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WELDING *Journal*

August 2009



WELDING JOURNAL • VOLUME 88 NUMBER 8 • AUGUST 2009

- **Welding for a “Green” World**
- **Developments in Nondestructive Examination of Welds**
- **Essen Welding and Cutting Trade Fair Preview**

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

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On the cover: At Bosch Rexroth's new facility in Nuremberg, Germany, it is anticipated around 300 large gearboxes will be manufactured this year for the latest generation of multimegawatt turbines. (Photo courtesy of Bosch Rexroth.)


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WASHINGTON

WATCHWORD

BY HUGH K. WEBSTER

AWS WASHINGTON GOVERNMENT AFFAIRS OFFICE

Law Enacted to Protect Intellectual Property Rights Abroad

The primary purpose of the Foreign Relations Authorization Act, as the name suggests, is to finance the international activities of the federal government, in particular the U.S. Department of State. But tucked away in the approximately 100-page statute is a provision designed to bolster the enforcement of intellectual property rights of U.S. citizens in other countries.

This law directs the Secretary of State to “ensure that the protection in foreign countries of the intellectual property rights of United States persons in other countries is a significant component of United States foreign policy in general and in relations with individual countries.” To effectuate this goal, the law establishes ten intellectual property attaché positions to serve in U.S. embassies around the world, such embassies to be selected based on which countries have most egregiously denied adequate protection or market access for intellectual property rights.

The Secretary of State is also required to ensure that the U.S. diplomatic presence will have sufficient resources to support enforcement actions in that country against violations of intellectual property rights owned by U.S. persons or companies and to cooperate with the host country to reform its laws, regulations, practices, and agencies to enable that country to fulfill its obligations with respect to the protection of intellectual property rights.

Bill Introduced to Establish Manufacturing Loan Fund

The Investments for Manufacturing Progress and Clean Technology (IMPACT) Act of 2009, introduced in the House and Senate, would establish a two-year, \$30 billion Manufacturing Revolving Loan Fund through which states can assist small and medium-size firms in retooling, expanding, or establishing domestic clean energy manufacturing operations, and improving energy efficiency.

The bill would also drastically increase funding for the Manufacturing Extension Partnership (MEP), a division of the Department of Commerce’s National Institute of Standards and Technology, from roughly \$100 million annually to \$1.5 billion in federal funds over five years, but on the condition that such funds be used to help manufacturers diversify to clean energy markets and adopt innovative, energy-efficient manufacturing technologies.

Legislation to Impact Electrical and Electronics Products

A bill has been introduced in both the U.S. House and Senate aimed at restricting the use of certain materials in the manufacture of electrical and electronics products. The Environmental Design of Electrical Equipment Act (H.R. 2420) would prohibit the manufacture after July 1, 2010, of “electroindustry products” that contain lead, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs) above 0.1% and cadmium above 0.01% at the homogeneous level. The term “electroindustry product” is defined as “any product or equipment that is directly used to facilitate the transmission, distribution, or control of electricity, or that uses electrical power for arc welding, lighting, signaling protection and communication, or medical imaging, or electrical mo-

tors and generators.” The bill may exempt certain products and product categories, including products or equipment designed for use with a voltage rating of 300 V or above, medical diagnostic imaging and therapy equipment and devices, electrical wire and cable products and accessories, and high-intensity discharge lamps.

These standards are intended to equal the maximum concentrations established under the European Union’s RoHS Directive.

Increased Highway, Bridge Funding Sought

The Surface Transportation Authorization Act of 2009, which is moving quickly through Congress, is a six-year \$500 billion bill that would significantly increase federal transportation funding. Among other things, this legislation would provide the following:

- \$337 billion for highway construction, including at least \$100 billion for the National Highway System (including the Interstate System) and bridges;
- \$88 billion from the Mass Transit Account of the Highway Trust Fund;
- \$12 billion from the General Fund for public transit; and
- \$50 billion over six years to finance planning, design, and construction of high-speed rail.

If enacted, this legislation would effect a 38% increase in funding.

House Considers Viability of ‘Green’ Claims

The House Subcommittee on Commerce, Trade and Consumer Protection is considering ways of addressing green marketing practices by businesses. Any number of terms are used to indicate some kind of environmental legitimacy, e.g., “natural,” “biodegradable,” “eco-friendly,” “sustainable,” “carbon-neutral,” “recyclable,” and “non-toxic,” with no uniform standards of what these terms mean and on what basis they may be truthfully employed.

While specific legislation may not be forthcoming providing additional parameters or guidance, it is possible that Congress will direct the Federal Trade Commission to do so. At a Subcommittee hearing held earlier this summer titled, “It’s Too Easy Being Green: Defining Fair Green Marketing Practices,” the Subcommittee chairmen lamented that, “while some responsible companies have created certifications and labels backed by criteria and testing, other companies have spotted an opportunity amidst the consumer demand for information. For a fee, these companies will certify anything as green, affording false comfort to purchasers that the products meet environmental and safety standards.”♦

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PRESS TIME

NEWS

AWS Weldmex Combines with Metalform and Fabtech, Attracts a Crowd at Recent Tradeshow



A symbolic plasma cutting of a metal ribbon across the AWS Weldmex, Metalform Mexico, and Fabtech Mexico entrance officially opened the doors to this well-attended event.

Association (FMA), and the Society of Manufacturing Engineers (SME).

A special opening ceremony brought together AWS President Victor Matthews, PMA President William Gaskin, and FMA Director of Expositions Mark Hoper, along with Mexican dignitaries, who all shared in greeting the waiting crowd.

"We achieved our goal of making this a true national show with more than 30% of the attendance coming from outside of Monterrey including 15% from Mexico City and the south," said Chuck Cross, show manager. In addition, there were also attendees from the U.S., Canada, and other Latin American countries.

The event will be held next year May 11–13 in Mexico City.

North American High Performance Ceramic Coatings Market to Reach \$1.8 Billion by 2012

Global Industry Analysts, Inc., San Jose, Calif., has released "High Performance Ceramic Coatings — A North American Market Report." Thermal spray represents the largest segment in this market; the technology segment is also expected to retain its dominance by 2015. Chemical vapor deposition makes up the second largest segment, and physical vapor deposition is expected to have the fastest growth over the period 2006–2015. Additionally, revenues for high-performance ceramic coatings in North America are projected to reach \$1.8 billion by 2012.

Bayou Receives Contract in Connection with Fayetteville Express Pipeline Project

The Bayou Companies, Inc., a subsidiary of Insituform Technologies, Inc., Chesterfield, Mo., has been awarded a \$27.6 million contract with ILVA S.p.A. for welding, pipe coating, and logistical support services. ILVA is manufacturing and transporting pipe for installation on the Fayetteville Express Pipeline, which will originate in Conway County, Ark., and terminate at an interconnect with Trunkline Gas Co. in Panola County, Miss. In particular, Bayou's work on the project will include coating and double joint welding of approximately 185 miles of 42-in. pipe.

American Foundry Society and North American Die Casting Association Combine Government Affairs Efforts

The American Foundry Society board of directors has approved combining its federal government affairs services with the North American Die Casting Association. This collective effort will entail a coordinated, joint federal advocacy effort while maintaining each groups status as separate organizations and be called the Metalcasters Alliance for Government Affairs. A Web site has even been created at www.metalcastinggov.com.

A record of more than 6100 attendees came to see the latest technology in welding, fabrication, and metalforming at the AWS Weldmex, Metalform Mexico, and Fabtech Mexico exhibition in Monterrey, Mexico, June 2–4. The event attracted 73% first time attendees, which is also a record.

For the first time this exhibition combined two existing shows, AWS Weldmex and Metalform Mexico, as well as a new event, Fabtech Mexico. The exposition is sponsored by the American Welding Society (AWS), the Precision Metalforming Association (PMA), the Fabricators and Manufacturers

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EDITORIAL

The 'Green' Dilemma

"It isn't easy being green," sang Muppet Kermit the Frog on an episode of *Sesame Street*. Now, Kermit was singing about his green-colored skin rather than today's "green" environmental movement, but the sentiment applies. It isn't easy being green, either for companies or individuals who wish to help improve the environment or at the least do as little harm as possible. There's information out there, but some of it is confusing, or conflicting, or it just adds steps to our already too-full lives.

Think about your own households. You've probably asked yourself some of the same questions that I have when trying to follow today's three Rs of reduce, reuse, and recycle. Do the benefits of recycling a peanut butter jar and keeping it out of a landfill outweigh the amount of water I must use to clean it prior to putting it into the recycling bin? I know that compact fluorescent bulbs save electricity, but they contain mercury and so need to be disposed of properly. But nowhere on the packaging does it tell me how to do that, so what do I do? I want to get rid of those half-empty paint cans in my garage. I know that I shouldn't just put them in the trash, but instead need to take them to a special collection center. That will take about three hours out of my time, time that I don't really have to spend. So what do I do?

If there's that many questions about activities in an average-sized U.S. home, how many more will there be for a manufacturing facility or for issues that cross large expanses of geography? For instance, wind power is a green technology. But if we place that wind tower out in a rural area, how do we move the power it generates to the urban area where it is needed? And if we build more power-generation infrastructure, what impact will that have on the environment?

This issue of the *Welding Journal* focuses on how welding is involved with green manufacturing. Four feature articles cover green issues including one by Associate Editor Kristin Campbell, who profiles a company that has the technology to turn waste into a gas for welding, cutting, and other uses. Two other feature articles discuss issues related to nondestructive examination. NDE can also be considered green technology because no parts are destroyed when they undergo testing.

While green issues are getting plenty of attention these days, green isn't really new. The conservation movement began in the United States and other countries in the late 19th century. This political, social, and scientific movement sought to protect natural resources including plant and animal species and their habitats for the future. The conservation movement led to the establishment of the U.S. national park system and our forest reserves, among other things.

The end of the 1960s saw establishment of the global ecology movement, which was spurred by an acknowledgment of an ecological crisis on our planet. In the 1960s and 1970s there was concern over nuclear weapons and nuclear power, acid rain was an issue in the 1980s, deforestation and ozone depletion were hot-button items in the 1990s, and today we're worried about climate change and global warming. Today, the green movement supports, among other things, environmentally friendly products as opposed to those that pollute or harm the environment.

The public's interest in environmental issues fluctuates — sometimes because of such superficial reasons as the price and availability of gasoline. I believe conservation, ecology, and green must be more than buzzwords. They need to be philosophies individuals and companies live by. It may not be easy being green, but if we want to protect our resources and environment for future generations it's necessary that we make the effort.



Mary Ruth Johnsen
Editor, *Welding Journal*



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NEWS OF THE INDUSTRY

Advances Take Shape in Manufacturing for a “Green” World

Bosch Rexroth Expands Wind-Power Capacity with New Plant



Bosch Rexroth's facility in Nuremberg, Germany, manufactures large gearboxes for the latest generation of multimegawatt wind turbines. Designers and engineers must consider many technical requirements in developing these drive systems such as operating environment and wind loads, durability, output efficiency, noise, size, weight, and serviceability.

Bosch Rexroth has expanded its capacity for producing large wind-turbine gearboxes by opening a facility in Nuremberg, Germany. The plant covers a surface area as large as five football fields and will manufacture around 300 large gearboxes in 2009 for the latest generation of multimegawatt turbines. Approximately \$246 million will be invested in it by 2013.

The company also produces large wind-turbine gearboxes in Witten, Germany, and Beijing, China, and intends to expand its U.S. presence for this industry in the near future.

“The long term forecasts continue to predict global growth for the wind-power market,” said Reiner Leipold-Büttner, member of the executive board, responsible for engineering and manufacturing at parent company Bosch Rexroth AG.

In addition, the company has acquired a majority share in IGUS ITS GmbH, a manufacturer of condition monitoring systems for wind energy plants. The brochure, *Drive & Control Technology for Wind Turbines*, is available for free download at www.boschrexroth-us.com/Sustainable.

Energy Academy Expands at Kalamazoo Valley Community College

The Wind Energy Center at Kalamazoo Valley Community



Tom Sutton (left) and Greg Meeuwssen prepare to remove a generator from a wind turbine during training this spring in Germany. What these instructors learned will help them teach students at Kalamazoo Valley Community College's new Wind Energy Center.

College (KVCC) in Michigan will launch a 26-week training academy starting in October. Fifteen students will be selected for its inaugural class. More details on this program can be found by visiting www.mteckvcc.com/windtechacademy.html.

The college's Wind Turbine Technician Academy is certified by Bildungszentrum fur Erneuerbare Energien (Renewable Energy Education Center), a trainer for wind turbine technicians across Europe.

According to James DeHaven, vice president for economic and business development at KVCC, the training model allows graduates to earn two credentials. Participants will complete the classroom content associated with preemployment, electrician apprenticeship programs, and wind turbine technician competencies. The last three weeks will be spent in a practical experience on a wind farm as a requirement for certification.

Tom Sutton will be the academy's mechanical instructor, and Greg Meeuwssen will serve as electrical instructor.

U.S. Representative Fred Upton and Senator Debbie Stabenow are also seeking a \$2.5 million federal grant to allow KVCC to purchase additional training equipment.

Apollo Alliance Joins Ohio Senator to Introduce Clean Energy Manufacturing Bill

U.S. Senator Sherrod Brown of Ohio, joined by Apollo Alliance Chairman Phil Angelides and other notable business, labor, and clean energy leaders, has introduced the “Investments for Manufacturing Progress and Clean Technology (IMPACT) Act of 2009.” This bill would put America's manufacturing sector on the road to recovery by facilitating the development of domestic clean energy manufacturing and production.

“It is critical that Congress enact legislation that provides direct and substantial investment in clean energy component manufacturing to ensure that jobs are created in the U.S., and to wean us from our dependence on other nations to meet our energy needs,” said Angelides.

The IMPACT Act would also provide resources for small- and medium-sized manufacturers through a 2-year, \$30 billion man-



The new "Investments for Manufacturing Progress and Clean Technology (IMPACT) Act of 2009" would advance U.S. energy security by investing in domestic clean energy manufacturing. Shown are two members of the International Brotherhood of Electrical Workers (IBEW) assembling photovoltaic modules at the Sharp Electronics plant in Memphis, Tenn. (Photo courtesy of IBEW.)

ufacturing revolving loan fund. The Apollo Alliance estimates that, once enacted, the bill will create 680,000 direct manufacturing jobs and nearly 2 million indirect jobs over five years.

Career Day Promotes Welding as a 'Gold Collar' Job



At South Texas College's First Welding Gold Collar Career Day, held recently in conjunction with the American Welding Society, activities included a trade show for employers to discuss the benefits of their companies and industries, welding and new technology demonstrations, as well as guest speakers. A student (pictured above) uses a semiautomatic welding process with the assistance of a turntable. More than 350 students and community members attended this event to discover what a future in welding offers. The college's Welding Technology Program, chaired by Ricardo Salinas, consists of ten classes and labs covering four welding processes and safety.

FPL Next-Generation Solar Energy Centers Underway

Florida Power & Light Co. (FPL) is proposing to construct and operate three solar energy projects at diverse locations throughout Florida. Together, these centers would provide customers with renewable energy that could reduce greenhouse gas emissions and decrease fossil fuel usage.

The DeSoto Next Generation Solar Energy Center will bring commercial-scale solar photovoltaic power to Florida, use 90,000

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photovoltaic panels on 180 acres of land, and provide enough electricity to power more than 3000 homes.

The Martin Next Generation Solar Energy Center, a hybrid solar facility to combine a solar-thermal field with a combined-cycle natural gas power plant, will consist of approximately 180,000 mirrors over roughly 500 acres of land at the existing FPL Martin Plant location. It will provide enough power to serve about 11,000 homes.

Plus, the company will build a Space Coast Next Generation Solar Energy Center at NASA's Kennedy Space Center.

Aluminum Industry Launches Green Building Initiative

International Aluminum Institute Chairman Artem Volynets recently announced a new green architecture Web site at green-building.world-aluminium.org. It features some of the world's leading architects and their designs for green buildings utilizing aluminum applications in innovative ways; provides credible and accurate life cycle data; and has detailed cases to illustrate aluminum's performance in six key areas. The Aluminum Association Chairman Kevin Anton said its Building & Construction Committee was proud to partner with global aluminum associations to develop this site and future sustainability initiatives.

Manufacturing Ranked No. 1 Industry for Economic Prosperity

Public Viewpoint on Manufacturing, a new annual index released by Deloitte LLP and The Manufacturing Institute, shows Americans view manufacturing as the most important industry

for a strong national economy.

The majority of respondents (71%) view manufacturing as a national priority with 59% agreeing that the United States manufacturing industry effectively competes on a global scale. When asked what industry they would most want to have creating jobs in their community, respondents listed manufacturing as their top choice. However, the index shows they are not pursuing careers in manufacturing.

Also, the majority (77%) believe that the United States needs a more strategic approach to develop its manufacturing base, and 74% said the United States should further invest in manufacturing industries. The public further sees technology use and availability (77%), skilled workers (74%), and energy availability (72%) as resources giving the nation its competitive edge.

'The Economic Report' Show to Feature Aquasol Corp.

The Economic Report producers recently announced Aquasol Corp., North Tonawanda, N.Y., will be featured in an upcoming episode as part of the show's Environmental Impact series on 21st Century Practices for a Sustainable Future. The company manufactures water-soluble paper; applications for these types of products range from packaging and entertainment to financial and welding industries.

Girls Learn about Welding and Electronics at 'SWeETy' Camp

Calhoun Community College, Decatur, Ala., recently hosted its third annual Summer Welding and Electrical Technology

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High school student Tiffany Ferguson tries her hand at welding during the latest Summer Welding and Electrical Technology event that allows girls to gain technical skills.

(SWeTy) camp. The week-long, free event sparks area high school girls' interest in these high-tech careers. In addition, it helps students develop problem-solving skills and teamwork as they participate in instructor-led projects, field trips, and interact with women role models during industry-sponsored lunches.

Camp coordinator Gwen Baker mentioned participants agree this SWeTy camp is a fun and educational experience. "By introducing these career options to young women still in high school, we hope to guide them early on into the math and science courses they will need to prepare them for earning a degree or certificate in these high-demand, high-paying fields," said Jim Swindell, associate dean for technology education at Calhoun.

The camp continues to be successful through the support it receives each year from the local chamber of commerce and area business and industry.

Industry Notes

- **Laboratory Testing Inc.**, Hatfield, Pa., has been reaccredited for nondestructive examination by PRI/Nadcap for liquid penetrant, magnetic particle, and ultrasonic inspection methods.
- Celebrating its 60th anniversary this year is **Space-Ray**, Charlotte, N.C. The company currently offers a broad infrared heater product line in the industrial heating market.
- **Praxair China** has signed a contract with Nanjing Puzhen Rolling Stock Works for the supply of liquid argon to be used for welding processes during vehicle production.
- To better serve users needing high-pressure water jet units, accessories, and service, **NLB Corp.** has relocated its Houston-area branch to a new 10,800-sq-ft facility in LaPorte, Tex.
- **P&G Steel Products Co.**, Buffalo, N.Y., has been awarded a national Safety and Health Achievement Recognition Program honor by the Occupational Safety & Health Administration.
- An online virtual factory tour including images and videos for **Plouse Precision Manufacturing**, Harrisburg, Pa., can be found by visiting PlouseManufacturing.com/Tour.



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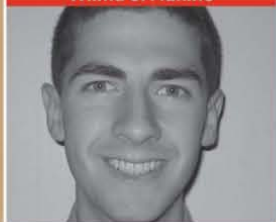
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Wilma J. Adkins**

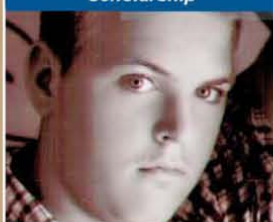


Adam Truog

The Ohio State University
Welding Engineering

"I am grateful to be the recipient of the Howard E. and Wilma J. Adkins Scholarship. I would like to thank the AWS Foundation for their continued support of students and their commitment toward higher education in welding related fields. This award will assist me in furthering my education at The Ohio State University in welding engineering."

**Airgas – Jerry Baker
Scholarship**



Bradley W. Feight

Pennsylvania College of Technology
Welding and Fabrication Engineering
Technology

"I would just like to say that it is a privilege to be awarded the Airgas – Jerry Baker Scholarship. I would like to thank everyone who provided funding to make this scholarship possible. I would also like to thank my family, friends, and professors for pushing me to do my best."

**Airgas – Terry Jarvis
Memorial Scholarship**



Scott Allen

Weber State University Manufacturing
Engineering – Welding Emphasis

"I would like to thank Airgas for their generosity in my educational pursuit as a welding engineer at Weber State University. Their contributions have helped me to focus on school while also developing valuable leadership opportunities in extra curricular activities. Because of Airgas and AWS, I will continue to strive for excellence in education, leadership, and work experience. It is because of these two parties I am able to continue and excel as a future Welding Engineer. Thank you very much for your support."

**Arsham Amirikian
Engineering Scholarship**



Daniel G. Talbot

Weber State University Manufacturing
Engineering – Welding Emphasis

"I would like to express my sincere appreciation in being this year's recipient of the Arsham Amirikian Engineering Scholarship. It is an honor for me to be recognized by the AWS and I would like to extend my gratitude for giving me this award. This will assist me in furthering my education at Weber State University as a Manufacturing Engineer with a Welding emphasis."

**Edward J. Brady
Memorial Scholarship**

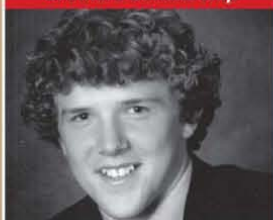


Stephanie J. Irvine

Pennsylvania College of Technology
Welding and Fabrication Engineering
Technology

"Once again in my time of need the AWS has provided me the funding necessary for me to continue studying at PCT. Great honor is bestowed upon me by receiving the Edward J. Brady Memorial Scholarship. I offer my gratitude to the donor, AWS, my parents and everyone else who has put faith in my ability to achieve great things. I want to say just simply thank you and none of this is possible without any of you."

**William A. and Ann M.
Brothers Scholarship**



Brian D. Love

The Ohio State University
Welding Engineering

"I am honored to have been selected, by the AWS selection committee, to receive the 2009-2010 William A. and Ann M. Brothers Scholarship. I am very thankful for the AWS Foundation, as well as all who are involved with the Brothers Scholarship, for the financial support to achieve my goal of becoming a Welding Engineer."

**Donald F. Hastings
Scholarship**

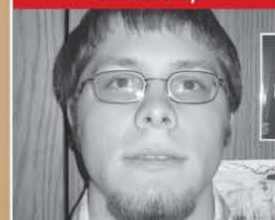


Boris Shneyder

The Ohio State University
Welding Engineering

"What an enormous honor it is to be the 2009-2010 Donald F. Hastings Scholarship recipient! I am indebted to the Hastings family for assisting me and continuing financial support of welding engineering studies in general. Also, I would like to thank AWS Foundation for their help and betterment of welding studies across the country and around the world."

**Donald and Shirley Hastings
Scholarship**



Kenneth A. Bean, Jr.

LeTourneau University Materials
Joining Engineering Technology

"Being selected for an AWS Foundation National Scholarship is truly a privilege. Since funding educational pursuits is a challenge, scholarships like this provide relief. I would like to thank the Hastings Family for their contribution, specifically. I would also like to thank all the individuals and families that have worked hard and sacrificed to provide this support to students, even more so in these trying economic times. And let our identity not rest in economic failure or success, but rather in God upon whom this great nation was founded. - Psalm 119."

**Miller Electric Mfg. Co.
Scholarship**



Steven Hart

Ferris State University
Welding Engineering Technology

"Receiving the Miller Electric Mfg. Co. Scholarship is truly an honor. I would like to thank the American Welding Society for their continued support for undergraduate students across the country trying to continue their careers in the welding industry and also Miller Electric for selecting me as the recipient of this scholarship."

**Miller Electric Mfg. Co.
Scholarship**



Brian J. Peterson

Ferris State University
Welding Engineering Technology

"This scholarship will play a huge role in the advancement of my welding studies. Welding is a huge part of everyday life and if it wasn't for Miller Electric and people from the AWS, I wouldn't be able to study and try and help the advancement of everyday welding. I would like to thank again anyone who took part in the decisions for the AWS national scholarships, with your help it makes not only mine but many other futures much more achievable."

**Past Presidents
Scholarship**



Westley Smith

Pennsylvania College of Technology
Welding and Fabrication Engineering
Technology

"It is a true honor and privilege to be the recipient of the Past Presidents scholarship. I am thankful to everyone who is involved in making the Past Presidents scholarship possible. I would also like to thank the American Welding Society for their continued dedication to the strengthening of the welding industry. Your contribution to my education will not be forgotten."

**Robert L. Peaslee –
Detroit Brazing and Soldering
Division Scholarship**



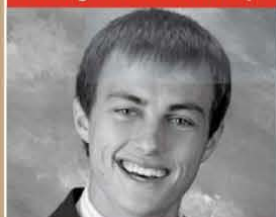
Thomas B. Reynolds

University of California at Berkeley
PhD. in Materials Science and
Engineering

"I am incredibly grateful to be chosen as a recipient of the Robert L. Peaslee - Detroit Brazing and Soldering Scholarship. I would like to thank AWS for their support and helping me to further my research in metal-ceramic joining processes."

National Scholarship Recipients

Jack R. Barckhoff Welding Management Scholarship



Michael Eff

The Ohio State University
Welding Engineering

"I would like to thank the AWS Foundation and Jack Barckhoff for their commitment to furthering joining technology through education and for selecting me for this award. I am thankful for this opportunity to further my education in joining technology and welding."

Jack R. Barckhoff Welding Management Scholarship



David G. Fosnaugh

The Ohio State University
Welding Engineering

"I am very honored to be the recipient of the 2009-2010 Jack R. Barckhoff Welding Management Scholarship. I greatly appreciate the AWS Foundation's commitment to the future of welding and look forward to my career in the industry."

D. Fred and Marian L. Bovie Scholarship



Brett J. Bercaw

The Ohio State University
Welding Engineering

"It is a great privilege to be selected to receive the D. Fred and Marian L. Bovie Scholarship. I would like to thank the American Welding Society Foundation for their generosity and support. This scholarship will greatly assist me in reaching my educational goals."

Each year, the American Welding Society Foundation provides scholarship funds to help hundreds of students who otherwise would be unable to afford a welding education. We are the only industry foundation with the specific mission of helping to fund the education of welding students. In so doing, we create the careers that sustain and grow our industry.

We get these funds from your contributions. The more you contribute, the more students we can help educate.

To make a scholarship contribution or to set up your own District, Section or National Named Scholarship, contact Sam Gentry at the AWS Foundation.

Call **800-443-9353, x331**, or email to sgentry@aws.org.

Thank you for your continued support.



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William B. Howell Memorial Scholarship



Travis S. Woiderski

Ferris State University
Welding Engineering Technology

"I am truly honored to be the recipient of the William B. Howell Memorial Scholarship. I would like to thank the American Welding Society for all of their generosity. They have helped me out greatly over the past few years, and the help is indeed appreciated. I would also like to thank all of the Welding Faculty at Ferris State University for all that they have done for me."

John C. Lincoln Memorial Scholarship

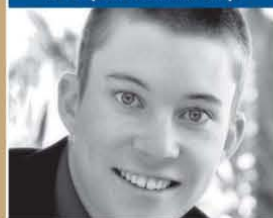


William Tomich, Jr.

The Ohio State University
Welding Engineering

"I am proud to be the recipient of the John C. Lincoln Memorial Scholarship; it is an honor to receive an award that is dedicated to an individual whose legacy is such a large part of welding history. I would like to thank the AWS Foundation and The Lincoln Electric Company for their financial support and for their investment in the future of the welding industry; your generosity is greatly appreciated and will not be forgotten."

Matsuo Bridge Company Ltd. of Japan Scholarship

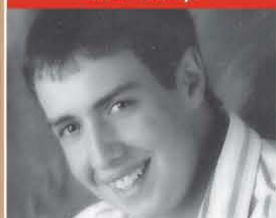


Reuben Brooks

LeTourneau University
Materials Joining Engineering

"I would like to thank the Matsuo Bridge Company and the American Welding Society for the generous support of my education. As I move closer to my undergraduate degree, I am looking forward to moving to the next level, whether to graduate school and/or to my eventual career. This award is a bridge that allows me to continue on the journey towards my career."

Praxair International Scholarship

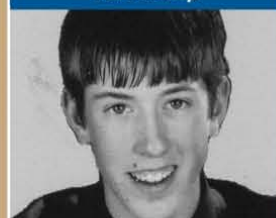


Lucas Crumley

The Ohio State University
Welding Engineering

"I am extremely honored to receive Praxair International Scholarship. I would like to thank Praxair and the AWS Foundation for all of their support. I would like to thank the committee for selecting me and helping me further my education in Welding Engineering."

RWMA Scholarship



Eric J. Koster

Ferris State University
Welding Engineering Technology

"I am very grateful to the AWS Foundation for awarding me the RWMA scholarship and to my professors at Ferris who challenge me everyday and support my growing interest in welding. I am excited for the upcoming years in the welding industry and greatly appreciate the support from the AWS Foundation for assisting me in the attainment of my educational goals."

AWS International Scholarship



Vahid Firouzdar

University of Wisconsin - Madison
PhD in Materials Engineering

"I would like to extremely express my appreciation to the AWS Foundation and its supporting companies for awarding me the AWS International Scholarship. It is a great honor and a big encouragement for me to continue my research in Welding."



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LETTERS TO THE EDITOR

Detail About Apollo 10 Mission Garners Attention

A reader shares his thoughts on a recent article, "Those Were the Days," consisting of write ups from Omer W. Blodgett, August F. Manz, and Gerald D. Uttrachi about welding in the 1940s, 1960s, and 1980s.

I thoroughly enjoyed reading August F. Manz's piece, "The 1960s: New Processes Help Welding Expand," in the June 2009 issue of the *Welding Journal*. However, being a history buff, I couldn't help but notice a slight error in the chronological list of events shown on page 53. Specifically, Apollo 10 was launched to the moon in May 1969, not 1965 as stated in the article. A more significant milestone was Apollo 8, which was the first manned vehicle to orbit the moon in December 1968. Of course, the first manned lunar landing was Apollo 11 in July 1969.

Paul H. Nordeen
Welding Technician
Dart Container Corp.

Historical Welding Story Gets Appreciated Once More

The letter below also refers to the article, "Those Were the Days," which this reader especially liked along with the rest of the Welding Journal's June 2009 issue.

I am 58 years old and have been practicing as a mechanical engineer for 37 of those years. While attending college as an undergraduate, I came upon some books the library was discarding. One of these was a 1940 or 1941 edition of *Studies in Arc Welding*. I recall reading Omer Blodgett's name and studies of weldments he had been involved with the design of. I kept that book and have it some 40 years later. I really enjoyed reading the article "Those Were the Days" and making the connection to Omer Blodgett, still active in the field some 60 years later.

The article made me realize that while I might not have the years of experience Mr. Blodgett has, I, too, have seen many changes. I started as a "green" engineer

with Bechtel Power Corp. on field power plant construction sites. I was assigned to field design quite a bit of carbon steel pipe and had a great deal to learn. The crafts taught and made me into a real engineer, aside from keeping me safe on the job. Back then, in 1972, field run piping was welded using direct current (DC) shielded metal arc welding (SMAW). The welding power supplies were all motor-generators on that first job with a few engine-driven Lincoln machines as well. The pipefitters began teaching me to weld and to cut with a torch when time permitted.

I moved on to a nuclear site in 1973, where rectifier machines were the prevailing power supply. There were two welding processes in use then: DC SMAW and scratch-start gas tungsten arc welding. On that job, the pipefitters and boilermakers used to take me in the welding test booths at lunch and teach me to weld.

I worked a few more power plant jobs in the U.S. and then opted for overseas work. I did a few jobs in South America where I designed small power plants based on used medium-speed diesel generators. My last such job was to design and oversee construction of a wood-fired steam power plant for a sawmill in Paraguay. I designed the plant based on soil conditions for the foundations and what materials, equipment, and crafts were available. Welding equipment initially consisted of a Lincoln SA machine we started with a hand crank. As we got to welding more, we needed a second machine, and the only one available was home made. This consisted of a Brazilian-built welding generator belted to a one-lung air-cooled diesel and took three men to start it.

Afterward, I returned stateside and re-joined modern times. I've been with the New York Power Authority these last 27+ years on hydroelectric work. In that time, I've watched welding equipment and processes evolve at what seems an ever faster rate. Nowadays, it seems the welding power supplies are incredibly sophisticated with all the modes and parameters that can be controlled. Perhaps the most impressive thing to me are the new inverter power supplies.

I'm nearing retirement from my formal employment, but I still enjoy my work. As an AWS Certified Welding Inspector, I get to keep a hand in welding quite literally, and it also keeps me current with advances in the equipment and practices. Thanks for the fine article and making the connection with Omer Blodgett after my reading of his work some 40 years earlier.

J. M. Michaels, P.E.

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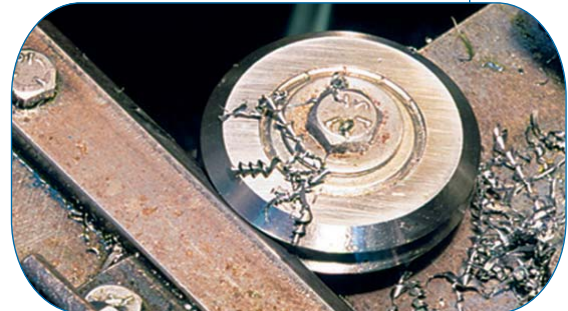
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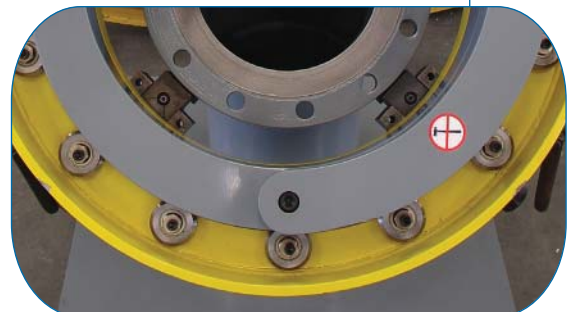
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ALUMINUM

Q&A

Q: I am about to move into the welding of aluminum components. I am looking at acquiring some new gas metal arc welding (GMAW) machines and want to ensure that I select the most appropriate equipment. I will be welding aluminum sheet starting at around $\frac{1}{8}$ in. thickness and up to $\frac{1}{4}$ in. In the past I have used short-circuit transfer for welding steel sheet of this thickness, but I have been informed that this may not be the best solution for aluminum. Is the selection of metal transfer mode to be used for aluminum any different than that for steel, and if so, what is the preferred mode of metal transfer to be used when welding aluminum?

A: We should start with some definitions.

Mode of Metal Transfer — the manner in which molten metal travels from the end of a consumable electrode across the welding arc to the workpiece.

In GMAW, the type of metal transfer employed is usually determined by the thickness of the material being welded and the size of the welding electrode being used, and it is directly influenced by the current setting and shielding gas type employed during welding.

The principal modes of metal transfer are defined as follows:

Short Circuiting Transfer — metal transfer in which molten metal from a consumable electrode is deposited during repeated short circuits.

This metal transfer, which is sometimes known as short arc or dip transfer, has been perfected for and is most widely used in the welding of steels; to a much lesser degree, it is sometimes used for the welding of thin-gauge aluminum. This metal transfer is achieved by using low currents and voltage as well as small-diameter wires. The primary characteristic of this metal transfer is the frequent shorting of the welding wire to the workpiece. This short circuiting often takes place at a rate of around 200 times/s. When produced with the correct equipment, this transfer mode can provide a very stable arc of low energy and heat input. The emphasis here is on the correct equipment, a power source with the correct amount of slope, and inductance. All power sources are not created equal when it comes to their ability to produce acceptable arc characteristics for short circuit transfer. When evaluating the suitability of short circuit transfer for use on aluminum, we need to recognize the low energy and heat characteristics of this transfer mode. One of the primary differences

BY TONY ANDERSON

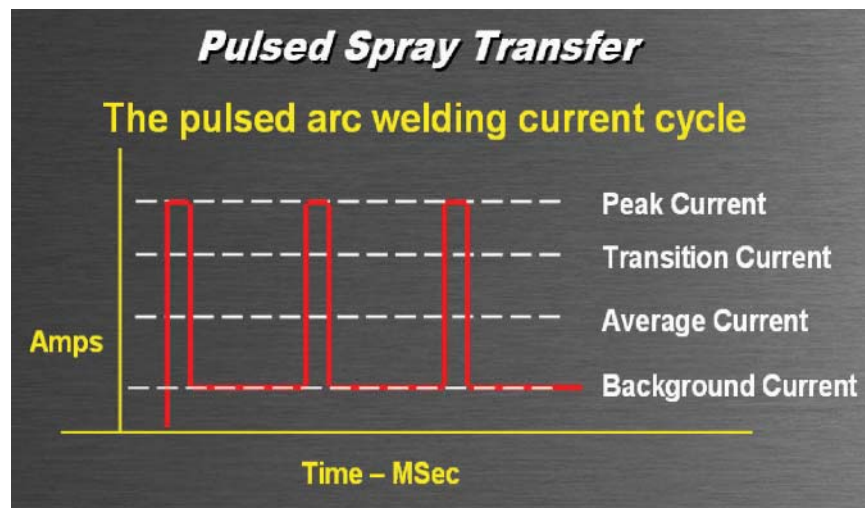


Fig. 1 — The basic current cycle for pulsed spray transfer.

between steel and aluminum is their thermal conductivity; the thermal conductivity of aluminum is close to six times greater than that of steel. I am aware of some applications that have successfully used the short circuit transfer for welding aluminum. However, I would be reluctant to recommend this mode of metal transfer without first considering the potential for incomplete fusion when used on aluminum. I believe it is reasonable to say that the short circuit transfer is generally not recommended for GMAW of aluminum and has in the past been identified as such in technical publications and welding specifications.

Globular Transfer — the transfer of molten metal in large drops from a consumable electrode across the arc.

This transfer mode is not considered for welding aluminum and is most predominantly seen when welding carbon steel with CO₂ shielding gas. This transfer mode is characterized by large amounts of weld spatter and a general lack of arc stability.

Spray Transfer — metal transfer in which molten metal from a consumable electrode is propelled accurately across the arc in small droplets.

When using argon or an argon-rich shielding gas with the GMAW process, we can produce the spray transfer mode. When we increase current to beyond the globular-to-spray transition current, the metal transfer moves into spray transfer. Table 1 shows globular-to-spray transition currents for a selection of aluminum electrode diameters for welding aluminum. The spray transfer is a result of a pinch ef-

Table 1 — GMAW Globular-to-Spray Transition Currents for a Selection of Aluminum Electrode Diameters for Welding Aluminum

Wire Diameter in. (mm)	Shielding Gas	Spray Arc Transition Current
0.030 (0.8)	100% Argon	90 ± 5 A
0.035 (0.9)	100% Argon	110 ± 5 A
0.047 (1.2)	100% Argon	135 ± 5 A
0.062 (1.6)	100% Argon	180 ± 5 A

fect on the molten tip of the consumable welding wire. The pinch effect physically limits the size of the molten ball that can be formed on the end of the welding wire, and therefore only small droplets of metal are transferred rapidly through the welding arc from the wire to the workpiece. The droplets produced in the spray transfer mode are equal to or smaller than the diameter of the wire being used. This transfer mode is characterized by its high heat input, very stable arc, smooth weld bead, and very little, if any, spatter.

Because spray transfer has a very high heat input that can overcome aluminum's high thermal conductivity, the spray transfer mode is recognized as the preferred mode of metal transfer for welding aluminum with the GMA process.

Making the Choice

The selection of the most suitable metal transfer for your application is

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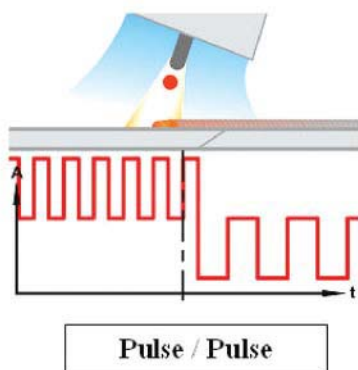


Fig. 2 — The pulse/pulse process offers the prime advantage to more precisely control the heat input.

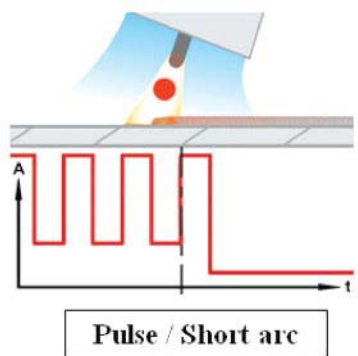


Fig. 3 — The pulse/short arc process enables full control of the heat input for thin-sheet welding.

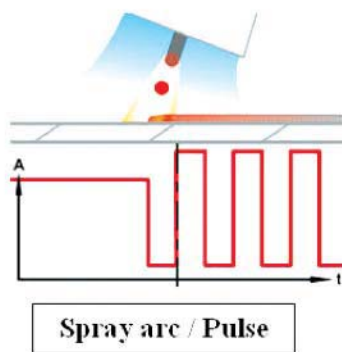


Fig. 4 — Spray arc/pulse provides an efficient process in positional welding of thicker materials.

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somewhat dependant on the size of the parts being welded and the types of joint design being used. Larger components with well-fitted fillet welds may be welded successfully with regular spray transfer. However, smaller parts in the thinner material, with poor fitup particularly in butt joint welds, may prove challenging to accomplish with this transfer mode without overheating and burning through.

One option that may be worthy of consideration is the pulsed spray transfer.

Pulsed Spray Transfer — an arc welding process variation in which the current is pulsed in order to use the advantages of the spray mode of metal transfer at average current equal to or less than the globular to spray transition current.

This transfer variation is sometimes a suitable compromise between the low heat input short circuit transfer, which is susceptible to fusion problems when used on aluminum, and the high heat input spray transfer, which may prove to be too hot to handle on some thinner-material applications.

Pulsed spray transfer is a modified form of GMA spray transfer welding that produces a controlled and periodic melting off of droplets projected across the arc. This process allows spray transfer welding at average currents that are considerably lower than the current necessary for regular spray transfer welding. The pulsed spray process allows welding of thin sheet that would be melted through by the standard spray transfer. In the pulsed spray process, the filler wire is heated by a background current, and the end of the wire may start to melt into a drop. When the high current pulse occurs, the drop melts completely and is propelled, by the arc pinch effect, directly from the wire to the weld pool. The pulsed spray transfer mode will typically provide deeper penetration and better root fusion than short circuit transfer, and it is often the preferred choice for welding thinner material.

With the introduction of solid-state devices and computers, pulse current power supplies are designed so that the pulsing rate can be varied over a wide range, and the width of the pulse can be varied independently of the pulsing rate. The magnitude of the background and pulse current can be adjusted independently of one another providing the opportunity to develop pulse programs that can accommodate many welding applications. Figure 1 shows the basic current cycle for pulsed spray transfer. Basic pulsed spray transfer has been around for many years, originally developed by Airco in the late 1950s. More recently, some very imaginative variations of this technology have

been developed that involve multiple pulse programs operating together and pulsing within various metal transfer modes. With today's more sophisticated pulsed GMAW equipment, it is possible to weld very thin aluminum sheet, and if required, even provide the weld with an appearance close to that produced by the gas tungsten arc welding process.

Figure 2 displays the pulse/pulse process. The prime advantage of this is the ability to more precisely control the heat input. Pulse/pulse is a well-established process and has mainly been focused on aluminum welding.

Figure 3 illustrates the pulse/short arc process that enables full control of the heat input for thin-sheet welding and has even been used for the root run on pipes.

Lastly, Fig. 4 highlights spray arc/pulse, an efficient process in positional welding of thicker materials. It provides additional control over conventional spray transfer. ♦

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BRAZING

Q&A

Q: We are torch brazing brass to 304 stainless steel using a silver solder containing 50% silver. With the price of silver so high, and with increasing pressure to be competitive, we'd like to change to a less expensive solder. It would be nice if we could eliminate the silver entirely. What do you recommend?

A: The first thing I'd like to address is the term, "silver solder." Historically, there have been many terms used for brazing alloys. In the jewelry industry, for example, the terms Easy, Medium, and Hard were used to describe a series of silver-copper-zinc alloys with varying melt ranges. For the joining process, terms such as hard soldering, soft soldering, and silver soldering have been used, to name a few.

The term silver solder was given to braze material that contains silver and is low in melt temperature compared to high-temperature alternatives such as bronzes and brasses. They bear no resemblance to materials we think of as solders, such as the tin-lead series, but, because they are easier to use, their low tempera-

ture made them seem like solder. Thus the term silver solder.

This has led to confusion between what is a braze and what is a solder. Adding to it, many new plumbing solders are tin based with additions of silver. Consequently, AWS established a standard term to describe all metals used to produce a braze joint. The term is, "brazing filler metal." It is defined as a metal, used to make a joint, with a liquidus temperature above 840°F (450°C). If it has a liquidus temperature below 840°F, it is called a, "soldering filler metal."

It may sound like a confusing way to eliminate confusion but there is a simple fact that helps make it easier to deal with. There are very few commercially available filler metals with melting ranges that overlap 840°F. It's in a sort of no man's land of filler metals. Simply put, chances are that if you melt your filler metal below 840° F you are soldering and if above that, you are brazing.

In this application, the main constraints you are up against are the melting point of the brass and the performance re-

quirements of your joint. The brass was probably chosen because it is easily machined and is a relatively common and inexpensive material. The stainless steel was most likely selected for strength and corrosion resistance.

You did not identify the brazing filler metal that you are using but, with 50% silver, I would expect it to be either AWS A5.8 BAg-3 or BAg-24. The former contains cadmium and the latter is cadmium-free. Either is a standard selection for low-temperature brazing of 300 Series stainless steels, although the health hazards associated with using the BAg-3 cadmium-bearing filler metal has greatly reduced its use. (Refer to ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, or the *AWS Brazing Handbook* for more details). Each of these has an alloying addition of nickel. This provides better wetting of the stainless, improved joint strength, and enhanced resistance to interface corrosion.

In addition, these brazing filler metals are about as low in temperature as you can

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go while still being defined as brazing. The melt range of the BAg-3 is 1170°–1270°F (632°–688°C) and 1220°–1305°F (660°–707°C) for the BAg-24. These low melt ranges provide added rationale for brazing with silver brazing filler metal. The energy usage is less than with higher-temperature filler metals, the lower process temperatures allow for greater throughput and the heat effects are reduced.

One approach is to convert to a silver brazing filler metal with a lower silver content. For stainless steel, you want to stay with a filler metal containing a nickel addition and that is compatible with torch brazing. You could consider BAg-4 with 40% silver and a melt range of 1240°–1435°F (671°–779°C) or BAg-26 with 25% silver and a melt range of 1305°–1475°F (707°–800°C). You go up in brazing temperature but reduce silver content.

Be sure to consult with your braze consumables supplier before you make any assumptions on savings however. It may not provide the cost savings you assume because the production quantities of these al-

ternative filler metals may be far less than the standard filler metal you are currently using. There may be a volume effect to the pricing. Some are more difficult to manufacture which can also add to their cost.

Keep in mind, the higher you go in temperature, the higher your energy costs, the more heat effect on your parts, the longer the cycle time, and you will probably have more cleaning headaches. There will also be process changes required to use the higher-temperature filler metal. In general, the lower the temperature and the tighter the melt range of a silver brazing filler metal, the more forgiving it is in manufacturing.

Due to the melting point of your brass component, you are limited in how high a temperature you can go to. Eliminating the silver (if you literally removed it from your filler metal you would essentially be changing to a BCuZn filler metal) is not an option as you would then be trying to braze brass with brass. In the range of available brazing filler metals, the only filler metals that fall between 840°F and the melting points of common brasses, 1650°–1830°F (899°–999°C) are those of aluminum, the BAlSi series. Unfortunately these are not metallurgically com-

patible with brass or stainless steel. The nickel-based, BNi series, cannot be considered as they are too high in temperature for the brass.

As for going down in temperature, you would need to consider a solder filler metal such as 96.5% tin–3.5% silver melting at 432°F (222°C). You save on filler metal and energy cost but would no longer be brazing. This would be a drastic change. Only extensive testing would answer the question as to whether it was strong enough for your application. Alternatively, you could investigate using different materials in your assembly. Changing the brass component to stainless, for example, would allow you to go to a nickel or copper braze filler metal, perform the brazing in a furnace and eliminate post-braze cleaning.

Whatever you do, a significant amount of engineering and testing would be required to make a switch. Changing base materials may offset any savings gained by eliminating silver. In addition, capital may be needed.

It sounds like I am trying to convince you to stay with what you are doing. The list of advantages of brazing with a silver brazing filler metal in your application is long but, I agree with the thinking that you must take out all the cost you can to stay competitive. Unfortunately, the cost of the silver brazing filler metal stands out in the total cost equation. With silver prices inflated, it is highlighted even more.

It is crucial that you consider the total cost of your process before making a decision. It is more likely that savings can be achieved by looking at variables that affect production rate, cleaning costs, scrap, and rework. Automation options may also make sense. In this application, the bad news of brazing with a silver brazing filler metal is that the silver metal market has inflated the price of the consumable. The good news is that using a silver brazing filler metal allows you to design and implement an optimized production process. ♦

This column is written alternately by TIM P. HIRTHER and ALEXANDER E. SHAPIRO. Both are members of the C3 Committee on Brazing and Soldering and several of its subcommittees, A5H Sub-committee on Filler Metals and Fluxes for Brazing, and the Brazing and Soldering Manufacturers Committee (BSMC). They are coauthors of the 5th edition of AWS Brazing Handbook.

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Readers are requested to post their questions for use in this column on the Brazing Forum section of the BSMC Website www.brazingandsoldering.com.

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Conventional arc welding processes are all used effectively on 4130, 2 1/4Cr-1Mo, and modified 9Cr-1Mo steels. Some newer processes like hybrid welding have also become popular. Proper administration of the preheat and postweld heat treat operations is most critical.

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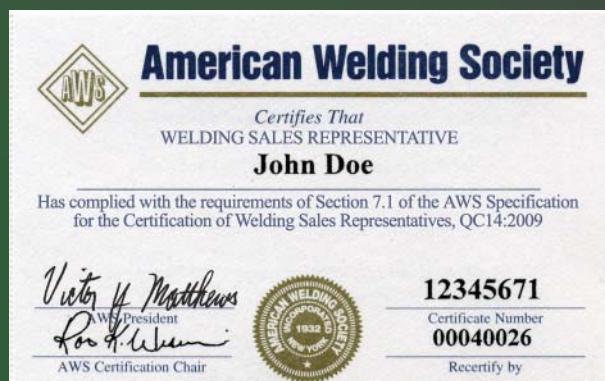
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American Welding Society®

Converting Waste into a Welding and Cutting Fuel

The technology pioneered at MagneGas enables liquid waste to become a clean burning fuel

BY KRISTIN CAMPBELL

Wouldn't it be neat if cities across the world could take their own nonhazardous liquid waste to create fuel? "Green" gas practices could occur on a daily basis, thereby saving the environment, reducing global warming impacts, and revolutionizing how operations run.

This reality could happen with new, transforming technology that turns different waste types into an efficient fuel for industrial application needs.

Details on MagneGas Corp.

Founded in 2007, the public company (MNGA) is headquartered in Palm Harbor, Fla. Its metal cutting fuel and natural gas alternative, which is lighter than air, benefits welding, metal working, automobile, and shipbuilding industries.

Dr. Ruggero Santilli serves as CEO, board chairman, director of research and development, and chief scientist. This former Harvard and M.I.T. physicist, who was also nominated twice for a Nobel Prize, recently won the 2009 Gold Prize Mediterraneo for Science and Technology award. Additional employees include President Rich Connelly and CFO Luisa Ingargiola; Carla Santilli, Ruggero's wife, is one of

KRISTIN CAMPBELL (kcampbell@aws.org) is associate editor of the Welding Journal.



Rich Connelly, president of MagneGas, cuts steel with a torch powered by the company's fuel. It provides fast cutting capabilities with no flashbacks to save time and improve equipment performance.



Fig. 1 — The MagneGas team in Palm Harbor, Fla., consists of (front row, from left) CEO Dr. Ruggero Santilli and President Rich Connelly along with (back row, from left) Director Carla Santilli and CFO Luisa Ingargiola.

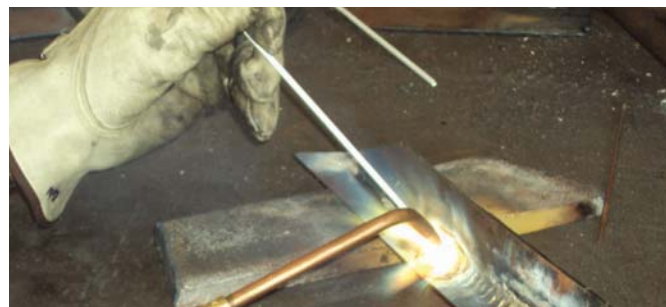


Fig. 2 — Rich Connelly, company president, brazes bronze with a brass flux coated filler metal to carbon steel using MagneGas™ fuel.

the company's directors and a member of the board — Fig. 1.

Ruggero Santilli's foray into creating a new energy source started under the administration of President Jimmy Carter. "The target at that time was to develop a new way of processing petroleum into a fuel," Santilli said. He accepted this challenge that had one condition — finding a new way of bonding the atom together.

Since then, he has met this goal and achieved a new chemical species. "We can now create our own fuel while we recycle liquid waste," Santilli said.

How the Technology Works

Numerous components are used to create MagneGas™ fuel. Manufacturing takes place at the company's 6000-sq-ft production facility in Florida. Seven independent contractors are employed here with Gene West serving as shop foreman. Work also takes place off-site following nondisclosure clauses.

A container holding liquid waste provides the feedstock. This could be city sewage and/or sludge; liquid and solid animal waste; automotive liquid waste; petroleum; oil based liquid waste; byproducts of petroleum, glycerin, bio-fuel, and ethanol; and paint and thinner waste. The waste determines which of three recycler types — total, linear, or total-linear — to use.

Electrical engineer Mike Rodriguez builds and wires the control panels along with wiring the electrical machine's design. Behind the maintenance board is a control circuit. Users pick the settings for their application. "Everything's fully automatic," Rodriguez said. If an error arises, an alarm button will come on, and the machine shuts down.

Santilli developed the patented Plasma Arc Flow™ recycler that turns liquid waste into a combustible fuel. He has worked on this concept for 25 years. Creation takes place through a submerged electric arc between carbon electrodes, superheating the waste to 10,000°F. The liquid breaks down to the atomic level, and fuel bubbles to the surface for collection.

A back-pressure regulator runs at 30 lb/in.² or higher as determined by the operator. Using more pressure yields more gas production.

Machines can be built for various configurations meeting user's specific requirements. They are available in 50-, 100-, 150-, or 200-kW units. Each 50-kW refinery delivers 1000 A to the arc. Virtually the power and size of the machine determines the cubic foot per hour it provides.

The whole operation runs quietly in a sealed environment and takes up a small footprint for flexible installation. A generator can also run this, making it mobile.

Purchasing the Machines

Presently, these fuel producing recyclers are sold internationally as demand is high for an alternative fuel gas, but a lease program will be implemented by MagneGas Corp. this year for operation in the United States. Users also receive a couple weeks of training to ensure proper operations are followed.

It takes about three months to make a machine. Costs vary depending on how the machine's completed, its kW size, the fuel's usage, and liquid to be recycled.

Various Uses for the Fuel

What's produced, MagneGas™, pro-



Fig. 3 — Result of a bronze brazing application showing this technology replaces acetylene for metal working industries.

vides a replacement for oxyfuel processes, natural gas, carbon-based fuels, oxyacetylene, propylene, and propane. This makes it useful for oxyfuel welding, cutting, brazing, soldering, thermal spraying, hardening, cooking, and water/home heating — Figs. 2, 3.

"If you take this 'green' technology and put it in the future welders of the world, now you have a reason for its usage in all oxyfuel applications," Connelly said.

The clean burning fuel, essentially interchangeable with natural gas, is made on-site at its facility — Fig. 4. This product can be compressed up to 5000 lb/in.², does not require special care for shipping, and gets stored in 125 and 250 ft³ high-pressure cylinders.

Currently, testing wastewater provided for free from the City of Dunedin, Fla., is underway. "They want us to improve our equipment. Our goal in the future is to be a full fledged liquid waste processor and fuel producer," Ingargiola said.

Plus, this fuel is used locally by welding students at Pinellas Technical Education Center; the Pinellas County mainte-



Fig. 4 — At the company's Florida production site, this machine makes fuel for distribution. Its control panel (left) is followed by the recycler (center) and high-pressure cylinders holding the end fuel product (right). Sludge from the City of Dunedin provides its feedstock.

nance department for plumbing, operation, and repair tasks; Iron Workers Local Union No. 402, Riviera Beach, Fla., and 397, Tampa, Fla., for training operations; and Duckworth Steel Boats, Inc., Tarpon Springs, Fla., for cutting.

What's more, the fuel can be used for running bi-fuel automobiles. It surpasses all current Environmental Protection Agency requirements for combustion exhaust emissions. Santilli's Chevrolet Silverado works on the fuel — Fig. 5. He drives

this vehicle every day, which is fitted with a natural gas kit that enables full operation.

How remarkable would it be if car owners and dealers could turn into their own fuel producers? "If we do that, in due time, America will set the standard for fuel independence," Santilli said.

Beneficial Aspects

This high-burning fuel is primarily composed of hydrogen — Table 1. Its

Table 1 — Chemical Composition of MagneGas™

Ingredients	Concentration
Hydrogen (H)	55–65%
Carbon Monoxide (CO)	30–35%
Carbon Dioxide (CO ₂)	1–2%
Water Vapor	2%
Trace Gases	0.5–1%

byproduct emits oxygen into the atmosphere and is suitable to indoor use because of low toxicity levels. The fuel is safe to store and handle as well.

"We're cleaning the environment," Connelly said. "Our emissions are the same no matter how we combust a fuel."

In addition, the product enables users to cut metal fast, concentrates heat at the precise point of the cut for a better quality, and provides no flashbacks.

Its advantages as a metal cutting fuel are abundant as consumption of cutting fuel and oxygen is reduced; high-quality, clean cuts with less slag, narrower kerfs, no top edge rollover, and a smaller heat-affected zone are produced; and its natural scent enables any leaks to be detected rapidly.

Recent United States and Foreign Deals

A fuel distribution agreement with Florida-based Crumpton Welding Supply marked MagneGas's start into the metal cutting fuel market. Crumpton sells this fuel through its offices in Tampa, St. Petersburg, Auburndale, and Port Charlotte.

The company signed its first manufacturer's representative agreement with



Fig. 5 — This SUV, owned by Santilli, runs on fuel created by liquid waste. A trailer attached to the car features a portable recycling unit that can be taken to welding distributors.

Pennsylvania-based George KELSO Co., LLC, opening an equipment sales channel to much of the Mid-Atlantic Region including southern New Jersey, eastern Pennsylvania, Maryland, Delaware, Washington, D.C., and its five surrounding counties. Boca BioFuels, Inc., distributes its fuel for the metal cutting and welding market in the Greater Atlanta area, too.

Also, MagneGas signed an all-encompassing license with HyFuels, Inc., for its technology in North, South, and Central America as well as the Caribbean Islands. This intellectual property consists of all relevant present and future patents, patent applications, trademarks, and domain names.

The company's first equipment purchase order, from American Investment Co., is for a refinery to service the Philippines and Vietnam markets.

Additionally, it appointed distributor MagneGas Australasia Pty, Ltd., for Australia and New Zealand markets; acquired a 20% interest in MagneGas Israel, LLC, the owner of its technology intellectual property rights for Israel; and signed a contract to purchase shares and royalties

from Jeruz Energy Co., the licensee of its technology for India, Pakistan, Bangladesh, and Sri Lanka.

Future Ambitions

Participating in "green" technology is the way to go for helping current environmental conditions and showing upcoming generations to be energy efficient.

It's obvious there is always going to be a plentiful supply of leftover waste. Farms, cities, and communities leave a constant supply of feedstock from which to make fuel. What could be more resourceful than using one variable to make another?

MagneGas hopes to continue its success achieved in the international arena with an expanding technological presence. This year, it plans to install three industrial demonstration centers across the United States, and for 2010 aims to further research and development for specific applications. It would like also to form partnerships with existing wind and solar power companies.

More information can be obtained by visiting www.magnegas.com. ♦

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American Welding Society



Essen Welding Show 2009 Dubbed the Olympics of Welding Technology

Essen, Germany, site of the Essen Welding Show, September 14–19, 2009.

Despite the difficult economic situation worldwide, more than 1000 exhibitors from 40+ nations are expected to showcase their latest innovations at this year's event

BY HOWARD M. WOODWARD

The welcome mat will be out once again September 14–19 to continue the long tradition of the Essen Welding and Cutting Fair (Schweissen & Schneiden Essen). Promoted by Messe Essen GmbH and in partnership with the German Welding Society DVS, the trade fair is presented every four years. This year's exhibition of the world's latest welding, cutting, and allied technologies will be displayed throughout the entire Messe Essen complex of more than 1.1-million ft² (110,000 m²). More than

1000 exhibitors from 40 or more different countries are expected to display their wares at the event.

Fair Forum Changes to Be Introduced

For this year's event, a new format was developed for the Annual Welding Conference (AWC). For the first time, this event will be integrated into the happenings at the fair as the "AWC: Fair Forum," which will be divided into three conference subjects based on each day's theme topic.

The Industry and Research Forum will be devoted to the entire performance spectrum of today's joining technology from the latest research results to the reports on their application and future developments.

The Skilled Tradesmen Forum 2009 will focus exclusively on practical subjects specific to the skilled trades that relate to all aspects of joining, cutting, and coating.

The Student Congress will offer a platform for young engineers to present their current work and results. The purpose is

HOWARD M. WOODWARD (woodward@aws.org) is associate editor of the Welding Journal.



A 3-D diagram of the Messe Essen venue of the 2009 Welding Show.

to promote the up-and-coming generation of engineers and scientists.

New 'Subject Pavilions'

This year there will be two new "subject pavilions." One is designed to focus on quality testing and the other to highlight adhesive bonding techniques. Quality Testing International (QTI) will offer manufacturers and service providers from the fields of measurement technology,

quality assurance, and materials testing a platform for establishing customer contacts. The "Kleben" structural bonding pavilion will give companies and institutions active in the field of adhesive bonding technology the opportunity to present the advantages of their technologies at a centralized fair location.

The Young Welders Competition

For the first time, the grand finale of

the National Young Welders competition will be staged within the framework of the fair. The competition will take place with about 50 welders between the ages of 16 and 21 who have previously successfully completed their regional qualifying rounds. These young welders will strive for the national winners' titles in four welding processes: gas welding, manual metal arc welding, gas shielded metal arc welding, and tungsten inert gas welding.

There will be another debut at the fair in the form of a cross-border contest between various nations called the Young Welders International competition. Visitors to the fair will be able to see the welders in action. The contest action also will be transmitted by video to large screens for remote viewing.

Welding and Cutting Today

The newspaper *Welding and Cutting Today*, published by DVS, will be the official daily publication at the show. It will offer topical articles and report on show happenings.

Preregister on the Internet

Preregister for the Essen Welding Show on the Internet to save some money and expedite entrance to the show floor. If you register by September 9, the one-day ticket price is 28 euros (about \$40), thereafter the price is 35 euros (about \$50); the six-day ticket is 70 euros (about \$100) for early registration, and 84 euros (about \$120) thereafter. Visit the Schweissen & Schneiden Web site www.essen-welding.com for complete information.

Essen is about a 20-minute taxi ride and a 30-minute train ride from the Düsseldorf Airport. An airport shuttle service is provided to and from the exhibition complex. Visitors planning an extended stay in Germany may want to consider purchasing railway tickets at special rates available for the period September 12–21, 2009. Information is available on the Essen Web site.

The American Pavilion

As at previous shows, the American Pavilion, sponsored by the American Welding Society, will offer a cost-effective method for U.S. and Canadian companies to exhibit at the show.

For one fixed U.S. dollar price, Essen Trade Shows offers each vendor a completely constructed 130-ft² (12-m²) booth that includes carpeting, header, company sign, shelves, spotlights, electrical outlets, table, and chairs, plus use of the pavilion lounge with interpreters, Internet stations, a hostess, food, and refreshments. Larger booths and, additional furnishings are available.



A view of the 2005 Essen Welding Show floor.

As of May 7, the following companies were to have booths at the American Pavilion:

American Torch Tip
American Welding Society
AMET
AMPCO
Aquasol Corp.
Arcon Welding
Asiamet
Broco
CK Worldwide
CM-Cleveland Motion Control
Dyna Torque/Lastekniek
Esco Tool
The Fabricator
H & S Tool
Inweld Corp.
J. P. Nissen
Jetline
La-Co
Manufacturing Technology
Mathey Dearman
National Bronze & Metals
Oxford Alloys, Inc.
Polymet Corp.
Postle Industries
Special Metals
Techalloy Products
Uniweld
Weld Engineering.

Tour the Essen Area

While attending the show, be sure to save some time to explore the Essen-area attractions. More than half the city is green with parks and other lush landscape. It is a sharp contrast to what it was like in the early 1800s when Essen was a mining town of 4000, and later growing to 720,000 residents with the industrial revolution. Today, with the loss of the heavy industry, the population has declined to 600,000 and the mines have become tourist attractions.

Two of the mines, Zeche Carl and Zeche Zollverein, have been designated historic landmarks featuring cultural centers, restaurants, and conference facilities. Another attraction for locals and tourists alike is the Baldeneysee, a large water reservoir where one can stroll along the boardwalk past numerous cafés, restaurants, and beer gardens.

Also popular is the Villa Hügel, built in 1873 amid the 150-acre Hügel Park. It houses historical exhibits and is the site for special events. And, just behind the Messe exhibition complex is the 170-acre Grugapark famous for its attractive horticultural gardens of native and exotic plants. Close at hand to the showplace, it offers visitors a relaxing change of scene. ♦

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Robotic Fabrication of Wind Turbine Power Generators

Robotic automation of wind tower production can provide cost-effective energy with short-term payback of fabrication costs

BY MICHAEL SHARPE

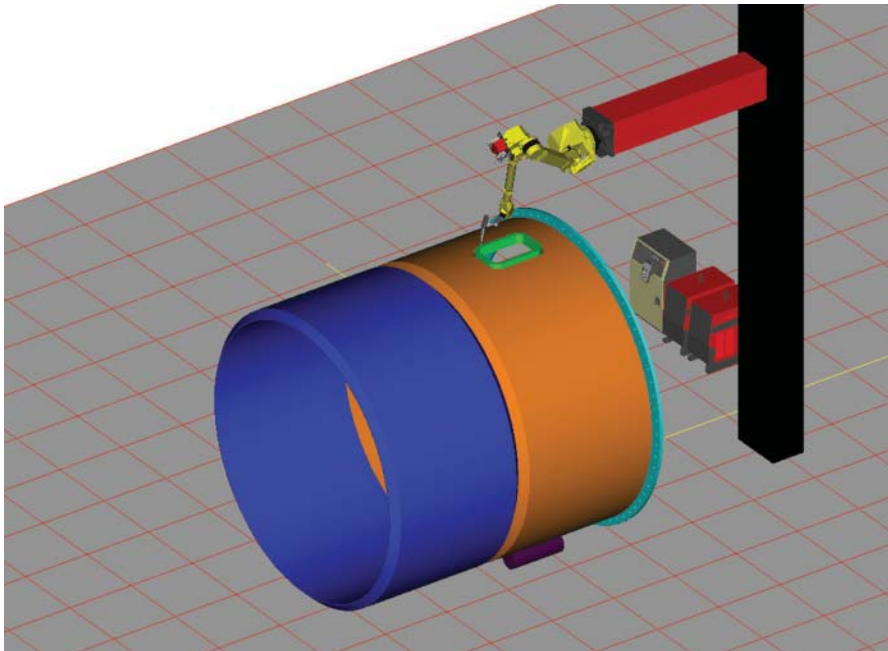


Fig. 1 — Wind tower robotic work cell design.

Through the ages, wind turbines of various designs produced energy for everyday jobs like grinding grain or pumping water, and were a core technology for early societies. In the last few decades, many industrialized countries have advocated their use for producing electrical energy for either stand-alone use or supplemental to a region's electrical power grid. The challenges that manufacturers have faced are the cost effec-

tiveness of the towers and turbines, and the ability to deliver the power efficiently to the grid. Both issues have limited their widespread use in North America. In addition, the geography to support ideal wind energy locations is likely a long distance from the utilities and some opponents claim that wind turbines interfere with the landscape. While no energy solution can perfectly blend into the environment, manufacturers, site developers,

and utility companies have made significant strides to improve the aesthetics of wind turbines by integrating tower columns. Tower columns may be more costly to manufacture than a lattice structure, but the latest manufacturing methods can bring the cost of the equipment down, making this green solution an economic success.

Automation equipment enables lower costs to produce wind tower equipment that meets numerous manufacturing challenges. Advances in automation have allowed fabricators to develop production methods by designing joining and cutting technologies to meet these challenges head on. While typical "hard" automation systems may consist of a manipulator, part positioning device, and welding equipment control, they are not considered robotic in function nor design. Robots consist of a programmable arm that can move a tool (welding torch) in a predefined motion path under operator control. The robot controls welding equipment as well as part manipulators and integrates with sensors to adapt and adjust the welding process as necessary.

Robotic automation is becoming easier for companies to apply especially in repetitive and localized welding tasks such as in automotive production. Welding robots provide manufacturers the means to be competitive because of the lower labor cost; for automotive manufacturer robots have become a necessity. Other industries such as heavy off-road and pipe manufacturing have also benefited, and robotic automation equipment is growing more

MICHAEL SHARPE (Michael.Sharpe@fanuc-robotics.com) is with Material Joining Segment, FANUC Robotics America, Inc., Rochester Hills, Mich.

common in wind tower production. The size of a wind tower makes it difficult to imagine how a welding robot could be a practical solution for welding something so large. It turns out that the towers are scalable and segmented so one welding system configuration is applicable over many modules along the wind tower.

In addition to size, the variability of the large and thick sections of the tower that need to be welded together is another challenge. The sections tend to be conical in shape and stack on one another to form the tower. The cones are roll formed to a specific diameter and then welded in large sections with the accessories, ladders, and doors added as needed. The components are cleaned and sand blasted prior to painting and on-site assembly.

Advances in robotic welding have increased dexterity and overall process capability. The updated control technology and welding process allows for greater deposition rates when applied to a flexible robot cell — Fig. 1. Robotic sensing technology allows parts to be properly cut and welded, improving the cycle time and overall throughput with less waste and improved structural integrity because of accurate weld sizes. Installation of robots on large manipulators enables them to reach over 6 m in height — Fig. 2. Teleoperation capabilities provide control of the welding robot without being in direct contact at the arc. New robotic safety controls provide a tailored workspace and can safely limit a robot's speed when a worker is near, enabling a cooperative working area for the robot and human.

Process of Manufacturing Wind Tower Columns

Horizontal-axis wind turbines (HAWT) consist of the tower column, and the nacelle mounted on top, which houses the generator assembly that holds the rotor and connects to the gearbox-generator. Tower heights are approximately twice to triple the blade length and help to balance the material costs of the tower structure against better use of the more expensive moving parts. (Note: If you were to double the height of a wind turbine, it would provide about a 35% improvement in energy efficiency but would increase the material cost more than eight times.) The tower column may mount on a concrete base for land-based installations or on pilings if installed on the ocean floor. Many different types of tower structures exist but most large wind turbines are designed with tubular steel towers, which are manufactured in sections. Tower columns are tapered to handle the excessive loads. This saves material and makes them more aesthetically pleasing. Taller towers — approximately 80 m in



Fig. 2 — A FANUC Robotics M-710iC robot welds large, heavy compactor wheels. When welding very large parts such as a wind tower, fabricators need a larger welding robot with a longer reach such as this one.

height — place the rotor at an elevation that supports stable wind speeds, and therefore produce higher output with capacities of more than 1.5 MW.

Wind tower fabrication starts out with flat plates of steel that are rolled into sections to form a conical shape. The cone section is closed and the joints welded on both the inside and outside. The conical sections are joined end to end into larger sections 15 to 30 m in length with flanges at either end so the assemblies may be shipped over the road and bolted together on the site to form the tapered tower. The welded sections are 100% inspected for quality, weld

size, and structural integrity. Many times the welds are shaved smooth through a grinding or milling process to further save weight and eliminate unnecessary stress in the section elements. Based on regional weather conditions, wind tower loads become quite variable due to unexpected forces of nature so every countermeasure to maximize safety is critical. For example, in the Great Plains of the United States installations have to survive winter's freezing conditions as well as higher sheer winds produced from tornados.

Robotic systems mimic their hard automation counterparts and are adapted to

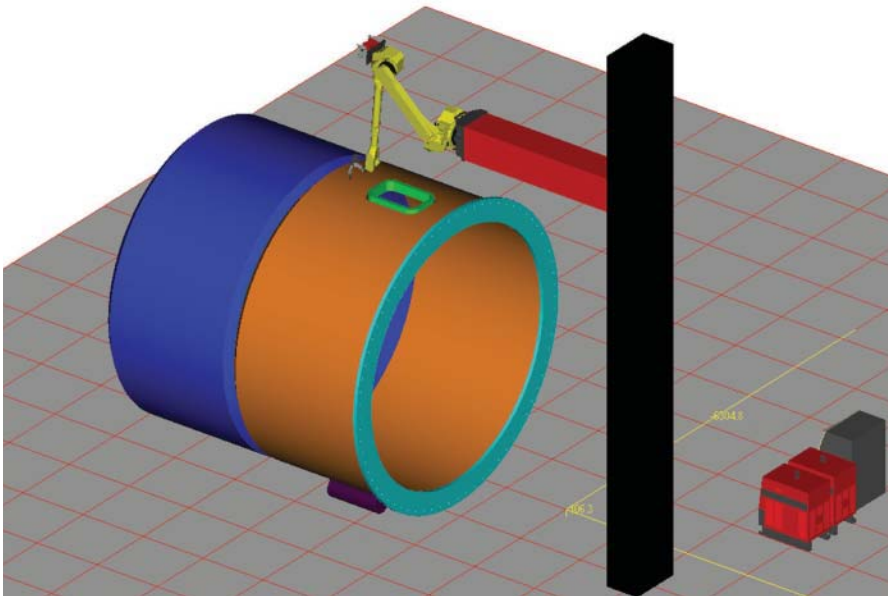


Fig. 3 — Robot mounted on boom manipulator.

the large positioning structures with booms and transporter manipulators to move the robot's torch near the work area — Fig. 3. Intelligent robotic sensors such as through-arc joint tracking or vision guidance are often required due to the inconsistent shape of the parts and the large weld joint configurations. Robots with multiple axes provide for additional servomotors integrated with the manipulator and turning rolls. The integration of servomotors allows all axes to coordinate together to provide a greater working

space for the robot and to turn the parts into the correct position for welding.

Challenges can exist for the control and safety configurations of the robotic systems. Robot software-based dual check safety provides a safe mechanism to limit the robot's working area to the weld locations, providing even greater flexibility for operators to work alongside intelligent robots completing pre- and postprocess preparations. Dual check safety is the most up-to-date technology and has been employed on hundreds of robots. It is

more cost effective and flexible than large fenced-in safety enclosures that limit the robots' working area. This technology enables the operator and robot to safely co-exist in the welding environment.

Tower Design

Designed with three-dimensional computer-aided design (CAD) and simulation programs, tower columns must meet structural requirements. 3-D design programs allow for exporting of the geometric data, utilized for finite element analysis as well as direct robot programming. Once the design criteria for a particular weld is established, the geometry and weld path are downloaded to the robot's simulation environment (virtual robot controller) where reach, accessibility, and collisions are determined for the particular assembly in the robotic welding system.

Wind tower sections tend to be modular in design and therefore lend themselves to robotic off-line programming. Robot programs and weld paths can be quickly adjusted to another tower section. The robotic off-line programming environment enables the virtual robot controller to develop the perfect work and travel angles. By placing the PC cursor on the weld joint, the virtual robot controller can determine the perfect work and travel angles for the weld and then download the information to the robot. This saves the operator from needing to be 6 m above the shop floor to program the robot. Intelligent robot sensors like through-arc joint tracking can then adapt these perfect robotic weld programs to the imperfect weld joint on the conical section. Joint tracking adapts the weld position based on the current feedback while weaving, achieving appropriate fill based on the variable weld joint geometry.

Building the Doors

Wind turbines require regular maintenance and manned access to the tower column and nacelle all accessed through a door near the base. This poses a design and manufacturing challenge because of the localized stresses in this area. Ideally, the location should have minimal impact on the structure design, but the application of the column design does not warrant this. Placing the door in the lower section eases the maintenance accessibility at the expense of fabrication complexity. The thickest material of the tower is at the base, approaching 180 mm in thickness, and is tapered in shape. Thus far, manual operators have had to cut and weld the door due to the thicker material and the imperfect shape of this rolled section.

The latest robotic solution is through laser scanning of the shape of the conical

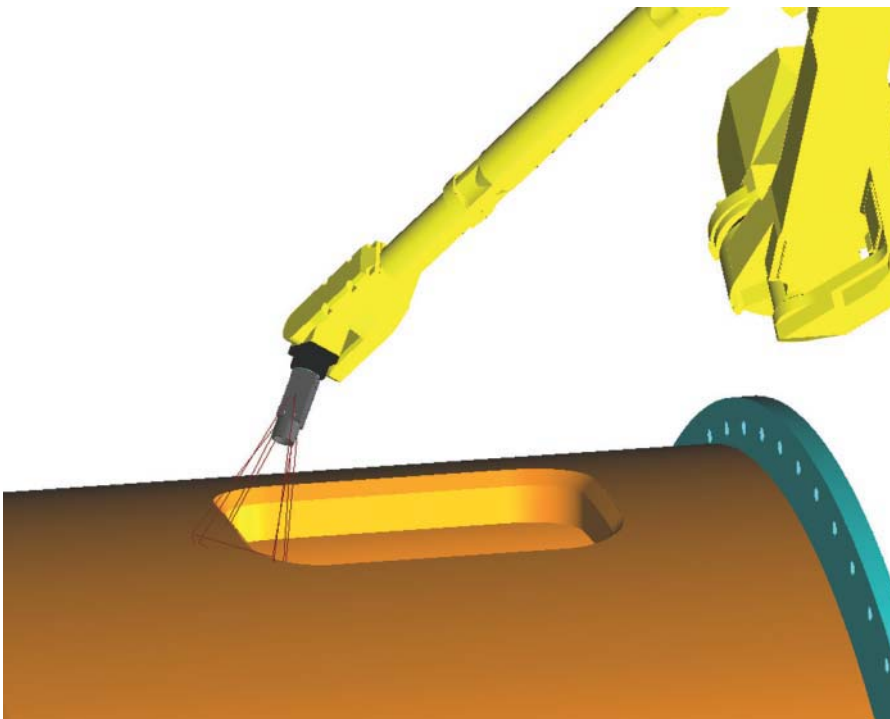


Fig. 4 — Automatic profile scan generates accurate cutting and welding paths.

section profile and building the cutting path for the door's hole size, shape, and bevel angle — Fig. 4. The robot moves the laser scanner along a prescribed path and measures the offset at very minute slices, generating 3-D data of the area for the door. This data virtually projects the door support ring into the tube and makes robot path adjustments based on the actual shape. Optimized robot programs automatically cut the opening, exceeding a manual operator's skill due to the size and shape of the parts. Therefore, the hole is custom profiled according to the radius of the conical tube at the location to be cut and beveled. In addition, weld sizes are optimized by laser scanning the profile and robotic beveling, taking into account the tube's profile shape. Matching the door intersection to the main column tube provides consistent root openings, reducing material waste, lower welding cycle time, and improved structural quality.

Steel is selected based on the specific mechanical properties for the application and then laser cut to a minor banana shape that is rolled into a taper to form the conical sections of the tower column. Weld areas are prepped based on the welding process including the bevel angle and root face. The parts are then arranged for the longitudinal weld by setting the root opening and then tack welding. Complete penetration is a requirement; the rings are joined lengthwise from the inside (Fig. 5) and out, and then placed on turning rolls to position the components in the optimum location for the robot — Fig. 6. Robots with more than 3 m of reach are typical for these longitudinal welds, and they produce multipass welding with a single setup. After the long joints are welded, the conical sections are placed on turning rolls and the same basic steps mentioned previously for preparation and setup are carried out. The difference is the turning rolls should be set up so that the smaller diameter is placed toward the top of the conical section so that it can spin the column smoothly. Welding multiple smaller cone sections together grows the tower in length up to the allowable size of the available transporter.

Using Submerged Arc Welding

The submerged arc welding (SAW) process allows for greater deposition rates, some as high as 45 kg/h, much more than the typical single and twin GMA welds. The higher deposition rates are attributed to many factors such as the powdered flux cover to shield the weld and improve current transfer. Flux is delivered to the weld joint just ahead of the arc and while some is consumed in the weld

process, most of it can be recovered. Other advantages that improve deposition rates are the ability to run on AC/DC welding machines where the polarity and current type (AC or DC) are switchable and can be modulated through variable balance AC current. Twin wires offer an effective improvement and allow for combinations on the leading and trailing arcs. Modern inverter welding power supplies increase welding efficiency due to the electronics. A side benefit is dynamic switching with no requirement to change weld torch leads based on the output desired as the machine is software controlled. Micro-processors monitor the welding process through state-of-the-art DSP control and communicate through networks across an Ethernet port, supporting data collection and reporting as well as sequence control. One feature that stands out is the welding network control, which allows direct control and sequencing through another computer or motion planning device. Robot controllers synchronize the welding machine and offer improved capabilities such as through-arc joint tracking and remote control and data monitor and collection. The new SAW power supplies with these capabilities opens up improved performance and higher throughput with intelligent welding control from the robot.

Submerged arc welding applied to a robot is a relatively new development in the industry and is equally capable for long continuous joints that require high deposition rates. The modern intelligent inverter power supply more readily connects to the robot controller and offers new application with SAW. Applying robotic SAW to the wind tower is a win-win as the robot can manipulate many more degrees of freedom than a typical mechanized transporter, improving the capabilities for many more applications on the tower. The robot has the capability to adapt to the weld location based on the welding current feedback signal providing a sense of direction to lead the arc into the weld joint. Robot controls handle multiple welding torches with ease, such as twin wire, so the operator can simply select the lead wire based on the weld direction and the appropriate through-arc joint tracking sensor function. The robot manipulates the SAW process, welding the door's curved profile while coordinating the turning rolls. Robotic coordinated motion provides 1G orientation, which is difficult for mechanized hard automation systems.

Normal production methods rely on cutting or shaving the weld to save weight and reduce propagation of stress risers. Operating a manual weld shaver is heavy work and with the long welds on the tower column, it becomes a time-consuming process. Robots have utilized machining equipment with specialized force control

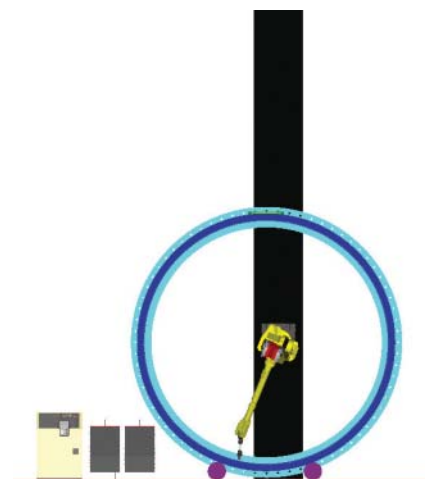


Fig. 5 — A robot is shown inside a tower section.

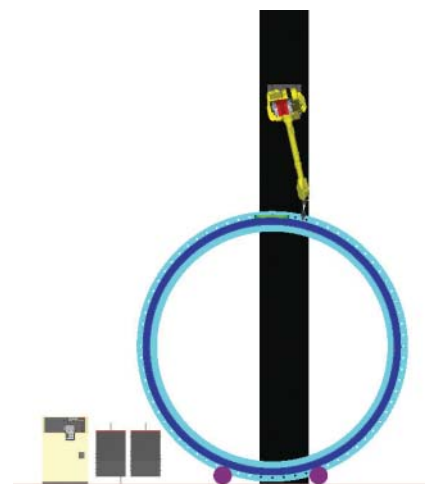


Fig. 6 — Turning rolls provide part rotation to achieve optimum weld position.

to manage the bead profile, reducing it to a smooth transition from each side of the weld. Weld sizes such as a 45-mm butt joint are routinely shaved by the robot. These automated weld shavers provide force feedback to the robot control so that appropriate material is removed with each pass. A force of 35 kg is applied to the work while the robotic auxiliary servomotor controls the velocity of the slot-milled cutting tool, cleanly and quickly removing the weld bead convex shape. Robots can remove this type of material at speeds of 10 to 12 mm/s providing continuous performance, making the robotic controlled weld shaver a necessity for wind tower production.

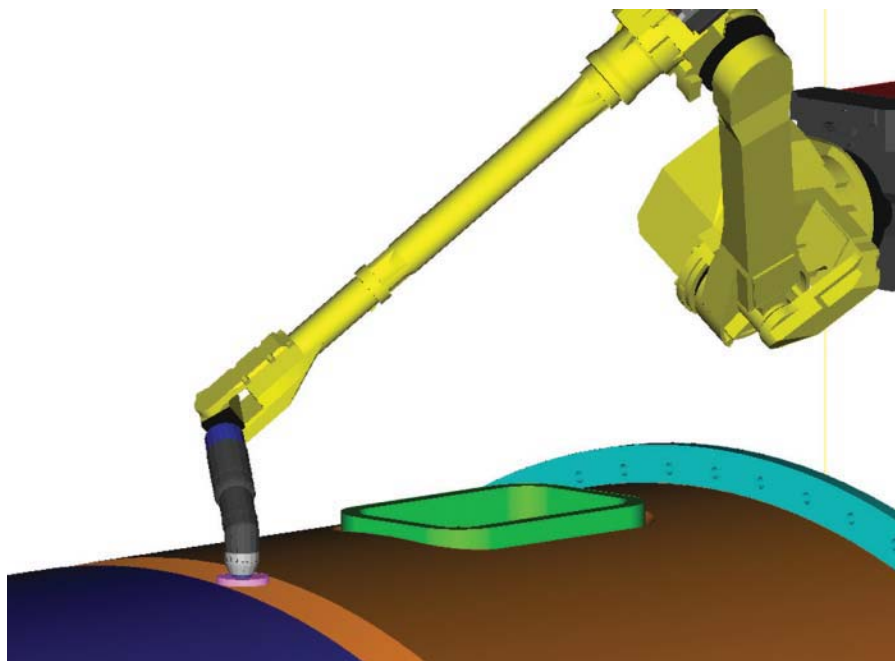


Fig. 7 — Robotic automatic ultrasonic weld inspection.

Testing the Welds

Nondestructive examinations such as ultrasonic testing (UT) are normally carried out on all main structure welds of the tower including the longitudinal weld

joints as well as the conical sections and mounting rings — Fig. 7. Typically, this is a tedious process where the scanning head is moved along each weld by an operator. Robotic automation provides the capability to handle the UT sensor with greater

precision and allow it to accurately travel along the welds at greater distances than possible with manual scanning. The interface is simple and the robot's accurate speeds provide excellent data feedback for the monitoring and validation of each weld, maintaining high quality standards and records for liability.

The large size of the parts places the robot and the welding torch far from the operator's view. Remote control is available on robots to allow for setup, operation, programming, and monitoring the weld. Remote access through the robot's teach pendant is achieved through standard PC office tools such as a Web browser, which lowers the cost of monitoring and control. Welding equipment settings and systems functions like the flux hopper control can be set and adjusted from the PC. Optional viewing cameras can be integrated through the remote PC for viewing the actual robot system, closing the loop for the operator.

Conclusions

Worldwide energy demands have been increasing at rates that will require developments of alternative sources in a larger scale. Wind energy appears to be an immediate technology offering lower risks because of the leveraged global installed base and experience. Manufacturing large wind generators utilizes much of the technology that has been developed over the years, including robotic automation. Many factories are already applying robotic automation for tower manufacturing, but some still utilize a manual method for production, and accrue higher production costs. Large volumes of wind towers are required to meet the energy demands of tomorrow and the taller, more efficient sizes are becoming commonplace, so manufacturers will have to adopt robotic automation to be competitive. Improved production volumes and robotic automation will likely lower the overall cost of manufacturing and therefore the kWh for energy produced. Most of the discussions to date have been tailored around developed nations, but if the costs can be lower, then developing countries may be able to take advantage of the clean energy provided by wind generators. Even future applications like wind to hydrogen become more viable when the cost to produce the equipment is reduced, making these storage technologies more practical.

Wind power generation can provide cost-effective energy with short-term payback but robotic automation of wind tower generators can make this an even shorter payback through improved efficiencies. Robots are extremely powerful and flexible and well suited for wind tower manufacturing. ♦

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Advancements in Ultrasonic Phased Arrays

BY COLEMAN FLANAGAN AND MICHAEL MOLES

Here's a look into how far inspection methods as well as instruments have progressed to help with various tasks at hand

Phased arrays have become a popular weld inspection technique for a variety of reasons (Ref. 1). Their benefits include being faster than conventional ultrasonic inspections (thereby often lowering overall cost); providing good imaging, which helps data interpretation; generally offering more repeatable inspections; and increasing operator productivity. As sales have increased, prices have typically dropped and may continue to do so. This article outlines a series of new instruments and where they stand with respect to the American Welding Society's (AWS) D1.1, *Structural Welding Code — Steel* (Ref. 2). Also, it addresses the main limitations today: training and, to a lesser extent, codes.

Identifying Inspection Techniques

There are two basic methods of inspecting with phased arrays — manual and encoded linear scanning. Manual phased arrays are similar to conventional manual ultrasonics; the operator rasters the probe along the weld while oscillating. However, manual phased arrays can generate all beam angles required by the D1.1 code simultaneously — Fig. 1. This saves scanning time. In addition, the angles can be swept through a range, say 40 to 70 deg,



For codes permitting automated ultrasonic testing, inspectors may use hand-held (displayed at top) as well as motorized versions.

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generating an S-scan image — Fig. 1. This gives much better imaging and allows the operator to view the full picture, not just a single waveform. If required, a screen display can be saved for reanalysis or posterity. Nonetheless, manual phased array scans cannot be audited as no position data are saved.

Calibration is straightforward using the International Institute of Welding calibration block and D1.1 code requirements. However, phased arrays can calibrate not just the specified angles of 45, 60, and 70 deg, but all beams in the S-scan. The normal procedure is to scan over the side-drilled calibration hole, then electronically compensate all beams in the S-scan range to calibrate. Full calibration is not specifically required for the D1.1 code, but it allows the operator a better image of the component.

Additionally, once calibrated, evaluating defects using the D1.1 code's indication rating is straightforward: Click on a selected defect, and the instrument calculates this score and puts it in an appropriate table.

In contrast to manual scanning, encoded linear scanning or automated ultrasonic testing (AUT) has significant technical advantages, but also AWS D1.1 code limitations as the probe is not oscillated (see the Encoded Linear Scanning Using Phased Arrays section).

A Review of Manual Scanning Instruments

AWS-Compatible Manual Array

The key issue in complying with AWS codes is developing an array fully compatible with the D1.1 code — Fig. 2. The AWS arrays must fulfill all the specifications in this code, specifically frequency, aperture size, and selected angles (45, 60, and 70 deg). In practice, these arrays exceed the D1.1 code requirements as they can perform S-scans (swept angle scans), save selected images, and even produce weld overlays on some instruments.

Following are descriptions of the features of two new instruments that fulfill these requirements:

The EPOCH 1000i is an advanced conventional flaw detector with basic imaging capabilities — Fig. 3. Based on conventional flaw detector design philosophy, it features a full VGA display, knob or navigation arrows for parameter adjustment, plus EN12668-1 compliance (Ref. 3).

The flaw detector's user interface design focuses on intuitive use and allows technicians with conventional experience to integrate the instrument immediately into existing inspection procedures. It addresses conventional procedures by im-

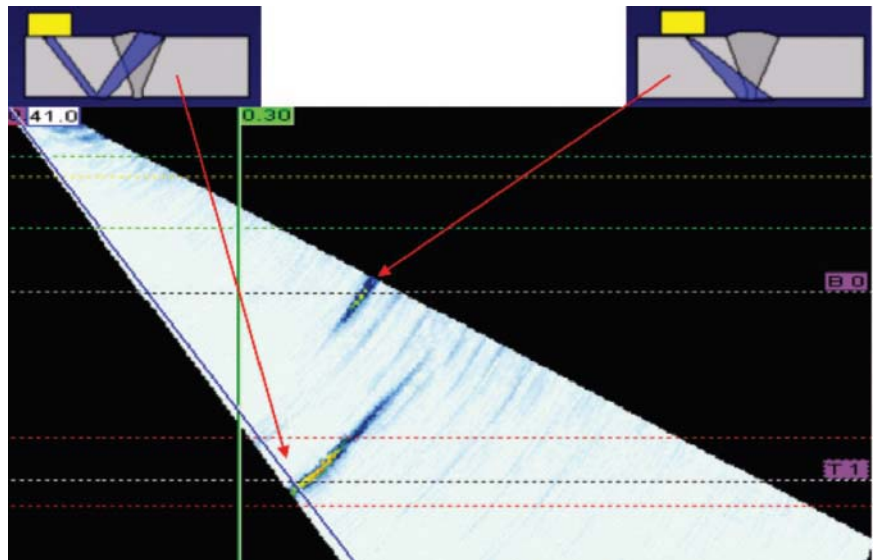


Fig. 1 — An S-scan image showing defect positioning.

plementing phased array imaging with the expectation that the technician still uses the A-scan presentation for flaw sizing and characterization. With this philosophy in mind, the product has been designed to produce a high-fidelity A-scan from each focal law used to generate the phased array image. This inspection philosophy allows conventional ultrasonic technicians to benefit from phased array imaging while relying on well-established sizing and characterization techniques including AWS D1.1 and the D1.5, *Bridge Welding Code*, indication ratings using single A-scans from the S-scan image.

The more advanced OmniScan M (M as in manual) has all the capabilities mentioned previously plus setup wizards, an ultrasonic flaw detector featuring a menu-driven interface, and AWS and American Petroleum Institute code wizards for easy setup — Fig. 4. For international operations, standard sizing curves are available as well.

Exceeding D1.1 code requirements, the RayTracing™ characteristic provides a visual display of the phased array beams in the part. In setup mode, the operator quickly sees what coverage is being achieved. Also, the weld overlay feature simplifies data interpretation. For this, the operator selects or draws the weld profile, then when a defect is found, the distance from the edge of the wedge to the weld is measured. The defect is automatically positioned and displayed — Fig. 5.

In addition, the weld overlay feature simplifies data interpretation of the S-scan view. In analysis mode, a table of indications can be used to record the information for each defect detected in the S-scan. For each table entry, a color point will be added on the RayTracing™ view.

Even though the D1.1/D1.5 codes nor-



Fig. 2 — This new array fulfills all specifications to the American Welding Society's D1.1, Structural Welding Code — Steel.



Fig. 3 — This product combines high-level of conventional portable flaw detection with the power of optional phased array imaging.



Fig. 4 — As another flaw detector, this instrument offers an easy-to-use interface. The array attaches to its side.

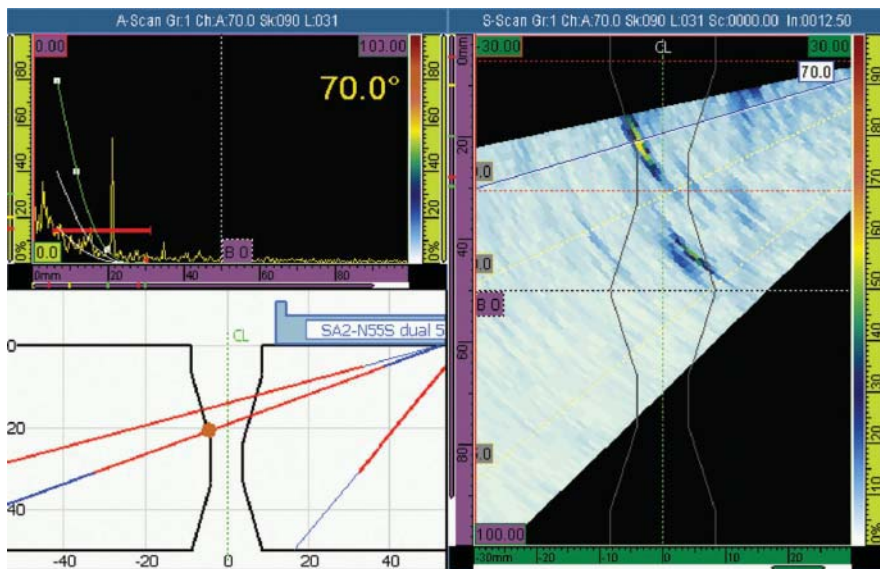


Fig. 5 — RayTracing™ shows the location of a weld defect.

mally do not require an extensive report, the instrument can provide one. All the set-up details are stored on the instrument and can be printed or e-mailed as appropriate. Customized reports can be built simply by pressing the build button in the report menu. The reports can show multiple scan images and data, so contentious defects can be reinspected later, sent to a third party for analysis, or archived. However, full auditing is not possible with manual inspections, even with all these additional features.

Encoded Linear Scanning Using Phased Arrays

Encoded phased arrays use a large

array to electronically scan while the instrument saves these scan and position data from an encoder. This linear scanning is shown schematically — Fig. 6.

Encoded linear scanning has significant advantages: All data are stored, including position data; scan speeds are higher than manual inspections; the data can be audited and reviewed; and the scans are reproducible. For suitable welds, inspection costs can be lower than manual phased arrays or radiography. However, the probes are not oscillated, so technically AUT is not compatible with current AWS D1.1 or D1.5 codes. For other codes where AUT is permitted though, hand and motorized scanners have been developed — see lead photos.

Scanners are now simple and afford-

able, and available from a number of sources. Some models can perform multiple scans simultaneously, for example, three waveforms, two E-scans, one S-scan, and three C-scans — Fig. 7. There are many display options depending on the component, operator's preference, and so on.

Proper Training Needed

The biggest problem facing phased arrays is trained operators. With the rapid increase in market penetration during recent years, training became critical. Olympus NDT recruited several training companies into its training academy and other manufacturers acted similarly. Hundreds of phased array courses are given each year around the globe, but training will always be an issue as it deals with people and not hardware or software. More recently, with the interest from AWS in phased arrays, training companies specializing in manual phased array inspections are being recruited.

Conveniently, the newer instruments are simpler to use and thus require less training. At this time, there is no special certification available for phased array ultrasonic operators, though this may change in the future.

Adhering to Code Requirements

Manual codes are relatively easy for phased arrays to fulfill in general as they mimic conventional ultrasonics, and the AWS D1.1 code is no exception. With the correct array and procedures, this code can be fulfilled. As shown above, phased arrays typically exceed its requirements.

Automated ultrasonic codes are a different matter. Phased arrays do not os-

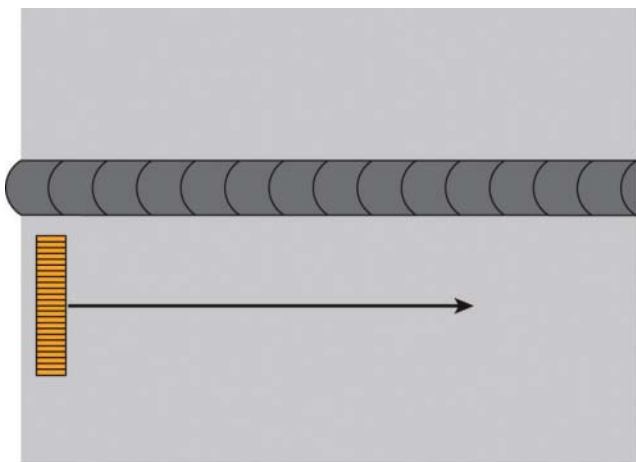


Fig. 6 — Schematic of linear scanning concept with one mechanical axis (along the weld) and one electronic axis (perpendicular to the weld).

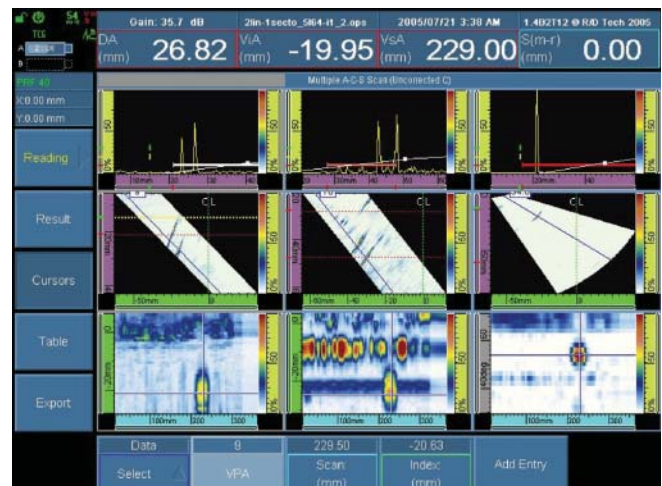


Fig. 7 — Sample automated ultrasonic testing with multiple displays illustrated.

cillate the probe, so technically they do not fulfill the D1.1 or D1.5 codes. It is always possible to use the AWS D1.1 Annex S for special inspections (Ref. 1); however, this Annex requires the engineer's approval. As many engineers know little about nondestructive examination, such special inspections are uncommon.

The AWS D1.1 Committee members are taking another approach. First, they are requesting a trial to compare radiography, manual ultrasonics, and AUT on the same weld. Also, they have set up a task group to develop an AUT Annex, which should be as close as possible to the manual aspects of the D1.1 code. ♦

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2. American Welding Society (AWS) D1.1/D1.1M: 2006, *Structural Welding Code — Steel*.

3. For a description of these instruments, visit www.olympus-ims.com/en/phasedarray/.

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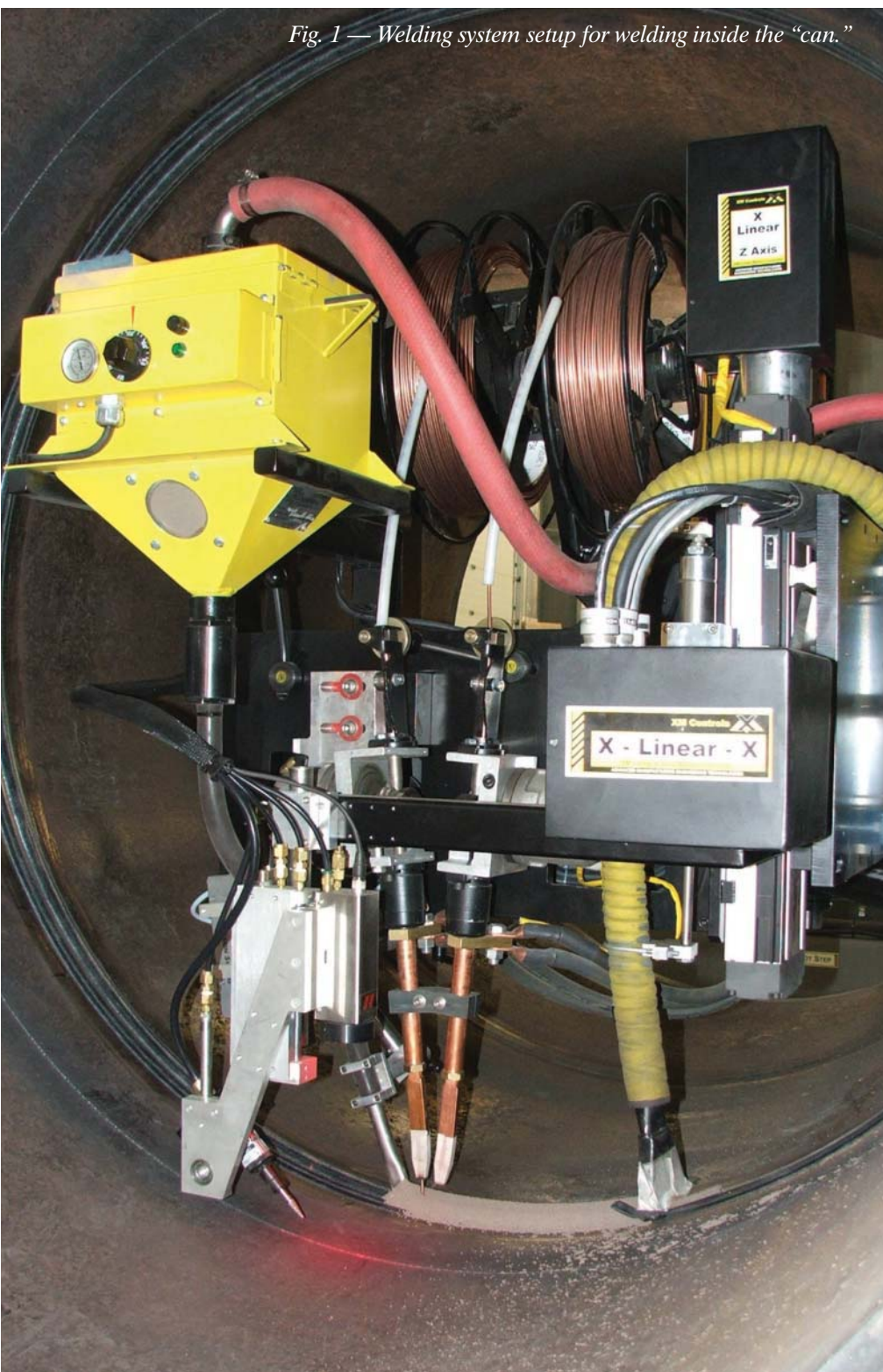
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Wind Turbine Welding System Uses Linear Motion Modules

Linear actuators help provide reliable performance in submerged arc welding

Fig. 1 — Welding system setup for welding inside the “can.”



Wind turbine technology, with its massive arrays of streamlined windmills blanketing hillsides, is an established sustainable, green technology. Many consider it a technology that will help define the energy future. But wind energy also depends, to a great extent, on traditional manufacturing techniques like welding, which is vitally important for fabricating the wind towers.

Fabricating the Towers

The massive wind turbine towers can be close to 90 meters (~ 300 ft) high. Typically, a flat metal plate is rolled into a cylindrical shape called a “can.” The can (the most common size is approximately 9 ft long by 8 to 15 ft in diameter) is then rotated, while the welding machine, staying more or less stationary, performs circumferential welding across the entire diameter. Longitudinal welds are also required. Wind tower welding systems generally operate both inside (Fig. 1) and outside of the can at different times. The welding equipment is usually suspended from a guide rail for outside welding — Fig. 2. In each case, while the bulk of the welding equipment remains stationary during a weld, the weld head constantly moves small distances along at least 2 (sometimes 3) axes, both along and across the joint. A linear control actuator mounted at the end of a horizontal arm determines the motion of the weld head.

Designing a System

AMET, Inc., a machine builder, was called upon to create a cost-effective, dependable welding system that could perform accurate longitudinal and circumferential submerged arc welding. The design, including the linear motion for weld head control, would ideally be relatively straightforward and simple.

One of the most important challenges, however, was to assure smooth and precise (within 1/100th of an in.) control of the weld head, to avoid the need to redo

Story based on information supplied by Bosch Rexroth, Hoffman Estates, Ill. (boschrexroth-us.com). Submit inquiries to Craig Dees, AMET, Inc. (www.ametinc.com), Rexburg, Idaho.



Fig. 2 — Welding equipment is usually suspended from a guide rail for outside welding.

welds, which wastes time and materials. This precise control had to be maintained within a demanding environment.

“The tremendous amount of particulates, especially flux dust, generated by this form of welding can really cause problems for this machine’s finer controls, particularly with systems such as linear actuators,” said Craig Dees, AMET engineering manager. “We needed to be sure that the linear motion components would stand up to this harsh welding environment, especially inside the can.”

In addition to good protection against flux particulates, the linear motion elements had to offer good strength (dynamic

loads in excess of 20,000 newtons) with light weight and compact size. Another challenge was to support smooth weld head acceleration of up to 3 m/s^2 , for a travel speed of 1.5 m/min .

To meet these needs, a source for linear motion components, Northwest Motion, Inc., a distributor of Rexroth CKK modules, was contacted. The company recommended a linear motion module with the desired strength-to-weight ratio. Hardened steel guide rails were specified for the guide rail that carries the suspended weld head for outside welding.

The linear actuator specified was CKK 20-145, which features a sealed rolling

strip. This seal keeps the module protected from the pitting that’s caused by particulates generated from welding. The two-carriage design gives the welding system a guideway dynamic load capacity of up to 61,000 newtons for the stability needed in the application.

The modules are complete prepackaged systems, with bearings and ball screws integrated in the module. This simplifies design, saves space, and removes the costs and effort of machining, assembly, and bearing alignment. The modules are helping AMET welding systems ensure dependable performance in wind tower applications. ♦

The Evolution of Weld Inspection in the Automotive Industry

Automotive weld inspection has moved from the destructive hammer and chisel method to nondestructive ultrasonic through-transmission techniques

BY STEFAN FRANK



Fig. 1 — Ultrasonic inspection of a gas metal arc weld.

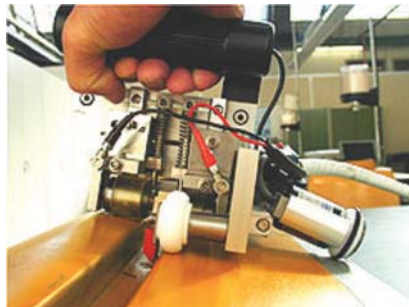


Fig. 2 — Ultrasonic inspection of a laser beam weld at a roof joint.



Fig. 3 — Instruments such as this Spotchecker™ ultrasonic spot weld inspection tool offer portability and easy-to-read screens.

The integrity of spot welds is critical to the overall integrity and reliability of an automobile. Over the last few years, the range of joining methods used in automotive body assembly lines has significantly increased. While resistance welding and gas metal arc welding (GMAW) have historically been the preferred joining methods, techniques such as laser beam welding and soldering are in common use today. Each of these processes can be used either individually or in conjunction with another method. This complexity places new demands on test engineering.

Safety is paramount, bearing in mind the increasing cost of product liability issues. At the same time, stricter environmental regulations and crash safety performance requirements compete in the design process with the increasing sophistication of driver requirements. Automotive manufacturers are continually looking for ways to fulfill vehicle requirements, increase the efficiency of production, and improve reliability and flexibility. Costly recall actions, increasing demands on quality management, and changing statutory regulations have increased the eco-

nomic pressures on the automotive industry, forcing change.

Lastly, the importance of vehicle weight, which includes materials and the methods of construction, is under increasingly close scrutiny. In addition to the development of these new materials, joining and bonding technologies are continually being evaluated to find more effective and cost-efficient welding and inspection methods.

Inspection Techniques to Match Welding Techniques

Welding technology is used widely in automotive construction. Power train assemblies and safety-relevant parts such as air bags and cartridges are welded. Spot welds are used throughout the manufacturing process to join body work.

It is critical to check and validate the integrity of welds as part of the rigorous quality control procedures in the automotive industry. Destructive testing is still routinely used as a quality management tool. However, by its nature, destructive testing generates high waste costs and can

be complex and difficult to automate. In contrast, nondestructive examination offers significant advantages because it does not generate much waste and is easily automated.

Testing Gas Metal Arc Welds

As it is difficult to examine the locations of some GMA welds, nondestructive examination may prove difficult. However, a nondestructive test may be carried out using the ultrasonic through-transmission method — Fig. 1. For this examination, a probe arrangement is selected with a number of transmitters. These are located in a fixed position on the test object. The ultrasonic receiver is guided along the weld joint. The received signal gives an indication of the weld joint quality.

Testing of Laser Beam Welds

Laser beam welds are increasingly being used in body construction. Testing of such joints is mainly carried out using the ultrasonic through-transmission technique. The ultrasonic head is guided over

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the test object parallel to the weld using a dry-coupled probe — Fig. 2. The test results are recorded and documented simultaneously during the test run. Flaw positions in the weld (e.g., incomplete fusion, inclusions, pores) may be displayed true to location via an integrated encoder.

Testing of Airbags

Airbag generators are safety-relevant components in a car. The flange edge of the cartridge is stretched in the shaping process, which can result in undertolerance in the thickness of the flange edge. By using an X-ray inspection station, the type of generator and the flange edge thickness can be automatically determined.

In another testing step, the laser-welded joints of the cartridge may be tested with ultrasonics. An automatic testing station scans the cartridge and a C-scan visual representation of the joint is displayed.

Testing of Spot Welds

The testing of spot welds is now primarily carried out via ultrasonics, replacing the old hammer and chisel destructive methods. An intelligent ultrasonic sensor is matched to the diameter of the nugget to be tested, and an evaluated result is displayed via the software to the operator. The operator can either accept the result or reject it.

Recent advances in spot weld testing equipment have done much to remove important decision-making from operators who may not be certified in nondestructive examination. Inspection advances have also allowed inspection to be carried out on the production line rather than having to use a dedicated inspection station.

Some of the latest equipment does not require intensive training, but offers the advantage of an “expert” system for less-qualified weld inspectors. By combining ultrasonic expertise with electronic data processing, a package solution is provided to perform the inspection, evaluation, and documentation of results, meeting strict quality management requirements. The operator receives inspection and test plans that specify the number of welds and describe the test location material data, test diagrams, and ultrasonic settings. With this information, the operator is guided through the inspection process. This can take the form of an image of the car frame on the instrument screen, with the welds highlighted so that the operator has to simply follow the inspection plan.

Portability and ease of use are also necessary requirements for today’s spot weld checking instruments, and it is important to look for equipment that features an ergonomically designed operator interface

and easy-to-read screen — Fig. 3. It is also important to look for equipment that is easy to operate in restricted test settings, such as the body of the car or on the production line.

Today’s instruments are much more than just “go, no-go” devices. They can be USB-connected to external periphery devices, such as a mouse, keyboard, or printer, to allow immediate printing of inspection results. More importantly, the instrument can also be connected to a PC wirelessly by LAN, WLAN, or Bluetooth technology for data upload and download. This data transfer can be done in real time, which makes it possible to get almost immediate feedback on weld quality. Adjustments can be made before the part is transferred from the welding station.

Conclusion

In the early days of the automotive industry, formalized quality control was quite basic. Mass production was based upon the concept of process repeatability and repeatability creates consistency, which in turn means controlled quality. Naturally, there were random checks to ensure that production line operations were being carried out satisfactorily and these checks

nearly always involved the destructive examination of a component. However, today’s automotive industry demands sophisticated and traceable quality control through nondestructive examination.

As the materials used in car manufacturing have evolved over the years, so have the methods to join them. Welding is still the major joining method and sophisticated techniques have been developed to ensure alignment with design concepts and long-term performance. Techniques for testing and evaluating the integrity of welds are now seen as essential components of reliable and meaningful quality control systems. ♦

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WELDING

WORKBOOK

Datasheet 308

Inspecting Welds by Penetrant Testing

Penetrant testing (PT) is a sensitive method for locating discontinuities such as cracks and porosity. The discontinuities must be clean and open to the surface to be detected. This method employs a penetrating liquid that is applied to the surface. Time is given for the liquid to enter the discontinuities, and then the excess liquid is removed. The discontinuities are detected when the penetrant exudes from them and causes a developer powder to colorize.

There are two classifications of penetrants: visible dye and fluorescent. The main difference between the two is the visible dye can be seen under normal lighting conditions, while an ultraviolet (or black) light is needed to detect discontinuities with the fluorescent method. The penetrants can be applied to the surface by brushing, dipping, flooding, or spraying. Since the eye can more readily detect fluorescence, this method is used more often for critical applications where minute discontinuities must be detected.

The four steps in penetrant testing include precleaning the surface, applying the penetrant, removing the excess penetrant after waiting a prescribed time (dwell time), and applying the developer. With the drying of the developer, the results are evalu-

ated with applicable standards.

Although PT can be used on magnetic materials, it is a good choice for metals such as aluminum, magnesium, and austenitic stainless steels, which cannot be examined by magnetic particle testing.

The advantages of PT are its ease of application, technicians find little difficulty in learning the technique, it is quick and inexpensive, and for smooth surfaces, there are few, if any, false readings.

The process does have some limitations. The discontinuities must be clean and open to the surface, penetrants can be difficult to completely remove, and some penetrants can have a deleterious effect on the welds and base metals, affecting their service lives.

To make sure interpretation is not compromised, sufficient time should be given for the penetrant to seep into the discontinuities. Large cracks will be obvious, but smaller ones need the extra time to become visible. Inadequate cleaning of the superficial penetrant will give false indications, such as general glow under black light, or a general pink coloration of the developer with the visible dye penetrant method.

IF YOU SEE:	INDICATION	YOU HAVE:
A CONCENTRATION OF RED SPOTS		PITS AND POROSITY
A CONTINUOUS STREAK WHICH BLEEDS UP RAPIDLY		LARGE CRACK OR OPENING
A BROKEN LINE OF DOTS WHICH TAKES SEVERAL MINUTES TO COME UP		CRACK OR COLD SHUT
A SERIES OF RED DOTS FORMING AN IRREGULAR LINE		FATIGUE CRACK, PARTIAL WELD OR LAP

Developer Interpretation

Excerpted from CM:2000, *Certification Manual for Welding Inspectors*.

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COMING EVENTS

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

Titanium 2009 Conf. and Expo. Sept. 13–16, Hilton Waikoloa Village, Waikoloa, Hawaii. Sponsored by the Int'l Titanium Assn. Visit www.titanium.org.

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

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

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

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

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

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

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

Power-Gen Asia and Renewable Energy World Asia Conf. and Expo. Oct. 7–9, IMPACT Exhibition & Convention Centre, Bangkok, Thailand. Visit www.powergenasia.com.

The Aluminum Association Annual Meeting, "2010: Opportunities & Challenges." Oct. 19, 20, Hotel Palomar & Waterview Conf. Center, Arlington, Va. Visit www.aluminum.org.

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

MACHTECH 9th Int'l Expo for Machine Tools, Industrial Tools, Welding and Cutting Equipment. Oct. 22–25, Cairo Fair Ground, Cairo, Egypt. Visit www.ifg-eg.com.

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

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

2009 Shanghai Int'l Science Journals Summit. Oct. 27, 28, Shanghai, P.R., China. Visit www.sjs-sh.org.cn.

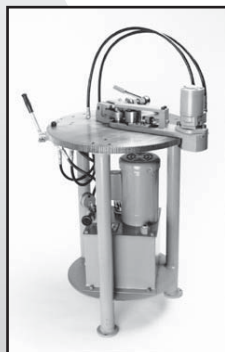
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ICALEO®, 28th Int'l Congress on Applications of Lasers & Electro-Optics. Nov. 2-5, Hilton in the Walt Disney World Resort®, Orlando, Fla. This conference is where researchers and end-users will meet to review state-of-the-art laser materials processing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

Metalworking and CNC Machine Tool Show 2009. Nov. 3-7, Shanghai New Int'l Expo Center, Shanghai, China. Visit www.messe.de.

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

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

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

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

♦ **Welding Chrome-Moly Steels Conf.** Nov. 17, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Con-

tact American Welding Society, (800/305) 443-9353, ext. 455; or visit www.aws.org.

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

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

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

♦ **LÖT 2010, 9th Int'l Conf. on Brazing, High-Temperature Brazing, and Diffusion Bonding.** June 15-17, Aachen, Germany. Sponsored by DVS (German Welding Society), cosponsored by AWS, ASM Int'l, and other societies. Visit www.dvs-ev.de/loet2010.

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

EuroBLECH 2010, 21st Int'l Sheet Metal Working Technology Exhibition. Oct. 26-30, 2010, Exhibition Grounds, Hanover, Germany. Visit www.euroblech.com.

Educational Opportunities

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

TECHNICAL TRAINING

The Hobart Institute of Welding Technology offers our comprehensive Technical Training courses throughout the year! Upcoming dates:

Prep for AWS Certified Welding Supervisor Exam
Aug 10-14 • Nov 30-Dec 4

Prep for AWS Welding Inspector/Educator Exam
Aug 24-Sep 4 • Sep 28-Oct 9 • Nov 2-13 • Dec 7-18

Visual Inspection
Nov 23-24

Welding for the Non Welder
Aug 17-20 • Oct 12-15

Arc Welding Inspection & Quality Control
Oct 19-23

Weldability of Metals, Ferrous & Nonferrous
Aug 10-14 • Sep 7-11 • Oct 5-9 • Nov 2-6 • Nov 30-Dec 4

Liquid Penetrant & Magnetic Particle Inspection
Aug 3-7 • Oct 26-30



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Basics of Valves and Actuators Seminars and Expo. Oct. 29, Sheraton Houston Brookhollow Hotel, Houston, Tex. Sponsored by Valve Manufacturers Assn. Visit <http://vma.yourmembership.com/?valvebasics>.

Basic and Advanced Welding Courses. Cleveland, Ohio. Contact The Lincoln Electric Co. for schedules, www.lincolnelectric.com.

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

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

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

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

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

EPRI NDE Training Seminars. EPRI offers NDE technical skills training in visual examination, ultrasonic examination, ASME

Section XI, and UT operator training. Contact Sherryl Stogner, (704) 547-6174; ssogner@epri.com.

Essentials of Safety Seminars. Two- and four-day courses are held at numerous locations nationwide to address federal and California OSHA safety regulations. Contact American Safety Training, Inc., (800) 896-8867, www.trainosha.com.

Fabricators and Manufacturers Assn. and Tube and Pipe Assn. Courses. Call (815) 399-8775; visit www.fmanet.org.

Firefighter Hazard Awareness Online Course. A self-paced, ten-module certificate course taught online by fire service professionals. Fee is \$195. Contact Industrial Scientific Corp., (800) 338-3287; www.indsci.com/serv_train_ffha_online.asp.

Fundamentals of Brazing Seminar. Sept. 29–Oct. 1, Hyatt Regency Hotel, Philadelphia, Pa. Visit www.lucasmilhaupt.com; or call (800) 558-3856.

Gas Detection Made Easy Courses. Online and classroom courses for managing a gas monitoring program from gas detection to confined-space safety. Contact Industrial Scientific Corp., (800) 338-3287; www.indsci.com/serv_train.asp.

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AWS Certification Schedule

Certification Seminars, Code Clinics and Examinations

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

Certified Welding Inspector (CWI)

LOCATION	SEMINAR DATES	EXAM DATE
Charlotte, NC	Aug. 16-21	Aug. 22
San Antonio, TX	Aug. 16-21	Aug. 22
Bakersfield, CA	Aug. 16-21	Aug. 22
Rochester, NY	EXAM ONLY	Aug. 22
Portland, ME	Aug. 23-28	Aug. 29
Salt Lake City, UT	Aug. 23-28	Aug. 29
Seattle, WA	Aug. 23-28	Aug. 29
Corpus Christi, TX	EXAM ONLY	Aug. 29
Pittsburgh, PA	Aug. 30-Sept. 4	Sept. 5
Houston, TX	Aug. 30-Sept. 4	Sept. 5
Minneapolis, MN	Aug. 30-Sept. 4	Sept. 5
St. Louis, MO	Sept. 20-25	Sept. 26
Miami, FL	Sept. 20-25	Sept. 26
New Orleans, LA	Sept. 20-25	Sept. 26
Anchorage, AK	EXAM ONLY	Sept. 26
Tulsa, OK	Oct. 4-9	Oct. 10
Long Beach, CA	Oct. 4-9	Oct. 10
Newark, NJ	Oct. 4-9	Oct. 10
Miami, FL	EXAM ONLY	Oct. 15
Portland, OR	Oct. 18-23	Oct. 24
Roanoke, VA	Oct. 18-23	Oct. 24
Cleveland, OH	Oct. 18-23	Oct. 24
Atlanta, GA	Nov. 1-6	Nov. 7
Dallas, TX	Nov. 1-6	Nov. 7
Sacramento, CA	Nov. 1-6	Nov. 7
Spokane, WA	Nov. 1-6	Nov. 7
Corpus Christi, TX	EXAM ONLY	Nov. 21
St. Louis, MO	EXAM ONLY	Dec. 5
Syracuse, NY	Dec. 6-11	Dec. 12
Reno, NV	Dec. 6-11	Dec. 12
Miami, FL	Dec. 6-11	Dec. 12
Corpus Christi, TX	EXAM ONLY	Jan. 23, 2010
Miami, FL	EXAM ONLY	Feb. 25
Perrysburg, OH	EXAM ONLY	Mar. 13
Miami, FL	EXAM ONLY	Mar. 18
Rochester, NY	EXAM ONLY	Mar. 20
Corpus Christi, TX	EXAM ONLY	Mar. 20
York, PA	EXAM ONLY	Mar. 27

9-Year Recertification Seminar for CWI/SCWI

LOCATION	SEMINAR DATES	EXAM DATE
Orlando, FL	Aug. 24-29	NO EXAM
Dallas, TX	Oct. 5-10	NO EXAM
Miami, FL	Nov. 30-Dec. 5	NO EXAM

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

Certified Welding Supervisor (CWS)

LOCATION	SEMINAR DATES	EXAM DATE
Philadelphia, PA	Aug. 31- Sep. 4	Sep. 5
Tulsa, OK	Oct. 5-9	Oct. 10
Long Beach, CA	Nov. 30-Dec. 4	Dec. 5

CWS exams are also given at all CWI exam sites.

Certified Radiographic Interpreter (CRI)

LOCATION	SEMINAR DATES	EXAM DATE
Miami, FL	Oct. 19-23	Oct. 24

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

Certified Welding Sales Representative (CWSR)

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

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

Certified Welding Educator (CWE)

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

Senior Certified Welding Inspector (SCWI)

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

Certified Welding Engineer – (CWEng)

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)

LOCATION	WEEK OF:	CONTACT
ABB, Inc., Auburn Hills, MI	Aug. 3	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Aug. 10	(970) 225-7736
ABB, Inc., Auburn Hills, MI	Aug. 24	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Sept. 21	(970) 225-7736
ABB, Inc., Auburn Hills, MI	Oct. 5	(248) 391-8421
Lincoln Electric, Cleveland, OH	Oct. 19	(216) 383-8542
ABB, Inc., Auburn Hills, MI	Nov. 2	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Nov. 2	(970) 225-7736
ABB, Inc., Auburn Hills, MI	Dec. 14	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Dec. 14	(970) 225-7736

Code Clinics & Individual Prep Courses

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

On-site Training and Examination

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

International CWI Courses and Exams

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

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



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The American Welding Society and **The International Thermal Spray Association** are organizing the first Thermal Spray and Coatings Conference, to be held in conjunction with the 2009 Fabtech Int'l & AWS Welding Show. This event will introduce the process and its uses to new potential users with morning and afternoon sessions focusing on actual applications and new developments in thermal spray technology.

In addition, on Sunday, Nov. 15, a free half-day tutorial on thermal spray fundamentals is scheduled, sponsored by the International Thermal Spray Association, titled **"What Is Thermal Spray?"**

For the latest conference information, visit our website at www.aws.org/conferences or call **800-443-9353, ext. 455**.

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SOCIETY NEWS

BY HOWARD M. WOODWARD

AWS Nominates National and District Officers for 2010



John C. Bruskotter
president



John L. Mendoza
vice president



William A. Rice Jr.
vice president



Nancy C. Cole
vice president

The 2008–2009 Nominating Committee has announced its slate of candidates who will stand for election to AWS national offices for the 2010 term, which begins Jan. 1, 2010. Nominated are the following candidates: **John C. Bruskotter** for president; **John L. Mendoza**, **William A. Rice**, and **Nancy C. Cole** for vice presidents; **Robert G. Pali** for treasurer; and **Dean R. Wilson** and **Thomas J. Lienert** for directors-at-large.

Three vice presidents, one treasurer, and two directors-at-large are to be elected.

The National Nominating Committee was chaired by Past President **Gerald D. Utrachi**. Serving on the committee with Utrachi were **E. D. Levert**, **D. C. Howard**, **M. D. Bell**, **J. R. Bray**, **K. R. Stockton**, **R. C. Pierce**, **R. J. Teuscher**, **G. D. Fairbanks Jr.**, **M. V. Harris**, **D. J. Kotecki**, **S. P. Moran**, and **D. J. Nangle**. **G. Manalich** served as secretary.

The Nominating Committees for Districts 1, 4, 7, 10, 13, 16, 19, and 22 have selected the following candidates for

election/re-election as District directors for the three-year term Jan. 1, 2010–Dec. 31, 2012. The nominees are **Thomas A. Ferri**, Dist. 1; **Roy C. Lanier**, Dist. 4; **Donald C. Howard**, Dist. 7; **Richard A. Harris**, Dist. 10; **W. Richard Polanin**, Dist. 13; **David J. Landon**, Dist. 16; **Neil S. Shannon**, Dist. 19; and **Dale A. Flood**, Dist. 22.

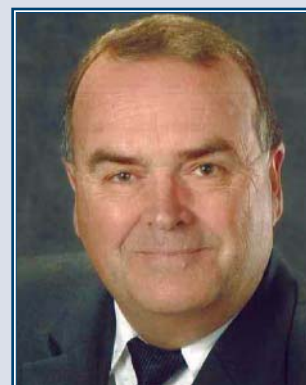
Nominated for President **John C. Bruskotter**

John C. Bruskotter is currently completing his third term as an AWS vice president. He has headed Bruskotter Consulting Services since 2004 working for an independent oil and gas operator. Previously, he worked as a project manager with Dynamic Industries, Inc. From 1986 to 2000, he was employed with Houma Industries, Inc., where his positions included fabrication and quality control manager, vice president of operations onshore, offshore fabrication and coatings, and warehousing and maintenance.

Bruskotter joined the AWS



Robert G. Pali
treasurer



Dean R. Wilson
director-at-large

New Orleans Section in 1993, where he served as its treasurer and vice chair. From 1999 to 2000, he served as both the Section chairman and District 9 deputy director.

Nominated for Vice President **John L. Mendoza**

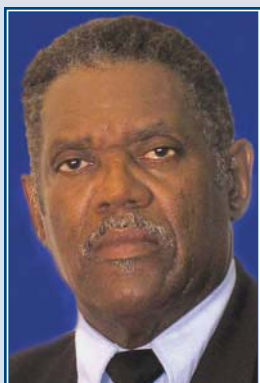
John L. Mendoza is currently completing his second term as an AWS vice president. He is an AWS Certified Welding Inspector, Certified Welding Educator, and a journeyman welder quali-



Thomas J. Lienert
director-at-large



Thomas Ferri
District 1 director



Roy C. Lanier
District 4 director



Donald C. Howard
District 7 director



Richard A. Harris
District 10 director

fied to ASME Section IX in SMA and GTA welding with 34 years of experience in power plant maintenance for CPS Energy, San Antonio, Tex. In 1994, he was promoted to Technical Trainer, responsible for developing training programs and training power plant welders. In 1996, he earned his Craft Instructor certification from the National Center for Construction Education and Research and was hired as an adjunct welding instructor for Texas A&M University. In 2005, Mendoza was elected to the State of Texas board of directors for the SkillsUSA college/post-secondary division. For the past two years, he has chaired the Texas SkillsUSA welding competition. He is a 33-year member of the International Brotherhood of Electrical Workers, Local 500, and a past chair of the St. Philip's College welding advisory committee. He has received the District Dalton E. Hamilton Memorial CWI of the Year Award.

Nominated for Vice President **William A. Rice Jr.**

William A. Rice Jr., an AWS member for more than 25 years, is currently completing his first term as a vice president. Rice currently serves as CEO for OKI Bering Supply, president of Dadco of West Virginia, and president of West Side Real Estate, LLC, and is on the boards of trustees for several health and financial organizations in West Virginia. Rice worked for Airgas from 1993 to 2001, where he served as its president and COO. From 1971 to 1992, he was president of Virginia Welding Supply Co. and president of several other welding-related companies, which he later sold to Airgas. He served as chairman of the state VICA welding contests from 1979 to 1983. Rice holds a degree in business marketing with postgraduate studies in journalism, publications, psychology, and labor relations, and has completed numerous welding-related courses presented by AWS and other organizations.

Nominated for Vice President **Nancy C. Cole**

Nancy C. Cole has been nominated for her first term as a vice president. She is an AWS Fellow, a Life Member, and a registered Professional Engineer in the state of Tennessee. She has been a member of the Northeast Tennessee, Chattanooga, and Northeast Florida Sections. She served as chair of the AWS Technical Activities, Fellows, and C3 Brazing and Soldering Committees, and has served on the International Standards, Awards, Research and Development, Technical Paper Selection, and National Nominating Committees. Cole also served on the Welding Research Council Brazing Research Committee, Materials Advisory Group, Marine Board, National Research Council, Advanced Joining Committee, and National Materials Advisory Board. She has received the Wasserman Award, McKay-Helm Award, AWS Honorary Member Award, and Outstanding Alumni Award from University of Tennessee. She holds three brazing-related patents. Cole worked at ABB Combustion Engineering where she developed welding electrodes, fluxes, and flux cored wires, and wrote computer programs for the process. Before forming her own company, she was program manager and contract manager at Oak Ridge National Laboratories.

Nominated for Treasurer **Robert G. Pali**

Robert G. Pali has been nominated for treasurer to succeed **Earl C. Lipphardt**. He is vice president, secretary, and COO of J. P. Nissen Co., where he has worked since 1979. He holds a master's degree in business administration with a concentration in finance from The Wharton School. Pali is currently vice chair of the AWS Finance Committee and a member of the AWS Publications, Expositions, and Marketing Committee. He has served on the Welding Equipment Manufacturers Committee (WEMCO) executive board, National Nominating Committee, and nu-

merous subcommittees and presidential task forces. From 1965 to 1978, Pali worked for Bethlehem Steel Corp. in analytical chemistry and plant operations research. In 2006, he received the AWS National Meritorious Certificate Award.

Nominated for Director-at-Large **Dean R. Wilson**

Dean R. Wilson is serving his first term as a director-at-large. He is vice president, welding business development, at Jackson Safety Products where he has worked since 2007. From 1987 to 2007, he served as president, CEO, and owner of Wilson Industries, Inc., in Pomona, Calif., a manufacturer of industrial partitions, clothing, safety products, and accessories for the welding, laser, materials-handling, and safety markets. He has completed graduate studies in business at San Diego State University and at Stanford University in executive management. Wilson is a Laser Institute of America director-at-large, and a member of Gases and Welding Distributors Assn., Industrial Fabrics Assn., Specialty Tools & Fasteners Distributors Assn., and Safety Equipment Distributors Assn.

Nominated for Director-at-Large **Thomas J. Lienert**

Thomas J. Lienert, an AWS Certified Welding Inspector, is a technical staff member, Materials Science Technology Division, at Los Alamos National Laboratory. He received his PhD in materials science and engineering from The Ohio State University in 1998. Currently, he is a Principal Reviewer and member of the AWS Technical Papers Committee, and chairs the AWS Handbook chapters on Friction Stir Welding and Stainless and Heat-Resisting Steels, and chairs the C6 Committee on Friction Welding and the AWS Higher Education Committee. Lienert is also vice chair of the Education Committees, and a member of the Technical Activities Committee. He has published widely and received the McKay-Helm Award and the Charles H. Jennings



W. Richard Polanin
District 13 director



David J. Landon
District 16 director



Neil S. Shannon
District 19 director



Dale A. Flood
District 22 director

Memorial Award. He is a member of Tau Beta Pi Engineering Honor Society and Alpha Sigma Mu Metallurgy/Materials Science Honor Society.

Nominated for District 1 Director **Thomas A. Ferri**

Thomas A. Ferri, an AWS CWI, is nominated for his first term as District 1 director. He is district manager New England for Thermadyne Industries, and an AWS member for 30 years. Ferri served four terms as Boston Section chair, certification chair from 2001 to 2008, and education chair from 1999 to the present. He serves as a welding consultant to many companies in Massachusetts, and is a member of the advisory committees at five vocational technical schools.

Nominated for District 4 Director **Roy C. Lanier**

Roy Lanier is reelected as District 4 director. An AWS member for more than 30 years, he has served as chairman of the Northeastern Carolina Section. Lanier has taught in the community college system for the past 33 years, performing as an instructor and chairman of the Welding Technology Department. At Pitt Community College, he held offices on various committees including its Scholarship Committee. He holds CAWI and CWE certificates. In 1989, Lanier received the Howard Adkins Award of Excellence for teaching. He recently retired from the North Carolina National Guard with 30 years of service. Today, Lanier teaches welding and serves as department chairman of the Welding Division.

Nominated for District 7 Director **Donald C. Howard**

Don Howard is reelected as District 7 director. He is a technical staff member at Concurrent Technologies Corp. in Johnstown, Pa., where he has worked in the Advanced Materials department since 1990. He specializes in welding high-strength low-alloy steels for use in shipbuilding. Prior to joining the com-

pany, he worked as a welder in a truck body manufacturing plant. He received his welding engineering technology degree from Westmoreland County Community College, where he serves as an adjunct faculty member, teaching courses in its welding program.

Nominated for District 10 Director **Richard A. Harris**

Richard Harris has been reelected as District 10 director. Harris is a contributing editor for Penton Publishing Co. in Novelty, Ohio.

Nominated for District 13 Director **W. Richard Polanin**

Rick Polanin is reelected District 13 director. He received a PhD from the University of Illinois. He is professor and program chair for the Manufacturing Engineering Technology and Welding Technology programs at Illinois Central College. An AWS member for 30 years, he has twice served as chair of the Peoria Section. Polanin is a member of the D16 Robotic and Automated Welding Committee. He is an AWS Certified Welding Inspector and Certified Welding Educator, and is a SME Certified Manufacturing Engineer. He has received the District Educator Award and the District CWI Award. Polanin has published numerous papers and textbooks. Polanin is also a consultant in manufacturing and welding for the construction equipment and chemical industries in central Illinois.

Nominated for District 16 Director **David J. Landon**

David Landon is reelected as District 16 director. An AWS member since 1983, he is manager of welding engineering at Vermeer Mfg. Co., Pella, Iowa. He has served two terms as chairman of the Iowa Section, and chaired the Welding Industry Network, and the Technical Activities Committee. He is a member of the D14 Committee on Machinery and Equipment, International Standards Activity Committee, and Awards Committee.

Landon is a Senior Certified Welding Inspector and a recipient of the District Dalton E. Hamilton Memorial CWI of the Year Award, and the District Meritorious Award. He holds a welding engineering degree from LeTourneau University.

Nominated for District 19 Director **Neil S. Shannon**

Neil Shannon, an AWS Life Member, is reelected as District 19 director. He has been active in the District and Portland Section activities for 30 years. He is a project manager and senior special inspector for Carlson Testing of Portland, Ore. He is a Senior Certified Welding Inspector, and Int'l Code Council special inspector, and provides special inspection services for complex building construction in Portland. He trained as a welding technician at the College of San Mateo, Calif., and later earned his engineering degree at California Polytechnic State University. He has experience in marine construction, material-handling equipment, railroad equipment, and robotics in welding applications.

Nominated for District 22 Director **Dale A. Flood**

Dale Flood is reelected as District 22 director. He is a project manager at Tri-Tool Inc., Rancho Cordova, Calif. He holds several patents for welding automation related work. Flood has served the Sacramento Valley Section in numerous capacities. Currently, Flood is a member of the executive committee where his involvement continues as a CWI supervising examiner. He is an active member of the D10 Committee on Piping and Tubing, and the D10U Subcommittee on Orbital Pipe Welding. He started his career as a welder with the Plumbers & Steamfitters Local Union 157. Later, he worked as a weld superintendent for CBI Services at several nuclear facilities where he was involved with machine and automated welding of critical application piping. ♦

Tech Topics

Errata D1.3

AWS D1.3/D1.3M:2008

Structural Welding Code — Sheet Steel

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

Page 25 - 4.6.1.2(2)(b) Incorrect reference. Change reference from "6.1.1.2" to "6.1.1.3".

Page 25 - 4.6.1.2(2)(c) Incorrect reference. Change reference from "6.1.1.3" to "6.1.1.4".

New Standards Projects

Development work has begun on the following new or revised standards. Affected individuals are invited to contribute to the development of these standards. Those wanting to participate may contact the Staff Engineer listed with the document. Participation on AWS Technical Committees and Subcommittees is open to all persons.

A5.5/A5.5M:200X, *Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding*. This specification prescribes the requirements for classification of low-alloy steel covered electrodes used for shielded metal arc welding. The requirements include chemical composition and mechanical properties of weld metal, weld metal soundness, usability tests of electrodes, and moisture tests of the low-hydrogen electrode covering. Requirements for standard sizes and lengths, marking, manufacturing, and packaging are included. Optional supplemental requirements include tests for absorbed moisture in the electrode covering and for diffusible hydrogen in the weld metal. Stakeholders: Welding industry. Revised. R. Gupta, ext. 301.

A5.14/A5.14M:200X, *Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods*. The chemical compositions of 51 nickel and nickel-alloy welding electrodes and rods are specified, including one composition not previously classified. Major topics include general requirements, testing, packaging, and application guidelines. This specification makes use of both U.S. Customary Units (SI). Stakeholders: Welding industry. Revised. R. Gupta, ext. 301.

A5.32/A5.32M:200X (ISO 14175:2008 MOD), *Specification for Shielding Gases Used for Welding*. This specification for welding shielding gases specifies minimum requirements for the composition

and purity of the most popular single-component shielding gases. Classification designators for both single and multicomponent gases are introduced. Other topics include testing procedures, package marking, and general application guidelines. This specification makes use of both U.S. Customary Units and International System of Units (SI). Stakeholders: Welding industry. Adopt ISO or IEC standard with modifications. Revised. R. Gupta, ext. 301.

A5.36/A5.36M:200X, *Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding*. This specification prescribes the requirements for classification of carbon and low-alloy steel flux cored electrodes for flux cored arc welding and metal cored electrodes for gas shielded arc welding. The requirements include chemical composition and mechanical properties of the weld metal and certain usability characteristics. Optional, supplemental designators are also included for diffusible hydrogen and to indicate conformance to special mechanical property requirements when the weld metal is deposited using low heat input, fast cooling rate and high heat input, slow cooling rate procedures. Stakeholders: Welding industry. New. R. Gupta, ext. 301.

B2.1/B2.1M:200X, *Specification for Welding Procedure and Performance Qualification*. This specification provides requirements for the qualification of welding procedures. It also provides requirements for the performance qualification of welders and welding operators. It is intended for use where referenced by a product or fabrication code, specification, contract document, or internal documents such as quality control or quality assurance manuals. The requirements imposed by the Referencing Document (see 1.3.2 Supplemental Definitions) supersede the requirements of this specification. Stakeholders: Welders, consumers, producers. Revised. S. Morales, ext. 313.

B5.1:200X, *Specification for the Qualification of Welding Inspectors*. This standard defines the qualification requirements to qualify welding inspectors. The qualification requirements for visual welding inspectors include experience, satisfactory completion of an examination, which includes demonstrated capabilities, and proof of visual acuity. The examination tests the inspector's knowledge of welding processes, welding procedures, nondestructive examinations, destructive tests, terms, definitions, symbols, reports, welding metallurgy, related mathematics, safety, quality assurance, and responsi-

bility. Stakeholders: Welding inspectors, metal fabricators, end users, erectors, educators, engineers, structural steel industry. Revised. J. Gayler, ext. 472.

D10.17M:200X, *Guide for Welding Tubular Steel Vehicle Structures*. This document presents a detailed discussion of the methods and recommended procedures for welding of steel tubing for vehicle structures. A number of figures and tables illustrate recommended joint designs, filler metal selections, and procedures. Stakeholders: Vehicle detail designers, fabricators, and end users. New. B. McGrath, ext. 311.

Reaffirmed Standards

Approved by ANSI on 5/29/2009

B2.1-4-217:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), ER80S-B2, ½ through ½ in. Thick, As-Welded Condition; ½ through ¾ in. Thick, PWHT Condition, Primarily Pipe Applications*

B2.1-4-218:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), E8018-B2, ½ through ½ in. Thick, As-Welded Condition; ½ through 1½ in. Thick, PWHT Condition, Primarily Pipe Applications*

B2.1-4-219:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), ½ through ½ in. Thick, As-Welded Condition; ½ through 1½ in. Thick, PWHT Condition, ER80S-B2 and E8018-B2, Primarily Pipe Applications*

B2.1-4-220:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), ½ through ½ in. Thick, As-Welded Condition; ½ through ¾ in. Thick, PWHT Condition, IN515 and ER80S-B2, Primarily Pipe Applications*

B2.1-4-221:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding (Consumable Insert Root) followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-4/P-4, Group 1 or 2), ½ through ½ in. Thick, As-Welded Condition; ½ through 1½ in. Thick, PWHT Condition, IN515, ER80S-B2, and E8018-B2, Primarily Pipe Applications*

B2.1-5A-222:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding of*

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PRIZE CATEGORIES

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

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

President's Roundtable: Recruit 9-19 new Individual Members and receive an AWS polo shirt, hat and an AWS key chain.

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

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

SPECIAL PRIZES

Participants will also be eligible to win prizes in specialized categories. Prizes will be awarded at the close of the campaign (June 2010).

Sponsor of the Year: The individual who sponsors the greatest number of new Individual Members during the campaign will receive a plaque, a trip to the 2010 FABTECH International & AWS Welding Show, and recognition at the AWS Awards Luncheon at the Show.

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

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

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

LUCK OF THE DRAW

For every new member you sponsor, your name is entered into a quarterly drawing. The more new members you sponsor, the greater your chances of winning. Prizes will be awarded in November 2009, as well as in February and June 2010.

Prizes Include:

- ★ Complimentary AWS Membership renewal
- ★ AWS t-shirt
- ★ AWS hat

SUPER SECTION CHALLENGE

The AWS Section in each District that achieves the highest net percentage increase in new Individual Members before the June 2010 deadline will receive special recognition in the *Welding Journal*.

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

*The 2009-2010 MGM Campaign runs from June 1, 2009 to May 31, 2010. Prizes are awarded at the close of the campaign.



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

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First Name _____ M.I. _____

Title _____ Birthdate _____

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

Primary Phone () _____ Secondary Phone () _____

FAX () _____ E-Mail _____

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

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

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Address Con't. _____

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

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

① Who pays your dues?: ☐ Company ☐ Self-paid ② Sex: ☐ Male ☐ Female

③ Education level: ☐ High school diploma ☐ Associate's ☐ Bachelor's ☐ Master's ☐ Doctoral

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NOTE: Dues include \$18.70 for *Welding Journal* subscription and \$4.00 for the AWS Foundation.

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

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- ☐ *Welding Handbook (9th Ed., Vol. 2)*
- ☐ *Welding Handbook (9th Ed., Vol. 1)*

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Type of Business (Check ONE only)

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

Job Classification (Check ONE only)

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

Technical Interests (Check all that apply)

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

Chromium-Molybdenum Steel (M-5A/P-5A), ER90S-B3, 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 3/4 in. Thick, PWHT Condition, Primarily Pipe Applications

B2.1-5A-223:1999 (R2009), Standard Welding Procedure Specification (SWPS) for Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), E9018-B3, 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 1 1/2 in. Thick, PWHT Condition, Primarily Pipe Applications

B2.1-5A-224:1999 (R2009), Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 1 1/2 in. Thick, PWHT Condition, ER90S-B3 and E9018-B3, Primarily Pipe Applications

B2.1-5A-225:1999 (R2009), Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding (Consumable Insert Root) of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 3/4 in. Thick, PWHT Condition, IN521 and ER90S-B3, Primarily Pipe Applications

B2.1-5A-226:1999 (R2009), Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding (Consumable Insert Root) followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 1 1/2 in. Thick, PWHT Condition, IN521, ER90S-B3, and E9018-B3, Primarily Pipe Applications

Standard for ANSI Public Review

B5.2:2001 (R200X), Specification for the Qualification of Welding Inspector Specialists and Welding Inspector Assistants.

AWS India International Agent Visits Headquarters



Selvaraj Murugaiyan (left), director of marketing, BETZ Engineering & Technology Services, is shown with Cassie Burrell (center), AWS deputy executive director; and Priti Jain, AWS director, international business and certification programs. BETZ, an AWS International Agent since May 2008, has been successfully administering the Society's certification programs in India. Murugaiyan visited AWS headquarters June 26 to discuss expansion plans.

Reaffirmed standard. \$25. Public review expires 8/17/2009.

AWS was approved as an accredited standards-preparing body by the American National Standards Institute (ANSI) in 1979. AWS rules, as approved by ANSI, require that all standards be open to public review for comment during the approval process. The above standard is open for review until the date shown. Draft copies may be obtained from R. O'Neill, ext. 451, roneill@aws.org.

ISO Standards for Public Review

ISO/DIS 3690, Welding and allied processes — Determination of hydrogen content in arc weld metal

ISO/DIS 14271, Resistance welding — Vickers hardness testing (low-force and microhardness) of resistance spot, projection, and seam welds

ISO/DIS 24034, Welding consumables — Solid wires and rods for fusion welding of titanium and titanium alloys

— 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.

Any comments regarding ISO documents should be sent to your national standards body. In the United States, if you wish to participate in the development of International Standards for welding, contact A. Davis, adavis@aws.org; ext. 466.

Technical Committee Meetings

Aug. 19, 20, International Standards Activities Committee. Cleveland, Ohio. Call A. R. Davis, ext. 466.

Aug. 19, 20, Technical Activities Committee. Cleveland, Ohio. Call J. L. Gayler, ext. 472.

Sept. 22–25, D1 Committee on Structural Welding and subcommittees. Philadelphia, Pa. Call S. Morales, ext. 313.

Members Sought for Technical Committees

Thermal Spraying

Volunteers are sought 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/IUQ4 to submit your application online.

Welding Sales Representatives

AWS established a new certification program for welding sales representatives in 2009. 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/IUQ4.

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, for information; or visit www.aws.org/IUQ4 to submit your member application online.

New AWS Supporters

Supporting Companies

Standard Aero Component Services
11550 Mosteller Rd.
Cincinnati, OH 45241

Technomarine Manufacturing, Inc.
598 Leclerc St.
Repentigny, QC J6A 2E5
Canada

Vulcan Steel Structures, Inc.
500 Vulcan Pkwy.
Adel, GA 31620

Yankee Metals, LLC
76 Knowlton St.
Bridgeport, CT 06608

Affiliate Companies

Amana Industries-FZE
PO Box 42098
Hamriyah Free Zone
Sharjah, UAE

Bare Metal Works, Inc
9007 Arrow Rte. #130
Rancho Cucamonga, CA 91730

Magnum Deputy Inspections, Inc.
29051 Modjeska Peak Ln.
Portola Hills, CA 92679

Munters Corp.
108 6th St.
Fort Myers, FL 33907

Phoenix Stair, Inc.
6029 W. Washington
Phoenix, AZ 85043

Rayco Industrial, Inc.
3810 Hwy. 41 S.
Selma, AL 36701

Valco Planer Works, Inc.
6161 Maywood Ave.
Huntington Park, CA 90255

Educational Institutions

AG&P Co. of Manila Foundation, Inc.
San Roque, Bauan
Batangas 4201, Philippines

Apollo Career Center
3325 Shawnee Rd.
Lima, OH 45806

Floyd County Schools College and
Career Academy, 100 Tom Poe Dr. SW
Rome, GA 30161

Hennepin Technical College
9000 Brooklyn Blvd.
Brooklyn Park, MA 55445

Membership Counts

Member Grades	As of 7/01/09
Sustaining.....	507
Supporting.....	309
Educational.....	495
Affiliate.....	480
Welding distributor.....	46
Total corporate members.....	1,837
Individual members.....	51,614
Student + transitional members.....	5,897
Total members.....	57,511

Keyano College
8115 Franklin Ave.
Fort McMurray, AB T9H 2H7, Canada

Lake City Community College
149 SE College Pl.
Lake City, FL 32025

National Centre for Professional Training
PO Box 50, Pandalam
Pathanamthitta, Dist. Kerala, India

District Director Awards Announced

John Bray, District 18 director, has nominated the following for this award:

Christopher Long, Corpus Christi
Danny Castro, Houston
Amy Dickey, Houston
Drew Fontenot, Lake Charles
George Baldree, Rio Grande Valley
Tom Holt, Sabine

Hamp Drew, San Antonio

Dale Flood, District 22 director, has nominated the following for this award:

Matt Wysocki, Sacramento
Trevor Robinson, Sacramento
Liisa Pine Schoonmacher, San Francisco
Tom Smeltzer, San Francisco
Jerry Azzaro, San Francisco

Brad Bosworth, Fresno

Tom Erichsen, Santa Clara Valley
Tony DeSouza, Santa Clara Valley

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

Nominations Sought for National Offices

AWS members who wish to nominate candidates for President, Vice President, and Director-at-Large on the AWS Board of Directors for the term starting Jan. 1, 2011, may

1) Send their nominations electronically by October 5, 2009, to Gricelda Manalich at gricelda@aws.org, c/o Gene E. Lawson, chairman, National Nominating Committee, or

2) Present their nominations in person at the open session of the National Nominating Committee meeting scheduled for 2:00 to 3:00 PM, Tuesday, November 17, 2009, at McCormick Place, Chicago, Ill., during the 2009 FABTECH International & AWS Welding Show.

Nominations must be accompanied by bi-

ographical material on each candidate, including a written statement by the candidate as to his or her willingness and ability to serve if nominated and elected, letters of support, plus a 5- x 7-in. head-and-shoulders color photograph. Note: Persons who present their nominations at the Show must provide 20 copies of the biographical materials and written statement.

Name Your Candidate for the Prof. Masubuchi Award

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

research and development.

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

and awards, plus at least three letters of recommendation from fellow researchers.

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

ACOSEND Becomes AWS International Agent in Colombia



Jorge Contreras Cruz (center), representing ACOSEND, an AWS Sustaining Company Member, visited AWS headquarters June 10 to document the company's authorization to serve as an AWS International Agent to conduct certification events in Colombia. Shown are (from left) Gricelda Manalich, executive assistant for board services; Ray Shook, executive director; Mr. Contreras; Cassie Burrell, deputy executive director; Martha Concepcion, manager, member services; and Priti Jain, director, international business and certification programs.

National AWS Membership Awards Announced

The **Houston Section**, District 18, has been awarded the Henry C. Neitzel National Membership Award for the greatest net numerical increase in membership for the year 2008-09.

The winner of the Henry C. Neitzel National Membership Award for the greatest net percentage increase for 2008-2009 is the **Mid Plains Section**, District 16.

Following are Sections in each District that achieved the greatest percentage increase in membership for the year.

District — Section

- 1 — *
- 2 — New York
- 3 — Lehigh Valley
- 4 — Tidewater
- 5 — South Carolina
- 6 — Northern New York
- 7 — Johnny Appleseed
- 8 — Greater Huntsville
- 9 — New Orleans
- 10 — Drake Well
- 11 — Northern Michigan
- 12 — Madison-Beloit
- 13 — J.A.K.
- 14 — Sangamon Valley
- 15 — Arrowhead
- 16 — Mid-Plains Section
- 17 — Central Arkansas
- 18 — San Antonio
- 19 — Alberta
- 20 — Southern Colorado
- 21 — Hawaii
- 22 — Fresno

An asterisk (*) means no Section in the District had an increase in membership.

Inspectors Certified at WeldMex Show in Monterrey



AWS President Victor Matthews (right in both photos) presents Sergio Martinez Magana (left) and Mateo Bettancourt their AWS Certified Welding Inspector (CWI) credentials at the WeldMex show held June 2-4 in Monterrey, Mexico.

Welding Journal Presented First Prize for Journalism

The Society of Professional Journalists has awarded the *Welding Journal* staff first-place honors in the 2009 Sunshine State Awards Competition, Trade/Special Interest division, presented by Julie Kaye, president, SPJ South Florida Chapter. Present to receive the plaque were Andrew Cullison, publisher, and Kristin Campbell and Howard Woodward, associate editors.

The awards presentations ceremony was held May 30 at the Art & Culture Center of Hollywood, Hollywood, Fla.

"We are honored," Cullison said, "to be recognized by our peers in journalism throughout the state of Florida, and we will find a prominent place on our department wall to display the plaque."



Andrew Cullison (far right), publisher, *Welding Journal*, displays the first-place plaque. Shown with him are Kristin Campbell and Howard Woodward, associate editors.

Member-Get-A-Member Campaign — Final 2008–2009 Tally

Congratulations to the following 2008–2009 MGM Campaign winning sponsors: **Steve Esders**: Most new Individual Members; **John Leen**: Most new Student Members; and **Satish Keskar**, most new International Members. Listed below are those who participated in the 2008–2009 campaign. See page 65 in this *Welding Journal* or visit www.aws.org/mgm for rules and prize list. These final standings are as of May 31, 2009. Call the AWS Membership Dept. (800/305) 443-9353, ext. 480, for information on your proposer status.

Winner's Circle

Sponsored 20+ new members.

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

J. Compton, San Fernando Valley⁷
E. Ezell, Mobile⁷
J. Merzthal, Peru²
G. Taylor, Pascagoula²
L. Taylor, Pascagoula²
S. Esders, Detroit¹
B. Mikeska, Houston¹
W. Shreve, Fox Valley¹
M. Karagoulis, Detroit¹
S. McGill, NE Tennessee¹
T. Weaver, Johnstown/Altoona¹
G. Woomer, Johnstown/Altoona¹
R. Wray, Nebraska¹
M. Haggard, Inland Empire¹

President's Guild

Sponsored 20+ new members.

S. Esders, Detroit — 22
E. Ezell, Mobile — 20

President's Roundtable

Sponsored 9–19 new members.

P. Betts, Mobile — 12
J. Compton, San Fernando Valley — 10
R. Ellenbecker, Fox Valley — 10
R. Biggs, Nebraska — 9
V. Craven, Pascagoula — 9
S. Keskar, India — 9

President's Club

Sponsored 3–8 new members.

L. Contreras, South Florida — 8
R. Robles, Corpus Christi — 7
P. Shahoveisi, International — 7
C. Daon, Israel — 6
D. Marquard, Cleveland — 6
D. Wright, Kansas City — 6
W. Rice, Tri-State — 5
R. Shepherd, Fox Valley — 5
G. Garner, St. Louis — 4
M. Hackl, Cuautitlan Izcalli — 4
D. Herr, York-Central Pa. — 4
G. Koza, Houston — 4
R. Newman, Maine — 4
B. Vernyi, Cleveland — 4
C. Becker, Northwest — 3
B. Franklin, Mobile — 3
R. Johnson, Detroit — 3
W. Komlos, Utah — 3
L. Moss, Sangamon Valley — 3
P. Newhouse, British Columbia — 3
M. Rahn, Iowa — 3
D. Roland, Upper Peninsula — 3
M. Wheat, Western Carolina — 3

President's Honor Roll

Sponsored 2 new members.

C. Alfaro, San Diego
T. Baldwin, Arrowhead
M. Boggs, Stark Central
M. Boyer, Detroit
R. Boyer, Nevada
K. Bristow, East Texas
K. Campbell, L.A./Inland Empire

J. Contreras, International
M. Cyphyert, Northwestern Pa.
D. De Almeida, Int'l
B. Donaldson, British Columbia
E. Dupree, Tidewater
T. Ferri, Boston
N. Goel, New York
F. Hendrix, New Jersey
J. Hilfiker, Kansas City
E. Hinojosa, L.A./Inland Empire
J. Hope, Puget Sound
T. Johnson, Pittsburgh
G. Lawrence, N. Central Florida
E. Levert, North Texas
J. Livesay, Nashville
J. Padilla, Cuautitlan Izcalli
S. Luke, Acadiana
M. Medrano, San Diego
T. Moffitt, Tulsa
J. Nash, Atlanta
R. Pitt, Tidewater
J. Polson, L.A./Inland Empire
J. Rule, Cleveland
W. Scott, Willamette Valley
J. Sisson, Niagara Frontier
K. Smith, North Texas
R. Somers, Northern New York
M. Spangler, J.A.K.
A. Stute, Madison-Beloit
J. Svatos, Siouxland
D. Thomason, Chicago
M. Torres, Pascagoula
B. Whatley, Albuquerque
R. Young, Iowa
M. Yung, Portland
D. Zabel, SE Nebraska
P. Zammit, Spokane

5+ Student Member Sponsors

J. Leen, Chicago — 136
D. Berger, New Orleans — 110
S. Esders, Detroit — 102
J. Kacir, Detroit — 86
B. Benyon, Pittsburgh — 46
D. Pickering, Central Arkansas — 40
D. Schnalzer, Lehigh Valley — 40
A. Baughman, Stark Central — 36
M. Boggs, Stark Central — 36
R. Jones, Puget Sound — 36
A. Rowe, Philadelphia — 36
A. Zinn, Eastern Iowa — 34
T. Moore, New Orleans — 32
D. Saunders, Lakeshore — 31
E. Hinojosa, L.A./Inland Empire — 30
R. Hutchinson, Long Beh./Or. Cty. — 30
J. Carney, Western Michigan — 27
J. Roberts, Sacramento — 27
D. Zabel, SE Nebraska — 27
J. Harris, Pascagoula — 26
H. Hughes, Mahoning Valley — 26
E. Norman, Ozark — 26
S. Siviski, Maine — 26
T. Geisler, Pittsburgh — 24
J. Kline, Northern New York — 24
G. Moore, L.A./Inland Empire — 24
D. Newman, Ozark — 24

R. Newman, Maine — 24
R. Young, Iowa — 24
R. Cook, Utah — 23
D. Howard, Johnstown-Altoona — 23
J. Rule, Cleveland — 23
B. Suckow, Northern Plains — 23
L. Clark, Milwaukee — 22
R. Munns, Utah — 21
T. Strickland, Arizona — 21
A. Duron, New Orleans — 19
J. Fox, NW Ohio — 19
D. Kettler, Willamette Valley — 19
D. Vranich, N. Florida — 19
J. Ciaramitaro, N. Central Florida — 18
R. Schmidt, Philadelphia — 18
J. Boyer, Lancaster — 17
R. Boyer, Nevada — 17
C. Donnell, NW Ohio — 16
B. Hallila, New Orleans — 16
M. Arand, Louisville — 14
W. Galvery Jr., Long Beh./Or. Cty. — 14
D. Kowalski, Pittsburgh — 14
G. Smith, Lehigh Valley — 14
A. Mattox, Lexington — 13
M. Piper, San Fernando Valley — 13
R. Rummel, Central Texas — 13
A. Stute, Madison-Beloit — 13
D. Taylor, Kern — 13
J. Daugherty, Louisville — 12
R. Ledford Jr., Birmingham — 12
J. Marshall, Siouxland — 12
G. Putnam, Green & White Mts. — 12
R. Evans, Siouxland — 11
J. Theberge, Boston — 11
A. Badeaux, Washington, D.C. — 10
C. Kipp, Lehigh Valley — 10
C. Abram, Columbus — 9
K. Caliva, New Orleans — 9
S. Colton, San Diego — 9
R. Norris, Maine — 9
V. Facchiano, Lehigh Valley — 9
T. Hopper, Mobile — 8
D. Kearns, Northern Michigan — 8
M. Rabo, Sacramento — 8
G. Saari, Inland Empire — 8
N. Carlson, Idaho/Montana — 7
L. Caughron, Kansas City — 7
J. Fitzpatrick, Arizona — 7
J. Geesey, Pittsburgh — 7
M. Hayes, Puget Sound — 7
S. MacKenzie, Northern Michigan — 7
D. Roskiewich, Philadelphia — 7
B. Suarez, Houston — 7
I. Garza, Corpus Christi — 6
J. Reed, Ozark — 6
G. Rolla, L.A./Inland Empire — 6
C. Schiner, Wyoming — 6
G. Baldrée, Rio Grande Valley — 5
C. Hobson, Olympic Section — 5
J. Livesay, Nashville — 5
R. Olesky, Pittsburgh — 5
S. Robeson, Cumberland Valley — 5
R. Roehl, Nashville — 5
R. Sand, Northern Plains — 5
T. Shirk, Tidewater — 5 ♦

SOCIETY NEWS



Mike Wiswesser (far right), District 3 director, is shown with attendees at the District 3 conference.

District 1

Russ Norris, director
(207) 604-9262
russ.norris@airgas.com

District 1 Conference

MAY 30

Activity: The District 1 conference was held at Courtyard by Marriott in Norwich, Conn. Attending were Section officers **Bob Lavoie**, **Dave Paquin**, **Warren Ballard**, **Tom Ferri**, **Jim Shore**, **Rick Moody**, **Doug Desrochers**, **Steve Flowers**, **Walt Chojnacki**, **Joe Tokarski**, **Phil Witeman**, **Scott Lee**, **Dick Gregoire**, and District 1 Director **Russ Norris**, who presided. **Rob "Salty" Saltzstein**, AWS national sales director, presented an update on national Society business. **Tom Ferri** handled the awards presentation ceremony, and **Warren Ballard** awarded scholarships to **Derek Moody**, **Carrie Richesson**, **Adam Lyons**, **Daniel Anzalone**, and **Anthony Kotai**.



Shown at the District 1 conference are (from left) District 1 Director **Russ Norris**, **Dave Paquin**, **Rick Moody**, **Tom Ferri**, **Bob Lavoie**, **Warren Ballard**, and **Jim Shore**, Boston Section chair.



Shown at the Long Island Section tour are (from left) **Ken Messemer**, **Alex Duschere**, Chair **Harland Thompson**, **Brian Cassidy**, **Tom Gartland**, **Matt Graciott**, **Ray O'Leary**, and **Pete Ponticio**.

District 2

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

LONG ISLAND

JUNE 17

Activity: The Section members met with members of the local chapter of ASM International to tour Sulzer Metco in Westbury, N.Y., to study the manufacture of thermal spray coatings and associated equipment. The program was led by **Edward Sottile**, manufacturing engineering manager.

District 3

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

District 3 Conference

MAY 29

Activity: **Sam Gentry**, executive director of the AWS Foundation, discussed national Society news and scholarship updates. **Mike Wiswesser**, District 3 direc-

tor, conducted the meeting. **Tom Jacob** and **Dave Herr** were designated deputy District 3 directors to assist Wiswesser. **Mike Sebergandio** with **Tom Jacobs** as alternate were elected to represent District 3 at the Leadership Symposium. **Daniel Millan** with **Wayne Merrier** as alternate were elected to participate in the Instructors Institute to be held at AWS headquarters in Miami. The conference was held at Heritage Hill Golf and Conference Center in York, Pa.



Shown at the Lancaster Section meeting are (from left) John Boyer, Tim Siegrist, Trina Siegrist, Justin Heistand, and Russ Ross.



Shown at the Northern New York Section executive meeting are (from left) Larry Hidde, Chair Bruce Lavalle, Keith Flood, Bob Christoffel, and Dave Parker.



Mike Sebergandio presents Trina Siegrist the Lancaster Section Meritorious Award.



Shown at the Reading Section meeting are incoming Treasurer Allen Quigg (left) and Chairman Daniel Millan.



Winning contestants in the New York Regional SkillsUSA competition display their prizes.

tion meeting at Super King Buffet in Reading, Pa. The incoming slate of officers include Chair **Daniel Millan**, Vice Chair **John Sheets**, Secretary **Robert Wampler**, and Treasurer **Allen Quigg**. Also planned were several fall events to include joint meetings with the York-Central Pennsylvania Section

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

District 6

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

NORTHERN NEW YORK

MARCH 18

Activity: The Section members served as judges and participated in the New York Area III Regional SkillsUSA welding competition held in Colonie, N.Y. The contestants included **Justin Owen**, **T. J. Banahan**, **T. J. Carusone**, **Joe Marotta**, **Brandon Delong**, **Nathan Woods**, **Lester Wood**, **Zack Scoville**, **Chris Holt**, and **Bruce Moussean**.

MAY 28

Activity: The Northern New York Section held its spring executive committee meeting at Mill Road Tavern and Restaurant. Attending were Chair **Bruce Lavalle**, **Larry Hidde**, **Keith Flood**, **Bob Christoffel**, and **Dave Parker**.

District 7

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

COLUMBUS

JUNE 11

Activity: The Section held its annual golf outing at Foxfire Golf Club near Lockbourne, Ohio, the day before the District 7 conference. District 7 Director **Don Howard** awarded **Matt Boring's** team the first-place prize. The dinner and business meeting were held at Arlington Banquets in Columbus. Following an awards presentation ceremony, the Section elected its new officers: Chairman **Bryan Lyons**, Treasurer **John Lawmon**, and Secretary **Brian Victor**.

LANCASTER

MAY 11

Activity: The Section held its executive board meeting at Venice Pizza in Lancaster, Pa. Attending were Chair **Mike Sebergandio**, **John Boyer**, **Tim Siegrist**, **Trina Siegrist**, **Justin Heistand**, and **Russ Ross**. The Section Meritorious Award was presented to **Trina Siegrist**.

READING

JUNE 4

Activity: The Section held a reorganiza-

TRI-STATE

OCTOBER 13, 2008

Speaker: **Carl Smith**

Affiliation: Kan. Mfg.

Topic: Visual inspection and magnetic particle testing

Activity: The meeting was held at J. H. Fletcher Co. in Huntington, W.Va.

FEBRUARY 9

Speaker: **Rodney Craddock**

Affiliation: Airgas

Topic: Safety issues of cutting aluminum on a water table

Activity: This Tri-State Section program was held at Charleston Steel in Dunbar, W.Va.

MARCH 9

Activity: The Tri-State Section held a students' night program at Putnam Vo Tech School in Eleanor, W.Va. **Carl Spitzer** of Kan. Mfg. and **George Bodnar** of Valley National Gas presented talks. They discussed how to prepare for job interviews.

APRIL 13

Activity: The Tri-State Section members met at Charleston Steel for demonstrations of oxyfuel cutting systems. **Rudy Traczyk** operated the Burny 10 Phantom equipment.

MAY 20

Speaker: **Carl Spitzer**

Affiliation: Putnam Career & Tech Center

Topic: Modern marvels of iron

Activity: The program was held at the Golden Corral restaurant.

District 8

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

CHATTANOOGA

MAY 15

Activity: The Section hosted its 56th annual fish fry at Camp Columbus in Hixson, Tenn., as the final event of the season. More than 300 people participated in the activities. The chefs and other helpers included District 8 Director **Joe Livesay**, **Jason West**, **Wayne Lynn**, **Matt Jennings**, **Don Russell**, **Dave Hamilton**, and **Marty Dominy**.

GREATER HUNTSVILLE

MARCH 26

Activity: The Section members toured Summa Technology, Inc., in Huntsville, Ala., a precision machining, fabrication, welding, and engineering services facility in support of aircraft, missiles, space vehicles, electronic defense systems, auto-



Taking care of the Chattanooga Section raffle are (from left) Don Russell, Dave Hamilton, and Joe Livesay, District 8 director.



The 56th annual Chattanooga Section fish fry was a big success.



Chattanooga Section fish fry volunteers are (from left) Jason West, Wayne Lynn, Matt Jennings, and Marty Dominy.

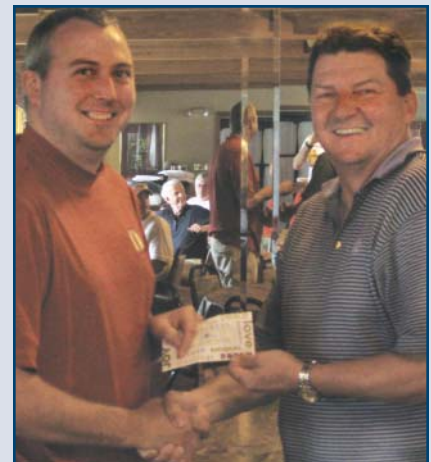
motive tooling equipment, and material-handling racks. Leading the tour were **Johnathan Alldredge** and **Andrew Copeland**.

MAY 21

Activity: The Greater Huntsville Section held a planning meeting at Marshall Technical School in Guntersville, Ala. Chairman **Ed Monroe** led the discussions of plans for the District conference, Section scholarships, and calendar of upcoming events.

District 9

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



Don Howard (left), District 7 director, is shown with expert golfer Matt Boring at the Columbus Section golf outing.



The District 9 conference attendees are shown at the June 6 event.

District 9 Conference

JUNE 6

Activity: **George Fairbanks**, District 9 director conducted the meeting in Hammond, La., with 18 members representing the Acadiana, Baton Rouge, Birmingham, Mobile, New Orleans, and Pascagoula Sections. Presenters included **John Bruskotter**, AWS national vice president, and **Peter Howe**, managing director, technical operations, AWS Certification Services.

NEW ORLEANS

APRIL 14

Speakers: **Pat Hoyt**, **Martin Kafferberger**
 Affiliation: Northrop Grumman Shipbuilding

Topic: Welding in shipbuilding

Activity: Chair **Matthew Howerton** presented Northrop Grumman an appreciation plaque for the company's support of the Section's activities. Forty-two people attended the program, held in New Orleans, La.

MAY 9

Activity: The New Orleans Section hosted its 11th annual fishing rodeo to raise funds for student scholarships. The winners in the redfish class were **Clayton Hinyup**, **Robbie LaChute**, **Lloyd Lemle**, and **Philip Straub**. **Mark Stein** capped the speckled trout class.

District 10

Richard A. Harris, director
 (440) 338-5921

richaharris@windstream.net

CLEVELAND

APRIL 21

Activity: The Section joined with the Lincoln Electric Automation Division to sponsor a welding and safety productivity program to address ways to improve safety measures and develop an action



Winners in the New Orleans Section May 9 fishing rodeo were (from left) **Robbie LaChute**, **Clayton Hinyup**, **Philip Straub**, and **Lloyd Lemle**.



Shown April 14 during the New Orleans Section recognition of Northrop Grumman are (from left) **Shaune Shepard**, **Cristian Dowing**, **Carey Addison**, **Roy Scott**, Chair **Matthew Howerton**, and **David Walker**.



New Orleans Section Chair **Matthew Howerton** (left) is shown April 14 with speakers **Pat Hoyt** (center) and **Martin Kafferberger**.



Mark Stein (left) and **Clayton Hinyup** took top honors at the New Orleans Section May 9 fishing rodeo.



Shown at the District 12 conference are (from left) Dan Crifase, Bob Bruss, Ben Newcomb, Karen Gilgenbach, Cory Satka, Craig Wentzel, Dave Ramseur, Dale Holschbach, District 12 Director Sean Moran, Chuck Fredericks, Ken Karwowski, Dan Roland, Al Sherrill, Jeff Weber, and Jerry Blaski.

plan to keep manufacturing competitive. More than 90 people participated at Lincoln's new automation center, led by Chair **Larry Boros**. Presenters included the center's **Chris Bailey**, general manager; and **Geoff Lipnevicius**, operations manager. Welding instructor **Ryan Eubank** and his students at Willoughby-Eastlake Technical Center made a presentation on their public service project. **Ryan Eubank** and **Bob Gardner** received District 10 Educator Awards, **Mark Demchek** was presented the CWI of the Year Award, and **Harry Sadler** received the District 10 Meritorious Award.



Shown at the Chicago board meeting are (from left) Eric Krauss, Cliff Iftimie, Chair Hank Sima, Jim Greer, Craig Tichelar, Pete Host, Chuck Hubbard, and Marty Vondra.

District 11

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

DETROIT

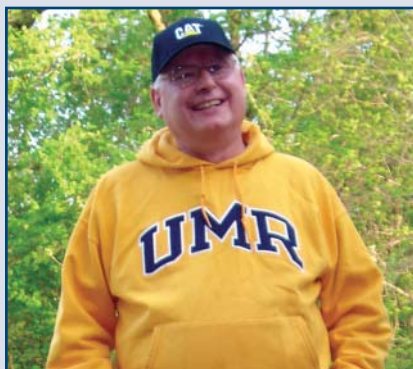
JUNE 13

Activity: **Michael Karagoulis** presented a review of the Section's progress during his year of service as chairman, then installed the incoming board members: **Tyler Alexander**, **Wes Doneth**, **Dan Galisher**, **Jeff Hill**, **Dan Wellman**, and **Bridget Young**; and incoming Chairman **Mark Rotary**. The program, held at The Inn at St. Johns, Northville, Mich., attracted 50 members and guests.

NORTHWEST OHIO

MAY 21

Speaker: **Mark Mayo**, CWI, materials technician
Affiliation: Soil and Materials Engineering, Inc.
Topic: Work performed by the company
Activity: Three members received Silver Membership Certificates for 25 years of service to the Society. Honored were **Ralph Mullins** of American Gas Group, **Larry Garrett** of Washington Group Int'l., and **James Simpson** of AGA Gas.



Phil England grilled steaks for the Illinois Central College Student Chapter cookout.

District 12

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

District 12 Conference

MAY 29

Activity: Attendees included District 12 Director **Sean Moran**, **Dan Crifase**, **Bob Bruss**, **Ben Newcomb**, **Karen Gilgenbach**, **Cory Satka**, **Craig Wentzel**, **Dave Ramseur**, **Dale Holschbach**, **Chuck Fredericks**, **Ken Karwowski**, **Dan Roland**, **Al Sherrill**, **Jerry Blaski**, and **Jeff Weber**, AWS senior associate executive director.

District 13

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



Outgoing Detroit Section Chair **Michael Karagoulis** (left) passes the gavel to incoming Chairman **Mark Rotary** on June 13.

CHICAGO

JUNE 3

Activity: The Section held an executive board meeting at Bohemian Crystal Restaurant in Chicago, Ill. Attending were Chairman **Hank Sima**, **Eric Krauss**, **Cliff Iftimie**, past AWS President **Jim Greer**, **Craig Tichelar**, **Pete Host**, **Chuck Hubbard**, and **Marty Vondra**.

Illinois Central College Student Chapter

MAY 1

Activity: The Student Chapter, led by Advisor **Eric Ockerhausen**, held a steak cookout at Morton Optimist Club in Morton, Ill. **Phil England** was the chef.



Indiana Section members toured the Airgas Mid-America facilities in May.



Shown at the Kansas City program are (from left) Jim Benny, Sam Newhouse, Mike Vincent, David McKenzie, speaker Lon Yost, Chair Brian McKee, Sarah Hurt, Jason Miles, Rob Dickerson, and Mike Williams.



Kansas City Chair Brian McKee is shown with Sarah Hurt, incoming vice chair.



Mike Vincent (left), Kansas City vice chair, chats with speaker Lon Yost.

KANSAS CITY

APRIL 8

Speaker: **Lon Yost**, application engineer
 Affiliation: The Lincoln Electric Co.
 Topic: New technology for submerged arc welding
 Activity: The incoming officers are Chair **Jason Miles**, Zephyr Products; Vice Chairs **Mike Vincent** of Ernest Spencer Metals; and **Sarah Hurt** of Lincoln Electric; Secretary **Mike Williams**, Olsson Associates; and Treasurer **Dennis Wright**, Zephyr Products. Outgoing Chair **Brian McKee** received an appreciation award. The program was held at Airgas in Kansas City, Kan.

District 17

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

District 17 Conference

JUNE 12, 13

Activity: The conference, conducted by District 17 Director **J. Jones**. **Ryan Rummel**, outgoing chair of the Central Texas Section, received the Section Educator Award. The event was held at LeTourneau University in Longview, Tex. **Bobby Roper**, a student at Texas State Technical College at Waco, received a \$1500 scholarship.

CENTRAL TEXAS

MAY 26

Activity: The Section held an executive officer meeting at Elite Circle Grill in Waco, Tex. **Joe Melendez** was elected incoming chairman. Melendez is assistant department chair and a welding instructor at Texas State Technical College in Waco.

TULSA

APRIL 17

Activity: The Section members managed a booth and distributed Society literature at an Engineering Challenge program held for seventh and eighth graders in the Tulsa County school system. Working the table were Chairman **Jamie Pearson**, **Jay Rufner**, **Paul Morgan**, and **Ray Wilsdorf**.

District 18

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

District 18 Conference

MAY 30

Activity: District 18 Director **John Bray** conducted the meeting, hosted by the Sabine Section. **Rhenda Mayo**, AWS director, member services, discussed na-

District 14

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

INDIANA

MAY 20

Activity: The Section members toured Airgas Mid-America in Indianapolis, Ind. **Michael Burton**, district sales manager, led the tour of the gas-filling area and spoke on gas safety.

District 15

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

Black Hills Student Chapter

Activity: The recently chartered Student Chapter, based at South Dakota School of Mines and Technology, is headed by Advisor Dr. **Michael West** and Chairman **Jay Marshall**. During its first year it has sponsored a campus-wide seminar featuring **Michael Blakely** of Dynamic Materials Corp., and programs in virtual reality welder training and friction stir welding technology.

District 16

David Landon, director
 (641) 621-7476
dlandon@vermeerfmfg.com



Shown are District 18 conference attendees with District Director John Bray (front row, fourth from left) and staff representative Rhenda Mayo (front row, third from left).



Houston Section members and guests are shown during their May outing.



District 17 Director J. Jones (left) presents the Central Texas Section Educator Award to Ryan Rummel at the District conference.



Standing are Jamie Pearson (left), Tulsa Section chair, and Jay Rufner; seated are Paul Morgan (left) and Ray Wilsdorf.



Speaker Mike Willis is shown with Janie Solano, Rio Grande Valley Section vice chair, at the May meeting.

tional Society issues. Bray and Mayo presented the Rio Grande Valley Section charter and banner to Chairman **George Baldree** and Treasurer **Richard Salinas**. The event, attended by 22 Section officers, was held at the MCM Elegante Hotel in Beaumont, Tex.

HOUSTON

MAY 22

Activity: The Section members and guests took a cruise on the *MV Sam Houston* to

enjoy the sights along the ship channel. Forty-seven people attended the outing, including **John Bray**, District 18 director.

RIO GRANDE VALLEY

MAY 13

Speaker: **Mike Willis**, director
Affiliation: South Texas Manufacturers Association

Topic: Labor statistics for the Rio Grande
Activity: The meeting was held in Westlaco, Tex.

MAY 27

Activity: Rio Grande Valley Section members participated in a Gold Collar Career Day event held at the South Texas College, McAllen, Tex., campus. About 350 students, instructors, and vendors attended the activities that included orbital welding and cutting demonstrations, and an underwater welding exhibition. The technical sessions included a description of the AWS SENSE program, a presentation by Prof. **Samuel Colton Sr.**, advisor to the AWS Arizona Western College In-



District 19 officers met in Seattle, Wash., for their annual conference.



Shown during the presentation of the Rio Grande Valley Section charter and banner are (from left) Rhenda Mayo, Chair George Baldree, Treasurer Richard Salinas, and John Bray, District 18 director.



Shown at the District 19 Stump the Experts event are (from left) Phil Zammit, Rich Irving, and Rick Henson.



A few of the British Columbia Section members are aglow at the top of the Lafarge tower.

stitute of Welding Technology Student Chapter (Yuma, Ariz); and a talk on careers in nondestructive evaluation and inspection by **Mike Oden**.

MAY 30

Activity: Rio Grande Valley Charter presentation. District 18 Director **John Bray** and **Rhenda Mayo**, AWS director, member services, presented the Section its charter and banner during the District 18 conference in Beaumont, Tex. Accepting the credentials were Chairman **George Baldree** and Treasurer **Richard Salinas**.

District 19

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

District 19 Conference

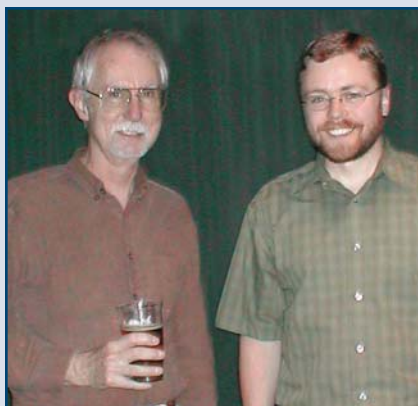
MAY 29, 30

Activity: The annual preconference Stump the Experts competition among the District 19 Sections was held in Seattle, Wash. Six teams participated. The Spokane Section team took top honors. Attending the conference were officers from the Alaska, Alberta, British Columbia, Inland Empire, Olympic, Portland, Puget Sound, Spokane, and Willamette Valley Sections. The after-conference recreation included a dinner cruise on Lake Washington.

BRITISH COLUMBIA

MAY 14

Activity: The Section members toured the Lafarge Cement facility in Richmond, B.C., including a trip to the top of the landmark Lafarge tower. **Claude Brule** and **Sean McCoy** presented talks on the company's history and how cement is made before conducting the tour. Brule is environmental and public affairs manager. McCoy is environmental coordinator at the plant. Thirty members participated in the program.



AWS Fellow Herschel Smartt (left) chats with speaker Corrie Nichol at the Idaho/Montana Section program.



Stephen Chase Kryger received a CWI exam study course from the Utah Section.

Clark College Student Chapter

APRIL 26-29

Activity: The Clark College, Vancouver, Wash., Student Chapter members attended the 4th International Brazing and Soldering Conference (IBSC) held at the Hilton Hotel at Walt Disney World Resort in Orlando, Fla. Heading the group were Advisor **John Kuhn** and Chair **Heather Evans**.

District 20

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

ALBUQUERQUE

MAY 7

Speaker: **Brian Harrison**

Affiliation: AlcoTec

Topic: Welding and weldability of aluminum alloys

Activity: Matheson-Tri•Gas hosted the event at its facility in Albuquerque, N.Mex.



Shown at the British Columbia Section program are member-at-large Roger Moren (center) with speakers Sean McCoy (left) and Claude Brule.



Clark College Student Chapter members are shown at the IBSC in April. Front row, from left, are Caleb Ogier, Roy Timmons, Justin Pithoud, and Ed Howalski; (middle row, from left) Brenton McKinnley, Scott Shirley, Jose Diaz, Advisor John Kuhn, Chair Heather Evans, and David Jellum; (back row, from left) Taylor Ray-Jones, Matthew Criswell, and Kenny Snyder, welding instructor.



Albuquerque Section members are shown at the May meeting. Speaker Brian Harrison is second from right in back row.

IDAHO/MONTANA

MAY 21

Speaker: **Corrie Nichol**

Affiliation: Idaho National Laboratory

Topic: Potential applications for haptic

feedback in robotic welding

Activity: The program, attended by AWS Fellow **Herschel Smartt**, was held at Brownstone Restaurant in Idaho Falls, Idaho.



The California Central Coast Section members man a booth at the Cuesta College November 12, 2008, career day.



Stan Luis (far left), CCC Section chairman, and Nanette Samanich, District 21 director, presided at the November 22 meeting.

UTAH

MAY 14

Activity: The Section held an executive board planning meeting in West Valley, Utah, led by Chair **Woody Cook**. **Stephen Chase Kryger** received a Section-sponsored seat for a week-long AWS CWI exam preparation seminar. The Section board seats will remain unchanged for the upcoming year.

District 21

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

CALIFORNIA CENTRAL COAST (CCC)

NOVEMBER 5, 12, 2008

Activity: CCC Chair **Stan Luis**, territory manager for Praxair, led welding demon-

strations for students at the Arellanes Jr. High School career day on Nov. 5. On Nov. 12, the Section worked with **Rob Thoresen**, welding instructor, at the Cuesta College career day.

NOVEMBER 22, 2008

Activity: District 21 Director **Nanette Samanich** met with the CCC Section to discuss forming a new Student Chapter. Attending were Chair **Stan Luis**, **Samuel Colton**, advisor, Arizona Western College Institute of Welding Technology Student Chapter, **Gonzolo Huerta Sr.** from Imperial Valley College, and **David Sanchez**, a welding engineer at Arc Dynamics.

FEBRUARY 24, 26

Activity: CCC Chair **Stan Luis** participated in a career day at Santa Maria High School on Feb. 24. On the 26, he worked with **Judie Ferreira**, program coordinator, Hancock College, on a career day at Tommie Kunst Jr. High School.

MARCH 2, 13, 24

Activity: The CCC Section toured Allan Hancock College Industrial Technology Dept with **Rayvell Snowden**, welding instructor, on March 2. On March 13, CCC Chair **Stan Luis** participated in a career day at Pioneer High School. On March 24, the Section met with **Kris Scherm**, district sales manager for Praxair for a



Sacramento Valley Section members toured Siemens Transportation Systems in March.

demonstration of Hypertherm's new plasma arc equipment.

APRIL 2, 10, 18

Activity: The CCC Section participated in career days at Fesler Jr. High School, Mesa Middle School, and Allan Hancock College.

MAY 2, 11

Activity: The CCC Section participated in the FFA state welding competition finals at Cuesta College on May 2. On May 11, **Victor Flores**, district sales manager for ESAB, discussed and demonstrated flux cored wires equipment at Cuesta College.



Speaker David Norris (right) is shown with Don Robinson, Sacramento Valley Section chair on May 20.



Rayvell Snowden (left) is shown with CCC Section Chair Stan Luis (center) and Kris Scherm.

District 22

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

SACRAMENTO VALLEY

MARCH 18

Activity: The Section members toured Siemens Transportation Systems in Sacramento, Calif., to study the production of power train components for commuter rail cars. **Mayk Lehmann**, lead supervisor of welding production, conducted the tour.

MAY 20

Speaker: **David Norris**

Affiliation: ES Geotechnologies, welding inspector

Topic: Highlights of his inspection career including the Northridge earthquake

Activity: The program was held in Sacramento, Calif.

KOREA

JUNE 13

Activity: The Section hosted a seminar on the introduction for structural inspection, including the inspector's role and responsibilities, how to read welding

drawings, and use of codes and standards. The program was held in Busan, South Korea. The incoming officers are Chair **Sun-Hyo Hwang**, Vice Chair **Sung-eun Seo**, Secretary and Librarian **Kyung-Sook Son**, and Treasurer **Sun-Hwan Kim**.

AWS Life Members to Get Valuable Perks at FABTECH International & AWS Welding Show

AWS Life Members are urged to take advantage of their complimentary free admission to the upcoming FABTECH International & AWS Welding Show, including MetalForm, plus free registration to the entire Professional Program (a \$325 value).

The event will take place Nov. 15-18, 2009, at McCormick Place in Chicago, Ill.

The free Professional Program registration entitles AWS Life Members to attend any of the technical sessions occurring during the three-day period.

The registration form is part of the *Advance Program* to be mailed to all members with the September issue of *Welding Journal*; or call the Membership Dept., (800) 443-9353, ext. 260, to have the form mailed to you.

To obtain your free registration, be sure to mark "AWS Life Member: Free Registration" at the top of the form. Then fax both sides of the form to (305) 443-7559, Attn: Ruben Lara, accounting director, or mail the form to AWS c/o Ruben Lara, 550 NW LeJeune Rd., Miami, FL 33126.

International Section

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.

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RWMA — Resistance Welding Manufacturing Alliance

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

WEMCO — Welding Equipment Manufacturers Committee

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Managing Director, Technical Operations
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Director, Int'l Business & Certification Programs
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EDUCATION SERVICES

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Director, Education Services Administration and Convention Operations
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Technical Publications
AWS publishes about 200 documents widely used throughout the welding industry.

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Annette Alonso.. aalonso@aws.org(299)
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Note: Official interpretations of AWS standards may be obtained only by sending a request in writing to the Managing Director, Technical Services. Oral opinions on AWS standards may be rendered. However, such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

Nominees for National Office

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

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

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

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

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

Treasurer: To be eligible to hold the

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

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

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

E-mail the letter to [Gricelda Manalich, gricelda@aws.org](mailto:gricelda@aws.org), c/o Gene Lawson, chair, National Nominating Committee.

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

Honorary Meritorious Awards

The Honorary Meritorious Awards Committee makes recommendations for the nominees presented to receive the Honorary Membership, National Meritorious Certificate, William Irrgang Memorial, and the George E. Willis Awards. These honors are presented during the FABTECH International & AWS Welding Show held each fall. The deadline for submissions is December 31 prior to the year of the awards presentations. Send candidate materials to Wendy Sue Reeve, secretary, Honorary Meritorious Awards Committee, wreeve@aws.org; 550 NW LeJeune Rd., Miami, FL 33126. Descriptions of these awards follow.

William Irrgang Memorial Award

Sponsored by The Lincoln Electric Co. in honor of William Irrgang, the award, administered by AWS, is given each year to the individual who has done the most over the past five years to enhance the Society's goal of advancing the science and technology of welding. It includes a \$2500 honorarium and a certificate.

George E. Willis Award

Sponsored by The Lincoln Electric Co. in honor of George E. Willis, the award, administered by AWS, is given each year to an individual who promoted the advancement of welding internationally by fostering cooperative participation in technology transfer, standards rationalization, and promotion of industrial goodwill. It includes a \$2500 honorarium and a certificate.

Honorary Membership Award

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

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

National Meritorious Certificate Award

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

International Meritorious Certificate Award

This honor recognizes recipients' significant contributions to the welding industry for service to the international welding community in the broadest terms. The awardee is not required to be an AWS member. Multiple awards may be given. The award consists of a certificate and a one-year AWS membership.

AWS Publications Sales

Purchase AWS standards, books, and other publications from **World Engineering Xchange (WEX), Ltd.**
orders@awspubs.com; www.awspubs.com
Toll-free (888) 935-3464 (U.S., Canada)
(305) 824-1177; FAX (305) 826-6195

Welding Journal Reprints

Copies of *Welding Journal* articles may be purchased from Ruben Lara.
(800/305) 443-9353, ext. 288; rlara@aws.org

Custom reprints of *Welding Journal* articles, in quantities of 100 or more, may be purchased from

FosteReprints

Claudia Stachowiak
Reprint Marketing Manager
866-879-9144, ext. 121
claudia@fostereprints.com

AWS Foundation

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

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AWS Mission Statement

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

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

NEW

LITERATURE

Die Casting Industry Census Report Issued

A recently released census updates information concerning the North American die casting business. It covers more than 500 captive and custom die casters to provide a thorough review of their capabilities and business activities. Included are a count of die casting companies, alloys cast, employment figures, additional services provided, an analysis of 2007 vs. 2008 shipment data, estimates for 2009 and 2010 volumes, die casting machines estimates including size and alloys produced, and end-market analyses to assist with targeting and planning. The publication is available as a full report or as four separate reports. See Web site for details. Available in printed form or by download. The complete report lists for \$600, \$300 for corporate members, and \$450 for individual members. Purchasers of the full report receive a complimentary CD of the *Die Casting Industry Capabilities Directory*.

North American Die Casting Assn.

www.diecasting.org

(847) 808-3164

Online Photo Gallery Features Industrial Tools

The company, a supplier of computer-controlled pipe-cutting equipment, has launched a comprehensive online gallery of about 325 application and product images. The site is designed so viewers can easily find high-quality photographs and other images that demonstrate the many industries and applications where the company's equipment has been used. Desired photos can be selected from a cate-

gory of products or industry segments with thumbnail images provided to refine the user's search. If desired, autoplay can be selected to view the entire gallery.

Vernon Tool Co.

www.vernontool.com

(760) 433-5860

Online Welding Torch Library Offered



The company has expanded its Web site to offer a Literature and Manuals page to help existing customers quickly find supporting documents for their torch model and easily locate replacement parts. For prospective customers, the site offers downloadable PDFs of its full-line products catalog and specification sheets for various torch models. Included are diagrams illustrating the proper methods

for connecting both air- and water-cooled torches to common power sources.

Weldcraft

www.weldcraft.com/literature-manuals

(800) 752-7620

Poster Pictures Tube Inspection Technology

The *Understanding Tube Inspection Technology* poster, designed by field experts, presents concise and clearly illustrated information. Shown are the basic concepts for eddy current, remote field, near field, magnetic flux leakage, and internal rotating inspection system (IRIS) testing methods. The poster is designed to be of value to engineers and technicians involved with the inspection of heat exchangers, feed water heaters, and boilers in the power-generation industry. The poster may be ordered online or send an e-mail request to info@olympusNDT.com.

Olympus NDT

www.olympus-ims.com/en/poster

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Laser Publications Catalog Updated



A 12-page catalog illustrates and describes the company's collection of ANSI-approved standards, laser safety guides, training aids, signs, labels, and a complete price list, in addition to detailing laser applications, CALEO, ILSC, and PICALO conference proceedings, and complete membership information. Featured docu-

—continued on page 86

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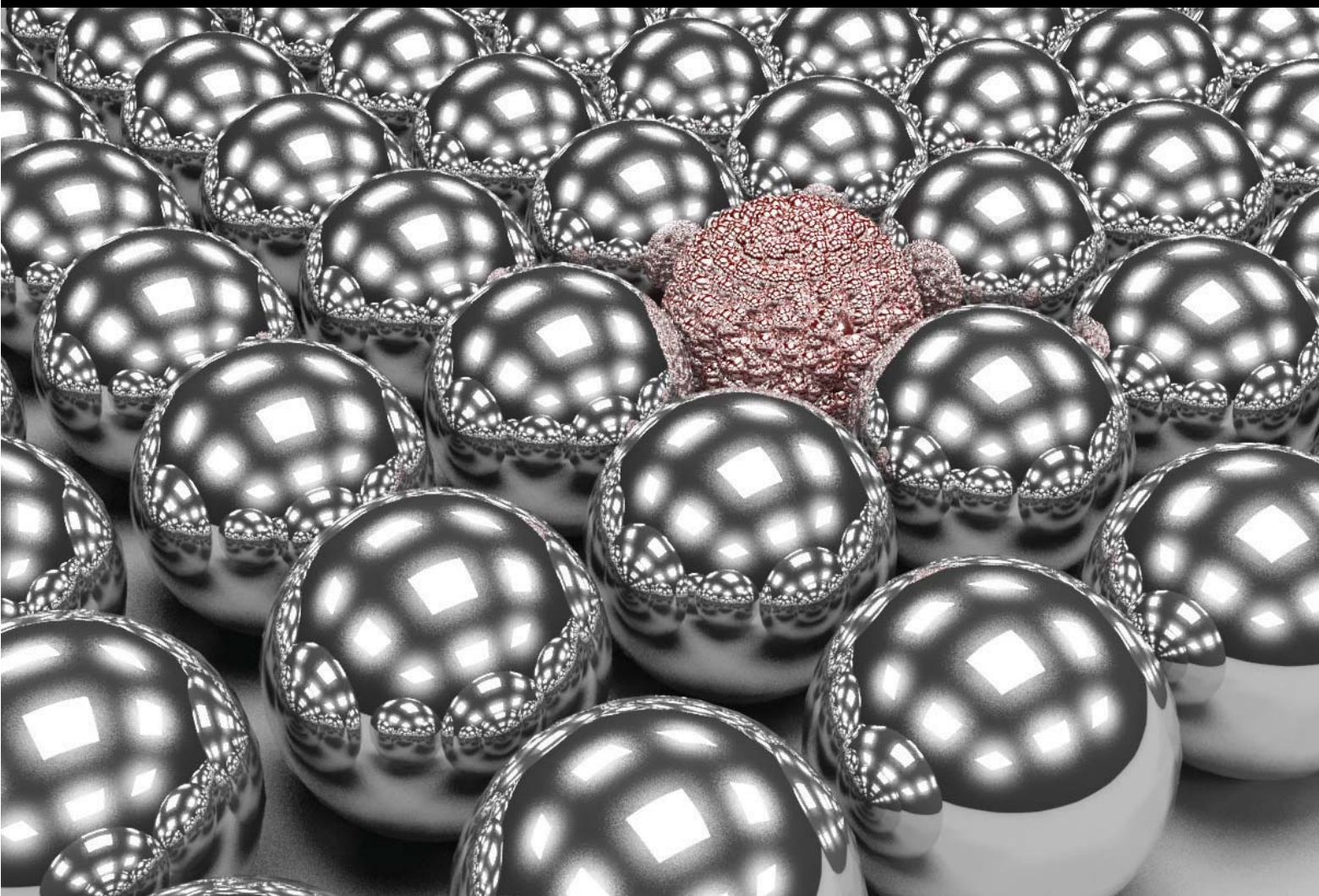
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Welding Corrosion Resistant Alloys Conference

Chicago, November 18th, 2009



Welding Corrosion Resistant Alloys Takes Center Stage. Find answers to the unknown and discover new processes.

The interest level is extraordinarily high when it comes to the welding of corrosion-resistant alloys. There are many reasons for this. One is the entry of the duplex stainless steels and other high-performance grades. Another is the unstable prices in nickel, molybdenum and titanium. When the price of nickel hit the roof, many fabricators switched from 316 to 201 stainless because of the latter grade's lower nickel content. Research is feverish throughout the world in the development of new and cheaper methods of producing titanium. Will a lower cost titanium make the metal more popular?

The overall activity is immense. Cladding and strip overlay processes have become more popular means of protecting parts exposed to heavy corrosion. Duplex stainless is now being welded for over-the-road tankage. New processes, like friction stir welding and the more

advanced thermal stir welding out of NASA will be discussed as well. Also, improvements in weld properties are being realized by increasing the weld interpass temperatures for conventional austenitic stainless steels.

Keep abreast of this exciting new world in welding where corrosion-resistant alloys have taken center stage. Mark your calendar for November 18, 2009, at the FabTech International and AWS Welding Show in Chicago, Illinois.

For the latest conference information visit our website at www.aws.org/conferences or call 800-443-9353, ext. 455.

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— continued from page 84

ments are *ANSI Z136.1, Safe Use of Lasers*, the *Laser Safety Guide*, 11th edition, *Guide for the Selection of Laser Eye Protection*, 6th edition; and the *LIA Handbook of Laser Materials Processing*.

Laser Institute of America
www.laserinstitute.org
(800) 345-2737

Alloy Phase Diagrams Posted on Web Site

The peer-reviewed phase diagrams for more than 30,000 alloys can be downloaded either individually or as a complete collection from the society's Web site. Offered are 1500 new items, including 20 aluminum-titanium binaries, 350 aluminum ternaries, and new ternary phase diagrams for the Industrial and Heat-Resistant category. This category includes iron, nickel, cobalt, chromium, niobium, and manganese; and the Solder, Brazes, and Copper Alloys category includes lead, bismuth, silver, gold, antimony, indium, gallium, cadmium, zinc, copper, and tin. To purchase and download individual diagrams or learn about other diagram collections, visit the Web site and click on Materials Information.

ASM International
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Thermal Spraying Safety Featured in Brochure



Safety Precautions
For Wall Colmonoy Spraywelder and Fusewelder Units

This booklet was created to provide our customers with general safety guidelines to follow during spraying and fusing applications; in order for them to ensure a safe working environment for employees engaged in these operations. We cannot furnish information that would address all workplace environments, and it is the responsibility of the user to evaluate what controls and/or personnel protective equipment (PPE) are best suited for their particular application(s).

In addition to this booklet, consult the Spraywelder™ and Fusewelder® Operating Manuals as well as the Material Safety Data Sheet for the Sprayweld™ or Fuseweld™ powder being used.

A new brochure features safety precautions for thermal spraying and fusing.

The information includes general safety guidelines for proper ventilation, clothing, air sampling, respirator usage, and other general warnings. To download the brochure from the Web site, specify Safety Brochure No. SB6091.pdf, or request a copy via e-mail wcc@wallcolmonoy.com, or call.

Wall Colmonoy Corp.
www.wallcolmonoy.com
(248) 585-7960

Aluminum Staining Guidelines Revised

A new publication, *Guidelines for Minimizing Water Staining of Aluminum*, describes how proper shipping, handling, and storing procedures can minimize water staining. Chapters include the cause of water stains, inspection procedures, packaging recommendations, and ways to prevent water stains. Another highlight of the publication is a Dew Point Calculator Table that shows the conditions when water will condense on metal, that can lead to staining. The guidelines include a list of instrument suppliers, manufacturers of moisture-indicating labels, and suppliers of water stain preventatives. Included is a large wall poster outlining steps to protect aluminum against staining. The hard copy lists for \$35, \$20 for association members, plus shipping and handling.

The Aluminum Assn.
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Custom Rolling Services Pictured in Brochure



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

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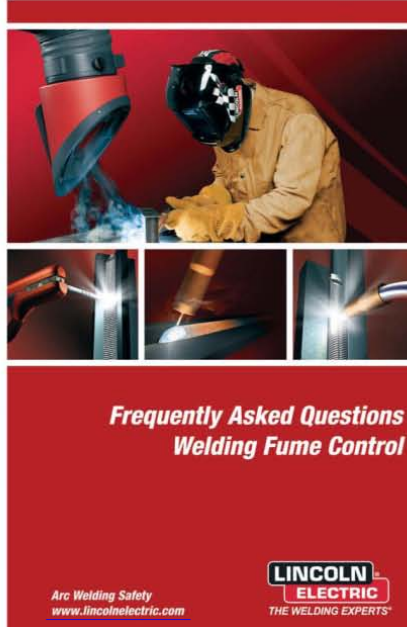
- PLATE ROLLING & FLATTENING
- PRESS BRAKE FORMING
- HOT FORMING
- STRUCTURAL SECTION ROLLING
- FABRICATING

A new four-page, full-color brochure illustrates and describes many of the com-

pany's plate rolling, forming, section rolling, and fabricating services for the heavy manufacturing, automotive, steel, pulp and paper, mining, petrochemical, and forestry industries. Detailed are its plate rolling and flattening of plate up to 7 in. thick and 12 ft wide, and cylinders rolled with diameters from ten inches to 20 ft. Also pictured are press brake forming, structural section rolling, fabrication of heavy weldments and pressure vessel components, and its car-bottom furnace and hot-forming services.

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Fume Control FAQ Guide Solves Real-Life Problems



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The 44-page, full-color *Frequently Asked Questions Welding Fume Control* guide replies to concerns about compliance with OSHA PEL and/or ACGIH TLV limits to hazardous dusts and fumes. Questions are answered under the headings Hexavalent Chromium Compliance, Welding Fume Control, and Ventilation System Operation. A separate section deals with arc welding safety issues. A table charts TLVs and PELs of typical electrode ingredients, six pages illustrate and describe the company's fume-removal and filtration systems. The guide can be downloaded as a PDF from the Web site, search for Bulletin MC09-31, or call for a hard copy.

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

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

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PERSONNEL

Lincoln Electric Makes Management Changes



Christopher Brodnick



Jeff Bennett

Jeff Bennett has been promoted to the position of managing director of Lincoln-owned Vernon Tool Co., Ltd., a producer of computer-controlled pipe cutting equipment. Bennett, with Lincoln Electric for 11 years, most recently served as the general manager of the Automation Solutions Group, Canada. The Lincoln Electric Company of Canada, Toronto, has promoted **Christopher J. Brodnick** to the position of general manager of the Automation Solutions Group Canada. With the company for 12 years, Brodnick most recently served as manager of production and robotic integration for the Automation division in Cleveland, Ohio.

Wall Colmonoy Fills Three Key Posts



Rick Rackley



Justin Madrid

Wall Colmonoy Corp., Madison Heights, Mich., has named **Rick Rackley** director of quality management systems, promoted **Justin Madrid** to production manager for the Alloy Products Group, and appointed **Lydia Lee** to brazing products manager for the Alloy Products Group. Rackley has 27 years of quality management experience with ten years at the company. Madrid, with the



Lydia Lee

Member Milestone Gary Gammill Tapped for MMA Excellence Award



Gary Lee Gammill (left)

The Mississippi Manufacturers Assn. (MMA) presented **Gary Lee Gammill**, a welding instructor at East Mississippi Community College (EMCC), Mayhew, Miss., its 2009 Award for Excellence in Vocational Education. Gammill was recognized June 4 during the MMA annual convention in Jackson, Miss., for his close involvement with area manufacturers, which enabled him to keep abreast of local workforce needs and to help students be job-ready after graduation. Gammill has provided welding-related training for many companies, including SeverStal Steel Mill, Toyota North America, and Navistar Defense Systems.

Jay C. Moon, MMA president and CEO, said during the presentation, "It is important that our educators work with industry to provide the specific skills training necessary for our people to succeed in their jobs."

Melanie Sanders, EMCC-- associate dean of instruction, said, "Gammill is the consummate professional who seeks to further his personal knowledge and share his expertise with those around him. Through his leadership, the college is providing the workforce needed to see our area grow."

Gammill is AWS District 8 deputy director and treasurer as well as scholarship committee chair of the Northeast Mississippi Section. He is a Certified Welding Inspector, Certified Welding Educator, and holds ASNT Level I and Level II in ultrasonic testing, and serves as a writer for curriculum revision of postsecondary welding with the Research and Curriculum Unit at Mississippi State University.

company since 2003, previously served as production coordinator. Lee, who studied brazing technology with the late Robert Peaslee, holds master's degrees in engineering and business.

CenterLine (Windsor) Hires Account Manager



Brad Dierickse

CenterLine (Windsor), Ltd., Windsor, Ont., Canada, has appointed **Brad Dierickse** as account manager. Prior to joining the company, Dierickse gained 20 years of practical business experience in the industrial automation sector.

Crystal Flame Award Presented to Kartsonis

Mike Kartsonis, president, Dynamic Fabrication, Inc., Santa Ana, Calif., a contract metalworking firm, has received the Crystal Flame Award from the National Tooling and Machining Assn. The organi-



Mike Kartsonis

zation presents the award annually to select members whose leadership and dedication have significantly contributed to the organization's mission of assisting and guiding individuals in the manufacturing and machining industry.

CMW Names Chief Engineer/Metallurgist



Lane Donoho

CMW Inc. (formerly Mallory Metallurgical Co.), Indianapolis, Ind., has named **Lane Donoho** chief engineer/metallurgist. Donoho has experience in the areas of laboratory testing and manufacturing support with expertise in heat treatment, laboratory management, product line quality control, failure analysis, and cost reduction.

EWI Names Nuclear Fabrication Chair

Edison Welding Institute (EWI), Columbus, Ohio, has named **Jerry Oliver** chairman of the newly established Nuclear Fabrication Consortium (NFC). Most recently, Oliver was executive vice president of commercialization at GreatPoint Energy, Inc. The NFC is a collaborative effort between the nuclear industry's utilities, OEMs, system manufacturers, and component suppliers.

Laser Institute Announces Education Director

Laser Institute of America, Orlando, Fla., has appointed **Gus Anibarro** education director. With the company for ten years, Anibarro previously served as education manager.

Farr Names Thermal Spray Market Manager



Scott Goodspeed
Farr Air Pollution Control, a supplier of dust- and fume-collection equipment, has appointed **Scott R. Goodspeed** to the newly created position of thermal spray market manager. Goodspeed most recently served as a regional sales manager for H.C. Starck, Inc., involved with material sales and thermal spray training.

VP Appointed at WestWind

WestWind Technologies, Huntsville, Ala., a provider of aviation integration, engineering, manufacturing, and logistics services, has appointed **Chester Schickling** vice president of business development. Schickling has 35 years of experience in the aviation industry including positions at Beech Aircraft Corp., Raytheon Aircraft, Sino Swearingen Aircraft, and most recently with AAI Acquisition in Englewood, Colo.

Laser Sales Engineer Hired at Miyachi Unitek

Miyachi Unitek has appointed **Andrew Dodd**, based in Detroit, Mich., as senior sales engineer with responsibilities for laser and systems sales and applications support in the midwest United States. Most recently, Dodd was director of sales and service for the Laser Group at GSI Lumonics where he worked for 20 years.

Milligan to Head ABET



Michael Milligan

ABET, Inc., Baltimore, Md., the accreditor for college programs in applied science, computing, engineering, and technology, has selected **Michael K. J. Milligan** as its third executive director. Milligan most recently led a team of scientists, engineers, and support staff assisting in the development of an environmental satellite for the National Oceanic and Atmospheric Administration at the NASA Goddard Space Flight Center.

C&J Cladding Names Technology Director



David R. Berridge

C&J Cladding, Houston, Tex., has named **David R. Berridge** director, technology. Previously, Berridge spent 19 years with FMC in its defense and petroleum equipment divisions.

Obituaries

J. Paul Shaughnessy

J. Paul Shaughnessy, 87, an AWS Fellow, died May 15. An active member and past chairman of the Detroit Section, he was active in the resistance welding community. He worked for Chrysler Corp. for more than 35 years and was one of the prime movers that introduced resistance



J. Paul Shaughnessy

welding equipment in the automotive industry. He had extensive knowledge about arc and resistance welding processes and advised the automobile design groups how to economically maximize structural integrity. He served in the U.S. Navy during World War II as a sonar man first class. Shaughnessy loved music. He sang in church choirs and played the clarinet, saxophone, and violin. He was a member of the Knights of Columbus and served as a volunteer for the St. Vincent de Paul Society and Harvest Time Ministries. He is survived by his wife, Juanita, two sons,

three daughters, two sisters, grandchildren, and great grandchildren.

Fred C. Breismeister

Fred C. Breismeister, 69, died May 27 at his home in Moraga, Calif. For many years, he was an AWS member affiliated with the San Francisco Section, and a member and unofficial "historian" of the AWS D1 Committee on Structural Steel and many of its subcommittees where he contributed to D1.1, *Structural Welding Code — Steel*, D1.6, *Structural Welding Code — Stainless Steel*, and most recently D1.8, *Structural Welding Code — Seismic Supplement*. He chaired the D1B Subcommittee on Prequalification from 1988 to 1994. Breismeister held a master's degree in engineering from Rensselaer Polytechnic Institute. He worked for Bechtel for more than 25 years then relocated to Strockal Inc. in Stockton, Calif. His hobbies included playing ice hockey (well into his 60s), gardening, and mechanics. He is survived by his wife, Eileen, three children, a brother, nephews, and cousins.

Albert T. Brennan



Albert Brennan

Albert T. Brennan, 87, died May 15 in Framingham, Mass., following a brief illness. In 1975, he purchased the Evans Supply Co., Winchester, Mass., and later renamed it ESCO Tools. He built the company into a successful tool manufacturer for the power-generation industry, noted for its portable Millhog® welding end-prep tools, and Panelhog® air-powered saws and high-speed hand-held bevelers. He is survived by his wife, Margaret, two sons, three daughters, and ten grandchildren.

Ralph Wheeler Minga

Ralph Wheeler Minga, 89, an AWS Life Member, died April 22 in Chattanooga, Tenn. He became active in the Chattanooga Section in 1954 where he served as chairman, technical representative, and for 20 years was the education committee chair. Minga served in the U.S. Navy during World War II, working in a submarine repair unit at Pearl Harbor, Hawaii. A graduate of the University of Alabama, he worked as an engineer in metallurgical engineering at Combustion Engineering. On his retirement, he pursued a career in consulting, specializing in technical support in the areas of welding and metallurgical engineering on boilers, piping, and pressure vessels.

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BY C. ROEPKE AND S. LIU

ABSTRACT

The macrostructure, microstructure, chemical composition, inclusions, and hardness of hybrid laser arc welds in HY-80 steel were evaluated. Experiments were conducted to compare hybrid laser arc welding (HLAW) to gas metal arc welding (GMAW) and laser beam welding (LBW). The effect of the laser power and arc power levels on weld morphology and the effects of heat input (controlled by travel speed) and preheat on microstructural control were studied. It was found that a minimum arc-to-laser power ratio exists to prevent laser-only penetration, and that the heat input of the hybrid process is dominated by the arc. It was shown that HLAW welds were microstructurally similar to GMAW welds with similar heat input but significantly improved from the LBW welds at similar laser powers. HLAW produced a suitable inclusion size distribution for the nucleation of acicular ferrite. Increasing the heat input in HLAW showed the expected trend of increasing the content of ferritic microstructures and reducing the weld metal hardness. Increasing preheat in HLAW increased the amount of acicular ferrite and reduced the hardness in both the fusion zone and heat-affected zone. This research work has shown that hybrid laser arc welding is a suitable process for welding high-strength, quenched-and-tempered grade steels using conventional control of heat inputs and preheats.

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Introduction

Hybrid laser arc welding (HLAW) is a combined process of gas metal arc welding (GMAW) and laser beam welding (LBW) incident on the same weld pool. It was first developed by Eboo and Steen in the late 1970s (Ref. 1). However, there has been limited research work on the process until recently because of the cost and availability of high-power welding lasers. Early research work has shown that the process can increase welding speeds with fewer surface defects and improved penetration (Refs. 1, 2). At lower laser powers (typically less than 1 kW) the hybrid process is dominated by the arc and the laser primarily is used for stabilization of the arc (Refs. 1, 3, 4). Typically for industrial applications, high laser powers (greater than 1 kW) are used. In addition to enhancements in welding speed and penetration over GMAW, the ability of HLAW to bridge gaps (LBW requires tight joint tolerances) has led to great industrial interest (Refs. 5–11). In this study, a high laser power is used, and the weld morphology is a combination of those of the laser and arc welds. Hybrid welding also has many new variables that are different from those of GMAW and LBW, e.g., laser-arc separation, angles, leading or following process, and power ratio. Much research work has been done on the effects of these parameters on penetration, gap bridging ability, welding

speed, energy and process efficiency, and joint geometries (Refs. 3, 5–11). However, only recently has there been research work on the characterization of the metallurgy and microstructure of the hybrid welds (Refs. 12–17). This paper focuses on the development of macrostructure and microstructure of hybrid laser arc welds.

High-yield (HY) steels are alloys within the quenched-and-tempered low-alloy steel family. They typically have 0.12 to 0.20 wt-% carbon with up to approximately 8 wt-% total alloy content. As such, they are hardenable and, when quenched, provide high strength in thick-section plates, and with tempering, good toughness. To improve the toughness of the HY grade steels, nickel is added as the main alloying element. There are three grades of HY steels with yield strengths of 80, 100, and 130 ksi (550, 690, and 900 MPa), and they are typically welded with an AWS E100S-1 type or similar welding wire. For HY-80 steel, austenitizing is done at 900°C followed by water quench and tempering at 650°C. The final steel microstructure is tempered martensite/bainite.

Autogenous welding of HY steels leads to a predominately untempered martensite weld metal microstructure because of the high carbon and alloy content and fast cooling rates. For these reasons, filler metals are generally required for the welding of HY steels. The filler metal can reduce the alloy content (hardenability) and carbon content (peak hardness) by dilution and provide new alloying elements (Mn, Al, and Ti) that will form oxide inclusions necessary for the nucleation of acicular ferrite, which is the desired microstructure for HY steel weldments. The acicular ferrite microstructure provides a good combination of strength and impact toughness. However, for the formation of an acicular ferrite microstructure a critical amount of filler metal must be added to the weld metal and the cooling rate cannot be too rapid (Refs. 18, 19).

The effect of inclusions on steel weld

KEYWORDS

Acicular Ferrite
Gas Metal Arc
HY-80 Steel
Hybrid Welding
Laser Beam Welding
Travel Speed

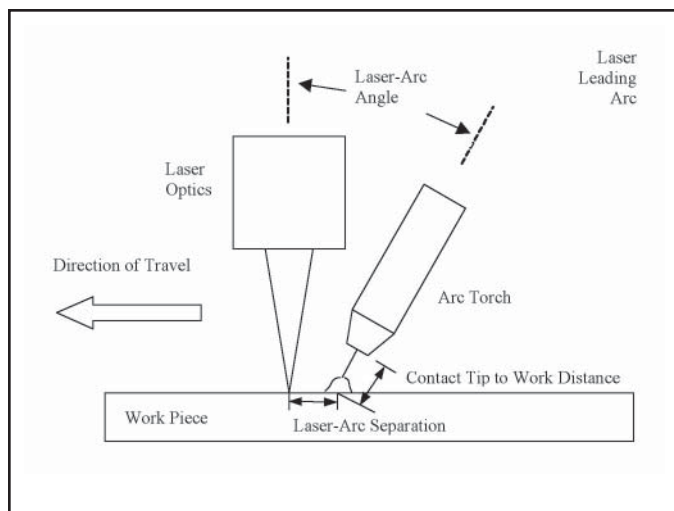


Fig. 1 — Diagram of the experimental setup showing the processing constants.

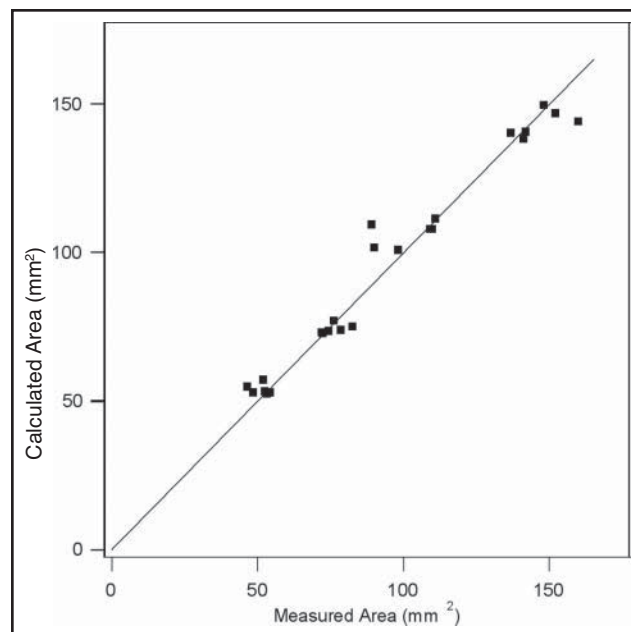


Fig. 2 — Fit of the measured weld areas to the areas calculated from the regression analysis, $R^2 = 0.967$.

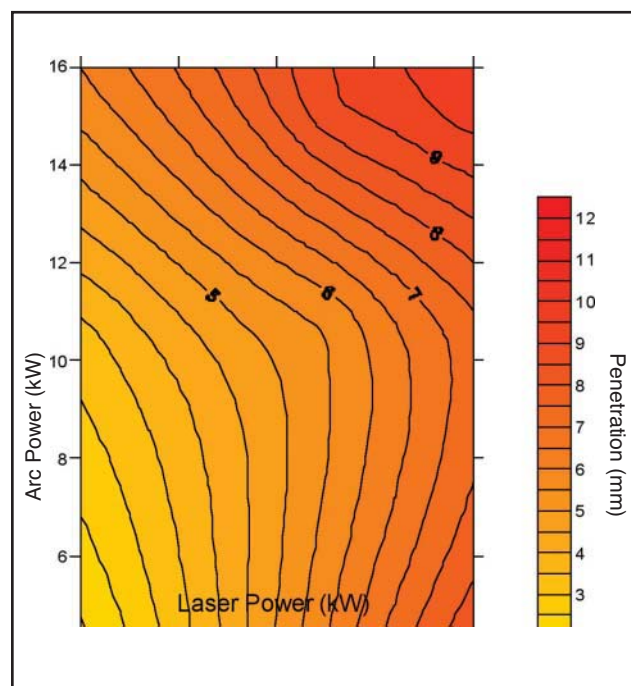


Fig. 3 — Map of weld penetration against laser power and arc power at 15 in./min travel speed.

metal microstructure is very important. As HY-80 steel possesses high hardenability, martensitic microstructures are readily found in HY-80 steel weldments that exhibit high strength, low ductility, and hydrogen cracking susceptibility (Refs. 18, 19). As was discussed in the previous paragraph, the presence of inclusions in a weldment will promote the nucleation of acicular ferrite (Refs. 20–26). The distribution of the inclusion sizes is critical for controlling the final microstructure. A low number of small inclusions with diameters smaller than the Zener diameter will allow austenite grain growth, consequently decreasing the amount of grain boundary ferrite formed in competition with acicular ferrite. There must also be a substantial amount of large intragranular inclusions of diameter between 0.4 and 0.6 μm to nucleate acicular ferrite (Refs. 20–22). The acicular ferrite content of the weld metal microstructure has been shown to increase with increasing inclusion size mode (Refs. 20, 21). Increasing the heat input of a weld increases the solidification time and consequently increases the average size of the inclusions resulting in an inclusion population more prone to nucleating acicular ferrite (Ref. 23). Specific alloying additions also contribute to the formation of oxide inclusions that will nucleate acicular ferrite.

Manganese is primary in importance for the formation of inclusions that will nucleate acicular ferrite, silicon and low levels of aluminum and titanium are also found in inclusions that nucleate acicular ferrite (Ref. 24). It is necessary that HLAW welds have a suitable inclusion population for the nucleation of acicular ferrite.

High-yield steels are typically welded with the application of preheat to prevent hydrogen-induced cracking. Because of the

high hardenability of HY steels, due to their high alloy content, both the fusion zone (FZ) and heat affected zone (HAZ) of the weldment can develop hard micro-structures that are susceptible to hydrogen-induced cracking. The FZ microstructure can be readily controlled by alloy additions in the filler metal however, the HAZ microstructure must be controlled with preheat. In addition, low-hydrogen welding practices must be used when welding HY steels to reduce the amount of hydrogen initially present in the weldment. The application of too high a preheating temperature or a combination of high preheat and heat input can produce a very slow cooling rate in the HAZ resulting in a detrimental two-phase HAZ microstructure. On cooling from austenite, large amounts of ferrite are initially formed, rejecting carbon; then, because of the increased carbon content, the remaining austenite transforms into a brittle, high-carbon martensite. With an appropriate level of preheat for the heat input of the welding process, the cooling rate in the HAZ produces a martensite/bainite microstructure. The correct application of preheat when welding HY steels is important

to prevent hydrogen-induced cracking and to produce an HAZ microstructure with similar properties to the base material.

Earlier work on HLAW HY-80 steel was not able to produce a weld metal microstructure of predominately acicular ferrite (Ref. 12). This was likely due to low manganese content in the weld metal because of greater dilution from the increased melting of the base metal (Ref. 12). Another study (Ref. 15), however, reported

that pipeline steels with higher levels of manganese were able to produce a weld metal microstructure with predominately acicular ferrite.

Research Objectives

The objectives of this research are as follows:

- To characterize the effects of laser and arc powers levels on the weld morphology,
- To develop a predominately acicular ferrite microstructure in the HLAW welds,
- To observe the effect of HLAW on the inclusion population of the welds, and
- To demonstrate control of the HLAW microstructure using different preheats and heat inputs.

Experimental Procedures

The laser arc hybrid welding system consisted of a continuous-wave 14-kW CO₂ laser with a F/# (ratio of raw beam diameter to focal length) of 5.2, a spot size of 1 mm and a constant voltage GMAW power source. The electrode was 3/16-in.- (1.6-mm) diameter ER100S-1 wire, fed using a conventional wire feeder and GMAW gun. The laser-electrode separation was held constant at 6 mm and the shielding gas used was 50%He-45%Ar-5%CO₂. Base material was 3/4-in.- (19-mm) thick HY-80 steel, cut into 4 × 8-in. (101 × 202-mm) coupons. Welding was done with the laser leading the arc. Contact tip-to-work distance and welding angles were all held constant throughout the experiment as shown in Fig. 1. All the constant processing parameters are shown in Table 1. Three separate experiments were done to examine the hybrid welding process. Welds were made comparing HLAW with GMAW and LBW. To examine the effect of heat input, laser power, arc current, and voltage were all kept constant while the travel speed was adjusted from 15 to 30 in./min (6.4 to 12.8 mm/s). Finally, the effect of preheat was studied with welds done at ambient temperature (80°F or 26.7°C) and at 140°F (60°C) and 250°F (121°C). In addition, two different laser powers (5 and 8 kW) and two different arc parameters (32 V with 200 in./min or 85 mm/s wire feed speed (WFS) and 35

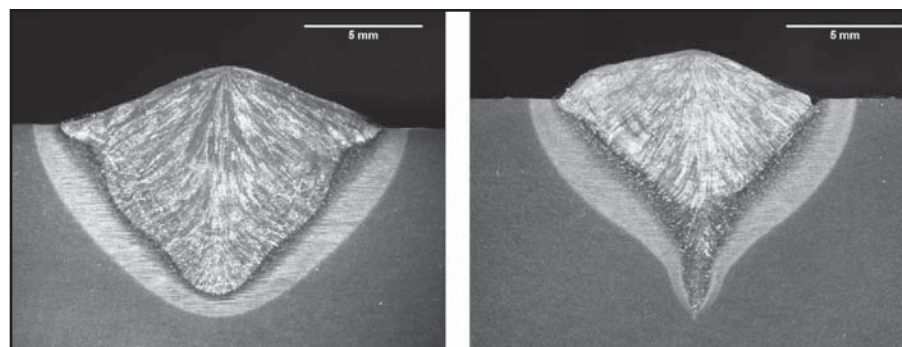


Fig. 4 — Left: pure hybrid weld with a uniform fusion zone; Right: hybrid weld with some laser-only penetration and nonuniform fusion zone.

V with 300 in./min or 127 mm/s WFS) were used in heat input and preheat experiments to explore the parameter space for hybrid welding. Laser-only and arc-only tests were also done for comparison.

Samples from these weld specimens were taken and the weld surface was ground flush for chemical analysis using optical emission spectroscopy. In addition, the base metal chemical composition was also analyzed. A summary of the chemical compositions of these welds is shown in Table 2.

The welds were sectioned at least one inch from the weld start and weld stop and were ground and then polished down to 1-μm diamond suspension and etched with a 2% Nital solution for 10 s. Macrographs of the welds were taken using a stereomicroscope. The weld morphology was observed and characterizing dimensions such as width, penetration, and fusion zone area were measured.

The HLA welds that exhibited a uniform fusion zone with no laser-only penetration and the reference GMA and LB welds were repolished to 0.05 μm with alumina for microstructural characterization. Initially left

unetched, those welds were examined for inclusions using the light microscope as well as the scanning electron microscope (SEM). In the SEM, the backscatter electron detector was used to observe the presence of inclusions in the welds. Since most inclusions are oxides, they appear darker than the matrix material in the weld and could be readily distinguished from pits or any other topographical artifacts. Thirty backscatter images at 4000× magnification were taken and used for the analysis. An image analysis software, Image J, was used to locate and measure the area of each inclusion by adjusting the grey scale threshold. The minimum inclusion area measured was 0.005 μm². A statistical analysis of the inclusion populations for size distribution, number density, and volume fraction was performed. An inclusion size distribution histogram was made and the inclusion diameters were sorted into 0.05-μm bins. The histograms were fit using a gamma distribution function (Ref. 27) as shown below.

$$f(x) = A \cdot \frac{1}{\beta^\alpha \cdot \Gamma(\alpha)} \cdot x^{\alpha-1} \cdot e^{-x/\beta} \quad (1)$$

Table 1 — HLAW Processing Constants

Welding position	Flat
Process orientation	Laser leading arc
Laser focus	At workpiece surface
GMAW polarity	DCEP-CW
Contact tip-to-work distance	0.75 in.
Laser-arc separation	6.0 mm
Laser-arc angle	15 deg
Shielding gas	50%He-45%Ar-5%CO ₂
Shielding gas flow rate	150 ft ³ /h
Electrode	E100S-1, 3/16 in. diameter

Table 2 — Chemical Composition for the Welds of Interest

Weld No.	Process	C	Mn	Al	Si	Cr	Ni	Mo	V	Ti	Cu	CE	P _{CM}
3	HLAW	0.22	0.68	0.014	0.29	1.48	3.18	0.38	0.01	0.01	0.14	0.98	0.42
27	GMAW	0.20	0.96	0.016	0.35	0.98	2.69	0.37	0.01	0.02	0.11	0.87	0.38
25	LBW	0.21	0.29	0.012	0.22	1.53	2.65	0.27	0.01	0.01	0.11	0.84	0.38
4	HLAW	0.20	0.64	0.020	0.28	1.32	2.87	0.36	0.00	0.01	0.11	0.89	0.39
13	HLAW	0.20	0.68	0.019	0.29	1.22	2.82	0.37	0.01	0.01	0.11	0.87	0.38
16	HLAW	0.21	0.70	0.008	0.25	1.06	2.61	0.32	0.01	0.01	0.11	0.83	0.38

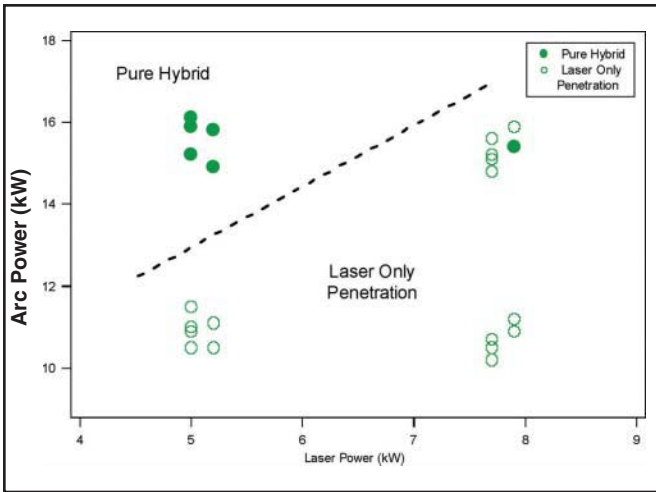


Fig. 5 — Parameter space map showing weld morphology (note the one pure hybrid weld in the upper right, this result is likely an outlier due to temporary decreased laser penetration at the location of the weld section).

The inclusions were further characterized using the SEM, energy dispersive spectroscopy (EDS). The chemical composition of the inclusions was determined using the spot scan and mapping features of the EDS. These welds were then etched with a 2%

monk indenter with a 500-g load was used. The hardness traverses were done at 0.100 in. (2.54 mm) below the base metal surface at 0.025-in. (0.635- mm) intervals with at least three measurements in the unaffected base metal on each side of the weld.

Nital solution for 5 s, and photomicrographs were taken at 1000× magnification using the light microscope. Welds were examined for their microstructural constituents using the IIW guidelines for the classification of microstructures. Ten micrographs were taken from each weld and 100 points were counted on each micrograph for a total of 1000 point counts. Finally, microhardness traverses were performed on the welds to relate microstructure to mechanical properties. A Vickers diamond indenter with a 500-g load was used. The hardness traverses were done at 0.100 in. (2.54 mm) below the base metal surface at 0.025-in. (0.635- mm) intervals with at least three measurements in the unaffected base metal on each side of the weld.

Results and Discussion

The macrostructural analysis first examined the hybrid welds. Since weld area is directly proportional to heat input, a statistical analysis was performed using the Minitab software to examine how the welding parameters affected the weld morphology (bead shape, area, and penetration) and consequently the heat input. A broader experimental matrix (in addition to those described in Table 2) was performed for weld characterization and the data of these welds are given in Table 3. Initially in the analysis, the measured weld areas for the entire set of hybrid welds were set to be linearly related to preheat, travel speed (v), laser power (P_L), and arc power (P_A). A regression analysis was used to find the proportionality coefficients. The coefficient for preheat was orders of magnitude smaller than the other coefficients. Consequently, preheat was removed from the analysis because preheat would have a minimal effect on weld area. The coefficient for travel speed had a negative coefficient. Since the weld area is proportional to the energy input per unit length and not the power or the velocity directly, the power parameters were divided by the travel speed to obtain an en-

Table 3 — Process Variables and Weld Morphology Effects for All Welds

Weld No.	Process	Preheat (°F)	Travel Speed (in./min)	Laser Power (kW)	Arc Power (kW)	Penetration (mm)	Measured Area (mm ²)	Pure Hybrid
2	HLAW	80	15	5.2	10.5	5.9	89.9	No
14	HLAW	140	15	5.0	11.5	5.4	89.1	No
15	HLAW	250	15	5.0	10.5	5.5	98.2	No
3	HLAW	80	15	5.2	14.9	8.9	141.0	Yes
13	HLAW	140	15	5.0	15.2	8.9	142.0	Yes
16	HLAW	250	15	5.0	15.2	8.9	137.0	Yes
7	HLAW	80	15	7.9	10.9	7.8	111.0	No
22	HLAW	140	15	7.7	10.5	6.7	110.0	No
21	HLAW	250	15	7.7	10.5	7.1	109.0	No
6	HLAW	80	15	7.9	15.4	11.2	148.0	Yes
18	HLAW	140	15	7.7	15.2	9.2	152.0	No
17	HLAW	250	15	7.7	14.8	8.7	160.0	No
1	HLAW	80	30	5.2	11.1	5.3	52.5	No
9	HLAW	140	30	5.0	10.9	5.0	53.3	No
10	HLAW	250	30	5.0	11.0	4.7	54.5	No
4	HLAW	80	30	5.2	15.8	7.2	72.3	Yes
12	HLAW	140	30	5.0	16.1	7.6	78.9	Yes
11	HLAW	250	30	5.0	15.9	7.4	72.1	Yes
8	HLAW	80	30	7.9	11.2	5.0	52.3	No
23	HLAW	140	30	7.7	10.2	7.9	48.5	No
20	HLAW	250	30	7.7	10.7	6.2	46.6	No
5	HLAW	80	30	7.9	15.9	7.8	76.5	No
24	HLAW	140	30	7.7	15.6	7.1	82.6	No
19	HLAW	250	30	7.7	15.1	6.9	74.4	No
26	GMAW	80	15	0.0	10.6	3.3	58.5	N/A
32	GMAW	140	15	0.0	10.6	2.9	55.9	N/A
29	GMAW	250	15	0.0	10.5	3.8	51.7	N/A
27	GMAW	80	15	0.0	15.5	6.7	101.0	N/A
33	GMAW	140	15	0.0	15.4	4.7	108.0	N/A
30	GMAW	250	15	0.0	15.4	5.9	107.0	N/A
25	LBW	80	15	7.7	0.0	8.9	44.7	N/A
31	LBW	140	15	7.7	0.0	13.4	54.0	N/A
28	LBW	250	15	7.7	0.0	9.5	49.1	N/A

ergy per unit length parameter. Because the energy transfer efficiency of the individual energy sources in the hybrid process is not known, no efficiency term was applied to either the laser or the arc power. By not applying an efficiency term and then taking the ratio of the coefficients on the laser and arc energy terms, the relative contribution of each energy source to the melting can be estimated. The fitting equation for weld area (A) is shown below.

$$A = k_L \frac{P_L}{\nu} + k_A \frac{P_A}{\nu} \quad (2)$$

Using a regression analysis the following fit coefficients were determined.

$$k_L = 15.8 \quad k_A = 53.5$$

Using this equation and fit coefficients the measured area was accurately calculated over the range of the data — Fig. 2. While the fit coefficients by themselves have little physical significance, their ratio provides an estimate of the relative contribution of the two power sources to melting. The ratio between the arc energy coefficient and the laser power coefficient is 3.4, indicating that arc power contributed 3.4 times more to the weld area than the laser power. Since heat input is proportional to the weld area, it can be concluded that the arc dominates the heat input in the hybrid process. The heat transfer and melting efficiency of the hybrid welding process was not determined; however, other research work (Ref. 28) has shown that the interaction of the laser and arc does not change the heat transfer efficiency but does improve the melting efficiency.

In the macrostructural examination, it was observed that at all arc power levels, the addition of the laser immediately improved weld penetration, and continued to

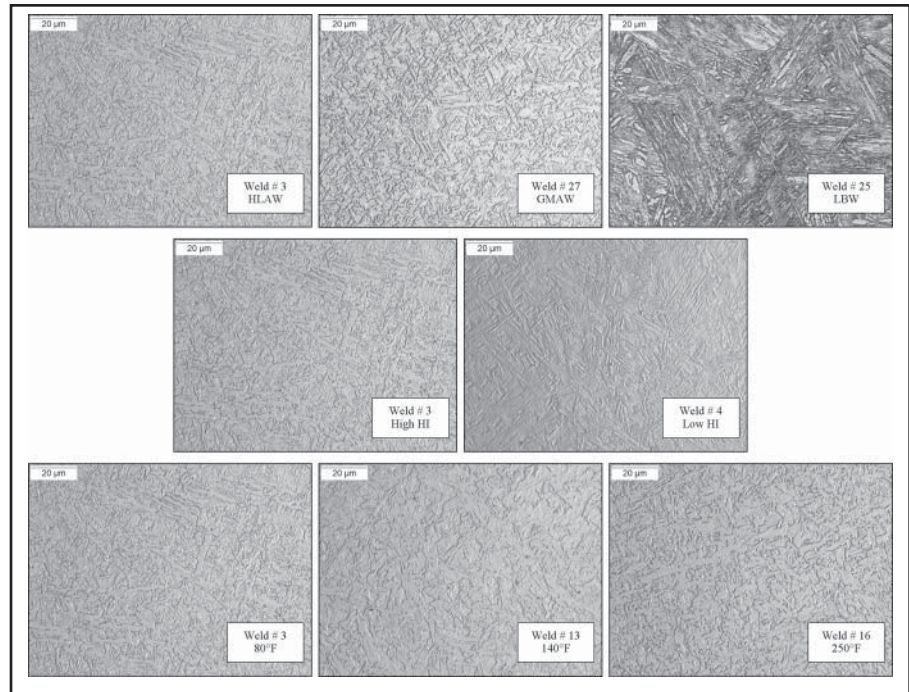


Fig. 6 — Light micrographs of the welds of interest. First row shows the process comparison, second row shows the heat input comparison, and third row shows the preheat comparison.

increase penetration as laser power was increased. At low laser power levels, up to about 5 kW, the addition of arc power also increased weld penetration. Above 5-kW laser power, however, the addition of the arc to the laser initially decreased penetration, likely because of both the destabilization of the keyhole by the arc and the increased absorption of the laser by the arc plasma. Continuing to increase the arc power to levels above 12 to 14 kW then increased the penetration. This effect is shown in Fig. 3. Weld width increased with both the laser power and arc power. The

depth-to-width ratio followed a similar trend to penetration.

When examining the hybrid welds two distinct morphologies were seen — Fig. 4. Some of the welds had a two-section fusion zone: a GMAW-like upper section and some laser-only penetration below as shown in the right-hand-side macrograph. The upper section of the weld profile can be easily described by a semihemispherical geometry. The root part of the weld shows a finger-like penetration clearly illustrating the laser keyhole effect. This morphology has been observed before by

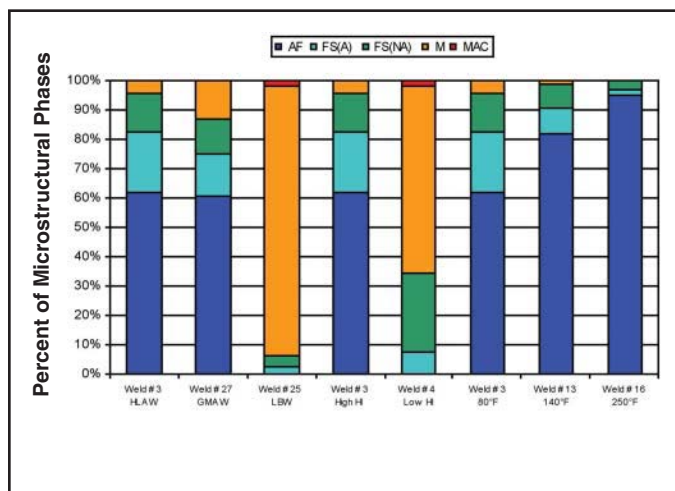


Fig. 7 — Weld metal microstructures of the welds of interest. First three bars show the process comparison, middle two bars show the heat input comparison, and last three bars show the preheat comparison.

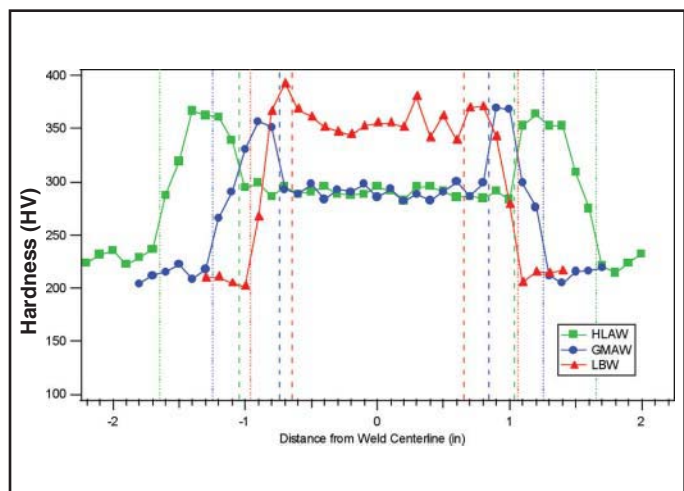


Fig. 8 — Weld hardness traverses comparing processes. The coarse dotted line shows the location of the weld interface and the fine dotted line shows the location of the HAZ-unaffected base metal boundary.

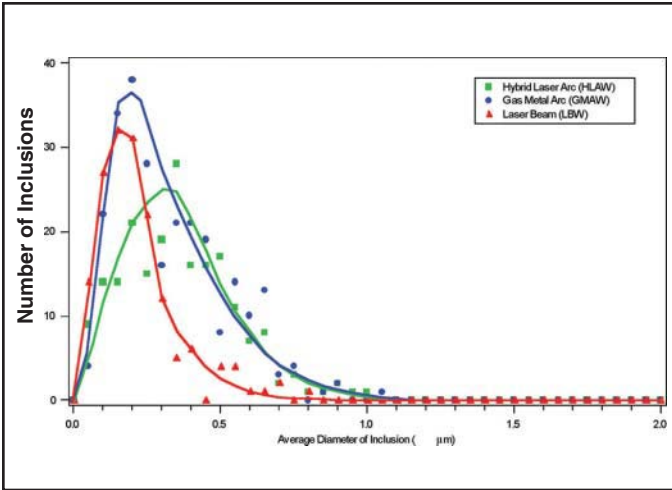


Fig. 9 — Weld metal inclusion size distributions comparing processes.

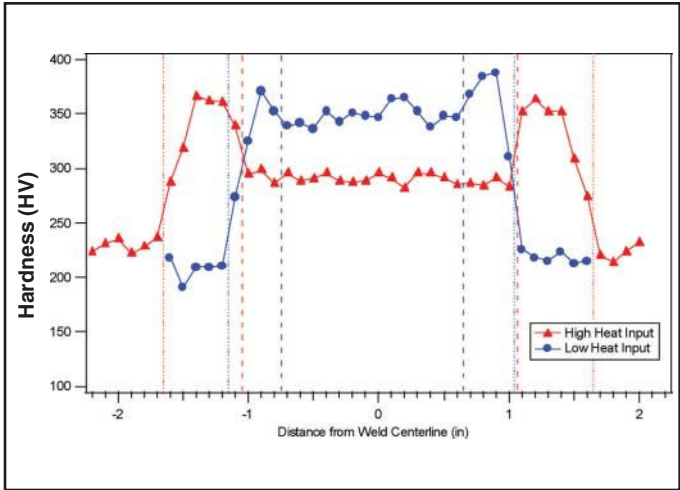


Fig. 10 — Weld hardness traverses comparing heat input. The coarse dotted line shows the location of the weld interface, and the fine dotted line shows the location of the HAZ-affected base metal boundary.

previous researchers at an arc-to-laser power ratio of 1.2 (Refs. 13, 29). This work also showed a more ferritic microstructure in the upper GMAW-dominated zone and more martensite in the lower LBW-dominated zone. They also observed reduced mixing of the filler metal in the laser-only zone. While the mechanism for the formation of this morphology has not been studied in detail, it is possible that there is incomplete mixing of the molten pool from the GMAW in the back to the front and down the LBW keyhole. It is also conceivable that the bottom of the LBW keyhole is at least partially solidified and not remelted by the GMAW. The other group of welds as shown in the

right-hand-side macrograph in Fig. 4 had a uniform fusion zone with no GMAW-like or LBW-like section. Named as pure hybrid in this work, this macrostructure is the generally desired morphology because of its uniformity in chemical composition and microstructure. This morphology has been reported numerous times in the literature (Refs. 5–12).

These two distinct morphologies were mapped on a laser power vs. arc power parameter space — Fig. 5. It was observed that the power ratio of arc power-to-laser power determined whether the weld was a pure hybrid weld or had some laser-only penetration. A high ratio of arc-to-laser power produced pure hybrid welds, while

low ratios of arc-to-laser power produced welds with some laser-only penetration. This effect was observed to be independent of both travel speed and preheat. This power ratio provides the upper limit on laser power for the hybrid process. For the welding parameters tested and the 6-mm laser-arc separation, the boundary between the two morphologies was between an arc-to-laser power of 2 and 3. This boundary is likely dependent on the laser-arc separation; decreasing the laser-arc separation should result in more pure hybrid welds and lower the arc-to-laser power ratio limit (Ref. 29). It should be noted that when mapping the pure hybrid weld morphology, one of the pure hybrid

Table 4 — The effects of Process, Heat Input, and Preheat on the Cooling Rate, Acicular Ferrite Content, and Average Weld Metal Hardness for the Welds of Interest

Weld No.	Process	Preheat (°F)	Heat Input (kJ/mm)	Δt_{8-5} (s)	Acicular Ferrite Content (Vol-%)	Average Weld Metal Hardness (HV)
3	HLAW	80	1.9	6.0	62	290.3
27	GMAW	80	1.8	5.8	61	290.6
25	LBW	80	0.6	1.9	0	367.4
4	HLAW	80	1.0	3.1	0	347.9
13	HLAW	140	1.9	6.8	82	254.2
16	HLAW	250	1.9	8.6	95	240.0

Table 5 — Inclusion Parameters for the Welds of Interest

Weld No.	Process	Number Fraction (No./mm ²)	Inclusion Volume Fraction (vol-%)	Inclusion Ratio Large to Small	Inclusion Diameter Mode (μm)	Median Inclusion Diameter (μm)
3	HLAW	6474	0.071	4.6	0.35	0.367
27	GMAW	7642	0.073	3.3	0.20	0.311
25	LBW	5066	0.021	1.2	0.15	0.221
4	HLAW	5747	0.084	4.6	0.25	0.371
13	HLAW	5786	0.070	4.8	0.20	0.355
16	HLAW	6724	0.072	4.4	0.25	0.337

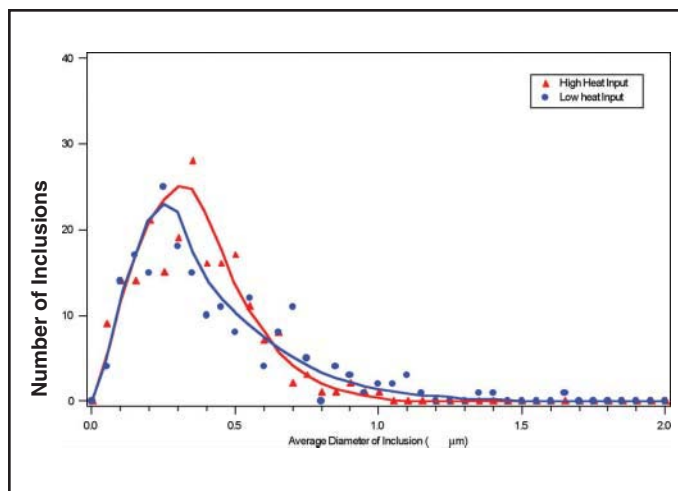


Fig. 11 — Weld metal inclusion size distributions comparing heat input.

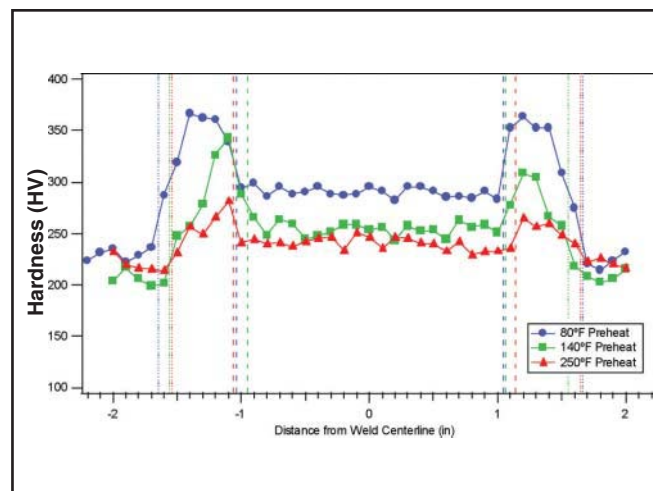


Fig. 12 — Weld hardness traverses comparing preheat. The coarse dotted line shows the location of the weld interface, and the fine dotted line shows the location of the HAZ-unaaffected base metal boundary.

welds fell in the laser-only penetration region — Fig. 5. This outlier result is likely due to laser beam “spiking,” where the penetration of a laser beam weld can vary by several millimeters because of instability of the keyhole and laser energy absorption. It is likely that this outlier weld was sectioned at a location where the laser penetration was temporarily lower than normal because of keyhole instability; consequently, the weld section had the pure hybrid morphology.

Microstructural characterization was performed on welds described in Table 2 that exhibited only the pure hybrid morphology, i.e., from the high arc power and low laser power group. The characterization also included the reference GMA and LB welds to examine the effects of process, heat input, and preheat. All the HLA welds of interest had the same laser (~5 kW) and arc (~15 kW) parameters. The GMA weld had the same arc parameters as the HLAW but with no laser power, but the LB weld had a higher power level (~8 kW) than the HLAW laser power in order to provide additional heat input. Changes in heat input of the HLA welds were made by changing the travel speed. Welds 3 (HLAW), 27 (GMAW), and 25 (LBW) were used to compare the three processes. Welds 3 (high heat input) and 4 (low heat input) were used to examine the influence of heat input, and Welds 3 (80°F preheat), 13 (140°F preheat), and 16 (250°F preheat) were used to study the effect of preheat. The identification of these welds and related cooling rate, microstructures, and hardness information are given in Table 4.

Through light microscopy, a wide range of microstructures was observed in these welds of interest. The micrographs from these welds are shown in Fig. 6. As mentioned earlier, the IIW guidelines for

the identification of weld metal microstructures were used to quantify the phases present in the microstructures. The microstructural makeup in volume-percent of each of these welds is shown in Fig. 7

The first microstructural comparison made was the effect of the processes using Welds 3 (HLAW), 27 (GMAW), and 25 (LBW). As Fig. 6 shows, the HLA weld metal microstructure was similar to the GMA weld metal microstructure but different from that found in the LB weld. Both the HLA and GMA welds exhibited predominant (more than 60 vol-%) acicular ferrite microstructure. The remainder is mostly ferrite with secondary phases, approximately 20 to 30 vol-% — Fig. 7. However, the LB weld metal microstructure did not contain acicular ferrite. Only a small amount of ferrite with secondary phases, less than 10 vol-%, was observed. The majority of the microstructure was martensite — Fig. 7.

The resultant weld metal hardness for the GMA and HLA welds was similar, approximately 290HV. The LB weld metal exhibited much higher hardness, approximately 370HV — Table 4. The hardness traverses also show this effect — Fig. 8. The LB weld had high weld metal hardness, nearly equivalent to its HAZ hardness. The HLA weld metal hardness and

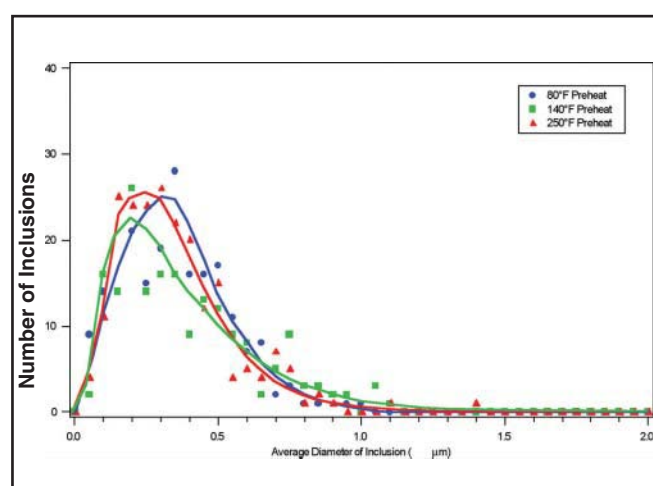


Fig. 13 — Weld metal inclusion size distributions comparing preheat.

GMA weld metal hardness are again nearly identical. Their peak hardness in the HAZ is also similar. The LB weld had the narrowest bead at approximately 0.3 in. The HLA weld, on the other hand, had the widest bead at almost 0.3 in. It also had a wider HAZ than the other two welds.

In the inclusion analysis, three different size distributions were observed for the three welds examined, as shown in Fig. 9. The LB weld inclusion size distribution was skewed to the left, with a large population of smaller inclusions but very few inclusions above 0.5 micrometers. The inclusion size mode is around 0.15 micrometers. The GMA weld inclusion size distribution was also skewed to the left, i.e., with a large number of small inclusions, but it had a greater number of large inclusions. The inclusion size mode for the GMA weld is 0.2 micrometers. Comparatively, the LB weld was cleaner than the GMA weld.

The HLA weld inclusion size distribution exhibited a more normal behavior, with the size mode located at $0.35\text{ }\mu\text{m}$. Its large inclusion size distribution was similar to the GMA weld, but the HLA weld had a smaller number fraction because of much fewer small inclusions. Note that both the HLW weld and the GMA weld have an acicular ferrite microstructure. The smaller number fraction of inclusions in the HLA weld will result in improved impact properties than for the GMA weld. In order to characterize the tendency of a given inclusion size distribution to nucleate acicular ferrite, the number ratio of large-to-small inclusions was calculated and the results are summarized in Table 5. The division between small and large inclusions was assumed to be $0.2\text{ }\mu\text{m}$ since inclusions of at least $0.2\text{ }\mu\text{m}$ in diameter have been observed to be necessary to nucleate acicular ferrite (Refs. 20–22). When this ratio of the number of large-to-small inclusions is large, the inclusion size distribution should have a greater tendency to nucleate acicular ferrite. The HLA weld has the highest ratio of large-to-small inclusions (4.6). The ratio for GMAW was moderately high (3.3) and the LBW the lowest (1.2). The inclusion size distribution of both HLAW and GMAW should readily nucleate acicular ferrite.

The cause of the differences in the inclusion size distributions of these welds is likely the weld metal chemical composition, specifically the manganese content (Table 2). Using the EDS capabilities of the SEM, the inclusions were determined to be predominately manganese-containing oxides. With low manganese in the HY-80 steel base metal, the autogenous LBW weld would have little manganese available to produce inclusions capable of nucleating acicular ferrite. On the other hand, the filler metal used in HLAW and GMAW is rich in manganese. These welds would be expected to exhibit higher levels of manganese and consequently a larger number of inclusions. The HLA weld had a larger fusion zone than the GMA weld because of the additional laser energy. The wire feed rates for both processes were the same. As a result, the HLA weld had greater dilution of the filler metal, and therefore lower manganese content, and smaller number of inclusions than the GMA weld.

The difference in weld metal microstructure between the three processes is also due to the different cooling rates experienced by the welds. Since the LB weld had a much lower heat input than both the HLA and GMA welds, its cooling rate expressed as $\Delta t_{8.5}$ was expected to be much faster. This speculation was substantiated by calculations that the $\Delta t_{8.5}$ of the LBW was 1.9 s , much shorter than the HLA weld, $\Delta t_{8.5} = 6.0\text{ s}$, or the GMA

weld, $\Delta t_{8.5} = 5.8\text{ s}$. These cooling rate calculations were made using the Rosenthal solution. The cooling path experienced by the LB weld, due to fast cooling, completely misses the ferrite nose on the CCT diagram. Even with proper size distribution of inclusions it is unlikely that the LB weld would produce a ferritic microstructure. The additional heat input of the arc, which slows the cooling rate and makes nucleation of ferritic phases possible, is a key advantage of HLAW over LBW.

The next microstructural comparison made was to investigate the effect of heat input in HLAW, using Welds 3 (high heat input) and 4 (low heat input). As mentioned earlier in the procedures section, the heat input was controlled by altering only the travel speed and not the laser or arc parameters. This practice was chosen to isolate the observations to only the effect of heat input and not the other process variables. Figure 6 shows the great differences observed in the two weld metal microstructures. The high heat input weld had a predominately acicular ferrite microstructure, more than 60 vol-%, with the remainder mostly ferrite with secondary phases, more than 30 vol-% — Fig. 7. However, the low heat input weld had no acicular ferrite and only a moderate amount of ferrite with secondary phases, approximately 35 vol-%. The rest of the microstructure was martensite — Fig. 7.

Weld metal hardness measurements showed low values for the high heat input weld, 290 HV, and high for the low heat input weld, 350 HV (Table 4). Figure 10 shows the hardness traverses for these welds. Increasing the heat input increases the size of the HAZ but decreases the weld metal hardness. While the low heat input weld had high hardness in the weld metal, it was slightly softer than the peak hardness found in the HAZ.

The inclusion size distributions for the two different heat input welds were similar — Fig. 11. However, the high heat input weld inclusion size distribution was shifted to the right (larger diameters), likely due to a longer time above melting than the low heat input weld allowing more time for the growth of the inclusions. Both inclusion size distributions have the same high ratio of large-to-small inclusions and inclusion modes and medians above $0.2\text{ }\mu\text{m}$ (Table 5). More specifically, the inclusion size mode of the higher heat input weld was $0.35\text{ }\mu\text{m}$, instead of $0.25\text{ }\mu\text{m}$ for the lower heat input weld. Consequently, both welds have the necessary inclusions to nucleate acicular ferrite. These similarities in inclusion size distribution are expected because the two welds have nearly identical chemical compositions (Table 2), particularly the manganese content that is necessary for the formation of inclusions. However, the microstructures of the two

welds are very different and, therefore, inclusion size distribution cannot be solely responsible for the microstructure. The cooling rate has an important effect of controlling the microstructure. Because the cooling rate was high in the low heat input weld, $\Delta t_{8.5} = 3.1\text{ s}$, weld metal microstructure shows that the transformation to ferritic phases was almost entirely missed. Increasing heat input lowered the cooling rate and promoted the formation of acicular ferrite. It can be safely concluded that HLAW responds to heat input changes just as conventional GMAW.

The final microstructural comparison made was to examine the effect of preheat in HLAW. Welds 3 (80°F preheat), 13 (140°F preheat), and 16 (250°F preheat) were used. As Fig. 6 shows, all three welds had similar weld metal microstructures of predominately acicular ferrite. Increasing the preheating temperature increased the content of acicular ferrite and lowered the content of ferrite with secondary phases and martensite — Fig. 7. The weld at the lowest preheat, 80°F , was 62 vol-% acicular ferrite, and the weld at the highest preheat, 250°F , was 95 vol-% acicular ferrite.

The weld metal hardness at the lowest preheat of 80°F was 290 HV, but increasing the preheat to only 140°F lowered the weld metal hardness to 250 HV. Further increasing the preheat to 250°F continued to lower the weld metal hardness (240 HV), but not as dramatically (Table 4). Figure 12 shows the hardness traverses for these welds. Increasing preheat reduces the weld metal hardness but more importantly lowers the peak hardness in the HAZ. Note that preheat is the only process variable that significantly lowered the peak hardness in the HAZ. This is important because preheat can prevent the formation of a hard microstructure in the HAZ that makes HY-80 steel susceptible to hydrogen-induced cracking.

The inclusion size distributions of the welds at the three different preheat levels are nearly identical as shown in Fig. 13. They have similar inclusion volume fractions, median inclusion diameter, and ratio of larger-to-small inclusions (Table 5). This is again due to the uniformity in chemical composition specifically manganese (Table 2) and nearly identical time above melting (preheat has little effect on peak temperature or time above melting temperature). All of the welds had a suitable distribution of inclusions to nucleate acicular ferrite, and changing preheat had little effect on the inclusion size distribution. However, there were differences in the microstructures caused by the changes in cooling rate because of preheat. The 80°F preheat had a $\Delta t_{8.5} = 6.0\text{ s}$ and the 250°F preheat had a $\Delta t_{8.5} = 8.6\text{ s}$. This change in cooling rate was significant enough to promote the nucleation of aci-

cular ferrite at slower cooling rates. HLAW responds to preheat control just as conventional GMAW.

Conclusions

The major conclusions from this research on hybrid laser arc welding of HY-80 steel are summarized below.

1) The addition of laser power to GMAW immediately begins to increase penetration; however, the addition of arc power to LBW initially decreases penetration, but then improves penetration as arc power is increased.

2) Arc power was found to dominate the melting (fusion zone area) and consequently the heat input over the laser power by a factor of 3.4 in the hybrid process. Substantially more energy was being transferred by the arc than the laser.

3) There is an upper limit to the laser power in HLAW defined by a ratio of arc-to-laser power that produces a pure hybrid weld with no laser-only characteristic. For the parameters tested, particularly the 6 mm of laser-arc separation, arc-to-laser power ratios greater than at least two are required for a pure hybrid weldment with no laser-only penetration.

4) The HLAW had suitable inclusion size distribution for the nucleation of acicular ferrite. Similar to the GMA weld, HLA welds showed a significant increase in acicular ferrite content and lower hardness than LB welds. This behavior is a combined result of the slower cooling rate and the improved inclusion size distribution of the hybrid weld.

5) Even though increasing heat input of HLAW by controlling travel speed had only a minor effect on the inclusion population, it greatly increased the amount of acicular ferrite in the weld metal, and lowered the weld metal hardness.

6) Increasing the preheat of HLAW had little effect on the inclusion population, but it increased the acicular ferrite content of the weld metal, and lowered the hardness of both the fusion zone and HAZ.

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Welding of Galvanized Dual-Phase 980 Steel in a Gap-Free Lap Joint Configuration

A new welding procedure based on GTAW as an auxiliary preheating source with a fiber laser as a main heat source has been developed to obtain the completely defect-free lap joints of galvanized DP 980 steel in a gap-free configuration

BY S. L. YANG AND R. KOVACEVIC

ABSTRACT

The feasibility has been investigated of producing sound gap-free lap joints in galvanized DP980 steel with laser beam welding and hybrid laser-gas tungsten arc welding (GTAW) with a common molten pool. Laser-welded lap joints and hybrid laser-GTA welded lap joints were characterized by different weld defects such as spatters and blowholes. A new welding procedure based on using GTAW as an auxiliary preheating source with a fiber laser as a main heat source is proposed to join the galvanized DP 980 steel in a gap-free lap joint configuration. The metal oxides produced during the GTAW preheating process can drastically improve the coupling of the laser beam to the welded material. Under this welding condition, the keyhole is readily formed by the laser beam and provides the channel for the highly pressurized zinc vapor developed at the interface of two metal sheets during the laser welding process to be vented out. The completely defect-free laser welds have been obtained by using this newly developed welding method. X-ray photoelectron spectroscopy (XPS) test is carried out to analyze the chemical compositions of the surface preheated by the GTAW torch. A CCD video camera with the frame rate of 30 frames per second is used to monitor the molten pool online. Microhardness measurement, SEM microstructure analysis, as well as a tensile-shear test were carried out to evaluate the mechanical properties of the hybrid GTAW preheated/laser welded joints with the separate molten pool.

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Introduction

Because of their excellent corrosive resistance, galvanized steels have been widely used in different industries such as automotive and shipbuilding. However, it is still a great challenge to weld the galvanized steels in a gap-free lap joint configuration. Due to the low boiling point of zinc (906°C) with respect to the melting point of steels (over 1500°C), the highly pressurized zinc vapor is easily developed at the interface of the two metal sheets. The highly pressurized zinc vapor expels the liquid metal out of the molten pool and produces different defects in the weld such as spatter and porosity. These weld defects significantly degrade the mechanical properties of the welded joints.

In order to mitigate the presence of the highly pressurized zinc vapor when using a laser beam to join the galvanized steels, a number of welding procedures have been developed in the past several decades. The simplest approach to mitigate the effect of the zinc vapor is to completely remove the zinc coating at the interface by mechanical means prior to welding (Ref. 1), as one of the American Welding Society standards for welding galvanized steel suggested (Ref. 2). Another technique used to weld lap joints in galvanized steels is to intentionally form a small root opening between the two metal sheets (Ref. 3). Mazumder et al. (Ref. 4) patented and described (Refs. 5, 6) a technique that places a thin copper sheet between two steel sheets along the weld interface. The copper has a melting temperature of 1083°C (between the melting tem-

peratures of steel and the boiling temperature of zinc) and can be alloyed with the zinc before the steel is melted. However, the presence of copper in the steel could generate additional problems, such as hot cracking and corrosion concerns (Ref. 7). The method of redesigning the lap joint, which allows the zinc vapor to be evacuated before the molten pool reaches the interface, is another way of mitigating the effect of the zinc vapor (Refs. 8–11). Pennington et al. (Refs. 12, 13) replaced the zinc coating in the weld zone with a nickel coating before laser welding; the nickel coating's melting point of 1453°C is higher than the melting point of zinc. By replacing the zinc coating with nickel coating in the weld area, the welding process is not affected by the highly pressurized zinc vapor and corrosion protection is still provided. However, this will increase the cost and lower the productivity. In addition, pulsed laser (Ref. 14), dual laser beam or two lasers (Refs. 15–19), and hybrid laser welding (Refs. 20–23) were also applied to lap join the galvanized steels. Gualini et al. (Ref. 18) proposed the modified dual-beam method to weld galvanized steel sheets in a gap-free lap joint configuration. In their studies, the first beam was used to cut a slot, which provided an exit path for the zinc vapor, while the second beam was employed to join the metal sheets. However, it was found that spatter and porosity were still produced in the welds by using this method. Kim et al. (Ref. 23) used the laser-arc hybrid welding technique to join 1.0-mm-thick SGCD1 galvanized low-strength steel in a gap-free lap joint configuration. They found that the formation of porosity was the main concern in the welding of galvanized steels. Moreover, the welding process is not stable in their study. Spatter and porosity are still produced in the welds, which significantly damages the electrode torch and lowers the mechanical properties of the welds. Additionally, Gu et al. (Ref. 24) also introduced the arc to share a common molten pool with the laser welding process, in which the molten pool is enlarged by the arc. The enlarged pool can provide more space for the zinc vapor to es-

KEYWORDS

Galvanized Steels
Hybrid Laser/GTA Welding
Metal Oxides
X-Ray Photoelectron
Spectroscopy
CCD Video Camera
Keyhole

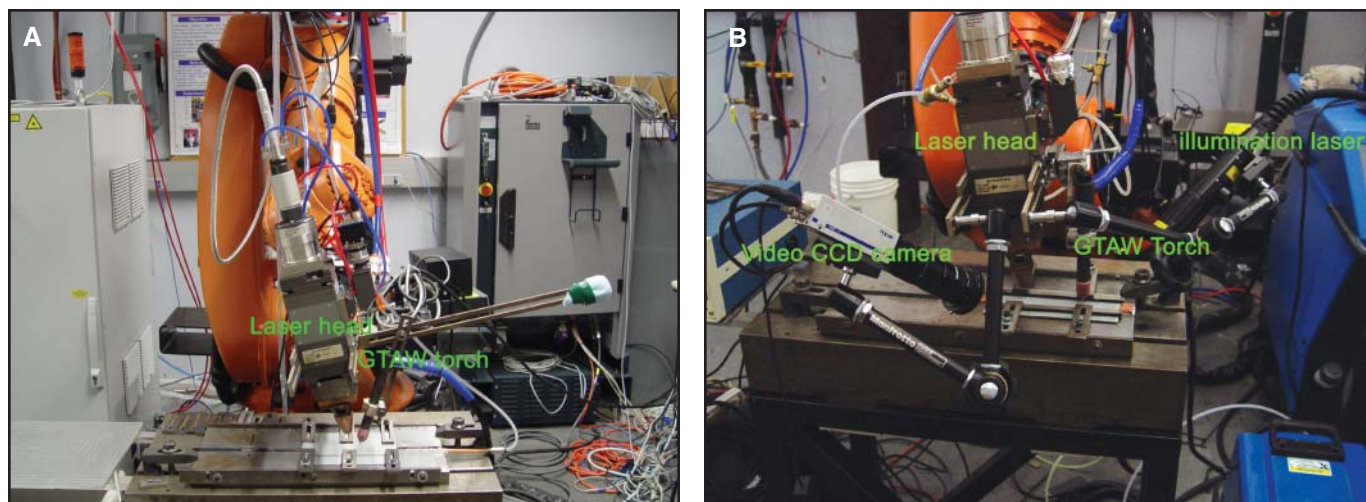


Fig. 1 — A — Experimental setup for hybrid laser/GTA welding in the common molten pool; B — experimental setup for hybrid GTAW preheating/laser welding in a separated molten pool.

cape from it. However, spatter and porosity were present in the welds. Recently, Li et al. (Ref. 25) patented and described in a paper (Ref. 26) a technique that sets the aluminum foil layer in the weld zone at the interface of two galvanized steel sheets to form the Al-Zn alloy; thus lowering the effect of the zinc vapor pressure. In order to use this method to weld galvanized steels in a lap configuration, there is a requirement of tightly clamping the two metal sheets. If a gap exists at the interface of two metal sheets, weld defects will form (Ref. 26). Furthermore, the dissolution of aluminum-steel alloy into the weld, which makes the weld brittle, has the potential to deteriorate the weld quality. Although the methods mentioned here can mitigate the presence of the highly pressurized zinc vapor at the interface of two metal sheets, they also have a number of disadvantages. Some of the proposed methods require preprocessing or postprocessing actions. Some require a high investment in equipment. In addition, during laser welding of steel, the coupling efficiency of laser beam energy is very low (Ref. 27). It has been reported that different surface conditions could affect the absorptivity of the laser beam energy by the metal sheets (Refs. 28, 29).

Dual-phase steels offer low yield ratio, high work-hardening ratio, and high bake hardening (BH) value. They have been used to manufacture auto components that demand high strength and good “crashworthiness and formability” such as “wheel, bumper, and other reinforcements” (Ref. 30). According to the UltraLight Steel Auto Body (ULSAB) program report, 74% of the ULSAB body structure is constructed of dual-phase steels (Ref. 31). The automotive industry has shown considerable interest in using laser welding techniques for replacing traditional spot welding to lap join galvanized dual-phase steels in a gap-free configuration. Because of its high speed, low heat

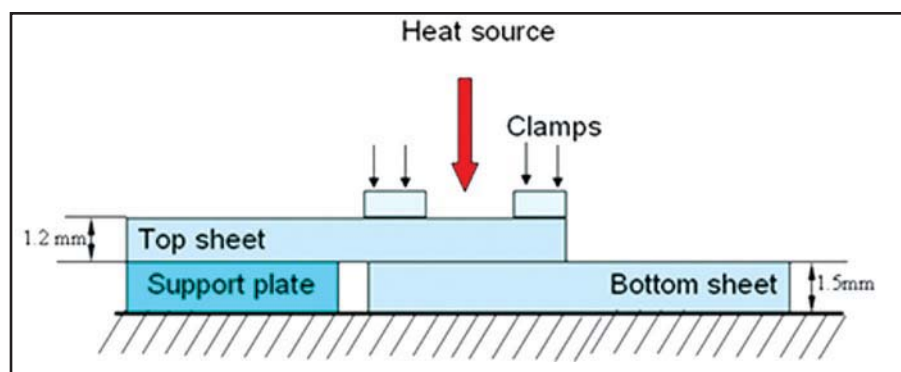


Fig. 2 — Schematic representation of the setup of gap-free lap joint configuration for the hybrid laser-GTAW preheating process.

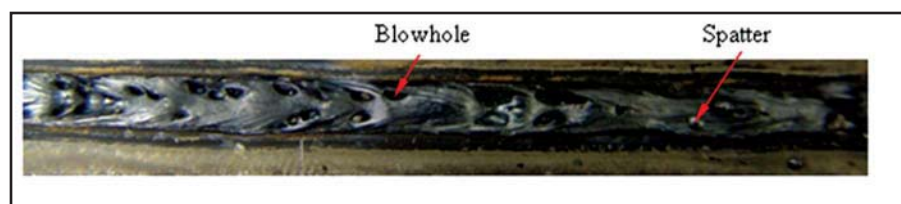


Fig. 3 — Typical laser beam welded lap joint (laser power: 3000 W and welding speed of 30 mm/s).

input, and low distortion, laser beam welding has been widely used in the automotive industry to fabricate different vehicles parts (Refs. 32, 33). While the automotive industry has shown significant interest in using laser welding techniques to lap join galvanized DP steels in a gap-free configuration, until now there has been no report on a cost-effective, efficient, and easy-to-use laser welding technique that can be practically applied to do so. To meet the requirement of obtaining sound lap joints for the automotive industry, therefore, it is important to develop an efficient and robust laser welding technique for welding of galvanized steels in a gap-free lap joint configuration and to fully understand the mechanisms of the welding process. The main objective of

this study is focused on developing a welding procedure to provide completely defect-free, gap-free lap joints in galvanized DP steels for the automotive industry.

In this study, laser welding is first used to weld galvanized DP980 steel metal sheets in a gap-free lap joint configuration. A large amount of spatter and porosity are produced during the laser welding process. Furthermore, in order to mitigate the presence of zinc vapor developed at the interface of two metal sheets, gas tungsten arc welding (GTAW) is combined with fiber laser welding in two modes to weld galvanized dual-phase DP 980 steel in a gap-free lap joint configuration. In the first mode, the laser beam and GTAW share a common molten pool. This approach was taken by other re-

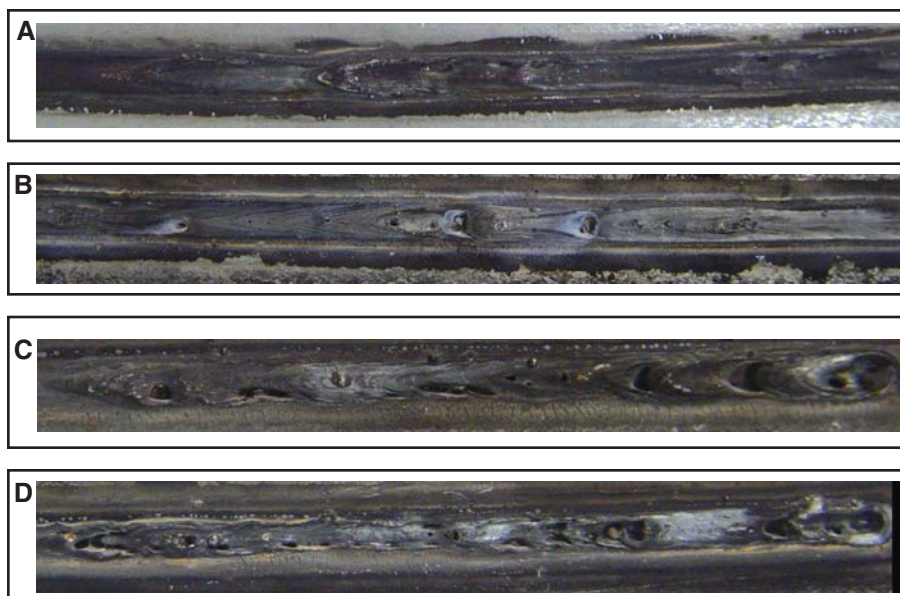


Fig. 4 — The effect of laser power on weldability using hybrid laser/GTAW in a common molten pool at the following laser powers: A — 2000 W; B — 2500 W; C — 3000 W; D — 3500 W. (Arc current: 200 A and welding speed: 30 mm/s.)

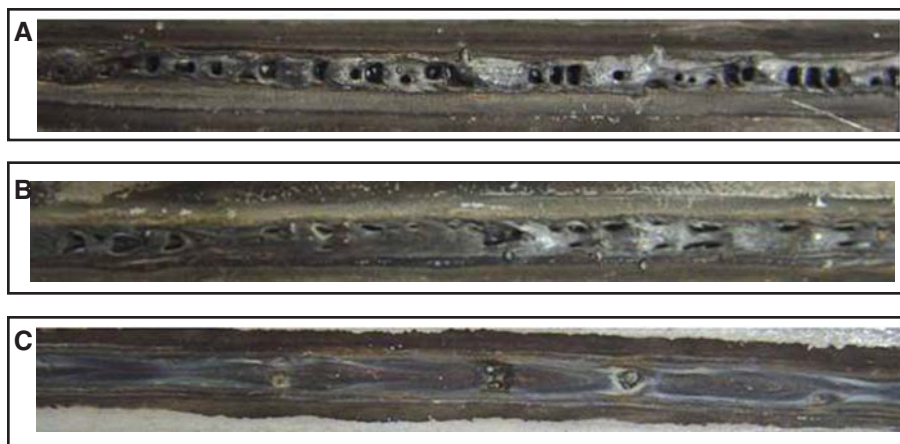


Fig. 5 — The effect of the distance between the GTAW electrode and the laser beam using hybrid laser/GTAW in a common molten pool at the following distances: A — 2 mm; B — 6 mm; C — 10 mm. (Laser power: 3000 W, arc current: 200 A, and welding speed: 30 mm/s.)

searchers (Refs. 23, 24). The effects of welding parameters on the feasibility of producing joints in a gap-free lap joint configuration are fully investigated. In the second mode, GTAW is only used as the preheating source to modify the surface conditions of the top surface in order to improve the coupling efficiency of the laser beam energy with the metal. In this approach, the laser beam and GTAW torch are kept at a specific distance. Through the controlled heat management of GTAW preheating process, the zinc coating at the top surface of the metal sheet is burned and metal oxides are generated at the top surface along the weld interface. In addition, the zinc coating along the weld interface of two metal sheets is transformed in the zinc oxides, and has a higher melting point (1975°C) than the boiling point of zinc (906°C). The following laser

beam is used to provide the required depth of weld penetration. Completely defect-free laser welds have been obtained using this newly developed welding method. Additionally, a CCD video camera with the frame rate of 30 frames per second was used to monitor the molten pool behavior online. It was found that the keyhole is the critical factor to guarantee successful achievement of defect-free galvanized DP 980 steel lap joints. X-ray photoelectron spectroscopy (XPS) tests were carried out to determine the chemical composition at the top surface as well as along the interface of the metal sheets. The microhardness and test tensile shear tests are carried out to evaluate mechanical properties of the welds. The microstructures in the different zones of welds are analyzed by using a scanning electron microscope (SEM). It was found that the

decrease in the volume of the martensite in the heat-affected zone (HAZ) reflected into the decrease in the hardness value in the HAZ. The tensile shear test results show that the fracture of welds mainly occurred in the HAZ.

Experimental Setup

The material used in this study is galvanized DP 980 steel sheet. The dimensions of the coupons used in this study are $200 \times 85 \times 1.2$ mm and $200 \times 85 \times 1.5$ mm. The 1.2-mm-thick coupon is selected to be at the top of the lap joint welding process. The gap between the two metal sheets is kept tight during welding, assuming that the gap is equal to zero. The laser/GTAW hybrid welding experiments are performed by using a 4-kW fiber laser, which has a 250-mm focal length and a 0.6-mm focused spot size. The GTAW machine is a 300 DX AC/DC inverter argon arc welding machine. Pure argon gas with the flow rate of 30 ft³/min is used as the shielding gas. A 3-mm-diameter GTAW electrode is used. A CCD color video camera is used to monitor the welding process. The video frame rate is set at 30 interlaced frames per second. A bandpass green laser with a 532-nm center wavelength and a maximum output power of 6 W is selected as the source to illuminate the molten pool in order to obtain clear images of it. The experimental setup is shown in Fig. 1. During the welding process, hybrid laser/GTAW is performed in two modes: in the first mode, the laser beam and GTAW torch share the common molten pool; and in the other, the laser beam and GTAW torch are kept at the appropriate distance. Welding is performed with the laser head tilted at 10 deg from the normal to the sheet surface in order to prevent the reflected laser light and the spatter from damaging the laser optics, as shown in Fig. 1. The GTAW torch is kept in the vertical position. Table 1 lists the chemical compositions of the galvanized DP 980 steels. Figure 2 shows the schematic presentation of the gap-free lap joint configuration for hybrid laser/GTA welding.

Results and Discussion

Laser Welding of Galvanized Dual-Phase DP 980 Steel in a Gap-Free Lap Joint Configuration

In order to investigate the influence of different welding parameters on the weld quality of laser-welded lap joints, laser power and welding speed are varied and a thin foil of stainless steel in thicknesses of 0.1, 0.2, and 0.4 mm is set as the gap in the weld zone to weld dual-phase DP 980 steels in a gap-free lap joint configuration. Figure 3 illustrates the typical surface appearance of a gap-free lap joint of galvanized DP 980 steel using laser welding. As shown in Fig. 3,

the laser-welded galvanized DP 980 steel joint is characterized by the presence of spatter and porosity, which are produced by the highly pressurized zinc vapor developed at the interface. When using the laser welding to join the galvanized steels in the gap-free configuration, it is difficult to safely vent out the highly pressurized zinc vapor from the small molten pool the laser beam produces. The highly pressurized zinc vapor tends to violently expand, expel from the molten pool, and remove liquid metal out of the molten pool (Ref. 34). The liquid metal removed from the molten pool is condensed in the air and produces different-sized spatter that scatters in all directions and is deposited in and/or around the weld zone. Moreover, excessive removal of the molten material will lead to the formation of porosity (Ref. 35). From the experimental results, it could be concluded that it is impossible to obtain sound welds of galvanized DP 980 steel using only laser welding in a gap-free lap joint configuration. In addition, it is found that the laser-induced plasma directly above the top surface of metal sheets fluctuates dramatically and this irregular plasma makes coupling of the laser beam very instable.

Feasibility Study of Gap-Free Lap Joint of Galvanized DP 980 Steel Using Hybrid Laser/GTA Welding with the Common Molten Pool

In order to address the problems caused by highly pressurized zinc vapor that develops at the interface of two metal sheets, GTAW is introduced to share the common molten pool to weld galvanized DP 980 steels in a gap-free configuration. The effects of the main process parameters on the weldability of galvanized DP 980 steel such as laser power, the distance between laser beam and electrode torch, and the arc current, as well as the welding speed are studied. Figure 4 shows the effect of laser power on the feasibility of achieving sound welds. Figure 5 shows the effect of distance between the laser beam and electrode torch on the surface appearance of hybrid laser/GTA welded joints. Figure 6 shows the effect of arc current on the surface appearance of hybrid laser/GTA welded joints. Figure 7 shows the effect of welding speed on the surface appearance of hybrid laser/GTA welded joints. As shown in Fig. 4, increasing laser power produces more spatter in the welds due to the higher heat input, which increases the pressure of zinc vapor at the interface of two metal sheets and makes the welding process more unstable. The stability of the welding process is improved by the increase in the distance between the laser beam and electrode torch, as shown in Fig. 5. This phenomenon is attributed to the lowering pressure of zinc vapor with the increase in the distance between the laser beam and GTAW torch and the partially

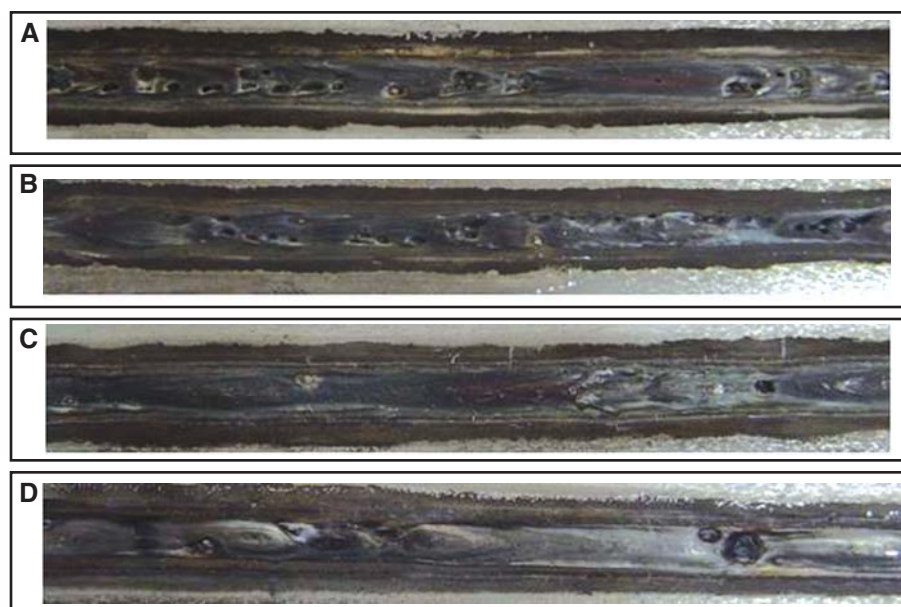


Fig. 6 — The effect of arc current using hybrid laser/GTA in a common molten pool at the following arc currents: A — 120 A; B — 160 A; C — 200 A; D — 240 A. (Laser power: 3000 W and welding speed of 30 mm/s.)

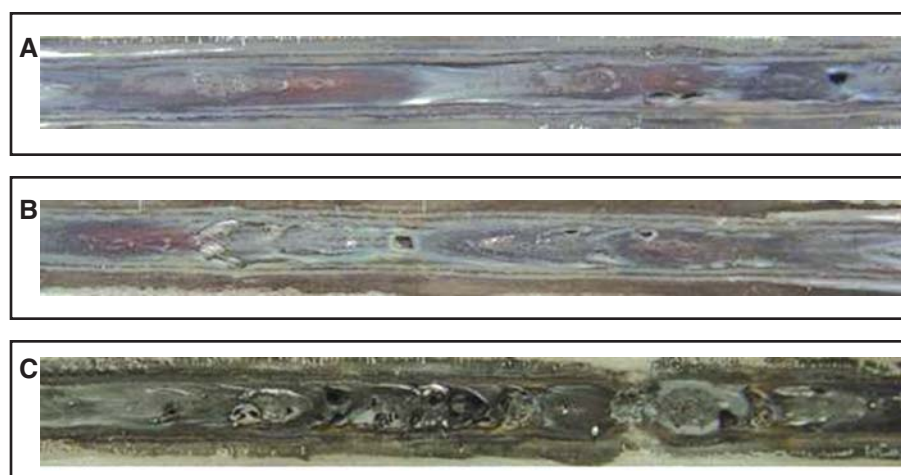


Fig. 7 — The effect of welding speed using hybrid laser/GTA in a common molten pool at the following welding speeds: A — 30 mm/s; B — 35 mm/s; C — 40 mm/s. (Laser power: 3000 W, arc current: 200 A, and the distance between laser beam and GTAW electrode: 6 mm.)

Table 1 — Chemical Composition (wt.-%) of DP 980 Steel

Steel	C	Mn	Mo	Si	Cr	Al	B
DP 980	0.135	2.1	0.35	0.05	0.15	0.45	0.007

burned zinc coating at the interface by the leading arc. In addition, the leading arc also oxidized the zinc coating in and around the weld zone at the interface of the two metal sheets. The zinc oxides have a higher melting point (1975°C for ZnO) than the boiling point of zinc (906°C), thus helping to stabilize the welding process (Ref. 23). Furthermore, it was found that the increase in the specific range of arc current, as shown in Fig. 6, improved the weld quality of the galvanized DP 980 steel. This phenomenon could be explained by the fact that the size

of the molten pool is enlarged by increasing the arc current. However, the weld quality of the galvanized DP 980 steel decreases with the increase in welding speed, as shown in Fig. 7. The main reason for this is the fact that the keyhole will collapse when the welding speed is increased (Ref. 36).

With respect to laser welding of galvanized DP 980 steels, the hybrid laser/GTA process with a common molten pool will produce less spatter because the addition of the arc will enlarge the molten pool. More importantly, the arc preheats the metal

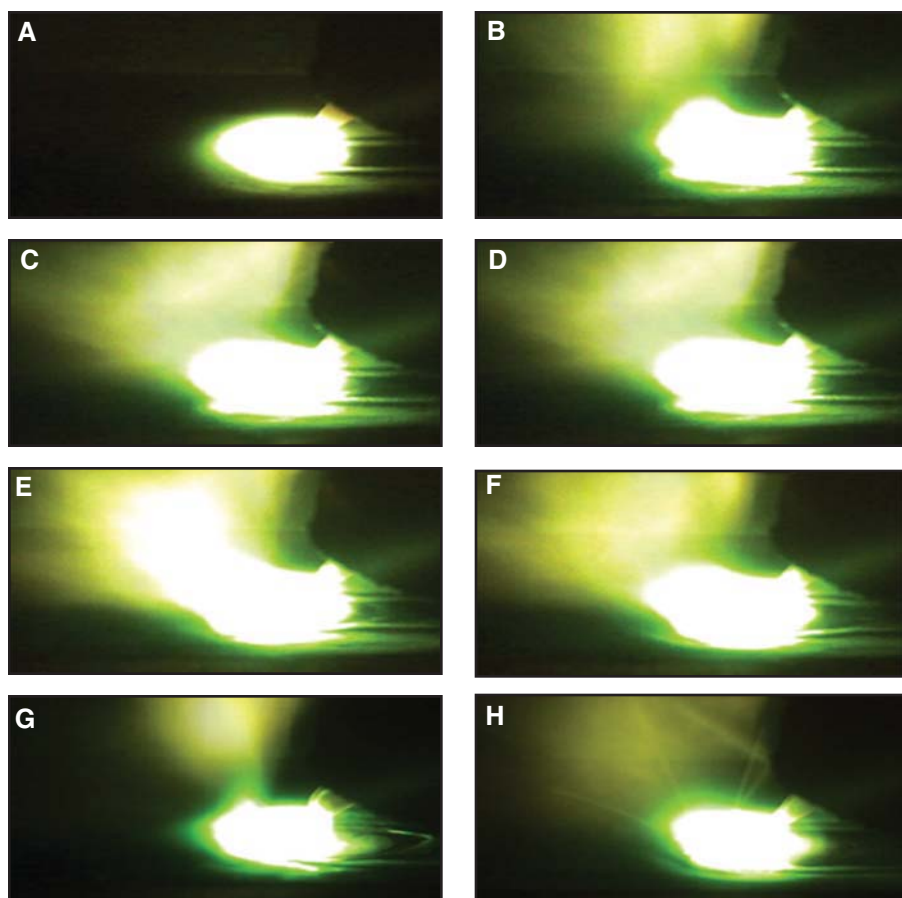


Fig. 8 — The shape of the arc plasma and the zinc vapor plume at different times: A — $t = 0$ ms; B — $t = 30$ ms; C — $t = 70$ ms; D — $t = 100$ ms; E — $t = 130$ ms; F — $t = 170$ ms; G — $t = 200$ ms; and H — $t = 230$ ms.

sheets. This facilitates the absorptivity of the laser beam into the metal sheets. The laser beam forms a hole in the molten pool, through which the zinc vapor will be vented out. However, it is still difficult to completely eliminate the generation of spatter, which tends to damage the expensive laser optical lens. In addition, spatter severely damages the electrode tip; thus, it is necessary to frequently sharpen it. Furthermore, when the laser beam and the electrode share a common molten pool, the plasma defocuses, absorbs, and refracts the laser beam (Refs. 37, 38). Figure 8 shows eight consecutive images of the interaction between the laser beam and arc taken by the video CCD camera. As shown in Fig. 8, the shapes of the arc and vapor plume vary over

time. The irregular arc plasma and the metal vapor plume, especially the highly pressurized zinc vapor, leads to significant instability of the coupling of laser beam energy into the specimens; thus, the keyhole tends to collapse. As a result, the welding process becomes unstable and the keyhole tends to collapse, which in turn influences the coupling of laser beam and arc and produces lots of spatter and/or porosity in the welds.

Another issue arising from using hybrid laser/GTAW in a common molten pool to gap-free lap join the galvanized steels is the formation of porosity in the welds. As shown in Fig. 9, porosity is produced at the top surface of welds and in the internal weld fusion zone, the location of which is de-

pendent on the welding conditions. The main reason for porosity formation is the entrapment of air and the shielding gas as well as the metal vapor into the molten pool. If these entrapped gases or metal vapors cannot escape from the molten pool during weld solidification, porosity is produced. Additionally, the collapse of the keyhole is also responsible for formation of porosity (Ref. 39). At the same time, it has been revealed that the increase in temperature exponentially increases the pressure level of the zinc vapor, as shown in Fig. 10 (Ref. 40). When the laser beam shares a common molten pool with the arc, the temperature at the interface of the two metal sheets dramatically increases due to the higher heat input; thus, the zinc vapor reaches a very high pressure level. This fact implies that the function of the arc-enlarged molten pool cannot completely compensate for the increase in the pressure level. From the further experimental results, it was found that only in a very narrow optimized welding condition can the spatter and porosity be dramatically decreased and a sound weld be obtained with the introduction of the arc. Additionally, the zinc coating at the top surface and the interface of the two metal sheets is widely damaged by the arc and the weld surface is nonuniform when the laser beam and GTAW torch share a common molten pool.

Gap-Free Lap Joint of Galvanized DP 980 Steels Using Hybrid Laser/GTA Welding with a Separated Molten Pool

Considering the issues arising from hybrid laser/GTAW in a common molten pool, a welding procedure based on using leading GTAW as an auxiliary preheating source followed by a fiber laser beam as a main heat source is developed to join galvanized dual-phase (DP) 980 steel in a gap-free lap joint configuration. The laser beam is separated from the GTAW torch at a specific distance to create two separate molten pools. It should be mentioned that the specific distance between the laser beam and GTAW torch depends on the welding speed and laser power used as well as the other welding parameter settings. Figure 11 shows top, back, and cross-sectional views of the GTAW preheating weld. Figure 12 shows top, back, and cross-sectional views of the

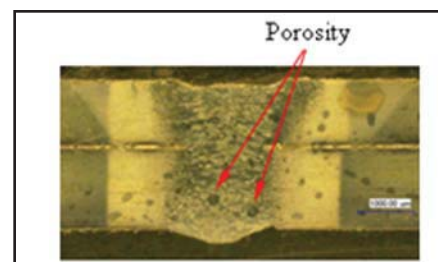
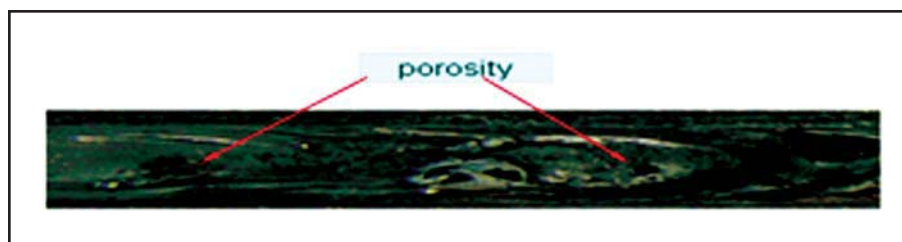


Fig. 9 — The formation of porosity in the welds produced by hybrid laser/GTAW in a common molten pool.

lap joint obtained by hybrid GTAW preheating/laser welding in a separated molten pool. As shown in Fig. 11A, after GTAW preheating, a thin layer of metal oxide film is produced at the top surface of the metal sheets with the specific heat input. In addition, a portion of the zinc coating in and around the weld zone at the interface of the two metal sheets is melted and the remnant zinc coating is oxidized, as shown in Fig. 11B. As mentioned previously, this zinc oxide can stabilize the welding process. Figure 12 shows that no spatter and porosity are produced in the surface of the weld. From Fig. 12C, it is observed that the weld is free from porosity. This suggests that a completely defect-free weld with complete penetration is obtained.

In this case, success in achieving completely defect-free welds is expected because of the formation of metal oxides produced by the GTAW preheating process. It is well known that for laser welding of steel or aluminum, most of the laser beam energy is reflected by the metal sheet surface (Ref. 41). In addition, when the welding process is under the keyhole mode the laser beam energy absorbed by the metal sheet can be significantly improved due to the multireflection function of the keyhole (Ref. 42). Furthermore, it was found that the presence of metal oxides (Refs. 41, 43) can significantly improve up to two to three times the absorption of laser beam energy. In this case, a thin film of metal oxide is produced during the GTAW preheating process with the controlled heat input welding condition. Due to the high transmittance and conductivity of zinc oxide and iron oxides, the coupling of laser beam energy into the specimen can be dramatically enhanced (Refs. 44, 45). Under this welding condition, the keyhole forms easily and keeps very stable, which provides the channel to vent out the highly pressurized zinc vapor developed at the interface of the two metal sheets. Consequently, the welding process can be stable. A CCD video camera is used to monitor the welding process and the dynamic behaviors of the molten pool online. By analyzing the film taken by the CCD video camera, it is found that when the keyhole is kept open, the welding process is very stable and a high-quality weld is achieved. However, when the keyhole collapses, the process becomes dramatically unstable and a weld is presented with the poor surface appearance and that is full of spatter and porosity. Figure 13 shows the open and the collapsed keyhole images. As shown in Fig. 13A, the black spot in the front of the molten pool presents the keyhole shape. A set of experiments is designed to verify that the absorption of laser beam energy by the metal sheets increases with the GTAW preheating process. The first test is performed with the removal of the zinc coating at the interface of the metal sheets; the second test

is carried out with the zinc coating at the interface of two metal sheets while using GTAW to preheating the top surface of the metal sheets prior to the followed laser welding process. Laser power of 3000 W and a welding speed of 50 mm/s as well as the shielding gas rate of 30 ft³/h are used in the first test. In the second test, the welding conditions were kept the same as in the first test, but an arc current of 300 A was used to preheating the metal sheet before the followed laser irradiated

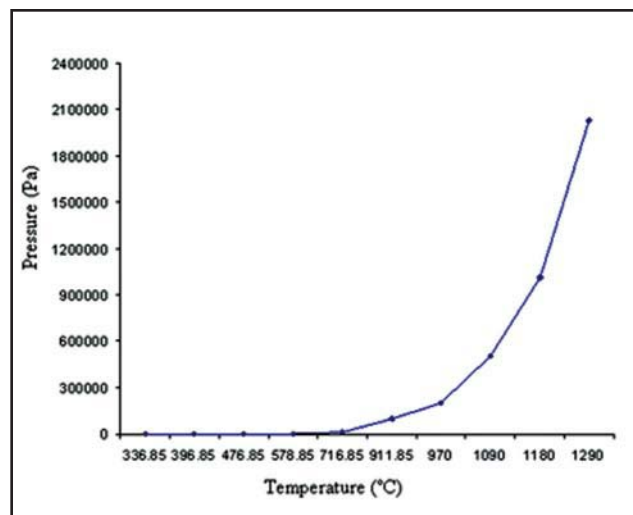


Fig. 10 — Relationship of the zinc pressure and temperature (Ref. 40).

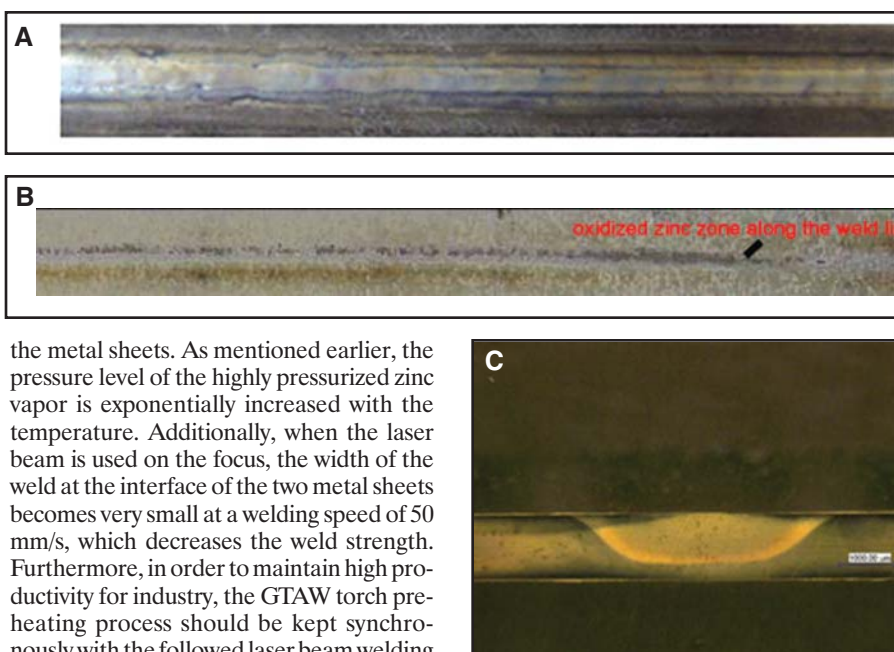


Fig. 11 — GTAW preheating weld with arc current 200 A: A — Top view of GTAW preheating weld B — back view of top metal sheet of GTAW preheating weld C — cross-sectional view of the GTA weld. (Arc current: 200A, the tip distance of electrode with respect to the top surface of the metal sheets: 3 mm, and welding speed: 30 mm/s.)

the metal sheets. As mentioned earlier, the pressure level of the highly pressurized zinc vapor is exponentially increased with the temperature. Additionally, when the laser beam is used on the focus, the width of the weld at the interface of the two metal sheets becomes very small at a welding speed of 50 mm/s, which decreases the weld strength. Furthermore, in order to maintain high productivity for industry, the GTAW torch preheating process should be kept synchronously with the followed laser beam welding process in practice. In order to produce the expected thin layer of metal oxides to enhance the coupling of laser beam energy into the welded materials, the GTAW preheating arc current should be increased when laser welding is increased, as mentioned before. The maximum arc current value that can be used is 300 A from the machine used in this study. When the laser welding speed is increased more than 50 mm/s, the 300-A GTAW preheating arc current fails to produce the thin layer of metal oxides required for improving the coupling of laser beam energy into the welded materials to generate the stable open keyhole to vent out the highly pressurized zinc vapor developed at the interface of the two metal sheets. Also, it is difficult to transform the zinc coating along the weld interface into the zinc oxides with the very high preheating speed at the current of 300 A. Considering these factors, the laser beam is defo-

cused with a spot size of 1 mm in the previous two cases. Figure 14 shows the experimental results. As shown in Fig. 14B, the penetration depth of the laser welded joint obtained is as the function of the weld location. However, complete penetration is achieved in the second test, as shown in Fig. 14D. This fact confirms that surface modification of the preheating welding process significantly enhances absorption of laser beam energy.

X-ray photoelectron spectroscopy (XPS) tests are also carried out to analyze

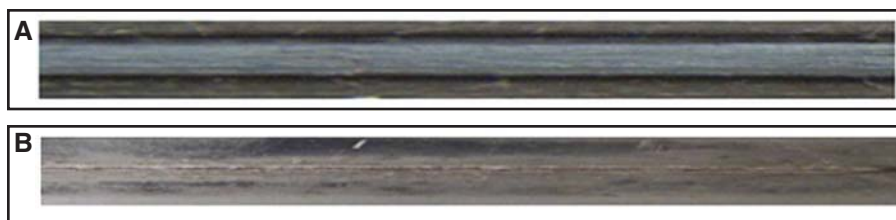


Fig. 12 — Views of the hybrid laser-GTAW preheating joint: A — Top view; B — back view; C — cross-sectional view. (Laser power: 3000 W, arc current: 200 A, and welding speed: 30 mm/s.)

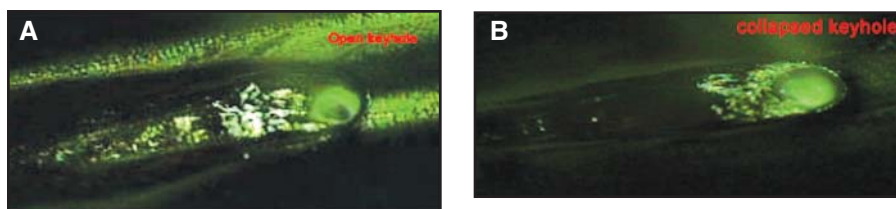


Fig. 13 — A — Opening of the keyhole; B — collapse of the keyhole.

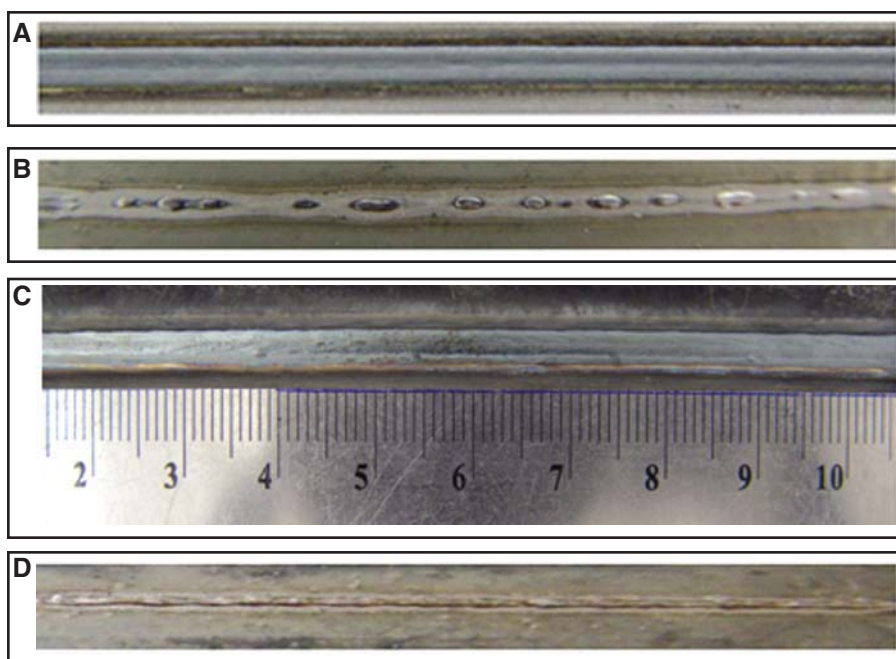


Fig. 14 — Comparison of the weld depth penetration in different welding conditions: A — Top view of laser weld without the zinc coating at the interface of two metal sheets; B — back view of laser weld without the zinc coating at the interface of two metal sheets; C — top view of hybrid laser-GTAW preheating weld with the zinc coating at the interface of two metal sheets; D — back view of hybrid laser-GTAW preheating weld with the zinc coating at the interface of two metal sheets. (Laser power of 3000 W and welding speed of 50 mm/s for A and B; laser power of 3000 W, preheating arc current of 300 A, GTAW preheating welding speed of 50 mm/s, and laser welding speed of 50 mm/s for C and D.)

the chemical compositions of the GTAW preheating weld to confirm the above speculation of the formation of metal oxides during the GTAW preheating process. The sample of the GTAW preheating weld for the XPS analysis is obtained with an arc preheating current of 200 A, welding speed of 30 mm/s, and shielding gas flow rate of 30 ft³/h. The distance between the tip and the top surface of the metal sheets is 3 mm. The elemental identification can be made by comparing the peak binding energies obtained through XPS analysis to the tabulated values. As shown in Fig. 15B, there are

two strong peaks located at 530.8 eV and 1022.3 eV due to the O(1s) and Zn (2p₃) binding energy of zinc oxides. This value of Zn2p₃ in this study (1022.4 eV) is good agreement with those for ZnO (1022.3 eV) reported in the literature (Refs. 46, 47). It indicates that zinc oxide is formed at the top surface and the interface. The proportion of C1s, O1s, Zn2P₃, and Ca2P for the GTAW preheating welds were presented in the Atomic Concentration Table shown in Fig. 15B on the basis of the relative area under the specific element peaks. Additionally, when the laser beam is in the separated

molten pool with the electrode torch, the coupling of laser beam energy into the metal sheets is free from the influence of arc plasma and laser-induced zinc plume which occur in the hybrid laser/GTA welding in the common molten pool. Furthermore, it is found that when the GTAW preheating arc current below some level the metal oxides could not be formed and only the soot was generated at the top surface.

During the GTAW preheating process, the zinc oxides have priority to be formed over the iron oxides because the zinc coating at the top surface of the metal sheets is first under the heat from the GTAW preheating. Once the zinc oxide is formed at the top surface, it inhibits formation of iron oxides. Before the zinc oxides decompose, it is difficult to produce the iron oxides. Due to the high temperature under the arc, the zinc oxides are generally unstable and susceptible to immediately decomposing. Under this welding condition, the top surface of the metal sheet melts and iron oxides are formed at the top surface of the metal sheets presented in Fig. 16A, which also can enhance the absorption of laser beam and help facilitate the formation of the keyhole. As shown in Fig. 16B, a sound weld is still obtained. As the GTAW preheating arc current keeps increasing, iron oxides are also completely decomposed. Once the preheating arc current reaches some kind of high level, different kinds of humping are present in the surface of the preheating welds, as shown in Fig. 16C. It should be mentioned that chemical compositions produced by the GTAW preheating process are sensitive to the GTAW preheating welding parameters such as the preheating arc current, the distance between the tip of the GTAW electrode and the top surface of two metal sheets, and the shielding gas rate. A change in any of the welding parameters mentioned above results in different surface conditions. It is also necessary to point out that the distance between the laser beam and the electrode is required to be long enough to lower the pressure level of the zinc vapor at the interface of two metal sheets to some extent. In this case, the distance is kept at 190 mm. Further study of the relationship between the pressure level of the developed highly pressurized zinc vapor at the interface of two metal sheets and the different welding parameters is important

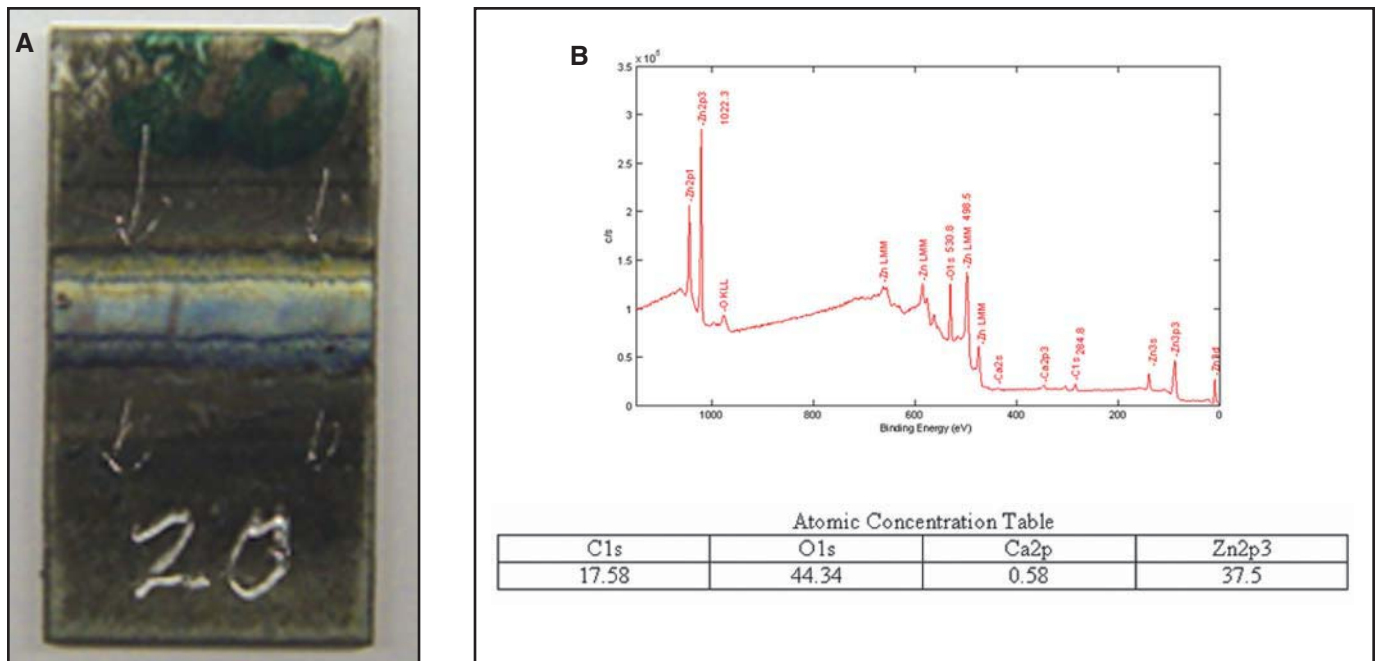


Fig. 15 — The XPS analysis results of the heated surface of DP 980 galvanized steel by GTAW torch: A — The measured points; B — XPS analysis results.

and required. Additionally, the distance between the laser beam and the electrode can be shortened with the assistance of using the copper block as the welding support platform or water cooling system.

For $\text{Zn} + 1/2\text{O}_2 \rightarrow \text{ZnO}$, the molecular weight of ZnO is 81.4084 mol/L and that of Zn is 65.38 mol/L . The density of zinc is 7.133 g/cm^3 and the density of zinc oxide is 5.606 g/cm^3 (Ref. 40). The rate at which the zinc oxide occurs during the GTAW preheating process can be calculated by the Pilling-Bedworth (PB) ratio equation (Ref. 48):

$$P - B = \frac{M_{ZnO} \rho_{Zn}}{M_{Zn} \rho_{ZnO}} = \frac{\left(81.4084 \frac{gn}{mol}\right) \left(7.133g / cm^3\right)}{\left(65.38 \frac{gn}{mol}\right) \left(5.606g / cm^3\right)} = 1.584$$

The P-B ratio of ZnO oxide indicates that the volumes of the zinc oxide and the transformed zinc coating are similar and “an adherent, nonporous, and protective” zinc film is produced at the top surface during the GTAW preheating process (Ref. 48).

Microhardness Measurement, SEM Analysis, and Failure Analysis for the Hybrid GTAW Preheating/Laser Welded Joints in the Separated Molten Pool

Vickers microhardness measurement is performed along the weld fusion zone and heat-affected zone (HAZ) for the hybrid GTAW preheating/laser welded joint. The



Fig. 16 — A — Top view of the preheating weld with the iron oxide film at the arc current of 230 A; B — top view of hybrid GTAW preheating/ laser welding with a separated molten pool; C — the humping produced in the GTAW preheating weld at an arc current of 240 A (welding speed: 30 mm/s; distance between the electrode tip and the top surface of two metal sheets: 3 mm; shielding gas flow rate: 30 ft³/h).

indenter load used in the microhardness test is 200 g. The impressions are made in the increment of 0.25 mm away from the interface of the two metal sheets. Figure 17 shows the typical microhardness features of the welded joint obtained by the hybrid GTAW preheating/laser welding process in the separated molten pool with a laser power of 3 kW, GTAW preheating arc current of 200 A, and welding speed of 30 mm/s. As shown in Fig. 17, the hardness distribution is not uniform along the weld. After showing a relatively uniform value in the weld zone, the hardness value decreased continuously to the minimum value in the

HAZ away from the weld zone toward the HAZ, and then gradually increased again in the base material. The maximum hardness value (393.5 HV) is located at the center of the weld. The minimum hardness value (200.6 HV) is found in the HAZ. As shown in Fig. 17, the HAZ has a lower hardness value than that in the base material and the welded zone, which indicates that the HAZ is softened. The degradation of the hardness in the HAZ has a weakening effect on the mechanical structure of the joint. Additionally, SEM analysis of the microstructure was also performed at selected locations in the cross section, as shown in Fig. 18A–F.

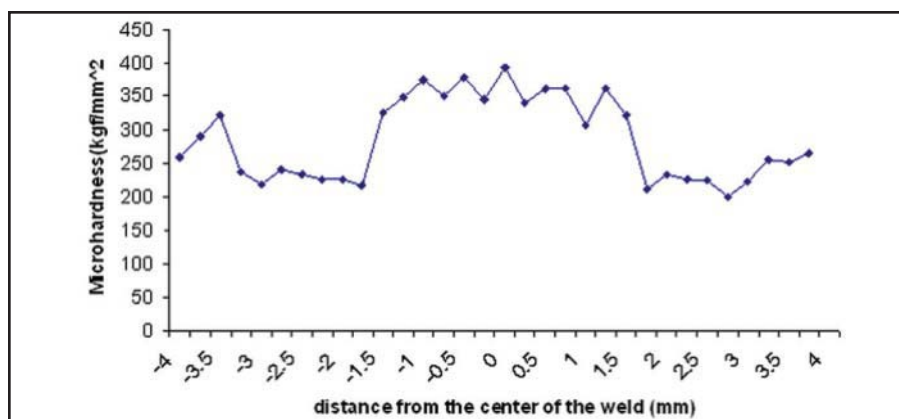


Fig. 17 — Microhardness distribution of the welded joint obtained by hybrid GTAW preheating/laser welding in the separated molten pool.

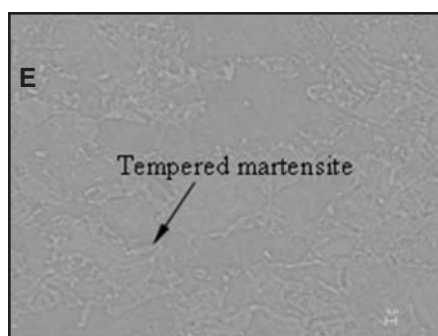
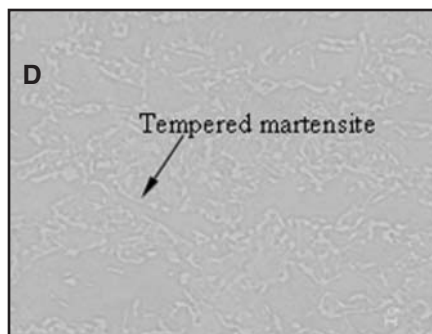
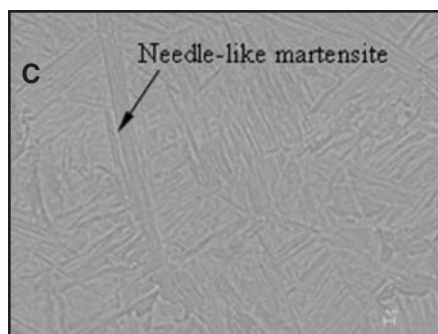
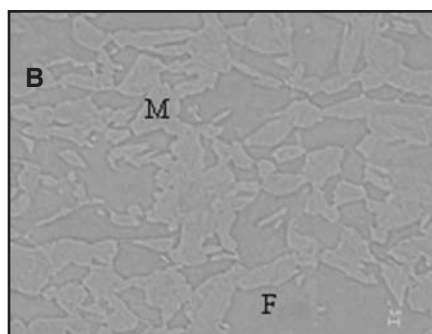
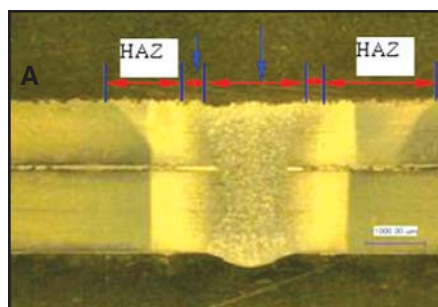


Fig. 18 — Microstructures in the different weld zones: A — Cross-sectional view of the weld; B — in the base material; C — in the fusion zone; D — in the transitional region between the fusion zone and HAZ; E — in the HAZ.

Figure 18A shows the cross-sectional view of the hybrid GTAW preheating/laser welded joint. Figure 18B shows the mi-

crostructures of the base DP980 material in the area far away from the weld bead. The martensite phase and ferrite phase in the DP 980 steel base material are clearly distinguished, and are marked as “M” (white color) and “F” (gray color), as shown in Fig. 18B. Figure 18C–E demonstrates the microstructure of the fusion zone, the transition zone between the fusion zone and HAZ, as well as the HAZ of the hybrid weld obtained by hybrid GTAW preheating/laser welding in the separated molten pool. As shown in Fig. 18C, the fusion zone microstructure was mainly composed of tempered martensite and ferrite. Compared to the volume of martensite in the base material and the weld zone, the volume of martensite in the transition between the weld zone and HAZ is decreased, as shown in Fig. 18D. Furthermore, it is obvious that the volume of martensite in the HAZ, as shown in Fig. 18E, is dramatically decreased compared

to that in the base material, fusion zone, and transition zone between the fusion zone and HAZ of the hybrid weld. This is the reason why the hardness in the HAZ of the hybrid weld is dramatically degraded.

Tensile shear tests were also performed to assess the strength of the welds. Figure 19 shows the tensile shear test specimen dimensions and the fracture location of the welds when applying the loads during the tensile shear tests. From the test results, it is found that all of the specimens broke in the HAZ instead of in the base material, as shown in Fig. 20. Only two specimens broke in the fusion zone of welds made at a welding speed of 50 mm/s and laser power of 3 kW as well as a pre-heating arc current of 200 A. The tensile shear test results confirmed that the HAZ is softened during the welding process.

Conclusions

In order to weld galvanized DP 980 steel in a gap-free lap joint configuration, a hybrid laser/GTA welding technique is accomplished in two modes: 1) The laser beam shares a common molten pool with the electrode; and 2) the laser beam and the electrode produced two separated molten pools and the GTAW is only used for the surface modification. The results obtained from this study are as follows:

1) Compared to laser welding of galvanized DP 980 steel in a gap-free lap joint configuration, the introduction of arc in hybrid laser-arc welding process when the laser and arc share a common molten pool can suppress the formation of spatter to some extent. In addition, the stability of the welding process is enhanced with the increase in the arc current in the specific range and distance between the laser beam and the GTAW torch.

2) When the laser beam and the GTAW torch share a common molten pool, the coupling of laser beam energy and arc plasma significantly fluctuates over time and the welding process is unstable, which results in different weld defects such as spatter and porosity.

3) When the air or metal vapor is entrapped into the molten pool and cannot escape from it during the solidification process, external or internal porosity is formed in the weld.

4) Completely defect-free welds are obtained by the GTAW preheating/laser welding procedure in the separated molten pool where the GTAW is only used to preheat the metal sheets to modify the surface conditions. Chemical compositions of the top surface of two metal sheets produced by the GTAW preheating welding process are sensitive to the GTAW preheating welding conditions. Different metal oxides are produced with various preheating welding

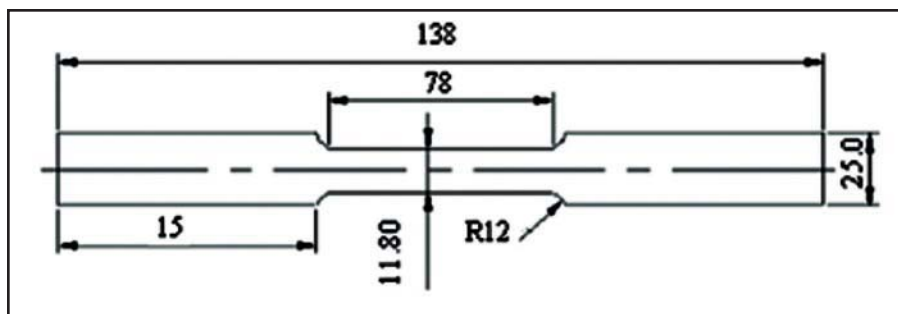


Fig. 19 — Schematic presentation of the tensile shear test specimen.

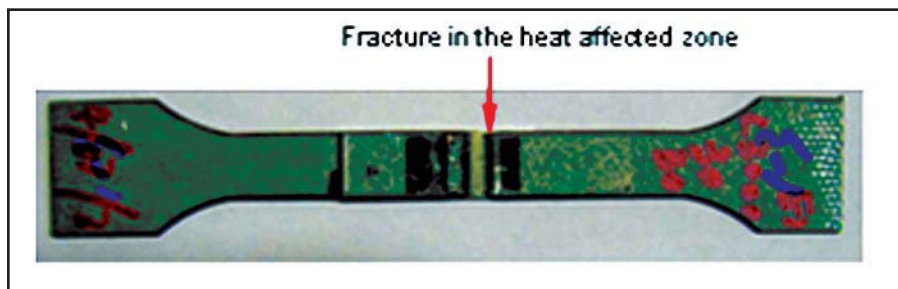


Fig. 20 — Fracture in the HAZ.

conditions. Compared to laser welding without GTAW preheating, these metal oxides can dramatically improve the coupling efficiency of the laser beam energy into the metal sheets by two or more times to generate the keyhole, which provides the channel for the highly pressurized zinc vapor developed at the interface of two metal sheets to be vented out. Thus, the welding process is stable and the welding speed can be significantly increased.

5) Under the specific GTAW preheating welding conditions, a portion of the zinc coating at the interface of two metal sheets melts and a portion of the zinc coating oxidizes. The zinc oxides have a higher melting point (1975°C) than the boiling point of zinc, which helps to stabilize the following welding process and lower the pressure level of the zinc vapor for the following laser welding process. The XPS analysis results confirm this fact. In addition, there is a minimum requirement of the distance between laser beam and electrode torch, which can be shortened with the assistance of a cooling system.

6) When the keyhole is kept open, the welding process is stable. However, the keyhole tends to collapse, and the welding process becomes unstable. Consequently, maintaining the opening of the keyhole is the critical factor to guarantee the achievement of sound welds.

7) The heat-affected zone is softened due to the decrease in the volume fraction of martensite. Due to the softening effect, the lowest microhardness value is obtained in the HAZ and the specimens broke in the

HAZ during the tensile shear tests.

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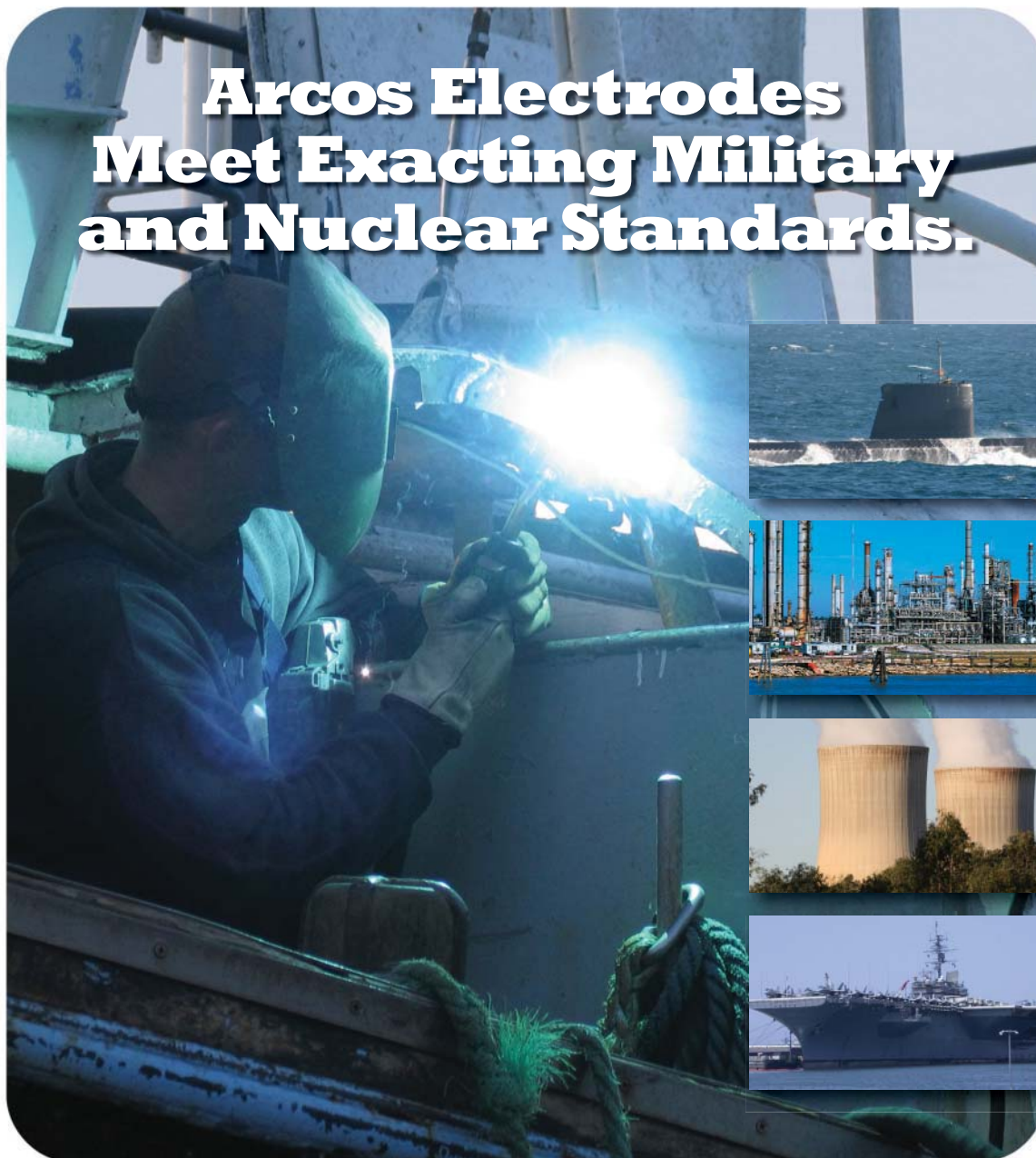
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