Welding Gear for Safety and Comfort

Improving Resistance Welding

Ways to Prevent Oxidation in Pipe Welds
Select-Arc Delivers

When your critical welding requirements demand a high quality, low alloy, gas-shielded, flux cored electrode, insist on specifying Select-Arc. Select-Arc offers an expanding lineup of over 50 premium wires specially designed for welding low alloy and high strength steels. Whatever your application - from bridge construction to oil exploration equipment, pressure vessels to petroleum plants, mining machinery to submarines, and so many others - we can provide the flat and horizontal or all position low alloy electrode that is ideally suited to handle your individual need.

Select-Arc’s comprehensive selection of low alloy electrode grades includes:
- Nickel Bearing
- Nickel-Molybdenum Bearing
- Nickel-Molybdenum-Chromium Bearing
- Manganese-Molybdenum Bearing
- Carbon-Molybdenum Bearing
- Chromium-Molybdenum Bearing
- Weathering Steel

For more information on choosing the Select-Arc low alloy electrode that is just right for your specific welding requirement, call us today at 1-800-341-5215 or visit our website at www.select-arc.com.
Hodgson Custom Rolling Inc. services a wide variety of industries in the ENERGY SECTORS of hydro, petro chemical, atomic, gas, oil, wind, etc. In addition to those in heavy manufacturing, steel, pulp & paper, mining, marine, forestry, etc. Hodgson’s commitment to providing customers superior products and personalized professional service has earned itself a reputation for excellence, making the name HODGSON synonymous with "paramount quality and workmanship".

Hodgson Custom Rolling Inc. is one of North America’s largest plate rolling, forming, section rolling and fabricating companies.

PLATE ROLLING & FLATTENING
Hodgson Custom Rolling specializes in the rolling and flattening of heavy plate up to 2 thick and up to 12 feet wide. Cylinders and segments can be rolled to diameters ranging from 10” to over 20 feet. Products made include ASME pressure vessel sections, Crane Hoist Drums, thick walled pipe, etc.

PRESS BRAKE FORMING & HOT FORMING
Hodgson Custom Rolling's brake department processes all types of steel sections and plate up to 3 thick. Developed shapes such as cones, trapezoids, parabolas, reducers (round to round, square to round) etc.

STRUCTURAL SECTION ROLLING
Hodgson Custom Rolling has the expertise to roll curved structural sections into a wide range of shapes and sizes (angle, wide flange beam, I-beam, channel, bar, tee section, pipe, tubing, rail, etc.). We specialize in Spiral Staircase Stringers, flanges, support beams, gear blanks, etc.

FABRICATING
Hodgson Custom Rolling combines expertise in rolling, forming, assembly and welding to produce various fabrications including kiln sections, rope drums, heavy weldments, ladles, pressure vessel parts, multiple Components for Heavy Equipment applications etc.

Hodgson Custom Rolling Inc.

5580 Kalar Road Telephone: (905) 356-8132
Niagara Falls Toll-free: (800) 263-2547
Ontario, Canada Fax: (905) 356-6025
L2H 3L1 E-mail: hodgson@hodgsoncustomrolling.com

U.S. Address: M.P.O. Box 1526
14302 - 1526 Niagara Falls, N.Y.

ASME Certified
ISO 9001:2000

HODGSON CAN HELP SOLVE YOUR PROBLEMS

For info go to www.aws.org/ad-index
3 Great Shows Come Together In Mexico City
May 11-13, 2010

Manufacturing, construction and energy projects are growing in Mexico, demanding new equipment, services and technologically advanced products. The co-located AWS Weldmex, FABTECH Mexico and METALFORM Mexico trade shows provide an opportunity to reach new markets and buyers located in the most important business center region in Latin America.

- 8,000 motivated attendees
- 60,000 square feet of technology
- 400 exhibitors

RESERVE YOUR BOOTH SPACE NOW!

AWS WELDMEX
Joe Krall
800-443-9353 ext 297
jkrall@aws.org

FABTECH MEXICO
Michael Scott
800-432-2832 ext 271
michaels@fmafabtech.com

FABTECH MEXICO
Cara Collins
800-733-3976 ext 3126
collins@sme.org

METALFORM MEXICO
Roger Judson
216-901-8800 ext 115
rjudson@pma.org

Features

33  Dressing for Welding Success
    Take a look at the modern safety gear on the market today
    B. Gardner

38  Ways to Prevent Oxidation in Stainless Steel Pipe Welds
    When welding gas-reactive metals, preventing oxidation is critical to weld integrity
    A. J. Schenk

40  Ensuring Quality in Resistance Spot Welds
    Vision-assisted tip-dressing machines are a factor in maintaining weld quality
    D. Shirkey

42  Validating the Resistance Welding Process
    This basic validation process can be used for all resistance welding applications
    D. W. Steinmeier

48  Essen Welding and Cutting Fair Comes Up Big in a Down Economy
    The main event in welding every four years was more international than ever
    A. Cullison

Welding Research Supplement

233-s  A Novel Preweld Laser Surface Treatment for Enhanced Intergranular Corrosion Resistance of Austenitic Stainless Steel Weldments
    The development of a laser surface treatment to suppress sensitization in the heat-affected zone is described
    R. Kaul et al.

243-s  Steel Thermal Sprayed Coatings: Superficial Hardening by Nitrogen Ion Implantation
    Implantation of nitrogen ions in thermal spray coatings dramatically improved wear resistance
    M. Belotserkovsky et al.

On the cover: Today's lithium ion batteries have helped to make powered air-purifying respirators lighter and smaller. (Photo courtesy of Miller Electric Mfg. Co.)
We’ve Made Our Goals Happen

My year as AWS president is winding down, and while many of our challenges continue, I am pleased to report we’ve had many successes. In January, I listed four priorities for the Society, its volunteers, and the staff, which are highlighted in bold type below. We have had a very, very good year in spite of one of the worst recessions most of us have ever seen. My congratulations to all the staff and volunteers who have worked so diligently to reach the Society’s goals.

Enhance welder education. Schools throughout the United States have increased enrollments. I have visited 36 schools so far and instructors at all of them report they expect this trend to continue for the foreseeable future. These include vo-tech welding schools and colleges with two-year and four-year degree programs.

Career growth for individuals. Many of these new welding students are older workers who are coming back to school to “retool” their careers. These older students come to class with great expectations for a good-paying future.

Increase technology support through new technical documents. The American Welding Society has seen a big increase in the number of technical documents it produces. We have gone from 230 to 306, and there are more in process. This is an incredible achievement.

Attract new members. This year AWS has reached an all-time high in membership — 59,705 (as of November 10). I fully expect Society membership to soon reach 60,000, and I commend everyone who has worked to make this happen.

My travels this year have been quite extensive. This was possible in large part because I retired from The Lincoln Electric Co. in April after 46 years. This allowed me to be a full-time AWS president. However, without the unequivocal support of Lincoln Electric, especially Chairman John Stropkii and Executive Vice President Richard Seif, I would not have been able to serve the Society as I have.

Following is a summary of my activities; there is no way I could write about each visit in this short space.

• 11 Districts. My thanks to all the District Directors who hosted my visits and arranged the itineraries.

• 32 Section Meetings. AWS is blessed to have so many people involved in its activities and who care about their profession. It was a true pleasure to meet so many Section members.

• 36 Schools. As I mentioned previously, I visited vocational welding schools, two-year colleges, and four-year universities. Many schools have integrated innovative projects into their curriculums that give students “true life” experience.

• 13 Plant Tours. The future of welding and welding careers depends on all of industry growing following this recession. Industry is looking at implementing best practices such as “green” innovations.

• 22 Conferences/Society Meetings. AWS needs to not only maintain, but improve, its relationships with other organizations as they are vital to its future and mean business opportunities for AWS.

• 7 Meetings with AWS Leadership. The business of being AWS president is demanding, and I have loved every bit of it. Executive Director Ray Shook and I have regular conversations through which we help each other with our respective challenges.

My presidency continues until December 31, and I will not be slowing down. I expect to visit societies in England, Spain, Portugal, and India (where I will present two papers).

Again, I am happy to report that AWS is very strong and growing both domestically and internationally. However, we must stay diligent and continue to improve. We need to support incoming President John Bruskotter with his program; I know he will do a great job.

I want to thank the AWS Board of Directors and their spouses for doing a great job this year. I also want the staff to know that they have done a fantastic job as well. Special thanks go to my wife, Sally, for all she has done both for me and for the Society this year.

I want to thank each AWS member for the honor of serving as your president. This has been one of the best experiences I’ve ever had. In closing, I want to wish you all a happy and enjoyable holiday season and a healthy and prosperous new year.

Victor Y. Matthews
AWS President
If you’re a steel fabricator looking to automate your one-off and small batch welding production, you most likely found out from other robotic solution providers that it wasn’t economically viable due to the lengthy robot programming needed or the varied fit of your work parts.

Yet, you may be experiencing the effects of the ever growing welder shortage as well as shrinking profit margins; making welding automation critical to your company’s prosperity in our highly competitive world.

... Fortunately, there’s SmartTCP.
OSHA Proposes to Adopt the Globally Harmonized System for Chemicals

The U.S. Occupational Safety and Health Administration (OSHA) is proposing to modify its existing Hazard Communication Standard (HCS) to conform to the United Nations’ (UN) Globally Harmonized System of Classification and Labeling of Chemicals. OSHA has made a preliminary determination that the proposed modifications will improve the quality and consistency of information provided to employers and employees regarding chemical hazards and associated protective measures.

The proposed modifications to the standard include revised criteria for classification of chemical hazards; revised labeling provisions that include requirements for use of standardized signal words, pictograms, hazard statements, and precautionary statements; a specified format for safety data sheets; and related revisions to definitions of terms used in the standard, requirements for employee training on labels and safety data sheets.

OSHA is also proposing to modify provisions for a number of other standards, including flammable and combustible liquids, process safety management, and most substance-specific health standards, to ensure consistency with the modified HCS requirements.

In particular, the proposed rule includes a mandate to modify the labeling requirements for welding consumables in OSHA’s welding, cutting and brazing standard. The standard currently provides that “suppliers of welding materials shall determine the hazard, if any associated with the use of their materials in welding, cutting, etc.” and OSHA is proposing to require these labels to be consistent with the UN’s Globally Harmonized System modifications to the Hazard Communication Standard.

EPA Issues Final Rule on Greenhouse Gas Reporting System/Monitoring

The U.S. Environmental Protection Agency (EPA) has issued a Final Mandatory Reporting of Greenhouse Gases Rule. The rule requires reporting of greenhouse gas emissions from large sources and suppliers in the United States, and is intended to collect accurate and timely emissions data to inform future policy decisions. In general, the threshold for reporting is 25,000 metric tons or more of carbon dioxide equivalent per year. Facilities and suppliers were to begin collecting data on January 1, 2010, though the first emissions report will not be due until 2011.

OSHA Program to Measure Accuracy of Injury and Illness Data

The U.S. Occupational Safety and Health Administration (OSHA) is initiating a national emphasis program (NEP) on record keeping to assess the accuracy of injury and illness data recorded by employers. The record keeping NEP involves inspecting occupational injury and illness records prepared by businesses, employee interviews, and a limited safety and health inspection of the workplace. The NEP will focus on selected industries with high injury and illness rates.

New U.S. Trade Representative Initiative on Small- and Medium-Sized Businesses

The U.S. Trade Representative (USTR) has announced a new initiative aimed at increasing exports by small- and medium-sized firms. The USTR is requesting an investigation by the International Trade Commission to better understand how many of America’s small- and medium-sized enterprises export now, their role in generating employment and economic activity in the U.S., and how increased trading opportunities might benefit these businesses and their workers. At the same time, the USTR is convening a USTR-wide working group to ensure that the lead trade agency’s policymaking and enforcement efforts immediately seek to better serve small- and medium-sized enterprises.

OSHA Developing Standard for Combustible Dust, Seeks Comments

The U.S. Occupational Safety and Health Administration (OSHA) is developing a standard that will comprehensively address the fire and explosion hazards of combustible dusts.

Combustible dusts are solids ground into fine particles, fibers, chips, chunks, or flakes that can cause a fire or an explosion when suspended in air under certain conditions. Types of dust likely to combust include metals such as aluminum and magnesium, wood, plastic, rubber, coal, flour, sugar, and paper. In support of this initiative, OSHA is compiling public comments, including information and data, on issues related to the hazards of combustible dusts in the workplace.

Key Administration Appointments Made

The administration recently filled two important positions.

Ron Bloom has been named as the White House senior counselor for manufacturing policy, commonly known as the manufacturing czar. He is expected to work with federal agencies to integrate existing programs and develop new initiatives affecting the manufacturing sector. Bloom is currently a member of the White House automotive industry task force and previously worked for the United Steel Workers Union.

Brenda Dann-Messier has been confirmed by the U.S. Senate as the assistant secretary for vocational and adult education in the U.S. Department of Education’s Office of Vocational and Adult Education. Dann-Messier served in the Department of Education during the Clinton administration and is a former member of the Rhode Island Board of Governors for Higher Education.

Lobbyists Deregistering at Record Pace

The restrictions being imposed on registered lobbyists by the executive branch appear to be the cause of scores of lobbyists terminating their federal registrations. The latest step by the administration is to prohibit registered lobbyists from serving on federal advisory committees. In the second quarter of 2009 alone, more than 1,400 lobbyists deregistered, which is seven times the number of deregistrations that historically occur in any quarter. In fact, in the past year, lobbyist deregistrations have actually exceeded new registrations, something that has never occurred in any prior 12-month period.

Contact the AWS Washington Government Affairs Office at 1747 Pennsylvania Ave. NW, Washington, DC 20006; e-mail hwebster@wc-b.com; FAX (202) 835-0243.
Our world class manufacturing plant in Florence, Kentucky is a showplace for producing the highest quality welding materials in North America.

Visit our website at: www.kiswelweldingproducts.com

Our products are sold through one of our fine distributors in your area. Call our office for one near you.
Recovery Act to Fund Wind Energy Research, Development, and Career Education

U.S. Energy Secretary Steven Chu recently announced new investments in three university-led wind energy research facilities that will enhance the United States’ role in testing and producing advanced and efficient wind turbines. The funding is from the American Recovery and Reinvestment Act.

Three university-led consortia have been selected for up to $24 million for supporting university research and development programs to improve land-based and offshore wind turbine performance and reliability, as well as provide career educational opportunities for undergraduate and graduate students in wind energy technologies. Final award amounts are subject to final project negotiations.

Over the next two years, the consortia will acquire utility-scale and prototype wind turbines that will provide researchers and students with hands-on research and development and educational opportunities. Also, universities will use the DOE funds to enhance their wind technology curricula and provide financial assistance to students for research fellowships and internships.

The Illinois Institute of Technology, Chicago, will use this funding to install a GE 1.5-MW test turbine at an existing project owned by a consortium partner at Marneilles, Ill., and develop and offer wind energy courses. The University of Maine, Orono, plans to design and deploy two 10-kW and one 100-kW floating offshore turbine prototypes. Its educational initiatives will include a model master of science degree in renewable energy and the environment with a focus on deepwater wind energy, and a new undergraduate minor in deepwater wind energy. The University of Minnesota, Minneapolis, plans to install a new Siemens 2.3-MW turbine research facility at the college’s Outreach Research and Education Park in Rosemount, Minn., plus feature new graduate and undergraduate Web-based course modules, and programs focused on wind power technologies and integration with other renewables.

SpaceForm and Welding Solutions Merge to Market Welding Technologies

SpaceForm, Inc., Detroit, Mich., and Welding Solutions, Inc., Madison Heights, Mich., have merged to form a new company called SpaceForm Welding Solutions, Inc.

The deformation resistance welding technology from SpaceForm, a Delphi Technologies, Inc., spin-off company, will be contributed. Welding Solutions, a wholly owned subsidiary of Weldmation, Inc., will offer its Super-MIG robotic welding technology under a license held from PLT, an Israeli-based welding company.

In addition, Alain Piette, president of SpaceForm, will serve as the president of SpaceForm Welding Solutions while Earl Kansier, chief executive officer of Weldmation, will be chairman of the new company.

SpaceForm Welding Solutions will operate a research laboratory in Madison Heights, and have the capability of providing product and welding development, product validation, and equipment infrastructure.

GM Plants Get Ready for 2011 Chevrolet Cruze and Volt

General Motors Co. is investing more than $230 million in four GM plants in the greater Flint, Mich., area representing more than 500 jobs. This will support producing the fuel-efficient 2011 Chevrolet Cruze, an all-new global compact car, and Volt, which will be GM’s first extended-range electric vehicle.

Also, these four GM plants — Flint Engine South, Flint Metal Center, Flint Tool & Die, and Grand Blanc Weld Tool Center — have made progress in reducing their impact on the environment, recycling more than 97% of the waste they generate. Their activities include development of automated equipment and tooling for the Chevy Cruze and Volt assembly plants, die development and stamping of body panels and other components, and the manufacturing and assembly of powertrain components.

In particular, the company is investing approximately $30 million in the Grand Blanc Weld Tool Center to build the robotic weld tool cells that will assemble the Volt body at its assembly plant. Approximately 250 employees are working on this project, including 60 who are installing the weld tool equipment at the assembly plant.
At last there’s a D1 for strengthening and repairing existing structures

Since the first D1 standard in 1928, the AWS D1 structural welding series has provided a consensus of the finest minds in the industry on the most reliable approaches to welding new structures.

Now there is a D1 that provides the same guidance for repair, corrective issues, and strengthening of existing steel structures. AWS D1.7/D1.7M, Guide for Strengthening and Repairing Existing Structures, is invaluable to the engineer who is obligated under D1.1 Clause 8 to plan for projects that involve strengthening and repairing.

Preview and order your AWS D1.7 by visiting www.awspubs.com, or call 888-WELDING for information on all of AWS’s structural welding codes.

American Welding Society
Founded in 1919 to advance the science, technology and application of welding and allied joining and cutting processes, including brazing, soldering and thermal spraying.
KUKA Launches U.S. Research Center

KUKA North America recently opened the KUKA Development Center (KDC) at its headquarters in Sterling Heights, Mich. Specializing in joining technologies like laser welding, this center becomes the second dedicated research center within the KUKA Systems Group, along with the company's TechCenter located at global headquarters in Augsburg, Germany.

The KDC’s mission includes adapting KUKA-branded solutions and new technologies for use by the company’s North American automotive, energy, aerospace, and logistics markets. Additional services include process development, training, and safety certification.

“The fact we launched the KUKA Development Center in a difficult economic environment shows how serious we are about supporting our customers with a steady stream of innovation while growing and diversifying our business,” said Larry Drake, president and CEO of KUKA Systems North America.

The center opened with a range of joining technologies, including the latest generation of lasers and robotics, and draws on the knowledge and expertise of the workforce at company facilities in the Detroit area. It is working with automakers on adapting laser welding technologies that can allow them to use more high-strength steel and aluminum in a vehicle for a stronger yet lighter weight body.

Also, the center is drawing on the company’s European experience with laser welding steel, and its own expertise in aluminum welding and joining different metal types. Vendors of lasers and robot end effectors are partnering with this center to develop new automation solutions, not only for automakers but other industries, said Peter Busuttil, director of technology for KUKA North America and head of the KDC.

Welsco Gets Ready to Host Sixth Annual Arkansas Welding Expo

The 2009 Arkansas Welding Expo presented by Welsco, Inc., the largest woman-owned gas and welding supply distributor in the United States, is set for December 10 at the Verizon Arena in North Little Rock, Ark., from 9 a.m. to 3 p.m. The show is open free to the public.

About 2500 welding professionals, students, and instructors are expected to attend the event. More than 40 companies will also demonstrate current products and technology for the welding industry. Most vendors will offer demonstrations for hands-on participation, and there will be special pricing on items promoted in their booths. Welsco employees will be on hand to help participants and answer questions.

In addition, a presentation will be made by the American Welding Society (AWS) titled “Let the Sparks Fly!” Individuals can hear about career opportunities in the welding industry; learn about the skills and education required for these jobs and where training and education is available; explore résumé-building resources and search a job board to find openings and starting salaries; and take home a copy of AWS’s new magazine that can connect them with a welding career. There will be a job/educational fair across from this presentation as well.

“Welsco started this event as a customer-appreciation lunch, and we are so proud that it has evolved into the only welding expo that we know of,” said Chairman and CEO Angela Harrison. “Each year we try to take it to the next level with more exciting equipment, and now with the AWS coming in, it will give the students and instructors more information on career opportunities, scholarships, and resources. There is a lot of hard work and money that goes into putting this show on, and I appreciate all the employees for making it what it is today — a truly amazing event.”

For additional information, e-mail Charles Ross, Welsco’s vice president of purchasing, at Charles.Ross@Welsco.com or visit www.welsco.com.

The upcoming Arkansas Welding Expo on December 10, 2009, will offer hands-on participation and a career presentation by the American Welding Society. The public is welcome to attend this free show. As shown above, an attendee tries welding during last year’s event.
Cladding Cuts Costs on Nuclear Submarines

Shown is an Astute-class nuclear submarine below sea surface. “By using readily available high-quality carbon steel, protected by a suitable corrosion-resistant alloy in areas where there is contact with sea-water, Arc Energy’s weld overlay cladding process was indeed able to make a contribution on both cost and delivery,” said Alan Brown, the company’s sales director. (Image courtesy of BAE Systems.)

Arc Energy Resources, Gloucestershire, UK, a weld cladding specialist, has delivered 24 tubular components for the main circularizing seawater system used to cool the nuclear reactors on two new Astute-class submarines, number four named Audacious and number five unnamed as of yet. The first three vessels — Astute, Ambush, and Artful — were built by BAE Systems Submarine Solutions at Barrow-in-Furness, UK.

BAE and the Ministry of Defence have an ongoing program for cost-cutting and productivity gains on Astute. The same components for the first three submarines in this class had been produced from solid billets of an expensive copper-nickel alloy, so engineering and procurement staff investigated alternatives.

Eight 2-m-long center tubes and 16 1.1-m-long end sections, all 430 mm in diameter, are clad throughout the bore and in the sealing areas at each end. Arc Energy recommended using ASTM A694 F65 forged steel as the base material. Nickel-copper Alloy 400 (AWS A5.14 ERNiCu-7) was selected as the welding consumable. A 5-mm cladding thickness was applied to ensure the surface of the deposit met the alloy’s chemical requirements.

Also included in the contract was purchasing carbon steel and premachining the components to ensure sufficient material was deposited to achieve the tight tolerance specified for final dimensions. After cladding, final machining, and nondestructive examination, Arc Energy Resources’ fabrication division produced and welded the location bosses in place. It then arranged for the components’ external surfaces to be aluminum spray coated.

ESAB Adds Wire-Drawing Lines to Ohio Plant

ESAB Welding & Cutting Products, Florence, S.C., has added...
two new wire-drawing lines at its Ashtabula, Ohio, manufac-
turing facility. These will produce wire for high-production sub-
merged arc welding (SAW) applications to increase the com-
pany’s SAW wire capacity.

The lines will descale, clean, and draw the wire to the proper
diameter, coat it with copper, and package the products.

**ABB and Vincennes University Partner to Enhance Robotic Training**

The $9 million Indiana Center for Applied Technology opened on
the Vincennes University campus in March 2009. ABB Robotics
will supply 29 industrial robots and related software and controllers
for Vincennes Technical and Workforce Development curriculum.

**Ferris Welding Engineering Technology Program Receives ABET Accreditation**

The Welding Engineering Technology bachelor of science pro-
gram at Ferris State University, Big Rapids, Mich., has been
granted accreditation from the Technology Accreditation Com-
mision of ABET, Inc. Accreditation is a voluntary, peer-review
process requiring programs to undergo comprehensive, periodic
evaluations. These evaluations, conducted by teams of volunteer
professionals working in industry, government, academia, and private practice within the ABET disciplines, focus on program curricula, faculty, facilities, institutional support, and other important areas.

“The ABET accreditation of the Welding Engineering Technology program is the culmination of a programmatic direction that began nearly 10 years ago that involved our advisory board, employers of graduates, alumni, and faculty working together to establish, measure, and achieve nationally recognized educational outcomes and objectives,” said Kenneth Kuk, welding engineering technology professor.

Pictured is the thermal spray room at Eutectic Corp.’s new facility in Milwaukee, Wis., home to CastoLab, a services workshop utilizing welding, brazing, and thermal spray equipment coupled with proprietary products and applications. The lab offers failure analysis to determine the wear mechanisms involved, and provides emergency repairs, periodic maintenance, rebuilding, wear facing, and specialty joining services using up-to-date fusion processes. This includes manual electrode, gas metal arc, gas tungsten arc, semiautomatic, and plasma transferred arc welding along with twin arc wire, cold and hot powder flame, and high-velocity oxyfuel spraying. A training laboratory and technical center are also featured in this facility.

Nederman
Extracts dangerous fumes without wasting energy

Nederman extraction arms safeguard employees and the environment and make the job more efficient

• Extraction at source with fan control and damper saves energy
• Flexible in all directions – easy to place close to objects
• Hood lamp for increased visibility (optional)
• Complete systems: vacuum/filter unit, piping, dampers

For more information contact Nederman at:
(800) 575-0609
for your local distributor

Nederman, USA
Westland, Michigan 48185
Telephone: (734) 729-3344
www.nederman.com
Email: infoUSA@nederman.com

For info go to www.aws.org/ad-index
NIST Wins Auto Industry Award

The Automotive Industry Action Group (AIAG) recently presented the National Institute of Standards and Technology (NIST) with its highest honor, the 2009 AIAG Chairman’s Award, in a ceremony at the Automotive Hall of Fame, Dearborn, Mich. Howard Harary (right), acting director of NIST’s Manufacturing Engineering Laboratory, accepted this award from Brian Vautaw (left), AIAG’s chairman of the board. “NIST is keenly aware of the importance of the automotive industry to the U.S. economy,” said Deputy Director Patrick Gallagher. “We’re delighted to accept this award and proud of the NIST researchers who have worked so diligently over the years with collaborators at AIAG and throughout the auto industry to help foster innovation.”

Industry Notes

- The Chesterfield Township Library, Chesterfield, Mich., has recently opened an American Welding Society Welding Resource Center in the library. It offers online access to all of the society’s codes, guides, and reference materials.
- North River Capital LLC, Fort Wayne, Ind., acquired the assets and business of Wayne Manufacturing Corp., LaOtto, Ind., whose capabilities include robotic and resistance welding. It will operate as Wayne Manufacturing, LLC.
- Cadorath Aerospace Lafayette LLC, a Rolls-Royce Authorized Repair Facility, has moved to a new 15,000-sq-ft facility in Broussard, La., situated on four acres of land.
- The Alloy Engineering Co., Berea, Ohio, recently received the Governor’s Excellence in Exporting Award presented by Ohio Governor Ted Strickland to company President and CEO Louis Petonovich.
- Babcock Power Services Inc. acquired all assets of Welding Technologies Inc., Gainesville, Ga., which provides field welded repair, replacement, and refurbishment of plant equipment and fabrication of ASME parts and pressure vessels.
- Republic Welding Co., Louisville, Ky., won a $96,100 federal contract from the U.S. Army Corps of Engineers for fabricating tainter gate debris shields at the Melvin Price Locks and Dam under the American Recovery and Reinvestment Act.

For info go to www.aws.org/ad-index
DeltaSpot: “Reel-time” Resistance Welding

The revolution of resistance welding expands the applications to new horizons: weld different materials and thicknesses with consistent high quality. Every spot is identical to the one before. Get your production "on a roll"- with DeltaSpot.

FRONIUS USA, LLC
10421 Citation Drive, Suite 1100, Brighton Michigan 48116, USA
Tel: 1-810-220-4414, Fax: 1-810-220-4424
email: sales.usa@fronius.com, www.fronius-usa.com

Perfect joining of aluminum - 7000 spots per process tape
100% reproducible welds - manual or automated
No tip dressing necessary

For Info go to www.aws.org/ad-index
AWS FELLOWSHIPS

To: Professors Engaged in Joining Research

Subject: Request for Proposals for AWS Fellowships for the 2010-2011 Academic Year

The American Welding Society (AWS) seeks to foster university research in joining and to recognize outstanding faculty and student talent. We are again requesting your proposals for consideration by AWS.

It is expected that the winning researchers will take advantage of the opportunity to work with industry committees interested in the research topics and report work in progress.

Please note, there are important changes in the schedule which you must follow in order to enable the awards to be made in a timely fashion. Proposals must be received at American Welding Society by February 16, 2010. New AWS Fellowships will be announced at the AWS Annual Meeting, November 2010.

THE AWARDS

The Fellowships or Grants are to be in amounts of up to $25,000 per year. A maximum of two students are funded for a period of up to three years of research at any one time. However, progress reports and requests for renewal must be submitted for the second and third years. Renewal by AWS will be contingent on demonstration of reasonable progress in the research or in graduate studies.

The AWS Fellowship is awarded to the student for graduate research toward a Masters or Ph.D. Degree under a sponsoring professor at a North American University. The qualifications of the Graduate Student are key elements to be considered in the award. The academic credentials, plans and research history (if any) of the student should be provided. The student must prepare the proposal for the AWS Fellowship. However, the proposal must be under the auspices of a professor and accompanied by one or more letters of recommendation from the sponsoring professor or others acquainted with the student’s technical capabilities. Topics for the AWS Fellowship may span the full range of the joining industry. Should the student selected by AWS be unable to accept the Fellowship or continue with the research at any time during the period of the award, the award will be forfeited and no (further) funding provided by AWS. The bulk of AWS funding should be for student support. AWS reserves the right not to make awards in the event that its Committee finds all candidates unsatisfactory.

DETAILS

The Proposal should include:

1. Executive Summary
2. Annualized Breakdown of Funding Required and Purpose of Funds (Student Salary, Tuition, etc.)
3. Matching Funding or Other Support for Intended Research
4. Duration of Project
5. Statement of Problem and Objectives
6. Current Status of Relevant Research
7. Technical Plan of Action
8. Qualifications of Researchers
9. Pertinent Literature References and Related Publications
10. Special Equipment Required and Availability
11. Statement of Critical Issues Which Will Influence Success or Failure of Research

In addition, the proposal must include:

1. Student's Academic History, Resume and Transcript
2. Recommendation(s) Indicating Qualifications for Research must include one or more letters of recommendation from the sponsoring professor or others acquainted with the student's technical capabilities
3. Brief Section or Commentary on Importance of Research to the Welding Community and to AWS, including Technical Merit, National Need, Long Term Benefits, etc.
4. Statement Regarding Probability of Success

The technical portion of the Proposal should be about ten typewritten pages; maximum pages for the Proposal should be twenty-five typewritten pages. Maximum file size should be 2 megabytes. It is recommended that the Proposal be typed in a minimum of 12-point font in Times, Times New Roman, or equivalent. Proposal should be sent electronically by February 16, 2010 to:

Vicki Pinsky (vpinsky@aws.org)
Manager, AWS Foundation
American Welding Society
550 N.W. LeJeune Rd., Miami, FL 33126

Yours sincerely,

Ray W. Shook
Executive Director
American Welding Society
STICK ELECTRODES

WELDING WIRES

WELDING MACHINES
MIG/MAG & RECTIFIERS, INVERTER, TIG, AC/DC TIG, DC TIG, Pulsed MIG/MAG, Synergic MIG/MAG, AC/MIG-MAG and air plasma cutting

GEDIK WELDING
Ankara Caddesi No 306 Seyhli 34913 Pendik - ISTANBUL / TURKEY
Phone: +90 216 378 50 00 (Pbx) Fax: +90 216 378 79 36 - 378 20 44
Web: www.gedikwelding.com  E-mail: gedik@gedik.com.tr

GEDIK US OFFICE
Phone: 800 - 468 - 0855

GEDIK EUROPE B.V.
Staalindustrieweg 15 2952 AT Alblaserdam THE NETHERLANDS
Phone: +31 (0)78 750 38 80 (Benelux countries)
Phone: +31 (0)78 691 36 05 (Europe, excluding Benelux)
Web: www.gedikeurope.com  E-mail: gedik@gedikeurope.com

For Info go to www.aws.org/ad-index
Q: I am looking at installing an automated cutting system for aluminum in my welding fabrication shop. I was thinking of using plasma arc cutting; however, I have been informed that there may be some advantages of using either laser cutting or waterjet cutting. Can you please give me an overview of plasma arc cutting of aluminum and some information about laser and waterjet cutting in comparison?

A: Traditionally, plasma arc cutting has been the predominant cutting process for aluminum plate. However, it may now be said that cutting technology is at a point where any size manufacturer may afford and operate state-of-the-art cutting equipment. It is also said that the newer laser and waterjet technologies have some inherent advantages over their older counterpart plasma that may be desirable for some specific applications. What we need to ask is this: Just because something is new or different, does this necessarily equate to it being better or more efficient? When choosing a cutting process, you always have to determine which process will supply you with the optimum solution for your particular application. The selection of the most appropriate cutting process is most definitely application driven.

Overview of Plasma Arc Cutting Aluminum

Plasma arc cutting is performed with specialized equipment developed for this purpose. The arc is drawn from a tungsten or hafnium electrode using direct current electrode negative (DCEN) power. The arc plasma is constricted through a small orifice to produce a concentrated heat source and high gas velocity, which melts, expels metal, and makes the cut. For cutting thin metal there may be a single gas flow to provide both plasma and arc shielding, but for cutting thicker metal, dual gas flows are used. The single flow gases may consist of air or nitrogen. For dual flows the gases may consist of nitrogen, argon, or an argon/hydrogen mixture. The selection of the gas or gases for a plasma arc cutting operation is based on such factors as gas cost, the thickness of metal to be cut, and the quality of cut required. Because air is the cheapest gas, single flow systems using air have been designed for cutting sheet metal gauges. For the medium thickness materials, nitrogen is common. For the thickest metal and the best quality cuts, an argon/hydrogen mixture is usually specified for the plasma gas. The manufacturer’s recommendations should be followed in selecting the gas or gases for each application.

Plasma arc cutting leaves a heat-affected zone and some partial melting of grain boundaries. The partial melting of the grain boundaries can result in micro cracking in the cut edges. The 2xxx, 6xxx, and 7xxx series (heat-treatable) alloys are particularly prone to this type of cracking. Most standards for fabricating aluminum require that the plasma cut edge be removed by machining to a depth of around ½ in. (3.2 mm) before the edge is incorporated into a weld.

The plasma arc process can also be very effective for gouging aluminum; unlike air carbon arc gouging, the plasma gouging process leaves a clean smooth surface after gouging. The orifice in the gun has to be larger than one for plasma cutting to reduce the plasma jet velocity, and the power source should have a high operating voltage to maintain a long but stable arc. Some expertise is involved in manipulating the gun to achieve effective gouging. A groove depth per pass of not more than about ⅛ in. (6.3 mm) is preferred, but multiple passes are practical. Mechanized gouging is also practical with this process.

Plasma cutting is sometimes performed either on a water table or under water. When aluminum is plasma arc cut on a water table, molten aluminum drooping into the water can “steal” oxygen from the water and release free hydrogen gas. If the hydrogen gas becomes trapped between the aluminum and water surface, an explosive mixture can develop and be ignited by the cutting arc. Forced air cross flow should be used between the aluminum and water to avoid a buildup of hydrogen. Dangerous concentrations should be avoided by inserting a perforated piping system in the tank to aerate the water. The situations in the above two examples can be accelerated by use of argon-hydrogen shielding gas mixtures, due to the extra hydrogen being available.

Safety precautions should also be taken when plasma arc cutting aluminum over or within water, when the apparatus being used is one that cuts a variety of metals. Steel dross can build up in the bottom of the tank and if molten aluminum contacts it, a thermite reaction can occur and sustain itself until the bottom of the tank opens up. Frequent removal of the dross and scrap metal from the cutting water tank is recommended.

Comparing Plasma Arc Cutting with Laser and Waterjet Cutting

Plasma arc cutting aluminum is typically the lowest capital investment — Fig. 1. Plasma arc cutting can be divided into conventional plasma and precision plasma.

Conventional plasma arc cutting provides high production rates and high cut-
ting speeds if cut face quality is not a major concern.

**Precision plasma arc cutting** provides improved cut quality but lower cutting speeds when compared to conventional plasma. Precision plasma arc cutting speed is comparable to laser but without the higher laser cut quality. This process is sometimes seen as an economical compromise between laser and conventional plasma.

**Laser cutting aluminum** is typically the highest capital investment — Fig. 2. This process cuts by converting an electrical energy source into a light energy beam, which is focused by a lens or series of mirrors onto the base surface, heating the material to a molten state. Laser will typically provide good quality cuts at speeds lower than conventional plasma but far greater than abrasive waterjet cutting. Cut accuracy is superior to both conventional and precision plasma arc cutting.

**Abrasive waterjet cutting aluminum** is typically a higher capital investment than plasma and lower than laser, but it retains the highest operating costs of all three — Fig. 3. This process cuts by passing high-pressure water through a cutting head orifice, mixing the water with fine garnet abrasive powder in a focusing tube, creating a high-velocity jet mixture. The jet mixture forces the abrasive particles through the material, creating a mechanical erosion of the workpiece.

This cutting process has superior cut quality and accuracy when compared to the plasma arc and laser cutting processes. However, its slower cutting speed and higher operating costs can be a hindrance when obtaining and operating this type of machine.

**Combination Cutting**

One should not overlook the possibility of combining more than one of the above cutting processes on the same cutting machine and using them within the same manufactured component. For example, it is often advantageous to implement waterjet cutting for some of the area of a component, taking advantage of its extremely high quality and accuracy of cut, but also implementing plasma for its highly superior speed. For instance, a flange or some other mechanically connected component, which requires very high tolerance on one section of the component, may have that section produced with waterjet. The larger profiles on the same part that have a lower tolerance requirement can be cut at higher speed by plasma. This is a method used to capitalize on the best characteristics of each of the cutting processes in order to produce the most economical part.

**Conclusion**

In order to select the most appropriate cutting process, there are a number of variables that need to be evaluated, such as material thickness to be cut, cutting speed, cut accuracy, cut quality, material savings, environmental issues, operation cost, equipment investment cost, and return on investment. The choice of cutting process is usually based on cutting speed and cut quality; however, economical and environmental considerations are often equally important. My advice is to work with a reputable cutting equipment supplier who has a trained and experienced staff. They will be able to evaluate your particular cutting requirements based on the above variables in order to determine which of these three processes or combination of processes may best meet your specific needs.

**Acknowledgment**

I would like to thank The Aluminum Association for allowing me to use some material on plasma arc cutting from their publication Welding Aluminum Theory and Practice.
Resistance Spot Welding Using Continuous Tape

Lightweight construction, but with identical strength characteristics as in the past, has become a matter of survival for the automotive industry. This is because lighter vehicles reduce fuel consumption and, thus, operating costs and CO₂ emissions. In addition, reducing the weight has a positive effect on the driving characteristics of vehicles. At the same time, automotive manufacturers demand more flexible, economical, and reliable manufacturing and joining processes. The automotive industry, as the trendsetter, is followed by manufacturers of commercial vehicles, rail vehicles, and ships, as well as providers of mobile or stationary industrial goods, machinery, and consumer goods. One material that meets these demands is aluminum, alone and in combination with other materials such as high-strength steel.

Resistance spot welding is essential to the joining of sheet steel in body work, but the joining of aluminum sheets and dissimilar materials is different. A recent development from Fronius uses resistance spot welding with process tape — Fig. 1. After some pilot testing in the automotive and other industries, positive results from large-scale production have been gathered, which are detailed in the following.

Welding Aluminum

Following are some of the difficulties encountered with conventional resistance spot welding of aluminum sheets. High electrode wear limits the process. Regular recutting and electrode replacement interrupts the production process thus increasing operating costs. Flying sparks and weld spatter, typical side effects of conventional spot welding, contaminate components and welding cells. Requirements for surface quality ensure that rework, with its associated costs, is necessary.

A variation of resistance spot welding, called DeltaSpot, is characterized by moving process tapes with constantly changing Fig. 2 — The comparison with and without process tape for the same welding parameters for current, power, and time shows the new variation features higher heat input.
contact surfaces instead of fixed electrodes with identical contact surfaces. Compared to a conventional sequence of 20 to 30, DeltaSpot achieves 5000 to 10,000 welds with one process tape. This corresponds to a tape length of 70 m and a 7-mm index between the spot welds. A simple process tape and electrode change is required for the next nonstop series.

Depending on the specific requirements, the contact surfaces of the process tape can also be used multiple times. If the situation allows repeated use of the contact surfaces, then the number of spot welds possible increases proportionally to the amount of times that the contact surfaces can be used.

**Dynamic Instead of Static**

The process tapes are multifunctional. They make the direct contact between the electrode and the workpiece. In this way, they protect the electrodes from contamination caused by the workpiece surface. This stabilizes the welding process and significantly increases electrode durability. They also improve the contact situation: In a conventional process, impurities settle as foreign bodies in the relatively soft electrode and cause surface spatter. Process tape, however, creates a new electrode contact surface on the workpiece weld by weld. This eliminates surface spatter and enlarges the process window considerably. The process tape also influences the heat balance in the workpiece. The material resistance of the process tape adds to the regular contact and material resistances, which generates heat when current flows. The material resistance of the process tape itself adds to this, and this generates heat when current flows. This additional heat energy is applied to the joint, and results in additional heat in the workpiece with a lower power output at the same time — Fig. 2. Using different materials as well as different coatings for the process tape, the user can customize the heat balance in the workpiece. These new welding variables provide the process technology with additional design opportunities.

**Cylinders Instead of Nuggets**

The conventional welding process creates a nugget-shaped melt zone in the cross section in the welded sheets. The variation with the continuous tape is different: As a result of the additional resistances and the added heat, the melt zone usually forms a weld cylinder or weld barrel shape — Fig. 3.

The ability to control the amount of heat and where the heat forms is especially relevant for practical applications. This enables you to create optimal conditions for joining different materials, thicknesses, and multisheet connections. The additional resistances are advantageous because they reduce the shunt effect by adding additional heat input focused on the weld area, i.e., undesired current transfer to another location of the workpiece has less of an effect. This is especially relevant for thin sheets and aluminum.
Electrode Shape Welding Variable

The standard shape of the electrode is spherical (convex). The slightly elastic process tape with its coating provides optimal contact to the base material. Problems due to the disruptive effects of oxides or surface impurities that can cause spatter are eradicated. However, a concave-shaped electrode can also have advantages. The current transfer takes place within a circular ring surface. This leads to a higher current density and results in greater process reliability. The so-called expo electrode also ensures that the surface of the aluminum sheet at the spot weld shows hardly any indentation. This is only possible if you do not have to tip dress the electrodes, which is the case with DeltaSpot.

Practical Experience

German, European, and Asian automotive and machine manufacturers have already tested these welding systems and integrated them into their large-scale production systems. For example, Georg Fischer in Austria spot welds the doors made from pressure cast aluminum for the new Porsche Panamera. A 1.5-mm-thick AlMg4.5Mn0.4 reinforcement plate is spot welded to the 2-mm-thick aluminum pressure cast door.

The Asian automotive industry also relies on the advantages of the resistance spot welding system using process tape; the aluminum hoods for the Hyundai Equus and Genesis models are manufactured with the system — Fig. 4.

The system is also meeting the high demands required for rail vehicle manufacturing. The Metro in Oslo, Norway, has been on the job for some time now with electronic control cabinets welded with DeltaSpot equipment — Fig. 5.

Conclusion

DeltaSpot has proven its practical feasibility in large-scale production systems. It offers sophisticated process parameters that open up new opportunities regarding different materials, workpiece thicknesses, and multiple joints. With regard to lightweight construction, the ability to reliably join aluminum to itself and to sheet steel is especially relevant.

GERD TROMMER is an editor, Gemseheim, Germany. For additional information, contact Fronius, Inc., at www.fronius.com.
What defines **excellence** in welding sales?

The American Welding Society announces the certification program for welding sales representatives.

If you are among the best and most successful sales professionals in the welding industry, it’s because you provide value-added expertise to your customers.

You are there for them when they want to try new solutions. You are there when they struggle to improve their welding quality and productivity. You are there to help provide a safe workplace.

You have years of expertise that back up every recommendation and every sale you make. And you never stop soaking up all the knowledge you can – because you strive to be among the best.

For you, there is a new certification stating that you exemplify excellence in sales professionalism.

The AWS Certified Welding Sales Representative program tells the industry that you have what it takes to add value to every sale.

If you meet the program’s requirements, you can take a two-hour exam to establish your credentials. Convenient examination sites are scheduled throughout the country. In addition, AWS offers three-day preparation seminars with the examination on the afternoon of the third day. The seminar can be taken at certain AWS-scheduled sites, or at your workplace for groups of sales personnel.

Examination topics will establish your level of knowledge concerning five arc welding processes, brazing and soldering, cutting, safety in processes 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 will not only prepare you for the exam, it can also enhance your professional knowledge, especially as you network with your peers in a stimulating, interactive classroom environment. You’ll receive a study guide and valuable reference books that you can keep: *Welding Handbook* volumes 1 & 2, AWS A5.32 Specification for Welding Shielding Gases, and ANSI Z49.1 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’ experience in an occupational function in direct relation to 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.

Completion of the AWS Certified Welding Sales Representative 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.

For more information and application forms, visit www.aws.org/CWSR. For information about applying, call 1-800-443-9353 ext. 273. To learn more about the exam-preparation seminar, call 1-800-443-9353 ext. 455. Or for customized training and examination of a group at your workplace, call 1-800-443-9353 ext. 219.

You are among the elite in welding sales. Now you can prove it, as an AWS Certified Welding Sales Representative.

www.aws.org/CWSR
Q: We are torch brazing brass fittings to copper tubes using a 56% silver braze alloy. Some of the brazing is done by hand and some is on a machine. We use a white flux for both operations that we purchase in 5-gal pails. When we open a pail, there is a large amount of water on top. We pour it off because it eliminates the need for mixing and the operators like it a bit thicker. They say they can put more flux on the part. The flux is applied by hand with brushes. Our braze results are quite variable, and we are looking at each step of our process. We are wondering whether the way we use the flux may be contributing to our lack of consistency.

A: The purpose of a flux in brazing is to minimize oxidation and to dissolve oxides that may form on both the brazing filler metal and base metals during heating. Since brazing with low-temperature silver base filler metals can be done with such a wide range of base metals and temperatures, general-purpose fluxes have been developed to handle most situations. For difficult-to-wet base metals and other nonstandard situations, specialty fluxes are available.

The specification that covers brazing fluxes is AWS A5.31, *Specification for Fluxes for Brazing and Braze Welding*. From the description of your application, you are most likely using a flux conforming to the FB3-A classification in A5.31. Purchasing a flux that meets the requirements of this specification ensures the product will be consistent over time and perform properly.

After first considering the use and control of torch heating, the use of flux can be the most difficult variable to control. Just as each brazier applies heat differently, each also applies flux differently. Flux requires heat to melt it and keep it active during the brazing process. Variations in the amount of flux applied will necessarily result in variations in heating. There is a misconception that the flux, being transient in the process, does not demand much attention. The reality is that flux has a critical role to play and variations should not be tolerated.


BY TIM P. HIRTHE

Q: We are torch brazing brass fittings to copper tubes using a 56% silver braze alloy. Some of the brazing is done by hand and some is on a machine. We use a white flux for both operations that we purchase in 5-gal pails. When we open a pail, there is a large amount of water on top. We pour it off because it eliminates the need for mixing and the operators like it a bit thicker. They say they can put more flux on the part. The flux is applied by hand with brushes. Our braze results are quite variable, and we are looking at each step of our process. We are wondering whether the way we use the flux may be contributing to our lack of consistency.

A: The purpose of a flux in brazing is to minimize oxidation and to dissolve oxides that may form on both the brazing filler metal and base metals during heating. Since brazing with low-temperature silver base filler metals can be done with such a wide range of base metals and temperatures, general-purpose fluxes have been developed to handle most situations. For difficult-to-wet base metals and other nonstandard situations, specialty fluxes are available.

The specification that covers brazing fluxes is AWS A5.31, *Specification for Fluxes for Brazing and Braze Welding*. From the description of your application, you are most likely using a flux conforming to the FB3-A classification in A5.31. Purchasing a flux that meets the requirements of this specification ensures the product will be consistent over time and perform properly.

After first considering the use and control of torch heating, the use of flux can be the most difficult variable to control. Just as each brazier applies heat differently, each also applies flux differently. Flux requires heat to melt it and keep it active during the brazing process. Variations in the amount of flux applied will necessarily result in variations in heating. There is a misconception that the flux, being transient in the process, does not demand much attention. The reality is that flux has a critical role to play and variations should not be tolerated.


BY TIM P. HIRTHE
There is a crisis in health care and AWS has done something about it. We are proud to introduce an outstanding package of benefits for our members, a single source with more than fifty insurance companies, offering value-priced health, dental, vision, disability, accident, cancer and life insurance.

Simply visit www.worldclassbenefits.com/aws or call 800-955-0418 to learn more.
NEW PRODUCTS

Powered Air-Purifying Respirator Comes with All System Components

The Arc Armor™ powered air-purifying respirator contains a lightweight blower and incorporates a company-exclusive belt/shoulder strap design that reduces fatigue over long shifts and distributes weight across both shoulders to provide a comfortable and secure fit. Also, the product features a 3.25-lb design; lightweight lithium ion battery with no memory retention from frequent charging; dual air speeds for comfort in varied work environments; and audible and vibrating alarms to notify users of low air flow or battery life in noisy workplaces. It comes with a Miller Elite™ Series autodarkening helmet (a nonautodarkening lens model is available as well) and is certified by the National Institute of Occupational Safety and Health (NIOSH, 42 CFR Part 84). The respirator has an assigned protection factor of 25. A high-speed (200 L/min) fan selection increases the helmet’s cooling effect, while the low-speed (>170 L/min) selection exceeds minimum standards for this product category. Additionally, it comes with HEPA filters (2), prefilter, spark guard, battery charger, air flow indicator, and tool bag.

Miller Electric Mfg. Co.
www.MillerWelds.com
(800) 426-4553

Footwear Deliver Slip Resistance on Many Surfaces

The Industrial Traction line of occupational footwear is designed for those transitioning through multiple work environments on a given day. The Rigmaster (pictured above), made with single-density polyurethane, is lightweight, shock absorbent, and chemical resistant. The outsole’s triangular-shaped lugs are positioned in a multidirectional pattern for a mechanical grip. It is available for men in two 8-in. steel-toe styles, one in full grain leather and the other with Ever-Guard™ leather; it is also offered in a 6- and 8-in. style for women. The Triflex outsole, made with Timberland PRO® rubber, is engineered to provide and help maintain traction on dirt or uneven surfaces. Its three blade traction lugs feature six different flex grooves. Polished grooves on the perimeter of the sole quickly disperse water and dirt. This is available for men in a 6-in. style and a classic oxford, both designed with the TiTAN® XL safety toe. In addition, the Quadro outsole is designed for workers needing slip protection on smooth surfaces both wet and dry. Its circular, segmented grip pods feature four independent edges and a concave center that works like a suction cup. Also made with Timberland PRO® rubber, it is available for men in the TiTAN® XL Bloucher with the TiTAN® XL safety toe. The styles come in sizes 7–15 M/W, and sizes 5–11 M/W for the Rigmaster only.

Timberland PRO
www.timberlandpro.com
(800) 258-0855

Inverter System Connects to Any Type of Resistance Welding Transformer

The WeldComputer® wave synthesis inverter interfaces directly to any resistance welding machine without replacing the existing transformer. Systems are available ranging from 50 to 8000 A to accommodate any size welding machine. Extra highlights include the following: control any type of resistance welding machine or process; emulate any weld function; provide comprehensive data collection with good signal integrity; make decisions and adjustments that are fully programmable from the control console; make hundreds of decisions and render adjustments on a millisecond-by-millisecond basis during each weld to reduce the occurrence of bad welds and increase the...
Backpad Insulates Hand from Hottest Contact Point

The BX-BP extreme performance backpad shields welding gloves from excess welding heat and sparks. It features an oversized coverage area and high-performance carbon felt that offers heat protection while staying flexible to minimize fatigue. The Heat-Standoffs™, a BSX® exclusive design, maintains an air pocket between the heat source and glove to help insulate the hand from this often hottest point of contact. This backpad is completed with an aluminized leather strap at the top, and a combination aluminized leather/cotton elastic strap at the bottom for a durable, snug fit.

Revco Industries, Inc.
www.bsxgear.com
(800) 527-3826

Earplugs Offer High Noise Reduction Rating

Magid® E2® IHP732 pink disposable earplugs provide quality hearing protection. The company teamed up with the National Breast Cancer Foundation to introduce these. Made from soft, hypoallergenic polyurethane foam, the earplugs feature a tapered design providing a secure, comfortable fit. A high noise reduction rating of 32 is offered. They are packed one pair per sealed polybag and come 200 pairs per dispenser.

Magid Glove & Safety Mfg. Co. LLC
www.magidglove.com
(800) 444-8030

Vision Kit Captures Critical Weld Information

Vision capabilities have been added to the WeldWorks Software Suite. This is useful for small-scale resistance welding, hot bar reflow soldering, and micro laser welding. The kit includes a gas shock articulating arm to easily position the USB color camera, zoom lens, and integrated LED light. Also, the system displays a large live video image within the application, enabling the operator to see small features. This kit automatically captures preweld and postweld images and allows the user to snap additional images in the event of weld failure. These pictures, weld data, waveforms, and part information are all stored in a central database. The kit further allows uploading of destructive test images from any source, providing users with a complete view of their weld process.

techMatrix, LLC
www.techMatrixLLC.net
(612) 605-8312

Filter Design Reduces Breathing Resistance

The advanced particulate 2200 Series filters developed for physically strenuous work areas and challenging environments...
**Welding Helmets Feature Skeleton and Fire Designs**

The company’s XVS Series of lightweight autodarkening welding helmets have two new designs. The Bonehead model shows a menacing skeleton clawing its way through the face and sides of the black hood, revealing a toxic green undertone radiating from a hidden world beneath. With a beady-orange eye, the skeleton clutches its metallic Hobart Hood emblem atop of the helmet. The Hothead design delivers realistic fire and flame. Pictured on top of a metallic black finish, these swirling heat and flames weave through a white-hot Hobart Hood logo. All XVS Series designs have a 3.74 x 1.57-in. viewing area with two independent arc sensors. These helmets also darken in 1/12,000 of a second after arc start and feature an internally adjustable autodarkening shade (#9–12), lens sensitivity, and delay controls.

Hobart Welding Products
www.HobardWelders.com
(877) 462-2781

**Storage Buildings Safely House Gas Cylinders**

The company’s secure gas cylinder storage buildings provide a range of options for meeting fire safety and environmental code requirements for managing the storage and access of gas cylinders under pressure and used, empty containers awaiting collection and disposal. These preengineered buildings can be equipped with separate compartments to accommo-
date a variety of gases, or individual gas storage buildings can be constructed. The 2- and 4-h fire rated buildings are constructed from noncombustible heavy-gauge steel materials and UL-classified fire-resistive gypsum wall board featuring bidirectional ratings. Explosion control venting is offered, where required. Optional equipment and accessories along with a range of standard and color choices are available.

Safety Storage, Inc.
www.safetystorage.com
(800) 344-6539

Beams Made with All-Welded Construction

Caldwell's expanded line of forklift beams provide positive load handling. These easy-to-attach beams have a strong, all-welded construction. Expanded sizes of the Model 10 single hook beams include 5-, 7.5-, 10-, and 15-ton capacities with 36-in. fork spreads. All models are offered with fixed or swivel hooks.

The Caldwell Group, Inc.
www.caldwellineno.com
(800) 628-4263

Waterjet Machine Strips Paint, Coatings from Floors

A QUICK LOAD™ gooseneck system for the company’s curved handle TOUGH GUN™ GMA guns enables welding operators to change gooseneck combinations quickly. A quick-release feature requires only the opening and closing of a simple latch to switch out different gooseneck styles. It also allows the gooseneck to be rotated 360 deg to reach awkward joints or weld in confined areas. This system operates on a common consumable platform and is compatible with the TOUGH LOCK™ contact system.

Tregaskiss
Tregaskiss.com
(877) 737-3111

Gooseneck System Rotates 360 Deg

The Ultra Deckblaster waterjet surface preparation machine uses ultrahigh pressure (UHP) waterjets to quickly blast away old paint, coatings, grease, and dirt from steel decks and concrete floors without using hazardous chemicals. This self-propelled machine operates at pressures up to 55,000 lb/in.² (3800 bar). The system utilizes UHP water supplied by a Jet Edge waterjet intensifier pump. Hydraulic pressure activates the motor to spin the spray bar assembly and open a high-flow water valve supplying fluid to the manifolds. The water travels through a high-pressure on/off valve and high-speed swivel before entering the rotating spray bar. Multiple waterjet orifices direct UHP water over an 18-in.-wide cleaning path as the machine advances. Operators control the rotation and drive speeds, forward/off/reverse, water, and rotation on/off of the spray bar.

Jet Edge
www.jetedge.com
(800) 538-3343

Jet Edge
www.jetedge.com
(800) 538-3343
CAN WE TALK?

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

Publisher
Andrew Cullison
cullison@aws.org, Extension 249
Article Submissions

Production Manager
Zaida Chavez
zaida@aws.org, Extension 265
Design and Production

Peer Review Coordinator
Erin Adams
eadams@aws.org, Extension 275
Peer Review of Research Papers

Editor
Mary Ruth Johnsen
mjohnsen@aws.org, Extension 238
Feature Articles

Advertising Sales Director
Rob Saltzstein
salty@aws.org, Extension 243
Advertising Sales

Associate Editor
Howard Woodward
woodward@aws.org, Extension 244
Society News
Personnel

Advertising Sales & Promotion Coordinator
Lea Garrigan Badwy
garrigan@aws.org, Extension 220
Production and Promotion

Associate Editor
Kristin Campbell
kcampbell@aws.org, Extension 257
New Products
News of the Industry

Advertising Production Manager
Frank Wilson
fwilson@aws.org, Extension 465
Advertising Production

TRIANGLE ENGINEERING, INC.
Services for the Welding Industry

► Weld engineering and consulting – WPS, PQR
► Welder training and qualification coupons
► Destructive test equipment
► Full testing services

Guided Bend Testing Machine

6 Industrial Way, Hanover, MA 02339-2425
(781)878-1500 • (781)878-1374 • Fax(781)878-2547
www.trieng.com

WELD TRAINING
Hobart Institute of Welding Technology offers our comprehensive Technical Training courses throughout the year!

Prep for AWS Certified Welding Supervisor Exam
Prep for AWS Welding Inspector/Educator Exam

Visual Inspection
Welding for the Non Welder
Arc Welding Inspection & Quality Control
Weldability of Metals, Ferrous & Nonferrous
Liquid Penetrant & Magnetic Particle Inspection

Visit www.welding.org for course dates

or call 1-800-332-9448
for more information.
©2009 Hobart Institute of Welding Technology, Troy, OH St. of OH Reg. #70-12-0064HT

For info go to www.aws.org/ad-index
NOW, EVEN BETTER

Introducing the Optrel e600 Series
Now 15% Lighter with a
33% Larger Viewing Area

The iconic styling of the “Satellite” is the inspiration behind our new Optrel e600 Auto-darkening Welding Helmet line. With a continuous spherical design and no flat surfaces for hot spatter and slag to rest, the Optrel e600 is one of the only welding helmet designs recommended for overhead welding. We’ve combined this proven helmet design with years of research and feedback to create a new generation of superior products for the expert welder.

For more information, call 1-800-682-0839 or visit www.optrel.com
www.sperianprotection.com
VALUE FOR UNDER $100.00

The all new Carrera™ features a super lightweight helmet with the variable shade 1000FCF filter; shades 9-13, sensitivity, delay and grind functions. The highest level of eye protection and all for UNDER $100.00. In these economic times don’t compromise looks and function. These Times are Right for Carrera™

* Black Carrera Only

www.arc1weldsafe.com  ArcOne: Where quality meets affordability without compromise™ 1-800-223-4685

For info go to www.aws.org/ad-index
Dressing for Welding Success

These tips will help you find the safety gear that’s right for you

BY BILL GARDNER

Ever since the beginning of arc welding, there has been safety gear to protect the welder from the arc, spatter, and heat emitted by the process. Unfortunately, many of today’s shops seem to be using those original safety products: heavy, cumbersome welding jackets; one-size, one-type-fits-all welding gloves, some with fingers cut out so the welder can better use the gas tungsten arc welding (GTAW) torch; passive welding shade helmets that can lead to stiff necks, poor weld quality, and, sometimes, welders even avoiding their use because they are just making a quick tack weld.

The longevity of these older products can be attributed mainly to their economy. They present an inexpensive solution to the safety issue. They’re not necessarily the best, safest, or most productive solution, though.

Today, welding gear is available that promotes what the welder has always known: Safety is an important consideration, but it’s not the only one. Operator comfort is important, too — Fig. 1. The more comfortable the gear, the less resistance to adhering to proper safety practices. But it’s more than that. It can also mean less operator fatigue at the end of the day and an improved sense of overall well being, which in turn can lead to increased productivity. With welding helmets, especially, the right choice cannot only make the job easier and more productive, it can lead to fewer weld defects and less neck strain.

In addition, the growing concern over exposure to welding fumes has increased the demand for air-filtration devices, such as powered air-purifying respirators (PAPRs) and other filtration masks. Many employers are finding that the costs of spending a bit more for better safety gear can easily be made up for in increased productivity, decreased absenteeism, and fewer injury claims.
More Than Just Safety Gear

While we can sense intuitively that lighter, cooler gear designed specifically for welding can decrease fatigue and lessen the need for frequent breaks, perhaps the greatest impact comes from using an autodarkening helmet.

For training a new welder, an autodarkening helmet can be a great help in keeping the electrode in position at the start of the weld, because the head doesn’t need to be moved to position the helmet. But even for the experienced welder, an autodarkening helmet has immediate benefits. It allows setting the shade to a level appropriate to the process for a better view of the weld pool for better results and can help protect against inadvertent arc flashes. Further, an autodarkening helmet saves time between welds, time that can quickly add up.

For example, Robert Lantrip, owner of Ourco Welding and Industrial Supplies, a mobile welding distributor in Texas and an independent fabricator, had his autodarkening helmet blow out of his truck and break.

“I was on a job that involved a lot of fitting and short 2- to 3-in. welds,” Lantrip explained. “With my autodarkening helmet, I was able to weld 14 pieces an hour for the first job. On the second go-round, after my hood flew out the window and I had to use a regular hood, 8 pieces an hour was the absolute best I could do, and that was pushing it.”

Industry Response

The head nod that brings a passive lens helmet into position can lead to neck fatigue by the end of the day and may lead to repetitive stress injury over a welder’s career. Because of this, said Ed Forbes, vice president of operations for Engineered Metals & Composites, Inc. (EM&C), in West Columbia, S.C., his company has never even allowed a traditional welding helmet into its plant.

“We knew that repetitive stress injuries can and do occur as a result of using traditional welding helmets, so we standardized all of our welders on autodarkening helmets right from the start,” Forbes said. “Because autodarkening helmets are all we use, we’ve been able to reduce our workers’ compensation insurance rates and had fewer trips to the emergency room from arc-flashed eyes than companies that use traditional helmets.”

Forbes isn’t alone in this belief. To encourage operators to use autodarkening helmets, companies such as Vermeer Mfg. Co. split helmet costs 50-50 with the operator, and the operator owns the helmet outright after three years. For a company

Fig. 2 — The lithium ion battery technology that has made cell phones lighter and smaller has had the same impact on powered air-purifying respirators.
Choosing Your Welding Helmet


There is no one “right” welding helmet for everyone. Although the temptation may be to buy the most or least expensive helmet, cost should be only one consideration. Others include the following:

- Passive or autodarkening lens
- Fixed or variable shade
- Size of viewing area
- Number of sensors
- Switching speed
- Adjustments
- Solid color vs. graphics

Passive or autodarkening. A passive lens is a piece of glass with UV and IR coatings, which is most often tinted to a #10 shade. When the welder is ready to begin welding, a quick nod or snap of the neck flips the helmet down before the arc is struck. When finished, the welder reaches to pivot the helmet up and away from his face to view the workpiece and reposition for the next weld. An autodarkening filter lens is a special LCD display that has a #3 shade (about that of sunglasses) in its inactive state and darkens to a welding shade (#8 to #13) when an arc is sensed. Because the filter has UV and IR coatings applied to it, your eyes are protected from harmful rays regardless of active/inactive shade setting. Autodarkening welding helmets enable you to set up your weld joint with the hood in position, eliminating poor starts due to movement when the helmet is snapped into place.

Your primary choice is which of these options is best for you. Factors to consider include how easy it is for you to flip the helmet into place while maintaining electrode position, how tired your neck feels at the end of the day, and will an autodarkening helmet help improve your cycle time. The more frequently you find yourself raising and lowering your passive helmet, the more advantageous you’ll find an autodarkening helmet.

Fixed vs. variable shade. A passive helmet has its shade, usually #10, predetermined. If a fixed shade is sufficient for your welding needs, a passive lens helmet may work well for you. A fixed-shade autodarkening helmet combines the convenience of autodarkening with the economy of a passive lens for a price that is somewhere between the two. The caveat is that when it activates, it will be one fixed shade. If your process and heat settings stay within the appropriate range of this fixed shade, this may be an economical choice.

With a variable-shade lens, you can dial in your shade setting, from #8 to #13, allowing more versatility if you’ll be changing settings or processes. OSHA offers a guide for choosing the correct shade based on welding criteria, such as process and amperage.

Viewing size. One of the major factors in autodarkening helmet price is the size of the viewing area. While a hobbyist or occasional welder may find a 6-in.² viewing area sufficient, most professional welders opt for the 7- or 9-in.² viewing area because of the expanded view of the weld and surrounding area. The more you weld, especially out of position, the more you’ll appreciate the larger viewing area.

Number of sensors. The number of sensors range from two for an entry-level helmet to three or four for a professional model. More sensors mean better coverage, especially for out-of-position welding where a sensor could be obstructed. Three sensors are appropriate for production work or when you will have more of a clear line of sight to your work. Four sensors are optimal for the vast majority of fabrication, out-of-position work, and low-amperage GTAW.

In addition, some helmets also have the ability to sense arcs electromagnetically, which can be especially useful when welding in bright sunlight or in confined spaces that might obscure the optical sensors.

Switching speed (lens reaction time). The time it takes for a sensor to detect the arc and bring the lens from its off state to its darkened state typically ranges from 1/3600 to 1/20,000 s. Generally, the quicker your eyes are shaded from the high-intensity light, the better. While 1/3600 s is quick, some arc light does get through. If you spend all day welding with a lens rated at 1/3600, the cumulative effect of the increased exposure to the arc light may contribute to eye fatigue at the end of the day. With faster switching speeds, these effects are greatly reduced. For professional use, 1/12,000 s is appropriate, but 1/20,000 s is optimal.

Adjustable controls. Usually, both intermediate- and professional-level autodarkening helmets provide the ability to adjust how much brightness will trigger the lens to darken. A sensitivity control is useful when welding at low amperages, especially for GTAW, when the arc isn’t as bright as with other welding processes, or when welding outdoors in bright sunlight.

A delay control enables you to set how long the lens stays dark after the welding arc stops. When tack welding on a large project, a short delay helps get the job done faster as you reposition for the next weld. A longer delay time is helpful when welding at very high amperages to prevent looking at the glowing weld zone, which can still emit harmful rays, even though the arc is extinguished.

Helmet color/design. While black welding helmets have long been the norm, many welders have opted for helmets with graphic designs because they allow room to express the welder’s personality. For most applications, the choice is one of personal preference; however, in high-amp (>300-A) applications, a better choice might be one of the new silver-colored helmets, which reflect heat away from the welder for less heat and a more comfortable workday.
where welders may make hundreds of tack welds an hour, the time savings easily justifies the investment. To make the helmets easy to purchase, Vermeer’s welding supply partner maintains an on-site inventory.

So, with these points in mind, what is the well-dressed safe welder wearing?

The Well-Dressed Welder

Welding Helmets

While autodarkening lens helmets have been with us for a while, the latest industrial lines include some important advances, such as extra protection from the heat in sustained high-amp applications (>300°F). This includes aluminum shields that protect the lens as well as silver coatings that reflect the heat away from the helmet for increased comfort.

Additionally, with more companies paying for all or part of their welders’ helmets, industrial-grade helmets are now being made with common lens covers for the entire series to ease inventory needs. One of the latest innovations includes an autodarkening lens that flips up to expose an ANSI-approved grind shield, and provides additional safety advantages: a clear, almost 180-deg view and the ability to switch between welding and grinding without removing the helmet, keeping the welder protected at all times. (See “Choosing Your Welding Helmet” sidebar for more information.)

Welding Jackets

While the green and brown welding jackets are still a common sight, rethinking jacket design and materials has led to additional options for increased flexibility and lighter weight.

Leather still provides maximum protection in shielding from heat and sparks; however, pigskin has proven to be a popular choice because it’s lightweight, more flexible, can stretch slightly, and is resistant to shrinkage due to moisture and heat.

When the protection of leather isn’t required, consider a cloth jacket made of Indura®, a 100% cotton material that is treated for flame resistance and may, depending on the manufacturer, be guaranteed for the life of the garment.

A good compromise, especially for overhead welding, is a combo jacket that combines leather protection for arms and shoulders with the breathability of Indura. Some welding sleeves also offer this combination, putting leather where its protection is most needed.

Gloves

Gloves, too, have progressed beyond the one-size-fits-all type. Manufacturers are paying more attention to the gloves’ purpose, and today’s quality welding gloves have ergonomically curved fingers and padded palms for comfort with reinforcements on high-wear portions, such as the thumb saddle. As usage changes, so do design and materials. A GTA welder can choose a goatskin glove to provide the necessary touch and dexterity, while a gas metal arc or shielded metal arc welder may be better served with a cow-grain glove reinforced with strategically placed leather for heat and abrasion resistance.

Air Filtration

With the growing concern about and increased government regulation regarding welding fumes, the bulky respirators of yesterday have given way to half-mask respirators that are designed to fit comfortably under the welding helmet. For heavier use, PAPRs specifically designed for the welder provide exceptional mobility and protection from the particulates found in welding fume and can be combined with an autodarkening helmet for an integrated system.

Lithium ion batteries, the same technology that has made cell phones lighter and smaller, have had the same impact on PAPRs and without the memory retention issues associated with nickel-hydride batteries — Fig. 2. Memory retention is a battery charging effect that causes unpredictable battery life. The lithium ion power pack can be recharged at any time during its 8-h charge cycle without reducing battery life, and it also contributes to lighter weight. Today’s PAPR blower can weigh as little as 3.25 lb, with shoulder straps comfortably distributing its weight for reduced operator fatigue.

Conclusion

If welding is your career, take the time to find the safety gear that’s right for you. You’ll be spending a lot of time under the helmet, so be safe, but be comfortable. Visit your welding distributor to see what’s available, and talk to your employer or safety officer to see if there are any company initiatives that can help you take advantage of the latest in safety gear.

For info go to www.aws.org/ad-index
2010 Co-located Wemco / RWMA Annual Meeting

Palm Beach Gardens, Florida
March 11-13, 2010

Join the Welding Equipment Manufacturers Committee (WEMCO), and the Resistance Welding Manufacturing Alliance (RWMA) at their first-ever co-located annual meetings at the award-winning PGA National Resort and Spa in Palm Beach Gardens, Florida.

Emergence from the Recession
The 3-day event will cover today’s pressing issues, such as the country’s economic state, the challenges manufacturers are facing during the economic recovery, and the global automotive industry crisis. Our highly respected speakers include:

Emily DeRocco, President, Manufacturing Institute, an affiliate of the National Association of Manufacturers
Dr. David Cole, Chairman, Center for Automotive Research
Martin Quinn, President, Thermadyne Holdings Corporation
Alan Beaulieu, Principal and Economist, Institute for Trend Research

Register by February 12, 2010
to be entered in a raffle for a special prize!
A limited number of rooms are now available for a special discounted room rate of $189.00 per night for meeting attendees.

Cost to attend:
RWMA / WEMCO Members $585 / Non-members $785 /
Spouse $225 / Child $75

For more information or to register contact:
Susan Hopkins at susan@aws.org or 800-443-9353, ext. 295
Ways to Prevent Oxidation in Stainless Steel Pipe Welds

Minute traces of oxygen during welding can have profound effects on the serviceability, life, and appearance of the joints

BY A. J. SCHENK

Stainless steel, titanium, and other gas-sensitive metals are being used for an amazing variety of applications from ornamental handrails to piping used in the petrochemical, food, semiconductor, nuclear, and chemical industries. Beside looking esthetically pleasing, these metals also have a very valuable characteristic. When welded correctly, these metals can be used in contact with corrosive or sensitive materials without contaminating them, thus making them the number-one choices for applications requiring long service life and non-contamination.

The importance of purging the joint with argon or an inert gas mixture is well known to most welders when joining gas-sensitive metals. Welders recognize the blue tinge on their welds as a sign of oxidation caused by exposure to oxygen. This oxidation is a form of corrosion that can be traced back to inadequate purging. This problem, though well known in the welding industry, is not as well understood by workers in some manufacturing plants in the petrochemical, food, semiconductor, nuclear, and chemical industries.

Industry has fortunately moved from welding critical gas-sensitive metals with gas metal arc welding (GMAW) to gas tungsten arc welding (GTAW), but there is still a long way to go. Welding procedures often do not adequately detail the requirements for proper purging. Most welding is done to comply with a code while documentation for purging is inadequate or lacking altogether.

The most critical piece of a piping job, after the selection of pipe schedule, is the quality of the weld. If the weld has oxidized, it will be much weaker and may fail and/or cause contamination of the product. Repairing oxidized pipe is costly.

To avoid oxidation while welding, the oxygen remaining in the purged atmosphere (rest oxygen) ideally should be 0. Oxidation is commonly called “sugaring” when welding stainless steels and chrome-nickel steels. This oxidation is even more serious when welding titanium, zirconium, molybdenum, and some other gas-reactive metals and alloys. The resulting oxidized surfaces are no longer corrosion resistant and further treatment may be necessary.

Removing the oxidation using mechanical means, such as grinding, also removes the metal’s passive protective layer. This passive protective layer is only 20 angstroms thick and must either be protected or restored. Other mechanical procedures, such as brushing, blasting, or pickling, can remove the oxidation and restore the metal’s resistance. However, in some cases, such as for pipes, this is difficult or impossible to do. The best solution is to prevent the oxidation from occurring in the first place by removing the oxygen.

The purging gas is usually a heavier-than-air inert gas such as argon. This purge gas displaces the oxygen during welding then shields the welded joint from oxygen until it has cooled.

When welding any gas-reactive metal, it is imperative that the rest oxygen content be below 70 parts per million (ppm) to avoid contamination or rejected welds. To give an idea of

Fig. 1 — Photos showing oxidation of 316L stainless steel coupons welded using argon purging gas with the following rest oxygen levels: A — 12 ppm; B — 60 ppm; C — 70 ppm; D — 200 ppm; E — 250 ppm; and F — 500 ppm.

A. J. SCHENK (sales@intercononline.com) is vice president, sales, at Intercon Enterprises, Inc., Blaine, Wash.
when inoperative. Lower-priced models are simply discarded while in storage. The electrolyte can be re-

zirconium cell. ppm are not good enough. Any serious ppm are useless for the welding industry ppm. The units that read down to 1000 ppm are not good enough. This means that a 70 ppm sample reading indicates there would be 70 parts of rest oxygen left in a sample size of 1 million parts of gas. This value sounds very low, but looking at the pictures of the rest oxygen levels, 70 ppm still gives considerable discoloration. Coupons made from 316L stainless steel were welded at various rest oxygen levels and photographs were taken of the welds — Fig. 1A–F. (Note: A titanium weld made at 12 ppm would be much more dis-
colored than what is shown here for stain-
less steel.)

Selvaduray and Trigwell (Ref. 1) wrote in their article on welding stainless steel for ultrapure fluid delivery systems, “Welding of the tubing often leads to dis-
coloration in the heat-affected zone, which can lead to corrosion.” They con-
cluded, “The discoloration in the heat-
affected zone commonly observed in welded electropolished stainless steel is caused by contamination by oxygen of the argon purge gas used during welding and is a function of the concentration of oxygen in the purge gas.” Their analysis showed an oxygen level as low as 31.6 ppm results in failure under both fluorescent and Maglite scans.

It is interesting to note that there are many oxygen indicators available that have operating ranges from either 25 to 0.1% (1000 ppm), or 25 to 0.01% (100 ppm). The units that read down to 1000 ppm are useless for the welding industry and even the units measuring down to 100 ppm are not good enough. Any serious welding application needs an indicator that can accurately measure 1 ppm (0.0001%) rest oxygen.

The two most common devices capable of measuring low levels of oxygen employ either an electrochemical-type cell or a zirconium cell.

The electrochemical cell is popular because it is lower priced and has an instant-on feature. It uses an electrolyte that is consumed during the mea-
suring process and will eventually dry up while in storage. The electrolyte can be re-
plished in some units, while other lower-priced models are simply discarded when inoperative.

The zirconium oxide cell (Fig. 2) is a very accurate way of measuring the rest oxygen. While the early units required 15-

min warm-up times and the fragile cells were easily damaged, the newer zirconium oxide cell units have addressed these concerns and offer quick warm-up times and robust housings to protect the cell. The big advantage with the zirconium cell is less maintenance and, depending on the type, the capability for being used around the clock, which makes it perfect for vessel work and orbital welding operations. Moreover, some oxygen indicators offer data-printout capabilities to automate documentation of each and every weld.

Documentation of the welding pro-
cedure before, as well as during, the purging process is of the utmost importance. This is an area that will see an increased activity in the next few years. Labor and material costs in all areas of construction have rocketed up to all-
time highs bringing a heightened aware-
ness to documenting everything that is done. Soon, documentation proving that the welds were made correctly will be just as important as proving they were made to code.

Welding the joints correctly will also minimize the repair and maintenance op-
cations that can add major costs and downturn time and impede industries attempting to run at full capacity. The desired low rest oxygen levels are quickly and more easily obtained by reducing the volume of area within the pipe. This is achieved by damming off sections inside the pipe on both sides of the weld joint. Use of a purging dam system can reduce purge times to only 1 or 2 min, instead of 30 or more min with older methods. This also reduces shielding gas consumption, costs, and im-
proves the rest oxygen levels.

In conclusion, as the use of stainless and titanium pipe and tube is increas-
ing year after year because of their desired properties, the increase of potential weld-joint failures and premature wear leading to costly replacement is a reality that must be avoided. The industries that demand these alloys should also demand the most exacting standards from their employees and contractors when these materials are welded. To avoid the myriad problems caused by excessive oxygen lev-
els while welding, manufacturers and con-
tactors are urged to examine their weld procedures, purging equipment and tech-
niques, and monitor the rest oxygen levels prior to welding, while routinely docu-
menting all parameters for every weld joint.

Reference

less steel as used in ultrapure fluid deliv-
ery systems for the semiconductor and
pharmaceutical industries. Journal of the
Arkansas Academy of Science: Vol. 56.

Fig. 2 — Newer zirconium oxide cell oxy-
gen indicators, such as this Pro2-plus from Intercon Enterprises, offer fast warm-up times, robust housings, and the ability to measure oxygen levels as low as 1 ppm.
Ensuring Quality in Resistance Spot Welds

Today’s newer tip-dressing vision systems allow more efficient maintenance of electrodes and reduce the need for redundant welds

BY DANIEL SHIRKEY

Spot welding is one of the most common forms of resistance welding. It is used to manufacture many types of products, and often the welding process is automated using robots with attached spot welding equipment.

As for all manufacturing processes, it is imperative that product quality be maintained at a high level. This has never been more critical than in today’s age of zero-defect requirements and increased pressure to improve productivity. When a process is out of control, lack of quality causes increases in two main areas: quality control costs and quality spill costs. Table 1 offers examples of the costs related to quality issues.

A common problem related to quality costs is that they are often hidden, overlooked, or known but hard to resolve. In the worst — and most common — case, these quality-related costs are simply accepted. Does that sound absurd? Yes, but it’s true. Market research revealed two items of significance: 1) most companies experience these costs and; 2) these same companies would take steps to prevent or reduce these costs if they could.

Process Features

To understand how to prevent these low-quality-related costs, we must first have a good understanding of the spot welding process and the current best practices.

The amount of heat (energy) delivered to the spot governs the quality of the weld. The amount of energy is chosen to match the sheet metal’s material properties, its thickness, and type of electrodes to be used. Applying too little energy won’t melt the metal or will make a poor weld. Applying too much energy will melt too much metal and make a hole rather than a weld. The amount of heat is determined by the resistance between the electrodes and the amplitude and duration of the current, as shown in Equation 1.

\[ Q = I^2Rt \]  

where \( I \) = current (amps), \( R \) = resistance (ohms), and \( t \) = time (seconds).

The amplitude and duration of the current delivered is typically controlled by the weld controller (timer). The resistance of the weld circuit is the most difficult factor to monitor and control. There are six primary sources of resistance in spot welds as depicted in Fig. 1.

Three of the six critical factors of resistance are related to the welding electrodes. Moreover, your manufacturing process already has robust controls on the other three factors (dimensions and material properties of the welding materials). What does all this mean? It means that electrode condition is at least as important as any other factor of the spot welding process.

So what are the critical characteristics of weld tips?

• **Type.** Many different types or styles of tips exist.

DANIEL SHIRKEY (dgshirkey@orbitform.com) is weld engineer, Orbitform Group, Jackson, Mich.
stitute policies that require frequent tip changes and convenient tip changes. These policies often create unnecessary downtime, and the copper costs for these manufacturers are typically high. Some companies use long current stepper profiles in an attempt to create the proper current density at the contact surface. This method may be effective at times; however, an expectation of uniform and predictable tip wear is often unreasonable. Other firms perform end-of-life tip inspections to monitor tip wear after the fact. Another common postprocess inspection is frequent destructive testing. Both of these reactions require labor and the latter produces unnecessary scrap. What do all of these practices have in common? They all add significant fixed and variable costs to the spot welding process, and they are all reactive. Does your company perform any of these “best” practices?

A truly best practice should require a justifiable expenditure and minimal ongoing labor costs. The solution should also provide forward-looking, proactive information. One current practice, tip dressing, is a step in this direction. Tip dressing is designed to remachine the tips to original size and shape specifications. In an automated work cell, this produces minimal downtime while ensuring that the tip condition is appropriate. To date, tip dressing has been the best practice for managing spot welding tips. However, because dressing used tips is not always as easy as it sounds, it often offers a false sense of security related to the condition of tips. Consider the example of turning a part on a lathe that will be joined with its mating component at the assembly line. Can you imagine cutting this part and sending it to the line without first inspecting the critical dimension? Obviously not. Well, cutting material from a used welding tip and then immediately welding is analogous to this example. Therefore, a method of inspecting dressed tips is necessary to have a truly robust best practice.

Investigating tip inspection methods is not necessarily breaking new ground. In recent years, multiple types of sensors have been tested for this purpose. Reflectivity and fiber-optic sensors are two methods of inspection that have been tried, but which have not been adopted because of their shortcomings. These sensors provide partial information, but not enough to determine whether a tip is fit for use. For example, a reflectivity measurement is a relative inspection based on the condition of the tip. Nearly identical reflectively results could come from a properly formed round face and an oversized round face with some embedded impurities. Obviously these are not robust solutions.

**Best Practice Developments**

A more robust solution would be able to ensure that the electrode’s face is the proper shape (circular), proper size (diameter), and adequate (subjective) condition. Certainly it seems visual inspection could perform this analysis. Traditional vision systems have been tested for this application, but have not performed as well as intended. These vision systems are incapable of managing the subjective nature of the good/bad tip decision, and they also struggle with the varying environmental conditions (lighting, debris, etc.) of the work cells.

As a result of these experiments, it was concluded that a complete solution to the tip inspection problem must include a method of managing the subjectivity and variance in the environmental conditions. These conclusions led to the inclusion of a neural network-based technology, CURE®, in the weld tip inspection product. CURE® stands for concurrent (64 parallel processors), universal (data independent), recognition (RBF neural network), engine (massively scalable). A vision system enabled with this technology was designed and tested, and the results show that it effectively manages the environment and subjective concerns. This product is known as Weld Tip System (WTS) — Fig. 2.

![How the Weld Tip System technology works.](image)

This system includes custom lenses and filters and requires no programming or toolkits. All it needs are examples of acceptable tips, and it learns automatically. It mimics the functionality of the human brain by learning patterns, storing the patterns as knowledge, later recognizing those patterns, and then acting accordingly.

This process intelligence tool converts sensor and image data of weld tips into actionable quality assurance information. The system status can be used by a cell controller to take an appropriate action. For instance, suppose that the system fails a test immediately following a dressing operation. This fail signal can be used to send the tips back to the dresser, and then the system can perform another inspection. If the dressing fails three times in a row, then operator intervention is likely required.

Another feature of the system is that it can store inspection images and the appropriate corresponding inspection data. This is used for two main purposes. First, these saved images can be used to perform offline training, which is an efficient method of starting up the system. The images can also be used for benchmarking and traceability.

**Quality Management**

The newer technology allows spot welding process managers to replace electrodes more efficiently, utilize current stepper profiles with more confidence, reduce tear-down frequencies and redundant welds, eliminate other forms of end-of-life inspection, and achieve more secure use of electrode dressers. These new best practices decrease variability in welding cells and help to increase profitability.
Validating the Resistance Welding Process

Following this systematic method improves process and product quality, reduces product scrap and field failures, and provides economic benefits

BY DAVID W. STEINMEIER

The resistance welding world encompasses a wide range of applications and part sizes. Within this unique arena, competition for securing new orders and retaining existing business is increasing, especially in a down economy. One way to provide a competitive edge is to validate your resistance welding process.

The automotive and medical device sectors have a long history of using the validation process. To ensure consistent resistance welding quality, the automotive companies require proof of resistance welding validation from their automotive subsystem suppliers. In addition, the U.S. Food and Drug Administration (FDA) requires medical device manufacturers to validate all of their processes. Both sectors essentially employ the same validation process, but they use different labels for each validation component.

While this article uses a battery pack example to illustrate the resistance welding validation process, this basic validation process is applicable to all resistance welding applications regardless of the part size.

Validation and Verification Definitions

The terms validation and verification are often used interchangeably but they actually have very different meanings. Validation ensures that the right product was made. Verification ensures that the product was made right. The FDA’s 21CFR820.3 regulation provides the following detailed definitions:

**Validation** means confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use can be consistently fulfilled (Ref. 1).

**Process validation** means establishing by objective evidence that a process consistently produces a result or product meeting its predetermined specifications (Ref. 2).

**Design validation** means establishing by objective evidence that device specifications conform with user needs and intended use(s) (Ref. 3).

**Verification** means confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled (Ref. 4).

Why Validate?

Listed below are the four major reasons for validating the welding process.

1. For Six Sigma oriented manufacturers, there is no resistance weld monitor or checker on the market today that can sep-
Design Validation

The design validation (DVAL) process consists of eight main components, beginning with the design process and ending with the product performance validation — Fig. 1.

Design Verification

Design verification (DVER) encompasses selecting verification metrics (Ref. 7) that potentially correlate with the DVAL metrics. Note that it is impossible to establish high or low verification metric limits at this point in the overall validation process before conducting the process qualification (PQ) and process validation (PV). Establishing process limits before developing the welding process will result in unnecessarily scrapping a large amount of useful product. To optimize and verify the resistance weld, use a quantifiable destructive test method such as a shear, tensile-shear, peel, or fatigue cycle test. Note that a cross section of the weld will provide information about the bond type but not the weld strength.

Using the battery pack example, there are several test options based on the physical limitations of testing the battery pack welded connections. Tensile testing is usually not very practical for a battery pack because there is limited connecting strap material to grip. Shear testing requires expensive shear equipment to precisely control the height of the shear tool in relation to the battery cell surface. The easiest option is to perform a 90-deg peel test, which requires isolating each spot weld. Cut each connecting strap in half and then cut each strap down the strap centerline in order to isolate each spot weld — Fig. 3.

Carefully bend one cut section 90 deg, protecting the two spot welds with a metal bar so they will not be stressed during the bending process — Fig. 4. Peel testing each weld separately provides quantitative weld strength information for optimizing and verifying each weld compared to peel testing both welds simultaneously. The PV step will determine the minimum 90-deg peel test magnitude necessary to ensure a successful resistance welding process validation.

Validation Protocol

Validation protocol (VP) requires writing a validation protocol before starting the validation process. Validation protocols differ between industry sectors, such as the medical device and automotive industries, but have the same basic components. Validation protocols also differ between manufacturers within the same industry sector. Figure 5 contains a comparison between the medical device and automotive sensor manufacturing validation steps.

Equipment Installation Qualification

Equipment installation qualification (IQ) involves setting up the equipment in accordance with supplier installation drawings and specifications and verifying equipment calibration. Repeat the IQ after moving or relocating equipment. Setup includes verifying that the resistance welding power supply is connected.
to the correct main voltage source using the manufacturer-recommended wire diameter size over the connection distance. An insufficient main connecting wire size can result in weld current, voltage, or power alarms on feedback-controlled resistance welding power supplies. Non-feedback-controlled power supplies may not provide the user with any alarms should the weld energy drop during the welding process.

Weld cables connecting the power supply transformer to the weld head in small-scale welding can be a major source of energy loss over time, particularly if the weld cables are subjected to robotic motion. It is good practice to make a four-terminal electrical resistance measurement of each weld cable after the cable installation as a baseline comparison when troubleshooting. For large-scale weld head installations using copper bus bars and copper flexures instead of weld cables, verify that all bolted connections are securely tightened.

Verify that the air supply line feeding a pneumatic weld head is sized in diameter and length per the manufacturer’s recommendation. An undersized or excessively long air supply line will result in poor weld head inertia follow-up capability. Finally, verify that any welding fixtures and tooling properly support the weld parts and ensure a consistent part-to-electrode tip alignment within the specified product assembly tolerance.

It is important to perform a calibration check at the beginning of the validation process. This step may be as simple as verifying the information on a calibration certificate from the welding equipment supplier to ensure that the welding equipment is still in calibration. Some Six Sigma manufacturers insist on performing their own calibration checks at the beginning and end of the validation process. For those manufacturers performing their own calibration measurements, use calibrated test equipment that is traceable to a known standard and has a resolution that is twice the smallest resolution of the measured parameter. Use a traceable standard power load when measuring the weld current, voltage, or power.

**Operating Qualification**

Operating qualification (OQ) establishes manufacturing procedures and records for equipment calibration, cleaning, operation, and maintenance. The OQ also includes operator training procedures and records. Identify important welding equipment parameters that can affect the weld. The OQ does not qualify or validate the welding process. For a resistance weld, the most important welding equipment parameters are weld energy, time, and force. Verify that the entire welding system produces the programmed welding parameter magnitudes over their projected operating ranges on a repeatable basis and append the data to the OQ procedure. In the automotive sensor industry, the OQ may also involve operating an automatic welding station without weld energy or parts for a 24-h “dry run.”

Most weld heads do not come with a force calibration certificate relating actual weld force at the electrode tips to the programmed weld force setting, such as...
the input air pressure. Therefore, as part of the OQ process, measure the weld head static and dynamic forces using a calibrated load cell. Dynamically measuring the weld force can reveal an unwanted impulse force, which can negatively affect the resistance welding process. Gather dynamic weld force data using a sampling technique, where the sampling rate must be twice as fast as the smallest power supply weld time increment. For example, a minimum weld time of 1 ms requires two weld force data samples during the 1-ms weld period. Thus, the sampling rate is 2 kHz. Figure 6 shows the weld head static force curves for both the right and left electrode used in the battery pack parallel gap resistance welding example.

**Process Qualification**

Process qualification (PQ) involves discovering the important welding parameters, optimizing the welding parameters, choosing the lot run and sample sizes, and conducting a series of confirmation runs.

**Discovery**

Conduct a Taguchi L9, L12, or L18 design of experiment (DoE) to find out which welding parameters affect the chosen DVER weld verification metrics (Ref. 8). The Taguchi DoE method quickly identifies the most important welding parameters with minimal parts.

**Optimization**

Optimize the welding parameters using the DoE results. Note that the Taguchi DoE model cannot identify welding parameter interactions and, therefore, may not produce the best optimized DoE results. If the results of the Taguchi DoE models are not satisfactory, eliminate the insignificant welding parameters and then conduct a full-factorial DoE using a maximum of four welding parameters. A full-factorial DoE will reveal welding parameter interactions and the optimized weld parameter values. Figure 7 shows the interaction results on 90-deg peel strength for just one spot weld. Note the strong interaction between weld force and time vs. weld force and current. For the single spot weld shown in Fig.7, use a weld force of 50 N, a weld time of 10 ms, and weld current of 2.1 kA. Repeat this optimization process for the remaining battery pack spot welds.

**Lot Run and Sample Sizes**

Select the lot run and sample sizes (Refs. 9, 10). A true sampling plan for determining sample size based on the lot run size is rarely implemented. Unfortunately, sample size selection is usually based on the following:

- “We have always done it this way before.”
- “A sample size of 30 sounds like a statistically significant number.”
- “Inspect two samples at the beginning and end of each lot run.”

Use a statistically significant variable data sampling plan from MIL-STD-414 (Ref. 11) or ISO-3951 (Ref. 12) to measure the process capability. Resistance welding electrode tips wear and oxidize over the lot run and may negatively affect the DVER metrics. Capture differences between vendor-supplied weld parts by using a separate lot run for each vendor. Figure 8 is representative of a typical resistance welding process over time. Within the first group of 30 parts, the weld quality metric, x-bar, is relatively high and the distribution fairly tight. After welding more than 30 parts, the electrode tips mushroom and become contaminated with plating and oxides. The total population or lot run weld quality metric, \( \mu \), decreases in comparison to the 30 parts weld quality metric, x-bar. In addition, the total population distribution is much wider than the limited 30-part sample. Neither population follows a perfect Gaussian dis-
tibution so there is no value in using an upper control limit. Setting the lower control limit (LCL) bases on the 30-part sample will result in an unacceptable Cpk — a statistical term used to measure process capability — for the total population because the LCL is inside of the total population distribution.

**Confirmation Runs**

Establish the capability of the welding system by making real parts at your automation vendor's facility before transferring the welding process to your own manufacturing facility. Conduct the confirmation run using one of two protocols.

**Protocol 1**

Weld one or more lot runs making no changes to the welding parameters during the confirmation run. For the battery pack example, collect PO data using DVER metrics such as the peak or RMS weld voltage, current, force, displacement, and 90-deg peel strength for each weld. Retain a statistically significant sample of complete battery packs for measuring the PV data that include measuring the electrical parameters for each welded and packaged battery pack before and after subjecting the battery pack to a specified number of tumbling cycles. The tumbling test simulates the impact forces encountered during shipping and handling. To conduct a tumbling test, place completed battery packs in drum that rotates about a horizontal axis. The drum speed affects how the battery packs impact each other and the inside surface of the drum.

**Protocol 2**

Weld one lot run using welding parameters that represent a low weld energy condition. Weld a second lot run using welding parameters that represent a high weld energy condition. Collect the same data required in Protocol 1.

**Data Analysis**

Test PQ lot run consistency by using the appropriate statistical metrics to mathematically verify process consistency. If multiple lot run populations are not statistically identical, then there is a difference in the part quality between vendors, operator methods, or automation stations. Do not set process limits at this time because correlation has not been established between the PQ and PV data.

**Process Validation**

Process validation (PV) establishes the welding process consistently produces a part or product meeting its predetermined specification. This involves correlating the PQ data with the PV data. In the case of the battery pack example, look for correlations between the PQ weld voltage, current, force, displacement, and the 90-deg peel test data with the PV data, comprising battery pack electrical parameters and tumbling cycles.

Unfortunately, the weld voltage, current, force, or displacement PO data did not correlate with the PV data, so monitoring these parameters does not provide a viable method of ensuring resistance weld quality during production. However, the 90-deg peel test PQ data correlated directly with the PV tumble cycling failures. Below a minimum 90-deg peel test value, some connecting strap welds within the welded battery pack separated from one or more battery cells during the PV tumbling cycle test. A close examination of the failed battery packs revealed that the failures occurred near the end of the lot run when the electrode tips increased in diameter (mushrooming) and contained a high degree of connecting strap material. To set the LCL value, find the minimum 90-deg peel strength value within the lot run population of nonfailures and use the minimum value for the LCL. In addition, reduce the manufacturing lot size to eliminate the possibility of connecting strap failures caused by electrode tip wear. Thus, the resistance welding process was validated by documented evidence that resistance welding consistency could be assured by 90-deg peel testing welded battery packs using a statistically significant sampling plan and then comparing the results against a proven LCL value and by limiting the manufacturing lot size.

**Product Performance Qualification**

Product performance qualification (PPQ) establishes with documented evidence that the finished product meets all requirements for functionality and safety. It incorporates a series of environmental tests used to simulate the operating environment of the finished product. Environmental tests for PPQ include, but are not limited to, the following: life cycling, temperature, vibration, humidity, impact, and shipping. Assuming that no failures occur, the product is considered to be validated. Should weld failures occur during PPQ, the basic product design for weldability, DVER metrics, or DVAL metrics are potentially faulty.

**Conclusion**

Resistance welding validation is no longer limited to the realm of medical device or automotive sensor manufacturing. Validation is a proven systematic method to improve process and product quality, reduce product scrap and field failures, and enhance the competitiveness of your product. Six Sigma oriented manufacturers are quickly discovering the economic benefits of establishing and maintaining validation over their resistance welding processes.

**References**

The first four references listed below are from Title 21 — Food and Drugs, Subchapter H — Medical Devices, Part 820 — Quality System Regulation, Subpart A — General Provisions, Sec. 820.3 — Definitions. Also, Refs. 6 and 7 are from Title 21 — Food and Drugs, Subchapter H — Medical Devices, Part 820 — Quality System Regulation, Subpart C — Design Controls, Sec. 820.30 — Definitions.

Built TOUGH in the USA by CMI for Welders around the WORLD.

Your best source for
Semi-Automatic and Automatic
MIG welding guns, including
air and water cooled,
Push-Pull, and
Smoke Extractor

With us, customer support
comes first. From custom
designed MIG guns
and consumables to
rapid delivery.

For a complete range
of our products,
visit us online at
cmindustries.com
or call us toll free.
1-800-530-0032

CM Industries has a full line of
Robotic Nozzle Cleaning Stations,
Wire Cutters, and Replacement
Reamer Blades to choose from.
Make robotic nozzle cleaning
operations easier with CMI.
Attendees from 128 different countries filled the halls at the Messe Essen complex.

Essen Welding and Cutting Fair Comes Up Big in a Down Economy

By the number of attendees that crowded the exhibitions at the 17th Essen Welding and Cutting Fair (Schweissen & Schneiden Essen), held Sept. 14–19 in Essen, Germany, you wouldn’t think there was a world economic downturn. The activity was brisk and there was a general feeling that even though the world economy was soft, the once-every-four-year Fair was not to be missed by attendees and exhibitors alike so as to be well positioned for the coming recovery. This show was more international than ever with more than 60,000 attendees coming from 128 countries compared to the count of 90 different nations from the previous show. The 18 halls of the Messe Essen facility were filled to capacity with 1015 exhibitors from 42 countries.

Positive Signs

Chief executive officer of the German Welding Society (DVS) Klaus Middelford noted that the strong turnout for the Fair reflected its position as a leading international innovation showcase and sent positive signals for future economic and technological developments in joining. Since 1952, DVS has partnered with Messe Essen GmbH to organize the Essen Welding and Cutting Fair.

The American Welding Society was active during the six-day event with its own exhibition as part of the U.S. Pavilion. President Victor Matthews, Treasurer Earl Lipphardt, and Executive Director Ray Shook all participated in representing the AWS. The U.S. Pavilion showcased 28 companies.

From purge dams to fiber laser technology, the attendees were hard pressed not to find whatever they might need. A brief sampling of some of the technology displayed is described below.

Products on Display

The TransSteel series of welding machines were introduced by Fronius. The 350-A and 500-A power sources (Fig. 1)
Showgoers and exhibitors alike were optimistic about a rebound in the welding industry

BY ANDREW CULLISON

are designed with simplicity in mind. The machine is preprogrammed to handle different thicknesses (0.035–1 in.) and material types. The only adjustments the operator has to be concerned with are wire feed speed and voltage. The wire feeder has a four-wheel drive for stability, and wire diameters from 0.035 to 1/8 in. can be accommodated. A universal connector will handle welding guns from various manufacturers. www.fronius.com

Kjellberg Finsterwalde added to its FineFocus line with the premier of the FineFocus 600 at the exhibition. This plasma cutting machine can cut metals from 3 to 60 mm (0.12 to 2.4 in.) in thickness at a current range of 60 to 200 A at 100% duty cycle. For cutting steel, shop air or oxygen can be used, while a mixture of argon/helium is recommended for stainless steel and aluminum. www.kjellberg.de

The P6 orbital welding power source (Fig. 2) was introduced at the Essen Fair by Polysoude. The wheeled carriage attached to this medium-sized machine gives it mobility. Interaction between the welding operator and the internal functions of the machine were designed into this unit. A touch screen accessible on the top of the power source allows the operator to monitor programs for various applications, receive real-time feedback of welding data, and administer an error-agnostic system. The unit has built-in arc voltage and torch oscillation control. Documentation of welding procedures is possible with the automatic printout of data. The machine operates at 300 A, 35% duty cycle; 265 A, 60% duty cycle; and 240 A at 100% duty cycle. www.polysoude.com

A first-time introduction of focusArc® gas tungsten arc welding system was made by EWM. The main design feature of the system is the densely concentrated and highly focused arc that produces welding conditions similar to laser beam arc welding. In fact, the unit is marketed to compete with the speed, minimal distortion, and concentrated arc capabilities of laser units without the six-figure capital costs of investing in a laser. The welding system has been tested on applications in the automotive industry. On one application where galvanized sheet metal was brazed, speeds of 5 m/min (16.4 ft) were attained. Other applications on which good results were achieved included exhaust manifolds and pedals. Operation includes either cold or hot wire automatic feeding. www.ewm-group.com

Regula Systems demonstrated its EWR Pro electronic gas flow regulator. The unit synchronizes the gas flow with the actual welding current to automatically adjust to the conditions — more gas flow with higher current and less with lower current. The company claims before it was used in a Honda manufacturing plant, 427 bodies were welded before a cylinder change. When the regulator was installed, that number went to 1086 bodies before the change of the cylinder. Two units are available with one controlling gas flow from 14–21 L/min at 90–300 A; and the other regulating gas flow from 6–13 L/min at 45–150 A. www.regulasystems.com

Kemper used the Essen Fair to premier its autoflow® XP, a portable respiratory package (Fig. 3) that prevents the infiltration of fumes and particles into a protective autodarkening helmet. A rechargeable battery-driven fan generates pressure to keep fumes at bay while incoming air passes through a particle filter that is 99.8% efficient. The unit is light-weight, and it straps to the waist of the welder. There are four different blower settings, and an acoustic alarm activates when the filter needs replacing or the batteries need recharging. www.kemper.eu

Vitronic demonstrated its automated weld joint inspection sensor VIROwsi® — Fig. 4. This combination laser/camera-based sensor detects and records flaws in real time. When the unit detects conditions outside of established limits, warnings are immediate and the manufacturing process can be adjusted accordingly. Conditions such as porosity, melt through, unfilled craters, and weld volume, width,
A unique situation arose during the Fair that brought four equipment manufacturers together with individual products that complemented the technology of each other. The VBC Group of Leicestershire, England, specializes in automated welding systems. The company has developed InterPulse, a gas tungsten arc welding (GTAW) power source (Fig. 6) that is designed to join hard-to-weld superalloys such as Inconel® 718 and 713, PK33, Rene 142 DS, and single crystal CMSX-10. It also works on titanium “in” or “out” of chamber. Operating on 20,000-Hz frequency, it produces a highly constricted arc at low temperatures, which leads to a very narrow weld bead and a corresponding narrow heat-affected zone (HAZ), which is an advantage with crack-sensitive superalloys. The machine has the capability of welding at amperages as low as 0.1.

A problem occurs when welding at the very low amperages of this machine. The standard autodarkening welding helmet would shut down (turn light) or flutter trying to adjust to the low light levels of the arc. Also, the standard ceramic gas cup of the GTAW torch would block the welder’s sight line with such a low-light arc.

Eyerex Ltd., Schindellegi, Switzerland, an exhibitor at the Fair, suggested the use of its Magic autodarkening helmet, which is not dependent just on light sensing for operation. It has a dual capability of being optical and magnetic sensitive to the arc. As long as the arc’s magnetic field can be sensed, the helmet remains autodarkened to the right filter. The helmet was tried, and it worked under the lowest amperage and most meager arc light conditions of the power source. The helmet is manufactured in Switzerland under license from Sellstrom Manufacturing Co., Palatine, Ill., which markets its own helmet in the U.S. as Impulse MagSense™.

The collaboration among equipment suppliers continued with the use of a GTAW torch with a Pyrex® glass cup from CK Worldwide, Auburn, Wash. The cup has a large diameter that allows extra gas coverage, which is especially good for titanium, and this see-through clear cup provided the visibility needed to see the weld pool with the low-light arc produced at the lowest amperages of the power source.

It proved to be a perfect mating of manufacturers whose combination of individual products produce a whole system for welding.

Selco’s green@wave® series of power sources were introduced to the market. The current flow in these units is designed to follow very closely the voltage supply. This technology allows only the power needed for the welding process to be drawn, thereby lowering energy consumption. The Genesis group of welding machines (Fig. 5) incorporates this technology for the GMAW, GTAW, and SMAW processes. With special software, multiple units can be controlled from a PC where welding parameters are displayed and adjusted. www.selcoweld.com

Selco’s green@wave® series of power sources were introduced to the market. The current flow in these units is designed to follow very closely the voltage supply.

Selco’s green@wave® series of power sources were introduced to the market. The current flow in these units is designed to follow very closely the voltage supply.

Selco’s green@wave® series of power sources were introduced to the market. The current flow in these units is designed to follow very closely the voltage supply.
**PROFESSIONAL PROGRAM ABSTRACT SUBMITTAL**
Annual FABTECH International & AWS Welding Show
Atlanta, GA - November 2 – 4, 2010

Submission Deadline: March 31, 2010
(Complete a separate submittal for each paper to be presented.)

<table>
<thead>
<tr>
<th>Primary Author (Full Name):</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Affiliation:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mailing Address:</th>
</tr>
</thead>
<tbody>
<tr>
<td>City:</td>
</tr>
<tr>
<td>Name (Full Name):</td>
</tr>
<tr>
<td>Name (Full Name):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Co-Author(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name (Full Name):</td>
</tr>
<tr>
<td>Name (Full Name):</td>
</tr>
</tbody>
</table>

**Answer the following about this paper**

- Original submittal? Yes □ No □
- Progress report? Yes □ No □
- Review paper? Yes □ No □
- Tutorial? Yes □ No □
- Tutorial? Yes □ No □

What are the welding/Joining processes used?
What are the materials used?
What is the main emphasis of this paper? Process Oriented □ Materials Oriented □ Modeling □
To what industry segments is this paper most applicable?
Has material in this paper ever been published or presented previously? Yes □ No □
   If “Yes”, when and where?
Is this a graduate study related research? Yes □ No □
If accepted, will the author(s) present this paper in person? Yes □ Maybe □ No □

**Keywords:** Please indicate the top four keywords associated with your research below

Guidelines for abstract submittal and selection criteria:
- Only those abstracts submitted on this form will be considered. Follow the guidelines and word limits indicated.
- Complete this form using MS Word. Submit electronically via email to techpapers@aws.org

**Technical/Research Oriented**
- New science or research.
- Selection based on technical merit.
- Emphasis is on previously unpublished work in science or engineering relevant to welding, joining and allied processes.
- Preference will be given to submittals with clearly communicated benefit to the welding industry.

**Applied Technology**
- New or unique applications.
- Selection based on technical merit.
- Emphasis is on previously unpublished work that applies known principles of joining science or engineering in unique ways.
- Preference will be given to submittals with clearly communicated benefit to the welding industry.

**Education**
- Innovation in welding education at all levels.
- Emphasis is on education/training methods and their successes. Papers should address overall relevance to the welding industry.

☑ Check the category that best applies:

☐ Technical/Research Oriented ☐ Applied Technology ☐ Education
Abstract:
Introduction (100 words max.) – Describe the subject of the presentation, problem/issue being addressed and its practical implications for the welding industry. Describe the basic value to the welding community with reference to specific communities or industry sectors.

Technical Approach, for technical papers only (100 words max.) – Explain the technical approach, experimental methods and the reasons why this approach was taken.

Results/Discussion (300 words max.) – For technical papers, summarize the results with emphasis on why the results are new or original, why the results are of value to further advance the welding science, engineering and applications. For applied technology and education papers, elaborate on why this paper is of value to the welding community, describe key aspects of the work developed and how this work benefits the welding industry and education.

Conclusions (100 words max.) – Summarize the conclusions and how they could be put to use – how and by whom.

NOTE: Abstract must not exceed one page and must not exceed the recommended word limit given above

Note. The Technical Program is not the venue for commercial promotions of a company or a product. All presentations should avoid the use of product trade names. The Welding Show provides ample opportunities for companies to showcase and advertise their processes and products.

Return this form, completed on both sides, to

AWS Education Services
Professional Program 2010
550 NW LeJeune Road
Miami FL 33126
FAX 305-648-1655

MUST BE RECEIVED NO LATER THAN MARCH 31, 2010
AWS can help you career with a variety of resources and opportunities unparalleled in the industry. AWS will help you do your job better - more quickly, more accurately and with the latest industry information available anywhere. AWS Members receive key benefits that help them in today's competitive market. Some of the benefits include discounts on welding equipment/tools of the trade, subscription to the award-winning Welding Journal, up to 90% off an AWS technical publication when you join, a 25% Discounts on AWS Publications, discounts on AWS Conferences, AWS Certification and AWS Education programs, networking opportunities, access to the Members'-only Web Site, access to a health insurance program, discounts on auto & home insurance and more.

Student Membership
Become part of a world-renowned organization. AWS provides students with a variety of resources and opportunities unparalleled in the industry. AWS knows that students are the future of the industry. For this reason, we offer a deeply-discounted Student Membership. Student Memberships start at just $15 a year.

Corporate Memberships
Join More Than 2,000 Companies and Educational Institutions. Become part of the Society committed to helping your organization grow. AWS offers Corporate Memberships for companies small or large, as well as Educational Institutions. AWS will provide your business or school with the tools you need to make an impact in the industry. Show your customers your commitment to excellence, and stand out from the competition by becoming an AWS Corporate Member. An AWS Member Specialist can help you determine which of the five different AWS Corporate Memberships fit your organization best.

JOIN TODAY BY CALLING 800-443-9353, EXT. 480 OR ON-LINE AT WWW.AWS.ORG/MEMBERSHIP

Stop by and visit us at the AWS Membership booth when you attend the 2009 FABTECH & AWS Welding Show.
COMING EVENTS

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


AWS Detroit Sheet Metal Welding Conf. XIV. May 11–14, Vis-TaTech Center, Livonia (Detroit), Mich. Contact American Welding Society Detroit Section at smwcc@awsdetroit.org, or visit www.awsdetroit.org.


♦FABTECH International & AWS Welding Show including METALFORM. Nov. 2–4, Georgia World Congress Center, Atlanta, Ga. 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.


♦JOM-16, 16th Int’l Conf. on the Joining of Materials. May 15–19, 2011. Contact JOM Institute, Gilleleje, Denmark. Phone: +45 48 35 54 58; jom_aws@post10.tele.dk.


Educational Opportunities


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

Applied Automation: Robots in Manufacturing. Free one-day seminar, Dec. 9 and Dec. 10, ARC Specialties, 1730 Stubbins Dr., Houston, Tex. To cover adaptive automation, robotic pipe welding, cut-to-fit technology, robotic spray applications, robotic vision, and through-the-arc technology using a Fanuc ARC Mate 100iC with iVision. Preregister online: www.arcspecialties.com.


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

Brazing School. May 11–13, Wall Colmonoy Aerobraze Cincinnati, Ohio. Contact Lydia Lee (248) 585-6400, ext. 252; bydialee@wallcolmonoy.com; or visit www.wallcolmonoy.com.

CWI/CWE Course and Exam. Troy, Ohio. This is a 2-week preparation and exam program. For schedule, contact Hobart Institute of Welding Technology, (800) 332-9448, www.welding.org.

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.

Consumables: Care and Optimization. Free online e-courses presenting the basics of plasma consumables, designed for plasma operators, distributor sales and service personnel, etc. Visit www.hyperthermcuttinginstitute.com.

Environmental Online Workshops. Free, online, real-time seminars conducted by industry experts. For topics and schedule, visit www.augustmack.com/Web%25Seminars.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; stogner@epri.com.


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


Welding Courses. A wide range of specialized courses presented throughout the year. Contact Lincoln Electric Co., visit www.lincolnelectric.com/knowledge/training/weldschool/courses.asp, or call (216) 486-1751.

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

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)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresno, CA</td>
<td>Jan. 10-15</td>
<td>Jan. 16</td>
</tr>
<tr>
<td>Beaumont, TX</td>
<td>Jan. 10-15</td>
<td>Jan. 16</td>
</tr>
<tr>
<td>Corpus Christi, TX</td>
<td>EXAM ONLY</td>
<td>Jan. 23</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Jan. 24-29</td>
<td>Jan. 30</td>
</tr>
<tr>
<td>Albuquerque, NM</td>
<td>Jan. 31-Feb.5</td>
<td>Feb. 6</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>Jan. 31-Feb.5</td>
<td>Feb. 6</td>
</tr>
<tr>
<td>Denver, CO</td>
<td>Jan. 31-Feb.5</td>
<td>Feb. 6</td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>Jan. 31-Feb.5</td>
<td>Feb. 6</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>EXAM ONLY</td>
<td>Feb. 25</td>
</tr>
<tr>
<td>Birmingham, AL</td>
<td>Feb. 21-26</td>
<td>Feb. 27</td>
</tr>
<tr>
<td>Long Beach, CA</td>
<td>Feb. 21-26</td>
<td>Feb. 27</td>
</tr>
<tr>
<td>Milwaukee, WI</td>
<td>Feb. 28-Mar. 5</td>
<td>Mar. 6</td>
</tr>
<tr>
<td>Atlanta, GA</td>
<td>Feb. 28-Mar. 5</td>
<td>Mar. 6</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>Feb. 28-Mar. 5</td>
<td>Mar. 6</td>
</tr>
<tr>
<td>Houston, TX</td>
<td>Mar. 7-12</td>
<td>Mar. 13</td>
</tr>
<tr>
<td>Norfolk, VA</td>
<td>Mar. 7-12</td>
<td>Mar. 13</td>
</tr>
<tr>
<td>Perrysburg, OH</td>
<td>EXAM ONLY</td>
<td>Mar. 13</td>
</tr>
<tr>
<td>Indianapolis, IN</td>
<td>Mar. 14-19</td>
<td>Mar. 20</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>Mar. 14-19</td>
<td>Mar. 20</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>EXAM ONLY</td>
<td>Mar. 20</td>
</tr>
<tr>
<td>Rochester, NY</td>
<td>EXAM ONLY</td>
<td>Mar. 20</td>
</tr>
<tr>
<td>Corpus Christi, TX</td>
<td>EXAM ONLY</td>
<td>Mar. 20</td>
</tr>
<tr>
<td>Boston, MA</td>
<td>Mar. 21-26</td>
<td>Mar. 27</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>Mar. 21-26</td>
<td>Mar. 27</td>
</tr>
<tr>
<td>Anchorage, AK</td>
<td>Mar. 21-26</td>
<td>Mar. 27</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>Mar. 21-26</td>
<td>Mar. 27</td>
</tr>
<tr>
<td>York, PA</td>
<td>EXAM ONLY</td>
<td>Mar. 27</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Mar. 28-Apr. 2</td>
<td>Apr. 3</td>
</tr>
<tr>
<td>Dallas, TX</td>
<td>Apr. 11-16</td>
<td>Apr. 17</td>
</tr>
<tr>
<td>Knoxville, TN</td>
<td>EXAM ONLY</td>
<td>Apr. 17</td>
</tr>
<tr>
<td>Springfield, MO</td>
<td>Apr. 18-23</td>
<td>Apr. 24</td>
</tr>
<tr>
<td>Mobile, AL</td>
<td>EXAM ONLY</td>
<td>Apr. 24</td>
</tr>
<tr>
<td>St. Louis, MO</td>
<td>EXAM ONLY</td>
<td>Apr. 24</td>
</tr>
<tr>
<td>Portland, ME</td>
<td>Apr. 25-30</td>
<td>May 1</td>
</tr>
<tr>
<td>Las Vegas, NV</td>
<td>Apr. 25-30</td>
<td>May 1</td>
</tr>
<tr>
<td>Waco, TX</td>
<td>EXAM ONLY</td>
<td>May 1</td>
</tr>
<tr>
<td>Baton Rouge, LA</td>
<td>May 2-7</td>
<td>May 8</td>
</tr>
<tr>
<td>San Francisco, CA</td>
<td>May 2-7</td>
<td>May 8</td>
</tr>
<tr>
<td>Nashville, TN</td>
<td>May 9-14</td>
<td>May 15</td>
</tr>
<tr>
<td>Jacksonville, FL</td>
<td>May 9-14</td>
<td>May 15</td>
</tr>
<tr>
<td>Baltimore, MD</td>
<td>May 9-14</td>
<td>May 15</td>
</tr>
<tr>
<td>Corpus Christi, TX</td>
<td>EXAM ONLY</td>
<td>May 15</td>
</tr>
<tr>
<td>Detroit, MI</td>
<td>May 16-21</td>
<td>May 22</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>May 16-21</td>
<td>May 22</td>
</tr>
<tr>
<td>Albuquerque, NM</td>
<td>May 16-21</td>
<td>May 22</td>
</tr>
<tr>
<td>Long Beach, CA</td>
<td>EXAM ONLY</td>
<td>May 29</td>
</tr>
<tr>
<td>Spokane, WA</td>
<td>Jun. 6-11</td>
<td>Jun. 12</td>
</tr>
<tr>
<td>Oklahoma City, OK</td>
<td>Jun. 6-11</td>
<td>Jun. 12</td>
</tr>
<tr>
<td>Birmingham, AL</td>
<td>Jun. 6-11</td>
<td>Jun. 12</td>
</tr>
<tr>
<td>Miami</td>
<td>EXAM ONLY</td>
<td>Jun. 17</td>
</tr>
<tr>
<td>Hartford, CT</td>
<td>Jun. 13-18</td>
<td>Jun. 19</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>Jun. 13-18</td>
<td>Jun. 19</td>
</tr>
<tr>
<td>Corpus Christi, TX</td>
<td>EXAM ONLY</td>
<td>Jul. 10</td>
</tr>
<tr>
<td>New Orleans, LA</td>
<td>Jul. 11-16</td>
<td>Jul. 17</td>
</tr>
<tr>
<td>Phoenix, AZ</td>
<td>Jul. 11-16</td>
<td>Jul. 17</td>
</tr>
<tr>
<td>Orlando, FL</td>
<td>Jul. 18-23</td>
<td>Jul. 24</td>
</tr>
<tr>
<td>Milwaukee, WI</td>
<td>Jul. 18-23</td>
<td>Jul. 24</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>Jul. 18-23</td>
<td>Jul. 24</td>
</tr>
<tr>
<td>Sacramento, CA</td>
<td>Jul. 18-23</td>
<td>Jul. 24</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Orleans, LA</td>
<td>Jan. 11-16</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Denver, CO</td>
<td>Feb. 22-27</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Dallas, TX</td>
<td>Mar. 15-20</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Apr. 12-17</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Sacramento, CA</td>
<td>May 3-8</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Pittsburgh, PA</td>
<td>Jun. 7-12</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>Jul. 12-17</td>
<td>NO EXAM</td>
</tr>
<tr>
<td>Orlando, FL</td>
<td>Aug. 23-28</td>
<td>NO EXAM</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta, GA</td>
<td>Jan. 25-29</td>
<td>Jan. 30</td>
</tr>
<tr>
<td>New Orleans, LA</td>
<td>Apr. 19-23</td>
<td>Apr. 24</td>
</tr>
<tr>
<td>Minneapolis, MN</td>
<td>Jul. 19-23</td>
<td>Jul. 24</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Sept. 13-17</td>
<td>Sept. 18</td>
</tr>
</tbody>
</table>

CWS exams are also given at all CWI exam sites.

### Certified Radiographic Interpreter (CRI)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami, FL</td>
<td>Feb. 1-5</td>
<td>Feb. 6</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Mar. 8-12</td>
<td>Mar. 13</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Apr. 19-23</td>
<td>Apr. 24</td>
</tr>
<tr>
<td>Allentown, PA</td>
<td>May 17-21</td>
<td>May 22</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Jun. 21-25</td>
<td>Jun. 26</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Jul. 26-30</td>
<td>Jul. 31</td>
</tr>
</tbody>
</table>

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

### Certified Welding Sales Representative (CWSR)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SEMINAR DATES</th>
<th>EXAM DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles, CA</td>
<td>Jan. 27-29</td>
<td>Jun. 29</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Feb. 24-26</td>
<td>Feb. 26</td>
</tr>
<tr>
<td>Houston, TX</td>
<td>Mar. 31-Apr. 2</td>
<td>Apr. 2</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>May 5-7</td>
<td>May 7</td>
</tr>
<tr>
<td>Chicago, IL</td>
<td>Jun. 9-11</td>
<td>Jun. 11</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>Aug. 25-27</td>
<td>Aug. 27</td>
</tr>
</tbody>
</table>

CWSR exams will also be given at CWI exam sites.

### Certified Welding Educator (CWE)

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

### Senior Certified Welding Inspector (SCWI)

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

### Certified Welding Engineer (CWEEng)

Exam can be taken at any site listed under Certified Welding Inspector. No preparatory seminar is offered. Two exam days are necessary for this certification.

### Certified Robotic Arc Welding (CRAW)

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>WEEK OR</th>
<th>CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wolf Robotics, Ft. Collins, CO</td>
<td>Jan. 25</td>
<td>(970) 225-7736</td>
</tr>
<tr>
<td>ABB, Inc., Auburn Hills, MI</td>
<td>Feb. 1</td>
<td>(248) 391-8421</td>
</tr>
<tr>
<td>ABB, Inc., Auburn Hills, MI</td>
<td>Mar. 1</td>
<td>(248) 391-8421</td>
</tr>
<tr>
<td>Lincoln Electric, Cleveland, OH</td>
<td>Mar. 1</td>
<td>(216) 383-8542</td>
</tr>
<tr>
<td>Wolf Robotics, Ft. Collins, CO</td>
<td>Mar. 8</td>
<td>(970) 225-7736</td>
</tr>
<tr>
<td>ABB, Inc., Auburn Hills, MI</td>
<td>Apr. 5</td>
<td>(248) 391-8421</td>
</tr>
<tr>
<td>Wolf Robotics, Ft. Collins, CO</td>
<td>Apr. 19</td>
<td>(970) 225-7736</td>
</tr>
</tbody>
</table>

### International CWI Courses and Exams

Please visit [http://www.aws.org/certification/inter_contact.html](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](http://www.aws.org/certification) or call AWS at (800) 443-9553, 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.
AWS Foundation Celebrates 20 Years of Service to the Welding Community

The AWS Foundation recently celebrated its 20 years of service to the welding industry at AWS headquarters in Miami, Fla.

The AWS Foundation officially opened for business Sept. 13, 1989. Led by a volunteer board of trustees, it is a nonprofit 501(c)(3) charitable organization. Its office space, administrative, and logistical support are provided by the American Welding Society, including the services of Sam Gentry, AWS Foundation executive director, and support staff Vicki Pinsky and Nazdhia Prado-Pulido. Past AWS President Gerald D. Uttrachi serves as the chairman of the board of trustees.

The AWS Foundation makes available scholarships for undergraduate and vocational-technical students to pursue welding-related studies. Graduate students conducting welding-related research may receive graduate research fellowships that are matched in-kind by the institution they are attending. To date, the AWS Foundation has awarded more than $4.5 million to more than 3000 students.

The Foundation and the American Welding Society work together to relieve the welder shortage from ‘recruitment to retirement’ using a variety of methods. The Foundation’s Solutions Opportunity Squad, headed by Monica Pfarr, corporate director, and Connie Bowling, director, visits AWS Sections, educational facilities, and industries nationwide to learn first-hand the local problems and help determine solutions to welding-related concerns.

The Foundation aims to help solve welder shortage problems, be recognized as a local workforce solution provider, determine industry needs, provide promotional materials and national spokespersons, build an Internet presence, provide a Welding Careers Web site, offer welding-related videos and useful commercials, and serve as an educational resource by offering welding industry career guides and literature, and conduct a welder workforce salary study.

Presently, the AWS Foundation maintains 22 National Named Scholarships that are funded by corporations or individual donors. These scholarships are presentation to students pursuing four-year degree programs.

In addition, there are five District Named Scholarships sponsored by a District and/or a donor to support students in a particular AWS District. Following are the District scholarships:

- The Shirley Bollinger, District 3, Named Scholarship; Ed Cable-BUG-O Systems, District 7 Named Scholarship; Detroit Arc, District 11, Named Scholarship; Detroit Resistance, District 11, Named Scholarship; and District 15 Named Scholarship.

Following are the 14 Section Named Scholarships sponsored by a Section and/or a donor to support students in their particular AWS Section: O. J. Temple-Baton Rouge Section Named Scholarship, Amos and Marilyn Winsand-Detroit Section Named Scholarship, Dr. Daryl Morgan-Houston Section Named Scholarship, Ronald Theiss-Houston Section Named Scholarship, Paul O’Leary Memorial-Idaho/Montana Section Named Scholarship, Lehigh Valley Professor Robert Stout Section Named Scholarship, Ronald and Joyce Pierce-Mobile Section Named Scholarship, Shelton Ritter-New Orleans Section Named Scholarship, Northwest Section Named Scholarship, James Gardner-Ozark Section Named Scholarship, Puget Sound Section Named Scholarship, Tri-Tool-Sacramento Section Named Scholarship, Lou DeFreitas-Santa Clara Section Named Scholarship, and Donald and Jean Cleveland-Willamette Valley Section Named Scholarship.

The AWS Foundation funds the needs for education and research in the fields of welding and related joining technologies. To make a donation or to establish your own National, District, or Section Named Scholarship, contact the AWS Foundation at (305) 443-9353, ext. 212.
Official Interpretation A5.18


Question: Is chemical analysis of a sample prepared from the rod stock from which the solid filler metal was produced an acceptable method for demonstrating conformance to solid filler metal classifications with AWS A5.18/A5.18M:2005?

Response: Yes.

New Standard Project

A9.5:20XX, Guide for Verification and Validation in Computational Weld Mechanics

Development work has begun on this new standard. Stakeholders include engineers, scientists, decision makers, program managers, and higher education instructors. It will be of particular interest to the shipbuilding, energy, automotive, aerospace, pressure vessel, and civil engineering industries, as well as government agencies. Interested individuals are invited to contribute to the development of this standard. Contact John Gayler, (800/305) 443-9353, ext. 472.

AWS Standards for Public Review


AWS was approved as an accredited standards-preparing organization by the American National Standards Institute (ANSI) in 1979. AWS rules, as approved by ANSI, require that all standards be open to public review for comment during the approval process. To order draft copies of these documents, contact Rosa Linda O’Neill, o'neill@aws.org; (800/305) 443-9353, ext. 451.

ISO Draft Standards for Public Review

ISO/DIS 544, Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings

ISO/DIS 14171.2, Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels — Classification

Copies of the above draft standards 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. Send comments regarding ISO documents to your national standards body.

In the United States, if you want to participate in the development of international standards for welding, contact Andrew Davis, adavis@aws.org, (800/305) 443-9353, ext. 466.

Technical Committee Meetings

Dec. 9, 10. Safety and Health Committee. Miami, Fla. Contact: Steven P. Hedrick, ext. 305.


Note: All AWS technical committee meetings are open to the public. To attend a meeting, call the committee secretary, (800/305) 443-9353, at the extensions shown.

Share Your Expertise with the World — Join an AWS Technical Committee

Magnesium Alloy Filler Metals

Volunteers are invited to participate on the ASL Subcommittee on Magnesium Alloy Filler Metals. This subcommittee is responsible for updating AWS A5.19-92 (R2006), Specification for Magnesium Alloy Welding Electrodes and Rods. For complete information, contact Subcommittee Secretary Rakesh Gupta at gupta@aws.org, or call (800/305) 443-9353, ext. 301. You may also visit www.aws.org/1UQ4 to submit your member application online.

Thermal Spraying

Volunteers are invited to participate on the C2 Committee on Thermal Spraying. Its documents include C2.16, Guide for Thermal-Spray Operator Qualification; C2.18, Guide for the Protection of Steel with Thermal Sprayed Coatings of Aluminum and Zinc and their Alloys and Composites; C2.19, Machine Element Repair; C2.20, Thermal Sprayed Coating for Reinforced Concrete; C2.21, Specification for Thermal Spray Equipment Acceptance Inspection; C2.23, Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel; C2.25, Specification for Thermal Spray Feedstock — Solid and Composite Wire and Ceramic Rods. Contact Reino Starks, rstarks@aws.org, (800/305) 443-9353, ext. 304, for information, or visit www.aws.org/1UQ4 to submit your application online.

Welding Sales Representatives

AWS established a new certification program for welding sales representatives in 2009. Volunteers are invited to be part of the technical subcommittee responsible for setting the qualification requirements, AWS B5.14, Specification for the Qualification of Welding Sales Representatives, that this program is based on. For complete information about this committee’s work, contact John Gayler, gayler@aws.org, (800/305) 443-9353, ext. 472; or submit a technical committee application online at www.aws.org/1UQ4.

Robotic and Automatic Welding

Volunteers are sought to participate on the D16 Committee on Robotic and Automatic Welding. Its documents include D16.1, Specification for Robotic Arc Welding Safety; D16.2, Guide for Components of Robotic and Automatic Arc Welding Installations; D16.3, Risk Assessment Guide for Robotic Arc Welding; D16.4, Specification for Qualification of Robotic Arc Welding Personnel. Persons engaged in robotic welding operations and suppliers of equipment who want to contribute their expertise to the preparation of one or more of these documents are urged to contact Matt Rubin, mrubin@aws.org, (800/305) 443-9353, ext. 215, or visit www.aws.org/1UQ4 to submit your member application online.
The American Welding Society hosted a Middle East and Indian Agent Meeting Aug. 13–15, in Dubai, UAE, where an International Agency agreement was signed between AWS and Jubail Industrial College (JIC), Saudi Arabia. Dr. Fouad Attar, executive director, NDT Training Center, at the college, told Cassie Burrell, AWS deputy executive director, “We are proud to announce that Jubail Industrial College has been granted the authorization to conduct AWS Certified Welding Inspector (CWI) seminars and examinations by the American Welding Society. Hundreds of welders and welding inspectors in the Kingdom of Saudi Arabia are in need of such certification annually to satisfy the increasing demand for quality manpower for the construction of many giant projects spearheaded by SAUDI ARAMCO, SABIC, MAADEN, and other organizations. Our schedule for conducting the AWS CWI seminars and examinations for the entire year 2010 will be posted on the AWS and Jubail Industrial College Web sites.” Attar added, “The NDT Training Center at Jubail Industrial College, within a short span of time, has made many pronounced achievements in the road of development by offering vital and unique training programs since it was established January 10, 2009.” In the photo, Cassie Burrell is shown with Dr. Fouad Attar.

Jenny McCall, incoming president of the Gases and Welding Distributors Association (GAWDA), is shown with Kent Van Amburg, GAWDA executive director, during her induction at the GAWDA annual meeting. The installation ceremonies were held in San Antonio, Tex. McCall is with WESCO Gas & Welding Supply, Inc., of Frichard, Ala. She is the daughter of Ron Pierce, an AWS past president and past chairman of the AWS Foundation.

Member-Get-A-Member Campaign

Shown are the member standings as of Oct. 20. See page 65 in this Welding Journal for campaign rules and prize list, or visit www.aws.org/mgm. Call the AWS Membership Dept. (800/305) 443-9353, ext. 480, if you have questions about your MGM status.
New AWS Supporters

Sustaining Company
C&P Welding & Steel Erection, Inc.
2141 Patterson Ave. SW
Roanoke, VA 24016
www.cp-welding.com

Representative: Eric L. Jeffers
For 33 years, C&P Welding has led the way in the fabrication and erection of structural steel in the Roanoke Valley. The company has dedicated itself to customer satisfaction and has proved itself to be an effective company capable of taking raw materials and producing finished products in a timely and cost-effective manner. The company also specializes in the fabrication and erection of miscellaneous structural steel, from handrails and stringers to lintels, beams, and columns.

Supporting Companies
Alloy Rod Products, Inc.
100 Quarry Rd.
Rochelle, IL 61068

EDYCE S.A.
Algarrobo 159, Talcahuano, Region 8 4260000, Chile

Marmen, Inc.
845 Berlinguet, Trois-Rivers
QC G8T 9T8, Canada

Optical Metrology Services
17421 Village Green Dr.
Houston, TX 77040

ROLASOL S.R.L.
Dr. Jose I. de la Rosa 7036
C.A. Buenos Aires 1439, Argentina

Educational Institutions
Buckeye Hills Career Center
351 Buckeye Hills Rd.
Rio Grande, OH 45674

Clovis High School
1900 Thornton St.
Clovis, NM 88101

Commercial Diving Academy
8137 N. Main St.
Jacksonville, FL 32208

Cutech Solutions & Services Pte., Ltd.
#04-32E, Iimm Bldg., 2 Jurong E., St. 21
Singapore 609601, Singapore

Delmar Cengage Learning
5 Maxwell Dr.
Clifton Park, NY 12065

Delta Technical College
6550 Interstate Blvd.
Horn Lake, MS 38637

Kansas City, Kansas, C.C.
Technical Education Center
2220 N. 59th St.
Kansas City, KS 66104

Kavosh Parto Azma
PO. Box 14155-7341
Tehran 14317-43563, Iran

Logan High School
14470 St., Rte. 328
Logan, OH 43138

Midwest Technical Institute
East Peoria Campus
280 Highpoint Ln.
East Peoria, IL 61611

Pioneer Technology Center
2101 N. Ash
Poneca City, OK 74601

Rockdale H.S. Agricultural Science
500 Childress
Rockdale, TX 76567

Roma ISD
2021 N. U.S. Hwy. 83
Roma, TX 78584

Universidad Mayor de San Simon
Calle Sucre, Frente al Parque la Torre Cocharamba, Cercado 992, Bolivia

W.T.E.C., Inc.
51787 M-40 N.
Marcellus, MI 49067

Affiliate Companies
A&D Custom Welding and Fabrication, Inc.
7316 NE Loop 410
San Antonio, TX 78219

Applied Testing & Geosciences, LLC
401 E. Fourth St., Bldg. 12B
Bridgeport, PA 19405

Carolina Steel and Stone, Inc.
9925 Metromont Industrial Blvd.
Charlotte, NC 28269

AWS Membership

<table>
<thead>
<tr>
<th>Member</th>
<th>As of Grades</th>
<th>11/01/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustaining</td>
<td>........................</td>
<td>500</td>
</tr>
<tr>
<td>Supporting</td>
<td>.......................</td>
<td>315</td>
</tr>
<tr>
<td>Educational</td>
<td>.....................</td>
<td>517</td>
</tr>
<tr>
<td>Affiliate</td>
<td>........................</td>
<td>459</td>
</tr>
<tr>
<td>Welding distributor</td>
<td>...........</td>
<td>45</td>
</tr>
<tr>
<td>Total corporate members</td>
<td>............</td>
<td>1,836</td>
</tr>
<tr>
<td>Individual members</td>
<td>.............</td>
<td>52,491</td>
</tr>
<tr>
<td>Student + transitional members</td>
<td>......</td>
<td>6,417</td>
</tr>
<tr>
<td>Total members</td>
<td>.............</td>
<td>58,908</td>
</tr>
</tbody>
</table>

Instituto Nacional de Tecnologia Industrial Extension y Desarrollo Biblioteca
Av General Paz 5445, Edif 5
B1650WAB San Martin
Buenos Aires, Argentina

Iron Boss, Inc.
4147 Fuqua St.
Houston, TX 77048

McGill Steel
8060 Dayton Pike
Hixon, TN 37343

Paradigm Steel Fabricators, Inc.
3510 Standard St.
Bakersfield, CA 93308

Pittsburgh Pipe
11 Skyview Dr.
Litchfield, IL 62056

Precision Welding, Inc.
H C 60, Box 323
Rocky Ridge, UT 84645

San Joaquin Steel Co, Inc.
PO Box 8426
Stockton, CA 95208

Vegter Steel Fabrication
800 French Creek Rd.
Morrison, IL 61270
District 1
Russ Norris, director
(207) 604-9262
russ.norris@airgas.com

BOSTON
OCTOBER 5
Activity: The Section members toured the Sheet Metal Workers International Assoc. Local 17 facility in Dorchester, Mass. The tour followed a video detailing the association’s five-year apprenticeship and journeyman programs. Conducting the tour were John Healy, training coordinator; Dave Angelis, lead welding trainer; and Steve McKenzie, national training coordinator. Attending were students from the Plymouth South Technical School Metal Fabrication and Welding Department.

CENTRAL MASS./R.I.
SEPTEMBER 28
Activity: The Section held an executive committee meeting at Pub 99 Restaurant in Dartmouth, Mass.

MAINE
SEPTEMBER 10
Speaker: Chris Andrews, owner
Affiliation: Integrated Robotics
Topic: Integrating robots into welding, surfacing, bending, and other operations
Activity: The program was held at Integrated Robotics in Dover, N.H. District 1 Director Russ Norris attended the program.

SEPTEMBER 14
Activity: The Maine Section executive board held a planning meeting at Verrillo’s Restaurant in Portland, Maine. Discussed were plans for the Jan. 28 Vendors’ Night to be held at Southern Maine C. C., and the District 1 conference on June 5. Tom Ferri was presented the Private Sector Instructor District Award.

District 2
Kenneth R. Stockton, director
(908) 412-7099
kenneth.stockton@pseg.com

Shown at the Boston Section program are (from left) Tom Ferri, John Healy, Dave Angelis, and Steve McKenzie.

Plymouth South Technical School students attended the Boston Section program.

Shown at the Central Massachusetts/Rhode Island Section meeting are Vice Chairs Brendon Pequita (left) and Steve Flowers.

Shown at the Maine Section Sept. 10 program are (from left) Russ Norris, District 1 director; Scott Lee; and speaker Chris Andrews.
Shown at the Maine Section executive meeting Sept. 14 are from left (seated) Tom Ferri, Mark Legel, Kevin Connolly, and Keith Trafton; (standing) Art Gallant, Fran Piccirillo, and Russ Norris, District 1 director.

Bob Waite (third from right) spoke at the New York Section program in September.

Speaker Allen Franks (left) is shown with Danny Millan, Reading Section chair.

Ken McKnight (right) receives the Silver Member Award from Robert Brewington, Florida West Coast Section chairman.

Tom Ferri (right) receives a Private Sector Instructor Award from District 1 Director Russ Norris at the Maine Section program.

NEW YORK
SEPTEMBER 14
Speaker: Bob Waite, vice chair, P.E.
Affiliation: Robert F. Waite Welding
Topic: Roundtable discussion on welding
Activity: The meeting was held at Buck-ley's Bar and Restaurant in Brooklyn, N.Y., for 14 attendees.

District 3
Michael Wiswesser, director
(610) 620-9551
mike@welderinstitute.com

LANCASTER
SEPTEMBER 22
Speaker: Chris Kisner, CWI, CWE
Affiliation: Kisner Welding Techniques, LLC (KWT), president, lead instructor
Topic: KWT’s methods for training welders
Activity: The program was held at William F. Goodling Regional Advanced Skills Center in York, Pa., where KWT is contracted to provide the instruction for the welder training program. Following the talk, Kisner and assistant instructor Greg Cordero led the Section members on a tour of the welder training areas.

READING
OCTOBER 15
Speaker: Allen Franks, coordinator
Affiliation: Sheetmetal Workers, Apprenticeship and Training Program of Central Pennsylvania, Local Union #19
Topic: OSHA regulations affecting welders
Activity: Students from the local vo-tech schools attended this program, held at Reading Muhlenberg Career & Technology Center in Reading, Pa. Danny Millan, Section chair, is a welding instructor at the center.
Shown at the Lancaster Section program are (from left) Tucker Hill, Justin Heistand, Chair Mike Sebergandio, presenter Chris Kisner, Greg Cordero, Ron Mersow, Kyle Cover, and Mark Haar.

Florida West Coast Section members are shown at their October meeting.

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

**District 5**
Steve Mattson, director  
(904) 260-6040  
steve.mattson@yahoo.com

**FLORIDA WEST COAST**
**OCTOBER 14**
Speaker: Craig Bachler, area sales manager  
Affiliation: Fronius USA, Welding Technology division  
Topic: Alternatives to the submerged arc welding process  
Activity: Ken McKnight received the Silver Member Certificate Award for 25 years of service to the Society. The program was held at Frontier Steakhouse in Tampa, Fla.

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

**NORTHERN NEW YORK**
**OCTOBER 6**
Speaker: Ken Phy, District 6 director  
Affiliation: Holtec International  
Topic: Qualifying procedures to Section IX, ASME: Boiler and Pressure Vessel Code  
Activity: The meeting was held at Mill Road Restaurant in Latham, N.Y.

**SYRACUSE**
**OCTOBER 14**
Speaker: Paul Lentzer  
Affiliation: Entergy Nuclear  
Topic: Repair welding in fossil fuel plants  
Activity: The meeting was held at Barbagallo’s Restaurant in Syracuse, N.Y.

Shown are some attendees at the Reading Section program.

Paul Lentzer discussed fossil fuel plants at the Syracuse Section program.
The Pittsburgh Section members met at the First Energy Corp., Bruce Mansfield Power Station, in October.

Speaker John Siefert (left) chats with Bryan Lyons, Columbus Section chair.

Shown at the Pittsburgh Section program are (from left) presenter Jeff Mercer, John Suter, Section Chair Dave Daugherty, Jack McIlvain, and Don Swiger.

Speaker William Ballis (left) is shown with Steve Whitney, Dayton Section chair.

Mobile Section Chair Teresa Hart presents a speaker plaque to Michael Dortch.

Bill Warwick (center) receives the Section Meritorious Certificate Award from AWS President Vic Matthews (left) and Joe Livesay, District 8 director, at the Northeast Tennessee Section program.

Gerald McCranie receives the Private Sector Instructor Award from Teresa Hart, Mobile Section chair.

District 7

Don Howard, director
(814) 269-2995
howard@ctc.com

COLUMBUS

September 24
Speaker: John Siefert, research engineer
Affiliation: Babcock & Wilcox Research Center
Topic: The material challenges in the construction of coal-fired power stations
Activity: The Columbus Section hosted this month’s program for the 42 attendees representing the local chapters of eight technical societies. Siefert’s talk had something of interest for everyone, touching on corrosion, creep strength, and the weldability of the older, current, and proposed future materials, and the problems that arise from carbon dioxide sequestration. The program concluded with a lively question-and-answer session.

DAYTON

September 15
Speaker: William L. Ballis, P.E. (ret.)
Topic: Napoleon Hill’s keys to success
Activity: The Section members pondered the wisdom Hill espoused in his 1937 classic book, Think and Grow Rich. The program was held at Amber Rose Restaurant in Dayton, Ohio.
PITTSBURGH
OCTOBER 13
Speaker: Jeff Mercer
Affiliation: First Energy Corp., Bruce Mansfield Power Station
Topic: Environmental controls, reuse and recycling of byproducts
Activity: The program was held at the power station in Pittsburgh, Pa.

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

GREATER HUNTSVILLE
SEPTEMBER 24
Speaker: Justin Sparks, account manager
Affiliation: Airgas Corp.
Topic: Safety products for welders
Activity: The Section members met at Marshall Technical School to plan upcoming meetings. The dinner was prepared by the Section officers.

HOLSTON VALLEY
SEPTEMBER 29
Activity: Bob Thomas, Section chair, conducted an executive committee planning meeting at Mama’s House Restaurant in Kingsport, Tenn.

NORTHEAST TENNESSEE
AUGUST 15
Activity: The Section members toured the welding shop at Karns High School in Knoxville, Tenn. Bill Warwick was appointed deputy District 8 director. Warwick also received the Section Meritorious Certificate Award from AWS President Vic Matthews and Joe Livesay, District 8 director.

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

MOBILE
SEPTEMBER 10
Speaker: Michael Dortch, regional sales manager
Affiliation: AlcoTec Wire Co.
Topic: The fabrication of aluminum
Activity: Michael Moore received the District Dalton E. Hamilton Memorial CWI of the Year Award, and Gerald Mc-

NEW ORLEANS
SEPTEMBER 15
Cranie was presented the District Private Sector Instructor Award. The meeting was held at Saucy-Q Bar B Que in Mobile, Ala.

Speaker: Joe Tortomase
Affiliation: Dynamic Industries
Topic: Welding in the oil fields and the need for more welders
Activity: Dynamic Industries sponsored this program for 91 attendees in New Orleans, La. AWS Vice President John Bruskotter attended the program.
Shown at the Detroit Section program are Don Maatz (left) with speaker Tim Ritter.

Shown at the Sept. 17 Milwaukee Section event are (from left) David Biddle, Mark Dietz, Jerry Blaski Sr., Jerry Blaske Jr., and Chair Karen Gilgenbach.

Speaker John Lanning (left) is shown with Chuck Frederick, Lakeshore Section chair.

Milwaukee Section event chair Rod Behnke (left) poses with the top shooters (from left) Jon Taylor, Gary Meyers, and Dale Joswick.

**District 10**

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

**Cleveland**  
October 13  
Speaker: Geoff Lipnevics  
Topic: Adaptive automation  
Activity: The program was held in Cleveland, Ohio, for 35 attendees.

**District 11**

Efthios Siradakis, director  
(989) 894-4101  
ft.siradakis@airgas.com

**Detroit**  
October 8  
Speaker: Tim Ritter, welding products manager  
Affiliation: Parker Hannifin Corp.  
Topic: New products offered at Parker  
Activity: This program was an open house program sponsored by Parker Hannifin Corp. in Troy, Mich., with 67 attendees. The Ladies’ Night Committee members were introduced: Rod Bereznicki, Don Czerniewski, John Bohr, and Tim Cesarz.

**District 12**

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

**Lakeshore**  
September 24  
Activity: The Section members toured the Manitowoc Cranes facility in Manitowoc, Wis., to study the numerous innovative welding operations developed by the company. The dinner was held at Light House Inn where John Lanning, director of advanced engineering and products, spoke and presented a video and slide program detailing the company’s newest crane, Model 3100, with a boom capacity of 2535 tons.

**Milwaukee**  
September 17  
Activity: The Section members and guests toured P&H Mining Equipment, Inc., in West Milwaukee, Wis. Mark Dietz, marketing communications, and David Biddle, manager, technical services, conducted the program for 92 attendees. The dinner was held at Tanner Paul Restaurant in Milwaukee.

September 26  
Activity: The Milwaukee Section members met for a clay shoot outing at Wern Valley Sportsman Club in Waukesha, Wis. The event attracted 36 contenders. Rod Behnke was the event chairman. The top three shooters were Gary Meyers, Dale Joswick, and Jon Taylor.

October 15  
Speaker: Bob Schuster, field sales representative
Hank Sima (left), outgoing Chicago Section chair, is shown with incoming Chair Jim Greer at the October program.

Les Joiner discussed underwater welding at the Lexington Section program.

Affiliation: Nelson Stud Welding
Topic: Stud welding practices and standards
Activity: This Milwaukee Section program was held at Tanner Paul Restaurant in Milwaukee, Wis.

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

**CHICAGO**
*SEPTEMBER 16*
Activity: The Section’s executive committee met to plan the coming year’s schedule, welding show events, and the Section’s Web site. The meeting was held at Bailey’s Restaurant in Chicago, Ill.

*OCTOBER 14*
Speaker: **Stuart Kleven, CWI**
Affiliation: Alloyweld Inspection Co.
Topic: Nondestructive testing of friction stir welds in aluminum
Activity: The Chicago Section cohosted this meeting with the local chapter of ASNT at Bohemian Crystal Restaurant in Chicago, Ill. AWS Past President and incoming Chicago Section Chair Jim Greer presented Hank Sima his past chairman’s certificate.

**District 14**
*Tully C. Parker, director*
*(618) 667-7795 tparke@millerwelds.com*

**INDIANA**
*SEPTEMBER 28*
Activity: The Section met at Airgas Mid-America in Indianapolis, Ind., for a demonstration of production monitoring, virtual welding and training, and the new Power Wave C300 portable power source. Conducting the demonstrations were Steve Gullig, Dave Koutz, and Kurt Radcliffe of Lincoln Electric.

**LEXINGTON**
*SEPTEMBER 24*
Speaker: **Les Joiner**
Affiliation: Olicon Co., Texas
Topic: Underwater welding
Activity: Jacob Melton received the $500 Woodrow Scott Memorial Scholarship Award. The program was held in Lexington, Ky., for 90 students and members.
The Kansas Section members are shown at the October meeting.

Shown at the Iowa Section meeting are (from left) Ted VanDrimmelen, Charles Burg, Bruce Spire, Anthony Rudkin, Ray Heimann, and host Roger Burman.

Shown at the Kansas City Section program are (from left) Brian McKee, Sarah Hurt, Dennis Wright, speaker Brian Smith, Chair Jason Miles, and Mike Vincent.

Speaker Brian Smith is shown with Sarah Hurt, Kansas City Section vice chair.

Dwight Haworth demonstrated brazing techniques at the Kansas Section meeting.

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

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

IOWA
OCTOBER 13
Speaker: Roger Burman, owner
Affiliation: Lakeside Rods and Rides
Topic: Building custom street rods
Activity: This Iowa Section meeting was held at Lakeside Rods and Rides in Rockwell City, Iowa.

KANSAS
OCTOBER 7
Speaker: Dwight Haworth
Affiliation: Airgas Mid-South
Topic: Compressed gas safety
Activity: The program was held at the Airgas facility in Wichita, Kan. Following the talk, Haworth offered a demonstration of powder alloy brazing.

KANSAS CITY
OCTOBER 8
Speaker: Brian Smith, assistant safety director
Affiliation: Kansas City Area Builders Association
Topic: Current and upcoming OSHA requirements affecting our industry
Activity: The program was held at the Builders Association facility in Kansas City, Mo.
**Tulsa Section**
Speaker: Ray Wilsdorf, president
Affiliation: Wilsdorf Manufacturing
Topic: Welding metallurgy of carbon steel and stainless steel

**NEBRASKA**
**OCTOBER 8**
Speaker: Victor Y. Matthews, AWS president
Affiliation: The Lincoln Electric Co.
Topic: Your career in welding
Activity: Mark Smith received his Life Membership plaque for 35 years of service to the Society. Karl Fogleman received an appreciation award for his service as Section chairman. Attending were Metro Tech Community College welding instructors Ruben Martinez and Chris Beaty and students Zach Bluuas and Aaron Wallin. The meeting was held in Omaha, Neb.

**SIOUXLAND**
**OCTOBER 5**
Speaker: Victor Y. Matthews, AWS president
Affiliation: The Lincoln Electric Co.
Topic: Careers in welding
Activity: Members of the Yankton High School Student Chapter attended the program. The meeting was held at Regional Technical Education Center in Yankton, S.Dak., hosted by Josh Svatos, general manager, and Section vice chair.

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

**OZARKS**
**SEPTEMBER 17**
Speaker: Larry Stiles
Affiliation: TAFA, Inc.
Topic: Thermal spraying
Activity: The program was held at OTC in Springfield, Mo.

**TULSA**
**SEPTEMBER 22**
Speaker: Ray Wilsdorf, president
Affiliation: Wilsdorf Manufacturing
Topic: Welding metallurgy of carbon steel and stainless steel

**SAN ANTONIO**
**OCTOBER 13**
Speaker: Robert Duron, superintendent
Topic: The importance of career preparation

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

**ATTENDANCE**
- Tulsa: 44 attendees
- Nebraska: 44 attendees
- Siouxland: 44 attendees
Shown at the San Antonio section program are Jim Mosman (left) and John Mendoza, an AWS vice president.

San Antonio Section Vice Chair Steve Sigler (left) is shown with speaker Robert Duron.

Gonzalo Huerta addressed the welding students at Arizona Western College Institute of Welding Technology Student Chapter.

Steve Prost (right) accepts a speaker’s gift from John Little at the British Columbia Section program.

Dan Finnigan (left) is shown with Tom Smeltzer, San Francisco Section chair.

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

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

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

Arizona Western College
IWT Student Chapter

OCTOBER 2
Speaker: Gonzalo Huerta Sr., CWI, CWE
Affiliation: Imperial Valley College, professor and dean of renewable energy
Topic: Reasons for seeking higher education in welding technologies
Activity: The Student Chapter held its first meeting of the academic year at Mandarin Palace in Yuma, Ariz. Prof. Huerta was a member of the first class to graduate from the Arizona Western College Institute of Welding Technology in 1967. His talk cited several of his outstanding students, including Samuel Colton, Student Chapter advisor. Attending were Chair Alexis Favela, Anthony Carroll, Travis McCallum, Britton Bowns, Ed Garcia, Herman Quiroga, Sprinter Finch, Ivan Soqui, Christopher Larson, and Joe Ulloa.

British Columbia
SEPTEMBER 23
Speaker: Steve Prost
Affiliation: M & R Sales
Topic: Basic metallurgy and challenges faced in repairing cast steel
Activity: The Bruce Third Welding Scholarships were presented to Jeremy Brousson and Mark Hall, both studying at Kwantlen Polytechnic University with instructors Al Sumal and Loc Hepburn. The checks were presented by Bob and Violet Third and Scholarship Chair Brad Moe. The meeting, attended by 60 members and guests, was held in Delta, B.C., Canada.

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

San Francisco
OCTOBER 7
Speaker: Dan Finnigan, district manager
Affiliation: Thermadyne
Topic: A new line of pressure regulators
Activity: The speaker demonstrated the Victor Equipment Co. Edge line of pressure regulators. The meeting was held at Spencer’s Restaurant in Berkeley, Calif., for 41 attendees.

Spokane
OCTOBER 14
Activity: The Section members met at Oxaré Training Center in Spokane, Wash. Presenters included Steve Siderius of Allwest Testing and Engineering, Tim Shatto and David Parr of Oxaré Training Center, and Carlos Roderos of Acuren. Siderius discussed nondestructive evaluation techniques; Shatto and Parr demonstrated ultrasonic testing and discussed phased array techniques. Roderos discussed and demonstrated radiographic testing of a butt joint.

Long Beach/Orange County
SEPTEMBER 17
Activity: The Section members visited Praxair in Costa Mesa, Calif. Diana Valdez, branch manager, demonstrated various types of welding and cutting tools and machines from Lincoln, Victor, Hypertherm, and Miller. Attending were Chairman Cary Chiu, Jeff Underhill from Jackson, Rob Averall from Therma- dyne, Chris Sherm from Hypertherm, Richard Hutchinson from Orange Coast College, and Winfred Sartlin from Long Beach City College.
Shown at the British Columbia Section program are (from left) Brad Moe, Rob Third, Al Sunal, Violet Third, Jeremy Brousson, Mark Hall, and Loc Hepburn.

Shown at the Long Beach/Orange County Section program are (from left) Jeff Underhill, Rob Averill, presenter Diana Valdez, Chris Sherm, Richard Hutchison, Chairman Cary Chiu, and Winfred Sartin.

Carlos Roderos discussed inspection techniques at the Spokane Section meeting.

Shown at the Arizona Western College IWT Student Chapter program are (front row, from left) Herman Quiroga, speaker Gonzalo Huerta Sr., Sprinter Finch, Ivan Soqui, Christopher Larson, and Joe Ulloa; (back row, from left) Anthony Carroll, Travis McCollum, Britton Bowns, Chair Alexis Favela, Ed Garcia, and Advisor Samuel Colton Sr.

Shown at right, Bill Komlos, District 20 director, visited Nanette Samanich, District 21 director, in Las Vegas, Nev., on the construction site for The Cleveland Clinic Lou Ruvo Center for Brain Health, where Samanich works as the Certified Welding Inspector.
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.mathews@lincolnelectric.com
The Lincoln Electric Co. 7955 Dines Rd., Novelty, OH 44072

ADMINISTRATION
Executive Director
Ray W. Shock. rshow@aws.org . . . . . (210)
Deputy Executive Director
Cassie R. Burrell. cburrell@aws.org . . . . (253)
Senior Associate Executive Director
Jeff Weber. jweber@aws.org . . . . . . . (246)
Associate Executive Director Accounting
Gesana Villegas. grillegas@aws.org . . . (252)
Executive Assistant for Board Services
Gricelda Manalich. gricelda@aws.org . . . . (294)

Administrative Services
Managing Director
Jim Lankford. jlankford@aws.org . . . . . (242)
IT Network Director
Armando Campana. acampana@aws.org . . . . (296)
Director
Hidail Nuñez. hidail@aws.org . . . . . . . (287)
Database Administrator
Natalia Swan. nswain@aws.org . . . . . (345)
Human Resources
Director, Compensation and Benefits
Luisa Hernandez. lhernandez@aws.org . . . . (266)
Manager, Human Resources
Dora A. Shade. dshade@aws.org . . . . . . (235)

INT'L INSTITUTE OF WELDING
Senior Coordinator
Sissibeth Lopez. siss@aws.org . . . . . (319)
Provides liaison services with other national and international professional societies and standards organizations.

GOVERNMENT LIAISON SERVICES
Hugh K. Webster. hwebster@we-2.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 Kral. jkral@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. ntapley@aws.org . . . . (444)

PUBLIC SERVICE NON-PROFIT ORGANIZATIONS
Department Information
Managing Director
Andrew Cullison. cullison@aws.org . . . (249)
Welding Journal
Publisher
Andrew Cullison. cullison@aws.org . . . (249)
Editor
Mary Ruth Johansen. mjohansen@aws.org . (238)
National Sales Director
RobSaltzstein. rsaltzstein@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)

MARKETING COMMUNICATIONS
Director
Ross Hancock. rhancock@aws.org . . . . (226)
Public Relations Manager
Cindy Weihl. cweihl@aws.org . . . . . (416)
Webmaster
Angela Miller. amiller@aws.org . . . (456)

MEMBER SERVICES
Department Information . . . . . . . . . . . . . . . . (480)
Deputy Executive Director
Cassie R. Burrell. cburrell@aws.org . . . . (253)
Director
Rhenda A. Mayo. rmayo@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 Osypa. jowoyna@aws.org . . . . . (462)

AWS AWARDS, FELLOWS, COUNSELORS
Director Information . . . . . . . . . . . . . . . . . . (340)
Managing Director
Andrew R. Davis. adavis@aws.org . . . . (466)
Int’l Standards Activities, American Council of the Int’l Institute of Welding (IIW)
Director, National Standards Activities
John L. Gayler. jgayler@aws.org . . . . . (472)
Personnel and Facilities Qualification, Computerization of Welding Information
Manager, Safety and Health
Stephen P. Hedrick. stevehedrick@aws.org . . . (305)
Technical Publications
AWW publishes about 200 documents widely used throughout the welding industry.

Technical Publications
Manager
Rosalinda O’Neill. rosenll@aws.org . . . . (451)
Staff Engineers/Standards Program Managers
Annette Alonso. aalonso@aws.org . . . . . (399)
Automotive Welding, Resistance Welding, Oxygen Gas Welding and Cutting, Definitions and Symbols, Sheet Metal Welding
Brian McGrath. bmcgrath@aws.org . . . . . (311)
Methods of Inspection, Mechanical Testing of Welds, Welding in Marine Construction, Pipelines, and Tubing
Selvis Morales. smorales@aws.org . . . . . (313)
Welding Qualification, Structural Welding
Rakesh Gupta. rgupta@aws.org . . . . . . . . (301)
Filler Metals and Allied Materials, Int’l Filler Metals, Instrumentation for Welding, UNS Numbers Assignment
Matthew Rubin. mrubin@aws.org . . . . . . . (215)
Aircraft and Spacecraft, Machinery and Equipment, Robotics Welding, Arc Welding and Cutting Processes
Reino Starks. rstaieks@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, Andrew R. Davis, at adavis@aws.org. 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 Munalich, 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, National Meritorious Awards Committee, wreve@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 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.
Resistance Seam Welding

Most resistance seam welding consists of making a series of overlapping spot welds by using one or two rotating wheel electrodes without opening the electrodes between spots. This process produces gas-tight and liquid-tight welds. Figure 1 shows the arrangement of the secondary circuit when two rotating electrodes are used. The principle involved is exactly the same as that for spot welding, except that wheels are substituted for the spot welding points or electrodes.

When a series of spot welds is made without opening the electrodes between the spots and there is sufficient cool time between welds, the weld becomes known as a roll spot weld. Roll spot welds are not gas tight or liquid tight. The difference between a roll spot weld and a seam weld is in timing. Seam welding requires higher currents than does roll spot welding for the same material. The same equipment may be used for either type of weld, provided the weld timing control is adaptable for both. Figure 2 shows the two types of welds.

As with other resistance welding processes, seam welding is well suited for high-speed welding with consistent joint strength and appearance.

All seam welds, by necessity, are lap welds with the exception of butt seam welds. Butt seam welds are also made with roller electrodes.

There are two main types of standard seam welding machines: longitudinal and circular. Longitudinal machines feed the weldment into or out of the throat of the machine. Circular machines are arranged to feed the weldment across the throat of the machine. There is also a universal-type machine that can be set up for either longitudinal or circular seam welding operations.

Fundamentals

The design principles for spot welding, in general, may also be applied to seam welding. Edge distance, electrode diameter, and welding forces are comparable. However, due to the rolling action of the electrode(s), each spot is more or less oval in shape. This, and the shunting effect of the overlapping spots alter the required values for "weld time" and current.

Mash seam welding is commonly used when there is need to reduce the thickness of the welded joint for functional or appearance reasons. The component parts are overlapped a very controlled amount, normally 1.5 times the thickness of the thinnest component. Since this small overlap causes the current concentration normally achieved by the contour of the welding electrode, the electrodes are flat-faced wheels.

As the weld interface becomes plastic during the weld, the weld force produces a strong spreading force between the components being welded. This spreading force must be resisted by robust clamping. If the components are to separate, the lap will be reduced and the weld quality compromised.

Assuming both pieces are the same thickness, the thickness of the welded joint is 150 to 120% of the thickness of a single base metal sheet. A postweld planishing process may further reduce the joint thickness.

The process can weld 0.0015- to 0.250-in.-thick mild steel with 100% weld strength. Weld speeds range from a few inches per minute to more than 80 feet per minute depending on the product and weld power characteristics. The weld speed benefits greatly when the welding current is DC, but the weld process becomes much more sensitive to changes in surface resistance. While AC weld current is less sensitive to surface resistance, it is more limited in speed due to the cyclic nature of the current. In some instances, especially with stainless steels, it is advisable to use an interrupted pattern of weld current to reduce overheating of the surface of the material being welded. With DC, the interrupted pattern is accomplished with a high-low heat pattern rather than a complete on-off as with AC. It is beneficial to flood cool the weld as it is being made. Constant current should be used where possible for maximum speed.

The mash seam welding process is most commonly used to weld carbon steels and stainless steels. Due to their narrow plastic range, most nonferrous materials are not weldable with this process.

YOU ASKED FOR IT, AND NOW IT’S HERE...
THE AMERICAN WELDING SOCIETY
CLOTHING & ACCESSORY LINE

AWS Members now have access to American Welding Society shirts, hats, accessories and more at the AWS E-store. All of the products in this store are branded with the American Welding Society logo. Don’t miss out on an assortment of great products.

Visit www.logodogz.net/aws

Check out the complete product line, and order online at www.logodogz.net/aws
The company has redesigned its Web site using cutting-edge design techniques. The new format simplifies browsing for conferences and events plus offers a career center and a revamped online store featuring more than 100 ANSI standards, online courses, training videos and CDs, laser application resources, safety publications, signs and labels, and conference proceedings.

Just released, the hard-cover, 323-page *Hybrid Laser-Arc Welding*, presents a comprehensive review of this technology and its applications, plus a summary of recent research involving the process. The book begins with a review of the fundamentals and characteristics of the hybrid laser-arc welding process, then discusses the applications of the technology, including shipbuilding and industrial robotic applications, as well as hybrid laser-arc welding as it is used in the processing of magnesium alloys, aluminum, and steel. The text may be ordered online for $245 list, $225 for institute members.

**Laser Institute of America**

www.laserinstitute.org  
(407) 380-1553

Completely updated, the 6th annual *Buyer's Guide* is a searchable online edition that makes finding information easier and faster. Included are sales contacts, addresses, and company information for more than 150 primary ingot, recycled ingot, and master alloys manufacturers; 200 extruders; 125 companies specializing in drawing stock, bare wire, pigments and powder, forgings and impacts, ACSR and bare cable, and insulated wires and cable; 200 nonferrous casting foundries; 100 aluminum distributors; and 350 suppliers to the industry ranging from coil coaters to lubricant manufacturers, and makers of protective apparel.

The 2008 *Statistical Review*, released in September, includes data on the North America aluminum industry including every cycle of the aluminum production process from primary aluminum to markets for finished goods to the recovery of aluminum scrap. The document is $175 list, $90 for association members as a CD or searchable online. Visit the Web site then click on the bookstore tab to review the publications.

**The Aluminum Association**

www.aluminum.org  
(703) 358-2976

A full-color brochure details the company’s new MistMax™ series high-efficiency mist collector line for controlling
oil and coolant mists in metalworking applications. Included are engineering data and performance charts on tested filter efficiency and filter life consumption. The filters are designed to be used up to five years before replacement. Featured are application photos and photographs of typical industrial installations.

Micro Air Clean Air Systems
www.microaironline.com
(866) 566-4276

Brazing and Welding Wires Detailed in Catalog

The company's complete line of bercoweld® filler metals for brazing and welding are detailed in a 10-page catalog. The products include low-alloyed copper materials, tin bronzes, aluminum bronzes, copper-nickel alloys, and numerous special alloys including oxygen-free copper, zinc-coated, seawater- and corrosion-resistant, high-strength alloys, etc. Each product includes the AWS, DIN, and ISO designations, and compositions in wt-%. Also provided are complete packaging information, spool sizes, dimensioned diagrams, and numerous photographs of the manufacturing foundry, application photos, and products. The catalog can be downloaded from the Web site; click on the Downloads button.

Berkenhoff GmbH
www.bercoweld.com
+49 0 641-6010

Low-Temp Aluminum Alloy and Flux Detailed in Flier

A brochure details the company's new Handy One® LT aluminum low-temperature flux and alloy all-in-one brazing products. The Alloys AL 802 (2Al-98Zn, 465°F window) and AL 822 (22Al-78Zn, 290°F window) offer much larger melt windows compared with the typical AL 718 (88Al-12Si, 110°F window) alloy. A chart details the solidus and liquidus temperatures, and the compositions (wt-%) for the three alloys. The products are expected to find wide acceptance in the brazing of aluminum heat exchangers and other aluminum base metals.

Lucas-Milhaupt, Inc.
www.lucasmilhaupt.com
(800) 558-3856

Catalogs Detail Submerged Arc Consumables and Automation Solutions

The 52-page Lincolnweld® product catalog details the company’s lines of submerged arc welding consumables. Included are complete details on low-alloy, mild steel, solid and cored electrodes, and more than 20 types of fluxes ranging from neutral to active to those specifically designed for pipe welding. The catalog can be viewed or downloaded online or ordered by phone. Specify Bulletin C5.10.

The 12-page, full-color, profusely illustrated Automated Welding Solutions for Every Industry brochure details the company’s lines of flexible and hard automation and the Vernon Tool™ industrial pipe and tube cutting equipment and fume-extraction systems. The catalog can be viewed or downloaded online or ordered by phone. Specify Bulletin MC09-27.

The Lincoln Electric Co.
www.lincolnelectric.com
(888) 355-3213

Explosion Protection in Dust Extractors Published

Guideline VDI 2263, Part 6.1, Dust fires and dust explosions; Hazards — assessment — protective measures; Fire and explosion protection in dust extraction installations, offers guidance to manufacturers and users of dust extractors using examples of how to carry out risk assessments and explosion protection measures in filter separators. The guideline applies to installations where, during specified normal use, combustible dust-air mixtures or hybrid mixtures occur, or may be formed. It complements the guideline VDI 2263, Part 6, which describes the general procedures of explosion protection, and knowledge of which is a prerequisite. The document is in German and English. Price is about $230.

VDI Society for Energy and Environment
www.vdi.de

Book Details 2009–2010 Economic Data

The data compiled from domestic and 31 foreign countries are presented in the 2009–2010 Economic Handbook of the Manufacturing Technology Industry. It provides product and country-specific manufacturing technology data on capital equipment purchases, employment, machine tool shipments, machine tools in use, and the financial condition of the industry. The handbook is intended for industry executives, market researchers, legislators, financial analysts, administrators, journalists, and students. The PDF and Excel versions of the handbook are available to association members free. Nonmembers may purchase the document online or as a CD for $345 from the Web site.

The Assn. for Manufacturing Technology
www.AMTonline.org
(703) 893-2900
Thermadyne Names President

Thermadyne® Holdings Corp., St. Louis, Mo., has appointed Martin Quinn company president. In this capacity, he will lead the operations of Thermadyne Industries, Inc., a manufacturer and marketer of metal cutting and welding products and accessories. Quinn, with the company for 25 years, most recently served as executive vice president, global sales and marketing.

Mathey Dearman Hires VP

Mathey Dearman, Inc., Tulsa, Okla., a supplier of pipe fitup equipment, including cutting and beveling machines, and welding electrode and flux ovens, has named Charles G. Lutz vice president of sales and marketing — Africa, Asia, Australia, Latin America, Middle East, and New Zealand. Previously, Lutz was director of international sales at La-Co Industries, Inc.

Wall Colmonoy Fills Two Key Posts

Wall Colmonoy Corp., Madison Heights, Mich., has named John Lapping general manager, Los Lunas, N.Mex., alloy products manufacturing facility. Lapping, with more than 25 years’ experience in the thermal spray and high-temperature brazing industries, previously worked for Hunprenco, UK, and has seven years with Wall Colmonoy, Ltd., in the United Kingdom.

Member Milestones

McQuaid Awarded ANSI Finegan Standards Medal

David L. McQuaid, an AWS member since 1975 and currently an AWS director-at-large, has been nominated by his peers to receive the American National Standards Institute (ANSI) 2009 Finegan Standards Medal. The medal “honors an individual who has shown extraordinary leadership in the actual development and application of voluntary standards.”

McQuaid accepted the award from Arthur E. Cote, chairman, ANSI board of directors, Oct. 6, at the ANSI Leadership and Service Awards Banquet and Ceremony held at Bethesda North Marriott Hotel and Conference Center in Bethesda, Md., in conjunction with World Standards Week 2009.

Heralded as an icon in AWS standards activities since 1982, McQuaid chaired the D1 Structural Welding Committee, responsible for AWS D1.1, Structural Welding Code — Steel, from 1998 to 2002. From 2002 to 2004, he chaired the Society’s Technical Activities Committee, which oversees all AWS consensus committees.

A peer said of him, “Through his extraordinary personality he can, seemingly easily, promote and cajole others into resolving what could be a very confrontational situation by stating facts, stating how he feels about it, and making a comment or telling a story that defuses the tension in the air as well as appropriately making the idea understandable.”

McQuaid’s résumé includes building, bridge, high-speed train, hydroturbine, and other projects, as well as consultancies for interests in North and South America, Europe, and Asia.

McQuaid has also been involved at nearly every level of standards work from task groups on policy, rules, and procedures to committee working groups focused on the technical details within AWS standards. In addition, he has grown a successful consulting business and is well known as a “go-to” expert in the steel construction industry. A peer noted, “It is impressive to me that McQuaid consistently makes himself available to mentor younger engineers and that he continues to serve on the various AWS and other technical committees at his own expense.”

McQuaid’s first job after graduating as a civil engineer from West Virginia University in 1964 was with American Bridge Division of United States Steel. There, he worked in the construction department as a field engineer, project engineer, quality control manager, application engineer, and consulting engineer. He is credited for playing an influential role in the process of evaluating the provisions necessary to bring an electroslag welding process into industrial use. In 1999, he formed his own construction consulting company, D. L. McQuaid and Associates, Inc., which he continues to operate.

Wall Colmonoy Aerobraze, Cincinnati, Ohio, a licensed FAA repair station, has named Mike Sweeney business development manager. Previously, Sweeney was sales manager for Doncasters Compressor Airfoils Group.
Aluminum Assn. Names Boultinghouse Awardee

The Aluminum Assn., Arlington, Va., has presented its prestigious Marlan Boultinghouse Award to Bob Longenecker, chairman, KB Alloys, LLC. In the presentation, Longenecker was cited for his contributions to the industry beginning in 1975 as a product manager, then rising to vice president, sales and marketing, and eventually president and CEO of KB Alloys. The citation reads, in part, “His work has promoted metal and made the Aluminum Assn. stronger. This recognition is well deserved.”

AWS Foundation Elects Board Member

The AWS Foundation, Inc., Miami, Fla., has named Jimmy B. Morgan a member of its board of directors. Morgan, with more than 20 years of experience in the energy business, currently serves as president of WEC Welding and Machining, LLC, a subsidiary of Westinghouse Electric Co. It provides welding and machining services to the nuclear industry, and pipe preparation for the energy and processing businesses. The AWS Foundation was established 20 years ago by the American Welding Society to support programs that ensure the growth and development of the welding industry. Its focus is on scholarships and workforce development issues.

TÜV Rheinland® Selects Senior Vice President

TÜV Rheinland®, Newtown, Conn., has named Deep Krishnan senior vice president of Business Stream Industrial Service. Previously, Krishnan was vice president of U.S. operations for TÜV Rheinland of North America, Inc.

Northwire Names CEO

Katina Kravik has been named the new owner and chief executive officer of Northwire, Inc., Osceola, Wis. Kravik succeeds her father, Mark Kravik, whose new role is chairman of the board of the 37-year-old, privately held company.

CEO Appointed at LMI

LMI Technologies, Inc., Delta, B.C., Canada, has appointed Terry Arden chief executive officer. He succeeds Len Metcalfe who continues to serve as chairman of the board. Since joining the company seven years ago, Arden has served as chief technical officer. LMI is a provider of 2-D and 3-D vision sensor solutions to many industrial measurement and control processes in the automotive, metal, glass, rubber and tire, transportation, livestock, and wood markets.

Obituary

Allan Ray Putnam

Allan Ray Putnam, 89, retired managing director of ASM International, died suddenly Oct. 13 in Palm Beach Gardens, Fla. Putnam graduated from the Wharton School of Finance, University of Pennsylvania, in 1942. Following four years of service in the U.S. Air Force, he joined the executive staff of the American Electroplaters Society. In 1949, the Society of Manufacturing Engineers appointed him assistant executive secretary and publisher of Tool and Manufacturing Engineer. Putnam served as president of the Council of Engineering and Scientific Society Executives (CESSE) 1958–1959, and received the CESSE Leadership Achievement award in 1983. He served as ASM International managing director from 1959 to 1985 when he retired. Putnam was elected an ASM Fellow for his lifetime of achievement and leadership in the materials community. In 1988, the society established the Allan Ray Putnam Service Award “in appreciation for the man who was ‘Mr. ASM’ for so many members and colleagues.” He served as president of the National Assn. of Exhibit Managers and on the board of directors of the American Society of Assn. Executives, the Metal Properties Council, and the Cleveland Convention and Visitors Bureau. He was a Life Member of the National Science Teachers Assn. and an Honorary Member of the Iron and Steel Institute of Japan, and the Institute of Materials, UK.

He retired to Orleans, Mass., where he served as president and a board member of The Cape Cod Symphony Orchestra, served on the board of the Cape Cod Conservatory, and was an active Rotarian.

He is survived by his wife, Ann, three children, 12 grandchildren, and three great-grandchildren.
Addressing the Future Shortage of Welding and Joining Technicians — J. Ondov and K. Smith, (April) 37

Advancements in Ultrasonic Phased Arrays — C. Flanagan and M. Moles, (Aug) 46

Aerospace Structures, Real-Time Crack Detection in — (Feb) 46


Aluminum and Copper for Cryogenic Applications, Soldering Silver to — L. A. Shapiro, (Oct) 43

Aluminum’s Role in Welded Fabrications — T. Anderson, (Oct) 26

Aluminum, Solving the Problems Inherent to Torch Brazing — K. Allen, (Oct) 59


America, Transitioning from ‘We Protect’ to ‘We Build’ — N. Borchert and A. A. St. Eloi, (Nov) 36

Anniversary Highlights — A. Cullison, (June) 60


Automation Optimizes Nuclear Component Fabrication — J. Noruk and J. Boillot, (May) 52

Automotive Industry, The Evolution of Weld Inspection in the — S. Frank, (Aug) 52

Barge Builder’s Gantry Boosts Weld Quality — C. Bishop, (Sept) 34

Better Gas Metal Arc Welds, Making — A. Monk and G. Bauer, (Jan) 40

Boiler Industry, Cost-Effective Thermal Spray Coatings for the — J. C. Lionza, (July) 38

Brazed Joints, Evaluating Margins of Safety in — Y. Flom, L. Wang, M. M. Powell, M. A. Soffa, and M. L. Rommel, (Oct) 31

Brazing Aluminum, Solving the Problems Inherent to Torch — K. Allen, (Oct) 39

Brazing: An Important Joining Option — C. Darling, (April) 41

Brazing and Soldering Methods, Exploring Different — J. Arnold, E. Miller, and G. Mitchell, (April) 50

Build’ America, Transitioning from ‘We Protect’ to ‘We Build’, and — N. Borchert and A. A. St. Eloi, (Nov) 36

Building on Experience, Welding for New Nuclear Power Plants: — S. McCracken, Eric Willis, and J. Hamel, (May) 40

Career Choices in Welding, Women Discover — E. Shelton, (Nov) 52


Certified Welding Fabricator, Take the Path to Become a — S. T. Snyder, (Nov) 48

Cladding Travel Speed, Pulsed Technology Increases — J. Rapp, Jan (53)


Coke Drum Construction, Evaluating SMAW Electrodes for — J. J. Perdomo, (June) 56

Construction, Evaluating SMAW Electrodes for Coke Drum — J. J. Perdomo, (June) 56

Converting Waste into a Welding and Cutting Fuel — K. Campbell, (Aug) 32

Corrosion, Thermal Sprayed Deposits Shield Structures from — D. Wixson, (July) 46

Cost-Effective Thermal Spray Coatings for the Boiler Industry — J. C. Nava, (July) 46

Crack Detection in Aerospace Structures, Real-Time — (Feb) 46

Cracking, Understanding Weld — J. Bundy, (Sept) 30

Crash Resistance of Welded Aluminum Structures, Optimizing — O. R. Myhr, Ø. Grong, O. G. Lademo, and T. Tryland, (Feb) 42

Cryogenic Applications, Soldering Silver to Aluminum and Copper for — L. A. Shapiro, (Oct) 43

Current Technology in Welding Guns and Torches — A. Cullison, K. Campbell, and M. R. Johnsen, (Feb) 34

Cut Quality, Plasma Arc Offers — (Sept) 54

Cutting Fuel, Converting Waste into a Welding and — K. Campbell, (Aug) 32

Defects in Submerged Arc Welding. Minimizing — D. Gerbec, (Sept) 78


Dressing for Welding Success — B. Gardner, (Dec) 33


Ensuring Quality in Resistance Spot Welds — D. Shirkey, (Dec) 40

Ergonomic Hand Tools, How to Choose — P. Holstein, (Mar) 90

Essen Welding and Cutting Fair Comes Up Big in a Down Economy — A. Cullison, (Dec) 48


Evaluating Margins of Safety in Brazed Joints — Y. Flom, L. Wang, M. M. Powell, M. A. Soffa, and M. L. Rommel, (Oct) 31

Evaluating SMAW Electrodes for Coke Drum Construction — J. J. Perdomo, (June) 56

Evolution of Weld Inspection in the Automotive Industry, The — S. Frank, (Aug) 52

Examining the Mechanical Properties of High-Strength Steel Weld Metals — E. T. Ramirez, (Jan) 32

Exchangers, Repairing Cracks in Refinery Heat — S. Hao, D. C. Niemeyer, and Nabeel S. Al-Bannai, (Sept) 38


Expo in Review, The 2008 AWS — A. Cullison, K. Campbell, and M. R. Johnsen, (Jan) 44

Fabrication, Automation Optimizes Nuclear Component — J. Noruk and J. Boillot, (May) 52

Fabricator, Take the Path to Become a Certified Welding — S. T. Snyder, (Nov) 48

Fair Comes Up Big in a Down Economy, Essen Welding and Cutting — A. Cullison, (Dec) 48

Filler Metals to Your Base Material, Know the Keys for Matching — D. C. Phillips, (Aug) 37

Fillet Welds, How to Accurately Measure — J. Pavilakis, (Feb) 38

Friction Stir Process Now Welds Steel Pipe — J. Defalco and R. Steel, (May) 44

Gantry Boosts Weld Quality, Barge Builder’s — C. Bishop, (Sept) 34

Gas Metal Arc Welds, Making Better — A. Monk and G. Bauer, (Jan) 40

Guns and Torches, Current Technology in Welding — A. Cullison, K. Campbell, and M. R. Johnsen, (Feb) 34

High-Tech Chair, Welder Achieves New Heights with — K. Campbell (Sept) 80

High-Strength Steel Weld Metals, Examining the Mechanical Properties of — J. E. Ramirez, (Jan) 32

How to Accurately Measure Fillet Welds — J. Pavilakis, (Feb) 38

How to Choose Ergonomic Hand Tools — P. Holstein, (Mar) 90

How to Choose Nickel-Based Filler Metals for Vacuum Brazing — M. Weinstein, R. L. Peaslee, and F. M. Miller, (April) 59

Important Joining Option, Brazing: An — C. Darling, (April) 41

Induction Soldering Gets Maglev Vehicle on Track — K. H. Holko, (April) 53


Inspection in the Automotive Industry, The Evolution of Weld — S. Frank, (Aug) 52

Inspection, Testing Sinter Brazing Integrity Using Resonant — R. W. Bono, (Oct) 48

Know the Keys for Matching Filler Metals to Your Base Material — D. C. Phillips, (April) 30


Laser Beam Welding and Cutting, One Machine Does It All for — D. Petring and F. Schneider, (Mar) 38

Laser Welding: It’s Not Just for Metals Anymore — S. A. Kocheny and B. Miller, (Mar) 28

Lead-Free Solders, The Effects of Adding Silver and Indium to — I. G. B.
**Part 2 – RESEARCH**

**SUPPLEMENT SUBJECT INDEX**

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Novel Preweld Laser Surface Treatment for Enhanced Intergranular</td>
<td></td>
</tr>
<tr>
<td>Corrosion Resistance of Austenitic Stainless Steel Weldments — R.</td>
<td></td>
</tr>
<tr>
<td>Dayal, and L. M. Kukreja, (Dec) 233-s</td>
<td></td>
</tr>
<tr>
<td>Al-to-Mg Friction Stir Welding: Effect of Positions of Al and Mg with</td>
<td></td>
</tr>
<tr>
<td>Respect to the Welding Tool — W. Fiourzdor and S. Kou, (Nov) 213-s</td>
<td></td>
</tr>
<tr>
<td>Aluminum Automotive Body Construction Applications, Ultrasonic Metal</td>
<td></td>
</tr>
<tr>
<td>Welding Process Robustness in — E. T. Hetrick, J. R. Baer, W. Zhu,</td>
<td></td>
</tr>
<tr>
<td>L. V. Weatherford, A. J. Grima, D. J. Scholl, D. E. Wilkosz, S. Fatima,</td>
<td></td>
</tr>
<tr>
<td>and M. Ward, (July) 43-s</td>
<td></td>
</tr>
<tr>
<td>Aluminum 7108 Weldability, The Effect of High-Temperature Eutectic-</td>
<td></td>
</tr>
<tr>
<td>Forming Impurities on — M. G. Mousavi, C. E. Cross, and O. Grong,</td>
<td></td>
</tr>
<tr>
<td>(May) 104-s</td>
<td></td>
</tr>
<tr>
<td>Austenitic Stainless Steel Weldments, A Novel Preweld Laser Surface</td>
<td></td>
</tr>
<tr>
<td>Treatment for Enhanced Intergranular Corrosion Resistance of — R.</td>
<td></td>
</tr>
<tr>
<td>Dayal, and L. M. Kukreja, (Dec) 233-s</td>
<td></td>
</tr>
<tr>
<td>Brass Plate, Microstructural and Mechanical Characterization of Friction Stir Butt Joint Welded 63% Cu-37% Zn — G. Çam, S. Mistikoglu, and M. Pakdil, (Nov) 225-s</td>
<td></td>
</tr>
<tr>
<td>CICT Diagram for an Offshore Pipeline Steel of X70 Type, A CCT — M. I. Onsoinou, M. M’Hamid, and A. Mo, (Jan) 1-s</td>
<td></td>
</tr>
<tr>
<td>Distortion of Built-Up Beams by High-Frequency Induction Heating,</td>
<td></td>
</tr>
<tr>
<td>Lee, (Feb) 29-s</td>
<td></td>
</tr>
<tr>
<td>Dual-Phase Steels, Transient High-Frequency Welding Simulations of —</td>
<td></td>
</tr>
<tr>
<td>R. Banerjee and Y. Adonyi, (Oct) 193-s</td>
<td></td>
</tr>
<tr>
<td>Ductility-Dip Cracking Susceptibility of Nickel-Based Weld Metals: Part 2 — Microstructural Characterization — N. E. Nissely and J. C. Lippold, (June) 131-s</td>
<td></td>
</tr>
<tr>
<td>Diagram for an Offshore Pipeline Steel of X70 Type, A CCT — M. I. Onsoinou, M. M’Hamid, and A. Mo, (Jan) 1-s</td>
<td></td>
</tr>
<tr>
<td>Distortion of Built-Up Beams by High-Frequency Induction Heating,</td>
<td></td>
</tr>
<tr>
<td>Lee, (Feb) 29-s</td>
<td></td>
</tr>
<tr>
<td>Duplex Stainless Steel at 12 and 35 Bar, Hyperbaric GMA Welding of</td>
<td></td>
</tr>
<tr>
<td>— O. M. Akssen, H. Fostervoll, and C. H. Ahlen, (Feb) 21-s</td>
<td></td>
</tr>
<tr>
<td>Effect of Buffer Sheets on the Shear Strength of Ultrasonic Welded</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel Joints — A. Bahadur and G. K. Kallam, (April) 94-s</td>
<td></td>
</tr>
<tr>
<td>Effect of High-Temperature Eutectic-Forming Impurities on Aluminum</td>
<td></td>
</tr>
<tr>
<td>7108 Weldability, The — M. G. Mousavi, C. E. Cross, and O. Grong,</td>
<td></td>
</tr>
<tr>
<td>(May) 104-s</td>
<td></td>
</tr>
<tr>
<td>Crack-Free Electron Beam Welding of Allvac 718Plus® Superalloy — O.</td>
<td></td>
</tr>
<tr>
<td>Idowu, O. A. Ojo, and M. C. Chaturvedi, (Sept) 179-s</td>
<td></td>
</tr>
<tr>
<td>Cracking in Ni-Based Alloys: Part II, Metallurgical Investigation</td>
<td></td>
</tr>
<tr>
<td>into Ductility Dip — F. F. Noecker II and J. N. DuPont, (Jan) 7-s</td>
<td></td>
</tr>
<tr>
<td>Cracking in Ni-Based Alloys: Part II, Metallurgical Investigation</td>
<td></td>
</tr>
<tr>
<td>into Ductility Dip — F. F. Noecker II and J. N. DuPont, (Mar) 62-s</td>
<td></td>
</tr>
<tr>
<td>Cracking Susceptibility of Nickel-Based Weld Metals: Part 2 —</td>
<td></td>
</tr>
<tr>
<td>Microstructural Characterization, Ductility-Dip — N. E. Nissely and</td>
<td></td>
</tr>
<tr>
<td>J. C. Lippold, (June) 131-s</td>
<td></td>
</tr>
<tr>
<td>Diagram for an Offshore Pipeline Steel of X70 Type, A CCT — M. I. Onsoinou, M. M’Hamid, and A. Mo, (Jan) 1-s</td>
<td></td>
</tr>
<tr>
<td>Crack-Free Electron Beam Welding of Allvac 718Plus® Superalloy — O.</td>
<td></td>
</tr>
<tr>
<td>Idowu, O. A. Ojo, and M. C. Chaturvedi, (Sept) 179-s</td>
<td></td>
</tr>
<tr>
<td>Cracking in Ni-Based Alloys: Part II, Metallurgical Investigation</td>
<td></td>
</tr>
<tr>
<td>into Ductility Dip — F. F. Noecker II and J. N. DuPont, (Jan) 7-s</td>
<td></td>
</tr>
<tr>
<td>Cracking in Ni-Based Alloys: Part II, Metallurgical Investigation</td>
<td></td>
</tr>
<tr>
<td>into Ductility Dip — F. F. Noecker II and J. N. DuPont, (Mar) 62-s</td>
<td></td>
</tr>
<tr>
<td>Cracking Susceptibility of Nickel-Based Weld Metals: Part 2 —</td>
<td></td>
</tr>
<tr>
<td>Microstructural Characterization, Ductility-Dip — N. E. Nissely and</td>
<td></td>
</tr>
<tr>
<td>J. C. Lippold, (June) 131-s</td>
<td></td>
</tr>
</tbody>
</table>
Fillet Weld Joint Tracking, Welding Gun Inclination Detection and Curved — Y. F. Gao, H. Zhang, and Z. W. Mao, (Mar) 45-s
Fricitn Stir Butt Joint Welded 63% Cu-37% Zn Brass Plate, Microstructural and Mechanical Characterization of — G. Çam, S. Mistikoglu, and M. Padikil, (Nov) 225-s
Fricitn Stir Welding: Effect of Positions of Al and Mg with Respect to the Welding Tool, Al-to-Mg — V. Firoozdor and S. Kou, (Nov) 213-s
GTA Weld Pool Surface Measurement System, Error Analysis of a Three-Dimensional — H. Song and Y. M. Zhang, (July) 141-s
Hardening by Nitrogen Ion Implantation, Steel Thermal Sprayed Coatings: Superficial — M. Belotserkovsky, A. Yelistratov, A. Byeli, and V. Kukareko, (Dec) 243-s
Heated-Astringen Zone Using the Small Punch Test, Mechanical Properties Characterization of — Ç. Rodríguez, J. García Cabaza, E. Cárdenas, F. J. Belzunec, and C. Betegóin, (Sept) 188-s
High-Temperature Eutectic-Forming Impurities on Aluminum 7108 Weldability, The Effect of — M. G. Mousavi, C. C. Er, and O. Grong, (May) 104-s
HY-80 Steel, Hybrid Laser Arc Welding of — Ç. Roepke and S. Liu, (Aug) 159-s
Hybrid Laser Arc Welding of HY-80 Steel — Ç. Roepke and S. Liu, (Aug) 159-s
Hyperbaric GMA Welding of Duplex Stainless Steel at 12 and 35 Bar — O. M. Akselsen, H. Fostervoll, and C. H. Ahlen, (Feb) 21-s
Influence of Nanoscale Marble (Carbonate CaCO3) on Properties of D600R Surfacing Electrode — B. Chen, F. Han, Y. Huang, K. Lu, Y. Liu, and L. Li, (May) 99-s
Laser Arc Welding of HY-80 Steel, Hybrid — Ç. Roepke and S. Liu, (Aug) 159-s
Low-Alloy Steel Weldments, Near Weld Interface Compositional Variations in — D. B. Knorr and J. J. McGree, (Oct) 202-s
Measurement System, Error Analysis of a Three-Dimensional GTA Weld Pool Surface — H. Song and Y. M. Zhang, (July) 141-s
Mechanical Characterization of Friction Stir Butt Joint Welded 63% Cu-37% Zn Brass Plate, Microstructural and — G. Çam, S. Mistikoglu, and M. Padikil, (Nov) 225-s
Mechanical Properties Characterization of Heat-affected Zone Using the Small Punch Test — Ç. Rodríguez, J. García Cabaza, E. Cárdenas, F. J. Belzunec, and C. Betegóin, (Sept) 188-s
Metallurgical Investigation into Ductility Dip Cracking in Ni-Based Alloys: Part I — F. F. Noecker II and J. N. DuPont, (Jan) 7-s
Metallurgical Investigation into Ductility Dip Cracking in Ni-Based Alloys: Part II — F. F. Noecker II and J. N. DuBunt, (Mar) 62-s
Microstructural and Mechanical Characterization of Friction Stir Butt Joint Welded 63% Cu-37% Zn Brass Plate — G. Çam, S. Mistikoglu, and M. Padikil, (Nov) 225-s
Microstructural Characterization, Ductility-Dip Cracking Susceptibility of Nickel-Based Weld Metals: Part 2 — N. E. Nisly and J. C. Lippold, (Jan) 131-s
Nanoscale Marble (Carbonate CaCO3) on Properties of D600R Surfacing Electrode, Influence of — B. Chen, F. Han, Y. Huang, K. Lu, Y. Liu, and L. Li, (May) 99-s
Near Weld Interface Compositional Variations in Low-Alloy Steel Weldments — D. B. Knorr and J. J. McGree, (Oct) 202-s
Ni-Based Alloys: Part II, Metallurgical Investigation into Ductility Dip Cracking in — F. F. Noecker II and J. N. DuPont, (Jan) 7-s
Ni-Based Alloys: Part II, Metallurgical Investigation into Ductility Dip Cracking in — F. F. Noecker II and J. N. DuPont, (Mar) 62-s
Nickel-Based Weld Metals: Part 2 — Microstructural Characterization, Ductility-Dip Cracking Susceptibility of — N. E. Nisly and J. C. Lippold, (June) 131-s
Pipeline Steel of X70 Type, A CCT Diagram for an Offshore — M. I. Onsien, M. M'Thamni, and A. Mo, (Jan) 1-s
Properties Characterization of Heat-Affected Zone Using the Small Punch Test, Mechanical — Ç. Rodríguez, J. García Cabaza, E. Cárdenas, F. J. Belzunec, and C. Betegóin, (Sept) 188-s
Shear Strength of Ultrasonic Welded Aluminum Joints, Effect of Buffer Sheets on the — M. Baboi and D. Grewell, (April) 86-s
Spatter Classification for Contaminant Detection, Vision-Based — G. Schwab, J. H. Steele, and T. L. Vincent, (June) 121-s
Steel Thermal Sprayed Coatings: Superficial Hardening by Nitrogen Ion Implantation — M. Belotserkovsky, A. Yelistratov, A. Byeli, and V. Kukareko, (Dec) 243-s
Surface Measurement System, Error Analysis of a Three-Dimensional GTA Weld Pool — H. Song and Y. M. Zhang, (July) 141-s
Surfacting Electrode, Influence of Nanoscale Marble (Carbonate CaCO3) on Properties of D600R — B. Chen, F. Han, Y. Huang, K. Lu, Y. Liu, and L. Li, (May) 99-s
Thermal Sprayed Coatings: Superficial Hardening by Nitrogen Ion Implantation, Steel — M. Belotserkovsky, A. Yelistratov, A. Byeli, and V. Kukareko, (Dec) 243-s
Transit High-Frequency Welding Simulations of Dual-Phase Steels — R. Baumer and Y. Adonyi, (Oct) 193-s
Ultrasonic Welded Aluminum Joints, Effect of Buffer Sheets on the Shear Strength of — M. Baboi and D. Grewell, (April) 86-s
Vision-Based Spatter Classification for Contaminant Detection — G. Schwab, J. P. H. Steele, and T. L. Vincent, (June) 121-s
Welding of Galvanized Dual-Phase 980 Steel in a Gap-Free Lap Joint Configuration — S. L. Yang and R. Kovacevic, (Aug) 168-s
Welding Gun Inclination Detection and Curved Fillet Weld Joint Tracking — Y. F. Gao, H. Zhang, and Z. W. Mao, (Mar) 45-s
**Primary Author (Full Name):**

**School/Company:**

**Mailing Address:**

<table>
<thead>
<tr>
<th>City</th>
<th>State/Province</th>
<th>Zip/Mail Code</th>
<th>Country</th>
</tr>
</thead>
</table>

**Email:**

**Poster Title (max. 50 characters):**

**Poster Subtitle (max. 50 characters):**

**Co-Author(s):**

<table>
<thead>
<tr>
<th>Name (Full Name):</th>
<th>Affiliation:</th>
<th>Address:</th>
</tr>
</thead>
<tbody>
<tr>
<td>City:</td>
<td>State/Province:</td>
<td>Zip/Mail Code:</td>
</tr>
<tr>
<td>Country:</td>
<td>Email:</td>
<td></td>
</tr>
</tbody>
</table>

**Poster Requirements and Selection Criteria:**

- Only those abstracts submitted on this form will be considered. Follow the guidelines and word limits indicated.
- Complete this form using MSWord. Submit electronically via email to techpapers@aws.org or print and mail.
- Any technical topic relevant to the welding industry is acceptable (e.g., welding processes & controls, welding procedures, welding design, structural integrity related to welding, weld inspection, welding metallurgy, etc.).
- Submittals that are incomplete and that do not satisfy these basic guidelines will not be considered for competition.

Posters accepted for competition will be judged based on technical content, clarity of communication, novelty/relevance of the subject & ideas conveyed and overall aesthetic impression.

Criteria by category as follows:

**A) Student**
- Students enrolled in 2 yr. college and/or certificate programs at time of submittal.
- Presentation need not represent actual experimental work. Rather, emphasis is placed on demonstrating a clear understanding of technical concepts and subject matter.
- Practical application is important and should be demonstrated.

**B) Student**
- For students enrolled in baccalaureate engineering or engineering technology programs at the time of submittal.
- Poster should represent the student's own experimental work. Emphasis is placed on demonstrating a clear understanding of technical concepts and subject matter.
- Practical application and/or potential relevance to the welding industry is important and should be demonstrated.

**C) Student**
- For students enrolled in graduate degree programs in engineering or engineering technology at time of submittal.
- Poster should represent the student's own experimental work. Poster must demonstrate technical or scientific concepts. Emphasis is placed on originality and novelty of ideas presented.
- Potential relevance to the welding industry is important and should be demonstrated.

**D) Professional**
- For anyone working in the welding industry or related field.
- Poster must demonstrate technical or scientific concepts. Emphasis is placed on original contributions and the novelty of the presentation.
- Potential relevance to the welding industry is important and should be demonstrated.

**E) High School**
- Junior or Senior high school students enrolled in a welding concentration at the time of submittal.
- Presentation should represent technical concepts and application to the welding industry.
- Practical application and creativity are important and should be demonstrated.
Check the category that applies:

- (A) Student 2-yr. or Certificate Program
- (B) Student 4-yr. Undergraduate
- (C) Graduate Student
- (D) Professional
- (E) High School

**Poster Title (max. 50 characters):**

**Poster Subtitle (max. 50 characters):**

### Abstract:

**Introduction** (100 words) – Describe the subject of the poster, problem/issue being addressed and its practical implications for the welding industry.

### Technical Approach & Results

(200 words) – Explain the technical approach. Summarize the work that was done as it relates to the subject of the poster.

### Conclusions

(100 words) – Summarize the conclusions and how they could be used in a welding application.

Return this form, completed on both sides, via email to techpapers@aws.org

**MUST BE RECEIVED NO LATER THAN April 16, 2010**
Research Welding Engineer and Research Welding Analyst

Candidates must have welding backgrounds, experience in cutting techniques, and be prepared to work in a team-based environment in a state-of-the-art R&D facility. The research engineer must possess an advanced degree from an accredited college or university, whereas the research analyst must possess an associate’s degree and a minimum of five years experience.

SSAB is a global leader in value added, high strength steel and offers products developed in close cooperation with its customers to reach a stronger, lighter and more sustainable world. SSAB employs 9,200 people in over 45 countries around the world and operates production facilities in Sweden and the U.S. To learn more, go to www.ssab.com.

Construction is currently underway for SSAB North America’s new R&D Facility adjacent to its steel mill in Montpelier, Muscatine County, Iowa. This $11 million investment includes a new building and a variety of specialized testing, simulation and metallographic equipment. The 25,000 sq. ft. facility will be environmentally designed and constructed to obtain Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ certification, and is expected to be completed by spring 2010.

If you are a reliable, self-motivated individual who wants to join a strong, growing company, you owe it to yourself to check out this opportunity. Only candidates legally eligible to work in the United States need apply. Only those being actively considered for employment will be contacted.

Send your resume to: paula.schmitt@ssab.com.

Looking for Regional Sales Managers

Take this opportunity to grow with Kiswel USA

Regions: Southwest Southeast North–central

Contact Paul Ryu
E-mail: paul@kiswelusa.com
Ph: 859-371-0070

SEEKING EMPLOYMENT

Advertising/PR Services

Talented marketing, advertising and PR expert with over 23 years of welding market expertise seeks full-time or contract position. I can help you develop your marketing materials and promote your business in these challenging times. Currently based on the west coast but willing to relocate.

Contact me at 818-846-3630.

AWS JobFind

Post Jobs. Find Jobs.
www.aws.org/jobfind

Job categories for welders, engineers, inspectors, and more than 17 other materials joining industry classifications!

REPRINTS

Custom reprints of Welding Journal articles, in quantities of 100 or more, may be purchased from FosteReprints at (219) 879-8366 or (800) 382-0808. Request for quotes can be faxed to (219) 874-2849. You can e-mail FosteReprints at sales@fostereprints.com.
Boiler Tube Alignment Tools

Walhonde Wallbanger™
- DB model fits 2 tubes on specific OD’s ranging from 7/8” to 1-3/4”.
- HD model fits 1 tube on specific OD’s ranging from 1-3/4” to 3-1/4”

Walhonde Wallstick™
NEW
- Quickly & accurately aligns waterwall tubes with 1/4” or 3/8” membrane. Fits OD tube sizes: 7/8” through 3” (Patented)

More alignment tools available at our website: www.walhonde.com

Walhonde Tools, Inc.
1-800-TUBE FIT (882-3348)
Tel: 304-756-3796 / Fax: 304-756-3834

Quality-Checked™ PRE-OWNED Equipment

An Excellent Selection of Used Welders, Welding Positioners, Welding-Related Specialty Equipment and Generators.

View at reddarc.com or call us toll-free.

Red-D-Arc
Welderentals. 1-866-733-3272
reddarc.com

MITROWSKI RENTS
Made in U.S.A.
Welding Positioners 1-Ton thru 60-Ton

Used Equipment for Sale
www.mitrowskiwelding.com
sales@mitrowskiwelding.com
800-218-9620
713-943-8032

Used and New Linking, Jump Ring and Looping Machines
Tack, Pulse Arc and Fusion Welding Machines
Repairs and Service Parts
401-284-4501
888-494-2663
E-Mail: ab1655@aol.com
www.abiusa.net

VERSATIG™
MULTIPLE TIG TORCH SELECTORS
www.versa-tig.com

VERSATIG™
MULTIPLE TIG TORCH SELECTORS
www.versa-tig.com

ATTENTION!!

Welding Equipment Sales People
- We pay you for finding us good used welding positioners, seamers, manipulators, turning rolls, systems, etc.
- We will buy your customers’ trade-ins.

800-288-9414
www.weldplus.com

JOE FULLER LLC
We manufacture tank turning rolls 3-ton through 120-ton rolls
www.joefuller.com

email: joe@joefuller.com
Phone: 979-277-8343
Fax: 281-290-6184
Our products are made in the USA

MITROWSKI RENTS
Made in U.S.A.
Welding Positioners 1-Ton thru 60-Ton

Used Equipment for Sale
www.mitrowskiwelding.com
sales@mitrowskiwelding.com
800-218-9620
713-943-8032

Used and New Linking, Jump Ring and Looping Machines
Tack, Pulse Arc and Fusion Welding Machines
Repairs and Service Parts
401-284-4501
888-494-2663
E-Mail: ab1655@aol.com
www.abiusa.net

markingpendepot.com
Paint markers for professionals

ArroMark, Artline Dixon, Dykem
Markal, Posca Sakura, Sharpie
SKM, UniPaint.

The worlds best selection of markers!

Order Online at markingpendepot.com or
call 888-996-1848
Internal Audit Training
After the AWS FabTech show Thursday November 19th
See us at FabTech booth #32046
312-861-3000 | info@atema.com
www.atema.com

RELIABILITY 2010
CWI PREPARATORY
Guarantee - Pass or Repeat FREE!
80+ HOUR COURSE
MORE HANDS-ON PRACTICAL APPLICATIONS
Houston, TX Feb. 1–12 & May 10–21
Beaumont, TX Mar. 15–26
Houma, LA Feb. 22–Mar. 5
Pascagoula, MS Jan. 15–22 & Apr. 15–16

56+ HOUR COURSE
EXTRA INSTRUCTION TO GET A HEAD START!
Houston, TX Feb. 4–12 & May 13–21
Beaumont, TX Mar. 18–26
Houma, LA Feb. 25–Mar. 5
Pascagoula, MS Jan. 14–22 & Apr. 8–16

40 HOUR COURSE
GET READY—FAST PACED COURSE!
Houston, TX Feb. 8–12 & May 17–21
Beaumont, TX Mar. 22–26
Houma, LA Mar. 1–5
Pascagoula, MS Jan. 18–22 & Apr. 12–16
Test follows on Saturday at same facility & includes additional self study for weekend.
FOR DETAILS CALL OR E-MAIL:
(800) 489-2890
info@realeducational.com
Also offering API 510, API 570, RT Film Interpretation, MT/PT/UT Thickness,
Welding Procedure Fundamentals and 9-Year Recertification Courses!

WELDING CONSULTANTS
EDWARD A. METZBOWER, PH.D.
WELDING METALLURGY LASER SAW GTAW MAG
8171 BLUEDALE STREET ALEXANDRIA, VA 22306 USA
TEL 703 780 3579 FAX 703 780 3579 ED@EAMWELD.COM
WWW.EAMWELD.COM

STS WELDING CONSULTATION
P.O. Box 1765 • Mandeville, LA 70448-1765
Phone/Fax: (985) 674-4006 Mobile: (504) 931-9567
E-mail: weldconsultant@mindspring.com www.weldconsultan.com
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
<th>Website</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcOne</td>
<td>32</td>
<td><a href="http://www.arclweldsafe.com">www.arclweldsafe.com</a></td>
<td>800-223-4685</td>
</tr>
<tr>
<td>Arcos Industries, LLC</td>
<td>IBC</td>
<td><a href="http://www.arcos.us">www.arcos.us</a></td>
<td>800-233-8460</td>
</tr>
<tr>
<td>Astro Arc Polysoude</td>
<td>29</td>
<td><a href="http://www.astroarc.com">www.astroarc.com</a></td>
<td>661-702-0141</td>
</tr>
<tr>
<td>Atlas Welding Accessories, Inc</td>
<td>22</td>
<td><a href="http://www.atlaswelding.com">www.atlaswelding.com</a></td>
<td>800-962-9353</td>
</tr>
<tr>
<td>AWS Certification Services</td>
<td>23, 56</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353</td>
</tr>
<tr>
<td>AWS Member Services</td>
<td>14, 25, 53, 77</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353</td>
</tr>
<tr>
<td>AWS RWMA</td>
<td>37, 78</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353</td>
</tr>
<tr>
<td>AWS Technical Services</td>
<td>9</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353</td>
</tr>
<tr>
<td>AWS WEMCO</td>
<td>37</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353</td>
</tr>
<tr>
<td>Commercial Diving Academy</td>
<td>27</td>
<td><a href="http://www.commercialdivingacademy.com">www.commercialdivingacademy.com</a></td>
<td>888-974-2232</td>
</tr>
<tr>
<td>Cor-Met</td>
<td>28</td>
<td><a href="http://www.cor-met.com">www.cor-met.com</a></td>
<td>810-227-3251</td>
</tr>
<tr>
<td>Diamond Ground Products, Inc</td>
<td>11</td>
<td><a href="http://www.diamondground.com">www.diamondground.com</a></td>
<td>805-498-3837</td>
</tr>
<tr>
<td>Divers Academy International</td>
<td>19</td>
<td><a href="http://www.diversacademy.com">www.diversacademy.com</a></td>
<td>800-238-3483</td>
</tr>
<tr>
<td>Fischer Engineering</td>
<td>39</td>
<td><a href="http://www.fischerengr.com">www.fischerengr.com</a></td>
<td>937-754-1750</td>
</tr>
<tr>
<td>Fronius Perfect Welding</td>
<td>15</td>
<td><a href="http://www.fronius-usa.com">www.fronius-usa.com</a></td>
<td>810-220-4414</td>
</tr>
<tr>
<td>Gedik Welding, Inc</td>
<td>17</td>
<td><a href="http://www.gedikwelding.com">www.gedikwelding.com</a></td>
<td>+90 216 378 50 00</td>
</tr>
<tr>
<td>Hobart Inst. of Welding Tech.</td>
<td>30</td>
<td><a href="http://www.welding.org">www.welding.org</a></td>
<td>800-332-9448</td>
</tr>
<tr>
<td>Hodgson Custom Rolling, Inc</td>
<td>1</td>
<td><a href="http://www.hodgsoncustomrolling.com">www.hodgsoncustomrolling.com</a></td>
<td>905-356-8132</td>
</tr>
<tr>
<td>Kiswa Welding Products</td>
<td>7</td>
<td><a href="http://www.kiswelweldingproducts.com">www.kiswelweldingproducts.com</a></td>
<td>859-371-0070</td>
</tr>
<tr>
<td>Lincoln Electric Co.</td>
<td>OBC</td>
<td><a href="http://www.lincolnelectric.com">www.lincolnelectric.com</a></td>
<td>216-481-8100</td>
</tr>
<tr>
<td>Nederman USA</td>
<td>13</td>
<td><a href="http://www.nederman.com">www.nederman.com</a></td>
<td>800-575-0609</td>
</tr>
<tr>
<td>Select Arc, Inc.</td>
<td>IFC</td>
<td><a href="http://www.select-arc.com">www.select-arc.com</a></td>
<td>937-295-5215</td>
</tr>
<tr>
<td>Smart TCP</td>
<td>5</td>
<td><a href="http://www.smarttcp.com">www.smarttcp.com</a></td>
<td>248-994-1041</td>
</tr>
<tr>
<td>Sperian Protection</td>
<td>31</td>
<td><a href="http://www.sperianprotection.com">www.sperianprotection.com</a></td>
<td>800-682-0839</td>
</tr>
<tr>
<td>Swagelok</td>
<td>11</td>
<td><a href="http://www.swagelok.com/m200welding">www.swagelok.com/m200welding</a></td>
<td>440-349-4934</td>
</tr>
<tr>
<td>Synetik</td>
<td>12</td>
<td><a href="http://www.synetik-di.com">www.synetik-di.com</a></td>
<td>514-488-7045</td>
</tr>
<tr>
<td>Triangle Engineering, Inc</td>
<td>30</td>
<td><a href="http://www.trieng.com">www.trieng.com</a></td>
<td>781-878-1500</td>
</tr>
<tr>
<td>Uniweld Products, Inc</td>
<td>13</td>
<td><a href="http://www.uniweld.com">www.uniweld.com</a></td>
<td>800-323-2111</td>
</tr>
<tr>
<td>Weld Hugger, LLC</td>
<td>22</td>
<td><a href="http://www.weldhugger.com">www.weldhugger.com</a></td>
<td>877-935-3447</td>
</tr>
<tr>
<td>WELDMEX</td>
<td>2</td>
<td><a href="http://www.aws.org">www.aws.org</a></td>
<td>800-443-9353, ext. 297</td>
</tr>
</tbody>
</table>

IFC = Inside Front Cover  
IBC = Inside Back Cover  
OBC = Outside Back Cover  

Visit Our Interactive Ad Index: www.aws.org/ad-index
A Novel Preweld Laser Surface Treatment for Enhanced Intergranular Corrosion Resistance of Austenitic Stainless Steel Weldments

A new scheme of preweld laser surface treatment is developed for Type 304 stainless steel for enhanced resistance against HAZ sensitization and intergranular corrosion


ABSTRACT

This paper describes the development of a new preweld laser surface melting treatment scheme to suppress sensitization in the heat-affected zone of gas tungsten arc weldment of Type 304 stainless steel. The results of the present study, performed on 6-mm-thick medium-carbon (0.044 wt-%) and 10-mm-high-carbon (0.1 wt-%) Type 304 stainless steel sheets, established that surface modification engineered by CO₂ laser treatment is highly effective in suppressing heat-affected zone sensitization during subsequent gas tungsten arc welding. Laser surface treated heat-affected zone of gas tungsten arc weldment exhibited a significantly lower degree of sensitization and susceptibility to intergranular corrosion than those of untreated heat-affected zone. This is attributed to higher fraction of Σ₁ subgrain boundaries introduced by laser-assisted melting and resolidification.

KEYWORDS

Laser Welding
Surface Treatment
Stainless Steel
Heat-Affected Zone
Sensitization
Intergranular Corrosion
Grain Boundary

Introduction

Austenitic stainless steels (SS), in spite of having excellent ductility and general corrosion resistance, are particularly susceptible to localized corrosion, e.g., crevice, pitting, intergranular corrosion (IGC), and stress corrosion cracking (SCC). Susceptibility to localized corrosion and SCC is mainly caused by the presence of chloride ions in the associated environment. In nuclear fuel reprocessing, waste management industries, and in many chemical industries, the main corrosion problem is IGC when nitric acid is used as the process fluid. Sensitization is also the prime cause for intergranular stress corrosion cracking (IGSCC) of SS weldments in certain environments, e.g., oxidizing water in boiling water reactors (Ref. 1). Intergranular corrosion of austenitic SS arises from intergranular precipitation of chromium-rich carbides in the temperature range of 773–1073 K. Intergranular carbide precipitation is accompanied by the development of a chromium-depleted zone adjacent to grain boundaries. This state is referred as “sensitization.” Chromium-depleted zones, being anodic with respect to grain interior, are preferentially attacked in the corrosive environment, leading to IGC (Ref. 2). During welding of austenitic stainless steels, particularly of high-carbon content, heat-affected zones (HAZ) of the weldment get sensitized, which adversely affects their resistance against IGC during service in the susceptible environment. There are several earlier studies involving the use of laser surface melting (LSM) treatment for enhancing corrosion resistance of austenitic stainless steels. However, most of these studies largely involved sensitization repair and dissolution of inclusions for improved IGC and pitting resistance (Refs. 3–10). Laser surface melting of SS dissolves inclusions and regions of segregation to homogenize treated surfaces, thus resulting in marked improvement in pitting resistance (Refs. 5, 8). In sensitized SS, LSM dissolves chromium-rich carbides, thereby releasing chromium back into the matrix, mitigating chromium depletion for enhanced resistance against IGC. Recent research on grain boundaries has shown that sensitization depends strongly on grain boundary character and atomic structure and low-energy grain boundaries such as coincidence site lattice (CSL) boundaries have strong resistance to IGC (Refs. 11–13). Grain boundaries with low-Σ CSL (Σ ≤ 29) are highly resistant against sensitization and IGC. Of late, it has also been demonstrated that the development of extremely randomized grain boundaries result in improved resistance to sensitization, IGC, and IGSCC (Refs. 14, 15). This approach of increasing the fraction of random boundaries to a value above 0.75 has been...
shown to result in improvement against sensitization. The main reasons given are high diffusion rates of chromium along random grain boundaries and a large number of chromium carbide nuclei formation. The beneficial effect of high fraction of random boundaries was demonstrated in this work through its effect on measurements of degree of sensitization, IGC and IGSCC (Refs. 14, 15). The approach usually adopted for controlling grain boundary character distribution (GBCD) involves thermomechanical treatment for inducing bulk recrystallization. A related study performed in the authors’ laboratory has demonstrated that a LSM treatment of 316(N) SS weld metal results in significant increase in its resistance against sensitization during subsequent postweld solution annealing treatment for stress relieving (Ref. 16). A recent work reported by Yang et al. has shown that a combination of LSM and a prolonged heat treatment of 304 SS at 1220 K, resulted in remarkable change in GBCD, thereby resulting in improvement of the resistance against IGC (Ref. 17). The present work was undertaken to develop a prewelding laser surface treatment for the would-be HAZ of Type 304 SS to impart enhanced resistance against sensitization during subsequent gas tungsten arc welding (GTAW). The study demonstrated the validity of the approach on a butt joint weld in sheet steel with a multi-kW CO₂ laser. Application of prewelding treatment with

<table>
<thead>
<tr>
<th>Base Metal</th>
<th>C</th>
<th>Cr</th>
<th>Ni</th>
<th>Mn</th>
<th>Si</th>
<th>Mo</th>
<th>P</th>
<th>S</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium-C SS</td>
<td>0.044</td>
<td>18.16</td>
<td>9.78</td>
<td>1.5</td>
<td>0.48</td>
<td>0.26</td>
<td>0.026</td>
<td>0.015</td>
<td>Bal</td>
</tr>
<tr>
<td>High-C SS</td>
<td>0.10</td>
<td>17.8</td>
<td>8.4</td>
<td>1.3</td>
<td>0.51</td>
<td>0.23</td>
<td>—</td>
<td>—</td>
<td>Bal</td>
</tr>
</tbody>
</table>
The Nd:YAG/fiber/diode laser would provide additional flexibility to facilitate in-situ pre-welding treatment of the internal surface of tubes/pipes, which often experience IGC during their operation in susceptible environment. Such a technique would be extremely important for austenitic stainless steel weldments operating in hostile environment (e.g., a reprocessing plant), where failures can have serious consequences.

**Experimental**

This experimental study was performed in two parts. Part 1 of the study was carried out on 6-mm-thick Type 304 SS sheet with a C content of 0.044 wt-%, while the subsequent part of the work was performed on 10-mm-thick Type 304 SS sheet with C content of 0.10 wt-%. The substrates used in Part 1 and Part 2 of the study are referred to as medium-C SS and high-C SS, respectively. Table 1 presents chemical compositions for both base metals (in wt-%), as found out by chemical analysis. Before carrying out laser surface treatment, single-V and double-V grooves (with included angle of 75 deg) were machined in 6- and 10-mm-thick SS sheets, respectively.

The experiments involved surface treatment of would-be heat-affected zones (on both top and bottom surfaces), in one of the two parts to be butt-joint welded, with pulse modulated CO₂ laser beam (LB). Laser surface treatment was carried out with an indigenously developed 4-kW CO₂ laser (Ref. 18). The laser processing setup consisted of the laser system, integrated with a beam delivery system and a computer-controlled 3-axis workstation. The laser beam-emitting out of the laser system, was folded with a 45-deg plane gold-coated copper mirror and subsequently focused with a 127-mm focal length zinc selenide lens, housed in a water-cooled copper nozzle. Laser surface melting treatment involved scanning the surface of the base metal with a defocused LB. The working distance between movable copper nozzle and the specimen (placed below the focal plane) was adjusted to get a beam diameter of 4 mm. During the course of LSM, argon gas flowed through the nozzle to protect the expensive zinc selenide lens from possible spatter at the laser-interaction zone. The laser surface treated part was subsequently gas tungsten arc (GTA) welded to a similar untreated part — Fig. 1. Experimental parameters used for LSM and GTAW are summarized in Table 2. The HAZ developed on the laser-treated and untreated sides of the weld are referred as LSM-HAZ and N-HAZ, respectively. Laser-treated and untreated HAZ specimens were characterized by optical and scanning electron microscopy (SEM), IGC tests as per ASTM A 262 Practices A and E, and double-loop electrochemical potentiokinetic reactivation (DL-EPR) test. In addition, untreated base metal and corresponding laser-treated specimens were also characterized by X-ray diffraction and electron backscattered diffraction (EBSD).

The ASTM A 262 Practice A test is used for rapid screening of the material with respect to sensitization and IGC (Ref. 19). The test involves electrochemical etching of the polished surface of the specimen in 10% oxalic acid solution with a current density of 1 A/cm² for 90 s. The test is used for the acceptance of material against IGC. A specimen with “ditch” microstructure in Practice A test may be susceptible to IGC but this susceptibility needs to be tested by another appropriate practice of ASTM A262. On the other hand, ASTM A 262 Practice E test involves exposing the specimens (embedded in copper turnings) to boiling 10%

---

**Table 2 — Experimental Parameters Used for LSM and GTAW**

<table>
<thead>
<tr>
<th>Laser Surface Treatment (LSM)</th>
<th>Frequency</th>
<th>Duty Cycle</th>
<th>Beam Diameter</th>
<th>Overlap Between Successive Tracks</th>
<th>Scan Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power</td>
<td>100 Hz</td>
<td>50%</td>
<td>4 mm</td>
<td>50%</td>
<td>5 mm/s</td>
</tr>
<tr>
<td>Base Power</td>
<td>3.1 kW</td>
<td>0.6 kW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Tungsten Arc Welding(GTAW)</td>
<td>Groove</td>
<td>Polarity</td>
<td>Current</td>
<td>Welding Speed</td>
<td>No. of Passes</td>
</tr>
<tr>
<td>Base Metal</td>
<td>Joint</td>
<td>Type</td>
<td></td>
<td>2 mm/s</td>
<td>3</td>
</tr>
<tr>
<td>Medium-C SS</td>
<td>Butt</td>
<td>Single V</td>
<td>DCEN</td>
<td>70A</td>
<td></td>
</tr>
<tr>
<td>High-C SS</td>
<td>Butt</td>
<td>Double V</td>
<td>DCEN</td>
<td>70A</td>
<td></td>
</tr>
</tbody>
</table>

---

**Fig. 5 — Comparison of the microstructures of N-HAZ and LSM-HAZ regions of medium-C SS weldment, as brought out by ASTM A262 Practice A test.**
CuSO$_4$-16% H$_2$SO$_4$ solution for 24 h. The exposed specimen is subsequently slowly bent with a suitable mandrel in such a way that the zone to be tested (N-HAZ or LSM-HAZ) fell at the center of the bent portion, i.e., subjected to maximum tensile stress (Ref. 19). The specimens in which cracks appeared in the bent portion were categorized as sensitized. Repeating the test in each case checked the reproducibility of the results. The dimensions of the specimens used for Practice E test were 80 mm × 10 mm × thickness, and they were prepared in such a way that each contained weld metal (WM), heat-affected zones (LSM-HAZ and N-HAZ), and base metal, as shown schematically in Fig. 1. The specimens used for the DL-EPR test were mounted in cold-setting resin in such a way to expose the desired surface. Before specimen mounting, an electrical connection was provided to the specimen by spot welding a metallic wire to its back. Subsequent specimen preparation involved 1) macro-etching the specimens, 2) identification and marking of various zones of the weldment, 3) grinding and diamond polishing up to 0.5 μm finish, and 4) masking with 3M electroplating tape to expose only the HAZ. All the edges of the specimens were masked with lacquer to avoid any crevice attack during the test. The tests were conducted in a de-aerated solution of 0.5 M sulfuric acid and 0.01 M potassium thiocyanate (KSCN). A platinum electrode was used as counter electrode while a saturated calomel electrode (SCE) was used as a reference electrode. The DL-EPR test involved sweeping electrode potential from open circuit potential in the active region to +300 mV (with respect to SCE) in the passive region at the rate of 6 V/h, followed by reverse scan back to the open circuit potential. The basic principle involved in the EPR test involves passivating the specimen's surface, followed by subjecting it to active scan (Ref. 20). In the reverse scan, the resultant current arises mainly from incompletely passivated chromium-depleted zones (Ref. 21). Hence, the charge that passed during reactivation cycle was taken as an index of chromium-depletion. Degree of sensitization (DOS), as determined from the DL-EPR test, is expressed as $\text{DOS\%} = \left( \frac{I_r}{I_a} \right) \times 100$, where $I_r$ = maximum reactivation current in reverse scan, and $I_a$ = maximum activation current in forward scan, as shown schematically in Fig. 2 (Refs. 22, 23). For characterizing each zone of the weldment, one specimen was used for the DL-EPR test. Various specimens, used for the DL-EPR test, were extracted from the central region of the welded plate.

Electron backscattered diffraction (EBSD) (Refs. 14, 24, 25) was used to characterize the respective microtextures. A Quanta 200HV SEM (scanning electron microscope) with a TSL-EDX OIM (orientation imaging microscopy) or EBSD system was used. The EBSD samples were electropolished using standard technique (Ref. 14). Beam and video conditions were kept identical between the scans. For phase identification, between FCC austenite and BCC ferrite, a minimum of 5 Kikuchi bands was used. Grain boundary nature was characterized by co-incident site lattice (CSL) notation. It needs to be noted that the CSL nature can affect dramatically the grain boundary energy (Ref. 26), and in turn, may determine the sensitization response (Ref. 14). CSL boundaries were identified from OIM data using Brandon’s criterion (Ref. 27):

$$\Delta \theta = 15^\circ \Sigma^{-}$$

where $\Delta \theta$ is the angular deviation from the exact CSL and $\Sigma$ is the type of CSL boundary (Refs. 28–30). The grain boundary nature (Refs.
between different samples, can be collated in terms of possible differences in energy (Refs. 30, 14). The low-angle and the low-2 boundaries are expected to have lower energies than the so-called random boundaries (Refs. 28–30, 14). This energy, however, depends on the exact CSL nature and also on the grain size. In an earlier study (Ref. 14), it was proposed to bring in a single parameter defining the grain boundary nature. This parameter, termed generically as effective grain boundary energy (EGBE), considered fractions of different types of CSL (f_i) with stipulated (Ref. 31) differences in CSL energy (E_{i}). EGBE = \left(\frac{\sum f_i E_i}{\sum f_i}\right)_{\text{max}}^{\text{max}} (Ref. 14), where f_i for respective CSL was calculated using the general formula: \text{EGBE} = \left(\frac{\sum f_i E_i}{\sum f_i}\right)_{\text{max}}^{\text{max}}. The formalism, though used effectively in bringing out effects of grain boundary nature on DOS (Ref. 14), has two problems. Firstly, it does not consider possible differences in tilt-twist nature of the boundaries. Secondly, it does not consider the deviation from exact CSL nature. Two-dimensional EBSD measurements are incapable of resolving the first issue. The second issue can, however, be estimated and incorporated in an EGBE formula. The modified EGBE formulation, as used in the present study, is indeed an improvement over the earlier formalism and has been used for studies on sensitization (Ref. 32) and also to define developments in grain boundary nature with thermomechanical processing (Ref. 33).

The existing CSL model (Refs. 28–30) for grain boundaries accounts for two-dimensional misfits, but this may not be adequate in giving a three-dimensional misfit or an effective index of energy (Refs. 34, 35). For example, 23 twin boundaries have completely different energies based on their tilt or twist nature, though the CSL notation in both cases remains the same (Refs. 28, 30). The boundary nature can also be affected by the solute presence (Refs. 28, 30). In spite of such limitations, CSL theory, in general, and EGBE, in particular, have been quite effective in defining the grain boundary nature and relating the same with sensitization behavior in austenitic stainless steel. The present study also shows a relationship between DOS and EGBE before and after laser treatment.

**Results**

**Part 1: Conducted on Medium Carbon Type 304 Stainless Steel**

**Optical Microscopy**

Optical microscopic examination of the transverse cross section of the weldment revealed the presence of overlapping laser surface melted tracks of about 600 μm depth on one side of the GTA weld. Laser surface melted zones exhibited typical cellular/dendritic microstructure. Figure 3 presents an optical photomicrograph of the transverse cross section of the weldment showing laser surface melted zone adjacent to weld metal (WM).

**X-Ray Diffraction (XRD)**

X-ray diffraction, performed on laser surface melted and untreated base metal specimens, demonstrated that, in contrast to, single-phase austenite microstructure of untreated base metal, laser melted surface was associated with duplex microstructure of austenite and δ-ferrite, as shown in Fig. 4. The amount of δ-ferrite present on laser-melted surface was estimated as 4.3%.

**IGC Test: ASTM A262 Practice A**

Heat-affected zones, developed on the two sides of WM (i.e., LSM-HAZ and N-HAZ), exhibited dual microstructures with discontinuous carbide precipitation along the grain boundaries. However, compared to the N-HAZ specimen, the width of the chromium-depleted zone in LSM-HAZ specimens was reduced and carbide precipitation became more discontinuous. Figure 5 compares microstructures of LSM-HAZ and N-HAZ near top and bottom surfaces of the weldment.

**Double-Loop Electrochemical Potentiokinetic Reactivation (DL-EPR) Test**

In order to compare DOS, induced by GTAW in LSM-HAZ and N-HAZ of gas tungsten arc weldment, DL-EPR test (Refs. 36–38) was performed on the top and bottom surfaces of the specimens extracted from the concerned regions of medium-C SS weldment. The test results demonstrated a high value of DOS% (1.12) of top LSM-HAZ surface. It should be noted that the examined surface at this stage carried surface irregularities and oxide layers, introduced by LSM and subsequent welding operation. The value of DOS% rapidly reduced as the specimen was sequentially polished off. At a depth of about 100–150 μm from the top of the treated surface, DOS% dropped to very low value of 0.0123, confirming the highly passivating nature of LSM-HAZ. The exposed surface at this stage was free of surface irregularities and all traces of oxide layer. On the other hand, all four N-HAZ specimens exhibited largely similar DOS% values viz. 0.45 and 0.26 for top and bottom surfaces, respectively. The results of DL-EPR tests are summarized in Table 3 and Fig. 6. It should be mentioned that the DOS% reported here is the average of 2 tests and the values vary within ±0.01%.

---

![Microstructures of the substrate and laser-melted zone (LSM) of high-C SS, as brought out by ASTM A 262 Pr. A test.](image)
Fig. 9 — Microstructures of untreated HAZ (N-HAZ) and laser treated HAZ (LSM-HAZ) of high-C SS, as brought out by ASTM A 262 Pr. A test.

The reproducibility was achieved by keeping the time between polishing and electrochemical testing exactly the same for both specimens.

IGC Test: ASTM A262 Practice E

ASTM A262 Practice E test was conducted on four different specimens (two each from LSM-HAZ and N-HAZ) taken out of the weldment. Out of the two specimens of each kind, one was bent with top surface in tension (i.e., on the convex side) while the other specimen was bent with bottom surface in tension. All four tested specimens passed the test, indicating that heat-affected zones, developed on both the sides of WM remained unsensitized, and hence, not susceptible to IGC. Test results are summarized in Table 4.

Electron Backscattered Diffraction

Electron backscattered diffraction (EBSD) analysis revealed that the fraction of $\Sigma 1$ boundaries (with angle of misorientation $\Delta \theta = 1–15$ deg) in the base metal was 0.04 and it increased to 0.13–0.19 after LSM. Figure 7 presents the typical result of the investigation carried out to measure grain boundary character distribution in base metal and laser surface melted specimen.

Part 2: Conducted on High-Carbon Type 304 Stainless Steel Sheet

IGC Test: ASTM A262 Practice A

The base metal, in solution annealed condition, exhibited step microstructure with banding and isolated carbide precipitation at grain boundaries, as shown in Fig. 8. The base metal was associated with heterogeneity in microstructure (in terms
of carbide precipitation) across its thickness. Metallographic examination of laser treated specimens exhibited a surface melted layer with thickness in the range of 270–500 μm. Laser surface melted zone was associated with typical cast microstructure, as shown in Fig. 8. On the other hand, the N-HAZ specimen exhibited ditch microstructure, while the LSM-HAZ specimen was associated with lightly etched grain boundaries, indicating relatively lower value of chromium-depletion at the grain boundaries than that in N-HAZ specimen. Figure 9 presents microstructures of N-HAZ and LSM-HAZ specimens, as revealed by ASTM A 262 Practice A test.

Double-Loop Electrochemical Potentiokinetic Reactivation Test

Double-loop electrochemical potentiokinetic reactivation (DL-EPR) tests were performed on top and bottom surfaces of N-HAZ and LSM-HAZ specimens of high-C SS. On the basis of the results of first part of the study, treated surfaces of LSM-HAZ specimens were polished to remove surface irregularities and oxide layers before conducting DL-EPR tests. The results of the tests demonstrated that GTAW brought about very large increase in DOS% in the untreated HAZ (N-HAZ). Base metal specimen in the solution annealed condition exhibited a DOS% of 0.0003, whereas the DOS% of N-HAZ specimens from top and bottom surfaces was 12.38 and 42, respectively. In sharp contrast, both LSM-HAZ specimens, exposed to similar thermal history, recorded significantly lower DOS% than their N-HAZ counterparts. The DOS of LSM-HAZ specimens taken from top and bottom surfaces were 0.031% and 0.029%, respectively. Results of DL-EPR tests are summarized in Fig. 10 and Table 3. It is believed that the difference in DOS% of top and bottom surfaces of the N-HAZ specimens is caused by microstructural inhomogeneity present in the base material. Optical microscopic examination of DL-EPR tested N-HAZ specimens revealed chromium-depleted zones along grain boundaries — Fig. 11A. On the other hand, LSM-HAZ specimens exhibited lightly etched grain boundaries — Fig. 11B, indicating significantly reduced chromium-depletion at the grain boundaries than that observed in N-HAZ specimens.

IGC Test: ASTM A262 Practice E

ASTM A262 Practice E test was conducted on four numbers of specimens (two each for N-HAZ and LSM-HAZ), taken out from high-C SS weldment — Fig. 1. The two numbers of N-HAZ specimens broke into two pieces. In sharp contrast, both LSM-HAZ specimens remained uncracked, as shown in Fig. 12. Table 4 summarizes the results of ASTM A262 practice E test.

Electron Backscattered Diffraction

Electron backscattered diffraction analysis of untreated base metal and laser surface melted specimens of high-C SS revealed that LSM brought about an increase in the percentage fraction of Σ1 boundaries (ΔΘ = 1–15 deg) from 0.536 (in the base metal) to 0.759 (on laser melted surface). Figure 13A presents typical results of the experiments carried out to measure GBCD in base metal and laser surface melted specimen. Further analysis of EBSD data, as presented in Fig. 13B, revealed that the bulk of Σ1 boundaries in laser-melted specimen belongs to subgrain boundaries, introduced by melting and resolidification. On the contrary, Σ1 grain boundaries constitute a major part of total Σ1 boundaries in the base metal. In addition, LSM also brought about considerable reduction in the percentage fraction of Σ3 coherent twin boundaries — from 0.1905 (in the base metal) to 0.03 (on laser-melted surface). Microstructural modification, induced by LSM, resulted in significant reduction in effective grain boundary energy (EGBE) from 1.12 (in the base metal) to 0.459 (on the laser melted surface).

Another important output of EBSD analysis is that laser-melted surface carried very little amount of delta-ferrite in a largely austenitic matrix. The fraction of delta ferrite in the base metal and on laser-melted surface was estimated as 0.7% and 0.3%, respectively. Figure 13C presents austenite-ferrite map of the microstructures of base
Fig. 12 — Magnified views of untreated HAZ (N-HAZ) and laser treated HAZ (LSM-HAZ) specimens of high-C SS after undergoing IGC test as per ASTM A 262 Practice E.

Fig. 13 — A — Typical result of the investigation performed to measure grain boundary character distributions in base metal (BM) and laser surface melted (LSM) specimens of high-C SS; B — typical distributions of (A) $\Sigma 1$ boundaries ($\Delta \theta = 1\text{--}15$ deg) between identifiable grains, (B) all $\Sigma 1$ boundaries ($\Delta \theta = 1\text{--}15$ deg), and (C) high-angle grain boundaries ($\Delta \theta = 15\text{--}180$ deg) in base metal (BM) and laser surface melted (LSM) specimens. Concerned boundaries are marked in black whereas associated percentage fractions (F) are indicated on respective images; C — EBSD-generated austenite/ferrite phase maps of the microstructure of base metal (BM) and laser surface melted (LSM) specimens of high-C SS.
metal and laser-melted surface.

Synthesis of Results and Discussion

The results of first part of the study, conducted on 6-mm-thick Type 304 SS sheet with 0.044 wt-% C, demonstrated that microstructural modification induced by GTAW resulted in a development of a moderate degree of sensitization (0.26% and 0.45% for top and bottom surfaces, respectively) on the surface of untreated HAZ. A prewelding surface treatment of the would be HAZ with pulse-modulated LB, brought about a reduction in DOS of the resultant HAZ. Because of relatively lower value of C content and moderate heat input associated with 3-pass GTAW of 6-mm-thick medium-C SS sheet, the DOS induced in the HAZ was not very significant and as a result, degree of LSM-induced improvement in the DOS% of HAZ was not very prominent. This fact is reflected in both untreated and laser-treated HAZ specimens passing ASTM A 262 Practice E test.

The results of the first part of the study, although indicated an increase in materials resistance against sensitization, did not establish strong effectiveness of the technique in suppressing sensitization due to moderate level of C content and heat input associated with GTAW of 6-mm-thick SS sheet. Hence, in Part 2 of the study, LSM treatment approach was evaluated on 10-mm-thick Type 304 SS plate of high-C content (0.1 wt-%), where welding-induced microstructural damage in the HAZ was expected to be significantly extensive. Results of second part of the study exhibited that 5-pass GTAW brought about extensive sensitization in the untreated HAZ of high-C SS. As a result of GTAW, the DOS% of material rose from 0.0005 (in the base metal in solution annealed condition) to extremely high values of 12.38% and 42% on the top and bottom surfaces of untreated HAZ, respectively. In sharp contrast, DOS of laser surface treated HAZ specimens (LSM-HAZ) remained at very low level (0.03), even after experiencing similar thermal exposure. Extremely large reduction in DOS% brought about by prewelding LSM treatment, even under extremely adverse conditions (combination of high-C concentration and large heat input), underlines strong effectiveness of LSM treatment in suppressing HAZ sensitization during subsequent GTAW. The large difference in the DOS% between N-HAZ and LSM-HAZ specimens is translated into large difference in their susceptibilities against IGC. This fact is reflected in laser-treated HAZ specimen successfully passing IGC test as per ASTM A 262 Practice E, in sharp contrast to untreated HAZ specimens, which broke into two pieces. It should be noted here that in order to realize maximum beneficial effect, surface undulations introduced by LSM treatment should be removed before the parts are welded.

The EBSD analysis, performed on both medium-C and high-C SS specimens, demonstrated that LSM brought about significant increase in the fraction of $\Sigma 1$ boundaries. In the case of high-C SS specimens, the increase in the fraction of $\Sigma 1$ boundaries is reflected in about 2.5 times drop in effective grain boundary energy. $\Sigma 1$ boundaries, with small angle of misorientation ($\Delta \theta = 1$–15 deg), are characterized by low energy, slow transport properties (e.g., grain boundary chemical and thermal diffusion, grain boundary migration and sliding) as compared to high angle grain boundaries. These boundaries, because of their low energy, are more resistant to nucleation of chromium carbides. Hence, such boundaries are more resistant to sensitization (Revs. 14, 23). The increased fraction of low-angle boundaries on the laser melted surface is largely attributed to large increase in sub-boundary associated with fine subgrain features (like dendrites, cells, etc.), arising as a result of melting and resolidification. It is believed that these subgrain boundaries introduce frequent disruptions in random grain boundary network, thereby resulting in enhanced resistance against IGC. It should be noted that unlike duplex (austenite + ferrite) microstructure of laser-melted surface of medium-C SS, the same treatment generated a largely austenitic microstructure in high-C SS. In spite of this difference in ferrite content on the laser-treated surface, both kinds of laser-melted specimens exhibited enhanced resistance against sensitization and IGC. Hence, the large reduction in the DOS and susceptibility to IGC, brought about LSM, is primarily contributed by significant increase in the fraction of $\Sigma 1$ subgrain boundaries associated with resolidified microstructure on the surface.

Conclusions

The present study demonstrated that laser surface melting treatment of the would be heat-affected zones of Type 304 SS components results in a surface microstructure with significantly enhanced resistance against sensitization during subsequent GTAW operation. The reason for enhanced resistance of laser-melted surface against sensitization and IGC is attributed to a significant increase in the fraction of $\Sigma 1$ boundaries (mostly subgrain boundaries), introduced by melting and resolidification. Frequent disruptions in the random grain boundary network by intersecting subgrain boundaries is believed to be the cause for its enhanced resistance against sensitization and IGC. In light of the results of the study, a new noncontact prewelding laser surface treatment approach is proposed for GTA weldments of austenitic stainless steel to effectively enhance their resistance against HAZ sensitization and IGC. The proposed technique has a great potential in enhancing the life of austenitic stainless steel welded components operating in corrosive environments, especially prevalent in the process industry.

Acknowledgments

The authors are extremely thankful to R. K. Soni and Harish Kumar for their contributions during various stages of the present investigation. Technical assistance of J. B. Rathi, A. R. Adbol, B. S. Rawat, Ram Nihal Ram, and A. P. Singh is thankfully acknowledged.

References

11. Palumbo, G., and Aust, K. T. 1990. Struc...


Do You Have Some News to Tell Us?

If you have a news item that might interest the readers of the Welding Journal, send it to the following address:
Welding Journal Dept.
Attn: Mary Ruth Johnsen
550 NW LeJeune Rd.
Miami, FL 33126.

Items can also be sent via FAX to (305) 443-7404 or by e-mail to mjohnsen@aws.org.

Change of Address? Moving?

Make sure delivery of your Welding Journal is not interrupted. Contact the Membership Department with your new address information — (800) 443-9353, ext. 217; smateo@aws.org.
Steel Thermal Sprayed Coatings: Superficial Hardening by Nitrogen Ion Implantation

Experiments were conducted to optimize process parameters for thermal spraying and coating modifications

BY M. BELOTSEKOVSKY, A. YELISTRATOV, A. BYELI, AND V. KUKAREKO

ABSTRACT

Modification of steel thermal sprayed coatings by nitrogen ion implantation can dramatically increase wear resistance of their surface layers. The only obstacle for successful modification is low strength and defects in regular wire-sprayed coatings. However, different methods are available to improve physical properties of coatings. In this study, two methods of wire spray process activation were investigated: gas-jet activation (high-velocity spraying) for reduction of sizes and increasing velocity of particles; and ultrasonic activation for reduction of sprayed particle sizes. Once coatings were modified by implantation of nitrogen ions, wear resistance tests were performed. As a result of the following experiments, process parameters for thermal spraying and coating modification were optimized.

Introduction

Wear of machine parts creates a demand for new materials, which have optimized surface properties without altering the bulk properties of the part. This new demand stimulates development of bimetallic parts with special coatings to enhance their service performance.

Thermal spray coatings are a cost-effective way for manufacturing bi-metallic parts, and resurfacing and hardfacing worn machine components. There are two groups of thermal spray methods in relation to what kind of material is in use: powder-spray methods and wire-spray methods. The latter group includes oxyfuel wire spraying (OFWS) and dual-wire arc spraying (DWAS) that have some advantages in terms of lower cost of materials (wire vs. powder), and highest productivity (DWAS) in the group of thermal spray coatings. In the present study, only wire-spray methods were investigated.

For general engineering, wire-spray methods are extremely efficient in cases where there is no need to deposit special high-alloy coatings (ceramic, heat-resistant alloys), but single metals (aluminum, copper) or alloy steels. Since for most friction-wearing parts dimensional allowances are limited, just a thin surface coating with improved hardness/wear resistance can dramatically increase the whole machine’s performance.

Ion implantation is a process of inserting ionized atoms into a substrate with energy sufficient for their “penetration” into the crystalline lattice of a solid metal. The amount of ions of alloying elements implanted into a layer of substrate is determined not by the physical properties of the alloys and the diffusion coefficients, but by implantation process parameters. As a result, a superficial layer with a gradient structure and high wear resistance can be formed (Refs. 1–3). Radiation-stimulated diffusion of nitrogen ions, developed in a superficial layer of metal with a thickness of 10–200 μm (0.0004–0.008 in.), enhances its hardness. This method is applied in industry (Refs. 1, 2) for superficial hardening of metals. Preliminary experiments revealed steel thermal sprayed coatings could be successfully hardened by ion implantation.

In the present research, both wire-spray methods were modernized to improve their coating’s properties and steel coatings were superficially hardened by vacuum implantation of nitrogen ions.

Background

When metal wire(s) feeds inside the active zone of a thermal spray gun, it melts by gas flame (OFWS) or by electric arc (dual wire arc spray (DWAS)) and is atomized by the gas jet. Existing atomizing units can’t provide even or uniform particle sizes. For general OFWS and DWAS thermal spray methods, the range of atomized particle sizes varies from 10 to 300 μm (0.0004–0.012 in.). As a rule, particles are separated in the gas jet with the finest particles located in the middle of the gas jet along the axis and heavier particles are located in the outer layers of the gas jet (Ref. 4). Since the finest particles can be accelerated by the gas jet faster, they have higher dynamic characteristics and, upon striking the substrate, provide higher adhesion strength of the coating, compared to larger, slower moving particles. In other words, a coating formed from only fine axial particles can have a much higher adhesion strength than one formed from heavier outer particles. Furthermore, when the spray gun or workpiece is moving during spraying, the first layer on the surface, which is responsible for the adhesion strength of the whole coating, is formed from the outer, heavier particles (Ref. 5). As a result, the total adhesion strength of the coating is not high enough.

In order to increase adhesion of the coatings, modernized thermal spray guns with improved atomizing of the liquid metal at the tip of the wires were used in this study as follows:

- Dual-wire arc spray gun (HVAF-ARC, Fig. 1) has an activator (Refs. 8, 9) that provides atomizing of liquid metal

KEYWORDS

Steel Wires
Thermal Spray Coating
Particle Diameters
Particle Velocity
Nitrogen Ion Implantation
Hardness
Wear Resistance
and acceleration of particles. Two consumable wires are fused by an electric arc and atomized by a supersonic jet of air-fuel combustion products, generated in a combustion chamber — Fig. 2. The rear wall of the chamber is made of ceramic containing a high-temperature catalyst. After flame ignition with a spark, the rear wall is heated and provides continuous air-fuel combustion during the spray process. Wire tips are located inside the chamber with the flow of exhaust gases directed along them. Wire material atomization occurs in a short expanding nozzle. Since fine metal particles are prone to rapid in-flight oxidation, reduced condition in the arc zone is a critical factor. This is provided by an excess of the fuel gas (propane) in the air-fuel combustion mixture. The activator generates a supersonic gas jet with a total dynamic action three times that of regular plasma spraying. It has a velocity of up to 900 m/s (2950 ft/s) while for general DWAS guns, the atomizing air has a velocity of around 300 m/s (984 ft/s). The jet temperature was up to 1000 K (1340°F), while for general DWAS, the atomizing air is at room temperature. This provides an acceleration of particles up to 300 m/s (984 ft/s) with particle sizes ranging from 2 to 20 μm (8-80 μm.) while for general DWAS guns, the velocity of particles is up to 150 m/s (492 ft/s), with their size at 10-300 μm (0.0004-0.012 in.).

<table>
<thead>
<tr>
<th>Modification process</th>
<th>Thickness, μm</th>
<th>Hardness, HV</th>
<th>Phase composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>620 K (650°F)</td>
<td>5-10</td>
<td>1020</td>
<td>α-Fe, γ-Fe, γN, Fe₃O₄, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>670 K (746°F)</td>
<td>10-20</td>
<td>1428</td>
<td>α-Fe, γ-Fe, γN, Fe₃O₄, ε-(Fe, Cr)₂N, γ'-Fe₂N, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>720 K (836°F)</td>
<td>15-25</td>
<td>1377</td>
<td>α-Fe, γ-Fe, γN, Fe₃O₄, ε-(Fe, Cr)₂N, γ'-Fe₂N, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>770 K (926°F)</td>
<td>30-40</td>
<td>1020</td>
<td>α-Fe, γ-Fe, γN, Fe₃O₄, ε-(Fe, Cr)₂N, γ'-Fe₂N, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>HVAF-ARC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>620 K (650°F)</td>
<td>5-10</td>
<td>918</td>
<td>α-Fe, γ-Fe, γN, Fe₃O₄, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>670 K (746°F)</td>
<td>10-15</td>
<td>1428</td>
<td>α-Fe, Fe₃O₄, ε-(Fe, Cr)₂N, γ'-Fe₂N</td>
</tr>
<tr>
<td>720 K (836°F)</td>
<td>15-20</td>
<td>1377</td>
<td>α-Fe, Fe₃O₄, ε-(Fe, Cr)₂N, γ'-Fe₂N, ε-(Fe, Cr)₂N</td>
</tr>
<tr>
<td>770 K (926°F)</td>
<td>25-30</td>
<td>1020</td>
<td>α-Fe, Fe₃O₄, γ'-Fe₂N, ε-(Fe, Cr)₂N, γ'-Fe₂N, ε-(Fe, Cr)₂N</td>
</tr>
</tbody>
</table>

| Chemical Composition of Base Metal and Welding Wires, wt-% |
|-------------|-------------|-------------|-------------|
| Base Metal  | C           | Cr          | Ni          | Ti          | Mn          |
| Wire 40H13 | 0.18        | 0.3         | —           | —           | 0.42        |
| Wire H18N10T | 0.06       | 18.4        | 9.25        | 0.62        | 0.20        |

Table 1 — Chemical Composition of Base Metal and Welding Wires, wt-%
This results in higher coating density with porosity <1%, compared to 5–10% for regular DWAS (Ref. 10).

- **Oxyfuel wire spray gun** (OFWSTERKO) had an ultrasonic activator (Refs. 6, 7) that generates high-frequency acoustic waves inside the overlapping stream of air. Dynamic action of high-frequency oscillation of the air stream helps to form fine droplets of metal by breaking large liquid metal drops near the tip of the wire into small pieces by the gas jet. Also, turbulent pulses of air pressure helped to refine the particles during their movement to the base metal. In the activated mode, the velocity of the particles was 120–150 m/s (394–492 ft/s) and particle size was 5–12 μm (0.0002–0.0047 in.).

### Experimental Procedure

Mild steel plates with dimensions of 150 × 70 × 10 mm (6 × 3 × ⅜ in.) were sandblasted to an average surface roughness of 30–50 μm (0.0012–0.002 in.). Coatings were made by spraying of steel wires Ø 2 mm (%⅜ in.), from two different alloy groups: martensitic 40H13 (U.S. analog: 420SS) and austenitic X18N10T (U.S. analog: 321SS). The coating thickness was 0.8–1.2 mm (0.03–0.047 in.). The chemical composition of the wires and base metal is presented in Table 1.

After spraying, test blocks were cut from the plates, ground, cleaned, and subjected to nitrogen ion implantation. An implanter (Fig. 3) with an ion beam source based on close-looped drift of electrons (Ref. 3) was used for ion beam processing. The implanter generated a strip-type (120 × 2.5 mm or 4.72 × 0.098 in.) beam of nitrogen ions. The beam contained approximately 70% molecular nitrogen ions and approximately 30% atomic nitrogen ions.

The implantation parameters are as follows:
- Ion current density 2 mA/cm² (12 mA/in.²);
- Energy of ions 3000 eV;
- Fluency of ions (amount of ions per area at 1 cm²) 3 × 10¹⁹ cm⁻² (18.5 × 10¹⁹ in.⁻²);

Metallographic investigations were conducted using an optical microscope “Unimet.” To obtain durometric measure-
Fig. 5 — Microstructure of modified (at 770 K or 926°F) coatings: A, B) X18N10T steel; C, D) 40H13 steel.

DECEMBER 2009, VOL. 88
phase composition, and microhardness for modified OFWS coatings (40H13) are presented in Table 2. Thickness of the modified layer of the coating increased with processing temperature, up to 30–40 μm (0.0012–0.0015 in.). Hardness of the modified layer increased with processing temperature and reached a maximum value of 1480–1632 HV at Tp = 670–720 K (746°–836°F). Main phases in the modified superficial layer of coatings (40H13) are ε-(Fe, Cr)3N and γ′-Fe4N nitrides. After ion modification at Tp = 720 and 770 K (836° and 926°F), nitrogen-rich layers were observed to have sharply decreasing amounts of ε-nitrides (with high nitrogen content) and formation of CrN nitrides. Simultaneously, the hardness decreased up to 1020–1122 HV. In modified coatings the concentration of FeO oxides did not change, but concentration of FeO oxides was reduced. For OFWS coatings, a relatively high hardness and larger thickness of the modified layer were observed. Also, an interesting feature of modified OFWS coatings was the presence of α′-(Fe, Cr)N phase, which have a lower amount of γ′-Fe4N phase and higher amount of CrN nitrides.

The higher ability for diffusion for OFWS coatings can be explained by higher concentration of defects (vacancies, dislocations, pores), which were formed during rapid crystallization of molten particles. Thermodynamically stable Fe2O3 oxide alloyed by chromium was present inside the coating between particles. Those oxides impede the diffusion transfer of the nitrogen from the upper layer of the coating down. The maximum depth of the modified layer for OFWS coatings can be achieved at the lowest level of oxide.

Table 4 — Wear Resistance of Modified HVAF-ARC Coatings in Dry Friction Mode

<table>
<thead>
<tr>
<th>Coating</th>
<th>Temperature of implantation</th>
<th>Wear of layer, (10^{-3}) mg/m</th>
<th>Wear of counterbody, (10^{-3}) mg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial condition</td>
<td>620 K (656°F)</td>
<td>4.5</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td>670 K (746°F)</td>
<td>3.5</td>
<td>16.0</td>
</tr>
<tr>
<td>40H13</td>
<td>720 K (836°F)</td>
<td>0.7</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>770 K (926°F)</td>
<td>1.1</td>
<td>16.2</td>
</tr>
<tr>
<td>Initial condition</td>
<td>620 K (656°F)</td>
<td>1.3</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>670 K (746°F)</td>
<td>12.5</td>
<td>23.7</td>
</tr>
<tr>
<td></td>
<td>720 K (836°F)</td>
<td>10.3</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td>770 K (926°F)</td>
<td>4.1</td>
<td>26.2</td>
</tr>
<tr>
<td>H18N10T</td>
<td>670 K (746°F)</td>
<td>1.6</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>720 K (836°F)</td>
<td>1.4</td>
<td>16.9</td>
</tr>
</tbody>
</table>

Conversion: 1 mg/m is equal to 6.7 x 10^{-7} lb/ft²

The hardness values (vs. process temperature) of modified layers for HVAF-ARC and OFWS coatings were 663, 918–970, 1225–1275, and 1173–1224 HV, respectively. The hardness of the lower part of the coating, which was not modified by ionic implantation, did not change.

Wear Resistance of Modified Coatings

Wear tests, with a load of 1.5 MPa (217.5 lb/in.²) for HVAF-ARC (40H13)
coatings at different levels of ion modification, showed that increasing the implantation temperature led to a sharp increase in wear resistance (Table 4). Coatings modified at a higher temperature ($T_{\text{p}} = 670-770 \text{ K or 746\textdegree-926\textdegree F}$) have higher wear resistance. Ion modification at $T_{\text{p}} = 620 \text{ K (656\textdegree F)}$ for X18N10T coatings resulted in a modified layer with a thickness of 3-6 μm (11-23 μin.); however, no increase in wear resistance occurred during dry friction tests (Table 4). The reason for fast destruction of the thin hard layer is, probably, intensive plastic deformation of bulk metal under the hard layer during the test (Ref. 11).

Wear resistance of coatings increased when the ion modification was carried out at temperatures above 700 K (800\textdegree F). Higher hardness of the modified layer and greater thickness are the main reasons for this.

Studying the coefficient of friction's variation (test with limited lubrication) revealed that modified coatings (Fig. 6) have a smaller value of coefficient of friction compared to the same coatings without ion modification. Also, ionic modification of the steel coatings leads to an increase of their resistance to adhesion during dry friction test.

Tribo-tests of HVAF-ARC (40H13) coatings that were modified at 770 K (926\textdegree F) revealed (Fig. 7) a four times greater amount of cycles before adhesion in friction occurred between the test block and counterbody at a test load of 25 MPa (3625 lb/in.2) and its subsequent catastrophic destruction. Test conditions were as follows: lubrication, oil L-20A; load, 25 MPa (3625 lb/in.2); and counter-body, hardened 0.6% C steel. Higher wear resistance (resistance to adhesion in friction) of coatings modified at 770 K (926\textdegree F) is connected to the higher strength of the modified layer, which contains dispersed particles of CrN.

During dry friction tests of OFWS coatings with a load of 1.5 MPa (217.5 lb/in.2), there was local destruction of the coatings with formation of debris with a size of 100-300 μm (3.93-11.8 × 10^{-4} in.). This can be explained by insufficient adhesive strength of the OFWS coatings and sizeable porosity due to low velocity of particles. Gases from pores caused local destruction of the coating during implantation or following wear tests. Because of this, OFWS coatings were eliminated from the dry friction test.

Test results demonstrated that maximum efficiency of ionic implantation could be achieved for high-velocity spray coatings with a test load of up to 25 MPa (3625 lb/in.2) and a friction speed of up to 1.5 m/s (4.92 ft/s).

The technology of steel coating modification by ion implantation of nitrogen described in this paper was applied for resurfacing and hardening of hydro pump shafts, crankshafts, valve rods, etc.

The possibility of controlling the composition and concentration of diffused ions on a localized area of the workpiece makes the process technologically flexible. Modified coatings do not require subsequent polishing.

Conclusions

- The HVAF-ARC atomizing unit for wire thermal spraying allows considerable improvement in coating formation. Coatings, formed with particles of 2-30 μm (8-110 μin.) size and a velocity up to 300 m/s (984 ft/s) demonstrated high adhesion strength and uniform structure with minimal porosity, less than 1 vol.%.
- High-density coatings can be effectively modified by implantation of nitrogen ions. They form a superficial layer with thicknesses of up to 40 μm (160 μin.) and hardnesses of up to 1530 HV.
- Ion implantation of steel coatings, sprayed by the high-velocity wire-spray process, provides an 8x increase in wear resistance and up to 4x increase in resistance to adhesion in friction.

References


Dear Readers:

The Welding Journal encourages an exchange of ideas through letters to the editor. Please send your letters to the Welding Journal Dept., 550 NW LeJeune Rd., Miami, FL 33126. You can also reach us by FAX at (305) 443-7404 or by sending an e-mail to Kristin Campbell at kcampbell@aws.org.

REPRINTS REPRINTS

To order custom reprints of 100 or more of articles in Welding Journal, call FosteReprints at (219) 879-8366 or (800) 382-0808. Request for quotes can be faxed to (219) 874-2849. You can e-mail FosteReprints at sales@fostereprints.com.
We Can Meet Yours, Too!

When critical welding conditions necessitate performance without compromise, you can depend on Arcos to provide you with a comprehensive line of premium quality high alloy, stainless and nickel electrodes to conform to your stringent requirements.

You can be assured of our commitment to superior welding products because Arcos quality meets or exceeds demanding military and nuclear application specifications. Arcos’ dedication to excellence has earned these prestigious certifications:

- ASME Nuclear Certificate # QSC448
- ISO 9001: 2000 Certificate # GQC230
- Mil-I 45208A Inspection
- Navy QPL

To learn more about the many reasons you should insist on Arcos high alloy, stainless and nickel electrodes for your essential welding applications, call us today at 800-233-8460 or visit our website at www.arcos.us.

Arcos Industries, LLC
One Arcos Drive • Mt. Carmel, PA 17851
Phone: (570) 339-5200 • Fax: (570) 339-5206

For Info go to www.aws.org/ad-index
I CHOOSE LINCOLN... TO COMPLY WITH BUY AMERICA REGULATIONS.

Lincoln Electric introduces Buy America welding consumables to meet the Buy America requirements for infrastructure rebuild projects related to the American Recovery and Reinvestment Act of 2009 (ARRA).

Buy America requirements are applicable to most ARRA funded projects and mandate that contractors involved in infrastructure rebuild must use welding consumables made with steel melted in the U.S.

Lincoln’s Buy America consumables feature the same industry-leading performance as their standard counterparts but are manufactured using green rod melted in U.S. steel mills.

Buy America Products:
• Stick Electrode – Excalibur® 7018 MR, Excalibur® 7018-1 MR
• Flux-Cored Wire – UltraCore® 71C, UltraCore® 71A85, UltraCore® 71A75 Dual
• Submerged Arc Wire – Lincolnweld® L-61 and Lincolnweld® LA-75

To order Buy America products please contact a Lincoln Electric representative.

www.lincolnelectric.com
© The Lincoln Electric Co. All Rights Reserved.

For info go to www.aws.org/ad-index