — 5
W. Rice, Tri-State — 5
R. Shepherd, Fox Valley — 5
M. Hackl, Cuautitlan Izcalli — 4
R. Newman, Maine — 4
B. Vernyi, Cleveland — 4
C. Becker, Northwest — 3
B. Franklin, Mobile — 3
R. Johnson, Detroit — 3
L. Moss, Sangamon Valley — 3
P. Newhouse, British Columbia — 3
M. Rahn, Iowa — 3
M. Wheat, Western Carolina — 3

President's Honor Roll

C. Alfaro, San Diego — 2
T. Baldwin, Arrowhead — 2
M. Boggs, Stark Central — 2
M. Boyer, Detroit — 2
R. Boyer, Nevada — 2
K. Bristow, East Texas — 2
J. Contreras, International — 2
B. Donaldson, British Columbia — 2
E. Dupree, Tidewater — 2
T. Ferri, Boston — 2
F. Hendrix, New Jersey — 2
T. Johnson, Pittsburgh — 2
G. Lawrence, N. Central Florida — 2
E. Levert, North Texas — 2
J. Livesay, Nashville — 2
J. Padilla, Cuautitlan Izcalli — 2
S. Luke, Acadiana — 2
J. Nash, Atlanta — 2
R. Pitt, Tidewater — 2
J. Polson, L.A./Inland Empire — 2
D. Roland, Upper Peninsula — 2
J. Rule, Cleveland — 2
J. Sisson, Niagara Frontier — 2
K. Smith, North Texas — 2
A. Stute, Madison-Beloit — 2
J. Svatos, Siouxland — 2
D. Thomason, Chicago — 2
M. Torres, Pascagoula — 2
B. Whatley, Albuquerque — 2
M. Yung, Portland — 2
P. Zammit, Spokane — 2

Student Member Sponsors

D. Berger, New Orleans — 110
J. Kacir, Detroit — 54
B. Benyon, Pittsburgh — 42
A. Baughman, Stark Central — 36
M. Boggs, Stark Central — 36
R. Jones, Puget Sound — 36
A. Rowe, Philadelphia — 36
A. Zinn, Eastern Iowa — 34
T. Moore, New Orleans — 32
J. Carney, Western Michigan — 26
J. Harris, Pascagoula — 26
E. Norman, Ozark — 26
J. Roberts, Sacramento — 26
S. Siviski, Maine — 26
T. Geisler, Pittsburgh — 24
J. Kline, Northern New York — 24
D. Newman, Ozark — 24
R. Newman, Maine — 24
R. Cook, Utah — 23
D. Howard, Johnstown-Altoona — 23
B. Suckow, Northern Plains — 23
R. Young, Iowa — 23
L. Clark, Milwaukee — 22
H. Hughes, Mahoning Valley — 22
D. Schnalzer, Lehigh Valley — 22
J. Rule, Cleveland — 21
R. Munns, Utah — 21
A. Duron, New Orleans — 19
J. Fox, NW Ohio — 19
D. Zabel, SE Nebraska — 19

D. Pickering, Central Arkansas — 18
R. Schmidt, Philadelphia — 18
T. Strickland, Arizona — 18
J. Boyer, Lancaster — 17
R. Boyer, Nevada — 17
J. Ciaramitaro, N. Central Florida — 17
C. Donnell, NW Ohio — 16
B. Hallila, New Orleans — 16
M. Arand, Louisville — 14
R. Hutchinson, Long Bch./Or. Cty. — 14
G. Smith, Lehigh Valley — 14
A. Mattox, Lexington — 13
R. Rummel, Central Texas — 13
D. Saunders, Lakeshore — 13
A. Stute, Madison-Beloit — 13
D. Taylor, Kern — 13
D. Vranich, N. Florida — 13
J. Daugherty, Louisville — 12
J. Marshall, Siouxland — 12
R. Evans, Siouxland — 11
J. Theberge, Boston — 11
A. Badeaux, Washington, D.C. — 10
C. Kipp, Lehigh Valley — 10
D. Kowalski, Pittsburgh — 10
C. Abram, Columbus — 9
K. Caliva, New Orleans — 9
S. Colton, San Diego — 9
R. Ledford Jr., Birmingham — 9
R. Norris, Maine — 9
V. Facchiano, Lehigh Valley — 9
D. Kearns, Northern Michigan — 8
M. Rabo, Sacramento — 8
G. Saari, Inland Empire — 8
N. Carlson, Idaho/Montana — 7
L. Caughron, Kansas City — 7
W. Galvery Jr., Long Bch./Or. Cty. — 7
J. Geesey, Pittsburgh — 7
S. MacKenzie, Northern Michigan — 7
D. Roskiewich, Philadelphia — 7
J. Fitzpatrick, Arizona — 6
C. Schiner, Wyoming — 6
M. Hayes, Puget Sound — 5
R. Olesky, Pittsburgh — 5
J. Reed, Ozark — 5
T. Shirk, Tidewater — 5
T. Buckler Sr., Columbus — 4
H. Evans, Portland — 4
W. Geiger, N. Central Florida — 4
C. Hobson, Olympic Section — 4
W. Kielhorn, East Texas — 4
T. Hopper, Mobile — 4
S. Robeson, Cumberland Valley — 4
G. Rolla, L.A./Inland Empire — 4
S. Tennant, Fox Valley — 4
F. Gorglione, Connecticut — 3
D. Hamilton, Chattanooga — 3
S. Hansen, SE Nebraska — 3
J. Hayes, Oklahoma City — 3
R. Huston, Olympic Section — 3
J. Russell, Fox Valley — 3
R. Richwine — 3
D. Saunders, Holston — 3
M. Shelton, Sabine — 3
B. Wenzel, Sacramento — 3

SECTION NEWS

District 1

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BOSTON

FEBRUARY 23

Activity: The Section members toured the Metfab Engineering facilities in Attleboro Falls, Mass. The manufacturing plant processes all types of metal from thin gauge to heavy plate using both laser beam and waterjet cutting methods. **Steve Cronin**, plant manager, and **Jim Tremblay**, production manager, led the tour.

BOSTON and CENTRAL MASS./RHODE ISLAND

MARCH 9

Speakers: **Matthew Wallace**, CEO and president, and **Lucy Bolduc**
Affiliation: VRSim Inc.

Activity: The Sections had a hands-on demonstration of the Sim Welder™ virtual reality technology. Students **Rachel Auger**, **Erick Sowden**, **Kevin Guyette**, **Jacob Thomas**, **West LeBlanc**, **Thomas Donnellan**, and **Haeleigh Bigeau** were enthusiastic about working with the machine. The event was held at Assabet Valley Regional Technical High School in Marlboro, Mass.

GREEN & WHITE MOUNTAINS

MARCH 10

Speaker: **Geoff Putnam**, CWI
Affiliation: Thermal Dynamics

Topic: Preparations for the Vermont SkillsUSA welding test

Activity: The Section discussed the project and made job assignments for the contest. The meeting was held at Thermal Dynamics West in Lebanon, N.H.

MAINE

MARCH 12

Activity: The Section members met for a vendors' day and open house at United Technology Center in Bangor, Maine, in preparation for the following day's Maine SkillsUSA welding contest. **Lynn Malenfant**, head welding instructor at the center, coordinated the event. Working the booths and demonstrating their wares for



Shown at the Boston Section tour are (from left) **Steve Cronin**, **Jim Tremblay**, and **Tom Ferri**, Boston Section vice chairman.



Matthew Wallace demonstrated virtual reality welder training technology at the Boston and Central Mass./Rhode Island Sections.



High school students tested their welding skills using virtual reality at the joint meeting of the Boston and Central Mass./Rhode Island Sections.



Shown at the Green & White Mountains Section program are left to right (front row) **Jerry Ouellette**, Vice Chair **Gary Buckley**, and speaker **Geoff Putnam**; (middle row) Chair **Ray Henderson**, **Howard Knowlton**, and **Matt Santwire**; (back row) **Phil Witteman**, **Jim Read**, and **John Steel**.



Shown at the Maine Section's March 12 event are (from left) **Chris Maseychik**, **Josh Richardson**, **Paul Rice**, **Dean Donovan**, **Robb Smith**, **Adam Fallon**, and **Erik Miskin**.



Thirteen students competed at the state of Maine SkillsUSA competition March 13.



Shown at the Long Island Section program are (clockwise from left) Ken Messemer, Alex Duschere, Barry McQuillen, Chair Brian Cassidy, Harland Thompson, Ray O'Leary, Jeff Feiner, and Tom Gartland.



Sam Vinci demonstrates aluminum welding for the students at the October Career Institute of Technology Student Chapter program.



Career Institute of Technology Student Chapter member Scott Beers makes a good pipe weld under the watchful eye of presenter Tim Stott at the November program.

the students were CWI **Chris Maseychik**, welding department head at Eastern Maine Community College; **Josh Richardson** and **Paul Rice** of Maine Oxy; **Dean Donovan** of Smith Equipment; **Robb Smith** and **Erik Miskin** of Advantage Gases; and **Adam Fallon** representing Lincoln Electric. District 1 Director **Russ Norris** attended the event.

MARCH 13

Speaker: **Joe Champagne**, CWI, trainer
Affiliation: Plumbers and Pipefitters UA Local #716

Topic: The Maine SkillsUSA welding contest

Activity: The Section members participated in judging the students' work in the State of Maine SkillsUSA welding competition for 13 entrants. Attending were vendors from all over New England who contributed their consumables, equipment, pipe, and plates for the event.

District 2

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LONG ISLAND

MARCH 12

Activity: The Section held an awards presentation program at The Nook Restaurant in Wantagh, N.Y. **Jeff Feiner** received the District Meritorious Certificate Award, **Ray O'Leary** accepted the



Doug Detwiler (right) receives his Silver Membership Certificate from Mike Seberandio, Lancaster Section chairman.

Section Meritorious Certificate Award, and **Harland Thompson** won the Section Dalton E. Hamilton Memorial Certified Welding Inspector of the Year Award.

District 3

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Career Institute of Technology Student Chapter

OCTOBER 2008

Speaker: **Sam Vinci**

Affiliation: The Lincoln Electric Co.

Topic: Programming and operation of the Lincoln Powerwave 455

Activity: The program was held at the Career Institute of Technology's Welding Technology Lab in Easton, Pa. Vinci demonstrated for the students how to weld aluminum and stainless steel using the pulsed gas metal arc process. Forty people attended the program including welding instructor **Christian Kipp**, Chapter advisor.

NOVEMBER 2008

Speaker: **Tim Stott**

Affiliation: Miller Electric Co.

Topic: Programming and use of the Miller PipePro™ pipe welding machine

Activity: This Career Institute of Technology Student Chapter program was held in the Welding Technology Lab in Easton, Pa. The students who tried their hands using the equipment had great success making good pipe welds on their first try.

DECEMBER 2008

Speaker: **Christian Kipp**, Chapter advisor

Affiliation: Career Institute of Technology, welding instructor

Activity: The Student Chapter members demonstrated their welding skills and displayed a number of welding projects they



Becky Lorenz receives Section and District Meritorious Awards from Tom Jacobs, chairman, Washington, D.C., Section.

completed during the year, including an aluminum water tank, hunting cabin out-house seat, pipe casing for well drilling, and stainless steel control boxes for a tow truck. The program was held in the institute's Welding Technology Lab in Easton, Pa.

LANCASTER

FEBRUARY 24

Speaker: **Bob Hosa**, district manager

Affiliation: T. J. Snow Corp., Inc.

Topic: Advanced resistance welding equipment with SPC capabilities

Activity: **Doug Detwiler** received the Silver Membership Certificate Award for 25 years of service to the Society. The meeting was held at Lancaster County Career & Technology Center in Mount Joy, Pa.

READING

FEBRUARY 19

Speaker: **Mike Wiswesser**, District 3 director

Affiliation: Welder Training and Testing Institute (WTTI), vice president

Topic: Welder training opportunities at WTTI

Activity: The Section hosted its past chairmen's night program at Wyomissing Family Restaurant in Wyomissing, Pa. In attendance were past chairs **John Miller**, **Paul Levensgood**, **Francis Butkus**, **Joe Young**, **Merilyn McLaughlin**, **Dave Hibshman**, and **Peter Shaub**. District 3 Director Wiswesser is a past chair of the Lehigh Valley Section.

WASHINGTON, D.C.

FEBRUARY 11

Speaker: **George Brunner**, AIA

Affiliation: EYP Architects and Engineers

Topic: The use of steel in modern buildings

Activity: Chairman **Tom Jacobs** pre-



Student Chapter Advisor Christian Kipp (far left in both photos above) proudly poses with his day class (top) and evening class at the Career Institute of Technology Welding Technology Lab in Easton, Pa.



Lancaster Section members are shown at the February meeting. From left are Chair Mike Sebergandio, Todd Sload, speaker Bob Hosa, Tim Siegrist, Justin Heistand, John Boyer, Greg Rzeplinski, Doug Detwiler, Clint Hinkle, and John Ament.



Reading Section past chairs are (seated, from left) John Miller, Paul Levensgood, Francis Butkus, and Merilyn McLaughlin; (standing, from left) Dave Hibshman, Joe Young, and Peter Shaub, with Mike Wiswesser, District 3 director.



Shown at the Washington, D.C., Section program are (from left) speaker George Brunner, Becky Lorenz, Chairman Tom Jacobs, Ron Flowers, and Alan Badeaux.



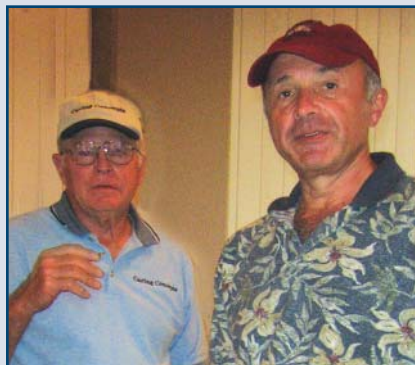
Washington, D.C., Section Chair Tom Jacobs (right) presents the Section Meritorious Certificate Award to Dave May in March.



Welding student Francisco Jimenez (left) receives a \$1000 Section scholarship award from Alan Shissler, Florida West Coast Section education chairman.



Speaker John Abbitt (right) is shown with Darrel Martin at the March Washington, D.C., Section meeting.



Past Chair Walt Arnold (left) and Chair Al Sedory raffled off door prizes at the Florida West Coast Section's fund-raising event.



Eric Morris (right) accepts a speaker gift from Bruce Lavallee, Northern New York Section chairman.



Speaker Uwe Aschemeier (left) is shown with Dayton Section Chair Steve Whitney.

sented artwork samples for the bumper sticker project, and an update to the Washington, D.C., Section's Web site (aws-washdc.org) was announced. The Section's 13th annual picnic will be held May 9. Past District 3 Director **Alan Badeaux** attended the program.

MARCH 11

Speaker: **John Abbitt**, district manager
Affiliation: Thermadyne
Topic: New technologies in Thermal Arc gas metal arc welding machines
Activity: At this Washington, D.C., Section program **Becky Lorenz** received the District Meritorious Certificate Award. Section Meritorious Certificates were awarded to **Dave May** and **Becky Lorenz**. The District Educator Award was dedicated to the late **Robert Worden** for his selfless dedication to the advancement of welding skills and knowledge. Many more photos are posted on the AWS Washington, D.C., Web site.

District 4

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District 5

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FLORIDA WEST COAST

MARCH 7

Activity: The Section hosted its 17th annual scholarship fund-raising golf tournament at Walden Lake Golf and Country Club in Plant City, Fla. **Francisco Jimenez** was awarded a \$1000 scholarship check to continue his welding education at Pinellas Technical Education Center.

District 6

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NORTHERN NEW YORK

MARCH 3

Speaker: **Eric Morris**
Affiliation: 3M Occupational Health and Environmental Safety Division
Topic: Welding safety and controlling hexavalent chromium fume
Activity: The SkillsUSA welding trials for New York State Area III were announced to take place March 18 at the Capital Region BOCES facility. The meeting was held at Mill Road Restaurant and Tavern in Latham, N.Y.



Dayton Section Chair Steve Whitney is shown with Monica Pfarr.

District 7

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DAYTON

MARCH 10

Speakers: **Uwe Aschemeier**, H. C. Nutting Co.; and **Monica Pfarr**, AWS corporate director, Solutions Opportunity Squad

Topics: Keynote speaker Aschemeier, a senior welding engineer and a commercial diver, discussed underwater welding. Pfarr detailed the educational opportunities available to students through AWS scholarship programs.

Activity: The program was hosted by Hobart Institute of Welding Technology in Troy, Ohio, for 112 Section members, welding instructors, and students. Chairman **Steve Whitney** of Motoman, Inc., served as emcee. The door prizes included a one-week basic robot programming course from Motoman, and auto-darkening helmets from Miller and Lincoln Electric. The program included a tour of the Hobart Institute of Technology training facilities.

JOHNSTOWN-ALTOONA

DECEMBER 9

Speaker: **Michael Myers**

Affiliation: Concurrent Technologies Corp.

Topic: Cladding to facilitate welding of dissimilar metals

Activity: The program was held at Concurrent Technologies Corp. in Johnstown, Pa.

FEBRUARY 10

Speaker: **Warren Krueger**

Affiliation: The Lincoln Electric Co.

Topic: Power Wave equipment and wave-form technology

Activity: This Johnstown/Altoona Section program was held at the Dale Oxygen facility in Johnstown, Pa.



Shown at the Johnstown/Altoona Section program in December are (from left) District 7 Director Don Howard, Dave Nuner, Dale Anderson, Bill Krupa, speaker Mike Myers, Dave Burke, students James McConnell, Tylor Luther, Shelby Tyler, and Chairman John Kish.



Speaker Warren Krueger (right) is shown with Steve Showalter, Johnstown/Altoona Section vice chair, at the February meeting.



AWS President Victor Matthews (left) is shown with John Kish, Johnstown/Altoona Section chair, at the March meeting.



Arc welding demos attracted a lot of attention at The Ohio State University Student Chapter open house.

MARCH 10

Speaker: **Victor Matthews**, AWS president

Affiliation: The Lincoln Electric Co.

Topic: Careers in welding

Activity: The Johnstown/Altoona Section hosted its past chairmen's night program at Hoss's Restaurant in Johnstown, Pa.

The Ohio State University Student Chapter

FEBRUARY 13

Activity: The OSU Student Chapter held its annual engineering open house for high school and community college students and the general public to learn



Pam Hussen spoke on scholarship and employment opportunities at The Ohio State University Student Chapter event.



Drayton Hales (left) receives a Chattanooga Section scholarship from Don Russell.



Speaker Larry Morrison (left) is shown with Chattanooga Section Chair Bill Brooks.

more about the OSU's unique welding programs. More than 250 visitors observed the demonstrations of laser beam welding, robotic arc welding automation, metallography, computer applications, and inspection. The event included a tour of the Edison Welding Institute labs and talks presented by the students and staff. **Pam Hussen**, undergraduate student advisor, presented a talk on welding scholarship opportunities and job prospects. For information, contact Hussen at hussen.2@osu.edu; (614) 292-2545.

District 8

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CHATTANOOGA

MARCH 17

Speaker: **Larry Morrison**, training coordinator

Affiliation: United Association Plumbers and Pipefitters

Topic: Details of the UA's apprenticeship training program

Activity: In attendance were welding students from Northwestern Technical College. On hand to answer the students' questions were **James Lockhart** with the Iron Workers Local Union #704, **David Hamilton** with WEC, and **Rick Friedman** with Lincoln Electric. **Don Russell**, scholarship and AWS Foundation representative, presented a Section scholarship to **Drayton Hales**.

HOLSTON VALLEY

FEBRUARY 10

Speaker: **Gary Roberts**, welding specialist

Affiliation: Airgas-Mid-America

Topic: Welding safety

Activity: The Section updated its bylaws with the addition of an indemnification amendment. Discussions were held on the Section's Web site, a newsletter, and plans for a students' night program.

District 9

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MOBILE

FEBRUARY 12

Speakers: **Gene Webb**, **Reggie Lambert**

Affiliation: Conam Inspections and Engineering Services

Topic: Developments in nondestructive testing

Activity: The program was held at Saucy-Q Barbecue in Mobile Ala.



Mobile Section Chair Joshua Sanders (center) is shown with speakers Reggie Lambert (left) and Gene Webb.



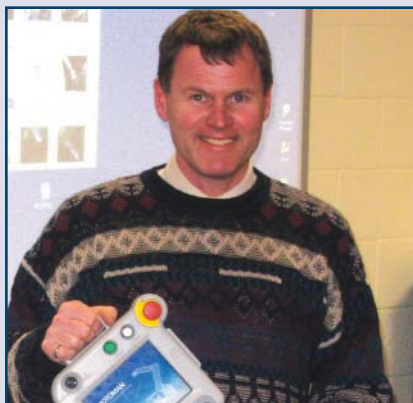
New Orleans Section Chair Matthew Howerton (left) accepts a speaker plaque from Travis Moore, a past Section chair.



Gary Roberts discussed welding safety for Holston Valley Section members and guests.



Tony DeMarco (left) accepts the 50/50 prize money from Travis Moore at the New Orleans Section raffle.



Harold Bransch demonstrated a robotic device for the CCCTC Student Chapter.

NEW ORLEANS

FEBRUARY 17

Speaker: **Matthew Howerton**, Section chair

Affiliation: The Lincoln Electric Co.

Topic: Factors affecting welding productivity

Activity: Howerton addressed how welding productivity is affected by the cost of consumables, overwelding of joints, power usage considerations, and wire selection. Eighty-three members and guests attended the meeting.

District 10

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MAHONING VALLEY & CCCTC Student Chapter

FEBRUARY 19

Speaker: **Harold Bransch**

Affiliation: Motoman

Topic: Affordable welding automation

Activity: This was a joint meeting of the Mahoning Valley Section and Columbiana County Career & Technical Center Student Chapter with 50 members and guests in attendance. The program was held at CCCTC in Lisbon, Ohio.

STARK CENTRAL

FEBRUARY 25

Speaker: **Clyde Shetler**

Affiliation: C and D Machine

Topic: Career opportunities in the metal fabrication field

Activity: This awards-presentation program was highlighted with the presentation of the prestigious AWS Image of Welding Award to **Clyde Shetler**. Shetler also received the District 10 Meritorious Award. Other presentations were made to **Gary Lazarus**: Two Section Meritorious Awards and the District 10 Director Award; **Gary Smeglia**: Private Sector Instructor Award; **Scott Burdge**: District 10 Director Award; and **Mike Medal**: District and Section Dalton E. Hamilton Certified Welding Inspector Awards. The event was held in Canton, Ohio.

District 11

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DETROIT

MARCH 12

Speaker: **Charles Orsette**, executive weld lab manager

Affiliation: Fusion Welding Solutions

Topic: Methods for improving industrial



The Detroit Section executive board toured Burtel, Inc., during its monthly meeting.

welding quality and process robustness

Activity: Fusion Welding Systems hosted the meeting at Automation & Technical Alliance Facility in Clinton Township, Mich. Fusion Welding Solutions hosted the program. President and CEO **John Inscho** attended the event.

NORTHWEST OHIO

MARCH 5

Activity: The Section members toured the Penta Career Center in Perrysburg, Ohio. Welding instructor **Earl Stevens** led the group on a tour of the welding lab that services 14 high schools in the daytime and adult education classes at night. Welding instructor **Jim Sliwinski** demonstrated a computer-controlled plasma arc cutting machine to make intricately scrolled parts used in the construction of power supply stands. Eight members and 15 students attended the tour.

District 12

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LAKESHORE

MARCH 12

Speaker: **Aaron Buchholz**, biologist

Affiliation: Wisconsin Department of Natural Resources

Topic: The history of the wolf population in northern Wisconsin

Activity: The Section held its annual ladies' night and past chairmen's night program at Machut's Restaurant in Two Rivers, Wis. **Jeff McLeod** received an appreciation plaque for his services as chairman. Other business included a revision to the Section's bylaws.

RACINE-KENOSHA

MARCH 9

Activity: The Section members met at Gateway Technical College in Elkhorn,



Shown at the Detroit Section program are (from left) John Inscho, Vice Chair John Bohr, and presenter Charles Orsette.



Jeff McLeod (left), outgoing Lakeshore Section chair, is shown with Chair Nick Freiberg.



Biologist Aaron Buchholz (left) accepts a speaker gift from Nick Freiberg, Lakeshore Section chairman.



Gateway Technical College welding students and Racine-Kenosha Section members pose for a group shot during their March program.



Shown at the Racine-Kenosha Section program are (from left) Chair Dan Crifase, presenter Bob Schuster, and Ken Karwowski, vice chair.



Craig Tichelar (left) received the Chicago Section Meritorious Award from Rick Polanin (center) District 13 director, and Chairman Hank Sima.



Peoria Section Chair Kerwin Brown is shown with speaker Scott Avis.



Shown from left are AWS President Victor Matthews, Dave Silver, District 13 Director Rick Polanin, and Chicago Section Chair Hank Sima.

Wis., to study demonstrations of stud welding presented by **Bob Schuster** of Nelson Stud Welding Inc. The 30 attendees included Racine-Kenosha Section members and welding students attending the college.

Topic: The KCC welding program
Activity: The Joliet Aurora Kankakee Section members discussed plans for the upcoming welding contest and the KCC welding rodeo events. The meeting was held at Al's Steak House in Joliet, Ill.

District 13

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CHICAGO

MARCH 11
Speaker: **Victor Matthews**, AWS president
Affiliation: The Lincoln Electric Co.
Topic: Careers in welding
Activity: **Craig Tichelar** received the Section Meritorious Award. **Dave Silver** was presented his Gold Membership Award for 50 years of service to the Society. District 13 Director **Rick Polanin** attended the program. The meeting was held at the Local Union 597 Pipe Fitters' Training Center in Mokena, Ill.

J.A.K.

MARCH 14
Speaker: **Mark Stevenson**, welding program director
Affiliation: Kankakee Community College (KCC)

PEORIA and Illinois Central College Student Chapter

FEBRUARY 18

Speaker: **Scott Avis**, component product manager
Affiliation: Caterpillar, Inc.
Topic: The use of steel castings in Caterpillar products
Activity: The members and students learned the mechanical and economic reasons for using welded castings in fabricated structures. The program was hosted by the Student Chapter Advisor **Eric Ockerhausen** and members of the Peoria Section. The Section and Student Chapter held the annual student welding contest March 19 at the Illinois Central College welding shop in Peoria, Ill., in separate divisions for high school and college-level students. The Peoria Section's annual steak fry is planned for May 1 at the Morton Optimist Club.

District 14

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AWS IS ON A MISSION

Win Great Prizes in the 2007-2008 AWS Member-Get-A-Member Campaign*

MISSION: AWS is looking for individuals to become part of an exclusive group of AWS Members who get involved and win. Give back to your profession, strengthen AWS and win great limited-edition prizes by participating in the 2007-2008 Member-Get-A-Member Campaign. By recruiting new members to AWS, you're adding to the resources necessary to expand your benefits as an AWS Member. Year round, you'll have the opportunity to recruit new members and be eligible to win special contests and prizes. Referrals are our most successful member recruitment tool. Our Members know first-hand how useful AWS Membership is, and with your help, AWS will continue to be the leading organization in the materials joining industry.



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

PRIZE CATEGORIES

President's Honor Roll: Recruit 1-2 new Individual Members and receive an AWS key chain.

President's Club: Recruit 3-8 new Individual Members and receive an American Welder™ camouflage hat and an AWS key chain.

President's Roundtable: Recruit 9-19 new Individual Members and receive an American Welder™ camouflage t-shirt, hat and an AWS key chain.

President's Guild: Recruit 20 or more new Individual Members and receive a Timex camouflage watch, an American Welder™ camouflage hat, a one-year free AWS Membership, the "Shelton Ritter Member Proposer Award" Certificate and membership in the Winner's Circle.

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

SPECIAL PRIZES

Participants will also be eligible to win prizes in specialized categories. Prizes will be awarded at the close of the campaign (June 2008).

Sponsor of the Year: The individual who sponsors the greatest number of new Individual Members during the campaign will receive a plaque, a trip to the 2008 FABTECH International & AWS Welding Show, and recognition at the AWS Awards Luncheon at the Show.

Student Sponsor Prize: AWS Members who sponsor two or more Student Members will receive an AWS key chain.

The AWS Member who sponsors the most Student Members will receive a free, one-year AWS Membership, an American Welder™ camouflage t-shirt, hat and an AWS key chain.

International Sponsor Prize: Any member residing outside the United States, Canada and Mexico who sponsors the most new Individual Members will receive a complimentary AWS Membership renewal.

LUCK OF THE DRAW

For every new member you sponsor, your name is entered into a quarterly drawing. The more new members you sponsor, the greater your chances of winning. Prizes will be awarded in November 2007, as well as in February and June 2008.

Prizes Include:

- ★ Complimentary AWS Membership renewal
- ★ American Welder™ camouflage t-shirt
- ★ American Welder™ camouflage hat

SUPER SECTION CHALLENGE

The AWS Section in each District that achieves the highest net percentage increase in new Individual Members before the June 2008 deadline will receive special recognition in the *Welding Journal*.

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

*The 2007-2008 MGM Campaign runs from June 1, 2007 to May 31, 2008. Prizes are awarded at the close of the campaign.



American Welding Society

Visit www.aws.org

SPECIAL OFFER FOR NEW AWS INDIVIDUAL MEMBERS – TWO YEARS FOR \$135 (a \$25 savings)

★ PLUS... Get a popular welding publication for only \$25 (\$192 value)

AWS MEMBERSHIP APPLICATION

4 Easy Ways to Join or Renew:

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

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

Last Name _____

First Name _____ M.I. _____

Title _____ Birthdate _____

Were you ever an AWS Member? ☐ YES ☐ NO If "YES," give year _____ and Member # _____

Primary Phone () _____ Secondary Phone () _____

FAX () _____ E-Mail _____

Did you learn of the Society through an AWS Member? ☐ Yes ☐ No

If "yes," Member's name: _____ Member's # (if known): _____

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

ADDRESS

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

Company (if applicable) _____

Address _____

Address Con't. _____

City _____ State/Province _____ Zip/Postal Code _____ Country _____

PROFILE DATA

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

- ① Who pays your dues?: ☐ Company ☐ Self-paid ② Sex: ☐ Male ☐ Female
- ③ Education level: ☐ High school diploma ☐ Associate's ☐ Bachelor's ☐ Master's ☐ Doctoral

PAYMENT INFORMATION (Required)

ONE-YEAR AWS INDIVIDUAL MEMBERSHIP\$80
TWO-YEAR AWS INDIVIDUAL MEMBERSHIP†~~\$160~~ \$135



New Member? ___ Yes ___ No

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

Domestic Members add \$25 for book selection (\$192 value), and save up to 87%†.....\$ _____ (Optional)
International Members add \$75 for book selection (note: \$50 is for international shipping) ††..\$ _____ (Optional)
(Note: Book Selection applies to new Individual Members only – Book selections on upper-right corner)

TOTAL PAYMENT\$ _____

AWS STUDENT MEMBERSHIP†††

☐ Domestic (Canada & Mexico incl.).....\$15
☐ International\$50
TOTAL PAYMENT.....\$ _____

NOTE: Dues include \$18.70 for *Welding Journal* subscription and \$4.00 for the AWS Foundation.
\$4.00 of membership dues goes to support the AWS Foundation.

Payment can be made (in U.S. dollars) by check or money order (international or foreign), payable to the American Welding Society, or by charge card.

- ☐ Check ☐ Money Order ☐ Bill Me
☐ American Express ☐ Diners Club ☐ Carte Blanche ☐ MasterCard ☐ Visa ☐ Discover ☐ Other

Your Account Number _____ Expiration Date (mm/yy) _____

Signature of Applicant: _____ Application Date: _____

Office Use Only Check # _____ Account # _____
Source Code **WJ** Date _____ Amount _____



American Welding Society

P.O. Box 440367
Miami, FL 33144-0367
Telephone (800) 443-9353
FAX (305) 443-5647
Visit our website: www.aws.org

Member Services Revised 5/4/06

†Two-year Individual Membership Special Offer: applies only to new AWS Individual Members. ††Discount Publication Offer: applies only to new AWS Individual Members. Select one of the four listed publications for an additional \$25; International Members add \$75 (\$25 for book selection and \$50 for international shipping); Multi-Year Discount: First year is \$80, each additional year is \$75. No limit on years (not available to Student Members). †††Student Member: Any individual who attends a recognized college, university, technical, vocational school or high school is eligible. Domestic Members are those students residing in North America (incl. Canada & Mexico). This membership includes the *Welding Journal* magazine. Student Memberships do not include a discounted publication. Airmail Postage Option: International Members may receive their magazines via Airmail by adding \$99 to the annual dues amount.

BOOK/CD-ROM SELECTION

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

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

- ☐ *Jefferson's Welding Encyclopedia (CD-ROM only)*
☐ *Design and Planning Manual for Cost-Effective Welding*
☐ *Welding Metallurgy*
☐ *Welding Handbook (9th Ed., Vol. 2)*

☐ New Member ☐ Renewal

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

Type of Business (Check ONE only)

- A ☐ Contract construction
B ☐ Chemicals & allied products
C ☐ Petroleum & coal industries
D ☐ Primary metal industries
E ☐ Fabricated metal products
F ☐ Machinery except elect. (incl. gas welding)
G ☐ Electrical equip., supplies, electrodes
H ☐ Transportation equip. — air, aerospace
I ☐ Transportation equip. — automotive
J ☐ Transportation equip. — boats, ships
K ☐ Transportation equip. — railroad
L ☐ Utilities
M ☐ Welding distributors & retail trade
N ☐ Misc. repair services (incl. welding shops)
O ☐ Educational Services (univ., libraries, schools)
P ☐ Engineering & architectural services (incl. assns.)
Q ☐ Misc. business services (incl. commercial labs)
R ☐ Government (federal, state, local)
S ☐ Other

Job Classification (Check ONE only)

- 01 ☐ President, owner, partner, officer
02 ☐ Manager, director, superintendent (or assistant)
03 ☐ Sales
04 ☐ Purchasing
05 ☐ Engineer — welding
20 ☐ Engineer — design
21 ☐ Engineer — manufacturing
06 ☐ Engineer — other
10 ☐ Architect designer
12 ☐ Metallurgist
13 ☐ Research & development
22 ☐ Quality control
07 ☐ Inspector, tester
08 ☐ Supervisor, foreman
14 ☐ Technician
09 ☐ Welder, welding or cutting operator
11 ☐ Consultant
15 ☐ Educator
17 ☐ Librarian
16 ☐ Student
18 ☐ Customer Service
19 ☐ Other

Technical Interests (Check all that apply)

- A ☐ Ferrous metals
B ☐ Aluminum
C ☐ Nonferrous metals except aluminum
D ☐ Advanced materials/Intermetallics
E ☐ Ceramics
F ☐ High energy beam processes
G ☐ Arc welding
H ☐ Brazing and soldering
I ☐ Resistance welding
J ☐ Thermal spray
K ☐ Cutting
L ☐ NDT
M ☐ Safety and health
N ☐ Bending and shearing
O ☐ Roll forming
P ☐ Stamping and punching
Q ☐ Aerospace
R ☐ Automotive
S ☐ Machinery
T ☐ Marine
U ☐ Piping and tubing
V ☐ Pressure vessels and tanks
W ☐ Sheet metal
X ☐ Structures
Y ☐ Other
Z ☐ Automation
1 ☐ Robotics
2 ☐ Computerization of Welding



Bobby Coffey (right) receives the Section Instructor of the Year Award from James Maddox, Lexington Section vice chair.

INDIANA

FEBRUARY 19

Activity: The Section members took a three-hour tour of Major Tool & Manufacturing in Indianapolis, Ind. The facility employs 60 welders and four welding engineers working on a variety of projects for national defense, aerospace, nuclear, and power-generation industries. **Matt Vislay**, manager of fabrication, conducted the tour.

LEXINGTON

FEBRUARY 26

Speakers: **Robert Smith**, **Ed Varekozis**

Affiliation: The Lincoln Electric Co.

Topic: Flux cored arc welding

Activity: **Bobby Coffey** received the Section Instructor of the Year Award. The Section Meritorious Award was presented to **Karl Watson**, an instructor at Somerset C.C. **Delora McGuire** received a \$500 Section scholarship award to continue her studies at Somerset C.C. The program was held at Bluegrass Community College in Lexington, Ky.

District 15

Mace V. Harris, director

(612) 861-3870

macevh@aol.com

NORTHWEST

FEBRUARY 18

Activity: The Section held its annual Behind the Mask contest at St. Cloud Technical College in St. Cloud, Minn., coordinated by **Pam Lesemann**. Forty-seven contestants competed in projects involving the GTA, GMA, and SMA welding processes. Assisting were welding instructor **Eric McAllister**, Section Chair **Todd Bridigum**, and **Matt Roszak**. **Trevor Larson** took first place in GTAW and GMAW-P, and **Nick Wuertz** won first place for SMAW.



Shown at the J.A.K. Section program are from left (front row) speaker Mark Stevenson, Mike Spangler, and Secretary Zach Awad; (back row) Bryce Kale and Chair John Willard.



Ed Varekozis (left) and Robert Smith discussed welding at the Lexington Section program.



Karl Watson (right) receives the Section Meritorious Award from James Maddox, Lexington Section vice chair.



Shown at the Northwest Section Behind the Mask contest are (from left) Eric McAllister, Trevor Larson, Pam Lesemann, Nick Wuertz, Matt Roszak, and Chairman Todd Bridigum.

District 16

David Landon, director

(641) 621-7476

dlandon@vermeerimg.com

KANSAS CITY

JANUARY 8

Speaker: **Dick Blaisdell**, retired

Topic: How to prepare effective written welding procedures (WPS)



Shown at the Nebraska Section program are (front, from left) Monty Rodgers, Karl Fogelman, and Nick Weidenbach; (standing, from left) are Zach Meyers, Betzabel Castor-Diaz, Harrison Bernhagea, Brian Moeller, Brando Weis, Cody Pettigrew, and Cesar Tarango.



Dennis Pickering (left), speaker and chairman of the Central Arkansas Section, is shown with Jay Glass, a welding instructor at South Arkansas Community College.

Activity: Carolyn Bunch of the Youthful Offender Registered Apprenticeship Program explained how the program operates. This Kansas City Section meeting was held at Johnny C's Restaurant in Kansas City, Mo.

NEBRASKA

FEBRUARY 20

Activity: The Section members and Praxair donated more than \$1200 worth of leather welding aprons, gloves, and sleeves to Freemont High School in Omaha, Neb. Welding instructor Brian Moeller accepted the gifts on behalf of the school and his 90 students. He acknowledged the supplies would benefit the students in his metal fabrication classes for many years to come.

District 17

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



"First Lady" Sally and President Victor Matthews sport the headgear presented to them at the East Texas Section and LeTourneau University Student Chapter meeting.

CENTRAL ARKANSAS

FEBRUARY 19

Speaker: Dennis Pickering, Section chair
 Affiliation: Arkansas Career Training Institute

Topic: The Image of Welding Awards and the American Welding Society

Activity: The program was held at South Arkansas Community College in El Dorado, Ark.

EAST TEXAS-LeTourneau University Student Chapter

FEBRUARY 19

Speaker: Victor Matthews, AWS president

Affiliation: The Lincoln Electric Co.

Topic: Careers in the welding industry

Activity: District 17 Director J. Jones presented Matthews a presidential cowboy hat and a "First Lady" hard hat to Sally Matthews. Seventy-two Section and Student Chapter members attended the event, held at LeTourneau University in Longview, Tex.



J. Jones (left), District 17 director, chats with Vic Matthews, AWS president, at the East Texas Section meeting.

District 18

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

RIO GRANDE VALLEY

MARCH 4

Activity: The new Section organization business meeting was conducted by George Baldree, a welding engineer at Keppel AmFELS, Inc., Brownsville, Tex. Elected to the activation committee are George Baldree, chairman; Janie Solano and Ramon Pizana, vice chairs; Ray Rivera, secretary; and Richard Salinas, treasurer. In attendance were District 18 Director John Bray and Ellery Francisco, District 18 deputy chair and chairman of the Corpus Christi Section. Forty-five people attended the event.

SAN ANTONIO Alamo Student Chapter

MARCH 10

Speaker: John Bray, District 18 director
 Affiliation: Affiliated Machinery, Inc., president

Topic: District 18 activities update

Activity: Bray discussed plans for the upcoming District 18 conference and an update on the new Rio Grande Valley Section. AWS Vice President John Mendoza and members of the Alamo Student Chapter, Alfonso Rodriguez, advisor, attended the program. The meeting was held at The Little Red Barn Steak House in San Antonio, Tex.

District 19

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

ALASKA

FEBRUARY 20

Speaker: Bruce Jaffa, quality control
 Affiliation: Jaffa Construction, Inc.

Topic: Alaska's boilermaker

Activity: Jaffa discussed his company's history from an ornamental steel fabrication company into a provider of a wide range of construction for electrical power



Speaker Sil Nonis (left) is shown with Brad Moe, vice chair, British Columbia Section.

generation plants, at the Clean Coal facility in Healy, Alaska, and the Bradley Lakes hydroelectric project near Homer, Alaska. The meeting was held at AVTEC in Seward, Alaska. Attendees included students from local structural and pipe certification programs.

BRITISH COLUMBIA

FEBRUARY 19

Speaker: **Sil Nonis**, senior sales manager
Affiliation: Red-D-Arc Specialty Products

Topic: Induction heating

Activity: The program was held at Red-D-Arc Welderentals in Delta, B.C., Canada.

District 20

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

ALBUQUERQUE

FEBRUARY 18

Activity: **Mike Thomas**, program chair, conducted a program to inform 50 students from the welding programs at Eastern New Mexico University — Roswell (ENMU-R) and Clovis Community College about the District scholarship opportunities. **Dusty Heritage**, ENMU assistant VP, received the Section Educator Award for her contributions to welding education.

IDAHO/MONTANA

FEBRUARY 19

Activity: The Section members toured the Montana Tech's new welding facility in Butte, Mont. **Bruce Madigan**, professor of welding engineering, made a presentation and conducted the tour. **Dale Detrich** of NIST's Montana Manufacturing Center in Billings, Mont., discussed some of the industries he assists in the Billings area.



Elected to the Rio Grande Valley Section activation committee are (from left) Richard Salinas, Chairman George Baldree, Janie Solano, Ramon Pizaña, and Ray Rivera.



Alaska Section members are shown at the February program.



Speaker District 18 Director John Bray (right) is shown with Hamp Drew, chairman of the San Antonio Section.



Bruce Madigan (left) and Dale Detrich made presentations at the Idaho/Montana Section program.



District 18 Director John Bray is shown at the Rio Grande Valley Section meeting.



Mike Thomas presents Dusty Heritage the Albuquerque Section Educator Award.

District 21

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

LONG BEACH/ORANGE CTY.

FEBRUARY 19

Activity: Past AWS President **Gene Lawson** and **Paul Anderson**, both of ESAB Welding and Cutting Products, discussed welding as a profession and demonstrated several ESAB products. The meeting was held at Orange Coast College in Costa Mesa, Calif.



Shown at the Long Beach/Orange County program are (from left) Ross Bumcrot, Bill Galvery, presenter Gene Lawson, Diana Valdez, Richard Hutchison, and Winford Sartin.

L.A./INLAND EMPIRE

FEBRUARY 24

Speaker: **Victor Matthews**, AWS president

Affiliation: The Lincoln Electric Co.

Topic: AWS goals for 2009

Activity: Attending were AWS Past President **Gene Lawson**, District 21 Director **Nan Samanich**, Chairman **George Rolla**, **Kenneth Reid**, chairman of the Los Angeles Trade-Technical College Student Chapter, and **Sandra Schreiner** Student Chapter representative.



The San Fernando Valley Section members toured Liberty Inspection in February.

SAN FERNANDO VALLEY

FEBRUARY 26

Activity: **Ed Dunn**, president, and **Kevin Dunn**, vice president, conducted the Section members on a tour of Liberty Inspection Co., Inc., in Simi Valley, Calif., to study its nondestructive testing operations. Featured were presentations on radiography, dye penetrant, magnetic particle, and passivation technologies.

District 22

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

SACRAMENTO VALLEY

JANUARY 21

Activity: The Section members toured the facilities of Transfer Flow Inc., a manufacturer of aftermarket and original fuel tanks and fuel systems for Ford Motor Co., National RV, U-Haul, UPS, and other firms. **Mark Forwalter** conducted the program.



Shown at the San Francisco Section program are (from left) Chair Liisa Pine, Secretary James Bulgerin, and speaker Mario Lento.



Shown at the Sacramento Valley Section tour of Transfer Flow Inc. are Mark Forwalter (left) and Chairman Don Robinson.

SAN FRANCISCO

MARCH 4

Speaker: **Mario Lento**, product specialist

Affiliation: Berkeley Process Control, Inc.

Topic: Development of a remote welding system for sealing spent nuclear fuel storage casks

Activity: The program was held at Spenger's Restaurant in Berkeley, Calif.



Kenneth Reid is shown with Sandra Schreiner at the Los Angeles/Inland Empire meeting.



Speaker Mario Lento chats with Liisa Pine, San Francisco Section chair.

Guide to AWS Services

American Welding Society

550 NW LeJeune Rd., Miami, FL 33126
www.aws.org; (800/305) 443-9353; FAX (305) 443-7559
 Staff telephone extensions are shown in parentheses.

AWS PRESIDENT

Victor Y. Matthews
vic_matthews@lincolnelectric.com
 The Lincoln Electric Co.
 7955 Dines Rd.
 Novelty, OH 44072

ADMINISTRATION

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Cassie R. Burrell.. cburrell@aws.org(253)

Senior Associate Executive Director
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Executive Assistant for Board Services
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Armando Campana.. acampana@aws.org ... (296)

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Natalia Swain.. nswain@aws.org(245)

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Luisa Hernandez.. luisa@aws.org(266)

Manager, Human Resources
Dora A. Shade.. dshade@aws.org(235)

INT'L INSTITUTE of WELDING

Senior Coordinator
Sissibeth Lopez.. sissi@aws.org(319)
 Provides liaison services with other national and international professional societies and standards organizations.

GOVERNMENT LIAISON SERVICES

Hugh K. Webster.. hwebster@wc-b.com
 Webster, Chamberlain & Bean, Washington, D.C., (202) 785-9500; FAX (202) 835-0243. Identifies funding sources for welding education, research, and development. Monitors legislative and regulatory issues of importance to the welding industry.

CONVENTION and EXPOSITIONS

Senior Associate Executive Director
Jeff Weber.. jweber@aws.org(246)

Corporate Director, Exhibition Sales
Joe Krall.. jkrall@aws.org(297)
 Organizes the annual AWS Welding Show and Convention, regulates space assignments, registration items, and other Expo activities.

Brazing and Soldering Manufacturers' Committee

Jeff Weber.. jweber@aws.org(246)

RWMA — Resistance Welding Manufacturing Alliance

Manager
Susan Hopkins.. susan@aws.org(295)

WEMCO — Welding Equipment Manufacturers Committee

Manager
Natalie Tapley.. tapley@aws.org(444)

PUBLICATION SERVICES

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Andrew Cullison.. cullison@aws.org(249)

Welding Journal

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National Sales Director
Rob Saltzstein.. salty@aws.org(243)

Society and Section News Editor
Howard Woodward.. woodward@aws.org .(244)

Welding Handbook

Welding Handbook Editor
Annette O'Brien.. aobrien@aws.org(303)
 Publishes the Society's monthly magazine, *Welding Journal*, which provides information on the state of the welding industry, its technology, and Society activities. Publishes *Inspection Trends*, the *Welding Handbook*, and books on general welding subjects.

MARKETING COMMUNICATIONS

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Webmaster
Angela Miller.. amiller@aws.org(456)

MEMBER SERVICES

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Cassie R. Burrell.. cburrell@aws.org(253)

Director
Rhenda A. Mayo.. rhenda@aws.org(260)
 Serves as a liaison between Section members and AWS headquarters. Informs members about AWS benefits and activities.

CERTIFICATION SERVICES

Department Information(273)

Managing Director, Certification Operations
John Filippi.. jfilippi@aws.org(222)

Managing Director, Technical Operations
Peter Howe.. phowe@aws.org(309)
 Manages and oversees the development, integrity, and technical content of all certification programs.

Director, Int'l Business & Certification Programs
Priti Jain.. pjain@aws.org(258)
 Directs all int'l business and certification programs. Is responsible for oversight of all agencies handling AWS certification programs.

EDUCATION SERVICES

Managing Director
Dennis Marks.. dmarks@aws.org(449)

Director, Education Services Administration and Convention Operations

John Ospina.. jospina@aws.org(462)

AWS AWARDS, FELLOWS, COUNSELORS

Senior Manager
Wendy S. Reeve.. wreeve@aws.org(293)
 Coordinates AWS awards and AWS Fellow and Counselor nominees.

TECHNICAL SERVICES

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 Int'l Standards Activities, American Council of the Int'l Institute of Welding (IIW)

Director, National Standards Activities
John L. Gayler.. gayler@aws.org(472)
 Personnel and Facilities Qualification, Computerization of Welding Information

Manager, Safety and Health
Stephen P. Hedrick.. stevhe@aws.org (305)
 Metric Practice, Safety and Health, Joining of Plastics and Composites, Welding Iron Castings

Technical Publications
 AWS publishes about 200 documents widely used throughout the welding industry.

Senior Manager
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Staff Engineers/Standards Program Managers
Annette Alonso.. aalonso@aws.org(299)
 Automotive Welding, Resistance Welding, Oxygen Gas Welding and Cutting, Definitions and Symbols, Sheet Metal Welding

Stephen Borrero.. sborrero@aws.org(334)
 Joining of Metals and Alloys, Brazing and Soldering, Brazing Filler Metals and Fluxes, Brazing Handbook, Soldering Handbook

Rakesh Gupta.. gupta@aws.org(301)
 Filler Metals and Allied Materials, Int'l Filler Metals, Instrumentation for Welding, UNS Numbers Assignment

Brian McGrath.. bmcgrath@aws.org(311)
 Methods of Inspection, Mechanical Testing of Welds, Welding in Marine Construction, Piping and Tubing

Selvis Morales.. smorales@aws.org(313)
 Welding Qualification, Structural Welding

Matthew Rubin.. mrubin@aws.org(215)
 Aircraft and Aerospace, Machinery and Equipment, Robotics Welding, Arc Welding and Cutting Processes

Reino Starks.. rstarks@aws.org(304)
 Welding in Sanitary Applications, High-Energy Beam Welding, Friction Welding, Railroad Welding, Thermal Spray

Note: Official interpretations of AWS standards may be obtained only by sending a request in writing to the Managing Director, Technical Services. Oral opinions on AWS standards may be rendered. However, such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

Nominees for National Office

Only Sustaining Members, Members, Honorary Members, Life Members, or Retired Members who have been members for a period of at least three years shall be eligible for election as a director or national officer.

It is the duty of the National Nominating Committee to nominate candidates for national office. The committee shall hold an open meeting, preferably at the Annual Meeting, at which members may appear to present and discuss the eligibility of all candidates.

To be considered a candidate for the positions of president, vice president, treasurer, or director-at-large, the following qualifications and conditions apply:

President: To be eligible to hold the office of president, an individual must have served as a vice president for at least one year.

Vice President: To be eligible to hold the office of vice president, an individual must have served at least one year as a director, other than executive director and secretary.

Treasurer: To be eligible to hold the

office of treasurer, an individual must be a member of the Society, other than a Student Member, must be frequently available to the national office, and should be of executive status in business or industry with experience in financial affairs.

Director-at-Large: To be eligible for election as a director-at-large, an individual shall previously have held office as chairman of a Section; as chairman or vice chairman of a standing, technical, or special committee of the Society; or as a District director.

Interested persons should submit a letter stating which office they seek, including a statement of qualifications, their willingness and ability to serve if nominated and elected, and a biographical sketch.

E-mail the letter to Gricelda Manalich, gricelda@aws.org, c/o Gene Lawson, chair, National Nominating Committee.

The next meeting of the National Nominating Committee is scheduled for November 2009. The terms of office for candidates nominated at this meeting will commence January 1, 2011.

Honorary Meritorious Awards

The Honorary Meritorious Awards Committee makes recommendations for the nominees presented to receive the Honorary Membership, National Meritorious Certificate, William Irrgang Memorial, and the George E. Willis Awards. These honors are presented during the FABTECH International & AWS

Welding Show held each fall. The deadline for submissions is December 31 prior to the year of the awards presentations. Send candidate materials to Wendy Sue Reeve, secretary, Honorary Meritorious Awards Committee, wreeve@aws.org; 550 NW LeJeune Rd., Miami, FL 33126. Descriptions of these awards follow.

William Irrgang Memorial Award

Sponsored by The Lincoln Electric Co. in honor of William Irrgang, the award, administered by AWS, is given each year 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.

George E. Willis Award

Sponsored by The Lincoln Electric Co. in honor of George E. Willis, the award, administered by AWS, is given each year 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 and a certificate.

Honorary Membership Award

The honor is presented to a person of acknowledged eminence in the welding

profession, or to one who is accredited with exceptional accomplishments in the development of the welding art, upon whom the Society deems fit to confer an honorary distinction. Honorary Members have full rights of membership.

National Meritorious Certificate Award

This certificate 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.

International 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 awardee is not required to be an AWS member. Multiple awards may be given. The award consists of a certificate and a one-year AWS membership.

AWS Publications Sales

Purchase AWS standards, books, and other publications from **World Engineering Xchange (WEX), Ltd.**
orders@awspubs.com; www.awspubs.com
Toll-free (888) 935-3464 (U.S., Canada)
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Welding Journal Reprints

Copies of *Welding Journal* articles may be purchased from Ruben Lara.
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AWS Foundation

AWS Foundation, Inc., is a not-for-profit corporation established to provide support for educational and scientific endeavors of the American Welding Society. Information on gift-giving programs is available upon request.

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AWS Mission Statement

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

It is the intent of the American Welding Society to build AWS to the highest quality standards. Your suggestions are welcome. Please contact any staff member or AWS President Victor Y. Matthews, as listed on the previous page.



THE AWS WELDER MEMBERSHIP

EXCLUSIVELY FOR WELDERS

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- ★ The Welder's Exchange bulletin board on the AWS web site
- ★ and more...

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



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Visit: www.aws.org/membership

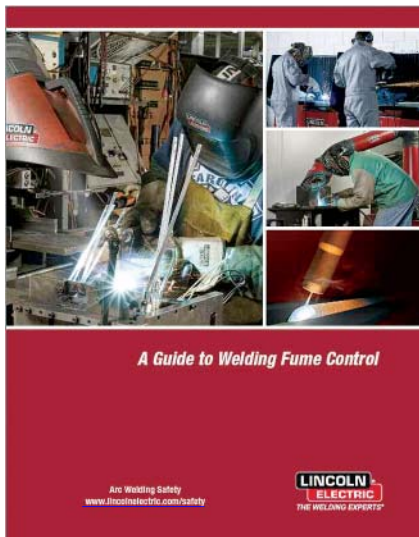


American Welding Society

NEW

LITERATURE

Fume Control Guide for Engineers Released



The four-page, full-color *A Guide to Welding Fume Control* offers practical information for providing a safer workplace.

The centerpiece is the company's welding fume control methodology presented in graphic format to assist engineers in determining what must be done to ensure a healthier workplace. The chart considers regulatory assessment, exposure determination, engineering controls, safe work practice controls, and personal protective equipment. One page considers methods for controlling the employees' route of exposure to fume with advice on monitoring, training, and equipment maintenance. Also described are support literature available free from the company. The PDF document can be downloaded from the company's Web site; search for publication MC08-67; or call for a hard copy.

The Lincoln Electric Co.
www.lincolnelectric.com
(216) 481-8100

Welding Accessories Catalog Updated

A 33-page, 2009–2010 welding acces-



sories catalog pictures and describes the company's lines of electrode holders and replacement parts, ground clamps, cable connectors, machine plugs and GTA adapters, stud and terminal connectors, power output terminals, cable lugs, splicers, heat shrink and Swed-On tool,

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chipping hammers, electrode stabilizing rod ovens, welding blankets, pneumatic tools, circle burners, cylinder wrenches, antispatter, wire lube pads, nozzle gel, and Spray-Galv. Included are the company's line of dent-pulling systems and Lencospot® resistance spot welding machines. For easy reference, a four-page item code index lists hundreds of products by item code number, company model number, and catalog page number.

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Welding Torches Pictured in Catalog



A 264-page catalog illustrates and describes the company's comprehensive lines of welding torches and guns, wire straighteners, wire feeders, regulators and flowmeters, gauges, spool guns, portable cutting and beveling machines, drive rolls, hand controllers, positioners, plasma coolant, cable covers, air regulators, compressed air filters, contactors, gas and water hoses. Included are myriad accessories and replacement parts to fit many popular brands of welding equipment.

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Laser Safety Spec Revised

The recently released 56-page Z136.5-2009, *Safe Use of Lasers in Educational Institutions*, applies the requirements of ANSI Z136.1, *Safe Use of Lasers*, to the unique environments associated with educational institutions, including teaching laboratories, classrooms, lecture halls, sci-

ence fairs, and science museums that have lasers incorporated into their educational process. It is intended for staff and students using lasers for academic instruction in university, college, secondary, or primary educational facilities. It represents a significant revision to the 2000 edition, which it replaces. Other significant revisions can be seen in the laser laboratory layouts, standard operating procedures, figures, and tables. The Definitions section has been updated with some terms

being redefined and the addition of many new terms and definitions. The standard is intended to be used with Z136.1-2007, *Safe Use of Lasers*, the 276-page, soft-bound parent document of the series. The two-document set may be purchased online or ordered by phone for \$260 list, \$225 for Institute members.

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NEMA Graphic Symbols for Arc Welding Published

EW 4-2009 - 24 - © 2009, NEMA				
NO.	SYMBOL	FUNCTION, KEYWORD OR PHRASE	APPLICATION	SOURCE(S)*
#7b		SUBMERGED ARC WELDING (SAW)	Signifies the SAW process, function, or control	IEC 60974-1-55
#7a		GAS TUNGSTEN ARC WELDING (GTAW) / TUNGSTEN INERT GAS (TIG) WELDING	Signifies the GTAW/TIG process, function, or control	ISO 7000-0462
#7b		GAS TUNGSTEN ARC WELDING (GTAW) / TUNGSTEN INERT GAS (TIG) WELDING	Signifies the GTAW/TIG process, function, or control	IEC 60974-1-52
#2		AIR CARBON ARC GOUGING	Signifies air carbon arc gouging	IEC 60974-1-50
#3		PLASMA ARC CUTTING (PAC)	Signifies the PAC process, function, or control	ISO 7000-0479
#4		PLASMA ARC WELDING (PAW)	Signifies the PAW process, function, or control	ISO 7000-0479
#5		PLASMA ARC GOUGING (PAG)	Signifies the PAG process, function, or control	IEC 60974-1-50

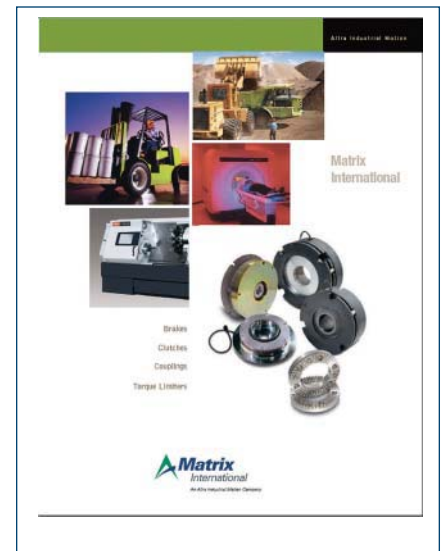
Just released, the 65-page NEMA Standards Publication EW 4-2009, *Graphic Symbols for Arc Welding and Cutting Apparatus*, provides manufacturers and users of arc welding and cutting equipment with a system of 217 graphic sym-

bols that can be used and recognized throughout the industry. Included are symbols used to identify controls, indicators, connection points, operations, functions, commands, and processes. It does not cover graphic symbols used to alert personnel of immediate or potential personal hazards in the use of the equipment. This edition adds symbols from Annex L of IEC 60974-1 and uses an international style that harmonizes with ISO/IEC documentation methods. Each graphic is listed with its function, keyword or phrase, an application description, and the reference source(s). Visit the Web site to download the PDF edition free of charge, or order the hard copy for \$114.

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Brochure Details Brakes and Clutches

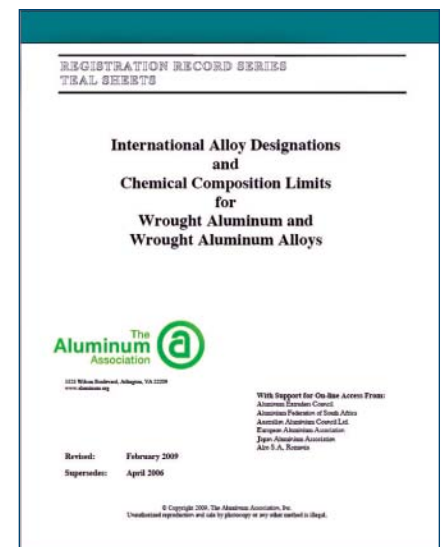
An eight-page, full-color brochure details the company's engineering, testing, and research capabilities, plus highlights eight key product lines: off-highway vehi-



cle brakes; clutches and torque limiters; winch, crane, and marine products; machine tool face tooth couplings; forklift truck brakes; servo motor brakes; pneumatic clutches and brakes; and custom design units. To download the PDF brochure, visit its Web site then click the Literature tab.

Matrix International
www.matrix-international.com
(815) 389-3771

Updated Aluminum Alloy Designations Published



The 29-page, 2009 edition of *International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys*, known as the "Teal Sheets," supersedes the 2006 edition. Featured are 23 new alloy designations and their associated chemical composition limits, including the

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calculated densities of the registered alloys. The document composition tables have been reformatted to improve readability. Included are nearly 500 designations and chemical composition limits for wrought aluminum and wrought aluminum alloys, a table of nominal densities for the registered alloys, and a list of previously registered but currently inactive alloy designations. The hard copy may be ordered from www.aluminum.org/bookstore. The price is \$40 list, \$20 for association members. To download the document free of charge, visit the Web site below.

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Safety Products Catalog Now Smaller and Better

The company's smaller (116 pages) S-27, *Safety, Facility, and Equipment Identification Catalog*, eliminates a lot of the product information and focuses on safety and identification solutions including compliance, lockout/tagout, visual workplace, and slips, trips, and falls. The reor-



ganization makes it easier to understand the company's differentiated products, processes, and services that are better illustrated and described online. Catalog 27 and other publications can be requested online at the listed Web site.

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About AWS Corporate Memberships:

The American Welding Society (AWS), understands that one size does not fit all. For that reason, we've created FOUR different levels of corporate membership, starting for as little as \$150 per year, allowing you to select a program that best fits with the way your company operates. With an 88-year history in the welding industry, and 50,000+ members worldwide, AWS Corporate Membership offers your company the ability to **INCREASE ITS EXPOSURE** and **IMPROVE ITS COMPETITIVE POSITION.**


American Welding Society

Contact Us:

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(800) 443-9353, EXT. 480, OR (305) 443-9353, EXT. 480.
OR VISIT US ON-LINE AT WWW.AWS.ORG/MEMBERSHIP.

PERSONNEL

Retro Systems Appoints Regional Managers



Randall J. Damas



Kelly Craft

Retro Systems, Valley Center, Kan., a manufacturer of CNC profile cutting machines for the oxyfuel and plasma arc cutting processes, has appointed **Randall J. Damas** and **Kelly Craft** regional managers. Damas, based in Cleveland, Ohio, will service sales from Michigan to Maine and the Canadian Province of Ontario eastward. Craft will manage sales in the southeastern United States.

Alloy Products VP Named at Wall Colmonoy



Craig Johnson

as commercial director for the Group.

Wall Colmonoy, Madison Heights, Mich., has appointed **Craig Johnson** to vice president, Alloy Products Group, responsible for the sales and marketing functions. Johnson, with the company for more than 20 years, most recently served

VP Operations Named at Bishop-Wisecarver



Mike Citro

operations for Micropump for 11 years and as director of operations and general manager at Tuthill Pump Group for nine years.

Bishop-Wisecarver Corp., Pittsburg, Calif., manufacturer of DualVee® wheel-guided linear motion systems, has named **Mike Citro** VP of operations. Citro previously owned his own manufacturing business for 20 years, and served as director of

RathGibson Taps Sales VP



Kirk Thorne

Thorne worked for Lennox International in a number of high-level executive and managerial positions.

RathGibson, Lincolnshire, Ill., a manufacturer of welded, welded and drawn, and seamless stainless steel, nickel, and titanium tubing, has appointed **Kirk Thorne** vice president, sales and marketing. Prior to joining the company,

COO Named at CMW

CMW Inc., Indianapolis, Ind., a manu-



Eric Krepps

in Asia, Mexico, and other countries.

factory of highly engineered metal alloys and composites, has appointed **Eric L. Krepps** chief operating officer. Krepps previously held leadership positions with Eaton/Aeroquip, Sanmina-SCI, and Faurecia Systems managing operations

PFERD of Canada Fills General Manager Post



Mark Crump

pointed to fill the newly created position of general manager, PFERD of Canada. Crump previously worked for 15 years at Kennametal U.K. Ltd. as distributor development manager, based in London.

August Rüggeberg GmbH & Co., Marienheide, Germany, manufacturer of PFERD abrasives, power tools, and other products, recently established a new distribution service center in Toronto, Ont., Canada. **Mark Crump** has been ap-

Taylor Hobson Names Managing Director



Craig Howarth

for Hanovia, a manufacturer of UV-based water-disinfection equipment.

Taylor Hobson, Leicester, England, a manufacturer of ultrahigh-precision industrial metrology and nanotechnology instrumentation, has named **Craig Howarth** managing director. Previously, Howarth served as managing director

Showa-Best Glove Signs on Technical Manager

Showa-Best Glove, Menlo, Ga., a supplier of hand protection for industrial and

— continued on page 98

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The Emmet A. Craig Resistance Welding School

Sponsored by the American Welding Society and the Resistance Welding Manufacturing Alliance (RWMA)

is coming to Chicago!

**Tuesday & Wednesday,
November 17 & 18, 2009
at the**

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Topics to be covered:

Introduction & Basics of
Resistance Welding

Electrodes and Tooling

Welding Controls

Electrical Power Systems

Welding Processes & Machines

Troubleshooting and Maintenance

Initial Machine Set-Up

Each year, this two-day resistance welding school is attended by seasoned professionals, shop supervisors, production managers, electrical engineers, and mechanical engineers. Sessions on the basics of resistance welding and real-life applications of the process are conducted by industry specialists with extensive resistance welding experience. Participants are able to learn at their own pace, discuss specific welding concerns with the instructors, and are invited to bring their own samples for discussion. In addition, attendees can visit with RWMA-member companies during a tabletop exhibit reception to learn about the latest resistance welding products being offered.

For the latest information on the RWMA Welding School visit our website at www.aws.org/show/rwma.html or call 800-443-9353, ext. 455

To register online, go to www.aws.org/show/rwma.html and click on **REGISTER**



A STANDING COMMITTEE OF
American Welding Society®



Neil Redpath

medical markets, has named **Neil Redpath** technical/research and development manager. Redpath previously had global responsibility for nitrile glove polymer applications development and customer support for Dow Reichhold Specialty Latex LLC.

Laser Design and GKS Inspection Fill Key Post



Giles Gaskell

Laser Design, Inc., and GKS Inspection Services, Detroit, Mich., providers of 3-D laser scanning systems and services, has appointed **Giles Gaskell** business development manager. After founding companies in the UK and Italy, Gaskell moved

to the United States in 2005 where he most recently served as director of business development for NVision Inc.

Veridiam Names CEO



Andrew Gale

Veridiam, San Diego, Calif., a manufacturer of build-to-print metal tubing, components, and assemblies for the power-generation, aerospace, and other industries, has named **Andrew Gale** chief executive officer, replacing **Neal Nord-**

strom who remains with the company in an executive capacity. Gale, with 25 years of experience, most recently was president and CEO of C-Tech Industries.

Dinh Selected INL Fellow



Nam Truc Dinh

Nam Truc Dinh has been selected as an Idaho National Laboratory Fellow in recognition of his 20 years of research and development as a nuclear safety engineer. Dinh was cited for his "significant impact on the resolution of several safety issues

in Light Water Reactor safety and played a principal role in the severe accident

Obituary

Robert 'Bob' Peaslee



Robert Leon "Bob" Peaslee, 92, an AWS Fellow, a Life Member, and world-renowned nickel brazing expert, died March 5 at his home in Rochester, Mich. At the time, he was working as a brazing consultant for Wall Colmonoy Corp. (WCC).

Born in Milwaukee, Wis., he earned a degree in chemical engineering at the University of Cincinnati in 1940. During WW II, he worked at Curtiss Wright Corp. as a metallurgist where he became welding engineer in charge of fabrication development on jet engines. It was there Peaslee invented a process for high-temperature furnace brazing jet engine parts using Colmonoy 6, a nickel alloy. The process he developed is now known as diffusion brazing.

In 1950, he joined WCC where he further developed high-temperature and high-quality structural brazing techniques for use throughout the jet engine industry. He established the first commercial job shop for nickel brazing aircraft components and was instrumental in expanding the operation in eight facilities.

Peaslee conducted his first brazing conference in London, UK, in 1969. The success of that three-day, two-night seminar prompted Peaslee and the AWS C3 Committee on Brazing and Soldering to initiate the first annual International Brazing Conference at the 1970 AWS Welding Show held in Cleveland, Ohio, for 160 attendees. In 1999, the International Brazing and Soldering Conference (IBSC) became a stand-alone event held every third year.

In 1970, Peaslee established the Wall Colmonoy Modern Furnace Brazing course and served as the main instructor for more than 35 years. He also taught the ASM Brazing Technology course from 1973 to 1996.

Peaslee is well known for his *Brazing Q & A* column that ran bimonthly in the *Welding Journal* for many years. A compilation of these columns, *Brazing Footprints: Case Studies in High-Temperature Brazing*, published in 2003, is available from Wall Colmonoy Press. He initiated the work on *Brazing Handbook* and was a major contributor to all five editions. He also initiated work on the *Soldering Handbook* in the 1950s.

He served as chair of the C3 Committee, and was a member of A2 Committee on Definitions and Symbols, A5 Committee on Filler Metals and Allied Materials, A5X Executive Committee, A5H Subcommittee on Filler Metals and Fluxes for Brazing, B2A Subcommittee on Brazing Qualifications, and committee groups with American Society of Mechanical Engineers and the American Chemical Society. In 1991, he received the AWS Comfort A. Adams Lecture Award.

At the AWS Detroit Section he founded the Brazing and Soldering Division and served as chair 1985-1987 and 1999-2003. In 2004, the Robert L. Peaslee Scholarship Fund was established by Peaslee and the Detroit Brazing and Soldering Division to annually benefit a college student majoring in the brazing, welding, or materials science field.

Peaslee is survived by his son, Robert II, two grandchildren, and five great grandchildren.

treatment and passive safety design in the GE-Hitachi's Economic Simplified Boiling Water Reactor plant design."

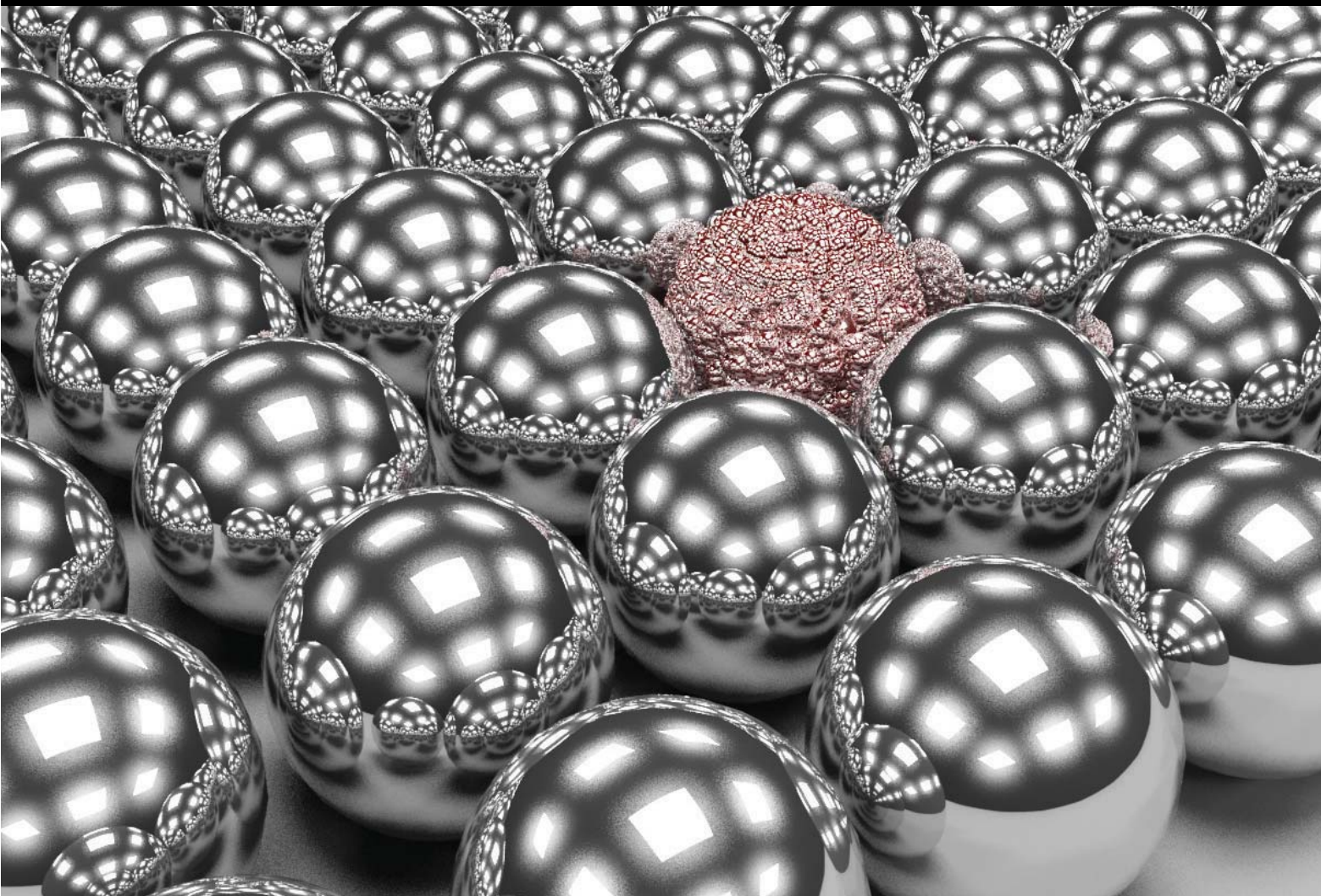
Three Tapped for ASM Thermal Spray Hall of Fame

On May 4 in Las Vegas, Nev., the ASM Thermal Spray Society will induct **Daryl E.**

Crawmer, Akira Nakahira, and Anatolii N. Papyrin into its Hall of Fame. Crawmer is director of technology for Thermal Spray Technologies, Inc., in Sun Prairie, Wis. Nakahira is chairman and CEO of TOCALO Co., Ltd., and president of the Japan Thermal Sprayers Assn. Papyrin is president of Cold Spray Technology, LLC, in Albuquerque, N.Mex.

Welding Corrosion Resistant Alloys Conference

Chicago, November 18th, 2009



Welding Corrosion Resistant Alloys Takes Center Stage. Find answers to the unknown and discover new processes.

The interest level is extraordinarily high when it comes to the welding of corrosion-resistant alloys. There are many reasons for this. One is the entry of the duplex stainless steels and other high-performance grades. Another is the unstable prices in nickel, molybdenum and titanium. When the price of nickel hit the roof, many fabricators switched from 316 to 201 stainless because of the latter grade's lower nickel content. Research is feverish throughout the world in the development of new and cheaper methods of producing titanium. Will a lower cost titanium make the metal more popular?

The overall activity is immense. Cladding and strip overlay processes have become more popular means of protecting parts exposed to heavy corrosion. Duplex stainless is now being welded for over-the-road tankage. New processes, like friction stir welding and the more

advanced thermal stir welding out of NASA will be discussed as well. Also, improvements in weld properties are being realized by increasing the weld interpass temperatures for conventional austenitic stainless steels.

Keep abreast of this exciting new world in welding where corrosion-resistant alloys have taken center stage. Mark your calendar for November 18, 2009, at the FabTech International and AWS Welding Show in Chicago, Illinois.

For the latest conference information visit our website at www.aws.org/conferences or call 800-443-9353, ext. 455.

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American Welding Society

Friends and Colleagues:

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

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

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

For specifics on the nomination requirements, please contact Wendy Sue Reeve at AWS headquarters in Miami, or simply follow the instructions on the Counselor nomination form in this issue of the *Welding Journal*. The deadline for submission is July 1, 2009. The committee looks forward to receiving these nominations for 2010 consideration.

Sincerely,

Alfred F. Fleury
Chair, Counselor Selection Committee



CLASS OF 2010 COUNSELOR NOMINATION FORM

(please type or print in black ink)

DATE _____ NAME OF CANDIDATE _____

AWS MEMBER NO. _____ YEARS OF AWS MEMBERSHIP _____

HOME ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____ PHONE _____

PRESENT COMPANY/INSTITUTION AFFILIATION _____

TITLE/POSITION _____

BUSINESS ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____ PHONE _____

ACADEMIC BACKGROUND, AS APPLICABLE:

INSTITUTION _____

MAJOR & MINOR _____

DEGREES OR CERTIFICATES/YEAR _____

LICENSED PROFESSIONAL ENGINEER: YES _____ NO _____ STATE _____

SIGNIFICANT WORK EXPERIENCE:

COMPANY/CITY/STATE _____

POSITION _____ YEARS _____

COMPANY/CITY/STATE _____

POSITION _____ YEARS _____

SUMMARIZE MAJOR CONTRIBUTIONS IN THESE POSITIONS:

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

****MOST IMPORTANT****

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

SUBMITTED BY:

PROPOSER _____

AWS Member No. _____

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

NOMINATING MEMBER: _____ Print Name _____

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SUBMISSION DEADLINE JULY 1, 2009



American Welding Society

Nomination of AWS Counselor

I. HISTORY AND BACKGROUND

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

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

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

II. RULES

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

III. NUMBER OF COUNSELORS TO BE SELECTED

Maximum of 10 Counselors selected each year.

Return completed Counselor nomination package to:

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American Welding Society
Senior Manager
Award Programs and Administrative Support
550 N.W. Lejeune Road
Miami, FL 33126

Telephone: 800-443-9353, extension 293

SUBMISSION DEADLINE: July 1, 2009

LETTERS TO THE EDITOR

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physically measure larger than the size of the weld.

Now let's take a look at the other thing Fig. 25 says, "By measuring the leg length, the 2nd side of the triangle is known. Now the actual size can be determined as well as convexity and concavity issues be determined." We already know that is not true (see above information), and one should never take for granted that each leg is equal in length. You always measure the length of the shortest leg to determine the size of a fillet weld.

Ron Theiss, NHC (ret.),
and John Husfeld, Conformance
Consulting Services

The statement regarding the theoretical throat vs. the actual throat is correct, and it should have read "theoretical" throat. I can measure each leg of a fillet weld so I know if weld lengths are of equal size, and I have the ability to measure convexity/concavity of a weld as well.

Joe Pavilanis
Process/Quality Engineer
Woolf Aircraft Products, Inc.
Romulus, Mich.

NEWS OF THE INDUSTRY

— continued from page 12

"I can think of no enterprise more worthy than one devoted to inspiring the next generation of engineers, builders, and manufacturers," said Ratzenberger. "I am proud to join forces with FMA and know that with each child who attends one of our camps or receives one of our scholarships, we are rebuilding America's foundation one tinkerer at a time.

"We must encourage kids when they graduate from high school to consider manufacturing as a career. . . we need to do better at informing the next generation and their parents that working a skilled job with your hands can be rewarding financially and fulfilling personally," added Ratzenberger.

The new organization will feature an 18-member board of directors; six members from the former NBTF will join the 12 former FMA Foundation board members.

Industry Notes

- **Vincennes University**, Vincennes, Ind., now offers a new associate degree in Welding Technology designed to open opportunities in management, inspection, and automation. Expected first-year enrollment is 23 students with this to possibly double by the fifth year of the program.
- **GE Sensing & Inspection Technologies** and **SGS-CSTC**, a Chinese joint venture of SGS group, opened a joint nondestructive examination application center in Shanghai, China.
- **Detroit Tool Metal Products**, Lebanon, Mo., has been awarded a \$1.4 million contract from DRS Technologies, West Plains, Mo., for welding M989A1 Heavy Expanded Mobility Ammunition Trailer frames.
- **Diversified Industrial Staffing**, Troy, Mich., is expanding into new markets around the country to bring an approach of matching manufacturers with the best skilled-trades workers, including welders, according to Todd Palmer, its president and owner.
- A 40,000-sq-ft warehouse expansion bringing the total area dedicated to nickel alloys to 112,000 sq ft has been completed by **Corrosion Materials**, Baker, La. This includes a Kasto Unicomact 5.0 automated storage and retrieval system for bar and tubular products along with 3000 sq ft for on-site X-raying.

NEW PRODUCTS

— continued from page 38



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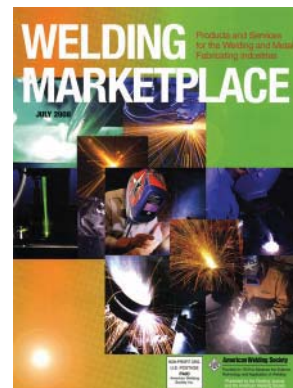
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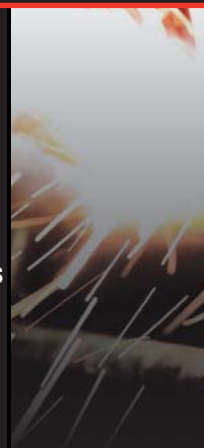
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SUPPLEMENT TO THE WELDING JOURNAL, MAY 2009
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Influence of Nanoscale Marble (Calcium Carbonate CaCO_3) on Properties of D600R Surfacing Electrode

Nanoscale marble was added to the flux coating of D600R, a newly developed hardfacing electrode for the repair of steel rolls

BY B. CHEN, F. HAN, Y. HUANG, K. LU, Y. LIU, AND L. LI

ABSTRACT

Conventional microscale marble in the flux coating of D600R, a hardfacing shielded metal-arc welding electrode, was replaced by marble of nanoscale sizes for possible enhanced electrode characteristics. The microscale marble was substituted with different proportions of nanoscale marble particles. An arc characteristics analyzer was used to measure the welding current, arc voltage, and short-circuiting characteristics of the electrode under various welding conditions. Hardness and wear resistance properties of the weld deposit were characterized. The results show that the smaller marble particle sizes in the flux coating produced lower short-circuiting voltage, lower short-circuiting current, and shorter short-circuiting time. A significantly improved arc stability resulted in better welding characteristics of the electrode. The nanoscale marble particles in flux coating produced greater metal deposition efficiency, as well as increased hardness and wear resistance of the deposit.

B. CHEN and F. HAN are with Wuhan University of Technology, Department of Material Process Engineering, Wuhan, China. Y. HUANG is with Sinosteel Xingtai Machinery & Mill Roll Co., Xingtai, Hebei, China. K. LU and Y. LIU are with Wuhan Anchor Welding Consumables Co., Wuhan, China. L. LI is with Department of Mechanical & Aerospace Engineering, Utah State University, Logan, Utah (leijun.li@usu.edu).

Introduction

Due to their small size and large surface effects, nanomaterials have unique mechanical, electrical, magnetic, and optical properties differing from traditional materials (Refs. 1–8). These properties enabled nanomaterials to be used in an array of applications, including the defense, electronic, aerospace, and chemical industries. The introduction of nanotechnology to welding started at the end of the 20th century. There are currently commercial welding consumables that contain nanomaterials. Although systematic studies on the roles of nanomaterials during welding process are still missing, a few research papers are available on nanomaterial-containing welding consumables (Refs. 9–12).

In this investigation, nanoscale marble particles were added to the flux cover of D600R hardfacing welding electrodes, partially or entirely substituting the original (microscale) marble particles. The hypothesis was the small size of the nanoscaled marble particles, with an effective constituent of CaCO_3 , will significantly affect the chemical reactions in the slag, and change the properties of the flux coating. An investigation was conducted on the effect of concentration of nanoscale marble in flux coating on the welding procedural and metallurgical properties of a hardfacing electrode. The melting charac-

ter, which includes the melting temperature and its range, was investigated for the experiment electrodes. The effects of nanoscale marble on the length of flux sleeve, stability of electric arc, formation of weld bead, and adaptability for all-position welding were characterized.

Experimental Procedure

The D600R is a newly developed electrode for the repair of steel rolls. The core of the electrode is H08A steel, with a nominal composition of C < 0.1%, Mn 0.3–0.55%, Si < 0.03%, Cr < 0.2%, Ni < 0.3%, S and P < 0.03%. The composition of the flux system for D600R is kept constant, except the conventional, microscaled marble was replaced with nanoscaled particles. The composition of the flux is listed in Table 1, and replacement ratios for nanoscale marble are given in Table 2.

A Model TL-25 hydraulic electrode extrusion machine was used to produce the experimental electrodes. No apparent effect was observed of nanoscale marble on the extrusion behavior of the electrodes. The flux coating has sufficient strength, moisture resistance, and smooth appearance. The electrodes were dried according to the following sequence: at room temperature for 24 h, at 50°C for 7 h, at 120°C for 3 h, at 250°C for 2 h, and finally at 380°C for 1.5 h.

A high-temperature physical properties measurement device (Model GX) was used to measure the melting range of the fluxes. The mixed fluxes were made into cylinders 3 mm in diameter and 3 mm high. The specimen was sealed in the test chamber that was filled with Ar. The contour of the specimen and temperature indication were recorded digitally as shown in Fig. 1. The heating current was 4–5 A,

KEYWORDS

Welding Electrode
Flux Coating
Nanoscaled Marble
Calcium Carbonate

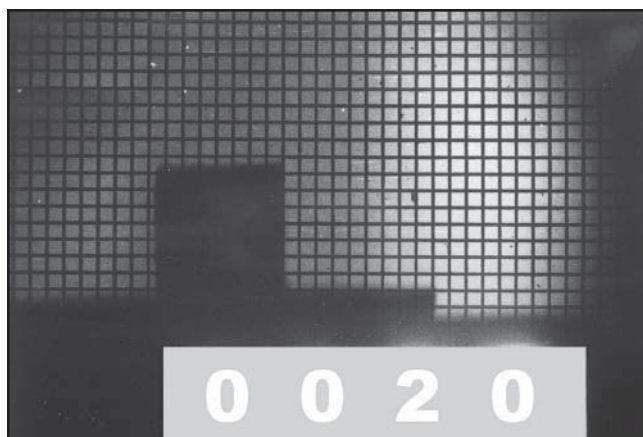


Fig. 1 — The contour of the specimen and temperature indication before heating test.

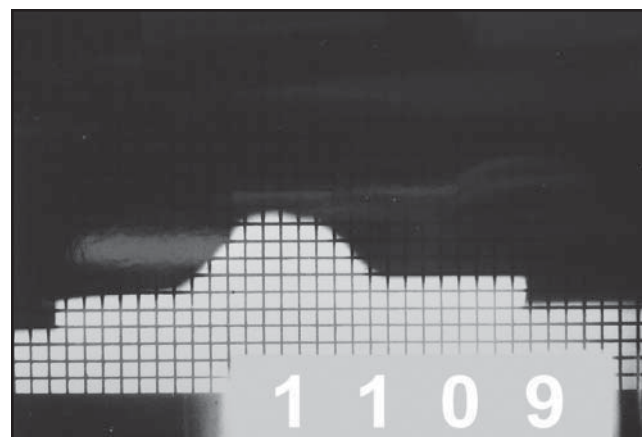


Fig. 2 — The specimen with its height collapsed to half of the original height at the melting temperature.

Table 1 — Composition of Flux Coating of Electrode D600R

Flux Constituent	Percentage (wt-%)
Marble	31
Fluorite	36
High carbon ferromanganese	3
Carbon ferrochromium	14
Ferromolybdenum	2
Rare-earth silicoferrite	1.5
Ferrotitanium	10
Sodium carbonate	1.5
Graphite	0.5
Light rare-earth oxide	1

Note: The total amount by weight of the flux constituents is 100.5%; water glass: sodium silicate with density 1.49–1.51 g/cm³ and modulus M = 2.9–3.0; electrode core wire is steel H08A with 4.0-mm diameter; extrusion die throat-diameter is 6.8–6.9 mm.

Table 2 — Concentration of Nanoscale Marble and Electrode Properties

Flux ID	Nanoscale Marble (%)	T _m (°C)	Melting Range (°C)	Sleeve Length (mm)
HT1	0	1110	80	1.73
HT2	10	1098	40	1.62
HT3	20	1073	24	1.10
HT4	25	1063	26	1.08
HT5	50	1082	38	1.15
HT6	100	1079	76	1.13

and the heating rate was 10–15°C/min. The change of contour in the specimen during heating and melting was observed and recorded. The effective melting point of the fluxes was defined as the temperature at which the fluxes start to melt. This effective melting temperature was measured when the specimen height collapsed to one-half of the original height upon heating — Fig. 2. The melting temperature range was defined as the temperature between the start of the specimen collapse and the melting point defined above.

The deposit (cladding) efficiency tests were conducted on the low-carbon steel plates (dimensions 400 × 50 × 10 mm). Three electrodes were used for each test on three plates, and the remaining length

the electrode was about 50 mm. The length of electrode and weight of plate were measured before welding. The remaining length of the electrode, weight of the electrode core, and weight of the test plate were also measured after welding. The error of measurement was below 0.1 g. The equation for the deposit efficiency calculation was (Ref. 14)

$$\text{Deposit efficiency} = \frac{\text{deposit metal weight (g)}}{\text{total weight of 3 melted electrode cores (g)}} \times 100\%$$

where deposit metal weight (g) = plate weight after welding (g) – plate weight before welding (g).

The diffusible hydrogen content in the weld bead was measured according to standard GB-T3965—1995, *Measurement Methods for Diffusible Hydrogen in the Electrode Deposit Metal*, which is similar to ISO 3690. The diffusive hydrogen results obtained using GB-T3965 are comparable to those obtained from ISO 3690. The distribution of arc voltage probability density is generated by the Hanoverian electric arc quality analysis device (Ref. 17). The bead-on-plate welding was conducted on the Q235 low-carbon steel plate (400 × 50 × 10 mm). Each test was repeated three times. The sampling time used was 5 s. The density distribution of the probability $n\%$ of arc voltage occurring randomly was recorded for the given time.

Results and Discussion

Melting Characteristics

The effective melting point (T_m) and melting temperature range of the test flux coatings are shown in Table 2. The addition of nanoscale marble had the effect of decreasing the melting point and melting temperature range of the flux coating. As the concentration of nanoscale marble increased, the melting point and melting temperature range increased. HT4 had the lowest melting point (1063°C). The melting ranges of HT3 and HT4 are narrow, being 24°C and 26°C, respectively. HT1 and HT6 have wider ranges of melting temperature, being 80°C and 76°C, respectively. A decreased melting point makes the formation of a long flux sleeve on the end of an electrode difficult. It was found that the variations of the flux sleeve length and melting point have the same trend, i.e., the Flux HT4 (with 25% nanoscale marble) has the shortest flux sleeve. Maintaining similar welding conditions, electrodes with shorter sleeve length tend to produce less penetration. For a hardfacing electrode, minimization of di-

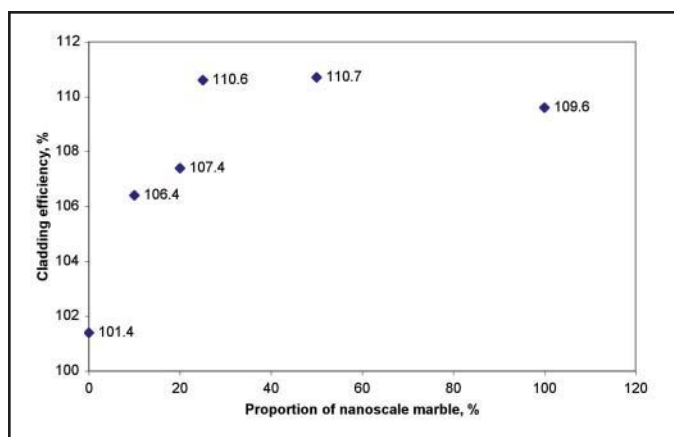


Fig. 3 — Deposit (cladding) efficiency of electrodes vs. proportion of nanoscale marble in flux.

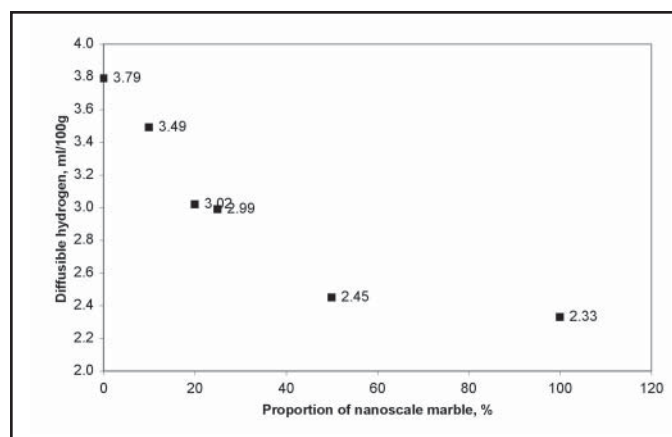


Fig. 4 — Diffusible hydrogen content in the deposit metal vs. proportion of nanoscale marble.

Table 3 — Chemical Composition of Fusion Deposit of Electrodes (wt-%, Balance Is Fe)

Flux ID	C	Mn	Si	P	S	Cr	Mo
HT1	0.49	0.95	0.34	0.017	0.005	3.58	0.50
HT2	0.55	1.09	0.22	0.017	0.005	3.74	0.53
HT3	0.57	1.12	0.32	0.017	0.005	3.85	0.56
HT4	0.56	1.06	0.32	0.016	0.005	3.71	0.50
HT5	0.52	0.97	0.33	0.017	0.005	3.42	0.48
HT6	0.53	1.00	0.34	0.017	0.005	3.54	0.49

lution due to deep penetration may be desired. Nanoscale marble provides an additional method to control the penetration through the sleeve length design.

The changes in melting temperature and its range are believed to be caused by two effects. First, nanoscale marble with more surfaces will decompose more completely into CaO, which may increase the melting point of the electrode flux. Second, the increased surface areas may also cause nanoscale particles to absorb arc energy more efficiently. Thus, adding nanoscale marble may decrease the melting point of the flux. For different proportions of nanoscale marble, one of the effects may dominate. This would account for the changes in melting point and melting temperature range.

Deposit Efficiency

The deposit efficiency varying with the nanoscale marble is shown in Fig. 3. The deposit efficiency increases with the increasing portion of nanoscale marble. When the portion of nanoscale marble is more than 25%, the deposit efficiency reaches a plateau with a small decrease, until the marble is entirely substituted with nanoscale marble. HT4 and HT5 have the higher deposit efficiencies, which are 110.6% and 110.7%.

When the alloy components are transferred from the coating to the weld bead, the equilibrium is (Ref. 15)

$$M_d = M_o - (M_{sl} - M_{ox})$$

where M_d is the amount of alloy transferred to deposit; M_o is the initial amount of the alloy in the electrode (core and flux coating); M_{sl} is the remaining amount of the alloy in the slag; and M_{ox} is the amount of the oxidized alloy. With more instant generation of CO_2 caused by more nanoscale marble added, the stirring effect of the weld pool may be increased, and the remaining amount of alloy components in slag M_{sl} decreases. Meanwhile, the increasing oxidation effect increases the amount of alloys that are lost by oxidation. These two potentially competing effects would determine the final amount of alloy components transferred to the weld pool. The chemical composition of the fusion deposit of the test electrodes indicates such an effect (Table 3). The concentration of alloying elements first increases then decreases with an increasing portion of nanoscale marble in the fluxes.

Diffusible Hydrogen Content

The content of diffusible hydrogen in the deposit metal decreases with the increase of nanoscale marble in the flux — Fig. 4. When nanoscale marble is more than 50%, the diffusible hydrogen level reaches a low plateau. The reason for the beneficial effect of nanoscale marble is believed to be related to the increased surface areas of the particles. More CO_2 is

Table 4 — Arc Stability Measured Using Analystor Hanover

Flux ID	ΣU_s (%)	ΣI_s (%)	ΣT_1 (ms)
HT1	7.56	35.80	176
HT2	7.48	32.05	175
HT3	7.12	30.55	170
HT4	6.57	28.83	156
HT5	6.57	29.72	159
HT6	6.94	29.39	156

generated by the decomposition of fine marble ($CaCO_3$), and the effect of oxidation is enhanced. The partial pressure of hydrogen is reduced due to an increased CO_2 partial pressure. A strong relation exists between the partial pressure of hydrogen and the solubility of hydrogen in the deposit metal (Refs. 15, 16).

Arc Stability and Metal Transfer

The distributions of arc voltage probability density for the test electrodes under the same welding parameters are shown in Fig. 5. The probability density (n , %) is a function that represents a probability distribution in terms of an integral. The probability for arc voltage to fall between, for example, 4 and 6 volts, equals the area underneath the curve (i.e., integration) between the 4 to 6 interval. All the distributions of arc voltage probability density have a similar shape of two peaks. The left peak describes the probability density distribution of the short-circuit voltage for coarse drop short-circuit transfer (Refs. 17–19). Therefore, the smaller the left-peak area, the better the arc stability for the electrode.

The area of the left peak was integrated from the minimum voltage to the minimum probability value between two peaks. This integrated probability is defined as ΣU_s (%). It can be used as a parameter for evaluating the short-circuit droplet transfer. A smaller ΣU_s means

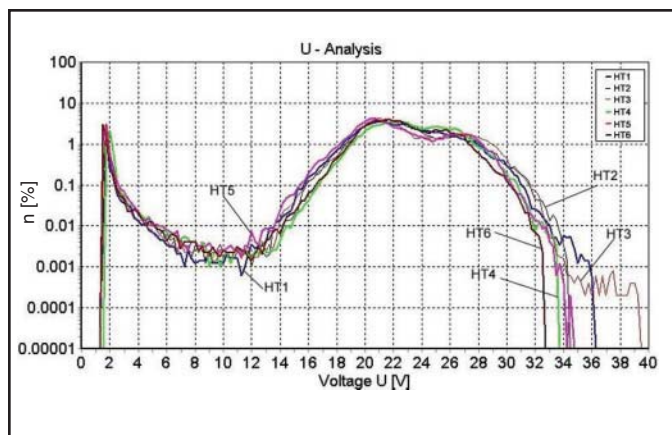


Fig. 5 — Voltage probability density.

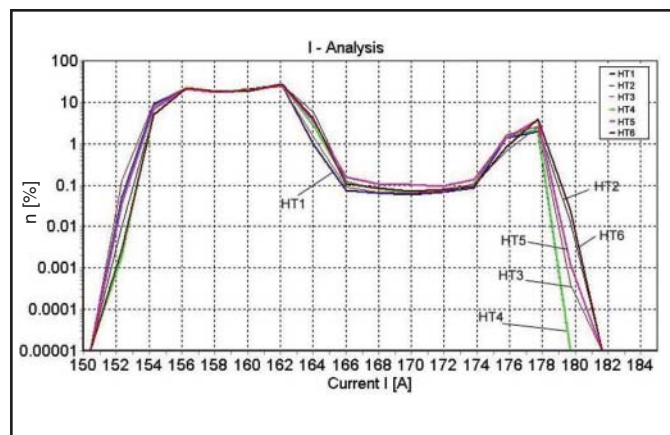


Fig. 6 — Comparison of current probability distributions of test electrodes.

Table 5 — Hardness and Abrasive Wear Resistance of Test Electrodes

Flux ID	Deposit Metal Hardness, (HRC)	Abrasion Weight Loss (g)
HT1	58.3	0.021
HT2	59.6	0.018
HT3	60.4	0.008
HT4	62.1	0.005
HT5	61.2	0.011
HT6	60.1	0.016

less of a chance for short-circuit and explosion drop transfers. Table 4 shows the ΣU_s for the test electrodes. HT4 has the smallest ΣU_s , which is 6.57%. HT4 has a more stable arc, with less splash, and better processing properties. While the ΣU_s for HT1 is the largest (7.56%), creating a greater tendency for short-circuit and explosion drop transfer.

The distributions of welding current probability density for the test electrodes are shown in Fig. 6. The rising part on the left portion of the curves shows the distribution of welding current probability density for the moment of the end of short circuit and the re-ignition of the arc. The next portion of the curves shows the distribution of welding current probability density for the period of the stabilized arc, which has the maximum probability density. The rest of the curves represents the period of short-circuiting. It has the maximum current when the molten drop contacts the weld pool. The higher the curve intersects with the current axis (horizontal), the higher the short-circuit current (Refs. 20, 21). All the distribution curves for the electrodes share a similar shape and the probability density decreases after 162 A. The short-circuit current probability densities (ΣI_s) above 162 A for test electrodes have been calculated and shown in Table 4. The sum of short-circuit current probability density ΣI_s for HT4 is 28.83%, much smaller compared with others. It shows that less short-circuit transfer

and explosion transfer exists for HT4 and it has better arc stability. Flux HT1 has the maximum ΣI_s (35.80%), so it has worse arc stability. The reason for HT4 to have shown a lower short-circuit current than other fluxes, especially HT3, is not clear. One reason may be that the small variations in the arc length during testing have affected the arc voltage and current.

The short-circuit time T_1 is the time from the contact of the liquid drop with the weld pool to the detachment. The larger molten drop has the longer short-circuit time. Thus, the short-circuit time reflects the size of the liquid drop. Among the frequency distributions of short-circuit time T_1 , a threshold of 2.05 ms has been used to separate the short-circuit probability distribution (Ref. 18). The short-circuit time $T_1 \leq 2.05$ ms corresponds to fine droplet transfer in the slag bridge, while the short-circuit time $T_1 > 2.05$ ms corresponds to coarse droplet short-circuit transfer. The total short-circuit time T_1 , defined as the accumulated short-circuit time for $T_1 > 2.05$ ms, can be used as an arc stability parameter. The shorter the T_1 , the more stable the welding arc. The T_1 data for all electrodes are calculated and listed in Table 4. The largest ΣT_1 is for HT1 with 175.9 ms, while all the ΣT_1 time for the electrodes with nanoscale marble added are shorter than HT1. Flux HT4 has the shortest ΣT_1 , which is 155.5 ms. Thus, the nanoscale marble can shorten the short-circuiting time.

Deposit Metal Properties

The microstructure was observed using an Olympus™ BX51M microscope. Specimens were prepared according to standard metallographic preparation method. It was found that there was no significant difference in the microstructure of the deposit metal. The structure is needle martensite, retained austenite, and some carbide — Fig. 7.

In Table 5, the average hardness numbers and wear resistance results are listed. Flux HT4 has the highest hardness, while HT1 has the lowest. The averaged hardness of the deposit metal with nanoscale marble added is slightly higher than that with microscale marble. The distribution of hardness is more uniform throughout the deposit metal with nanoscale marble added. The difference between the maximum and minimum hardness values is 7 HRC for HT1, while the difference is only 3 HRC for HT6.

The abrasive resistance tests were conducted on a Model MM-200 continuous sliding dry abrasion machine. The deposit metal from test electrodes was machined into 1-mm-diameter, 15-mm-high pin specimens. The pin specimen slid against the outer surface of a 40-mm-diameter cylinder made from a 0.45%C steel, machined and quenched to a hardness of HRC 60. During the test, the pin specimen was held stationary with its rotational axis perpendicular to that of the 40-mm steel cylinder, which rotated at 200 rev/min, and a load of 98 N was applied to the pin specimen. The abrasive wear test did not involve a lubricant. The test procedure was the following: The pin specimen was first wear tested for 15 min; then it was removed from the machine, cleaned, dried, and weighed for the initial weight. The specimen was then tested for 120 min. The tested specimen was cleaned, dried, and weighed for the postwear weight. The abrasive resistance was evaluated by

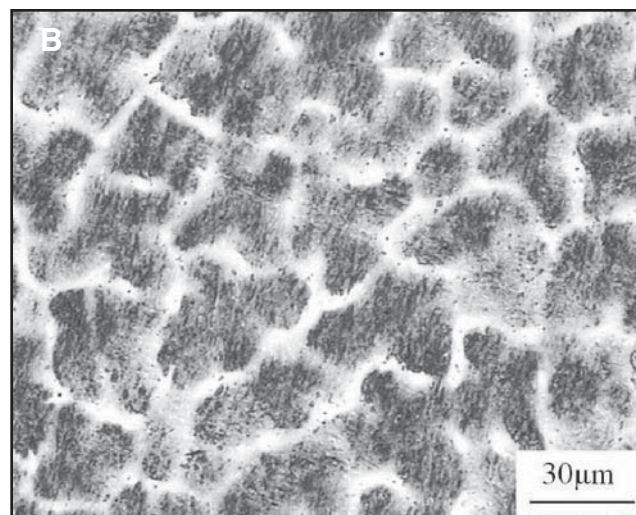
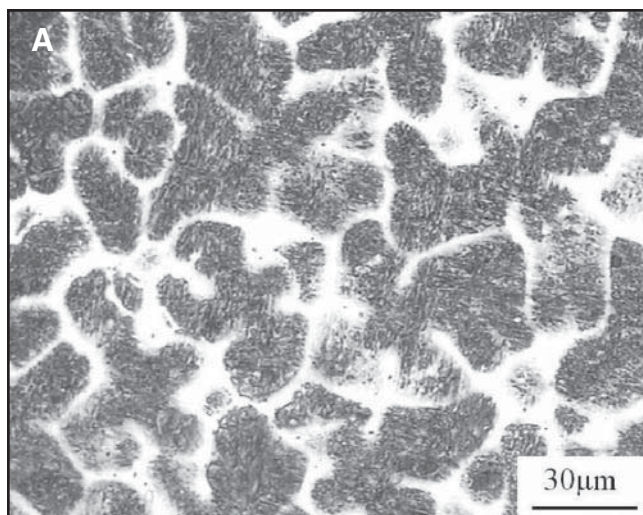


Fig. 7 — The as-deposited microstructure. A — Electrode with HT1 coating (microscale marble); B — electrode with HT6 coating (100% nanoscale marble). 4% Nitral etch.

weight loss. The weights of the sample before and after the abrasion test were measured on an analytical scale, with a precision of 0.0001 g. Each measurement was repeated at least three times, and the average value was reported. The variation between the readings in weight was ± 0.0002 g. Shown in Table 5, the increase of nanoscale marble in the coating improves the abrasive resistance of the deposit sample. Specimen HT4 has the best abrasive resistance and HT1 with zero nanoscale marble has the worst wear resistance.

Conclusions

The introduction of nanoscale marble (calcium carbonate) has a significant influence on the properties of D600R shielded metal arc welding electrode flux. The stability of the electrical arc, content of diffusible hydrogen in the deposit metal, and deposit efficiency are improved by replacing the conventional (microscale) marble with nanoscale marble in the electrode flux coating. The nanoscale marble improves the hardness and abrasive resistance of the deposit metal. The optimum proportion of the nanoscale marble seems to be between 20 and 25% for both the arc stability and deposit metal properties.

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References

1. Yang, Z. Y. 2004. *Nanotechnology*, Beijing, Mechanical Engineering Press.
2. Zhang, Q. Q., and Zhang, J. W. 2005. *New Development in Nanotechnology*, Beijing, Defense Industry Press.
3. Aizawa, T., and Kondoh, K. 2001. Nanostructured materials via bulk mechanical alloying. *Scripta Mater.*, 44: 1751–1755.
4. Aizawa, T. 2000. Nanogranulation process into magneto-resistant Co–Cu alloy on the route of bulk mechanical alloying. *Materials Science and Engineering*, A285, 1–7.
5. Xu, G. C., and Zhang, L. D. 2002. *Nanoscale Complex Material*. Chemical Industry Press, Beijing.
6. Kear, B. H., and Strutt, P. R. 1995. Chemical processing and application of nanostructured materials. *Nanostructured Materials*, 6(1): 227–236.
7. Rawers, J. C. 1998. Thermal stability of nano-structured metal alloys. *Thermal Spray Tech*, 7(3): 427–428.
8. Tao, N. R., Sui, M. L., and Lu, K. 1999. Surface nano-crystallization of iron induced by ultrasonic shot peening. *Nano-structured Materials*, 11(4): 433–440.
9. Yang, D. X., Zhao, X. J., and Chen, C. H. 2003. Investigation of application of nanoscaled W-FeC powder in fusion welding. *Mechanical Engineering Materials*, 27(2): 36.
10. Zhao, X. J., Yang, D. X., and Chen, C. H. 2003. D707 electrode with nanoscaled compound powder. *Hard Alloys*, 20(2): 76–79.
11. Chen, C. H., Zhao, X. J., and Shi, C. Y. 2003. Using nanoscaled powder for developing new hardfacing welding electrode. *Transactions of Dalian Railway Institute*, 24(1): 52–56.
12. Zhao, X. J. 2003. Chromium carbide nanoscaled powder used in a hardfacing weld electrode. *Thermal Processing Techniques*, (3): 27–28.
13. Zhang, Q. H., Wu, X. P., and Hong, B. 2002. *Welding Filler Materials Development Theory and Techniques*. Beijing, Metallurgical Industry Press.
14. Zhang, Z. R., and Li, S. H. 1998. *Welding Electrodes*. Beijing, Mechanical Engineering Press.
15. Zhang, W. Y. 1999. *Welding Metallurgy (Fundamental Principles)*. Beijing, Mechanical Engineering Press.
16. Tang, B. G., Ying, S. K., and Wang, Y. R. 1987. *Welding Filler Materials for Low-Carbon and Low-Alloy High-Strength Steels*. Beijing, Mechanical Engineering Press.
17. Song, L., and Wang, B. 2006. Shielded flux-cored wire welding under various welding parameters. *Transactions of Zhongbei University*, 27(1): 83–85.
18. Gao, J. H., Wang, B., and Song, L. 2006. Analysis of arc physics of a fluoride-type carbon steel welding electrode. *Welding*, (10): 51–54.
19. Rehfeldt, D. D., and Rehfeldt, M. D. 2003. Computer-Aided Quality Assurance (CAQ) of Al-MIG-welding with Analysator Hanover. *Proc. International Forum on Automobile Welding*, Beijing, Mechanical Engineering Press.
20. Yang, L., and Wang, B. 2004. Analysis of several flux-cored welding wires using the Hanover Welding Quality Analyzer. *Welding Equipment and Materials*, 33(5): 38–42.
21. Wang, B., Yang, L., and Wang, Y. 2006. Critical analysis of droplet transfer modes for welding electrode. *Transactions of Welding*, 27(11): 95–98.

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The Effect of High-Temperature Eutectic-Forming Impurities on Aluminum 7108 Weldability

Iron and other similar transition impurity elements can form high melting temperature eutectics that can affect weldability, grain size, and interdendritic feeding

BY M. G. MOUSAVI, C. E. CROSS, AND Ø. GRONG

ABSTRACT

The weldability of the 7108 aluminum extrusion alloy has been found to exhibit a high sensitivity to iron impurity content. This is believed to be related to the formation of a high-melting-temperature Al-Fe eutectic, capable of blocking interdendritic fluid flow and impeding the feeding of solidification shrinkage and thermal strain. Other high-temperature, eutectic-forming impurities have been found to behave in a similar manner when added to Alloy 7108 in a controlled manner. The circular patch test (CPT) was adapted to evaluate the effect of impurity elements on the solidification cracking susceptibility of welds made on cast 7108 coupons, treated with different impurity metal additions. Results from the CPT have shown a correlation between the amount of eutectic generated, as predicted using the Scheil Equation, and the susceptibility to cracking. However, in some instances, impurities are also observed to refine the grain size, an effect that tends to counteract their negative influence on weldability.

Introduction

Weldable 7xxx alloys were developed in the 1960s as a high-strength alternative to weldable 5xxx alloys (e.g., Alloy 5083). These are basically Al-Mg-Zn alloys that are copper free and respond well to natural aging in the weld metal and heat-

affected zone (HAZ) following welding (e.g., Alloys 7039, 7005, and 7108). The copper-containing 7xxx alloys (e.g., Alloy 7075) constitute high-strength aerospace alloys and are generally not considered weldable.

Alloy 7108 is one such Al-Mg-Zn precipitation-hardenable extrusion alloy (Al-5½Zn+1Mg), considered to be readily weldable when using an appropriate filler alloy such as Alloy 5183 (Al-5Mg). The high zinc in the base metal, when diluted with the high magnesium in the filler metal, shifts the composition of the weld metal away from the region of highest cracking susceptibility (Ref. 1). From the standpoint of maintaining high strength, however, it is preferable to minimize the amount of filler dilution and keep the weld metal zinc content high (Ref. 2).

During a circular patch test (CPT) study examining the autogenous weldability of different alloy variations of 7108, it was discovered that high-purity variants exhibited no tendency toward cracking (Ref. 3). Whereas, the same test applied to a commercial 7108 alloy resulted in severe cracking. This led to a suspicion of the role of impurity elements and their influence on weldability. Alloy 7108 normally contains up to 0.25 wt-% Fe, 0.12 wt-% Si, and 0.04 wt-% Mn as acceptable impurity levels (Ref. 4). The impurities Fe and Si, in particular, are common to all commercial aluminum alloys as residuals from the extractive processing of aluminum ore.

The present study was specifically initi-

ated to systematically investigate how Fe impurity levels affect the weldability of Alloy 7108. Other transition elements that form a high-melting eutectic similar to Fe (i.e., Sc, Mn, Co, and Ni) were also examined in order to provide a basis for comparison. Data regarding the effect of Sc, although not specifically generated for this study, have been drawn from previous work (Ref. 5). Such comparisons become important when developing mechanistic models to explain observed behavior. The role of Si, an impurity normally found together with Fe, was not addressed in this study. However, it is recognized that the presence of Si, and its tendency to form intermetallics with Fe, has the potential to alter the effect of Fe on weldability.

Background

Transition Element Phase Equilibrium

Fe sits in the first row of the transition elements in the periodic table and, just like its neighbors Sc, Mn, Co, and Ni, it forms a high-melting eutectic with aluminum at the aluminum-rich end of the binary phase diagram — Fig. 1. On the other hand, the transition elements Ti, V, and Cr all form peritectics with aluminum (as do all the elements in these three columns: IVB, VB, and VIB). It is interesting to note that Ti, V, and Zr (Zr lies below Ti on the periodic table) are often added to aluminum alloys for grain refinement, because the peritectic reaction ($L + \beta \rightarrow \alpha$) provides an ideal nucleating substrate (Ref. 6). However, Sc has also been found to result in grain refinement even though it is not a peritectic former, presumably because the eutectic $ScAl_3$ compound favors the nucleation of aluminum grains (Refs. 5, 7).

The eutectic-forming transition elements shown in Fig. 1 all involve the formation of an intermetallic compound with aluminum at relatively high temperatures (see Table 1). Sc and Fe form a binary eutectic with aluminum at 655°C, Mn and Co form a eutectic at 657°C, and Ni forms a eutectic at 640°C. The eutectic tempera-

KEYWORDS

Sc, Mn, Fe, Co, and Ni
Alloy 7108
Eutectic
Interdendritic Fluid Flow
Weldability
Grain Size
Circular Patch Test (CPT)

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tures for Sc, Fe, Mn, and Co are all within two deg of one another, whereas the Ni eutectic temperature is somewhat lower. The partition coefficients (k) shown in Table 1 were calculated assuming straight liquidus and solidus lines:

$$k = C_S / C_E \quad (1)$$

where C_S is the solute solubility at the eutectic temperature and C_E is the eutectic composition. These coefficients, although specifically meant for Al-X binary alloys, are used in this study for Al-Zn-Mg-X alloys assuming a high dilution of X impurity in aluminum. It is understood that this is only an approximation, making an assumption that Zn and Mg do not significantly alter the solubility of these impurity elements in aluminum.

In Fig. 2, the Scheil Equation has been used to calculate the quantity of nonequilibrium eutectic (f_E) generated in aluminum binary alloys as a function of solute content (C_0) using the data in Table 1:

$$f_E = (C_0 / C_E)^{1/(1-k)} \quad (2)$$

At normal impurity levels (i.e., less than 0.3 wt-%), Co and Sc are observed to generate the greatest amount of eutectic, followed by Fe and Ni. Mn, however, generates only a negligible amount of eutectic in this solute range.

Considering in more detail the effect of Fe on the solidification of 7108 requires knowledge of the Al-Zn-Mg-Fe quaternary system, which is not well documented. Mondolfo predicts three phases, FeAl_3 , $\text{Mg}_3\text{Zn}_3\text{Al}_2$, and MgZn_2 , for conditions where $\text{Zn:Mg} > 2.2$ and $\text{Fe} \gg \text{Si}$ (Ref. 9). From the Al-Zn-Mg ternary equilibrium system, one would expect to form $\text{Mg}_3\text{Zn}_3\text{Al}_2$ through a eutectic reaction starting below 489°C , followed by a peritectic reaction to form MgZn_2 at around 475°C . From examining Al-Zn-Fe and Al-Mg-Fe ternary equilibrium systems, it is to be expected that FeAl_3 will form at elevated temperatures close to the liquidus through a eutectic reaction. However, it has been well documented that FeAl_6 is more commonly observed in place of FeAl_3 for fast cooling rates (Ref. 10). Also, for fast cooling rates, the peritectic reaction to form

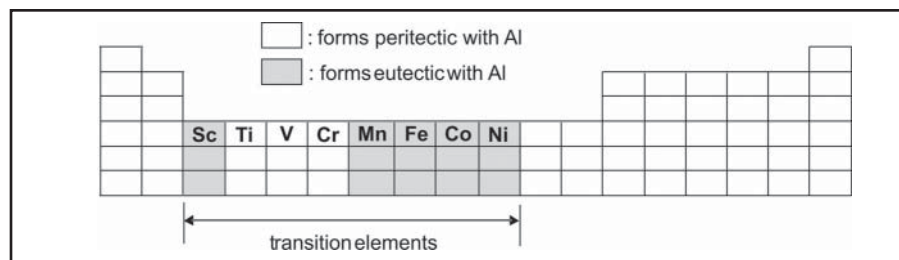


Fig. 1 — Periodic table showing transition elements pertinent to this study.

MgZn_2 is not expected to occur to any significant extent. Hence in 7108 weld metal, FeAl_6 and $\text{Mg}_3\text{Zn}_3\text{Al}_2$ are the two intermetallic phases expected to form.

Aluminum Weldability

Solidification cracking is a defect common to many aluminum alloys, where susceptibility to this form of cracking is normally used to define weldability. Formation of this defect involves the separation and tearing of liquid films present at grain boundaries in the mushy zone trailing the weld pool. Recent models have suggested that crack initiation may arise from a pressure drop in the interdendritic liquid due to insufficient liquid feeding of solidification shrinkage and thermal contraction (Refs. 11–13). Accordingly, anything that inhibits interdendritic fluid flow should promote crack formation.

The link between liquid feeding and crack formation is being considered in this study to explain how interdendritic phases that form at high temperature and block interdendritic channels may influence weldability. Evidence that a high-temperature Fe-bearing phase can affect the pressure drop in solidification has been found in several aluminum castability studies, where it has been shown that shrinkage porosity increases with Fe impurity content (Refs. 14–16). Specifically, this effect has been related to coarse $\beta\text{-Al}_5\text{FeSi}$ needles in Al-Si alloys that effectively block liquid feeding in interdendritic channels. Regarding solidification cracking susceptibility, however, Fe has actually been shown to have a positive effect in castings (Refs. 16–19), attributed in some cases to mechanical bridging be-

tween dendrites by the β phase. Such bridging is not possible in welds, however, where interdendritic phases are considerably finer in size and refined in shape. Instead of its traditional coarse needle shape spanning across dendrites in castings, the weld metal β phase is found to be refined in size and restricted to grain boundaries (Ref. 20).

Weld metal grain size can also have a pronounced effect on weldability (Refs. 5, 21). Grain refinement results in more weld metal grain boundaries, with less strain per grain boundary and more resistance to cracking (Ref. 22). Thus, any effect that impurity additions may have on weldability must include an analysis of grain size. Grain refinement involves the heterogeneous nucleation of new grains, which requires both undercooling and the presence of an appropriate substrate (Ref. 6). When the substrate is similar in crystal structure to the metal being nucleated, less undercooling is required. Constitutional undercooling can be related to alloy partitioning and compared using the parameter P (Ref. 23):

$$P = \frac{m_L(1-k)C_0}{k} \quad (3)$$

where m_L is the liquidus slope. Undercooling parameter values for the transition elements are compared in Table 2 (for $C_0 = 1$), where it is observed that Mn should generate the least amount of undercooling and Ni the highest.

Experimental

The effect of impurity elements Fe, Mn, and Co on the solidification cracking susceptibility of Alloy 7108 was studied by per-

Table 1 — Compilation of Phase Equilibrium Data for Select Transition Elements in Aluminum (Refs. 8, 9)

Solute	T_E Eutectic Temp ($^\circ\text{C}$)	C_S Solubility at T_E (wt-%)	C_E Eutectic Comp. (wt-%)	C_I Inter- Metallic (wt-%)	k Partition Coefficient	Intermetallic Compound
Sc	655	0.31	0.6	35.7	0.52	ScAl_3
Mn	657	1.8	1.9	25.3	0.95	MnAl_6
Fe	655	0.04	1.8	37.0	0.022	FeAl_3
Co	657	0.02	1.0	32.7	0.020	Co_2Al_9
Ni	640	0.04	6.0	42.0	0.0067	NiAl_3

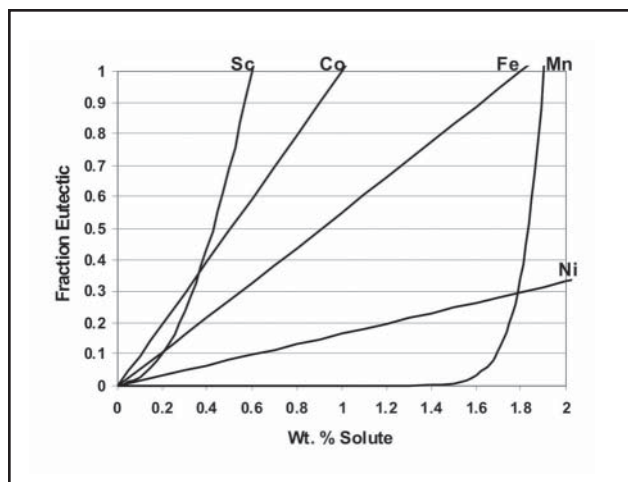


Fig. 2 — Graphical representation of Scheil Equation predictions for quantity of interdendritic eutectic in aluminum binary alloys based upon Equation 2 and Table 1.

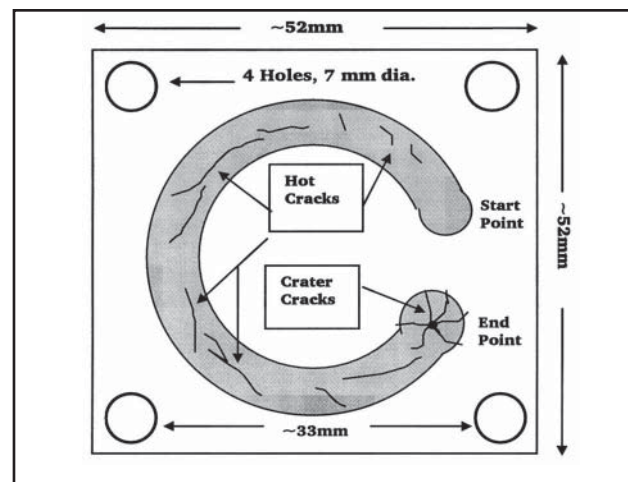


Fig. 3 — Schematic diagram showing coupon design used for CPT weldability test with crack pattern traced from Al-5½Zn-1Mg-0.2Fe specimen.

forming weldability tests on specially prepared cast coupons having variable impurity content. Details of the weldability test and alloy preparation are discussed below.

Weldability Testing

The CPT was developed for use in this study, specifically adapted for evaluating small cast coupons of experimental alloys (Ref. 3). There are numerous versions of this test as described in a review on this subject (Ref. 24), but the basic test consists of a weld made in a circular pattern on a flat plate. As the weld nears completion of the circle, it begins to experience transverse tensile strain from the weld bead made at the beginning of the circle. Thus, when welding susceptible alloys, a solidification crack (normally a centerline crack) will eventually form and trail behind the weld pool until the circle is completed. The total length of the crack generated can then be measured and used as an indication of relative weldability.

The CPT fixture developed for use in this investigation consisted of a coupon affixed to a water-cooled copper heat sink, mounted to the headstock of a rotary lathe. A stationary gas tungsten arc welding (GTAW) torch was mounted perpendicular to the head stock and was offset from the lathe centerline, so that a circular path of approximately 40 mm in diameter was traced as a result of coupon rotation. The

CPT weld coupons were 10-mm-thick cast alloys (approximately 52 mm square) with four corner holes provided for mounting bolts, as shown schematically in Fig. 3. A heat sink was found necessary for these small coupons to avoid overheating and subsequent melt-through.

Weld Parameter Development

Circular patch test welds were made using an autogenous, gas tungsten arc, bead-on-plate process. In order to obtain a narrow weld bead with high penetration, welds were made using direct current and straight polarity (electrode negative) with welding-grade helium shielding gas. A set of CPT weld tests were conducted in an earlier study (Ref. 3) to develop an appropriate test procedure and determine the effect of welding process variables on solidification cracking. The variables examined included welding current and welding speed, with the diameter of the circle kept constant at 40 mm. Results indicated that the most effective (i.e., the most crack producing) range of parameter combinations was a current of 130 A combined with a travel speed of 3.5 mm/s. These parameters were similarly adopted for this study.

Crack Length Measurement

Quantitative crack length measurements were obtained by grinding and pol-

ishing the top surface of the welded specimen to a 3- μ m grit finish. A digital caliper and a metallurgical light stereoscope, equipped with oblique lighting, were used to measure the total, accumulative length of cracks. The magnification range selected was in accordance with the best visibility of cracks and varied from 10 to 16 $\times$. Crater cracks and HAZ cracks were not included in crack length measurements.

Figure 3 is a schematic illustration of the way a typical specimen appeared under the stereoscope. A crack pattern has been traced onto this schematic from an actual test specimen (Al-5½Zn-1Mg-0.2Fe). Cracking is most severe in weld segments located near the corners of the coupon where high restraint is exerted due to fixturing (i.e., corner bolts), indicating that the imposed restraint on the specimens is nonuniform. Also, it should be noted that the crack pattern observed in this test is not the same as the pattern normally found in a CPT test (i.e., one long centerline crack at the end of the circular patch). However, because the restraining condition was the same for all specimens, the resulting crack length measurements still serve as a valuable solidification cracking index for comparative purposes.

CPT Validation

In order to validate the ability of the CPT test to correctly compare relative

Table 2 — Comparison of Grain Refining Parameters for Impurity Additions (for $C_0=1$) (Ref. 9)

Solute	$m_L(1-k)/k$ ($^{\circ}\text{C}/\text{wt.}\%$)	Intermetallic	Lattice Spacing ($\times 10^{-10}\text{m}$)
Sc	7	ScAl_3 , cubic	$a = 4.11$
Mn	0.1	MnAl_6 , orthorhombic	$a = 6.49, b = 7.54, c = 8.86$
Fe	123	FeAl_6 , orthorhombic	$a = 6.49, b = 7.44, c = 8.79$
Co	147	Co_2Al_9 , monoclinic	$a = 6.21, b = 6.29, c = 8.56$
Ni	494	NiAl_3 , orthorhombic	$a = 6.61, b = 7.37, c = 4.81$

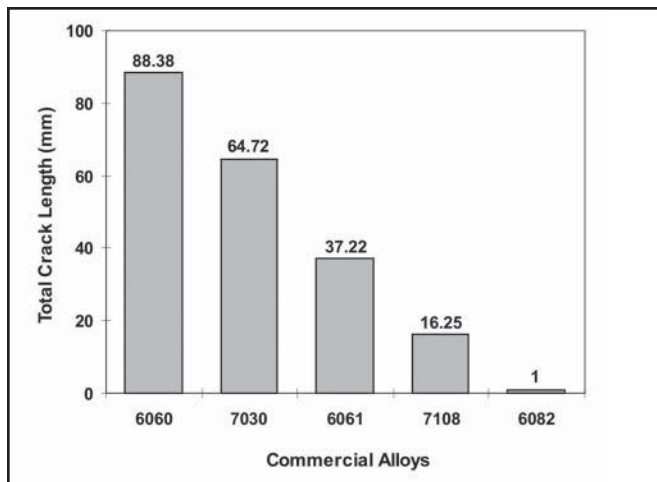


Fig. 4 — Circular patch test weldability analysis comparison of commercial aluminum alloys.

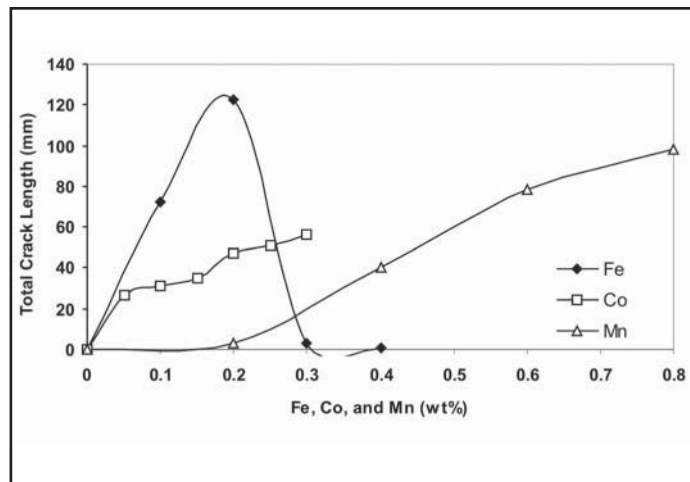


Fig. 5 — Circular patch test weldability data showing variations in total crack length (TCL) with Co, Fe, and Mn impurity additions to Al-5½Zn-1Mg alloy.

weldability, a series of CPT coupons were made from 5-mm-thick 6xxx and 7xxx aluminum alloy extrusions as listed in Table 3 (with the exception of Alloy 6061, which was cut from 7-mm-thick rolled plate). All materials were tested in the T6 temper. These coupons were welded autogenously using the same conditions and welding parameters discussed earlier for cast 7108 coupons. Alloys compared in such a way are shown in Fig. 4, where it is observed that the most susceptible alloy was 6060, and the least susceptible alloy was 6082. This agrees with industrial experience, where Alloys 6060 and 7030 are normally considered unweldable, whereas Alloys 7108 and 6082 are normally considered readily weldable when using a proper filler metal (Ref. 1).

Experimental Alloy Preparation

The experimental alloys examined in this study were prepared by adding preweighed amounts of impurity master alloys (Al-10Fe, Al-10Mn, and Al-5Co) to

a high-purity Al-5½Zn-1Mg alloy. The Al-5½Zn-1Mg alloy was made to simulate Alloy 7108, prepared by adding Mg and Zn to 99.999 wt-% pure aluminum under a protective sulfur hexafluoride gas cover. The range of impurity additions made, compared in Table 4, shows values that extend beyond normal impurity limits.

Once an impurity master alloy was added to the molten Al-Zn-Mg alloy, the mixture was sparged with argon and then cast into a graphite book mold, precoated with boron nitride. Coupons were prepared for welding by rough grinding both sides of the coupon (800 mesh grit) followed by alcohol degreasing. Corner holes were dry machined with the aid of a template.

Metallography

In order to prepare CPT coupons for grain size evaluation, they were first ground and polished to 3-µm grit, followed by electro-etching and anodizing. The areas of interest were viewed using polarized light under a light microscope at an appropriate

magnification. Grain size measurements in the castings were made using a line intercept method, calculating an average grain diameter over approximately 150 grain intercepts. Measurements in the weld were made from a top view, using a line intercept method across the full width of the fusion zone. Mean grain size values were used to represent the overall effect of a particular impurity element.

Results and Discussion

Weldability Measurements

Figure 5 gives the results of the CPT test, showing the variation of total crack length for different additions of Fe, Mn, and Co. What is readily apparent from this data is that Fe additions result in the highest amount of cracking. The crack length data for Fe is also unique in that it passes through a maximum, with cracking dropping to zero at around 0.3 wt-% Fe. This corroborates a reference made in the literature, where a high Fe content (0.3–0.4

Table 3 — Nominal Compositions for Commercial Aluminum Alloys Evaluated in CPT Validity Test (Refs. 4, 25)

Alloy	wt-%	Si	Fe	Cu	Mn	Mg	Cr	Zn	Zr	Other Total	Al
7030.60	min	—	0.15	0.26	—	1.10	—	5.10	—		
	max	0.10	0.25	0.34	0.04	1.30	0.03	5.40	0.03	0.10	bal
7108.70	min	—	—	—	—	1.10	—	5.30	0.15		
	max	0.12	0.20	0.05	0.04	1.30	0.03	5.60	0.18	0.10	bal
6060.35	min	0.40	0.18	—	0.01	0.45	—	—	—		
	max	0.45	0.22	0.02	0.03	0.50	0.02	0.02	—	0.10	bal
6061	min	0.40	—	0.15	—	0.80	0.04	—	—		
	max	0.80	0.70	0.40	0.15	1.20	0.35	0.25	—	0.10	bal
6082.26	min	0.85	0.17	—	0.50	0.60	0.13	—	—		
	max	0.95	0.23	0.01	0.60	0.65	0.18	0.02	—	0.10	bal

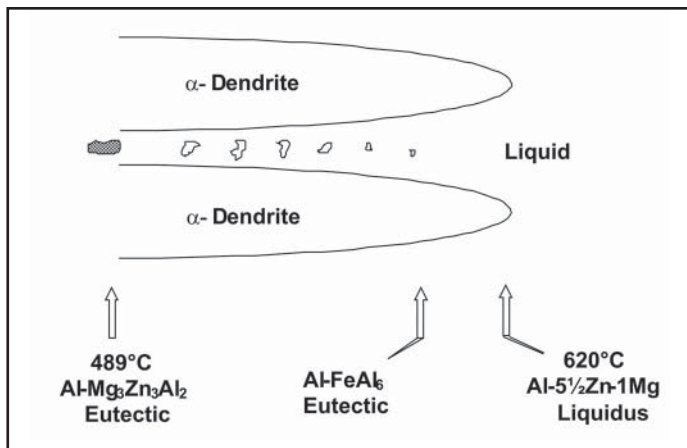
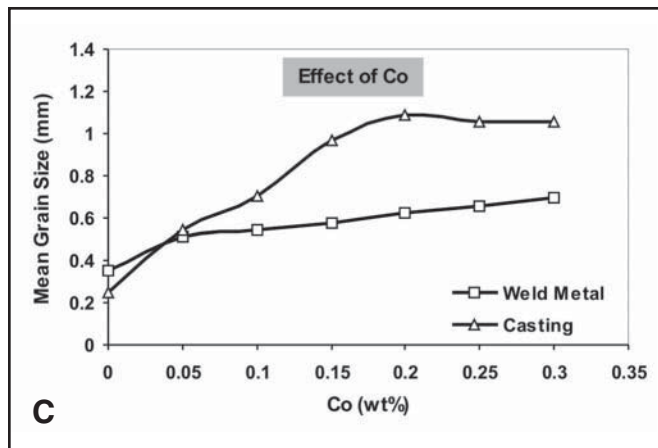
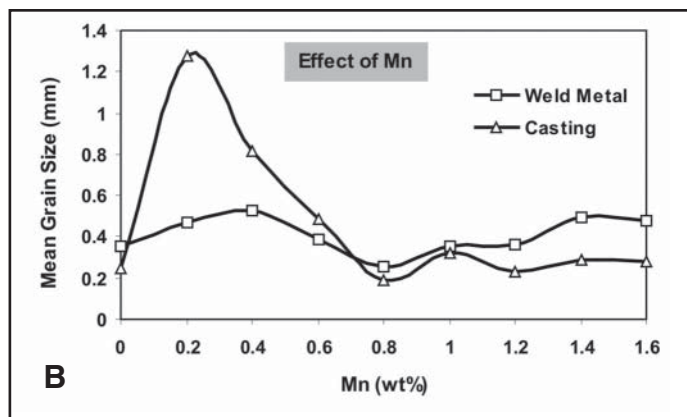
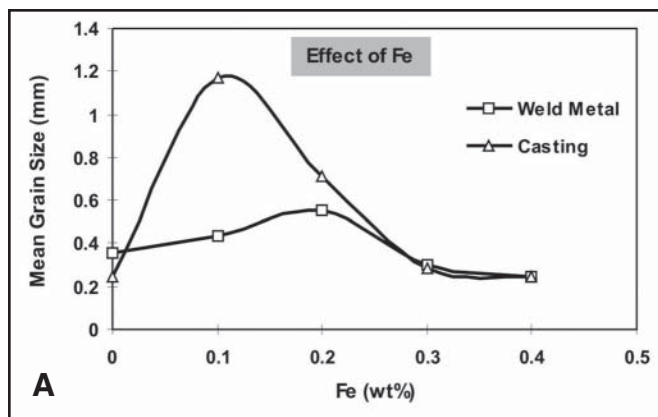


Fig. 6 — Effect of the following impurity additions on Al-5½Zn-1Mg weld metal and casting grain size: A — Fe, B — Mn, and C — Co.

Fig. 7 — Schematic diagram showing phase-temperature sequence for Fe impurity in Al-5½Zn-1Mg alloy.

wt-% Fe) was reportedly found to be beneficial to the weldability of Alloy 7039 (Ref. 26). This improvement in weldability corresponds directly with a reduction in grain size, discussed below.

It should also be noted that cracking begins to occur for Fe and Co additions at a much lower solute content than for Mn additions. This follows from the fact that much larger quantities of Mn are required to generate the same quantity of eutectic (Fig. 2). If a certain volume fraction of eutectic is required to impede interdendritic flow, it makes sense that more Mn must be added before hot cracking will initiate. Additions of Mn above 0.8 wt-%, although not shown in Fig. 5, resulted in a plateau of about 95 mm total crack length (up to 1.4 wt-% Mn). Mn behaved uniquely in a second regard, in that it was the only impurity addition that resulted in severe HAZ cracking. However, these HAZ cracks were not included in the total crack length count.

Grain Size Comparison

Grain size measurements were taken for all welds, and their corresponding castings, for each CPT coupon. The results of these evaluations are presented in Fig. 6, where it is noted that two modes of behavior are observed. Both Fe and Mn additions result in a peak in grain size, whereas Co results in a continuous rise in grain size for welds and castings. For all additions, however, the weld metal grain size rests below or is approximately the same as the casting grain size. This is to be expected due to the higher growth rates, and hence higher undercooling, associated with welding. Actual cooling rate measurements, made using implanted thermocouples, showed the weld to cool at 280°C/s and the casting to cool at 19°C/s during solidification. Also, the weld metal grain size is to some extent influenced by the casting grain size due to the tendency

for epitaxial grain nucleation.

The average grain diameter for welds and castings with no impurity addition is between 0.2 and 0.4 mm. By making small amounts of impurity additions (Fe, Mn, or Co), the casting grain diameter is found to increase up to around 1.2 mm. One explanation for this dramatic increase in grain size may be related to the eutectic heat of fusion, evolved near the solidification interface where grain nucleation is expected to occur.

If the impurity eutectic latent heat of fusion is to blame for inhibiting grain refinement for Fe, Mn, and Co, some other mechanism must account for the drop in grain size observed at high levels of Fe and Mn. From Equation 3 it is clear that undercooling increases with solute content and, hence, this may explain the observed refinement. Even so, Fe and Co are both capable of producing higher undercooling than Mn, for a given impurity content, and yet Mn showed grain refinement and Co not. It is also possible that particles of these eutectic compounds may serve as substrates to nucleate new grains, although none of these compounds (from Table 2) appear to be suitable substrates. Only ScAl₃ has a crystal structure and lattice spacing close to that of aluminum (Al: $a = 4.05 \times 10^{-10}$ m, FCC).

Table 4 — Range of Impurity Additions Made to Al-5½Zn-1Mg Alloy (in wt-%)

Fe	0.05	0.10	0.15	0.20	0.25	0.30	0.40	
Mn	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60
Co	0.05	0.10	0.15	0.20	0.25	0.30		

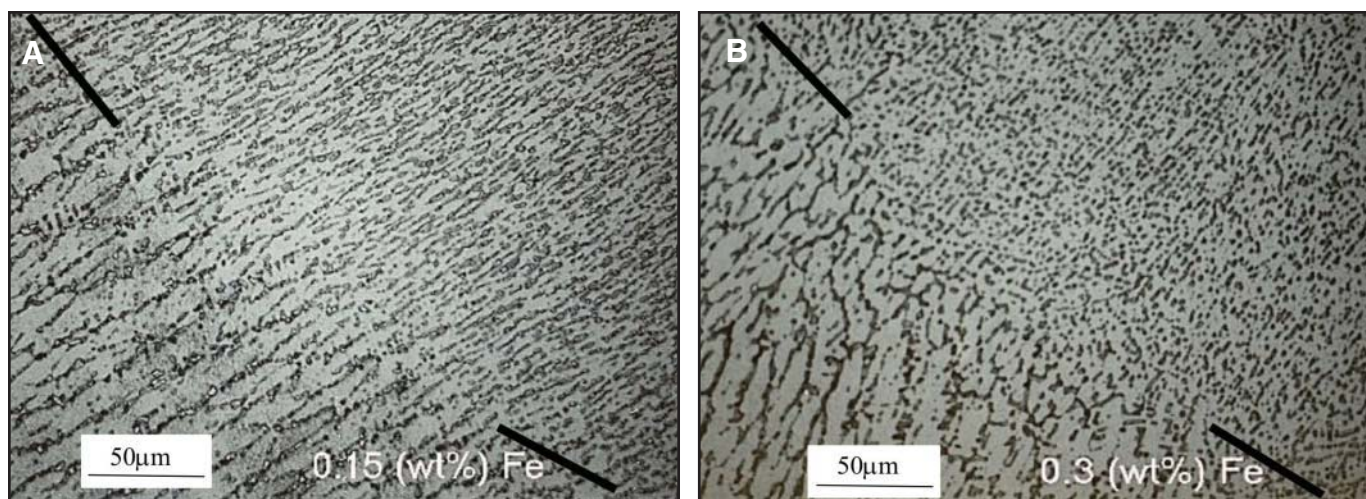


Fig. 8 — Photomicrographs showing cross section through quenched weld pool for Al-5½Zn-1Mg alloy treated with the following: A — 0.15 wt-% Fe and B — 0.30 wt-% Fe. Heavy line demarks boundary between normal and quenched weld metal.

Microstructure Development

The Al-5½Zn-1Mg weld metal solidification microstructure consists of primary aluminum dendrites and a discontinuous, interdendritic eutectic second phase. This eutectic second phase has been determined to consist primarily of the $Mg_3Zn_3Al_2$ phase (Refs. 2, 27). According to ternary phase equilibria, the liquidus for this alloy is approximately 620°C and the $Mg_3Zn_3Al_2$ eutectic occurs around 489°C (Refs. 9, 28). When iron is added in small amounts, an additional phase is observed intermixed with the $Mg_3Zn_3Al_2$ phase, identified in this study as $FeAl_6$ using SEM-EDX analysis. The order of phase formation, depicted schematically in Fig. 7, has the $FeAl_6$ phase forming close below the 620°C liquidus temperature, providing the possibility for interference with liquid feeding and disruption in growth of the $Mg_3Zn_3Al_2$ phase.

Metallographic examination of the Al-5½Zn-1Mg weld metal for both low and high Fe content revealed little noticeable difference. The prevalent interdendritic $Mg_3Zn_3Al_2$ phase, although discontinuous, tends to be elongated in the direction of solidification. When solidification takes place at higher growth rates, however, a change in behavior is observed. This is demonstrated in Fig. 8, where weld pool quenching was achieved by extinguishing the arc with a blast of pressurized air. In the rapidly cooled zone, the interdendritic phase is seen to be divided into smaller, more spherical particles for the specimen with high Fe content. This suggests that the Fe eutectic has the tendency to disrupt the growth of the $Mg_3Zn_3Al_2$ phase.

Summary

Sc, Mn, Fe, Co, and Ni transition elements, when present at impurity levels

in aluminum and aluminum alloys (e.g., 7108), are unique in that they all solidify as eutectics at high temperature near the liquidus. The formation of eutectic early in the solidification sequence, near the dendrite tip, can have both positive and negative consequences. Interdendritic fluid flow is likely obstructed when high temperature eutectic is present, inhibiting the feeding of shrinkage and promoting the formation of porosity and solidification cracks. Adding to this negative effect on weldability is an increase in grain size associated with the release of latent heat near the dendrite tip. Countering these negative effects, however, is grain refinement that can occur at elevated impurity levels due to constitutional undercooling or the presence of a potent nucleating substrate.

How these different factors interact to influence 7108 weldability varies depending upon the particular element in question. Sc is known to be an effective grain refiner due to its eutectic compound serving as a potent nucleant. Compared to the other transition elements, Sc is unique in this regard. Both Mn and Fe additions resulted in grain refinement, but only at elevated impurity levels related to constitutional undercooling. Considerably more Mn is needed to achieve the same grain refinement, as reflected in its lower undercooling parameter. Fe additions showed improved weldability with grain refinement, whereas Mn did not. This difference in behavior may reflect upon the ability of the corresponding eutectic to block feeding, although Mn should generate less eutectic at the same impurity level. A more plausible explanation may be linked to HAZ cracking, observed only with Mn additions, where HAZ cracks could serve to initiate weld metal cracks.

Co did not produce any grain refinement even though its undercooling parameter is similar to that of Fe. Co addi-

tions resulted only in grain coarsening and a corresponding decrease in weldability. Ni additions, although not examined in the experiment, give the highest undercooling parameter and hence show potential for promoting grain refinement.

The role of Fe on 7108 weldability is of particular practical importance because of its natural occurrence as an impurity element. A peak in solidification cracking susceptibility has been observed to occur at approximately 0.2 wt-% Fe, which coincides with the typical Fe impurity level for commercial alloys. Controlling Fe is problematic, because restricting Fe to lower levels becomes cost prohibitive, whereas adding Fe to higher levels leads to poor toughness and reduced corrosion resistance. A more favorable approach may be to control the impurity Si, and hence its interaction with Fe, to avoid formation of the high-temperature $FeAl_6$ eutectic. This is a topic for future research.

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References

1. Mousavi, M. G., Cross, C. E., Grong, Ø., and Hval, M. 1997. Controlling weld metal dilution for optimized weld performance in aluminium. *Science and Technology of Welding and Joining* 2(6): 275–278.
2. Cross, C. E., and Grong, Ø. 1998. Microstructural and mechanical properties of simulated Al-Mg-Zn weld metal modified with Sc and Zr. *Proc. ICAA-6 Aluminum Alloys Conf.*, 1441–1446. Eds. T. Sato, S. Kumai, T. Kobayashi, and Y. Murakami. Japan Inst. Light Metals.

3. Mousavi, M. G., Cross, C. E., and Ramsland, A. R. 1997. Development of a patch weldability test for evaluating hot cracking in aluminium weldments. *Report No. STF24-F97712*. SINTEF. Trondheim, Norway.

4. Aluminium Alloy Specifications, Roufoss Hydro Automotive Research Center AS, Raufoss, Norway.

5. Mousavi, M. G., Cross, C. E., and Grong, Ø. 1999. Effect of scandium and titanium-boron on grain refinement and hot cracking of aluminium Alloy 7108. *Science and Technology of Welding and Joining* 4(6): 381-388.

6. Crossley, F. A., and Mondolfo, L. F. 1951. Mechanism of grain refinement in aluminum alloys. *Trans. AIME* 191(12): 1143-1148.

7. Norman, A. F., Prangnell, P. B., and McEwen, R. S. 1998. The solidification behaviour of dilute aluminium-scandium alloys. *Acta Materialia* 46: 5715-5732.

8. Gschneider, K. A., and Calderwood, F. W. 1989. Aluminium-scandium. *Bulletin of Alloy Phase Diagrams* 10: 34.

9. Mondolfo, L. F. 1976. *Aluminum Alloys: Structure & Properties*. London: Butterworth.

10. McL. Adam, C., and Hogan, L. M. 1972. The aluminium-iron eutectic system. *J. Australian Inst. Metals* 17(2): 82-90.

11. Feuer, U. 1977. Influence of alloy composition and solidification conditions on dendrite arm spacing, feeding and hot tearing properties of aluminium alloys. *Proc. Symp. on Quality Control of Engineering Alloys and the Role of Metals Science*, 131-145. Eds. H. Nieswag and J. W. Schut. Delft.

12. Rappaz, M., Drezet, J. M., and Gremaud, M. 1999. A new hot-tearing criterion. *Met. Mat. Trans.* 30A: 449-455.

13. Coniglio, N. 2008. Aluminum alloy weldability-identification of weld solidification cracking mechanisms through novel experimental technique and model development. Doctoral thesis dissertation, Otto-von-Guericke Universität, Magdeburg, BAM Pub., Berlin.

14. Eklund, J. E. 1991. On the effects of impurities on the solidification and casting of aluminium alloys. PhD thesis dissertation, Helsinki Univ. of Tech, Helsinki, Finland.

15. Taylor, J. A., Schaffer, G. B., and StJohn, D. H. 1999. The role of iron in the formation of porosity in Al-Si-Cu-based casting alloys: Part III. A microstructural model. *Met. Mat. Trans.* 30A(6): 1657-1662.

16. Lu, L., and Dahle, A. K. 2005. Iron-rich intermetallic phases and their role in casting defect formation in hypoeutectic Al-Si alloys. *Met. Mat. Trans.* 36A(3): 819-835.

17. Couture, A. 1981. Iron in aluminum casting alloys — A literature survey. *AFS Int. Cast Metals J.* 6(4): 9-17.

18. Singer, A. R. E., and Jennings, P. H. 1947. Hot-shortness of some aluminium-iron-silicon alloys of high purity. *J. Inst. Metals* 73: 273-284.

19. Mbuya, T. O., Odera, B. O., and Ng'ang'a, S. P. 2003. Influence of iron on castability and properties of aluminium silicon alloys — Literature review. *Int. J. Cast Metals Research* 16(5): 451-465.

20. Coniglio, N., and Cross, C. E. 2008. Ef-

fect of cooling rate and silicon content on solidification path and phase constituents in 6060 aluminum castings and weld metal. *Proc. 11th Int. Conf. on Aluminium Alloys*, 1889-1896. Deutsche Gesellschaft für Materialkunde.

21. Dvornak, M. J., Frost, R. H., and Olson, D. L. 1989. The weldability and grain refinement of Al-2.2Li-2.7Cu. *Welding Journal* 68(8): 327-s to 335-s.

22. Spittle, J. A., and Cushway, A. A. 1983. Influences of superheat and grain structure on hot tearing susceptibilities of Al-Cu alloy castings. *Metals Technology* 10: 6-13.

23. Tarshis, L. A., Walker, J. L., and Rutter, J. W. 1971. Experiments on the solidification structure of alloy castings. *Met. Trans.* 2(9): 2589-2597.

24. Nelson, T. W., Lippold, J. C., Lin, W., and Baeslack III, W. A. 1997. Evaluation of the circular patch test for assessing weld solidification cracking, Part I — Development of a test method. *Welding Journal* 76(3): 110-s to 119-s.

25. *Aluminum Standards and Data*. 1984. Washington, D.C.: Aluminum Association.

26. Gibbs, F. E. 1966. Development of filler metals for welding Al-Zn-Mg Alloy 7039. *Welding Journal* 45(10): 445-s to 453-s.

27. Liang, H., Chen, S. L., and Chang, Y. A. 1997. A thermodynamic description of the Al-Mg-Zn system. *Met. Trans.* 28A(9): 1725-1734.

28. Phillips, M. A. 1959. *Annotated Equilibrium Diagrams of Some Aluminium Alloy Systems*. Monograph and Report Series No. 25. London: The Institute of Metals.

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Mathematical Modeling of Electrode Cooling in Resistance Spot Welding

Mathematical models have been developed to simulate the electrode cooling in resistance spot welding and to evaluate a new cone-fin weld cap design capable of reducing the cap temperature

BY Z. H. RAO, S. M. LIAO, H. L. TSAI, P. C. WANG, AND R. STEVENSON

ABSTRACT

Due to the high heat flux from the weld nugget to the electrode, the electrode experiences thermal excursion and deformation, which lead to the requirement for frequent redressing or replacement of the weld cap. To extend the life of the weld cap, a better understanding of the thermal excursion experienced by the weld cap, and thus its cooling, is required. In this study, mathematical models that include the cooling water flow impinging onto the underside of the cap, resistance (or Joule) heating, as well as the heat transfer between the weld cap and the cooling water were developed. It was found that the conventional weld cap configuration results in a severe stagnation fluid flow near the underside of the weld cap and thus may lead to poor film boiling heat transfer there. Based on this understanding, a new cone-fin design on the underside of the weld cap was proposed to enhance the heat transfer. Our modeling results show that the fin not only lessens the stagnation flow near the cap but also increases the cooling area, leading to large reductions in temperatures at the underside of the weld cap. A roughened fin surface is also suggested to provide nucleation sites that can enhance the heat transfer between the cap and the cooling water due to nucleate boiling. Our implementation studies further confirm that the new cone-fin cap design can significantly extend the life of the weld cap.

Introduction

Resistance spot welding (RSW), as shown in Fig. 1, is the most widely used

joining technique for the assembly of sheet metal components, especially in the automotive industry. It is characterized by high operating speeds and suitability for automation or robotization. During the process, sheet metal components are welded together as a result of the heat generated by electric resistance to current flow. The RSW process consists of first applying a force through the electrodes to clamp the workpieces and reduce the interface resistance and then passing a current through all the components shown in Fig. 1. As a result of the current flow, heat will be generated due to Joule heating. Since the welding current remains constant along the components, the location at which the greatest electrical resistance exists will generate the greatest heat. As the resistance of the interface between the two workpieces is dominant, a great deal of heat generated at the interface leads to an incremental rise in temperature of the weld cap. Therefore, owing to the effects of the mechanical force and electrical current, the weld cap is subjected to significant thermal and mechanical excursions. After a few welding cycles, the weld caps tend to be mushroomed resulting in the increase of the electrode tip area and thus the decreases of the holding pressure and current density (Ref. 1). Consequently, the current density will become smaller, which may not be high enough for effective welding. For this reason, the weld cap should be replaced or redressed, especially when welding thin workpieces.

KEYWORDS

Resistance Spot Welding
Electrode Cooling
Weld Cap
Transient Thermal Analysis

Hence, good cooling of the weld cap is essential in order to prevent it from becoming too hot and too soft. A number of experimental and modeling studies have attempted to address and better understand the aforementioned issue (Refs. 2–4). And much experimental research on electrode cooling water has been carried out to study the effects of water flow rate and water temperature (Refs. 5, 6). However, few detailed descriptions of modeling cooling water flow in the weld electrode and improving cooling efficiency during RSW have been reported.

In this study, we first focus our attention on developing a model for the fluid flow of cooling water in a “conventional” weld cap and, then, a time-dependent thermal model is developed to simulate the transient weld cap cooling process. Based on the fundamental understanding of the fluid flow and heat transfer characteristics for the conventional weld cap, a new cone-fin weld cap design is proposed and the corresponding mathematical model is developed aiming at the enhancement of the weld cap cooling. The new cap design is also implemented. Our modeling results show that in the new cap design the weld cap temperature is reduced, which is indirectly confirmed by our implementation studies in which the cap lifetime has been significantly extended.

Mathematical Modeling

Figure 2A illustrates the geometry of the electrode including a conventional weld cap mounted on a supporting member (shank) with a cooling tube that pro-

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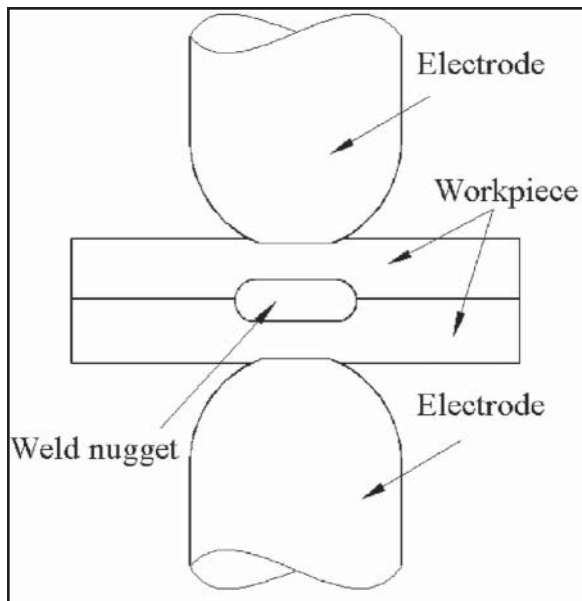


Fig. 1 — Schematic of the resistance spot welding process.

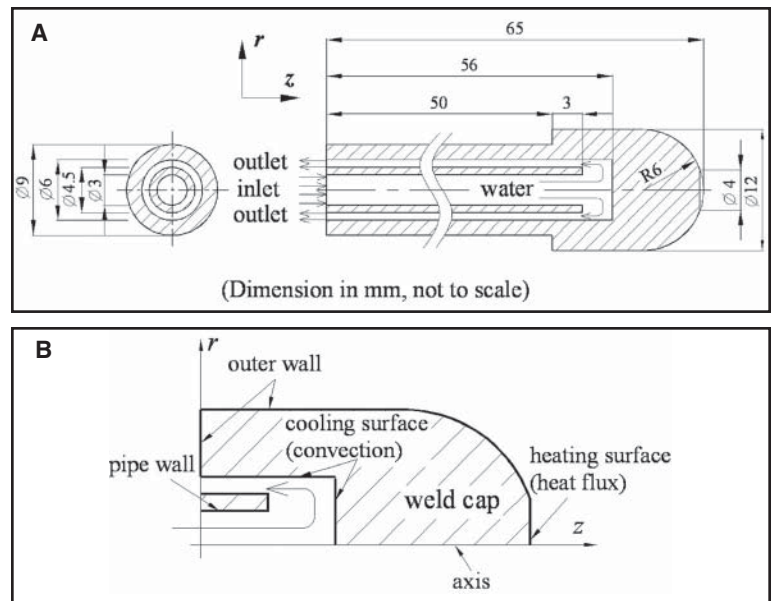


Fig. 2 — Schematic representation of the electrode with conventional weld cap: A — Geometry of the electrode; B — conventional weld cap and axisymmetrical computational domain.

vides cooling water. In this study, the shank-weld cap joint has been ignored, and the water supply tube is coaxially located relative to the shank wall. This sim-

plification for modeling has negligible effects on the fluid flow in the cavity of the cap and the heat transfer between the cap and the cooling water compared to the ac-

tual setup (Ref. 7). The cooling water enters the cap cavity through the inner tube and leaves via the annular channel between the inner and the outer tubes.

Modeling of Cooling Water Flow

The computational domain for modeling the cooling water flow is the cap cavity in the electrode that is idealized compared to real electrode caps, as shown in Fig. 2B. Due to symmetry arising from the presumed central location of the inlet flow tube, only one-half of the domain is considered. The inlet cooling water volume flow rate is assumed to be 2.46 L/min (0.65 gal/min) at 300 K, leading to about 5.8 m/s of average inlet velocity. The Reynolds number (Re) based on the tube diameter is about 17000 and, hence, the internal flow falls in the turbulent regime (Ref. 8). In the calculation, the relative pressure is used in the fluid flow field and a zero pressure is assumed at the outlet of the tube. The fluid flow governing differential equations based on the standard $k-\epsilon$ turbulence model are solved using Fluent software (Ref. 9).

Figures 3A and B show, respectively, the calculated velocity vectors and pressure contours of the cooling water. As shown, the flow velocity decreases significantly near the center of the underside of the weld cap (at which the maximum temperature occurs), leading to a local high pressure region and a stagnation flow there. Hence, the cooling water may not be able to “sweep” the heat away from the weld cap. Previous experiments (Ref. 7) have demonstrated that the temperature

Table 1 — Thermophysical Properties and Other Parameters

Nomenclature	Symbol	Value (unit)
Density of cap	ρ_c	8978 (kg/m ³)
Specific heat of cap	c_{pc}	381 (J/kg-K)
Thermal conductivity of cap	k_c	387.6 (W/m-K)
Electric conductivity of cap	σ_e	5.88×10^7 ($\Omega^{-1}\text{m}^{-1}$)
Density of cooling water	ρ_l	997.9 (kg/m ³)
Density of saturated water	ρ'	958.6 (kg/m ³)
Density of saturated steam	ρ''	0.596 (kg/m ³)
Density of superheated steam	ρ_v	0.565 (kg/m ³)
Specific heat of cooling water	c_{pl}	4176 (J/kg-K)
Specific heat of saturated water	c'_p	4214 (J/kg-K)
Specific heat of saturated steam	c''_p	2075 (J/kg-K)
Specific heat of superheated steam	c_{pv}	2021 (J/kg-K)
Thermal conductivity of cooling water	k_l	0.608 (W/m-K)
Thermal conductivity of saturated water	k'	0.679 (W/m-K)
Thermal conductivity of saturated steam	k''	0.025 (W/m-K)
Thermal conductivity of superheated steam	k_v	0.0265 (W/m-K)
Viscosity of cooling water	μ_l	8.90×10^{-4} (kg/m-s)
Viscosity of saturated water	μ'	2.82×10^{-4} (kg/m-s)
Viscosity of saturated steam	μ''	1.23×10^{-5} (kg/m-s)
Viscosity of superheated steam	μ_v	1.30×10^{-5} (kg/m-s)
Surface tension of saturated water	σ	0.059 (N/m)
Latent heat of evaporation	h_{fg}	2.259×10^6 (J/kg)
Cooling water temperature	T_l	300 (K)
Saturated water temperature	T'	373.15 (K)
Multiplier in Equation 4	F	27.12
Multiplier in Equation 6	S	0.1
Local vapor volume fraction	α_{lh}	0.9

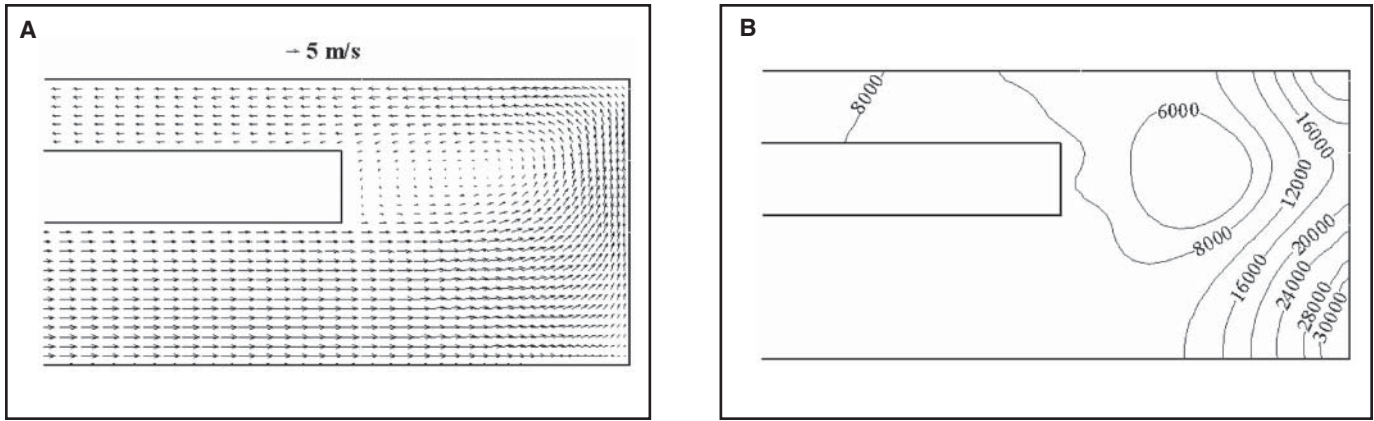


Fig. 3 — Calculated velocity vector and pressure contour for the cooling water in the conventional weld cap: A — Velocity vector; B — pressure contour (Pa).

at the underside of the weld cap can reach the boiling point of water. The very low flow velocity near the center of the weld cap will lead to an excessively high temperature of the weld cap, which may exceed the burnout point or the boiling crisis point (Ref. 10). As a result, the heat transfer mechanism between the cooling water and the weld cap may change from nucleate boiling to film boiling (Ref. 10). In the film boiling regime, the surface is blanketed by a film of vapor, and the heat transfer from the weld cap surface to the cooling water is by conduction across the vapor film, leading to a dramatic decrease of the heat transfer between the weld cap and cooling water. As a result, a further elevation of the cap temperature and thus a reduction in the strength of the cap will occur, which accelerates the softening and mushrooming of the cap.

Modeling of Weld Cap Temperature

Governing Equation

Figure 2B shows the computational domain of the weld cap in a cylindrical coordinate system that is enveloped by the heating surface, cooling surface, outer walls, and axis. For heat conduction in the axisymmetric weld cap, the governing equation is given by

$$\rho_c c_{pc} \frac{\partial T}{\partial t} = k_c \left(\frac{\partial^2 T}{\partial r^2} + \frac{1}{r} \frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial z^2} \right) + S \quad (1)$$

where ρ_c is the density, c_{pc} is the specific heat, and k_c is the thermal conductivity of the cap. S is the source term from the bulk resistive heat generation by welding current (W/m^3).

Boundary Conditions

The boundary condition at the interior cooling surface is given by

$$-k_c \frac{\partial T}{\partial n} = h(T_w - T_l) \quad (2)$$

where $\vec{n}$ is the unit outer normal vector from the wall, T_w is the cap wall temperature, T_l is the cooling water temperature, and h is the convective heat transfer coefficient that depends on the flow characteristics of the cooling water. As discussed previously, boiling of the cooling water may occur at the inner surface of the cavity, which will lead to a complicated two-phase flow. Depending upon the characteristics of fluid flow and heat transfer, the heat transfer coefficient h in Equation 2 can be a combination of forced convection boiling h_1 and natural convection film boiling h_2 , which are discussed below.

For forced convection boiling, the following convective heat transfer coefficient is considered to be the combination of single-phase liquid heat transfer and nucleate boiling heat transfer (Refs. 11, 12)

$$h_1 = h_c + h_{NB} \left(\frac{T_w - T'}{T_w - T_l} \right) \quad (3)$$

where T' is the saturated water temperature and h_c corresponds to the single-phase liquid heat transfer and is obtained from the following Dittus-Boelter equation modified by a multiplier F

$$h_c = 0.023 \frac{k_l}{d} F \times Re_l^{0.8} Pr_l^{0.4} \quad (4)$$

where the subscription l is for liquid, Pr is the Prandtl number, and F is determined by the Martinelli factor (Ref. 11). The nucleate boiling heat transfer coefficient h_{NB} , proposed by Forster and Zuber (Ref. 13), is employed in this study and given by

$$h_{NB} = c \left(p' \left[\min(T_w, 647) \right] - p_0 \right)^{0.75} (T_w - T')^{0.24} \quad (5)$$

where

$$c = 0.00122 S \left(\frac{k' c'_p}{\sigma} \right)^{1/2} Pr_l^{-0.29} \rho'^{1/4} \left(\frac{c'_p \rho'}{\rho'' h_{fg}} \right)^{0.24} \quad (6)$$

where the superscript “prime” refers to the saturated water, the “double prime” superscript refers to vapor phase, p_0 is atmospheric pressure, σ is the surface tension, and h_{fg} is the latent heat of evaporation. The multiplier S , defined as the ratio of the effective superheat to the total superheat of the wall, is a function of the Reynolds number provided by Bjornard and Griffith (Ref. 14).

The heat transfer coefficient for film boiling in this study is given by

$$h_2 = h_{FB} \left(\frac{T_w - T'}{T_w - T_l} \right) \quad (7)$$

where h_{FB} is the film boiling heat transfer coefficient. For natural convection film boiling on a horizontal plane, Berenson (Ref. 15) proposed the following expression

$$h_{Berenson} = 0.425 \left(\frac{k_v^3 \rho_v (\rho' - \rho'') h_{fg} g}{\mu'' (T_w - T') \lambda_{RT}} \right)^{1/4} \quad (8)$$

where

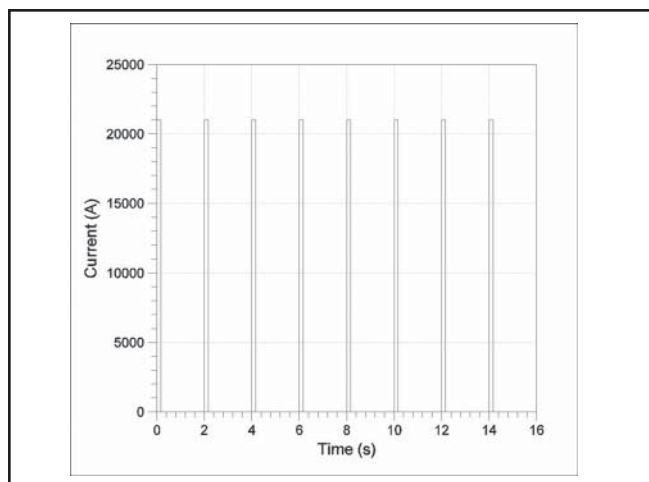


Fig. 4 — Weld current vs. time for a typical resistance weld.

$$\lambda_{RT} = \left[\frac{\sigma}{g(\rho' - \rho'')} \right]^{1/2} \quad (9)$$

where the subscript v is for vapor and g is the gravitational acceleration. For natural convection film boiling in channel with very low mass flux, Leperriere (Ref. 16) modified the Berenson's equation to obtain a correlation as

$$h_{FB} = h_{Berenson} \left(1 + 25.5 \frac{T_w - T'}{T_l} \right) (1 - \alpha_{lh})^{0.5} \quad (10)$$

where α_{lh} is the local vapor volume fraction (Ref. 16).

Based on the calculated flow characteristics and above discussion, the heat transfer mechanism along the cooling surfaces may involve several different regimes, including single-phase liquid heat transfer, nucleate boiling, and film boiling. Therefore, the heat transfer coefficient h in Equation 1 is regarded to be a weighted average of heat transfer coefficients h_1 and h_2 , which can be expressed as

$$h = \alpha_1 h_1 + (1 - \alpha_1) h_2 \quad (11)$$

where α_1 corresponds to the ratio of forced convection boiling heat flux to the total heat flux. Strictly speaking, the heat transfer coefficient h can be time and location dependent, and depends on the fluid flow and heat transfer characteristics. In this study, we assume $\alpha_1 = 0.5$, an average of the forced convection boiling and the natural convection film boiling. Note a constant temperature T_l of 300 K is assumed for cooling water, which is reasonable because the high flow rate results in only a few degrees (K) of temperature increase for fluid core

through the cavity (Ref. 1). As a result, the heat transfer in the internal fluid core is ignored. For heat conduction in the weld cap, various cooling rates due to the various heat transfer coefficients between the walls and cooling water are considered by Equations 2–11. It is also noted that the wall temperature T_w and the heat transfer coefficient h are coupled, and iterations are required in the calculation.

The boundary condition at the heating surface (see Fig. 2B) is considered as Joule heating flux due to contact resistance at the interface between the weld cap and workpiece. The contact resistance consists of the constriction resistance and the resistance from possible surface contamination. In general, contact resistance may vary both spatially and temporally. In this study, the contact resistance is assumed to be constant, and half of the power input determined by the experiment (Ref. 4), 910 W, is used, yielding a heat flux of $q = 7.24 \times 10^7$ W/m². For the outer walls (see Fig. 2B), the heat loss may consist of both the natural convection and thermal radiation. However, in this study the natural convection and radiation heat loss are negligible as compared to the convective heat transfer to the cooling water. Hence, the boundary condition at the outer walls is simply set as an adiabatic condition ($q = 0$).

Generation of Joule Heat

The bulk Joule heat generation due to

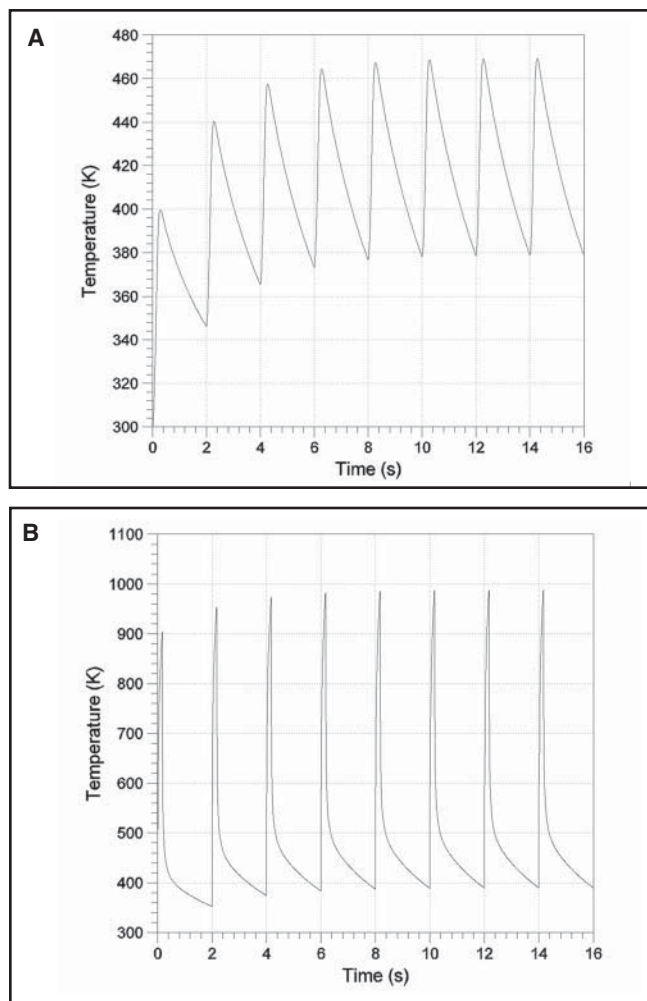


Fig. 5 — Calculated transient temperature at the underside center ($z = 6$ mm, $r = 0$ mm) and at the tip ($z = 14.66$ mm, $r = 0$ mm) of the weld cap: A — At the underside center; B — at the tip.

electric resistance is determined by Ohm's law. Hence, the source term in Equation 1 can be derived as

$$S = \frac{J^2}{\sigma_e} = \sigma_e E^2 \quad (12)$$

where σ_e is the electric conductivity of the material, J is the electric current density, and E is the magnitude of the electric field. In order to obtain the electric field, the following Poisson's equation must be solved.

$$\frac{1}{r} \frac{\partial}{\partial r} \left(\sigma_e r \frac{\partial \phi}{\partial r} \right) + \frac{\partial}{\partial z} \left(\sigma_e \frac{\partial \phi}{\partial z} \right) = 0 \quad (13)$$

where ϕ is the electric potential, and the two components of the electrical field can be found via

$$E_r = -\sigma_e \frac{\partial \phi}{\partial r}; E_z = -\sigma_e \frac{\partial \phi}{\partial z} \quad (14)$$

Finally, the magnitude of the electric field E

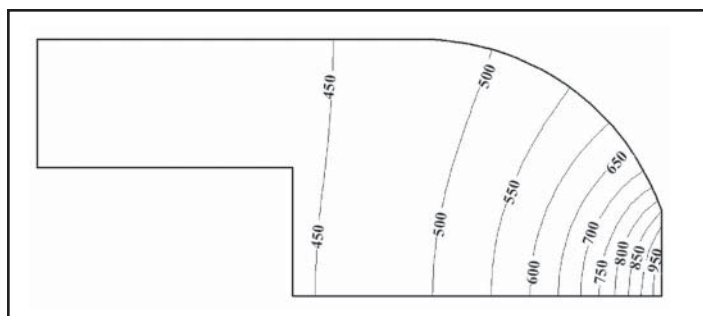


Fig. 6 — Temperature contour (K) of the conventional weld cap at a weld time of 14.165 s.

is computed, which is the square root of E_r^2 and E_z^2 .

Numerical Procedure

Equations 1 and 13, subjected to all required boundary conditions, are solved implicitly with a time step size of 0.005 s. At each time step, Equations 3–10 are first solved based on a new wall temperature to obtain the heat transfer coefficient through Equation 11. The boundary condition at the interior cooling surface is then updated using Equation 2. Equations 13 and 14 are also solved to obtain the new electric field and update the source term S using Equation 12. And then Equation 1 is solved to obtain a new distribution of temperature in the weld cap. Next, the calculation goes back to the first step. This process is repeated for each time step until the convergence criteria for wall temperature are satisfied.

Results and Discussion

In this study, the welding system is stationary and the time-dependent welding process with the given welding current cycles is shown in Fig. 4. In each cycle (2 s), an electric current of 21 kA is applied during the first 0.165 s and then is shut off for 1.835 s (Ref. 4). Thus, the heat flux at the heating surface and the bulk resistive heat source are generated periodically. Note some real welding current features are not considered in this study. The effect of multiple weld cycles (representative of the thermal exposure experienced by the weld cap when multiple sequential welds are made robotically in an individual station) is investigated by repeating this cycle eight times corresponding to eight welds made at 2-s intervals (i.e., robot duty cycle is 8). The thermophysical properties of the weld cap (copper) and water (Ref. 17) are listed in Table 1 with other parameters used for the calculation.

Transient Temperatures

Figure 5A and B show, respectively, the

transient temperature at the underside center ($z = 6$ mm, $r = 0$ mm) and the tip ($z = 14.66$ mm, $r = 0$ mm) of the weld cap. As shown in the figures, both the temperatures at the underside center and the tip of the weld cap increase rapidly after the cessation of electric current, as expected. The peak temperatures of the cap tip and the underside of the weld cap are about 985 and 470 K, respectively. The tip temperature decays rapidly after the electric current is ceased, while the temperature at the underside decreases slowly. The tip temperature remains “steady” after about four welding cycles, but it takes about six welding cycles for the underside of the cap. The predicted temperature trends for the cap underside are generally in good agreement with the experimental measurements (Ref. 7) where water boiling was observed. Figure 6 shows the temperature contour in the weld cap at $t = 14.165$ s for the last welding cycle.

As shown in Fig. 5B, under repeated weld cycles, the transient behavior associated with each individual weld cycle is superimposed on an increasing background temperature that quickly approaches an asymptotic limit (steady state) after several welding cycles, especially for the electrode with the high thermal conductivity. At the asymptotic limit, the heat loss to the cooling water balances with the heat input and generation during one cycle. Hence, the temperature varies periodically in a repeated fashion and no further increase in peak temperature takes place. Thus, the thermally driven mechanism of cap degradation will not be further enhanced even if more welds are added to a robot duty cycle. However, there is approximately 85 K difference in peak temperature between

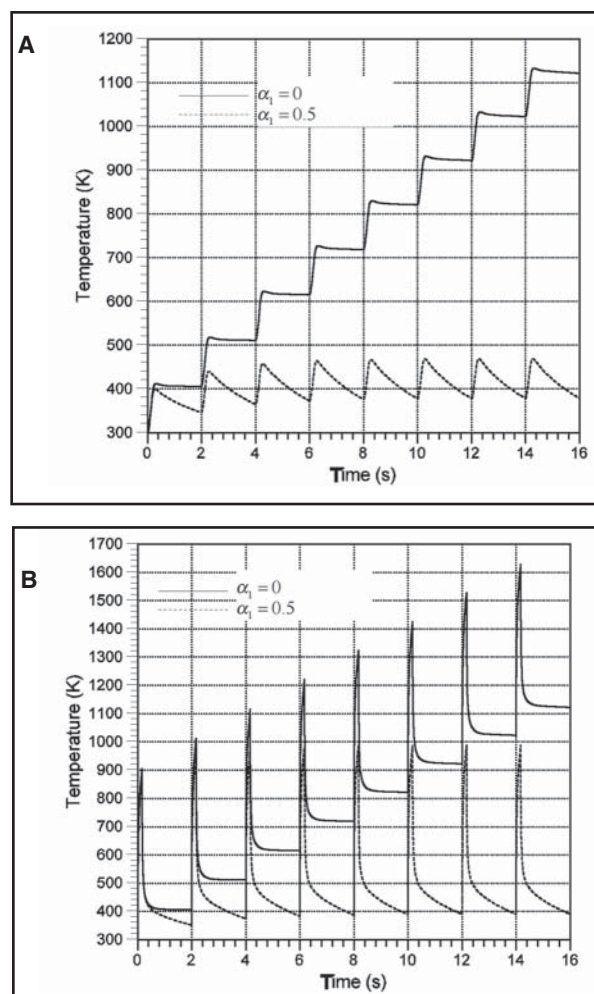


Fig. 7 — Effect of convective heat transfer coefficient on the transient temperature at the underside center ($z = 6$ mm, $r = 0$ mm) and at the tip ($z = 14.66$ mm, $r = 0$ mm) of the weld cap: A — At the underside center; B — at the tip.

the first and the eighth weld cycle, which plays a significant role in accelerating the weld cap degradation. Thus, while an increase in the number of welds in a duty cycle will not significantly increase the rate of cap degradation provided the background temperature has achieved its asymptotic limit, a decrease in the number of welds in the duty cycle, which enables a reduction in the background temperature, will effectively reduce the rate of weld cap degradation, and extend the weld cap life.

The above calculated results indicate that the underside wall temperature of the weld cap falls in the range of 300–500 K. As a result, the heat transfer coefficient h is in the order of 10^4 W/m²–K that is about the average of film boiling and nucleate boiling. Hence, our assumption of using $\alpha_1 = 0.5$ appears to be reasonable. However, it would be worthwhile to study the effects of the heat transfer coefficient on temperature cycles of the weld tip and the underside. Figure 7A and B, respectively, shows the transient temperature profiles at the underside center and the tip of the

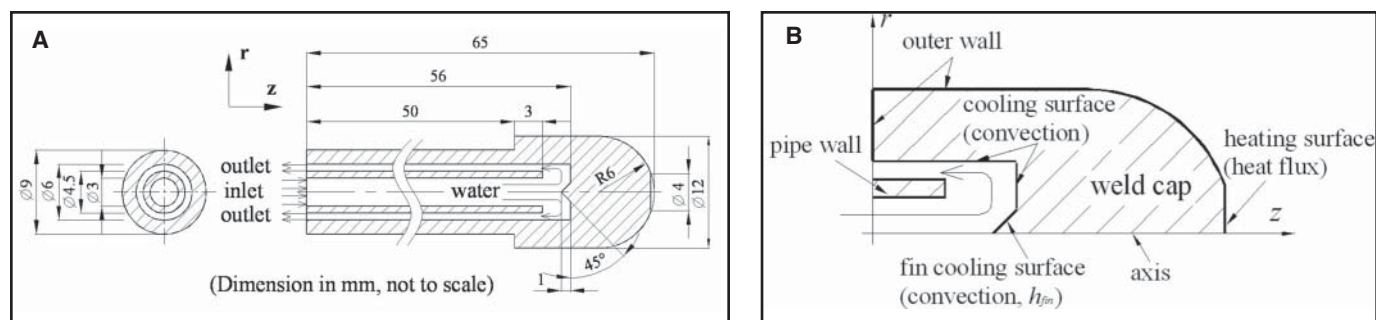


Fig. 8 — A schematic representation of the electrode with new weld cap design: A — Geometry of the electrode; B — new weld cap design and axisymmetrical computational domain.

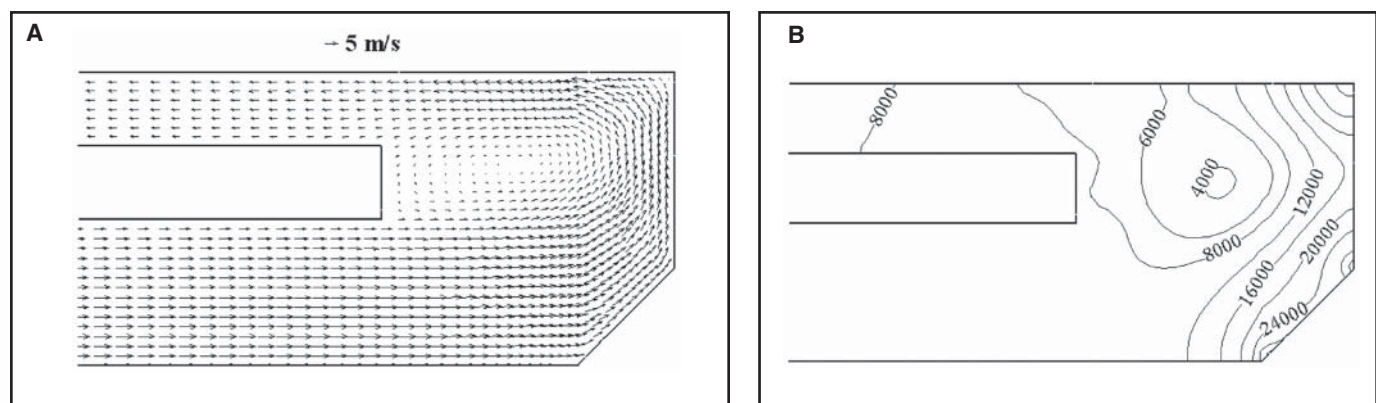


Fig. 9 — Calculated velocity vector and pressure contour for the cooling water in the new weld cap: A — Velocity vector; B — pressure contour (Pa).

weld cap between the cases with $\alpha_1 = 0$ and $\alpha_1 = 0.5$ (the case shown in Fig. 5). When $\alpha_1 = 0$, the heat transfer coefficient is calculated by Equation 7 and in the order of $10^2 \text{ W/m}^2\text{-K}$, which corresponds to the formation of a vapor film around the inner surface of the cap as a result of the stagnation flow of the cooling water. With the low heat transfer coefficient, our modeling results show that the quasi-steady state would never be achieved. This suggests that for each weld cycle the heat input is always larger than the heat removal and, consequently, the peak temperature increases progressively and promotes ever-increasing weld cap degradation. Note that, as shown in Fig. 7A, B, the differences in corresponding temperatures between the two cases are not significant during the first welding cycle. This is because the response from the cooling water is slow compared to the short welding duration of 0.165 s. Note similar results were also found by Yeung and Thornton (Ref. 4) that the convective heat transfer coefficient has little effect on the peak temperature for the first welding cycle. However, after the following cooling cycles the weld cap temperature cannot be restored to its initial condition as $\alpha_1 = 0$, indicating both the background tem-

perature and the peak temperature increase continuously.

New Weld Caps

The calculated velocity vectors and pressure contours are shown in Fig. 9A and B, respectively. It can be seen that near the underside of the weld cap, stagnation flow has been significantly reduced. The cooling water sweeps and carries away the heat transferred from the weld tip. Hence, the new cap design can effectively lessen the stagnation of the flow and avoid the occurrence of film boiling near the center of the cooling surface. Since boiling of cooling water near the cap underside is still inevitable, maintaining the nucleate boiling might be a good way to improve the heat transfer by taking advantage of large latent heat of vaporization. This can be achieved by roughening the surface of the cone-fin. The roughened surface would provide many nucleation sites for boiling, thereby suppressing film boiling and dramatically augmenting the heat transfer.

Figure 8B shows the calculation domain for modeling the new weld cap with a cone-fin of a height of 1 mm and a base radius of 1 mm, which is enveloped by the

heating surface, cooling surface, outer walls, fin, and axis. In this model, most conditions are the same as the conventional design without a fin, but a higher convective heat transfer coefficient in the fin area is used. Based on the above discussion, as there is no stagnation flow near the cone-fin and a possible nucleate boiling, the value of α_1 in Equation 11 is higher. For simplification, two constant heat transfer coefficients for the fin h_{fin} are assumed in the modeling (i.e., 30,000 and 50,000 $\text{W/m}^2\text{-K}$), which are in the range of the results obtained from Equation 3 for the forced convection boiling heat transfer. Note the selected values of the convective heat transfer coefficients are typical for nucleate boiling. It is also noted the heat transfer coefficient for the other cooling surface is coupled with wall temperature and, hence, iterations are required using the aforementioned method. Figure 10A, B show, respectively, the transient temperatures at the underside center ($z = 6 \text{ mm}$, $r = 0 \text{ mm}$) and the tip ($z = 14.66 \text{ mm}$, $r = 0 \text{ mm}$) of the new weld cap. It is seen that, compared to the case without a cone-fin, the temperatures at the underside of the weld cap are significantly decreased. The temperature reductions at the underside of the weld cap for a heat

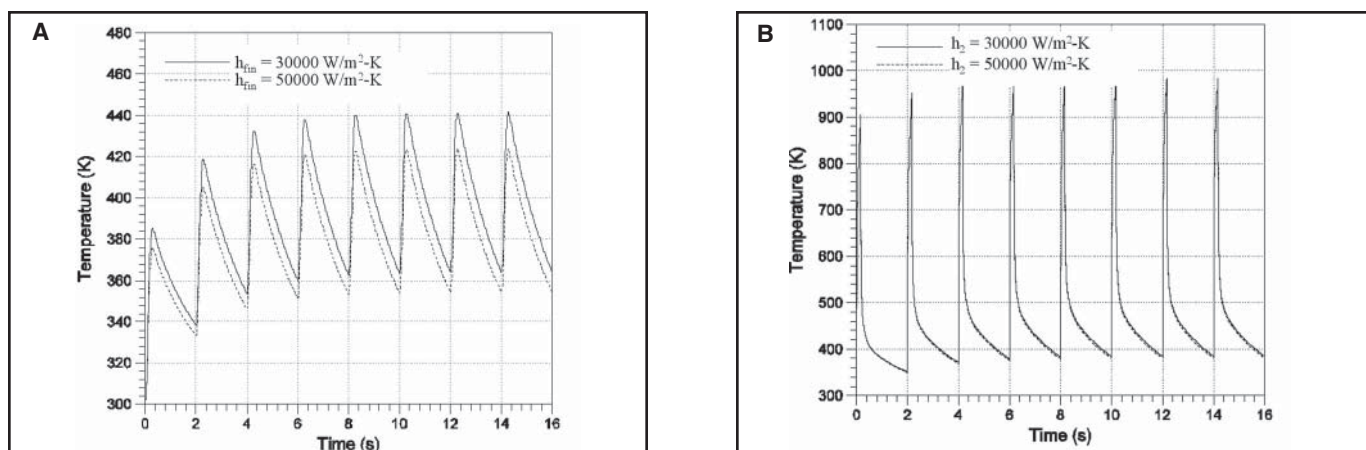


Fig. 10 — Effect of heat transfer coefficients of the fin on the transient temperature at the underside center ($z = 6 \text{ mm}$, $r = 0 \text{ mm}$) and at the tip ($z = 14.66 \text{ mm}$, $r = 0 \text{ mm}$) of the weld cap ($h_{\text{fin}} = 30,000 \text{ W/m}^2\text{-K}$ or $50,000 \text{ W/m}^2\text{-K}$): A — At the underside center; B — at the tip.

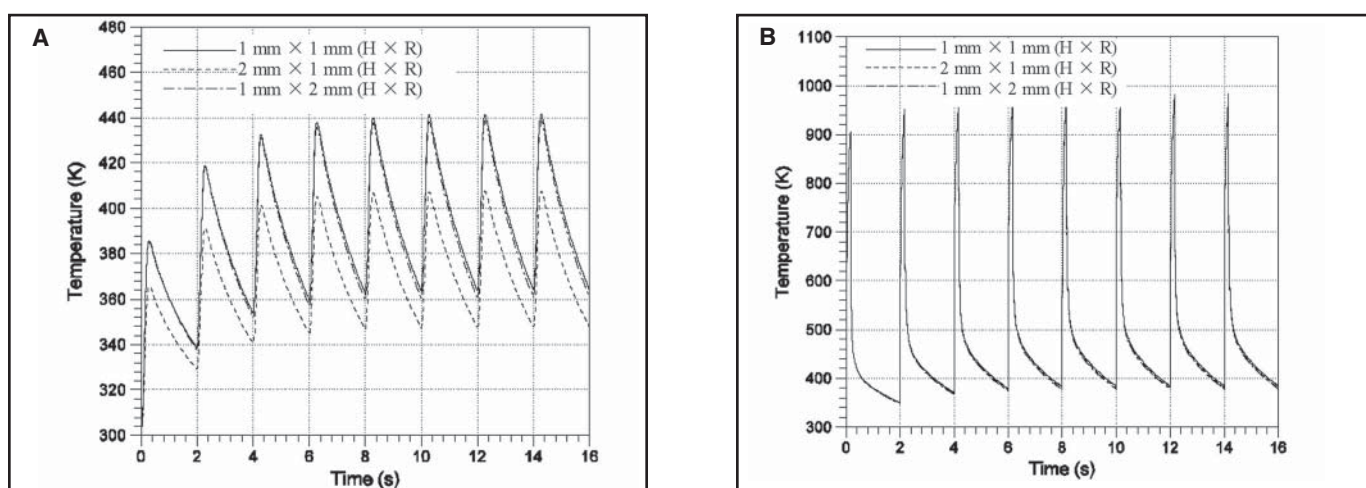


Fig. 11 — Effect of fin geometry on the transient temperature at the underside center ($z = 6 \text{ mm}$, $r = 0 \text{ mm}$) and at the tip ($z = 14.66 \text{ mm}$, $r = 0 \text{ mm}$) of the weld cap ($H = \text{height}$, $R = \text{base radius}$): A — At the underside center; B — at the tip.

transfer coefficient h_{fin} of $30,000 \text{ W/m}^2\text{-K}$ and $50,000 \text{ W/m}^2\text{-K}$ are 30 and 50 K, respectively. However, the temperature at the tip of the weld cap is determined by the heat dissipation rate from the tip and heat flux onto the tip. The heat flux for each case is unchanged due to the same welding current profile and contact resistance. As shown in Fig. 10B, when a cone fin is added, the temperature at the tip only has a slight decrease at the end of each cycle due to the slow response from heat removal by cooling water compared to the welding cycle duration (2 s).

Effect of Fin Geometry

The above results indicate the addition of a cone-fin at the underside of the weld cap improves the heat transfer significantly. To optimize the fin geometry, in addition to the original fin geometry, two more fin geometries were studied; one fin geometry has a height (H) of 2 mm and a

base radius (R) of 1 mm, and the other has a height (H) of 1 mm and a radius (R) of 2 mm. The heat transfer coefficient for the fin is assumed to be $30,000 \text{ W/m}^2\text{-K}$ in both cases. Figure 11A, B show, respectively, the effects of fin geometry on the temperatures of the underside center and the tip of the weld cap. In comparison to the original fin with 1 mm height and 1 mm base radius, the fin with higher height (2 mm) further reduces the temperature at the underside center by about 30 K, while there is no obvious decrease in temperature for the case with greater radius (2 mm). This can attribute to the fin efficiency discussed below. However, for all these cases, the temperature differences at the tip are insignificant due to the reason discussed in Fig. 10B. These results suggest that the variation in fin geometry has little influence on the temperature of the cap tip.

A theoretical study of a cone-fin, with a constant base temperature, yields the

following equation for the fin tip temperature (Ref. 18):

$$\frac{T_0 - T_\infty}{T_B - T_\infty} = \frac{m\sqrt{H}}{I_1\left(2m\sqrt{H}\right)} \quad (15)$$

where T_0 is the temperature of the cone-fin tip, T_B is the temperature of the cone-fin base, T_∞ is the fluid flow temperature, I_1 is the modified first-order Bessel function of the first kind, and

$$m^2 = \frac{2h}{k} \sqrt{\left(\frac{H}{R}\right)^2 + 1}. \quad (16)$$

The fin efficiency is defined as the ratio of the heat transfer rate for the case with a fin to the case without a fin. For an ideal cone-fin, its efficiency is given by

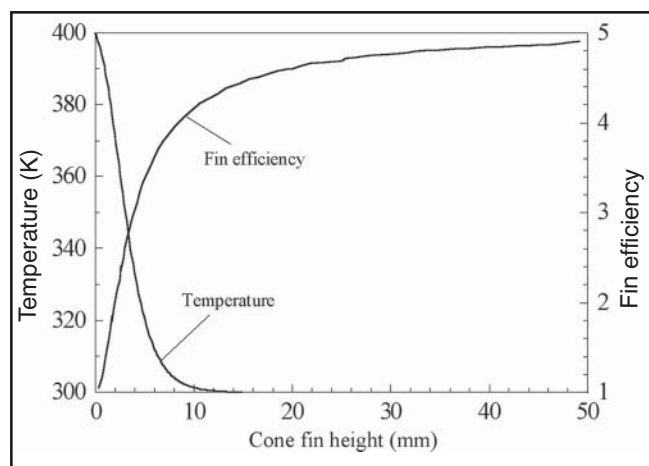


Fig. 12 — Effects of fin height on the fin tip temperature and the fin efficiency ($h = 30,000 \text{ W/m}^2\text{-K}$, $k = 387.6 \text{ W/m-K}$, $T_B = 400 \text{ K}$, $T_\infty = 300 \text{ K}$, fin base radius $R = 0.001 \text{ m}$).

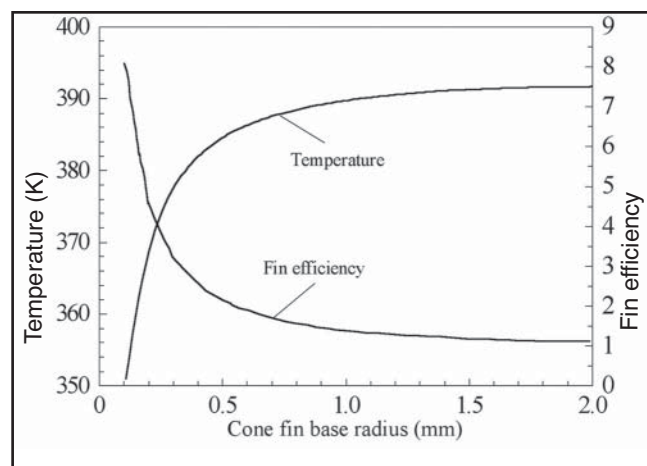


Fig. 13 — Effects of fin base radius on the fin tip temperature and the fin efficiency ($h = 30,000 \text{ W/m}^2\text{-K}$, $k = 387.6 \text{ W/m-K}$, $T_B = 400 \text{ K}$, $T_\infty = 300 \text{ K}$, fin height $H = 0.001 \text{ m}$).

$$E = \frac{k}{hH} \left(m\sqrt{H} \frac{I_0(2m\sqrt{H})}{I_1(2m\sqrt{H})} - 1 \right) \quad (17)$$

Figures 12 and 13 show, respectively, the variations of fin tip temperature and fin efficiency with respect to the variations of fin height and fin base radius. A convection heat transfer coefficient $h = 30,000 \text{ W/m}^2\text{-K}$ and a thermal conductivity $k = 387.6 \text{ W/m-K}$ for the fin are used in the calculations. The cone-fin base temperature and fluid flow temperature are taken at 400 and 300 K, respectively. Thus, trends for the effects of the fin geometry parameters on local temperature obtained from the theoretical solution agree with our modeling results as discussed above. It appears a fin of larger height has a better efficiency. However, when the fin height exceeds a certain range, the heat transfer enhancement is no longer significant.

Implementation Studies

During the normal welding process, the tip area of the weld cap will grow by mushrooming and consequently the current density and pressure will decrease. To maintain the effective RSW process and weld quality, a schedule of electrode redressing should be set up. With other variables held constant, 60-Hz, single-phase AC at different levels was used to examine the aforementioned weld caps. The cap material used was Class II Cr-Cu alloy with a 4-mm tip diameter. It is assumed that the electrode should be redressed as the diameter of the electrode tip increases to 1.3 times the starting diameter (Ref. 1). Thus, the weld numbers of the electrode before its redressing were obtained. Extensive experiments have been conducted and only one representative result is pre-

sented here. As shown in Fig. 14, it can be seen that the new cone-fin design increases the weld number significantly. At the same current level, the weld number for the new cone-fin cap is much larger than that for a conventional weld cap. For both kinds of weld caps, the weld numbers increase with welding current in a nearly linear relationship. This is because the weld time and hold time can be shortened for each welding cycle at a higher current level. Although the temperatures of the underside and the tip of the weld cap were not measured for direct comparison with modeling predictions, apparently the new cone-fin design and our modeling predictions are generally correct for improving the weld cap cooling and extending the life of the weld cap.

Conclusions

In this paper, models that include cooling water flow impinging onto the underside of the cap, heat generated by resistance to the flow of electric current in the weld cap, as well as heat transfer between the weld cap and the cooling water were developed. It was found that the conventional configuration of the weld cap results in stagnation of the fluid flow, leading to poor film boiling heat transfer at the underside

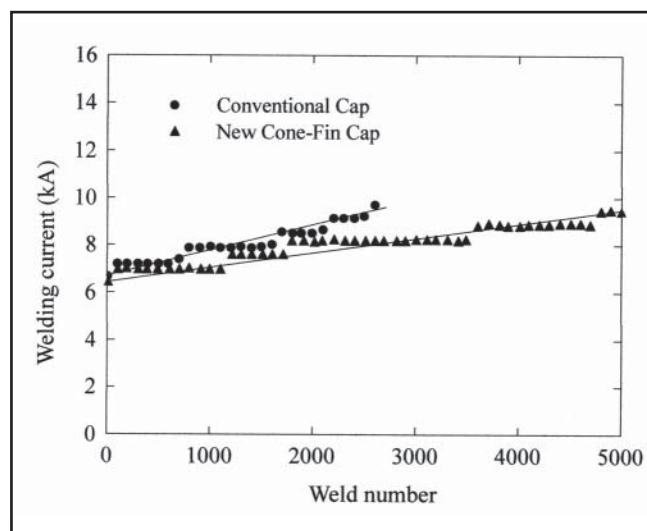


Fig. 14 — Weld number vs. welding current of different weld caps.

of the weld cap. A new cone-fin design at the underside of the weld cap was proposed to enhance the heat transfer. The fin effectively suppresses the film boiling and thus reduces the risk of reaching the burnout temperature. A roughened fin surface is also suggested to provide nucleation sites that can enhance the heat transfer between the cap and the cooling water due to nucleate boiling. As a result, the new cone-fin reduces the temperature at the underside of the weld cap, enables the tip temperature to quickly approach an asymptotic limit, and prevents the mushrooming of the weld cap. The implementation studies confirm that the new cone-fin design can extend the life of the weld cap significantly. The mathematical modeling provides an invaluable guidance in the design of the weld cap for the RSW process.

Nomenclature

c_p	specific heat at constant pressure, J/kg-K
d	tube diameter, m
E	magnitude of the electric field, V/m
F	multiplier in Equation 4
g	gravitational acceleration, m/s ²
H	height of fin, m
h	effective heat transfer coefficient, W/m ² -K
h_{FB}	film boiling heat transfer coefficient, W/m ² -K
h_c	convective heat transfer coefficient, W/m ² -K
h_{NB}	nucleate boiling heat transfer coefficient, W/m ² -K
h_{fg}	latent heat of evaporation, J/kg
I	electric current, A
I_0, I_1	Bessel functions
J	electric current density, A/m ²
k	thermal conductivity, W/m-K
n	unit outer normal vector from the wall
p	pressure, Pa
Pr	Prandtl number
q	heat flux, W/m ²
$r-z$	cylindrical coordinate system
R	base radius of fin, m
Re	Reynolds number
S	source term in Equation 1, or multiplier in Equation 6
T	temperature, K

Greek

α_1	ratio of forced convection boiling
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	heat flux to the total heat flux
α_{1h}	local vapor volume fraction
μ	dynamic viscosity of liquid, kg/m-s
ϕ	electric potential, V
σ	surface tension, N/m
σ_e	electric conductivity, $\Omega^{-1}\text{m}^{-1}$
ρ	density, kg/m ³

Superscript and Subscript

'	saturated liquid
"	saturated steam
l	liquid
v	gas
w	wall
c	cap

References

- Williams, N. T. 1993. Resistance spot welding. *ASM Handbook*, Vol. 6: Welding, Brazing and Soldering. ASM International, Materials Park, Ohio. p. 226.
- Browne, D. J., Chandler, H. W., Evans, J. T., and Wen, J. 1995. Computer simulation of resistance spot welding in aluminum: Part I. *Welding Journal* 74(10): 339-s to 344-s.
- Feng, Z., Bau, S. S., Santella, M. L., Reimer, B. W., and Gould, J. E. 1998. An incrementally coupled electrical-thermal-mechanical model for resistance spot welding. 5th International Conference on Trends in Welding Research, Pine Mountain, Ga.
- Yeung, K. S., and Thornton, P. H. 1999. Transient thermal analysis of spot welding electrodes. *Welding Journal* 78(1): 1-s to 6-s.
- Kim, E., and Eagar, T. W. 1998. Transient thermal behavior in resistance spot welding. *Proceedings, Sheet Metal Welding Conference 2* (AWS-Detroit Section, Southfield, Mich.). Oct. Paper 2.
- Hirsch, R. 1996. Influence of water temperature and flow on electrode life. *Proceedings, Sheet Metal Welding Conference 7* (AWS-Detroit Section, Troy, Mich.). Oct. Paper E3.
- Karagoulis, M., Private communication, General Motors Corp.
- Shames, I. H. 1992. *Mechanics of Fluids*, McGraw-Hill.
- 2004 FLUENT software, ANSYS, Inc., Canonsburg, Pa.
- Tong, L. S., and Tang, Y. S. 1997. *Boiling Heat Transfer and Two-Phase Flow*, Taylor & Francis.
- Chen, J. C. 1963. A correlation for film boiling heat transfer to saturated fluids in convective flow. ASME Publication-63-HT-34: 2-6.
- Groeneveld, D. C., Chen, S. C., Leung, L. K. H., and Nguyen, C. 1989. Computation of single and two phase heat transfer rates suitable for water-cooled tubes and subchannels. *Nuclear Engineering and Design*, 114: 61-77.
- Forster, H. K., and Zuber, N. 1955. Dynamic of the vapor bubbles and boiling heat transfer. *AIChE Journal*, 1(4): 531-535.
- Bjornard, T. A., and Griffith, P. 1977. PWR blow-down heat transfer, Thermal and Hydraulic Aspects of Nuclear Reactor Safety, American Society of Mechanical Engineers, New York, Vol. 1: 17-41.
- Berenson, P. J. 1961. Film boiling heat transfer from a horizontal surface. *J. Heat Transfer* 83(3):351-358.
- Lepperriere, A. 1983. An analytical and experimental investigation of forced convective film boiling. M.A. Sc. thesis, University of Ottawa, Ottawa, Canada.
- Harvey, A. H., Peskin A.P., and Klein S.A. 2004. NIST/ASME Steam Properties Database. National Institute of Standards and Technology.
- Incropera, F. P., Dewitt, D. P. 2001. *Fundamentals of Heat and Mass Transfer*, 5th Edition, John Wiley and Sons, New York.

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