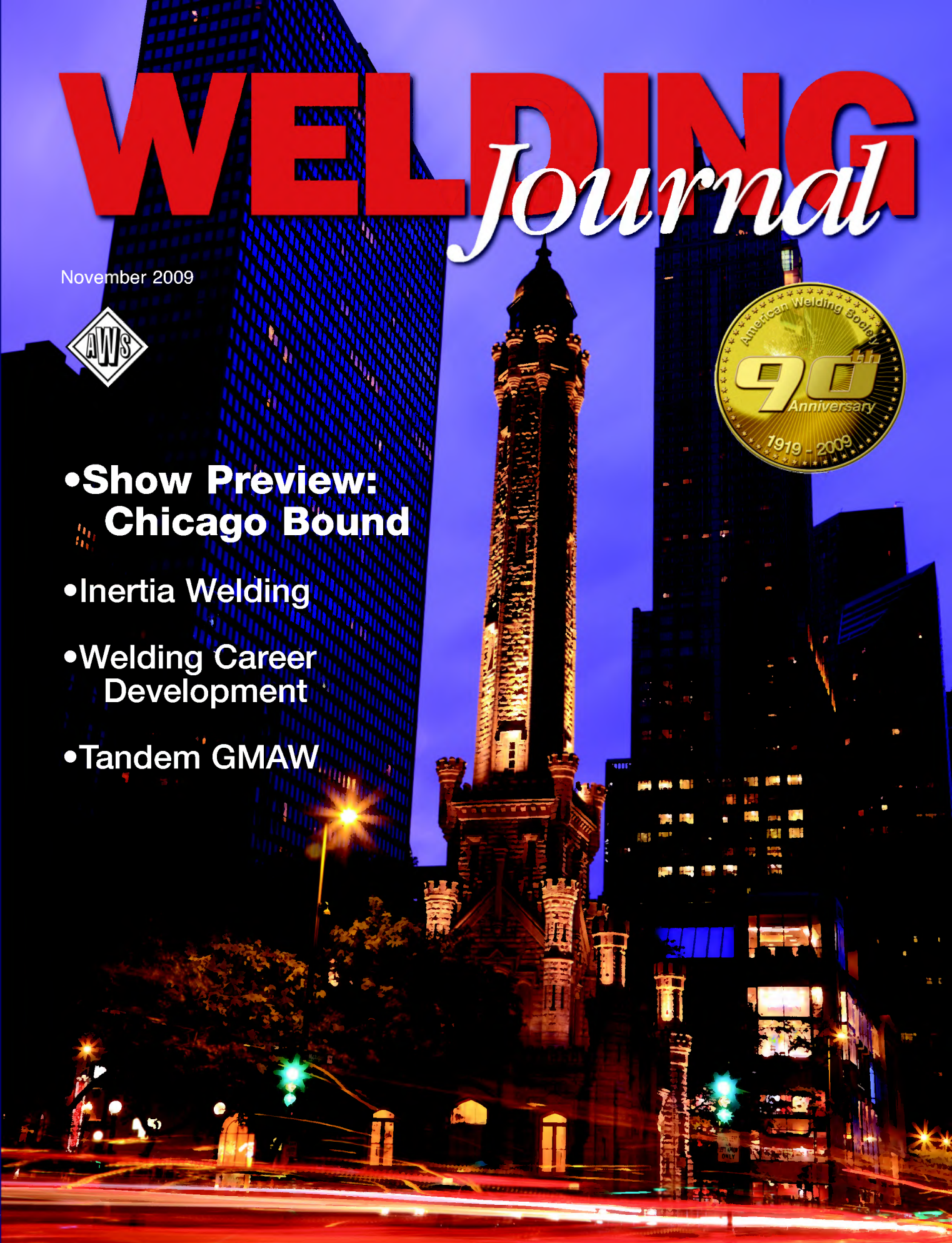
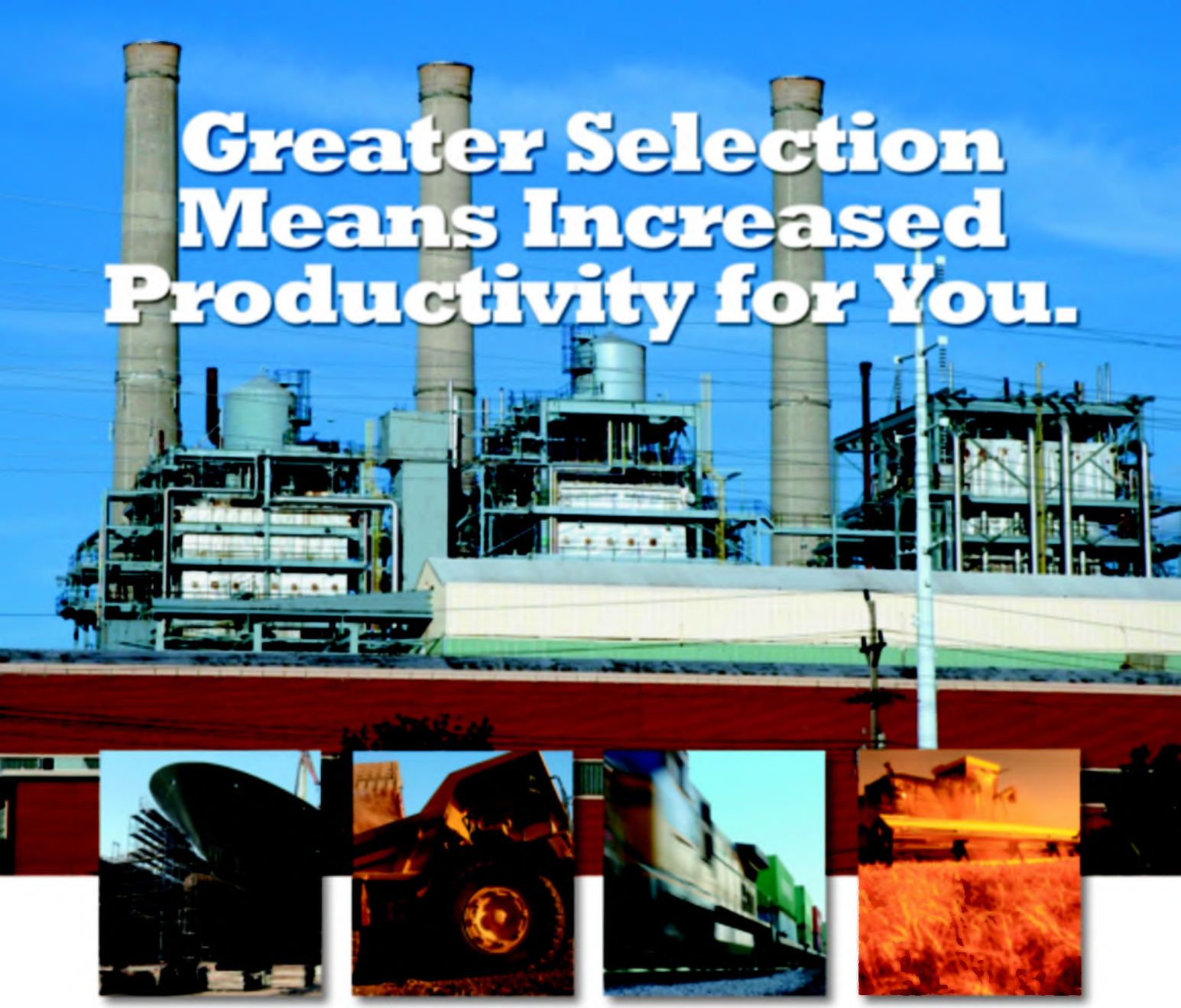
WELDING Journal

November 2009



- **Show Preview: Chicago Bound**
- Inertia Welding
- Welding Career Development
- Tandem GMAW

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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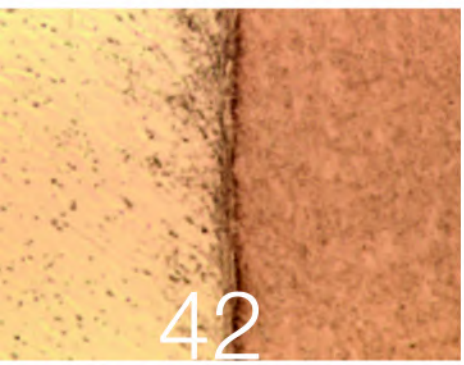

Features

Welding Research Supplement

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ESAB Appoints Masterman President and CEO

Andrew Masterman

Andrew Masterman has been named ESAB North America's new president and chief executive officer, based in Florence, S.C. He succeeds Brendan Colgan, who will be assuming the role of chairman of The ESAB Group, Inc. (North America), and additional responsibilities by year's end as operations director for ESAB Global.

"Andrew Masterman possesses a diverse background primarily within the metals business sectors," said Colgan. "His experience includes industrial engineering, manufacturing, finance, and general management. I feel confident that we will accomplish a smooth transition, and that I am leaving the company in the hands of an experienced business professional who will provide the leadership needed to meet the needs of the future."

Masterman was previously president of Metalico's Platinum Group Metals division. He has also held the position of president within Spartan Light Metals, TI Automotive, and Walbro Corp. He served in a senior financial role for Intel Corp.'s Server Business Unit as well.

"I am excited at the prospect of guiding ESAB during these difficult economic times," Masterman said. "This is a forward-thinking company, and I look forward to working with them to shape the future of manufacturing to meet the needs of the welding and cutting community."

Welding Student Awarded Silver Medal at WorldSkills

Joe Young welds during the WorldSkills Competition in Canada. His hard work paid off as he won the silver medal in this event's welding contest. (Photo courtesy of Mark Claypool.)

Joe Young won the silver medal for welding at the 40th WorldSkills Competition held September 1–7 in Calgary, Alb., Canada. He competed against 21 of the world's best welders from countries as far away as Iran and Korea.

Young is a member of SkillsUSA, the organization representing the United States in this competition. He earned the right to be a WorldTeam member by winning local, district, and national welding contests under the SkillsUSA program. Competitors must be under the age of 23.

"Experts from other countries commented on his capabilities, and were very interested in his training and what had to be his unwavering dedication to perfecting his craft," said welding instructor Glenn Kay, who together with instructor Coley McLean, worked to prepare Young for competition. "I was able to finally see what I knew to be true for as long as I have worked with Joe, that his commitment, dedication, and talent would truly shine and that he would represent the United States with as much enthusiasm, professionalism, and quality that he had shown me in the welding lab."

Prior to the event, Young spent several weeks in Atlanta, Ga., training with the American Welding Society and former United States competitors now working out of United Association Local 72.

Young will work in the welding department of Washtenaw Community College (WCC), Ann Arbor, Mich., as a technician while he completes his associate's degree in welding technology. Afterward, he will likely transfer to Ferris State University or Georgia Tech where he will apply the $40,000 scholarship he earned for his first-place finish at the International Pre-Trial Competition.

"You just go there and do the best you can," said Young. "It's like art. You put everything on the table and at the end of the day you know you've tried your hardest and no one can take that away from you. It meant a lot to me to represent the United States and WCC; I could've come in last place and felt like the luckiest person there."

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Adding Value in Tough Economic Times

None of us has to be reminded of the difficult economic times we are facing. We are certainly not out of the slump yet, but it finally appears that the worst is over and that the economy has bottomed out. We all hope to soon see businesses strengthened and on the road to recovery.

One of the bright spots for the metal forming, fabricating, and welding industry is the FABTECH International & AWS Welding Show, including METALFORM, being held November 15–18 at Chicago's McCormick Place.

Since the AWS Welding Show and FABTECH International formed an alliance for its first combined Show in 2005, the industry has benefited immensely. First, both attendees and exhibitors are now involved in a single show, rather than two, which makes prospecting, buying, and selling far more cost effective. Second, an additional partner has come into the fold with METALFORM (Precision Metalforming Association), which further enhances value to attendees. Most important, the Show has grown in size and product diversity in one location, which provides cost-effective solutions in keeping end users competitive with the latest technologies.

Some of the value-added opportunities at this year's Show include the following:

• **Location.** Chicago has proven to be the most effective show city for metalworking products and technologies. It consistently draws record numbers of attendees from both metal manufacturing and construction industries. Chicago is also a prime destination in terms of travel, accommodations, and entertainment.

• **Exhibitors.** Our exhibitors like Chicago for the same reasons given above, as well as the convenience of showing their products at one "mega-event" instead of several smaller shows.

• **Attendees.** Show visitors can shop for all their metalworking and construction needs at a single event — a real money saver.

• **Professional Welders' Competition.** This competition is held only at the Chicago shows, and it has grown significantly in popularity among participants, spectators, and the news media.

• **International Thermal Spray Association (ITSA).** The show will again feature a dedicated pavilion sponsored by ITSA. Thermal spray for wear and corrosion protection is a welding-based technology that is growing rapidly.

• **International Ambience.** Chicago is certainly one of the world's great industrial cities, and it attracts attendees from all over the globe. Convenient flights, local attractions, and its visitor-friendly atmosphere combine to bring in record numbers of people from overseas.

• **Educational Sessions.** Practical seminars on welding topics are a huge draw in Chicago. Look for the sessions you need most in the areas of the D1.1, *Structural Welding Code — Steel*, Welding Procedure Specs, Visual Inspection, Basic Metallurgy, the new Welding Sales Representative Certification, and others.

• **RWMA Weld School.** Conducted by industry specialists, the annual Resistance Welding School covers both RW basics and new applications for this versatile welding process.

• **Conferences.** Choose the topics you need most among several conferences being offered at the show: Weld Cracking, Thermal Spray, Electron Beam Welding, Chrome-Moly Steels, and Corrosion-Resistant Alloys.

• **Professional Program.** The AWS Professional Program will offer top technical papers on subjects ranging from International Trends in Welding Research to Friction Stir Welding, and from Weld Modeling to new Shipbuilding Techniques.

• **Image of Welding Awards.** These annual awards confer well-deserved recognition on those who have done the most to bring welding's importance and career opportunities before the general public.

• **FABTECH and METALFORM Sessions.** Our show partners will offer many of their own educational sessions in Chicago. Just a few of the offerings are Stamping High-Strength Steels, Laser Cutting Technology, Productive Robotics, Top 10 Secrets of Lean Success, and Controlling Raw Material Costs.

Overall, whatever your manufacturing or business needs, you just can't miss the huge show in Chicago this November. Both you and your employer will be glad you came.

Ray Shook
AWS Executive Director

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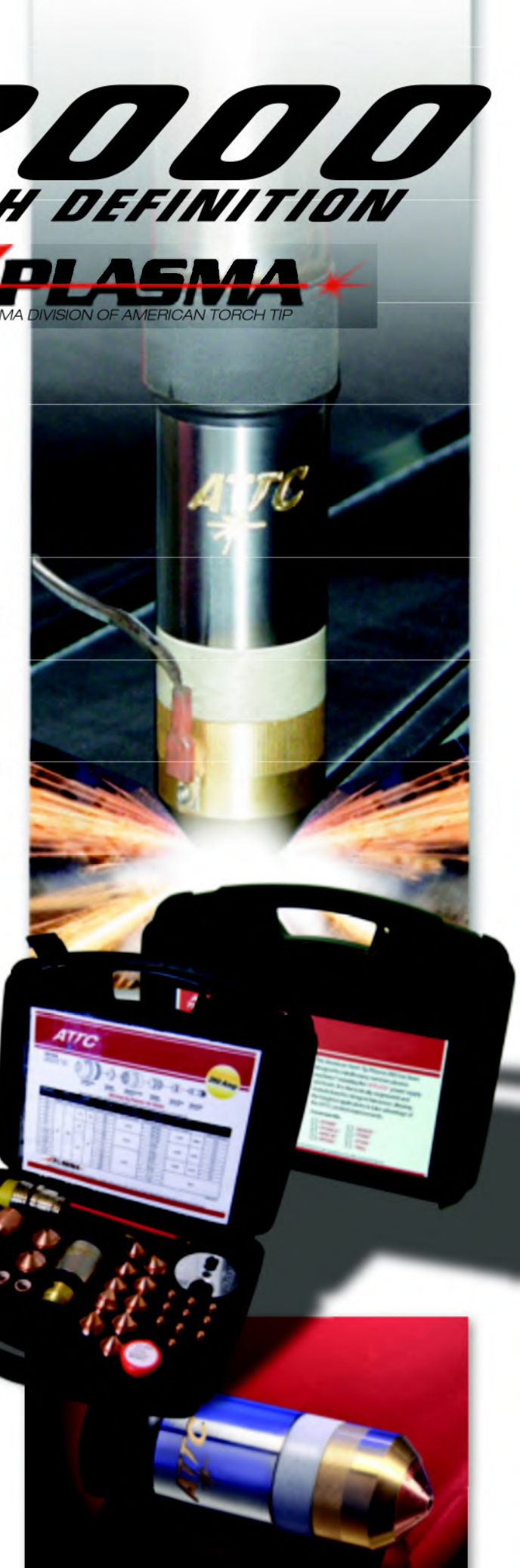

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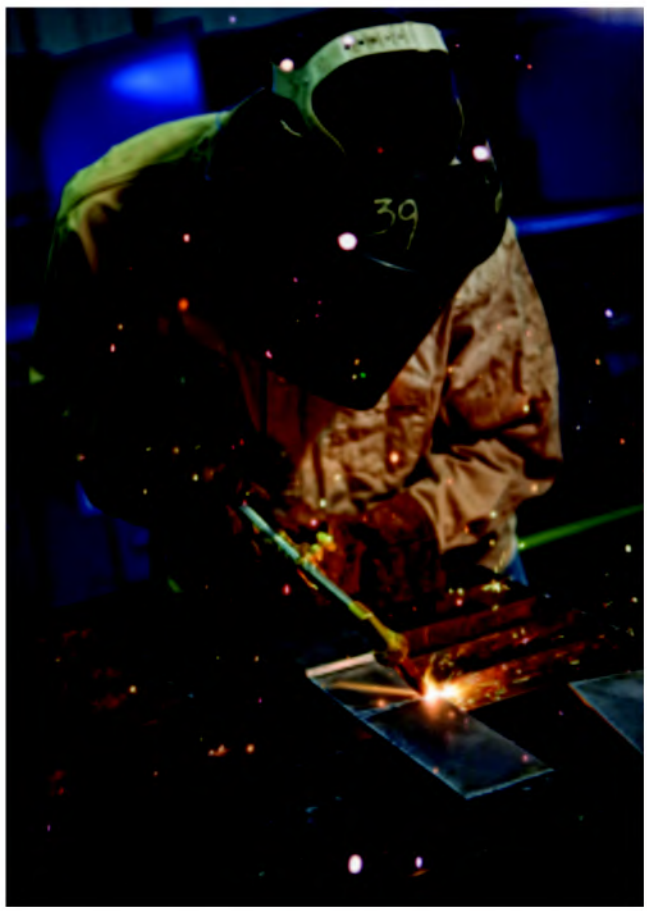
Westinghouse Holds Grand Opening for New Boiling Water Reactor and Welding Facility in Tennessee

Westinghouse employees recently gathered to celebrate the company's U.S. Boiling Water Reactor Training Center in Chattanooga, Tenn. It includes 66,000-sq-ft of training space, a full-scale, 85-ft-deep reactor, and fuel pool mock-up serviced by a refueling bridge and overhead cranes.

The WEC Welding Institute is located inside Westinghouse Electric Co.'s new U.S. Boiling Water Reactor Training Center. This is the company's second institute used to train and certify welders; the other school is in Rock Hill, S.C.



A student at the WEC Welding Institute practices his craft.

Westinghouse Electric Co. (WEC) held the grand opening of its first United States Boiling Water Reactor (BWR) Training Center and its second WEC Welding Institute on August 20 in Chattanooga, Tenn. This well-attended event included 225 Westinghouse employees, BWR customers, and invited guests. Site tours featuring 18 BWR tooling exhibits and welding demonstrations took place as well.

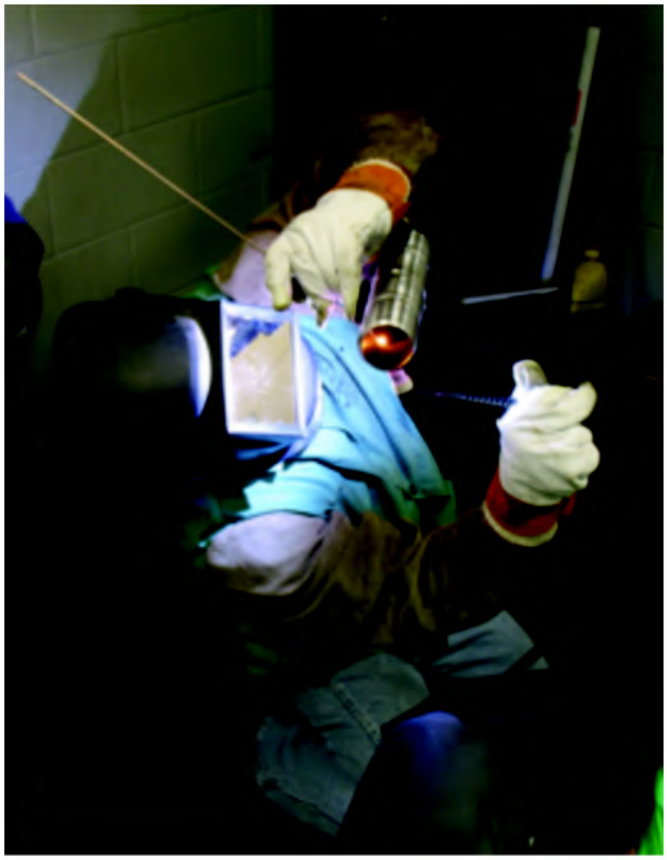
Nick Liparulo, senior vice president, Nuclear Services, cut the ribbon on the refueling bridge over the training center's full-scale BWR mockup with the assistance of Shigenori Shiga, senior vice president and chief coordination officer, Westinghouse Coordination Office; David Howell, vice president, Field Services; Wayne Bentley, vice president, BWR Operations & Growth; and Bruce Phares, director, BWR Reactor Services.

The BWR Training Center will be used to train Westinghouse employees, customers, and industry representatives on the safe maintenance and refueling of boiling water reactors in nuclear power plants. The facility is composed of a full-scale BWR cavity with vessel, internals, spent fuel pool, and refueling bridge; two 33-ton cranes, under-vessel mockup; and a 66,000-sq-ft shop floor. Combined, the welding institute and BWR training facility will provide approximately 50 jobs.

Additionally, the WEC Welding Institute offers a no-cost program equipped to train welders for working in nuclear and non-nuclear plants. Ten students are presently enrolled, and it has the capacity to train and graduate 288 welders per year.

The new institute is equipped with 48 weld booths and certifies students after completing an average of five months hands-on training. Afterward, they may take the American Society of Mechanical Engineers welding qualification exam; once students pass and receive certification, they must work for Westinghouse for 2000 hours. They have the opportunity to work as apprentices at power plants or any facility where Westinghouse is performing welding.

Hobart Institute Sees Welding Training Rise in Tough Economic Times



Hobart Institute welding instructor, Ralph Jenkins, demonstrates the 5G position on a root weld of a pipe. The school has recently seen enrollment in its classes go up.

Enrollment is high at the Hobart Institute of Welding Technology (HIWT), Troy, Ohio. High school graduates, displaced workers from the auto industry, and returning military personnel are finding their place in welding. The institute continues to hear from companies seeking welders to replace retiring workers or increase their employment levels.

This past year, a facility expansion increased classroom space to accommodate the demand. It has been necessary to hold second-shift classes to meet those wanting to be trained in welding.

Also, class size has increased for individuals seeking to become American Welding Society Certified Welding Inspectors and Certified Welding Supervisors. For more information about HIWT, visit *www.welding.org*.

Small Shipyard Grants Revealed as Part of American Recovery and Reinvestment Act

The Department of Transportation recently announced 70 grants totaling $98 million in American Recovery and Reinvestment Act (ARRA) funds. Awarded through the Maritime Administration's Assistance to Small Shipyards program, these will help create and preserve jobs, provide employment training, and make improvements to shipyards across the United States.

The Small Shipyards Grant program provides up to 75% in ARRA funds for a project and requires the remainder be matched by the shipyard.

Following is a list of recipients who will use their funds for welding equipment along with various other items: All American Marine, Inc., Bellingham, Wash.; Ellicott Dredges, LLC, formerly known as Baltimore Dredges, LLC, Baltimore, Md.; Foss Maritime Co. (Seattle Yard), Seattle, Wash.; ICE FLOE, LLC, doing business as Nichols Brothers Boat Builders, Freeland, Wash.; Marine Fluid Systems, Inc., Eastonville, Wash.; McGinnis, Inc., South Point, Ohio; and Union Dry Dock & Repair Co., Hoboken, N.J.

North Georgia Technical College Awarded Grant to Assist Nuclear Welding Training

The Nuclear Regulatory Commission (NRC) has awarded nearly $20 million to 70 institutions for education and workforce expansion in nuclear and nuclear-related disciplines. Congress provided the NRC funding for a $5 million Educational Curriculum program and an additional $15 million to supplement its grant program for scholarships and fellowships, faculty development, trade schools, and community colleges, with $5 million of this amount designated for the Integrated University Program.

In particular, North Georgia Technical College was awarded $119,000. This funding will be used to provide additional instruction, equipment, and scholarships for up to 30 qualified welders interested in training for employment in the nuclear field. The nuclear welding scholarships are designed to cover tuition, fees, required gear, and on-campus housing and food services for welders qualifying for the program. Recipients will be required to serve six months in nuclear-related employment. This opportunity is for welders who can benefit from the college's Pipe Welder Technical Certificate of Credit. The program will be based on the Clarkesville, Ga., campus, and interested welders may visit *www.northgatech.edu* for more information.

Terra Community College Breaks Ground for New Skilled Trades Center

Taking the first shovels of dirt for Terra Community College's Skilled Trades Center are (from left) Helene Zielinski, Bill Russell, Kevin Boyce, Marsha Bordner, and State Representative Dennis Murray.

More than 200 people gathered at Terra Community College, Fremont, Ohio, for a groundbreaking ceremony on September

14 to honor the college's new Skilled Trades Center.

This center will be approximately 23,225 sq ft at a total cost of about $3.5 million. Funding for the project is a combination of state and local funds. It will house labs including welding, HVAC, power technologies, and truck driving. Construction is expected to last a year.

Terra President Marsha S. Bordner welcomed visitors at the event and Helene Zielinski, chairperson of the board of trustees, presented a short historical perspective of the college. Featured speakers included Ohio Treasurer Kevin Boyce and Bill Russell, associate vice chancellor of the Ohio Board of Regents.

Stork Cellramic's Robot-Operated HVOF Chamber Applies Coatings to Long Parts

Staff and contractors from Stork Cellramic prepare the high velocity oxygen fuel spray chamber and robotic arm for installation.

A high velocity oxygen fuel (HVOF) thermal spray chamber has recently been completed by Stork Cellramic. The workspace (15 × 28 ft) accommodates a robotically operated thermal spray application and handling system for parts and products up to 20 ft in length and 15,000 lb. The chamber replaces two smaller spray booths in the company's north Milwaukee facility. "This is not our first robotic coating booth and not our only HVOF system, but it is our largest — and it is among the largest industrially available applicators in the Midwest," said General Manager Daniel Ruiter.

Wallace Community College Receives $90,000 Grant for Welding

Wallace Community College (WCC), Dothan, Ala., recently received $90,000 as part of the state's commitment to workforce development. Funds from the Governor's Recovery Act Skills Training Program will be used to purchase welding equipment for the college's existing welding program.

Senator Harri Anne Smith (R-District 29) presented the check to college President Linda C. Young on September 15. Senator Jimmy Holley (R-District 31), Representatives Steve Clouse (R-District 93) and Benjamin Lewis (R-District 86), and Houston County Commission Chairman Mark Culver were also present.

State industry forecasts suggest the welding workforce will increase 2.13% annually through the next decade, largely due to

Senator Harri Anne Smith presents a $90,000 grant from the Governor's Recovery Act Skills Training Program to Wallace Community College (WCC) President Linda C. Young. Joining them are Houston County Commission Chairman Mark Culver, WCC Dean of Career Technical Instruction Michael G. Babb, Senator Jimmy Holley, WCC welding instructor Dewey Lee, Representative Steve Clouse, and Representative Benjamin Lewis.

the influx of automobile manufacturing plants in Alabama.

According to Dr. Michael G. Babb, the college's dean of career technical instruction, welding is offered at the Wallace Campus in Dothan, Ala., and the Sparks Campus in Eufaula, Ala. He anticipates WCC purchasing at least eight pieces of training equipment with the grant funds and increasing the number of students to 30 per class, beginning spring semester 2010.

Orbitform Expands Prototype, Short-Run Production Capabilities with New Lab

Orbitform Group offers prototype services for parts assembly within the new Application Engineering Lab at its headquarters in Jackson, Mich. This 6000-sq-ft lab is staffed by two full-time engineers, Todd Hutson (left) and Brent Withrow (right), who have a combined 35 years experience developing all types of fastening applications and reviewed more than 25,000 applications. The lab provides process and product development services; short-to-medium production runs; custom machining capabilities; and tooling development and design. It is also equipped with more than 30 of the company's standard impact, orbital, spiral, roller forming, hot upset, gas metal arc, and resistance welding machines.

— continued on page 172

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

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Taiwan Welding Consumables Firm Establishes Subsidiary in India

Kuang Tai Metal Industrial Co. Ltd., recently set up a subsidiary, KT Welding Technologies Pvt. Ltd., in Pune, India. Kuang Tai manufactures welding consumables for shielded metal arc, gas metal arc, gas tungsten arc, flux cored arc, and submerged arc welding. It also produces stainless steel wires for both welding and nonwelding applications.

The Indian subsidiary has been incorporated as a trading company to deal in welding consumables. It offers a warehouse to supply a ready stock of products; sales and service engineers who were trained in Taiwan; and a testing laboratory.

V. K. Sud was named managing director and CEO of the Indian company. He has 40 years of experience in wire drawing and iron powder making. Prior to joining KT Welding Technologies, Sud served for 16 years as managing director of Hoganas India Ltd.

Global Industries Awarded $70 Million Project in Brazil

The Brazil Business Unit of Global Industries, Ltd., Carlyss, La., recently signed a contract with Petroleo Brasileiro S.A. (Petrobras) for diving, remotely operated vehicle, and construction services to be performed offshore Brazil in the areas of Camos, Santos, and Espirito Santo basins. Global Industries provides offshore construction, engineering, project management, and support services, including pipeline construction, platform installation and removal, deepwater/SURF installations, and diving to the oil and gas industry worldwide.

The 180-day contract is valued at approximately $70 million and has an option for an extension of up to six months.

General Dynamics Awarded $7 Million Contract for Saudi Tank Work

General Dynamics Land Systems, Sterling Heights, Mich., was recently awarded a $7 million contract to continue to design the new Saudi M1A2 (M1A2S) Abrams tank for the Kingdom of Saudi Arabia.

The contract is in addition to a $58 million contract awarded to General Dynamics in 2008 to design, develop, convert, implement, and test a hybrid configuration of the M1A1, M1A2, and M1A2 System Enhancement Package tank variants. That work will be performed in Sterling Heights.

Alcan to Supply Aluminum Automobile Products to Chinese Car Makers

Alcan Engineered & Automotive Solutions (EAS), part of Alcan Engineered Products, has created a joint venture with Changchun Engley Automobile Parts Co. Ltd. (Engley). The new company will be based in Changchun in northeast China and will have a second manufacturing plant located in Kunshan, close to Shanghai, to serve several manufacturers in China.

Alcan Engley Automotive Structures Co. Ltd. will produce aluminum crash-management systems and instrument panel beams, as well as other structural aluminum modules. Alcan Automotive is the majority shareholder and expects to begin supplying products before the end of this year.

"Alcan's advanced aluminum lightweight solutions play a significant role in today's fuel-efficient cars all over the world, including China," said Wolfgang Schmitz, EAS president. "China is posting double-digit growth in car sales and will continue to offer exceptional growth opportunities for our engineered products in the coming years."

The aluminum systems offer benefits in weight reduction, safety, and structural stiffness, as well as help lower emissions and improve fuel economy. The Alcan Engley joint venture group sees a strong demand for its products, which will help its customers develop the next generation of greener, more fuel-efficient cars in China and Asia.

Gedik Kaynak Establishes European Welding Consumables Company

In response to demands from the European consumables market for quick delivery and local logistical and technical support, Gedik Kaynak has founded Gedik Europe B.V., situated in The Netherlands. The location was chosen in order to have a minimum of transportation costs between Rotterdam, where the product is unloaded, and the new company.

Gedik Kaynak, headquartered in Istanbul, Turkey, has produced welding consumables since 1963. The European subsidiary became operational in September.

In addition to establishing Gedik Europe, Gedik has formed a cooperative venture with Valk Welding, The Netherlands. Valk will provide logistical, commercial, and technical support. Valk has subsidiaries in France, Denmark, and Czech Republic and will be able to supply Gedik welding wire within 72 h throughout Europe.

Tongxin International to Assemble Truck Cabs

Tongxin International Ltd., Changsha, China, recently signed a contract with a Chinese commercial vehicle manufacturer to assemble two of the customer's truck cab models on site. This marks the first time Tongxin has directly participated on the assembly line of a truck manufacturer in China.

The parts will ship to the truck manufacturer as a "complete knock down" for welding, finishing, and eventual fitting to the finished truck chassis. Under the five-year contract, Tongxin will assemble two of its most common over-the-engine cabs, both of which are considered light truck cabs. The customer elected to have Tongxin assemble its cabs on site instead of purchasing the complete truck bodies direct from Tongxin to save on shipping costs and to capitalize on the company's expertise in building engineered vehicle body structures.

"We continue to see an increased trend by our customers in China to outsource cab manufacturing to proven suppliers in the market," said Duanxiang Zhang, Tongxin CEO and vice chairman. "We were not surprised to see one of our customers take this step to utilize our expertise on their assembly line. This agreement created a win-win for our customer and Tongxin by reducing shipping costs for our customer while expanding the breadth and volume of our product offering."◆

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LETTERS TO THE EDITOR

Interesting Weld Cracking Article 'Couldn't Be Put Down'

A member comments on two stories he enjoyed reading in the September 2009 Welding Journal.

An active AWS member since 1964, I was particularly impressed with Joe Bundy's article, "Understanding Weld Cracking" (pages 30–32). It wasn't that I learned anything new, but the article was so effectively written and professionally presented that I could not stop reading. I plan to use it in my Materials-In-Design Class.

All of the articles were of interest, as well as the similar one by Dan Gerbec on "Minimizing Defects in Submerged Arc Welding" (The American Welder, pages 78, 79), but the thorough conciseness of basic techniques by Bundy had me mesmerized so that I couldn't put it down. Just had to write to say, "Keep up the great work."

C. A. "Buddy" Bollfrass, P.E.
Mechanical Engineering Department
Texas A&M University
College Station, Tex.

Innovative 'Cadillac' Chair Draws Praise

A long-time AWS member from the Ferrol area, La Coruña County, close to Santiago de Compostela in Galicia, Spain, shares his thoughts on an inspirational article.

In the *Welding Journal's* September 2009 issue, I read "Welder Achieves New Heights with High-Tech Chair" by Kristin Campbell (The American Welder, pages 80–82).

Many, many congratulations for this idea and solution. It is impossible to imagine the happiness of Jordan Kay [a disabled welder who received a unique wheelchair that lifts, enabling him to perform welding standing up], because with this "super-special tool," he will carry out new possibilities that until now were absolutely closed.

I wish a lot of luck for him, and I'm sure very soon he will be a 6G qualified welder. From this distance, again congratulations.

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BY DAMIAN J. KOTECKI

Q: We fabricated a large heat exchanger header from heavy-wall ASTM A358 Type 321H stainless steel pipe and ASTM A182 Type 321H forgings, using E347-16 covered electrodes. After welding, we performed a stabilization heat treatment at 900°C (1650°F) for 4 h. After the heat treatment, we found cracks, mostly close to the fusion boundary in the heavy-wall pipe. What happened? We will have to repair the header and again perform the stabilization treatment. What can we do differently to assure this cracking will not happen again?

A: What you have experienced is commonly called reheat cracking or stress relief cracking. It occurs fairly often in certain stainless steels containing titanium (Ti) or niobium (Nb) for stabilization, especially around welds in heavily restrained and thick sections. Probably the three best known alloys susceptible to this cracking are 321H, 347H, and Alloy 800H. Table 1 lists nominal compositions of these three alloys. The phenomenon also is known to occur in the lower carbon versions of 321 and 347 stainless steels.

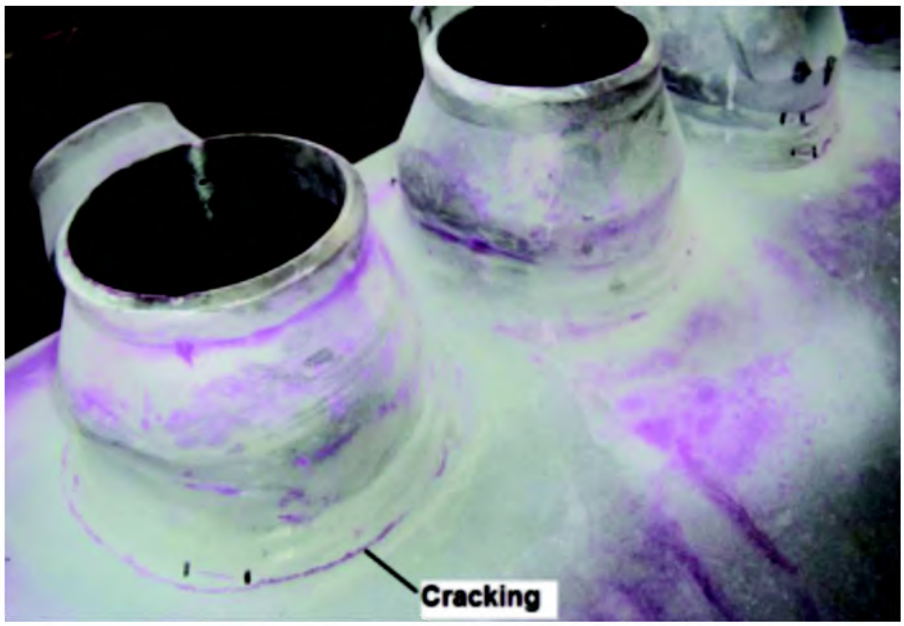

Fig. 1 — Stress relief cracking in a 321 stainless steel heat exchanger header.

These alloys are intended for use at high temperatures, usually in the range of 500° to 750°C (930° to 1380°F). They derive their high creep strength at these service temperatures from a fine dispersion of Ti or Nb carbides. However, welding produces dissolution of these carbides in the hottest part of the heat-affected zone (HAZ), and a subsequent weld pass can then precipitate chromium carbides on grain boundaries. This results in a very thin weak zone along the grain boundaries where there are little or no Ti or Nb carbides. The function of the stabilization heat treatment at 900°C is to dissolve the chromium (Cr) carbides and once again precipitate the Ti or Nb carbides.

In the early stages of the stabilization heat treatment, the zone beside the grain boundaries where the Ti or Nb carbides dissolved is quite a bit weaker in creep than the remainder of the grain, and creep takes place to relax the residual stresses due to welding. The creep strain is concentrated in the thin zone along the grain boundary that is initially free of Ti or Nb carbides, and that zone can fracture with very little overall strain. That is considered to be the mechanism of the stress relief cracking or reheat cracking you experienced. Figure 1 shows the results of this phenomenon in the heat exchanger header. Crack locations are evident, mostly in the base metal very near the fusion boundary, by the dye penetrant used to examine the weldment.

The phenomenon of stress relief cracking in stainless steels was reported at least as long ago as the 1950s. A number of re-

— continued on page 20

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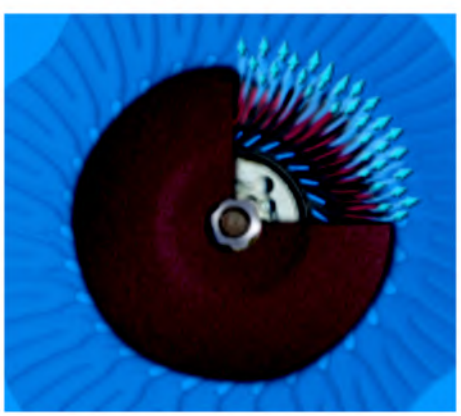

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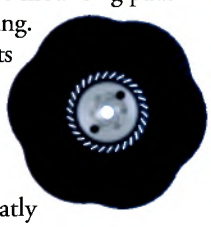

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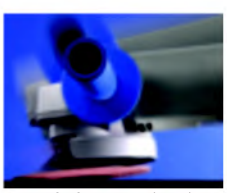

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views of the literature on this subject have been published. A recent one is that of Alfred Dhooge (Ref. 1). According to Dhooge, the factors that affect stress relief cracking are chemical composition, welding practice, weld metal strength, base metal grain size, and postweld heat treatment. In your situation, the chemical composition of the base metal is already fixed as 321H. The welding practice includes section thickness and geometrical discontinuities such as changes in section size that are largely dictated by the design of your weldment. It also includes notches and undercut, which you can minimize. The weld metal strength is largely determined by use of E347-16 electrodes. There may be some latitude open to you in filler metal selection, but I expect that you have to meet the creep property requirements of the base metal, so 347 filler metal seems to be the most appropriate choice.

Base metal grain size is worthy of consideration. Cracking reported in the literature seems to have been largely confined to base metals with coarse grain size — ASTM Grain Size 3 or larger. Note that a larger grain size number indicates finer grain size. Dhooge recommends grain size of ASTM 3.5 or finer for best resistance to stress relief cracking. The efficacy of finer grain size seems to lie in spreading the creep strain that occurs during stress relief heat treatment over more grain boundaries. For repair of your current heat exchanger header, I expect you can't change the base metal grain size. But for any future such fabrication, you would do well to specify finer grain size in your purchase order for the steel. You will probably need to work with the steel supplier to determine their capabilities for controlling the grain size, and you may have to pay a premium price for finer grain size.

Table 1 — Nominal Compositions of 321H, 347H, and 800H

Alloy	%C	%Mn	%Si	%Cr	%Ni	%Ti	%Nb	%Al
321H	0.07	1.0	0.4	18	10.5	0.5	—	—
347H	0.07	1.0	0.4	18	10.5	—	0.8	—
800H	0.07	1.0	0.4	21	32	0.5	—	0.4

The last factor has to do with the postweld heat treatment. The stabilization at about 900°C (1650°F) is necessary for developing the optimum creep properties. However, it is not necessary to go directly to that temperature for postweld heat treatment (PWHT). Dhooge notes that some intermediate PWHT has been used successfully, such as 850°C (1560°F). But perhaps more successful has been to go directly to a solution anneal at 1050°C (1920°F) or higher, then cool to 900°C for stabilization (precipitation of the Ti carbides in the 321H base metal and Nb carbides in the 347 weld metal). Dhooge suggests slow heating up to 430°C (805°F), then rapid heating to 1050°C to get through the temperature range around 900°C, where reheat cracking occurs, as quickly as possible. Dhooge does not state what "rapid heating" means, but Messer et al. (Ref. 2) propose heating rates of 18° to 30°C (32° to 54°F) per min in 347 stainless steel weldments. Such heating rates may be difficult to achieve in a large weldment going up to 1050°C. Furthermore, distortion during annealing may pose serious problems, and you may have to combat that.

References

1. Dhooge, A. 1998. Survey on reheat cracking in austenitic stainless steels and Ni-base alloys. *Welding in the World,* Vol. 41, 206–219, International Institute of Welding, Paris, France.

2. Messer, B., Oprea, V., and Phillips, T. 2004. Optimized heat treatment of 347 type stainless steel alloys for elevated temperature service to minimize cracking, Paper No. 04640, *Corrosion 2004,* NACE International, Houston, Tex.

DAMIAN J. KOTECKI is president, Damian Kotecki Welding Consultants, Inc. He is a past president of the American Welding Society, currently treasurer and a past vice president of the International Institute of Welding, and a member of the AWS A5D Subcommittee on Stainless Steel Filler Metals, and the AWS D1K Subcommittee on Stainless Steel Structural Welding. He is a member and past chair of the Welding Research Council Subcommittee on Welding Stainless Steels and Nickel-Base Alloys. E-mail your questions to Dr. Kotecki at damian@damiankotecki.com, or send to Damian Kotecki, c/o Welding Journal, 550 NW LeJeune Rd., Miami, FL 33126.

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BY KEVIN CHAN

Q: I have been working with RSW for the past 20 years, and recently my company has made the switch to galvanized dual-phase material. The welding machine I am using used to get around 5000 welds before we had to take a look at the tips; now we are getting less than 200. We have been using the standard FE-25 tips, but now we are finding that the welding window is much smaller and cold welds are popping up. What am I doing wrong?

A: I do not believe you are doing anything wrong. Let's look at this from the ground up. You have been using a welding machine and caps that have been set up for another process. Although your parts may be similar in shape and size, new materials and coatings will require a new setup. You may not need to start from the basics all the time, but if you are having problems, it's a good idea.

First things first: Double check the condition of your welding machine. Over time, joints and linkages loosen up and cables and shunts wear leading to a higher resistance in your secondary circuit and hence less power getting to your weld. Force actuators can also lead to trouble as higher-strength materials will need higher welding forces than was previously required to achieve the desired weld nugget size.

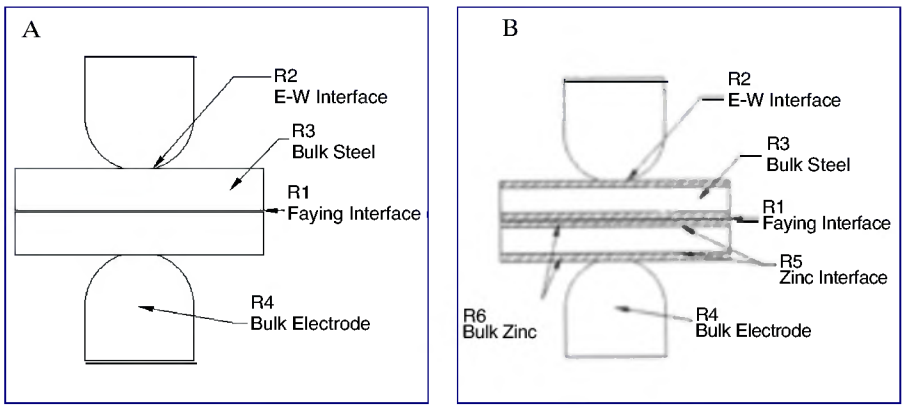

Fig. 1 — A — The schematic diagram of a steel weld showing electrical resistance; B — the added complexity and resistance of a coated steel weld.

In terms of the correct welding parameters to use, welding coated steel with a higher strength does change the required settings. Generally, a higher weld current is required to weld coated steels as compared to uncoated steels, and this is due to the zinc coating melting and pooling around the electrode and making the effective contact area larger — Fig. 1.

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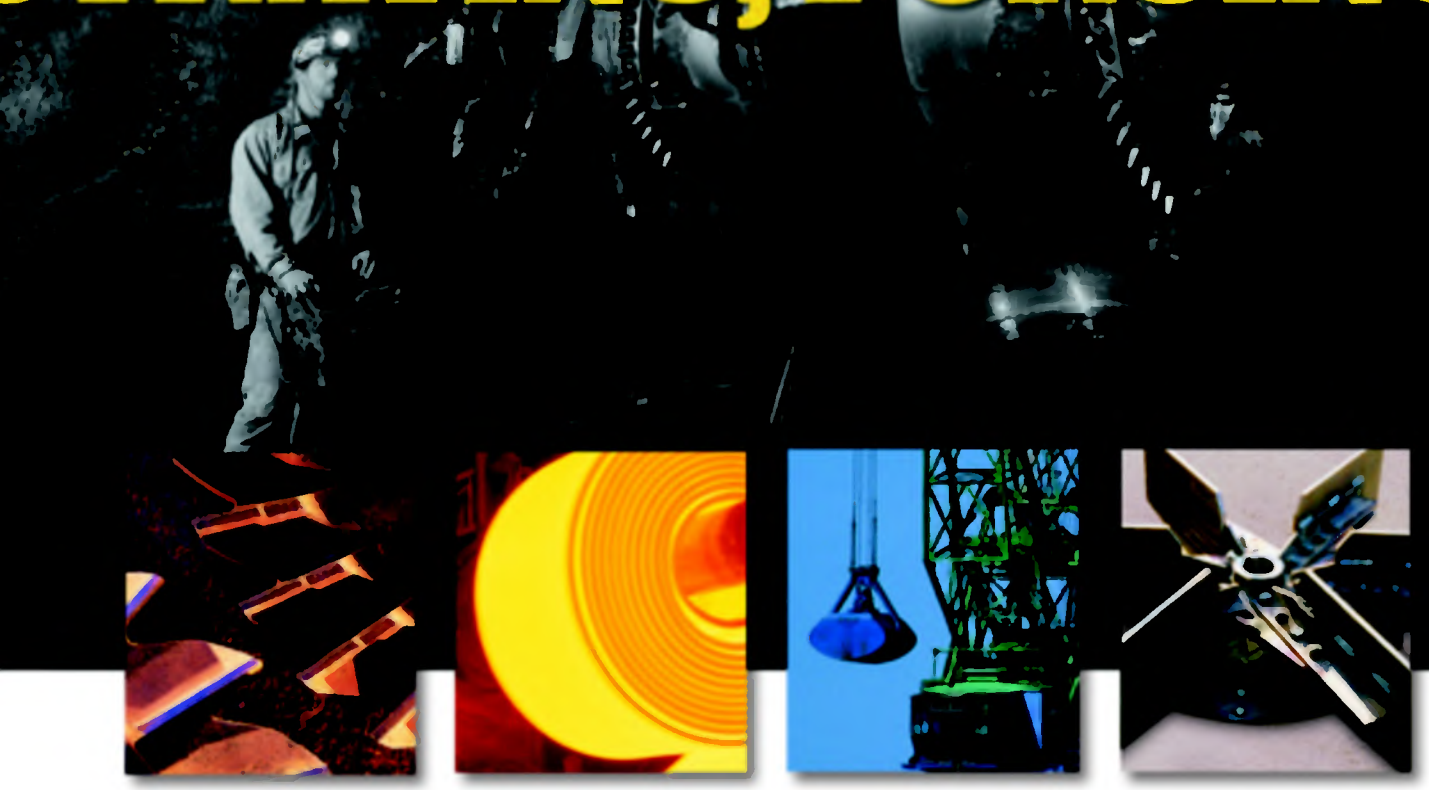

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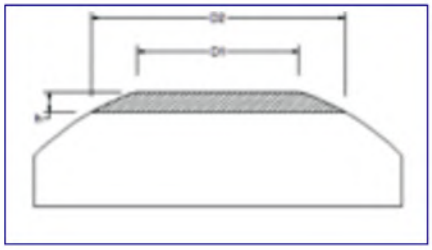

Fig. 2 — Tip wear either erodes the electrode face, causing geometric growth of the weld face, or mushrooming occurs, where buildup and flow of material expands the tip face.

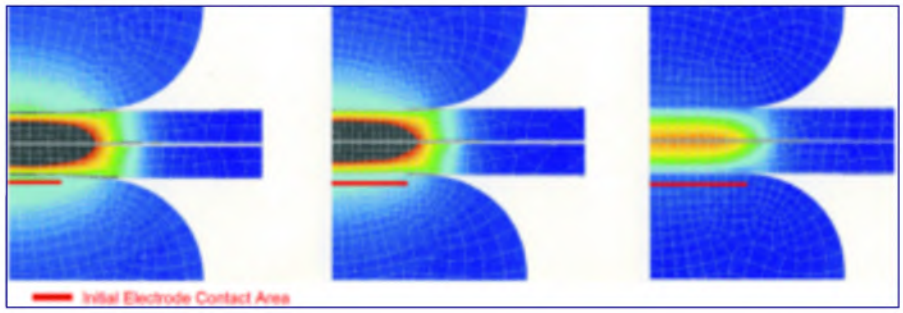

Fig. 3 — A larger weld face reduces current density. Here, the simulations show declining weld nugget size with a constant current and an increasing electrode face diameter (left to right).

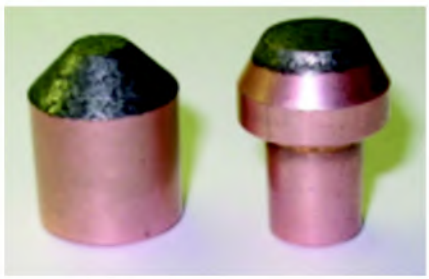

Fig. 4 — Coated weld electrodes are able to provide a hard wear surface as well as a barrier between the copper electrode and the zinc steel coating.

For a stronger material, a higher weld force is also needed as the stronger sheets will not conform as easily, and the contact resistance between your work sheets will be different with the same force compared to mild steel.

The standard weld face on the FE-25 is approximately 0.25 in.; this will give you a certain weld current density and resultant weld life when welding steels that is rather consistent. Current density is the amount of current you have passing through a unit of area. For this example, if your weld current with a new cap is 9 kA with a 0.250-in. weld face, you have an area of roughly 0.049 in.^{2}, giving a current density of roughly 183.7 kA/in.^{2}. The zinc coating on the new material melts and pools around the weld tip, making the weld face diameter much more critical in this case. If it were to increase the effective area of the weld face by just 0.010 in., the current density would drop to roughly 158 kA/in.^{2}. You may want to try using a smaller weld face, like the FB-25 with 0.19-in. weld face cap electrode, which will concentrate the weld current and allow for longer tip life due to higher current

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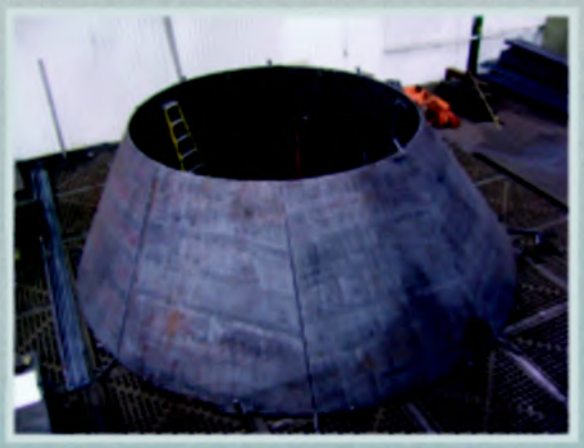

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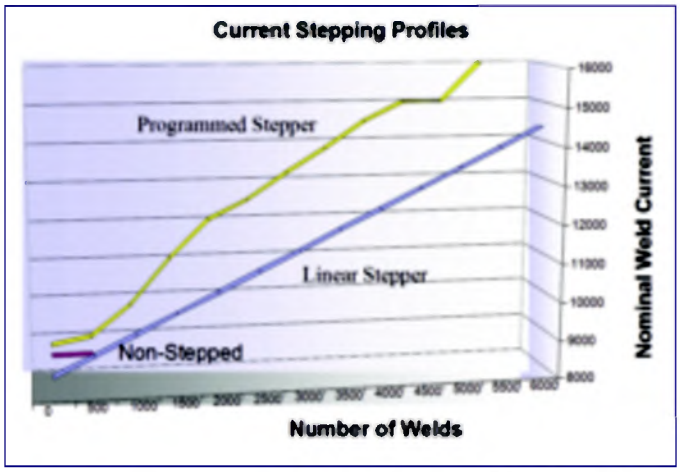

Fig. 5 — Current stepping gradually increases the weld current to compensate for tip wear, allowing for extended use of electrodes. Typical stepping rates range from 0.5–1.0 A per weld increase.

Fig. 6 — During the weld, the weld current (dark blue line) is automatically increased until the resistance signature of the weld indicates that a good weld has been made.

densities. As the tips wear, the weld face grows (Fig. 2) until the current density is no longer high enough to facilitate sufficient fusion of the weld sheets, and the weld will fail — Fig. 3.

Having set up your new weld properly with electrode choice and new parameter settings, the next step is to get the most out of your electrodes. There are other options that have been used by the industry to combat tip life and cold weld issues. Basically, to extend tip life and weld quality, one must reduce the wear on the electrodes. Tip dressing and tip rolling will physically machine and force the electrodes back to the original state in-process, electrode coatings can prevent the zinc-copper interaction and reduce wear (Fig. 4), and weld current steppers can maintain the current density if the wear rate is predictable — Fig. 5. And, in fact, all of these procedures can be used successfully together to extend weld electrode life.

The next generation adaptive weld controllers now coming on the market are also able to manage tip wear by closed-loop feedback of the weld current, ensuring good welds are made every time, and continuously, as the electrode wears — Fig. 6.

If you are finding that these strategies are not helping your weld issue, it may be time to call in a qualified resistance welding engineer to take a look at your weld process. As simple as the theory behind resistance welding can be, the influence of so many parameters often makes troubleshooting a difficult task with the best solution being experience and a solid understanding of weld parameters.◆

Kevin R. Chan is engineering/technical sales manager, Huys Welding Strategies Limited, Weston, Ont., Canada. Send your comments/questions to Kevin at kchan@HuysIndustries.com, *or to Kevin Chan, c/o Welding Journal, 550 NW LeJeune Rd., Miami, FL 33126.*

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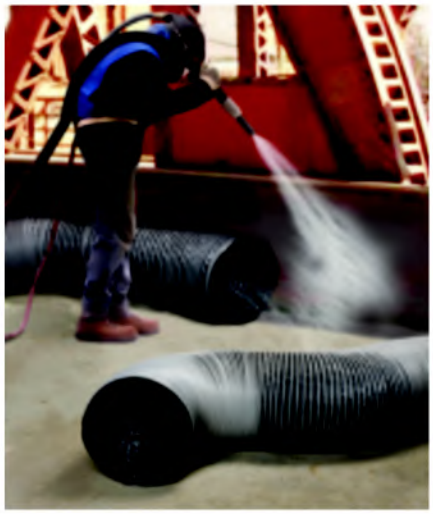

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Extraction Hood Contains Double Panel Roof Design

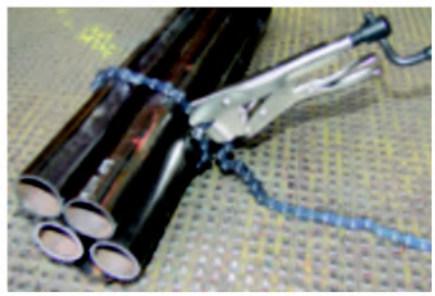
The company's modular extraction hood and filter bank system removes weld-

ing fume and grinding particulate. Users have an option to hang the hood in place from the ceiling or deploy as a free-standing unit with optional leg mounting kits. The modular extraction hood features semitransparent welding strips, and nontransparent curtain strips are also available. The hood's double panel roof configuration prevents sparks from entering the duct work. In addition, fabricators may choose one of eight Statiflex® filter bank units to complete the system. This low vacuum-type filtration station is available in sizes ranging from 2 to 32 banks. The unit features an internal airflow system and a self-cleaning design. The filter bank and fan motors come in sizes ranging from 1.5 to 10 hp.

The Lincoln Electric Co.
www.lincolnelectric.com/weld-fume-control/
(888) 355-3213

Chain Pliers Yield Greater Holding Capacity

The Xtra-Length locking chain plier comes standard with a 24-in. chain, which can be removed from the plier, and replaced with a series of six chains measuring from 16 to 78 in. in length. Each chain has a fishtail end for quick easy-in/easy-out assembly. A chain retainer on the plier jaws holds the chain in position during work setup. In addition, a quick-turn crank-handle enables simple adjusting of the opening and torque. An optional mounting base along with copper grounding, stainless steel, and aluminum pads are available.



Strong Hand Tools™
www.stronghandtools.com
(800) 989-5244

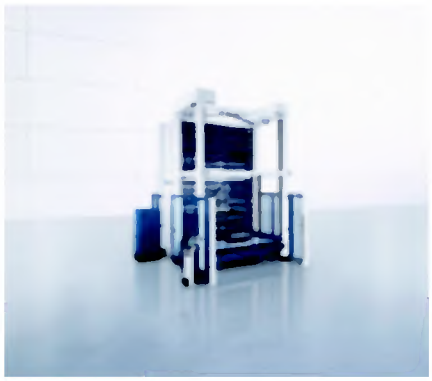
Cleanroom Robots Enable Long Reaches

The VM-Series six-axis articulated, Class 100 cleanroom robots feature reaches from 1000 to 1300 mm and standard cycle times of 0.89 to 0.95 s, along with repeatability from ±0.050 to ±0.070 mm and a payload capacity of 10 kg. Their long, slim arms allow reaching easily around tooling or peripheral equipment and into deep, narrow spaces. Also, their high maximum allowable moment of inertia (0.36 kgm² at J4 and J5 and 0.064

kgm² at J6) allows a wider choice of end effectors. Floor- and overhead-mount models are offered.

DENSO Robotics
www.densorobotics.com/products_6axis_vm.php
(888) 476-2689

Storage System Designed for Sheet Metal



TruStore and LiftMaster Cart, a storage system with automatic loading and unloading, offers a compact footprint. Its shelves can be quickly accessed, or if needed, additional modules added. The basic version of the TruStore 3130 consists of a storage module with up to 15 storage compartments in the first tower, 21 pallets in the second tower, and a manual storage and retrieval station with an integrated unpacking station. It is designed for sheet metal up to 5 × 10 ft. The LiftMaster Cart can be added to the TruStore system and shared by up to two TruLaser machines. The two-tower storage option can reach a height of up to 21 ft in a production facility. The TruStore basic module consists of 15 individual parts.

TRUMPF Inc.
www.us.trumpf.com
(860) 255-6000

Wires Used for Welding Low-Alloy and Mild Steel

Dual Shield 810X-Ni1 is an all-position 1% nickel flux cored wire for general purpose welding of low-alloy steel. It is designed for use with 100% CO_2 and is useful for welding CORTEN steel in applications where weathering grade wires are not desirable. Dual Shield 710X-M is an all-position flux cored wire for general purpose welding of mild steel. It is designed to be used with a 75/25 argon/CO_2 gas mix; however, pure CO_2 may also be

used. Typical applications for both wires include railroad cars, shipbuilding, barges, light equipment, and general fabrication. These wires are certified for seismic applications as well.

ESAB Welding & Cutting Products
www.esabx.com
(800) 372-2123

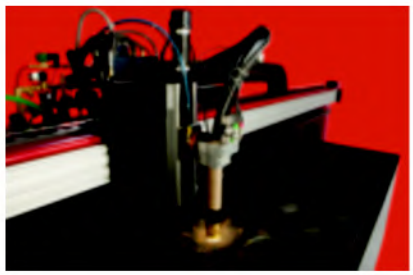
Laser Distance Measurer Features Backlight Display

DW030, a laser distance measurer, provides users with a quick way to estimate space by distance, square footage, and volume. It has a rubber over-molding for easy grip and operation. The unit has large, clearly marked buttons allowing

users to select between units, area, distance, and volume buttons. This measurer has a backlight display for improved visibility on job sites. It is built to withstand a 6-ft drop and is resistant to water and dust. For improved accuracy, it measures distance from the back of the unit. A flat bottom design provides added stability while measuring from set positions.

DEWALT
www.dewalt.com
(800) 433-9258

Thermal Cutting Machine Offers Two CNC Controllers



The Plate-Pro Extreme, a 3-axis, plasma and oxyfuel cutting machine, is a dual-side-drive product that cuts pieces from gauge thickness up to 6 in. Available cutting widths are 6, 8, and 10 ft; also, available cutting lengths are 10 to 100 ft. It uses a 22 kg, triple machined floor-mounted rail design. The machine has a capacity of six tools — up to four oxyfuel and two plasma torches. It can be outfitted with either conventional or high-definition plasma cutting systems. There are two CNC controllers, Burny Phantom or KARCNCx, as well as CNC autonesting upgrades. This machine can be used with downdraft or water tables.

Koike Aronson/Ransome, Inc.
www.koike.com
(800) 252-5232

Using Tandem Gas Metal Arc Welding to Create Heavy Weldments

For welding thick sections, this process provides increases in deposition rate and travel speed, plus a decrease in calculated heat input

BY MARC PURSLOW, STEVE MASSEY, AND IAN HARRIS

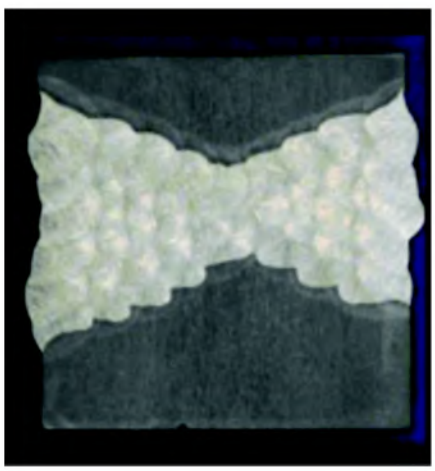


Fig. 1 — A 2-in.-thick weld made by T-GMAW in the horizontal (2G) position.

Fig. 2 — A 1-in.-deep groove weld created using T-GMAW in the vertical (3G) position with upward progression.

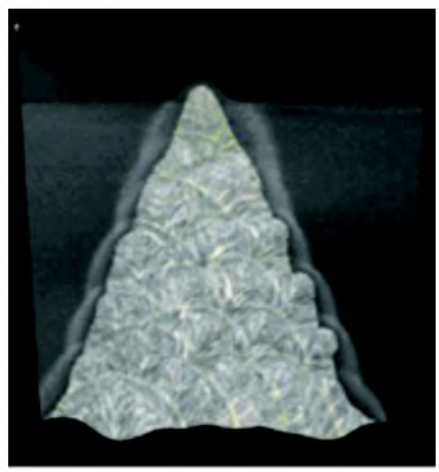


Fig. 3 — A 1-in.-thick weld accomplished with T-GMAW in the overhead (4G) position.

Although tandem gas metal arc welding (T-GMAW) has been around for many years, it has not been widely exploited for heavy structures. Understanding the best settings for the increased number of welding parameters compared with single-wire GMAW is part of the reason.

In a continuing effort to increase productivity and reduce welding costs in shipbuilding, power generation, heavy equipment, and other markets, the Edison Welding Institute's (EWI) arc welding team is developing new applications for T-GMAW. The aim is to achieve increases in welding productivity as compared with conventional techniques used for structural or heavy fabrication including pulsed GMAW (GMAW-P), flux cored arc welding (FCAW), GMAW constant voltage (CV) spray transfer, submerged arc welding (SAW), and hot-wire feed gas tungsten arc welding (GTAW-HW).

Defining the T-GMAW Process

Tandem gas metal arc welding is a variation of GMAW where two electrodes are fed through a single welding gun. The parameters at which each wire operates are independently controllable by separate welding power sources. Interactions between the two welding arcs promote improved process stability and allow increases in deposition rate and travel speed since both arcs operate in the same weld pool.

Out-of-Position Welding of Thick Steels

The fabrication of major structures often requires joining thick sections in the horizontal, vertical, and overhead welding positions as repositioning for welding can be impractical or prohibitively expensive. While SAW is often used to join such thick sections in the flat position, it is often difficult if not impossible to apply the process out of position. As a result, lower productivity processes such as single-wire FCAW or GMAW are often used. The inherent productivity limitations of these welding processes are a major contributor to the high cost of welding these joints. EWI has applied T-GMAW to thick sections in the horizontal, vertical, and overhead positions. Increases in deposition rate and travel speed as well as a decrease in calculated heat input (based on average instantaneous power) make T-GMAW an ideal high-productivity alternative to GMAW and FCAW.

Welds were produced in the horizontal (2G) position at an average deposition rate of 25 lb/h and travel speeds averag-

MARC PURSLOW is project engineer, STEVE MASSEY is application engineer, and IAN HARRIS (iharris@ewi.org) *is technology leader for arc welding at the Edison Welding Institute (EWI), Columbus, Ohio.*

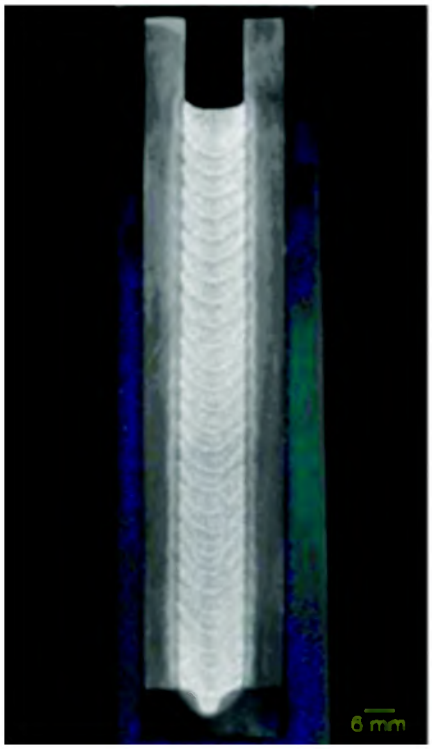


Fig. 4 — Weld joint of a narrow-groove T-GMAW.

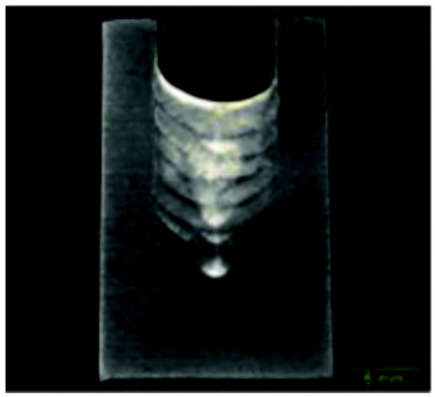


Fig. 5 — The narrow-groove T-GMAW process was used to join nickel Alloy 690 with Alloy 82 filler metal.

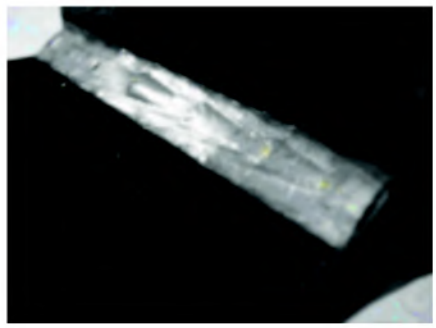


Fig. 6 — A 3/16-in. fillet weld made at 2 m/min.

ing 30 in./min resulting in increases of 195 and 185%, respectively, when compared to baseline single-wire parameters. In addition, the calculated heat input was reduced by 33%. Excellent sidewall fusion and weld integrity were obtained, as determined with nondestructive examination (NDE) methods. A cross section of a 2-in.-thick joint is provided — Fig. 1. Mechanical testing has established that the welds met mechanical property requirements.

Welds were produced in the vertical (3G) position, with upward progression, at deposition rates of more than 8 lb/h. When compared to common practice with solid wire using GMAW-P, this is a 75% increase in productivity. The cross section in Fig. 2 indicates that using T-GMAW for uphill welding is feasible; however, the effects of process variables on weld quality have not fully been characterized. Examination of the cross section indicates that by using T-GMAW for uphill welding, there may also be a benefit to impact toughness due to the presence of thin layers of refined grain structure.

Welds were produced in the overhead (4G) position at an average deposition rate of 15 lb/h and travel speeds averaging 35 in./min resulting in increases of 235 and 535%, respectively, when compared to baseline single-wire parameters. In addition, the calculated heat input was reduced by 33%. Excellent sidewall fusion and weld integrity were obtained, as determined by NDE methods. A cross section of a 1-in.-thick joint is provided — Fig. 3.

Narrow-Groove T-GMAW for Additional Productivity

Thick-section components are often joined using high-deposition-rate welding processes such as GMAW and SAW with conventional open-groove designs. Although these are considered high-deposition-rate processes, they are not necessarily high-productivity processes due to the large number of weld beads that are required to fill a conventional single- or double-V-groove joint. Narrow-groove joint configurations are advantageous as they reduce the overall volume of the weld joint; however, incomplete fusion into the sidewall is a common concern. This can prevent the successful application of many conventional high-deposition-rate arc welding processes. While mechanized GTAW is used in narrow grooves, its relatively low deposition rate limits overall productivity. By developing narrow-groove tandem GMAW (NG T-GMAW), EWI has succeeded in applying a high-productivity process to narrow-groove joint design, resulting in productivity increases.

Edison Welding Institute designed and constructed a prototype NG T-GMAW gun. The gun was designed with adjustability of the spacing of the electrodes, the relative height of the electrodes, and the included angle between the two. Excellent sidewall fusion and weld integrity were achieved.

Deposition rates surpassing 20 lb/h were achieved on HSLA-100 base materials at a travel speed of 15 in./min. This is more than a 900% increase over the deposition rate of the baseline, narrow-groove cold-wire GTAW process typically used with these joint configurations and materials. In addition, the narrow-groove joint configuration resulted in a reduction in the required volume of weld metal and in the number of passes needed to fill the joint. A cross section of a 5.25-in.-thick weldment is provided — Fig. 4. The joint was prepared with a ½-in. root opening and a 2-deg included angle. A total of 27 passes filled 4.5 in. of the joint.

The feasibility of applying NG T-GMAW to the welding of Ni Alloy 690 was also investigated. Edison Welding Institute has demonstrated the feasibility of welding nickel alloys with this process; however, the effect of process parameters on weld quality and process tolerance has not been fully characterized. An average deposition rate of 9.5 lb/h was achieved at a travel speed of 15 in./min. A cross section of a narrow-groove weld made with Alloy 82 (ERNiCrMo-3) filler metal is provided — Fig. 5.

High-Speed Fillet Welding for Structural Applications

Welding at increased travel speeds may yield a number of benefits. In addition to productivity increases, travel speed increases have been shown to reduce residual stresses and resultant distortion. In an effort to evaluate the ability of the T-GMAW process to produce welds at elevated travel speeds, weld trials were completed on T-joints of ¼-in.-thick material in the 2F position. Parameters were developed to produce 3/16-in. fillet welds at a travel speed of 2 m/min (78.7 in./min) and a deposition rate of 22 lb/h — Fig. 6.

The use of T-GMAW for conventional bevel groove joints, narrow root opening joints, and high-productivity, high-speed fillet welds illustrates the effectiveness and flexibility of this variant of the widely deployed GMAW process.◆

Transitioning from ‘We Protect’ to ‘We Build’ America

Fig. 1 — A VIP student practices at UA’s Local 26 training center in Lacey, Wash.

UA's Veterans in Piping program trains returning veterans

BY NEAL BORCHERT AND ANNE A. ST. ELOI

American veterans face one of the toughest job markets in decades. Despite high-level training, their military experience often doesn't translate into highly skilled civilian jobs. Veterans frequently find themselves stuck in dead-end work with little hope for advancement; others reenlist just to make ends meet. Even more can't find work; the unemployment rate for veterans is three times higher than the national average.

This is occurring at a time when the American job market is starved for skilled welders. Even in the current economy, welding-oriented companies continue to search for reliable, committed, skilled welders.

As a solution to both of these problems, the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry (UA) launched its UA Veterans in Piping (VIP) accelerated welder training program in August 2008. Based in the UA Local Union 26's training center in Lacey, Wash., the pilot program trained 16 returning veterans in the welding skills needed to meet union standards — Fig. 1.

With the help of state governments, local educators, equipment suppliers, and partner contractors, the VIP concept has proved to be successful. Camp Pendleton, a U.S. Marine Corps base in California, began its third VIP "Warriors in Welding" class September 28, and Local 26 will begin its fourth VIP class November 16.

"This is the right thing to do," said UA General President William P. Hite. "It's a win-win situation for all of us. These young people come back, they get great jobs, they get careers, and we get these wonderful recruits to help us with the demand for skilled labor."

Mike Arndt, UA director of training, added, "The VIP program sets an example for other industries. It's important that we help veterans exit the service and enter training programs that lead to careers in the skilled trades. These veterans are good people who work together and without conflict. They show up on time and are a really good, committed group."

Fig. 2 — VIP student Bill Gaertner inspects a test weld on a section of pipe as part of the VIP accelerated pipe welding training program.

An Inspired Plan

Hite conceived of and initiated the VIP program after observing other attempts to utilize the skills of veterans. He envisioned a program for the UA where returning veterans would receive valuable counseling and training before entering into apprenticeships (to give them a leg up on finding work), and where the skilled trade organization would become the interface with the government and with private employers.

Before the 16 weeks of intense welder training begin, the VIP program provides a two-week orientation designed to transition veterans into the civilian workforce. Judae Bost'n, Ed.D., coordinator of business management training at Bates Technical College in Tacoma, conducts this course.

"Veterans' culture, their language, how they operate, and how they process infor-

NEAL BORCHERT is with Miller Electric Mfg. Co., Appleton, Wis., www.millerwelds.com. *ANNE A. ST. ELOI* (annes@uanet.org) *is special representative, United Association, Blaine, Wash.*

For more information on the UA Veterans in Piping (VIP) program, visit www.uavip.org.

Fig. 3 — Members of the inaugural VIP accelerated pipe welding program at Local 26 discuss welding techniques with industry experts.

mation is defined by the military," she said. "The only trouble is, when you drop them into the civilian world, that doesn't work. Even though veterans have everything an employer wants (discipline, motivation), they have two things that get in their way: They have a hard time 'getting out of their lane' (assigned duties within a team), and they have a hard time having their own internal schedule because everything has been externally scheduled for them. If we spend two weeks of psychological training up front, we can knock down a lot of the barriers that have gotten in the way of veterans succeeding in the workplace."

Bost'n's program teaches veterans that retaining the teamwork, discipline, and motivation they have been taught by the military is important, but rediscovering the individual and recognizing personal strengths and weaknesses will make them better workers and employees.

"The transition phase helped us interact with each other and developed us mentally to transition from the military to the civilian world," said Joseph Witt, an Army veteran who served in Germany, Bosnia, and Iraq. "Judae broke us down, just like a drill sergeant, and then built us back up. We're able to use the same values we learned in the military — loyalty, duty, respect, self-of-service, integrity, honor, and personal courage — and apply that to the workforce we are training for right now."

"On the first day, I was thinking this is a bunch of psycho-babble," recalled Bill Gaertner (Fig. 2), a 17-year veteran of the Army, Navy, and National Guard who has served on every continent. "Once we got three days into it, I started to understand what it was actually doing. It was teaching us to be more honest with ourselves and to understand the way things work in the civilian world. After two weeks, you could see the change in everybody in the class. It was designed to tear down the barriers that we had already set up ourselves. Once you tear down those barriers, you will be more successful in everything you do, from work to family and relationships."

Part of tearing down those barriers includes understanding that the civilian workforce isn't as intense as military life, but if you apply yourself and pursue some-

Fig. 4 — A VIP student practices his gas tungsten arc welding skills.

thing you find interesting, you can be successful. Jacob Otten, a veteran of the Army National Guard who served in Kuwait, is a perfect example of taking a practical skill from the military and translating it to civilian life. He worked on aircraft structural repair in Kuwait and did not want to return to a job as a building engineer's assistant where all he did was replace light bulbs and perform menial maintenance tasks.

"I need something where I'm always doing something," Otten said. "I can't just be sitting around waiting for someone to call and say 'Hey, change a light bulb.' Metal is my passion. I like being able to take something and manipulate it in a way where I can create something completely new."

Training for Success

After completing Bost'n's class, the veterans at Local 26 begin work with their instructors — Mike Stull and George Glassman — for the accelerated welding program. Stull and Glassman are both Vietnam veterans with 41 and 35 years of experience in the UA, respectively.

"I was excited about this as soon as they told me about it," Stull said. "I've got a chance to help veterans. We're very fortunate to have this program here at Local 26" — Fig. 3.

Stull and Glassman work together to teach the students the finer points of each welding process and how they apply to pipe welding. By the time the students graduate from a VIP course, most will be ready to work with a minimum of UA 2 and UA 21 welding certifications (respectively covering shielded metal arc welding (SMAW) on 6-in. Schedule 40 and 2-in. pipe). Many of the graduates will also have additional certifications that include gas tungsten arc welding (GTAW) for the root and/or all passes — Fig. 4.

Student Enrique Rosano is thankful for the specialized training offered by VIP. "I went to a [local technical] school and noticed that they just gave you some rods and said 'Here you go, you paid for this class, so you can get out of it what you want,'" recalled Rosano, a U.S. Army veteran who served in Iraq. "When I came here, the VIP program geared training toward welding pipe. All I ever welded in that other class was a little block. Mike and George came in here and taught different tricks and procedures that will make us successful pipe welders."

Students Find VIP Invaluable

Welding was never something many of these students aspired to out of high school. A few had dabbled in it here and there, either on a farm or in school, but didn't know the level of skill required to meet pipe welding standards. And while many of the students had never before given welding serious consideration, they now see it as a superior alternative to much of what is available on today's job market.

"I was in a dead-end job with no opportunity for advancement," Gaertner said. "I need to provide for my wife and my daughter. That is my primary concern."

Fig. 5 — Army veteran Kenneth Duvall welds on a section of pipe as part of the VIP accelerated pipe welding training program.

Kenneth Duvall (Fig. 5), Army veteran (Iraq, Korea, Afghanistan, Thailand, and Japan), VIP student, and father of two, said, "I was getting ready to go back into the military because I didn't see any opportunities out there. When I heard about this program, I was skeptical at first because I had heard about so many 'miracle' programs, but when I got here, I found that the VIP program exceeded anything I could have ever asked for.

"Other industries should take a really hard look at this because there is no rea-

Fig. 6 — Washington Governor Chris Gregoire addresses a luncheon honoring the inaugural UA VIP accelerated welding program. Class members, UA representatives, and military personnel associated with the program share the stage.

son that this can't be done in other fields," he added. "Why not train veterans to become your guys? Not only are you helping people, but you are helping yourself. You're going to get quality because you're going to train quality — the quality of a military veteran."

Many of the VIP students enrolled to gain entrance into a career with good wages, job stability, and opportunities for future advancement. Many, however, are finding that welding is more than a means to an end.

"I really like welding," said John Scherer, a four-year veteran of the U.S. Army who served in Iraq. "I like seeing actual, physical results. There is no question of 'what did I accomplish today?' because it's right there in front of you."

"As long as that hood is down, it's just me and the metal," Duvall added. "It's almost like peace. Like everything else is blocked out. It's like meditation time."

"I appreciate the UA for doing this because they are not required to do this," said Scherer. "I recommend this program because it's a practical way of helping vets. It's good for the union, and it's good for the vets."

High Success Rate

The typical completion rate for an accelerated welding program like this with civilian students is 50%, but the VIP program's success rate is much higher, as shown in the following:

- **Local 26, first VIP class:**

12 of 16 students (75%) received welding certifications and one year of credit toward their four-year apprenticeship. Because of their skills, 9 of these 12 were placed in apprenticeship three weeks early; the remaining three entered apprenticeship upon class completion.

Four students without welding certifications received UA Pipefitting Apprenticeships.

- **Local 26, second VIP class:**

13 of 15 students (87%) received welding certifications and one year of credit toward their four-year apprenticeship; three students went to work two weeks early.

Two remaining VIP students without certifications also received UA Pipefitting Apprenticeships.

Candidates were placed all over the country, including Washington, Oregon, California, Montana, Georgia, and Virginia.

- **Camp Pendleton, first VIP Warriors in Welding class:**

11 of 13 students (85%) received welding certifications and one year of credit toward their four-year apprenticeship; many obtained multiple certifications (including one student with 11).

Students received training while on active duty because the UA worked with the military to create MOS 1316 (Military Occupation Specialty for Welding). This is the first time that active military members were paid while training for a civilian apprenticeship.

After the Class Ends

At the end of a VIP class, each successful participant is offered direct entry into a four-year welding apprenticeship program (with one year of credit for the class). They work with contractors and begin to earn steady wages and benefits, such as health insurance and enrollment in the pension plan. Further, those who did not achieve welding certification are offered the opportunity for additional welder training, as well as a UA Apprenticeship.

Team Effort

The VIP program is funded through the UA's International Training Fund, which is made possible by member donations. Its success has also been made possible through the help of private companies and government agencies. Manufacturers, such as Miller Electric Mfg. Co., have donated equipment and welding supplies. The state of Washington passed legislation that allowed veterans and others to quit dead-end jobs and draw unemployment while they undertook a training program, such as the VIP program, that led to an apprenticeship. Agencies such as the Workforce Investment Act and the Department of Veteran Affairs have also contributed to its success.

VIP is gaining attention for its value nationwide. National Guard units in four states are interested in starting VIP programs with the UA, and the Marines at Camp Lejeune are interested, too. Washington Governor Chris Gregoire saluted the program at a luncheon honoring the pilot program at Local 26 — Fig. 6.

"We are a country that needs our infrastructure to be built and rebuilt," said Gregoire, "and we need the workforce of today and tomorrow to make that possible. This is the beginning of that opportunity, not just here in Washington State, but around the country."

The opportunity is beneficial to both the veterans and the contractors. Returning veterans are taught an in-demand trade that helps them support their families and improve their lives. Contractors are given new employees who are naturally disciplined and motivated, and who know how to balance teamwork with individual forethought and initiative. Everyone wins. ◆

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Metallurgical Characterization of Nitronic-60 to PH 15-5 Stainless Steel Inertia Welds

An adhesive wear-resistant alloy has been successfully inertia welded to high-strength stainless steel, thus eliminating the need for a wear-resistant coating

BY TERENCE P. SAVAS

Inertia welding is a solid-state process capable of joining similar and dissimilar metals that in many cases cannot be joined by consumable and nonconsumable arc fusion welding, or by laser or electron beam welding (Ref. 1). In most metals, the welds produced are of full strength and highly repeatable. The processing time is rapid with a low unit cost. No welding rods, flux, electrodes, or shielding gases are required. The inertia welding process can also be implemented where a more conventional process may have low yield due to porosity or other weld defects (Ref. 2). In general, the primary advantages of inertia welding include 1) near net shapes, 2) elimination of costly machining operations, 3) elimination of waste material, and 4) overall lower manufacturing costs. Two disadvantages include capital equipment costs, and in some cases, part size limitations based on the capability of the equipment. The mechanics of the inertia welding process can be found in various publications (Refs. 1, 3–5).

Joining a Wear-Resistant Alloy to a Precipitation Hardened Alloy

For the present study, the inertia welding process is examined to produce a part that contains an adhesive wear-resistant alloy joined to a precipitation hardened martensitic stainless steel, UNS15500 (Ref. 6). Several wear-resistant alloys were evaluated including 1) precipitation hardened Cu-Be (Ref. 7), 2) spinodal hardened Cu-Ni-Sn (Ref. 8), 3) cold drawn Cu-Al-Ni-Fe (Ref. 9), and 4) strain hardened Fe-Mn-Si-Cr-Ni (UNS21800) (Ref. 10). However, the UNS21800 alloy was chosen because of its similar iron-based chemical composition to the UNS15500 and the expectation this would produce the strongest metallurgical bond.

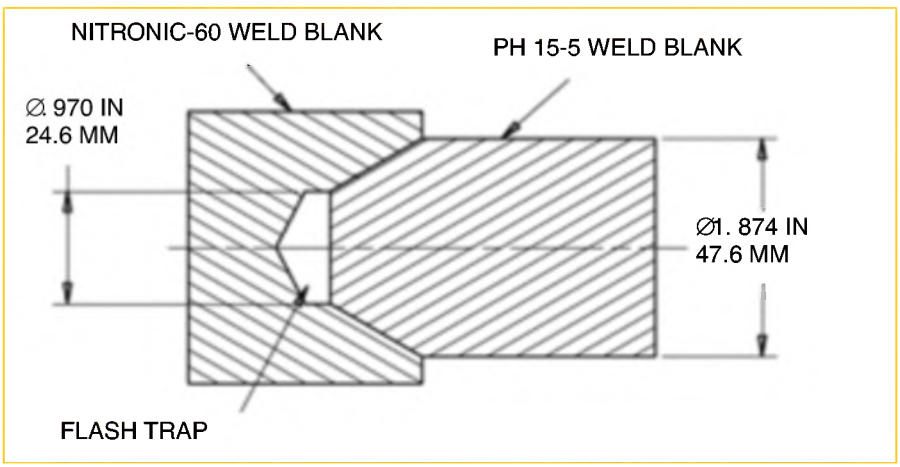

Fig. 1 — Inertia weld blank configuration implemented for the present study.

Characteristics of Adhesive Wear

Adhesive wear is a metal damage mechanism caused by strong adhesive forces that are created by a charge imbalance of electrons between the two mating surfaces (Ref. 11). The electrons are not bound by a rigid structure, and providing that the distance between two surfaces in contact is sufficiently small (i.e. < 1 nm), they can move from one surface to another. As a result, the electrons can bond two solids despite their differing atomic structures. Under low contact stress, slight bonds form where the high points of each surface come into contact. With subsequent metal movement, small fragments can detach from the metal surface. At higher contact stresses, much larger weld junctions can form between the surfaces causing excessive wear or even seizure of the components. In general, materials with similar chemical compositions and hardness have a higher tendency for adhesive wear (Ref. 12). This wear mechanism may be reduced by using hard materials, dissimilar materials, surface films, lubricants, plating, or surface hardening treatments such as nitriding or carburizing. Oxide films that form on wear surfaces can also reduce adhesive wear. Specialty alloys such as UNS21800 depend on oxide film formation and adherence to prevent metal-to-metal contact and subsequent surface damage (Ref. 12). These types of alloys also depend on a base material with a high strain hardening rate, such as austenitic stainless steel, since the local strain hardening supports the structure of the oxide film.

For applications that require a combination of stainless steels and are exposed

TERENCE P. SAVAS (tsavas@ parker.com), *is senior project engineer, Parker Hannifin Corp., Aerospace Group, Control Systems Division, Irvine, Calif.*

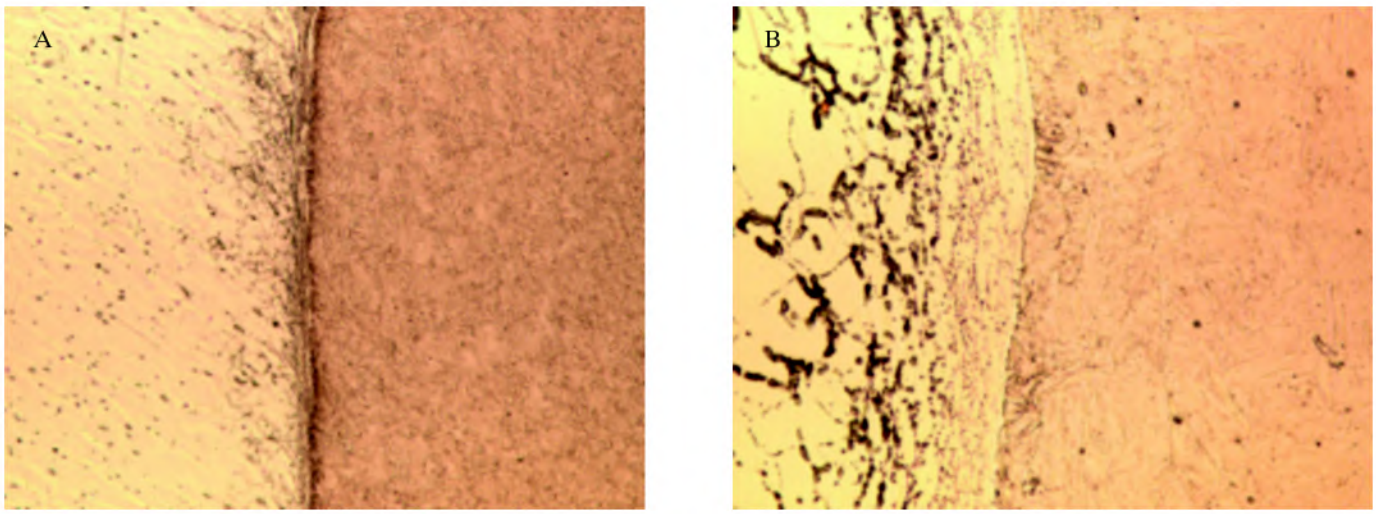

Fig. 2 — Microstructure of UNS21800 (left) to UNS15500 (right) inertia weld. A — 50×; B — 500× (etchant: Vilella's reagent).

to dynamic wear conditions with high contact stresses, a wear-resistant coating on one mating surface is often required to prevent adhesive wear. The most conventional coating types, for example, those used in the aerospace industry, include electroplated chrome, electroless nickel and nitride. In addition, high-velocity oxygen fuel (HVOF) coatings are also used, for example, tungsten carbide cobalt chrome (Ref. 13). This type of coating has a similar hardness to electroplated chrome and can be ground to extremely smooth finishes. Although chrome plating has historically been used with proven success, environmental restrictions on hexavalent chromium are prohibiting its use for new designs. Thus, HVOF coatings are becoming more prevalent as a chrome replacement. Although the HVOF coatings provide wear protection above uncoated metals, their adhesive wear properties are found to be significantly lower than chrome.

Objectives of Investigation

The specific objectives for the present study were as follows: 1) develop a conical shaped inertia weld joint configuration that consists of a UNS21800 outer (wear) member and a UNS15500 inner (structural) member. This configuration can be implemented on a part that is conventionally made from a single piece of bar stock and then processed with a plating or coating on a wear surface, 2) develop and optimize the weld process parameters such as inertia mass, rotation velocities, and upset force that produce a strong metallurgical bond between the UNS21800 and UNS15500, 3) perform microstructural characterization of the as-welded structures in addition to a Knoop microhardness traverse across the bond line interface, and 4) perform mechanical tensile load test on a representative weld coupon followed by SEM and metallographic examinations of the fractured surfaces.

Procedures

Experimental Material

The as-received UNS21800 austenitic stainless steel consisted of 3.625-in. (9.208-cm) diameter bar with a chemical composition controlled per AMS5848 (Ref. 10). This strength level specified in AMS5848 is for the annealed condition. These limits include a minimum yield and tensile strength of 55 ksi (379 MPa) and 105 ksi (724 MPa), respectively. However, the material can be ordered commercially in a strain hardened condition with tensile strengths up to 200 ksi (1379 MPa). In the case of bar stock, the strength level achievable depends on the bar diameter and is limited by the capability of the rotary forging presses used to induce the strain hardening. It should be noted that conventional drawing operations for UNS21800 are not as effective as the rotary forge process in providing uniform strain hardening throughout the entire cross section. Other important attributes of UNS21800 include a higher resistance to pitting corrosion than a Type 316 stainless steel in chloride environments, good high-temperature stability, and excellent adhesive wear resistance.

The as-received UNS15500 martensitic stainless steel consisted of 2.25-in. (5.715-cm) diameter bar with chemical composition controlled per AMS5659

Table 1 — Chemical Compostion (wt-%) for Alloys Evaluated and Allowable Ranges per AMS Specifications

Alloy Type	C	Mn	Si	P	S	Cr	Ni	N	Cb	Cu	Mo	Fe
Nitronic-60 (UNS21800)	0.072	7.94	4.09	0.036	0.001	16.37	8.27	0.16	—	0.28	0.32	Bal
Nitronic-60 AMS5848C	— 0.10	7.00 9.00	3.50 4.50	— 0.04	— 0.03	16.00 18.00	8.00 9.00	0.08 0.18	—	— 0.75	— 0.10	Bal
PH 15-5 (UNS15500)	0.042	0.81	0.31	0.022	0.006	14.41	4.46	—	0.33	3.28	0.36	Bal
PH 15-5 AMS5848C	— 0.07	— 1.00	— 1.00	— 0.03	— 0.015	14.00 15.50	3.50 5.50	—	5xC 0.45	2.50 4.50	— 0.10	Bal

Table 2 — Mechanical Properties for Alloys Evaluated and Minimum Values per AMS Specifications

Alloy Type	Yield Strength ksi (MPa)	Tensile Strength ksi (MPa)	%RA
Nitronic-60 (UNS21800)	143 (987)	157 (1083)	68
Nitronic-60 [a] Level 2 Strain Hardened	105 (896)	135 (930)	50
PH 15-5 (UNS15500)	157 (1081)	170 (1174)	56
PH 15-5 AMS5659L H1025 Temper	145 (1000)	155 (1067)	45

(a) Nitronic-60 values represent a Level 2 strain-hardened condition. AMS specification control only exists for the solution heat-treated condition.

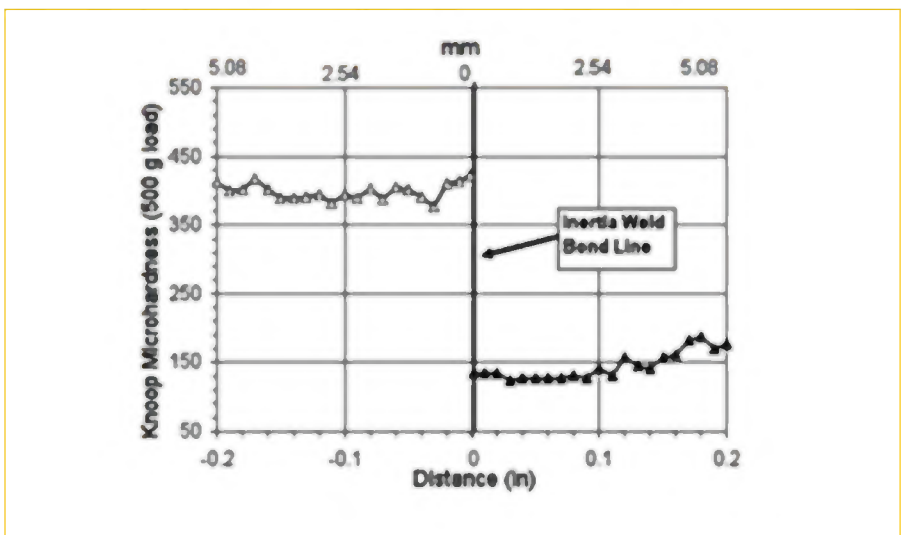

Fig. 3 — Knoop microhardness traverse results for UNS21800 to UNS15500 stainless steel inertia weld across metallic bond line and heat-affected zone (HAZ).

(Ref. 6) and precipitation heat treated to an H1025 temper condition. Although this temper does not produce the peak strength, for example, compared to H900, it allows for a higher resistance to hydrogen embrittlement and stress corrosion cracking (SCC). The chemical composition and mechanical properties of the UNS21800 and UNS15500 for the heat lots used in the present study and those required per the respective AMS specifications are provided in Tables 1 and 2, respectively.

Inertia Weld Blank Design

Figure 1 illustrates the inertia weld blank configuration implemented for the present study. The geometry consists of a conical shaped (frustum) configuration with a UNS21800 outer (wear) member and a UNS15500 inner (structural) member. The UNS21800 member also contains what is referred to as a flash-trap where upset and extruded material can flow during welding. In many cases, the inertia weld process is used to eliminate waste material, for example, joining two identical alloys with varying diameters that would normally require machining from a single piece of bar stock. However, for the present study, the use of a wear-resistant material welded to a dissimilar stainless steel material is the primary objective. Although the weld process parameters including inertia mass, rotation velocities, and upset force are optimized for the present investigation, they are not disclosed in this paper due to their proprietary nature.

Metallurgical Evaluations

Metallurgical evaluations consisted of the following: 1) postweld microstructural evaluation including Knoop microhardness traverses across the bond line interface, 2) a tensile load test with a coupon nearly identical to the configuration shown is Fig. 1 except the UNS15500 shaft was threaded for fixture retention during the load test while a hydraulic grip was used to restrain the UNS21800 outer member, 3) postfracture metallographic cross sectioning, and 4) postfracture SEM examination of the fracture surfaces.

Experiment Results

Figure 2A and B illustrates polished and etched cross sections of the as-welded microstructures. The weld joint is free from metallic bond line separation, voids, defects, or brittle intermetallic phases. The UNS15500 microstructure is consistent with a quench and tempered martensitic structure with no observable HAZ. The UNS21800 microstructure exhibited three distinct zones. In Zone 1 (located at the metallic bond line), there appears to be a finer, more elongated, recrystallized grain structure (apparently due to the hot working and plastic flow during the welding process). In Zone 2 (directly adjacent to Zone 1) evidence of second phase particle precipitation within the austenite grain boundaries is clearly evident. The particles are quite larger and more clustered than the matrix phase. It is presumed these particles are high in Mn and Si concentration (the primary alloy constituents in the UNS21800) although future studies are needed to verify this. The adjacent Zone 3 is indicative of the as-received microstructure. The apparent dark line, more pronounced at lower magnification (Fig. 2A), is a result of the refined grain structure and higher concentration of second phase particles. In addition, these microstructural attributes can lead to a more pronounced chemical attack during metallographic etching due to a differing chemical potential than the matrix phase.

Figure 3 shows the results of a Knoop microhardness traverse across the metallic bond line interface. The UNS21800

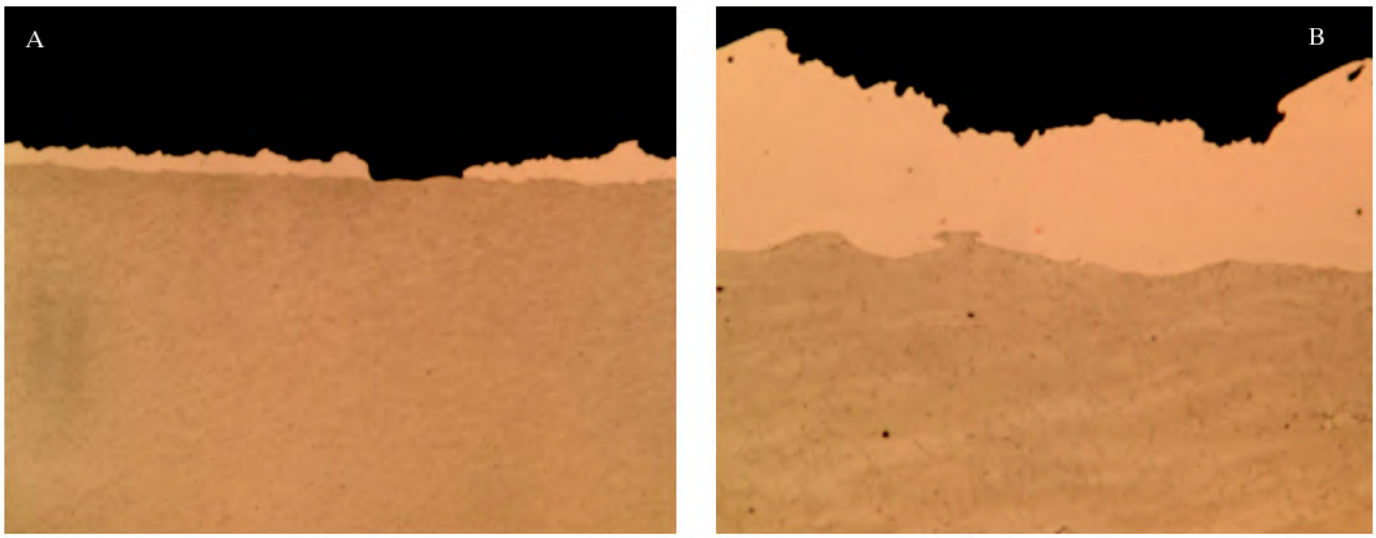

Fig. 4 — Postfracture micrographs of UNS21800 and UNS15500 inertia weld. A — 25×; B — 200×. Note fracture occurred predominantly in the UNS21800 alloy with isolated fracture regions at the metallic bond line (etchant: Vilella's reagent).

shows evidence of microstructural softening with a HAZ on the order of 0.15 in. (3.8 mm). However, full hardness indicative of the original properties is observed at 0.20 in. (5.1 mm) from the metallic bond line. The softening is attributed to local heating and relaxation of dislocation entanglements, thus relieving the strain hardening induced during the material fabrication process. The UNS15500 exhibits a slight increase in hardness at the metallic bond line with a depth of approximately 0.03 in. (0.76 mm) with consistent properties out to 0.20 in. (5.1 mm) where the measurements are terminated. Finding the cause for the slight hardness increase needs further investigation. However, this is of less interest for the present study where the joint strength and fracture mode are of primary importance.

Tensile load testing resulted in a failure load of 330,330 lb (1.47 MN). Based on the surface area of weld joint, calculated to be 3.88 in.^{2} (25.0 cm^2), this equated to a fractures stress of 85.1 ksi (586.8 MPa). It should be noted that an extensometer was not used to measure strain (percent elongation) since this was not feasible with the present weld blank geometry. Coupon testing with a standard geometry would be needed to derive these data (in addition to percent reduction in area), and this may be conducted in future studies. It was expected the fracture stress would be lower than the UNS21800 tensile strength since the stress state at the bond line consisted of both shear and tensile components due to the conical geometry.

Figure 4A and B shows metallographic cross sections of the fracture surface. It is clear that the fracture occurred in the UNS21800 material for a large majority of the welded surface with isolated regions of fracture occurring along the bond line. This indicated the inertia weld was actually stronger than the UNS21800. Corresponding SEM micrographs of the fracture are provided in Fig. 5A and B. A ductile rupture failure mechanism is observed.

Summary and Conclusions

The present study focused on implementation of the inertia welding process to produce a unique conical-shaped (frustum) configuration consisting of a UNS21800 outer wear member joined to a UNS15500 inner structural member. Depending on the part configuration and design application, this allows for the bond line and HAZ to be isolated from stress-critical regions and elimination of wear-resistant coatings. This same concept and weld geometry can be applied to various engineering applications, for example, the frustum angle of 30 deg can vary between 30–60 deg and the conical diameters can be modified (Fig. 1).

Although several wear-resistant alloys were considered (mostly copper based) UNS21800 was chosen due to its similar iron-based chemical composition to the UNS15500, and the expectation this would produce the strongest metallurgical bond. While the weld process parameters were optimized (including upset force, inertia mass, and rotation velocities), they are not disclosed in the present paper due to their proprietary nature. It was concluded that a highly consistent metallurgical bond was achievable. This was confirmed by postweld microstructural evaluations, tensile load testing of the weld joint, and postfracture SEM and metallographic examinations. Actual wear testing was not conducted as part of the present investigation; however, the exceptional adhesive wear properties of UNS21800 are well documented in the open literature. For example, in comparison to various stainless steel combinations that exhibit threshold galling stresses in the range of 2–5 ksi (14–34 MPa) (indicative of the adhesive wear resistance), when tested in accordance with ASTM G98 (Ref. 13), UNS21800 running against various stainless steels shows galling thresholds of 50 ksi (345 MPa) and higher.

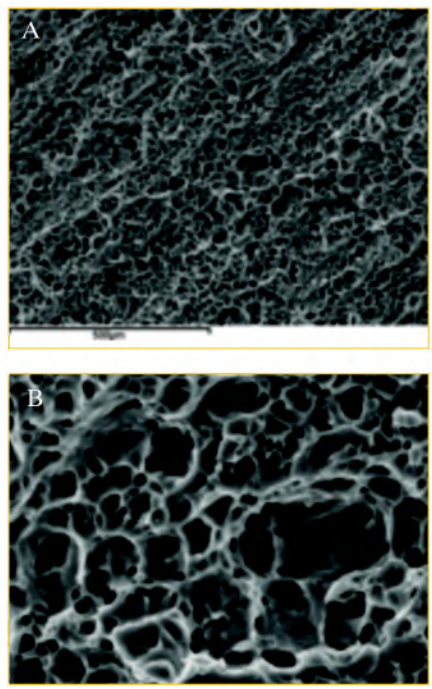

Fig. 5 — SEM micrographs of UNS21800 to UNS15500 inertia weld fracture. A — 1000×; B — 5000×. Note ductile rupture fracture mechanism.

It should be emphasized that implementation of this type of weld configuration can eliminate the need for wear-resistant coatings for applications requiring high contact stress. The most conventional coating types include electroplated chrome, electroless nickel, and nitride, in addition to HVOF coatings. However, these types of coatings are highly process sensitive, and if not strictly controlled, problems such chipping, blistering, cracking, poor adhesion, and related defects can occur. For HVOF coatings specifically, they do provide wear resistance above uncoated metals; however, their adhesive wear properties are inferior to the conventional coatings.

Acknowledgments

The author would like to thank Scott Hamlin and Leticia Santos from the Parker Hannifin Materials and Processes Laboratory for assisting in the metallurgical examinations. The financial support of Parker Aerospace, Irvine, Calif., is gratefully acknowledged.

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Take the Path to Become a Certified Welding Fabricator

With the proper preparation, commitment, and teamwork, many welding fabricators are capable of achieving AWS Certified Welding Fabricator status

BY STEVEN T. SNYDER

Considering the current economic situation, not having a documented company quality system can and likely will result in either missed business opportunities, increased costs due to rework, significant liability exposures, or a combination of all the preceding. A documented quality system is an important, and many times an essential element, for a welding-fabrication organization. It can be as vitally important as the business plan/financial model itself.

That being said, many welding fabricators do not require or are not ideally suited for an actual ISO, AISC, NADCAP, or ASME-aligned quality system and/or certification audit. Careful consideration should be taken in regard to the value of pursuing these quality management system certifications, depending on the type(s) of fabrication bid currently being performed, as well as the target markets. A proven, industry-recognizable quality system certification that can attest to the company's welding capabilities and that is appropriate for its target market can be the remaining attribute needed for overall success and diversity of clientele to the welding fabricator. Moreover, creating and certifying this quality system must be properly executed and implemented. This is no doubt a competitive business edge, and one of the major considerations that major oil companies, OEMs, and architectural and structural engineering firms now consider as a prerequisite when evaluating fabricators/bidders and determining the level of quality surveillance for the project itself.

Could You Achieve CWF Status?

With the proper preparation, guidance, commitment, and company personnel working in a team-oriented environment, many welding fabricators are capable of achieving the AWS Certified Welding Fabricator (CWF) certification. This certification is gaining recognition and is anticipated to be increasingly recognized by industry, both domestically and abroad. Interest in the AWS Welding Fabricator Certification has been increasing and is allowing small- to medium-sized fabrication facilities to be recognized and strategically place themselves in a high-quality category, showcasing their AWS code/standard-compliant welding abilities.

Many fabricators may weld to multiple codes in any given week, i.e., AWS D1.3, D1.2, D1.6, D9.1, D1.1, for ancillary products. Other miscellaneous types of welding job shops produce numerous components otherwise not part of a "main" structure per sé of a building, bridge, pressure vessel, pressure piping, or aircraft. Because of these differences, some welding fabricators may benefit from the AWS CWF certification more than others; as will many ISO 9000 registered companies that utilize welding as a special process that assures optimum process control, not just documentation process controls.

What a CWF Had to Say about the Program

As a contracted auditor over the last 13 years, I have conducted hundreds of combined audits for AISC, NADCAP, and AWS, and many ISO, API compliant au-

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Additional information on Duron Systems, Inc., Houston, Tex., is available at www.duronsystems.com.

dits for major companies, and I believe the AWS B5.17 program directly focuses on the "special process" of welding and is a cost-effective and achievable endeavor for any welding fabricator. The program allows fabricators to establish a welding program that is in compliance with the AWS welding code/standard work they perform.

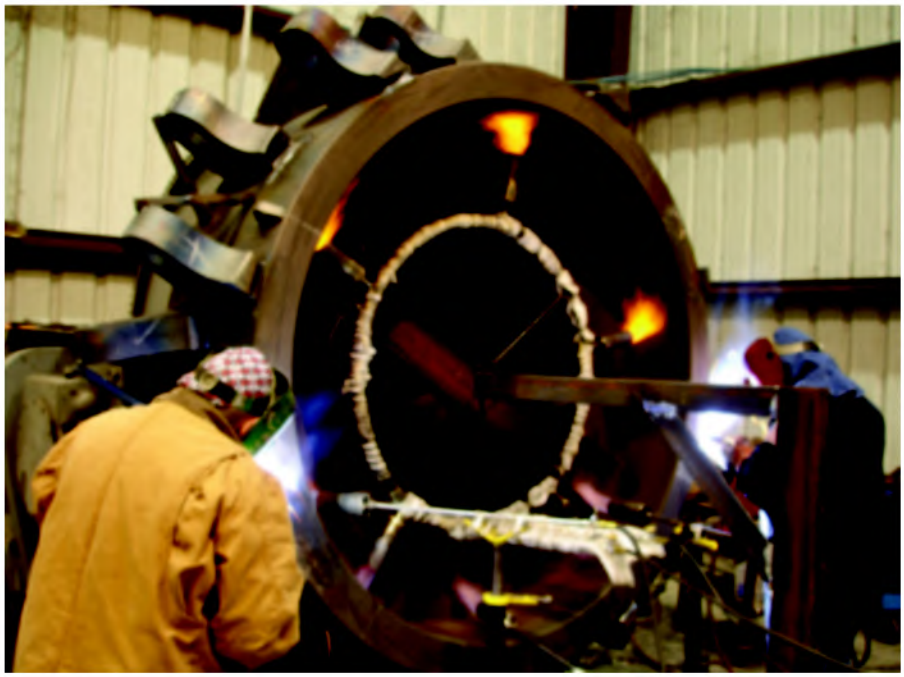
One such fabricator that can attest to the program first-hand is Duron Systems, Inc., which recently underwent an AWS CWF audit. Following that audit, Tom Lower, Duron's vice president, and Phillip Lower, weld engineer, submitted the following testimonial, which also included contributions from Charity Bass, of Duron's quality department.

"Duron Systems, Inc., was established in 1980 and has grown into a 27,000-sq-ft steel fabricating facility located in Houston, Tex. With our high-bay facilities and operations, we have the capability of fabricating large structures, as well as small components, catering to a variety of markets including refining, offshore, and subsea. We fabricate a variety of products from our customer's engineered drawings and specifications, such as BOP platforms, shipping frames, subsea mud mats, subsea tree frames, transportation skids, and wellhead connector parts. All of Duron's work is performed using AWS and/or ASME weld procedures and stringent quality control processes are in place to monitor each stage of the manufacturing process.

"Welding products with subsea applications means that we are expected to meet the highest standards possible in the products we fabricate. There is no room for errors in this industry, where errors translate into costly downtime — something our customers (and we) cannot afford.

"As a supplier in the oil and gas industry, it is absolutely necessary for safety and quality to be at the forefront of our practices. We viewed a welding endorsement from a respected authority, such as AWS, as a necessity. Certified Welding Fabricator recognition will further attest to our adherence to the strict technical aspects required when performing AWS welding.

"At Duron, we resolved to augment our credibility with current and prospective customers by obtaining accreditation that would, in effect, corroborate our commitment to product quality. Although Duron is an ISO 9001 registered facility, this accolade only guarantees the nonwelding elements of our quality program. In selling the benefits of our production services, however, it was important for us to focus on the quality of our primary special process — welding. The American Welding Society's Certified Welding Fabricator program was designed specifically for this purpose. The prestige and respect associated with the American Welding Society as the leading authority in the welding industry solidified our decision. The focus of this program is welding and the quality management system surrounding this special process. As a company, holding both certifications assures our products are fabricated to highest level of quality possible.



Continuous welding of 4-in.-thick 4130 pad eyes to a 4130 ring, maintaining a 450°F preheat for 12 days.

"Before we applied for AWS CWF certification, we had to be prepared. We started by conducting a gap analysis of our Quality Process Manual and the AWS requirements in B5.17:2008, *Specification for the Qualification of Welding Fabricators*. After updating our quality system, we then provided training to personnel on the changes and provided some refreshers on local work instructions. Over the course of several weeks, we focused on our daily continuity audits, capturing actual performance data. These audits are standard practice at Duron on both shifts, in addition to the start of new projects. Our

An airial view of Duron Systems, Inc., a steel fabricating company that has become the first AWS CWF in the Houston, Tex., area.

welders can be audited multiple times throughout their shift to ensure continuity of quality from project to project, and application to application. We felt really good about this intensive level of quality monitoring, which served as fine tuning from that point up to the audit.

"Although Duron has always taken pride in our welding program, the weight of having our processes put under a microscope by a highly accredited institution proved to be somewhat unnerving. However, the auditor was very approachable and easy to talk to — not the intimidating figure we anticipated. Instead, we were met with a constructive, informative experience. The audit schedule was straightforward. During the opening meeting, we discussed the auditor's suggested modifications to our Quality Manual, which he had reviewed prior to the audit. After that, the auditor conducted a complete shop walkthough where he interviewed welders, fitters, and inspectors. All the while, the auditor was asking pertinent operational questions from the AWS CWF checklist. At the close of the audit, we held another discussion with the auditor concerning the audit observations and findings, as well as commendations.

"The AWS standard and CWF audit helped our company recognize the added benefit of continuous formal education and training of our floor inspectors. We also identified a potential loss of traceability during the purchasing stage of consumables. We were able to make minimal adjustments to our purchasing process to be in compliance with AWS B5.17:2008. Overall, the audit was an excellent opportunity to have our quality procedures reviewed from an objective standpoint.

"So what was the result of our team effort and dedication to quality? We are the first AWS Certified Welding Fabricator facility in Houston! In a fiercely competitive market, Duron recognizes continual improvement as an essential element to maintaining a competitive edge. We are proud to claim Certified Welding Fabricator status and wear the title as a badge of honor. Achieving AWS certification demonstrates more than an ability to pass an audit; conformance to AWS B5.17:2008 means our products meet the highest specifications required. Because of the AWS Certified Welding Fabricator program, we are more confident in ourselves as a company and more cohesive as a team." ◆

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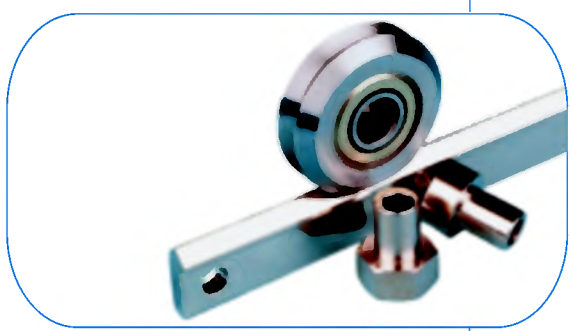

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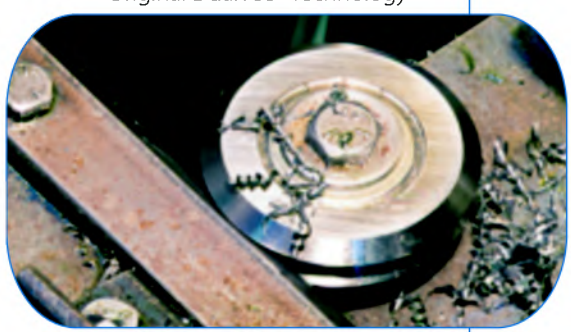

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AWS President Victor Matthews is shown with SkillsUSA competition welders (from left) Sally Rudin, Samantha Riley, and Ashley Webel.

A new era of Rosie the Riveters is emerging as the shortage of welders worsens and crumbling infrastructures increase the need for women in the workforce

BY ELEANOR SHELTON

Ashley Webel, Samantha Riley, and Sally Rudin are three Washtenaw Community College (WCC), Ann Arbor, Mich., students who have set their goals on establishing profitable careers in various welding fields.

To perfect their manual skills, they get together each week to practice as a team for a welding skills competition. For the first time in history, an all-woman welding and fabrication team competed for a SkillsUSA national title. They have learned that it's important that they coordinate with each other, to know exactly what each one's role is, and plan ahead for the next move.

No Pain, No Gain

The women practiced welding 25 to 30 hours a week, coordinating their skills into a well-organized team. Practicing welding forces us to make some social sacrifices, Riley admitted. "We watch our friends going away and having fun for the weekends, but it's worth it."

Webel said that she eventually wants to do construction work on buildings and bridges. Riley's ambition is to become a welding instructor. Rudin is already involved in the industrial field working for a company that makes custom filters and strainers.

Their welding coach and trainer is Jacob (Jake) Holland, a welding instructor in the WCC Welding & Fabrication Dept. He doesn't treat them any differently than the male students who are preparing for a welding competition.

"As their welding coach," Holland said prior to the competition, "I put as much pressure on them as I can. I don't give them an inch, so when they compete at the nationals the pressure will be something they are used to."

The Competition Results

The WCC welding and fabrication

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team was up against 13 other colleges from around the country. All were given the task of creating a rolling tool cabinet in just 6½ hours. There were a lot of considerations such as figuring out what works and what doesn't, how everyone can work efficiently as a team, and of course, observing safety precautions.

"We knew that this competition was going to be hard but it could change our lives," said Webel.

They took the silver medal, coming in behind American River College by just 20 points.

Coach Holland said, "These women are fantastic welders and now they have infinite career possibilities in front of them."

Women in Welding

Ilan Brat, a reporter for the *Wall Street Journal,* said there will always be a need for good welders because welding is not a job that is easy to automate and the nation's infrastructure is aging. Stressing the serious shortage of welders in the workforce, Brat wrote that currently the average age of welders is 54 years old and a wave of welder retirements is looming. Companies are having to use perks, like signing-on bonuses and guaranteed overtime, to attract welders into their employ.

Welders are earning $60,000 to $100,000 working for industries like the oil sands in Alberta, Canada. It is now more important than ever to attract workers entering the workforce into the welding industry.

Perhaps now is time for more women to consider becoming welders and train for these attractive and financially rewarding careers in this industry. You may recall the era of Rosie the Riveter — when women performed men's jobs in manufacturing during World War II because the men were away serving in the armed forces. Now, according to the American Welding Society, currently a full 6% of the welding workforce is female.

Women Have an Edge in Welding

Jessi Combs, a welder and host of the program "Xtreme 4X4" on Spike TV, said women make great welders because of their patience, rhythm, and attention to details. "Employers tell me some of their best welders are women. There should be no fear for women getting into welding," said Combs in her video, *Hot Bikes, Fast Cars, Cool Careers.*

Karen Gilgenbach has an engineering mechanics degree from Michigan State University but never wanted to sit behind a desk in a cubicle. When she interviewed for jobs she was most impressed by companies that offered a lot of variety and hands-on work. She is currently the Radnor product manager/regional manager of automation for Airgas North Central.

"The first time I took a welding class it scared me," admitted Gilgenbach. "But soon I began to enjoy it and now I love it. There is something about the art and focus of it that I like. Maintaining the arc, the sounds, the smells; everything else is drowned out."

Why Welding's a Good Career

One of the reasons that Gilgenbach thinks welding is a good career choice for women is there are benchmarks, such as certifications, that make the profession an even playing field. Gilgenbach has earned an AWS Certified Welding Inspector (CWI) designation. Also, her acceptance by her male coworkers has been overwhelmingly positive. Everyone has treated her professionally throughout her six years in the industry.

Coley McLean has served as a full-time welding instructor in the Welding & Fabrication Dept. at Washtenaw Community College for the last three years. She discovered her talent for welding through creating metal sculptures, and she still actively pursues her art when she's not teaching or fabricating commissioned projects.

"Welding has allowed me to pursue production, custom work, and teaching, which I love," said McLean. "Getting a diverse background and having crossover skills is important in today's economy."

Market Is Loosening up for Women

"I was rejected for the first two jobs I interviewed for because I was a woman," recalled McLean. "It wasn't my skill level, they were afraid that I physically wouldn't be able to do the job. I don't think that happens much anymore."

McLean agrees with Combs that women bring something special to welding. "I think that women have better hand-eye coordination, and can maintain a steady work flow."

Over the years, she has seen employers showing more favorable attitudes toward hiring women and women's increased opportunities for filling rewarding jobs in the welding industry.◆

FABTECH International & AWS Welding Show
General Attendance Information

Location
McCormick Place
2301 S. Lake Shore Drive
Chicago, IL 60616

Show Dates and Hours
Sunday, Nov. 15 — 11:00 a.m. – 4:00 p.m.
Monday, Nov. 16 — 9:00 a.m. – 5:00 p.m.
Tuesday, Nov. 17 — 9:00 a.m. – 5:00 p.m.
Wednesday, Nov. 18 — 9:00 a.m. – 3:00 p.m.

Transportation
By Air
Chicago is served by two major airports. You'll find tons of information about each of them at their Web sites including maps of the terminals, parking, etc.:

Midway Airport — (773) 838-0600, *www.chicago-mdw.com*
O'Hare International Airport — (773) 686-2200, *www.ohare.com*

By Car
Like the saying goes, all roads lead to Chicago. The following roads are among the major highways leading into the city:

Interstate 90 (the Chicago Skyway) runs northwest from the state of Indiana towards Chicago. It joins Highway 94 at which point it becomes the Ryan Expressway and then the John F. Kennedy Expressway.

Highway 55 (the Adlai E. Stevenson Expressway) leads into the city from the southwest.

Interstate 294 (the Tri-state Tollway) runs north-south about 25 kilometers (15 miles) west of downtown.

Highway 41 follows the lake shore and runs right through the city where it is known as Lake Shore Drive.

By Bus or Train
Getting in and around the city is simple and economical thanks to buses, and the "L" system of elevated trains that operate 24 hours a day.

Chicago Transit Authority (CTA): Train and bus service throughout the city of Chicago (312) 664-7200
www.transitchicago.com

Metra: Train service to Chicago and the suburbs. (312) 322-6777
www.metrarail.com

Pace: Suburban bus service (847) 364-7223 • *www.pacebus.com*

Taxicabs
Taxis are easy to hail from the street. Charges vary from $1.90 to $4.00 upon entry, $1.60 for each additional mile. There is a $.50 surcharge for every extra passenger. There is no extra charge for baggage handling or carrying devices to aid passengers with physical disabilities.

"Shared-Ride" Program: 2–4 passengers can share a taxicab from O'Hare/Midway airport to any downtown location (between 22nd St. and Fullerton Ave., Lake Michigan and Ashland Ave.)

You can also use public transportation via train or bus. For more information, contact the RTA of Chicago at 312-836-7000 or on the Web at *www.rtachicago.org*.

AWS Special Events

Sunday, November 15
1:00 a.m. – 5:00 p.m.
Registration Code: W10 – FREE

What Is Thermal Spray? Sponsored by International Thermal Spray Association
Provides a basic introduction to thermal spray benefits, and will cover four major areas: processes, equipment, applications, and industry usage. Processes covered will include molten metal flame spraying, powder flame spraying, wire flame spraying, ceramic rod flame spraying, detonation flame spraying, high velocity oxy/fuel spraying (HVOF), cold spraying, plasma spraying, electric arc spraying, and RF plasma spraying. Equipment will be on display. Several spray guns will be available for attendees to handle and discuss throughout the class. Other larger items such as complex systems and spray booths will be illustrated and discussed. Application examples will be presented for a variety of requirements from several different industries. Industry usage charts will be reviewed listing several processes and coating applications used by various industries.

Monday, November 16

9:00 a.m. – 2:45 p.m.
Registration Code: W11 – FREE

Electron Beam Welding Tutorial
Presented by Pro-Beam Foundation (Germany)

9:00 a.m. – 9:45 a.m.
Basics of Beam Generation
Beam source, influence of high voltage and magnetic fields, vacuum, deep penetration welding effect.

9:45 a.m. – 10:15 a.m.
Rules for Design
Theory and practical examples, EB conform design, parts preparation.

10:15 a.m. – 10:30 a.m. – Break

10:30 a.m. – 11:15 a.m.
Weldability of Metallic Materials
Rules and practical applications.

11:15 a.m. – 11:45 a.m.
The Multifunctional EB
Quality assurance, joint tracking, online process control, automatic beam adjustment, multi-spot and multiprocess technologies.

11:45 a.m. – 1:00 p.m. – Lunch

1:00 p.m. – 2:00 p.m.
EB Machines
Single machines, production cells, EB welding of large parts, product life cycle.

2:00 p.m. – 2:45 p.m.
Criteria for EBW Applications
Examples for industrial applications.

2:45 p.m. – Adjournment

9:00 a.m. – 10:30 a.m.

AWS Opening Session & Annual Business Meeting

During the AWS Opening Session and 90th Annual Business Meeting, 2009 AWS President Victor Y. Matthews will give the Presidential Report and John Bruskotter will be inducted as AWS President for 2010. Following the induction, the 2009 Class of AWS Counselors and Fellows will also be introduced. This meeting is open to all AWS Members and Show registrants.

10:30 a.m. – 11:30 a.m.

Comfort A. Adams Lecture – Innovative Developments in Friction Stir Welding

Wayne Thomas has considerable industrial experience. For the last 23, years he has worked in research and development at TWI. He is the author of more than 100 technical papers and has been responsible for the invention and development of a number of emergent technologies, including friction stir welding. He has been awarded the Sir William J. Larke Medal, the Japanese Welding Society Welding Process Technology Award, the AWS Samuel Wylie Miller Memorial Medal Award, the IIW Evgenij Paton Medal, and the American Society of Manufacturing Engineers Award. The Comfort A. Adams Lecture is named after the founder and first president of AWS. This annual lecture is made by an outstanding scientist or engineer, honored by the AWS Board of Directors.

11:15 a.m. – 1:30 p.m.

Image of Welding Awards Ceremony

Join the AWS Image of Welding Committee (a subcommittee of the Welding Equipment Manufacturers Committee) and special guests as they salute this year's heroes of welding. Individuals and organizations will be honored at this special ceremony for their outstanding public initiatives and programs that promote the image of welding throughout their communities. To reserve your seat, RSVP by October 16 to AWS Image of Welding Awards at (800) 443-9353, or e-mail *image@aws.org.*

6:30 p.m. – 8:00 p.m. Hilton Chicago Ballroom

AWS Officers/Presidents/Counterparts Reception

This reception is held annually during the Show and is open to all registrants. Take advantage of this opportunity to meet the AWS officers, and network with members and prospects. A complimentary hors d'oeuvres buffet is included, along with a cash bar. Evening business attire, please.

Tuesday, November 17

Noon – 1:30 p.m. • Price: $30

AWS Awards/AWS Foundation Recognition Ceremony & Luncheon

The first AWS award, the Samuel Wyllie Miller Memorial Medal, was presented to Comfort A. Adams in 1927. As the Society and the industry it serves have grown, so has the need to recognize outstanding scientists, engineers, educators, and researchers. Join an assembly of distinguished award presenters, recipients, and guests for a well-paced ceremony and a delicious lunch. The cost for attending the ceremony and luncheon is $30, and is open to all registrants. Tickets will also be available at the door.

2:00 p.m. – 3:00 p.m.

AWS National Nominating Committee – Open Meeting

AWS Members are requested to submit their recommendations for National Officers to serve during 2011. Nominations must be accompanied by 16 copies of biographical material on each candidate, including a written statement by the candidate as to his/her willingness and ability to serve if nominated and elected.

Wednesday, November 18

10:00 a.m. (American Council of IIW meeting immediately following lecture at 10:30 a.m.)

R. D. Thomas, Jr., International Lecture

This year's R. D. Thomas, Jr., International Lecture Award recipient, Dr. David Widgery, will speak on "Standardization – Brake on Innovation or Engine for Change?" The R. D. Thomas, Jr., International Lecture Award was created to honor R. D. Thomas, Jr., for his participation in IIW/ISO activities and is presented by AWS to an individual who is also involved in IIW/ISO international activities. The recipient is invited to deliver a lecture illustrating the incorporation of global studies in the standardization of welding technology during the AWS Welding Show and at the Annual Assembly of the IIW.

After taking a degree in metallurgy at Cambridge University, David Widgery joined the British Welding Research Association, later to become TWI, in 1964. He was awarded the AWS Lincoln Gold Medal for his 1976 paper "Deoxidation practice for mild steel weld metal."

In 1976, he left TWI to join GKN Lincoln Electric Ltd as development manager. In 1982, the GKN welding companies were acquired by the ESAB Group. He published a book, *Tubular Wire Welding*, in 1994. David Widgery became chairman of IIW SC II-E in 2001. The main work of this committee over the following years was to bring together the CEN and ISO standards by developing the so-called "cohabitation" drafts, many of which have now been adopted by CEN and ISO and published as national standards. Following retirement from ESAB in 2007, he now works as a consultant.

10:30 a.m. (immediately following the R.D. Thomas, Jr., International Lecture)

American Council of IIW

1:00 p.m. North Hall competition area

Professional Welders Competition Award Ceremony

Winners of the Professional Welder Competition taking place on the show floor November 15–17 will be announced at this awards ceremony. Awards will include a $2,500 grand prize, a $1,000 second prize and a $500 third prize, and the top 12 competitors will win an AWS duffel bag. Each participant will receive an AWS Professional Welders Competition T-shirt.

Free Seminars

Monday, November 16

8:00 a.m. – 9:00 a.m.

Registration Code: K1 – FREE

Monday Keynote Presentation: Best Practices for Thriving in Tough Times

Moderator: Jeff Knauf, President, Medalist Laserfab,Inc. Panelists: Steve Hasty, President, A & E Custom Manufacturing; Chris Kuehl, FMA Economist and Founder, Armada Corporate Intelligence; William Citron, President, Mazak Optonics; Dick Kallage, President, KDC Associates; Douglas K. Woods, President, Association for Manufacturing Technology

Business strategies for surviving and thriving during a tough economy are the focus of this keynote panel discussion comprised of diverse members from the metal forming, fabricating, and welding industry. Topics include workforce development, diversifying product lines and operations, obtaining financing/credit, and current tax incentives. Participants will provide a real-world perspective and offer practical ideas you can use immediately.

10:00 a.m. – 11:00 a.m.

Registration Code: T1 – FREE

Don't Lose Your Sales Focus in a Down Economy

Joe Mayer, Managing Partner, Mayer Business Group LLC

There is an upside to every downturn, and to be prepared for the turnaround, it is important to maintain your sales and marketing efforts. This discussion focuses on creating a recession-proof sales strategy, growing the accounts you have, gaining new customers in tough times, and making sure your Web site functions as part of your sales force.

11:30 a.m. – 12:30 p.m.

Registration Code: T2 – FREE

Smart Strategies for Preserving Stakeholder Relationships

Dick Kallage, Bill Barron, and Patric Donahue of KDC Associates

One of the keys to business success during recessionary times is frequent, quality communications with key stakeholders such as employees, bankers, accountants, suppliers, and customers. Even innocuous mistakes or missteps can result in long-lasting negative consequences that can damage a company. Attend this session to hear the dos and don'ts, what information can and should be shared, and the critical importance of knowing how relationships can dramatically change during times of market uncertainty.

1:30 p.m. – 2:30 p.m.

Registration Code: T3 – FREE

How to Protect Your Company from Customer Bankruptcy

Steven Gan, President, Stellar Risk Management

A customer's bankruptcy could easily bankrupt your business, too. It is important to take steps to strengthen your credit risk management system and protect yourself from the financial damage due to customer payment defaults or bankruptcies. During this session, learn tools to confirm customer credit worthiness, how to use accounts receivable programs, and crucial pre-and-post bankruptcy strategies.

Tuesday, November 17

8:00 a.m. – 9:00 a.m.

Registration Code: K2 – FREE

Tuesday Keynote Presentation: Energy – The Outlook Is Bright, But Where Will It Lead Us?

Moderator: William Haas, Client Program Manager, The Shaw Group. Panelists: Ed Weston, Director, Great Lakes Wind Energy; Richard Burns, National Solar Tour Manager, American Solar Energy Society; Jeff Anthony, Manager-Utility Programs, American Wind Energy Association; Tom Hunton, President, American Capital Energy

This panel discussion is the first of its kind to connect experts from the surging wind and solar energy sectors with oil and gas industries. They will discuss trends and forecasts, government issues, and what it all means to current suppliers and those that want to get in on the action. Special emphasis will be given to the corelationship of the energy sources and advancements that are needed to make sure we effectively operate within the ubiquitous "Smart Grid" and how these challenges spell opportunity for you.

10:00 a.m. – 11:00 a.m.

Registration Code: T4 – FREE

20% Wind by 2030 – What Does It Mean for Metal Manufacturing?

J. Mattew Garran, Director – Technical Services, Great Lakes Wind Network

The wind energy market has an aggressive goal to supply 20% of U.S. energy by 2030. Early indicators show that we're ahead of the curve. How does this translate into opportunities for metal fabrications, weldments, and sheet metal component parts? Take a ride down the manufacturing and installation pipeline for a deeper look into the opportunities for utility-scale and small wind turbine component manufacturing, tower fabrications, installation, and grid tie-in.

11:30 a.m. – 12:30 p.m.

Registration Code: T5 – FREE

Supplying Solar – More than Meets the Eye

Richard Burns, National Solar Tour Manager, American Solar Energy Society

The U.S. solar energy industry grew to record levels in 2008, and growing with it were component manufacturing and installations for residential and commercial systems. Find out where in the chain the opportunities are for metal forming, fabricating and welding. It's not readily seen without a full understanding of what takes place "behind the scenes" to convert, store, and distribute within a home and along the "Smart Grid."

1:30 p.m. – 2:30 p.m.

Registration Code: T6 – FREE

Powering Your Facility with Solar Energy

Tom Hunton, President, American Capital Energy

Wednesday, November 18

10:00 a.m. – 11:00 a.m.

Registration Code: T7 – FREE

The Essentials of Job Shop Marketing

Rob Edwards, VP, The Job Shop Company

It is challenging in manufacturing today; what to do until the economy sorts itself out. Many marketing-savvy contract manufacturers (job shops) are being aggressive right now. They are going after business while others are hiding their heads. This session points you in the right directions without breaking the bank. Topics will include:

- What's so important about Web sites and trade show displays?
- What is required in a successful Web site?
- How much WOW-factor should you have and why?
- How much thought to give to Google.
- How to avoid the Fatal Mistakes.
- How much should you be paying?

11:30 a.m. – 12:30 p.m.

Registration Code: T8 – FREE

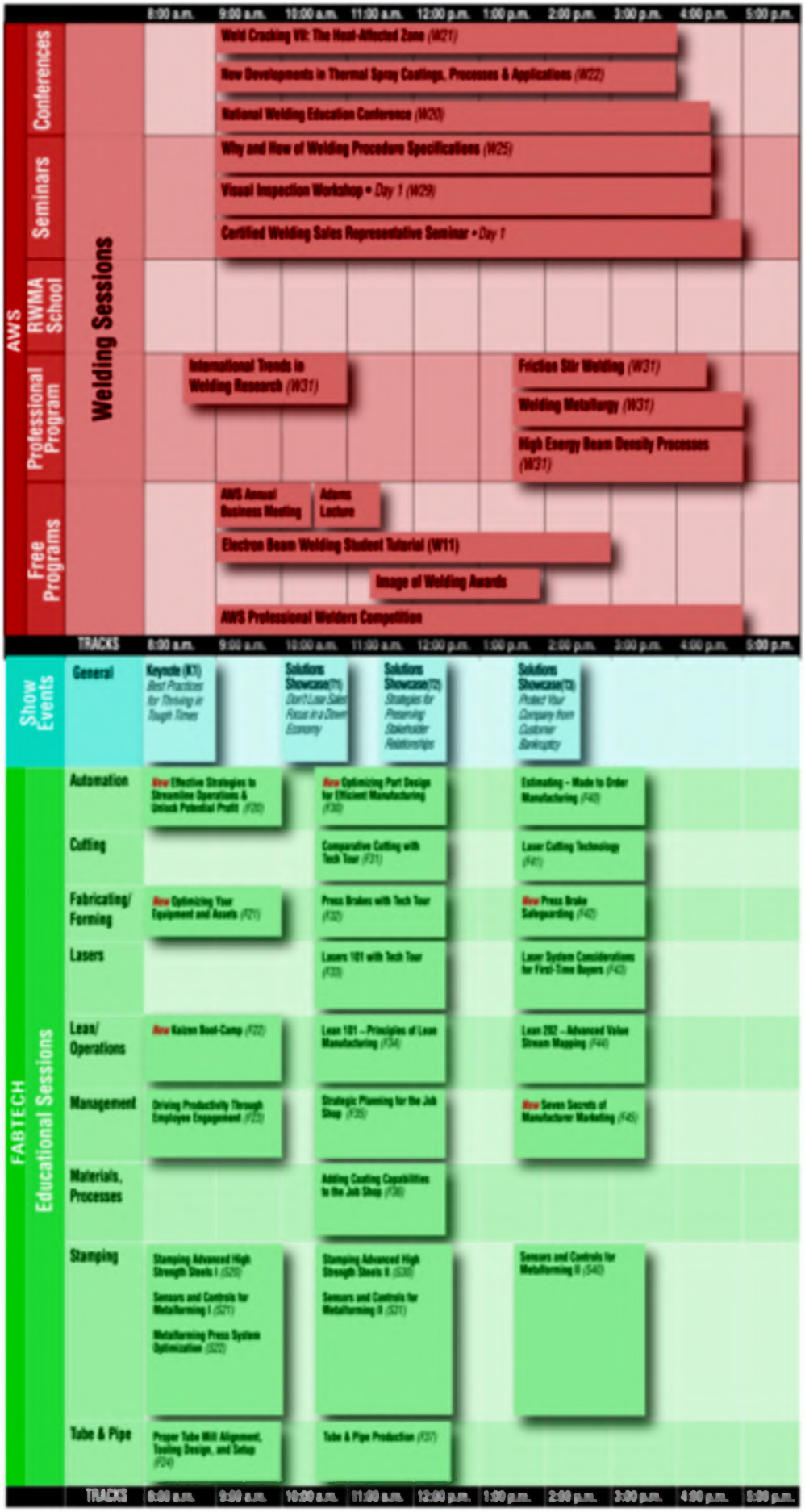
Social Media 101

Chris Campbell, Lakeshore Branding

Blogging, Twitter, LinkedIn, Facebook...You've probably heard all the buzz words, but do you know exactly what social media is all about? More importantly, do you know how social media can be used to communicate with your customers and prospects? This introductory session is designed to give you a better understanding of the different types of social media, the various benefits, and how some of the more popular Web sites can be used to enhance almost any type of business or career.

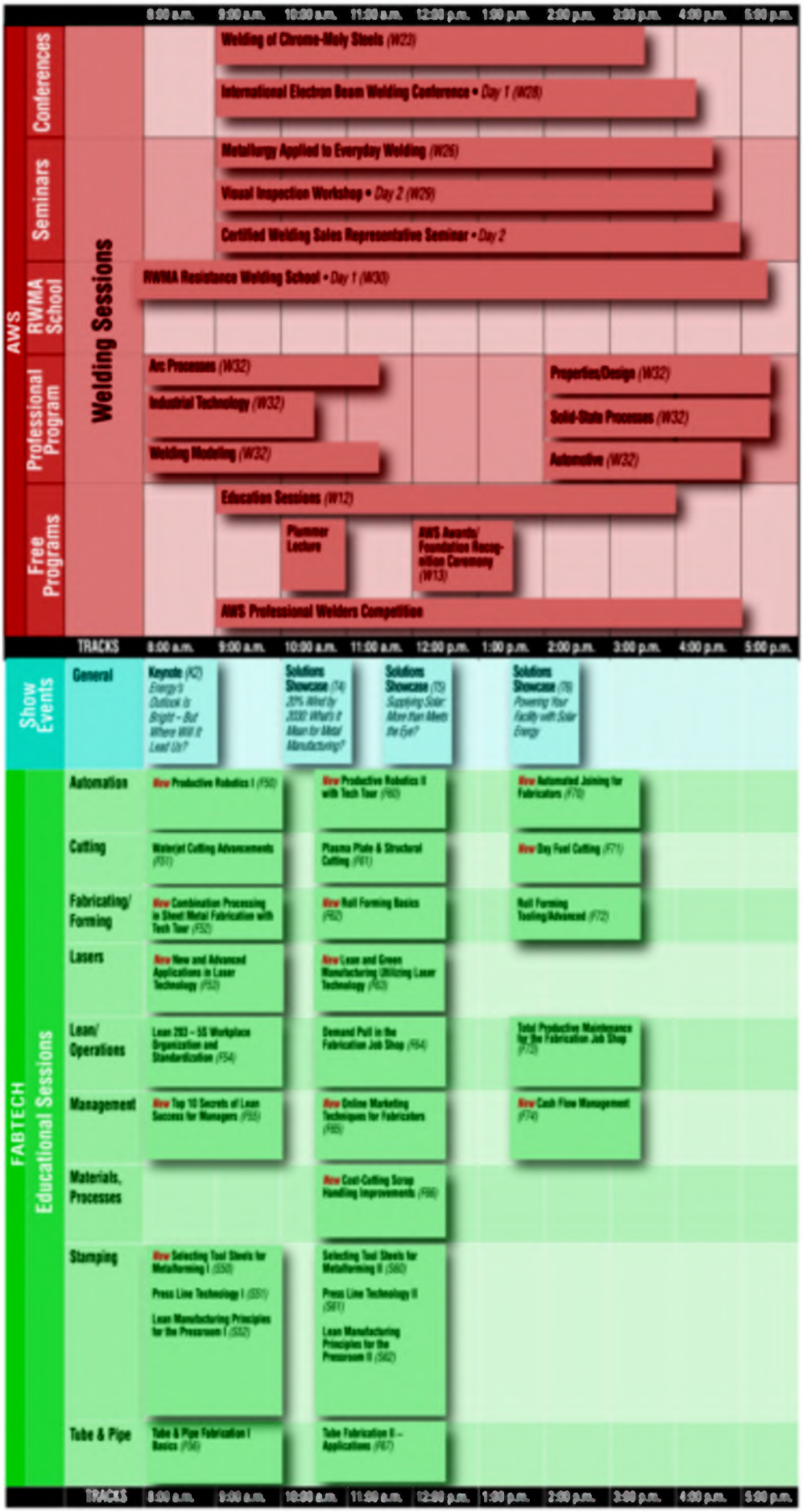
Monday, November 16

SHOW EVENTS AT A GLANCE



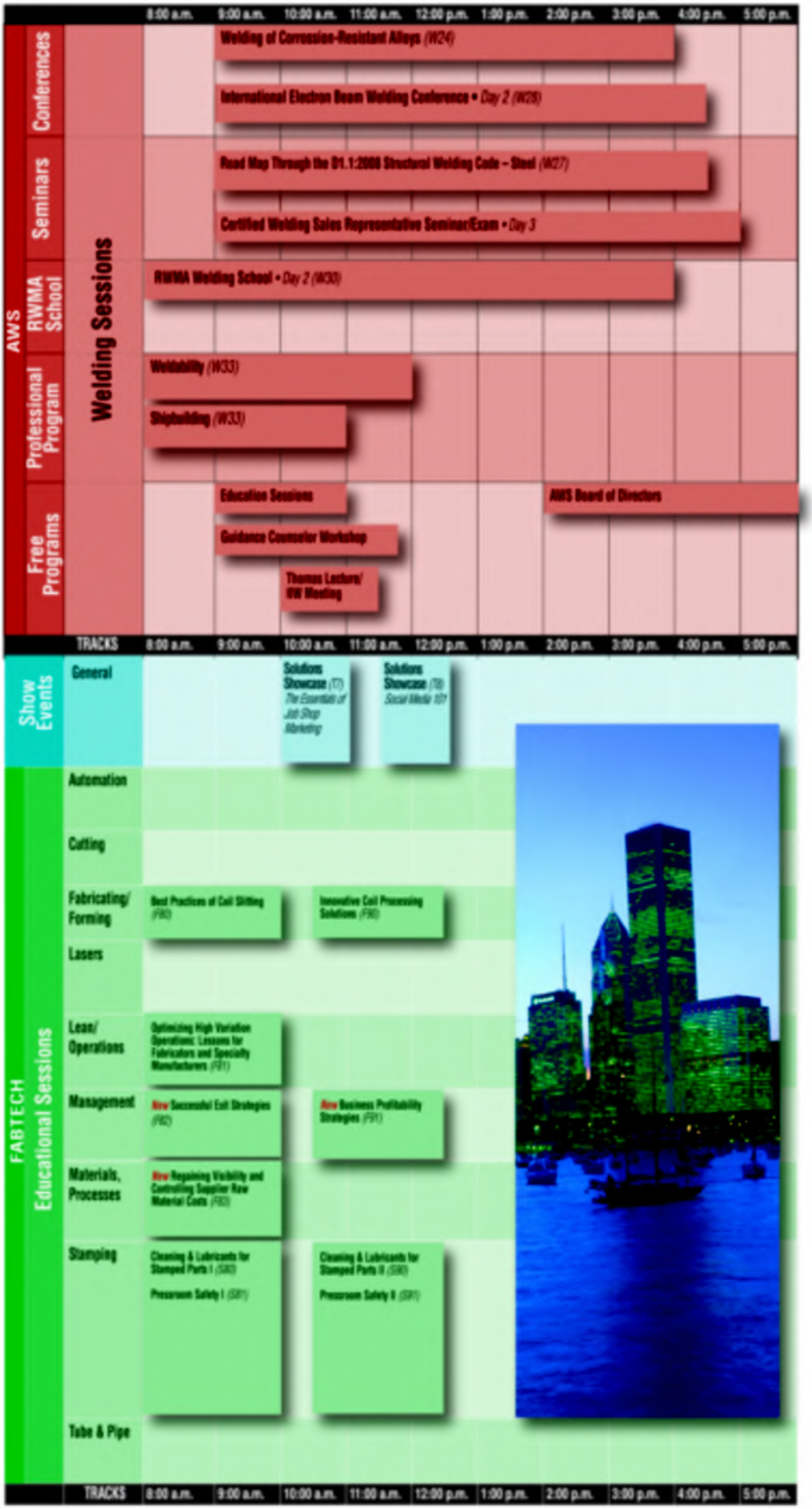
Tuesday, November 17

SHOW EVENTS AT A GLANCE



SHOW EVENTS AT A GLANCE

Wednesday, November 18



The 2009 FABTECH International & AWS Welding Show is packed with technical sessions, conferences, and seminars. If you are interested in the latest happenings in the research world, friction stir welding, thermal cutting, NDE technology, resistance welding, the D1.1 *Structural Welding Code — Steel*, visual inspection, welding stainless steel, welding procedure specifications, brazing and soldering, and education and training, to name a few, you are in the right place. Take a look at all the offerings below, and sign up today to improve your knowledge and productivity. It is a rare opportunity to have so much variety available in one place. Take advantage of it now.

Welding Show 2009
Professional Program

Pick and choose between concurrent sessions for the latest in welding research and commercial developments. Pay by the day or attend the entire three-day program, with special discounts for students and members of AWS, SME, FMA, NAM, or PMA.

3-day Professional Program for Member of AWS, FMA, SME, NAM, or PMA: $225; Nonmember: $360 (Code W34)

3-day Student Professional Program for Member of AWS, FMA, SME, NAM, or PMA: $75; Nonmember: $90 (Code W35)

1-day Professional Program (Monday [W31], Tuesday [W32], or Wednesday [W33] only) for Member of AWS, FMA, SME, NAM, or PMA: $150; Nonmember: $285

Monday, November 16
8:30 a.m – 5:00 p.m.

SESSION 1:
INTERNATIONAL TRENDS IN WELDING RESEARCH

A. 8:30 a.m. **"Status and Trends of Welding Technology and Industry in China"**
Ping Shan, Chinese Welding Society and Tianjin University

B. 9:15 a.m. **"Status and Trends of Welding Technology and Industry in Taiwan"**
Jong-Ning Aoh, Taiwan Welding Association and National Chun Cheng University

C. 10:00 a.m. **"Welding Research in Canada"**
Patricio Mendez, N. Zhou, A. Gerlich, and M. Yarmuch, University of Alberta

SESSION 2:
FRICTION STIR WELDING

A. 1:30 p.m. **"Effect of Joint Design on Strength of Dissimilar Mg-to-Al Friction-Stir Welds"**
Vahid Firouzdor and Sindo Kou; University of Wisconsin

B. 2:00 p.m. **"Friction Stir Spot Welding and Its Application for Magnesium"** **CANCELLED**
Blair E. Carlson, Cameron Dasch, Robert Szymanski, and Mark T. Hall; General Motors R & D

C. 2:30 p.m. **"Material Flow and Deformation Mechanisms During Friction Stir Welding"**
Adrian Gerlech, University of Alberta

D. 3:00 p.m. **"Synthesis of Experimental and Simulation FSW Results Using Scaling Techniques"**
Karem Tello and Patricio Mendez; Colorado School of Mines

E. 3:30 p.m. **"Ferrous Alloy Friction Stir Welding and Microstructure Simulation"**
David M. Failla II and John Lippold; The Ohio State University

F. 4:00 p.m. **"Conparison of Joining Thin Sheet TRIP 780 to CRIF Steels Using FSW and GTAW Processes"**
Scott Gordon and Stephen Liu; Colorado School of Mines

SESSION 3:
WELDING METALLURGY

A. 1:30 p.m. **"Optimizing Corrosion Performance of Welds"**
Andrew Stockdale and John DuPont; Lehigh University

B. 2:00 p.m. **"Loading, Heat Treatment and Welding Parameters Influence on Wear Resistance"**
Estela S. Surian, Agustin Gualco, Hernan Gabriel Svoboda, and Luis Alberto de Vedia

C. 2:30 p.m. **"Development of a Chromium-Free Ni-Base Consumable for Joining Stainless Steel"**
Jeffrey Sowards, Boian T. Alexandrov, Dong Liang, Gerald S. Frankel and John Lippold; The Ohio State University

D. 3:00 p.m. **"Gas Tungsten Arc Welding of Titanium: Complex Fluoride-Containing Flux Pastes and Flux-Cored Wires"**
Christine Hillier, Michael Liu, and Stephen Liu; Colorado School of Mines

E. 3:30 p.m. **"In-situ Thermite Welding of Boiler Tubing"**
John Nickell, Stephen Liu, and Kent Coleman; Colorado School of Mines

F. 4:00 p.m. **"Magnetic Stirring of High Chromium Nickel Based Weld Metals"**
Steve McCracken, Suresh Babu, Dave Farson, Yong Chae Lin, and Xinghua Yu; Electric Power Research Institute

G. 4:30 p.m. **"Microstructure Control in HSLA Steel Welds"**
Boian T. Alexandrov and John C. Lippold; The Ohio State University

SESSION 4:
HIGH ENERGY DENSITY BEAM PROCESSES

A. 1:30 p.m. **"Laser Hybrid Welding/Brazing of Al to Ti Alloys with Filler Wire"**
Liqun Li, Shuhai Chen, YanBin Chen, and Norman Zhou; Centre for Advanced Materials Joining, University of Waterloo and Harbin Institute of Technology

B. 2:00 p.m. **"Laser Welding of Open Root Thin Foil Materials for Producing Lattice Structures"**
Andrew Deceuster, Chunbo Zhang and Leijun Li; Utah State University

C. 2:30 p.m. **"Energy Transfer in Laser Spot Welding – Effect of Joint Geometry"**
Charles V. Robino, Jerome T. Norris, and Gerald A. Knorovsky; Sandia National Laboratories

D. 3:00 p.m. **"The Use of Filler Metal Shims to Improve Electron Beam Weldability"**
John Rugh, Gary LaFlamme, and Daniel Nowak; PTR-Precision Technologies, Inc.

E. 3:30 p.m. **"Fiber Laser Beam Oscillation Techniques for Spiking Suppression"**
Dave Farson, Matt Reiter, and Junho Cho; The Ohio State University

F. 4:00 p.m. **"Comparison of High Deposition Rate Laser Cladding with Yb Fiber and Direct Diode Lasers"**
Todd A. Palmer, Kenneth Meinert, and Keith Parker; Applied Research Laboratory

G. 4:30 p.m. **"Bead Geometry Control for Repair of Directionally Solidified Nickel-Based Superalloy"**
Andrew Deceuster, Chunbo Zhang and Leijun Li; Utah State University

Tuesday, November 18
8:00 a.m. – 5:30 p.m.

SESSION 5:
ARC PROCESSES

A. 8:00 a.m. **"New Advancements in AC GMAW for Steel Construction"**
Matthew Brooks, Ken Takahashi, Hideo Shiozaki, Tetsuo Era, and Tomoyuki Ueyama; OTC Daihen, Inc.

B. 8:30 a.m. **"A Compact, Low Cost, In-Process Welding Defects Detection System Based on Thermal Plasma Emission"**
Pengcheng Lv, Binglin Miao, Seun Hwan Lee, Jyoti Mazumder, and Matthew Sinfield; AlphaSense, Inc.

C. 9:00 a.m. **"Laser Enhanced GMAW Metal Transfer"**
Yi Huang and YuMing Zhang; Department of Electrical and Computer Engineering and Centre for Manufacturing

D. 9:30 a.m. **"Reflection of Illumination Laser from Gas Metal Arc Weld Pool Surface"**
Xiaoji Ma and YuMing Zhang; Department of Electrical and Computer Engineering and Centre for Manufacturing

E. 10:00 a.m. **"Droplet Heat Content in Various Transfer Modes in Gas Metal Arc Welding"**
Erik James Soderstrom, Kevin Michael Scott, and Patricio F. Mendez; Colorado School of Mines

F. 10:30 a.m. **"Compositional Variation of Individual Fume Particles by STEM-EDS"**
Neil T. Jenkins and Thomas W. Eager; The Ohio State University

G. 11:00 a.m. **"Influence of Behavioral Parameters on Duplex Weldments"**
Carolian Payares-Asprino, John P. Steele, and Homan Galezo; Universidad Simon Bolivar

SESSION 6:
INDUSTRIAL TECHNOLOGY

A. 8:00 a.m. **"Construction and Weld Overlay of Pipelines for the Petrochemical Industry"**
Borja Saiz Sanchez and Roberto Saiz Juarez; Nuevas Tecnologias de Soldadura S.L. (Newtesol)

B. 8:30 a.m. **"Evaluation of Arc Burning Behavior and Process-Integrated Quality Assurance in Pulse GMA Welding Al-Mg Alloys"**
S. Rajasekaran; Vinayaka Missions University

C. 9:00 a.m. **"Thermal Sprayed Aluminum Against Corrosion Under Insulation"**
Fred van Rodijnen; Sulzer Metco OSU GmbH

D. 9:30 a.m. **"Reducing the Noise Generated when Air-Arc Gouging Can Be as Simple as Flipping A Switch" CANCELLED**
George Durkt, Jr., U.S. Dept. of Labor - Mine Safety & Health Administration

E. 10:00 a.m. **"DeltaSpot - Real Time Resistance Welding"**
Stefan Mayr; Fronius USA

SESSION 7:
WELDING MODELING

A. 8:00 a.m. **"A Distortion Prediction Tool for Weld Sequence Optimization"**
Yu-Ping Yang and Bradrinarayan P. Athreya; Edison Welding Institute

B. 8:30 a.m. **"Preventing Dissimilar Metal Weld Failures: Application of New Functionally Graded Transition Joints"**
Gregory Brentrup, Brett Leister, and John DuPont; Lehigh University

C. 9:00 a.m. **"Analytical Three-Dimensional Temperature Field in Keyhole Welding"**
C. C. Chiang and P. S. Wei

D. 9:30 a.m. **"Experimental and Simulation Study of Laser-Stimulated Electrical Discharges in Nanoscale Gaps"**
Jian Chen and Dave Farson; The Ohio State University

E. 10:00 a.m. **"Bilinear Model Predictive Control of Plasma Pipe Welding Process"**
Kun Qian and YuMing Zhang; University of Kentucky

F. 10:30 a.m. **"Maximum Post-Weld Heat Treating Temperatures for 9-12 Cr-Mo Steels"**
Michael Santella

G. 11:00 a.m. **"Weld Profile Prediction of GMAW of Duplex Stainless Steel"**
John P. H. Steele and Carolina Payares-Asprino; Colorado School of Mines

SESSION 8: PROPERTIES/DESIGN

A. 2:00 p.m. **"Flux Cored Metal Arc Welding of Stainless Steels for 4.2 K Service"**
Edward N. Dalder; Dalder Materials Consulting, Inc.

B. 2:30 p.m. **"Influence of Material Properties and Weld Geometry on Fatigue Performance of DP780 and Mild Steel GMAW Lap Joints"**
David Anderson, Yan (Jack) Sang, Justin Hunt, and Chonghua (Cindy) Jiang; American Iron and Steel Institute

C. 3:00 p.m. **"Welding Specifications: What Makes for a Good One?"**
Gerald A. Knorovsky; Sandia National Laboratories

D. 3:30 p.m. **"Effect of Submerged Arc Welding Parameters on Weld Microstructure and Mechnical Properties of AISI 304 Welded Joints for Cryogenic Applications"**
Rafael Eiji Toma, Antonio Cordeiro Souza, Zorailde Morais and Sergio Duarte Brandi; Promon Tecnologia

E. 4:00 p.m. **"Impact Reliability of Hybrid Laser Arc (HLA) Welds on Mild Steels and High Strength Steels"**
Caleb Roepke and Stephen Liu; Colorado School of Mines

F. 4:30 p.m. **"Effect of Welding Parameters on Duplex Stainless Steel Performance"**
Matthew Yarmuch, Kimberley Sandy, and Galen Wright; Alberta Research Council

G. 5:00 p.m. **"Differences in Hardness Testing Techniques for Characterizing Wellhead Cladding"**
Joshua Sleigh, Martin Hukle, and Brian Newbury; ExxonMobil Development Co.

SESSION 9: SOLID-STATE PROCESSES

A. 2:00 p.m. **"An Explosion in the Uses of Explosion Welding"**
Michael Blakely; Dynamic Materials Corporation

B. 2:30 p.m. **"Explosive Bond Interface Characterization"**
Stephen Liu, Vilem Petr, Collin Trickel, Brandon Dugan, Scott Gordon, Dan Andrews, and Chris Paul; Colorado School of Mines

C. 3:00 p.m. **"Diffusion-Welded Superconducting Joints of Bi-2223/Ag Multifilamentary Tapes"**
Gui Sheng Zou, Wei Guo, Fang Big Zhou, Ai Ping Wu, and Norman Zhou; Centre for Advanced Materials Joining, University of Waterloo, and Harbin Institute of Technology

D. 3:30 p.m. **"Interfacial Microstructure Characterization in Magnetic Pulse Welds"**
Yuan Zhang, Suresh Babu, and Glenn Daehn; The Ohio State University

E. 4:00 p.m. **"Transient Thermal Response in Ultrasonic Additive Manufacturing"**
David Schick; The Ohio State University

F. 4:30 p.m. **"Very High Power Ultrasonic Additive Manufacturing"**
Siriraman Melatheru Ramanujam, Sudarsanam Suresh Babu, Matt Short, and Karl Graff; The Ohio State University

G. 5:00 p.m. **High-Resolution Transmission Electron Microscopy of Interfaces in UAM Bonds"**
Ryan Dehoff, David Schick, Ryan Hahnien, and Suresh Babu; The Ohio State University

SESSION 10: AUTOMOTIVE

A. 2:00 p.m. **"Failure Mode and Heat-Affected Zone Microstructure of AHSS"**
Victor H. Baltazar Hernandez, Yasuaki Okita, and Y. Zhou; University of Waterloo/Centre for Advanced Materials Joining

B. 2:30 p.m. **"Effects of Surface Conditions On Resistance Spot Welding of Mg-Alloy AZ31"**
Lei Liu, Jicai Feng, Yanhong Tian, and Norman

Zhou; Centre for Advanced Materials Joining, University of Waterloo, and Harbin Institute of Technology

C. 3:00 p.m. **"Corrosion and Corrosion-Fatigue of AZ31 Magnesium Weldments"**
Carl E. Cross and Suzanne Bender; BAM

D. 3:30 p.m. **"A Comparative Study of Joint Efficiency for Advanced High Strength Steels"**
John Bohr, Ted Coon, and Justin Hunt; General Motors R & D

E. 4:00 p.m. **"The Effect of Alloying Elements on the Resistance Spot Weld Performance in High Strength Dual Phase Steels"**
Murali Tumuluru and Takahiro Kashima; U.S. Steel

F. 4:30 p.m. **"Evaluation of the Partial Interfacial Fracture During Mechanical Testing for Spot-Welded Advanced High Strength Steels"**
Yeong-Do Park, Sang-Min Lee, Du-Youl Choi, and Ji-Ho Lim; Dong-Eui University

Wednesday, November 18
8:00 a.m. – 12:00 p.m.

SESSION 11: WELDABILITY

A. 8:00 a.m. **"Arc Waveform and Ni-Cr-Fe Weld Overlay Quality"**
Yoni Adonyi, Steve Wolbert, and Jordan Smith; LeTourneau University

B. 8:30 a.m. **"Failure Analysis of Welded Pipe Supports"**
Mikal C. Balmforth and John Wise; Exponent, Inc.

C. 9:00 a.m. **"High Chromium Nickel-Base Weld Filler Metals"**
Steve McCracken, Boian Alexandrov, John Lippold, Jeffrey Sowards and Adam Hope; Electric Power Research Institute

D. 9:30 a.m. **"Diffusible Hydrogen Characteristics of Hybrid Laser Arc Welding"**
Paul A. Blomquist, Stan Ferree, Dale Anderson, and Brian Marx; Applied Thermal Sciences

E. 10:00 a.m. **"A Comparison of the High Temperature Corrosion Resistance of Co-Extruded and Weld Overlay Coatings for Corrosion Protection in Coal Fired Boilers"**
John N. DuPont and William Van Geertruyden; Lehigh University

F. 10:30 a.m. **"Welding Technology for Reeled Linepipe Used in Offshore Sour Service Applications"**
Germanique Pickens, Craig Monahan, and Rick Noecker; ExxonMobil Development Co.

G. 11:00 a.m. **"GTAW and LBW of 304 to 304L Stainless Steels"**
P. W. Hochnanadel, M.Q Johnson, T.J. Lienert, J. Martinez, and R. Martinez; Los Alamos National Laboratory

H. 11:30 a.m. **"Effects of Local Cr Additions on Solidification Mode and Cracking in Pulsed Laser Welds on 304L Stainless Steel"**
T. J. Lienert, P.A. Papin, C.T. Necker, and D. J. Alexander; Los Alamos National Laboratory

SESSION 12: SHIPBUILDING

A. 8:00 a.m. **"Microstuctural Evolution and Mechanical Properties of a New High Strength Steel for Defense Applications"**
Jeff D. Farren and John DuPont; Lehigh University

B. 8:30 a.m. **"Atom Probe Tomography of Cu Precipitates in HAZ of Steel"**
Xinghua Yu, Jeremy Caron, Suresh Babu, and John Lippold; The Ohio State University

C. 9:00 a.m. **"Qualification of HLAW of HSLA-80 Under Naval Vessel Rules"**
Paul A. Blomquist, Erik Oller, Carl Chretien, and Brian Marx; Applied Thermal Sciences

D. 9:30 a.m. **"Weldability Evaluation of Blast-Resistant Naval Steel"**
Jeremy Caron and John Lippold; The Ohio State University

E. 10:00 a.m. **"Airborne Weld Fume Emission Profiles of HLAW"**
Paul A. Blomquist and Dan Chute; Applied Thermal Sciences

F. 10:30 a.m. **"Size-Fractionated Stainless Steel Welding Fumes Emissions in an Isokinetic Chamber and in the Breathing Zone"**
S. Erdal, J. J Schauer, J. Breskey, and E. Indacochea; UIC-UW-M

CONFERENCES

WELD CRACKING VII "THE HEAT-AFFECTED ZONE" CONFERENCE

The most perplexing problem in the welding industry has to be weld cracking. Back by popular demand, this one-day conference is for those who want or need to get a handle on any weld cracking situation. The 2009 conference will also include networking opportunities to talk to weld cracking experts and others in the industry who face the challenges weld cracking can present.

Monday, November 16

9:00 a.m. – 4:00 p.m.

Chairs: Robert R. Irving and David Farson
Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmembers: $480 • Registration Code: W21

9:00 a.m. – 9:30 a.m.

Keynote Address

William A. "Bud" Baeslack III, Provost and Executive Vice President, and Professor of Materials Science and Engineering, Case Western Reserve University, and formerly, Dean, College of Engineering, Executive Dean for the Professional Colleges, Professor of Industrial, Welding and Systems Engineering and Professor of Materials Science and Engineering, The Ohio State University

The metallurgical origins of weld cracking in such high-performance alloys as nickel-based materials and such high-performance nonferrous alloys as aluminum and titanium, and how those materials compare to weld cracking behavior in conventional and advanced steels.

9:35 a.m. – 10:05 a.m.

New Technique Determines Solid-Liquid and Solid-State Phase Transformations during Processing

Boian T. Alexandrov, Research Scientist, Welding Engineering Program, Dept. of Industrial, Welding, and Systems Engineering, The Ohio State University

A new technique for in-situ determination of solidification ranges and solid-state phase transformation temperatures in welded joints of various alloy steels, nonferrous alloys and Ni-based superalloys, and for development of continuous cooling transformation diagrams.

10:10 a.m. – 10:40 a.m.

Cracking Problems with Grade 91 and Other Creep-Strength-Enhanced Ferritic Steels

Jeffrey Henry, President, Energy Solutions Group, LLC

Failure to control the processing steps, and particularly the postweld heat treat temperature, can substantially increase the risk of brittle fracture and/or stress-corrosion cracking in the weld. Other factors that can promote cracking at the weldment include deficient design (e.g., saddle welded branch connections), improper support of components, and poor choice of filler metal for dissimilar metal combinations.

10:45 a.m. – 11:15 a.m.

Measuring Residual Stress Using X-Ray Diffraction

Robert Drake, Lab Sales, Proto Manufacturing Ltd.

Residual stresses in weldments can lead to such problems as stress corrosion cracking or even fatigue cracking. But it is often difficult to determine whether heat treatment or shot peening can be used to cure such conditions without prior knowledge of the residual stress state. X-ray diffraction is being used to provide the information needed.

11:20 a.m. – 11:45 a.m.

Quality Improvements in Heat Treatment

Gary Lewis, Director of Business Development, Superheat FGH

Advancements in heat-treatment equipment technology, software and process control solutions, with renewed emphasis on shoring-up weld procedures and industry codes, are revolutionizing traditional business models and enhancing quality assurance.

11:45 a.m. – 1:00 p.m. Lunch on your own.

1:00 p.m. – 1:30 p.m.

Reheat Cracking in Weldments

Jose E. Ramirez, Principal Engineer, Edison Welding Institute

Reheat cracking has been observed in low-alloy steels, stainless steels, and nickel-base superalloy weldments. Understanding the effect of material chemical composition and microstructure, joint design, welding procedures, and postweld heat treatment conditions on reheat cracking is of paramount importance to obtaining crack-free weldments.

1:35 p.m. – 2:05 p.m.

Hot Cracking in Welding of Austenitic Stainless Steels

Damian Kotecki, Damian Kotecki Welding Consultants, Inc.

Focus on solidification cracking, liquation cracking and ductility dip cracking, plus the role of ferrite in preventing hot cracking and means of lessening hot cracking tendencies when ferrite cannot be obtained in the weld metal.

2:10 p.m. – 2:40 p.m.

Fracture Mechanics – Operating with Defects

Kyle Koppenhoefer, Principal, AltaSim Technologies

Structural welding defects cannot always be avoided or removed and some may develop during in-service loading. In these situations, applied fracture mechanics can determine the effect of these defects on service life. Advancements in fracture mechanics, coupled with improved computational capabilities, have extended the application of fracture mechanics to practical problems of interest to welding engineers.

2:45 p.m. – 3:15 p.m.

Hot Cracking in Aluminum Welds

Thom Burns, Director of Technical Services and Business Development, AlcoTec Wire Corp.

Hot cracking of aluminum welds can be a function of contraction stresses or the hot-short tendency of certain weld compositions. The problem of hot cracking due to contraction stresses may be avoided by applying welding techniques that overcome the natural volume change that occurs during the heating and cooling of aluminum. It is necessary to understand the effects that alloying elements have on crack sensitivity and how the choice of joint design and the selection of a filler alloy can eliminate it.

3:20 p.m. – 3:55 p.m.

The Rewards in Purchasing Filler Metal by the AWS 5.01 Specification

William F. Newell, President, Euroweld Ltd.

The AWS A5.01 specification is organized in a logical order and is user friendly. Whether or not all or part of the criteria listed in the document for actual lot testing are used depends on the extent to which special criteria are needed to adequately describe the product(s) desired and to reduce the uncertainty of receiving a product that may not meet the procurer's specific needs. As a minimum, the manufacturer is required to have an established quality assurance system and is required to trace the product to some known lot that is unique to that manufacturer. This requirement also applies to those who repackage, relabel, and resell another manufacturer's product that is identified as meeting AWS specification and classification or having the AWS classification imprinted on the electrode.

THERMAL SPRAY CONFERENCE – NEW DEVELOPMENTS IN THERMAL SPRAY COATINGS, PROCESSES AND APPLICATIONS

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 International & AWS Welding Show including METALFORM. The program is intended to 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, November 15th from 1 a.m. to 5 p.m., a free half-day tutorial on thermal spray fundamentals, titled "What is Thermal Spray" is scheduled. The tutorial is being sponsored by the International Thermal Spray Association.

Monday, November 16

9:00 a.m. – 4:30 p.m.

Chairs: Dan Hayden, Hayden Corporation; Bob Unger, Polymet Corporation
Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmembers: $480 • Registration Code: W22

SESSION 1: PLENARY SESSION

9:00 a.m.

Welcome and Opening Remarks
Bob Unger, Polymet Corporation

9:00 a.m. – 9:30 a.m.

An Overview of Thermal Spray Processes & Applications

Richard Thorpe, Praxair Surface Technologies

Thermal spray processes have developed through the years from simple, unsophisticated devices used to spray a few pretty basic applications with common chemical compositions to ever more complex systems capable of applying highly developed coatings with intricate matrixes. Beginning with simple wire and powder flame guns using a flammable gas and oxygen spraying low velocity flames, the technology has evolved to the advanced air plasma spray (APS) and high velocity–oxygen fuel (HVOF) systems capable of spraying at much higher temperatures and velocities with alloys and composite materials used in the aerospace industry. Thermal spray processes and their applications have come out of the black art era and have now moved into an enlightened era of science and practicality.

9:30 a.m. – 10:00 a.m.

Practical Understanding of Materials for Thermal Spray Applications

Mitch Dorfman, M. Oechsle, and C. Dambra, Sulzer Metco

Thermal spray technology has been used successfully for many years in various wear-resistant applications. The technical success of an application is based not only on the correct thermal spray process and parameters, but on a clear understanding of the wear mechanism(s) associated with the application and the proper material selection. Based on this fundamental understanding, powders can be selected to meet specific application needs. This presentation will discuss various WC-Co(Cr) and WC-Co(Cr) self-fluxing alloy powders that are presently in the marketplace. Important characteristics related to powders for wear applications are 1) primary carbide grain size, 2) overall powder particle size, 3) manufacturing process, 4) matrix chemistry, and 5) powder density. Low and high angle erosion, adhesive wear, abrasive wear, and fretting are just a few of the types of wear mechanisms reviewed in order to help grow applications in industrial markets such as agricultural, paper and pulp, hydroelectric, and hard chrome alternatives.

10:00 a.m. – 10:25 a.m.

Comparison of Hardcoating Processes

Daniel Hayden, Hayden Corp.

Originally authored for the oil and gas industry, this presentation discusses the physical application and performance differences between common atmospheric (nonvacuum or inert environment) hardcoating techniques, including thermal spray, spray and fuse, traditional welding, and laser/PTA applied overlays. The discussion focuses on basic economic factors influencing the selection of one technology over another and attempts to highlight the pros and cons of each technology. It is intended to present each hardcoating method as a suitable choice for a select set of coating needs, rather than promoting one technology as superior to all others. Specific factors addressed are application cost, physical effects of the coating process to the substrate, durability of the overlay, and accuracy of deposition. For the purposes of this new thermal spray conference, additional discussion of individual atmospheric thermal spray processes is also included.

SESSION 2: SUCCESSFUL APPLICATIONS

10:40 a.m. – 11:00 a.m.

Wire Arc Sprayed Anti-Corrosion and Wear-Resistant Coatings for Waste Incineration Plants

J. Wilden, Berlin Institute of Technology, Berlin, Germany

In waste incineration plants the metallic components are subjected to conditions that can induce high-temperature corrosion. This kind of deterioration is especially related to the presence of chlorides, generated during the incineration of the waste. To protect metal parts inside the plant thermal spray coatings are in use. These coatings must be able to avoid the reaction of chlorine compounds and the metal surface. Typically, atmospheres containing chlorine at high temperature are Ni-based alloys. However, because of the high costs of these alloys, there is an aim to develop coatings with good corrosion resistance, but which are less expensive. There are indications that Fe-Cr-Si alloys are rather resistant in environments containing chlorine compounds at high temperatures. Therefore, in this study, different compositions of Fe-Cr-Si alloys are evaluated as coating materials. The layers were applied using the arc spraying process, which is generally the most economical method to apply metal coatings. Nevertheless, also this method has to be adapted to obtain coatings with required corrosion resistance. In this work, the first results in terms of characterization of the arc sprayed coatings and their performance in corrosion tests are presented.

11:00 a.m. – 11:20 a.m.

Tungsten-Based Coatings to Enhance the Performance of Casting Molds

J. Wilden, S. Jahn, V. E. Drescher, Berlin Institute of Technology, Berlin, Germany

Casting molds, especially in the aluminum industry, show a short lifespan due to the high corrosiveness of molten metals and alternating thermal and mechanical loads. By using new materials, for example tungsten-based pseudoalloys, the lifetime of casting molds can be elongated up to a thousandfold. In spite of the advantages of these materials, high manufacturing cost and the increasing commodity price of tungsten prohibit the use of molds consisting of these progressive materials. By coating the standard steel molds with a layer of these materials the excellent thermal and corrosive resistance of the pseudoalloy surface can be combined with minimal manufacturing costs. In the present work, steel substrates and real components of casting molds were coated with tungsten-based pseudoalloys. Different compositions and coatings processes were compared to produce the best performance of the coatings.

11:20 a.m. – 11:40 a.m.

A Review on Cold Gas Dynamic Sprayed Coatings

Tarun Goyal, SVIET, Ram Nagar (Banur), Punjab; Dr. T. S. Sidhu, SBSCET, Ferozpur Punjab; Dr. R. S. Walia, PEC Deemed University, Chandigarh

Cold gas dynamic spray process is a high-rate material deposition process in which fine, solid powder particles are accelerated in a supersonic jet of compressed gas to impact the target substrate surface at velocities ranging from 1640 to 3280 ft/s (500–1000 m/s). In this paper, a review of literature is made in respect to the coating deposition by cold spray process. The successful bonding of the powder particles on the impinging surface depends on the number of parameters — gas parameter, powder properties, substrate properties, nozzle geometry, process parameters and spray conditions. The deposition of particles on the substrate takes place due to plastic deformation at the onset of adiabatic shear instability. The cold-sprayed coatings are uniform, dense, and hard, and have good electrical and thermal conductivity, which provides cost-effective and environmental friendly technological applications.

11:40 a.m. – 12:00 p.m.

Practical Applications of Cold Gas-Dynamic Spray (Low Pressure Cold Spray)

David W. Wright, Accuwright Industries

Accuwright Industries, Inc. is a leader in research and development and in production applications of LP Cold Spray. By applying soft materials such as aluminum, copper, zinc, and alloys of these materials, Accuwright has developed and pioneered repairs for aluminum and magnesium housings and worn components with aerospace and industrial applications. We propose to describe a brief history of our developments, specific application success, and to share practical potential in Cold Spray process capabilities.

SESSION 3: NEW DEVELOPMENTS IN THERMAL SPRAY COATINGS, PROCESSES, AND MATERIALS

1:00 p.m. – 1:20 p.m.

Shockwave Induced Spraying: A New Cost-Effective Solid-State Spraying Process

Julio Villafuerte, Certerline Windsor Ltd

Shockwave Induced Spraying (SISP) is a new solid-state spraying process that enables the deposition of dense metals, alloys, cermets, and polymers on substrates at lower temperatures than what is typically used in traditional thermal spray processes and with high deposition efficiencies and rates. The properties of both the feedstock and the substrate remain unaffected throughout spraying. In thermal spray processes, such as high velocity oxygen fuel (HVOF) and plasma spraying, bonding is obtained by the combination of thermal and kinetic energy of the sprayed particles. In numerous applications the thermal component, which typically melts the spray material, is sufficient to produce undesirable oxidation, porosity, metallurgical transformations and residual stresses. Similar to cold gas dynamic spraying (or cold spray), SISP can produce thick coatings onto a diversity of surfaces at reduced temperature, minimizing thermal effects such as oxidation, tensile residual stresses, and metallurgical transformations. It is understood that this novel process can be used to enhance surfaces for corrosion protection, thermal insulation, thermal dissipation, wear resistance, electrical conductivity, restoration, and other applications without the detrimental effects of elevated process temperatures. In this presentation, the working principles, as well as potential benefits of the novel SISP technology for a number of applications are reviewed.

1:20 p.m. – 1:40 p.m.

Carbide Based Thermal Spray Powders with Alternative Matrix Alloys – The Only Choice to Protect Your Health and Environment

Stefan Zimmerman, Benno Gries, Jürgen Fischer, H.C. Starck GmbH

Cobalt-containing carbide powders such as WC-Co and WC-Co-Cr for thermal spraying exist in numerous modifications varying in chemistry, carbide size, and production method. They are widely used for wear, erosion, and corrosion protection in many industrial fields. However, for decades it has been well known from the hard metal industry that WC and Co-containing hard metals in breathable dust form can provoke severe lung diseases if inhaled. Recent examinations have proven that this toxicity can be significantly reduced if the Co is pre-alloyed by Fe. In thermal spraying, employees are also dealing with Co containing carbides; for example, in powder and coating production. Therefore, in order to reduce the hazards for health

and environment, new agglomerated and sintered carbide powders using alternative matrix materials — such as Fe-Cr-Al and other Fe-based alloys — have been developed and investigated. In the present study, the powders were HVOF sprayed in order to examine the influence of their different composition and morphology on the microstructure and the properties of the coatings in comparison to standard materials. The experiments comprise microstructural examinations, wear and corrosion tests.

1:40 p.m. – 2:00 p.m.

Optimization of Cold Sprayed Titanium Coatings on Adhesion Strength

W. Wong and S. Yue, McGill University; E. Irissou and J. G. Legoux, National Research Council Canada

Cold gas dynamic spray, a ground-breaking technology in the past decades for the field of thermal spray, is a solid-state high kinetic energy coating and free-form technique. This technique has triggered major interest in the aerospace industry due to its potential to fabricate aerospace engine components with minimal material waste. Owing to the severe requirements in producing these components, cold sprayed coatings must prove themselves reliable to earn recognition and to sustain their place in the industry. Thus, in this study, the adhesion strength of cold sprayed titanium coatings using nitrogen as propelling gas was evaluated according to the ASTM C-633-01 standard. A number of feedstock titanium powder size distributions were used. Different particle impact velocities were achieved by varying process conditions such as temperature and pressure. In addition, an assortment of substrates of different surface roughness and hardness were investigated, including aluminum alloy, pure titanium, and steel. Furthermore, the coating properties were studied via scanning electron microscopy and microhardness testing.

2:00 p.m. – 2:20 p.m.

Advanced Deposition Characteristics of Atmospheric Plasma Sprayed Bronze/Diamond Composite by Thermal Barrier Effect of Nickel Protective Thin Film

Hyunteak Na, Sanghoon Yoon, Kicheol Kang, and Changhee Lee, Hanyang University; Hyungjun Kim, Research Insttitute of Industrial Science & Technology

Atmospheric plasma spraying (APS) is one of the simple and economic processes. It can simplify and replace the conventional processes to obtain bronze/diamond composite coating in a single step. However, graphitization and oxidation of diamond in the high temperature plasma gas flow are the main drawbacks of the APS process. Hence, the diamond particle size was sharply decreased during flight in the APS gas flow field. Also, a high diamond fraction along with uniform diamond distribution could not be obtained without considering process parameters in relation with thermal properties. In this study, to reduce the graphitization and oxidation of diamond during flight in plasma gas flow field, nickel-coated (3 μm thickness) diamond particles were used. For comparison with the nickel-coated diamonds case, bare diamonds were also deposited with bronze on an aluminum substrate. The microstructure of the coating and the diamond size were observed and analyzed using a scanning electron microscope (SEM) and image analyzer. The results show that diamond size was retained with uniform distribution in the composite coating and the diamond fraction was also increased.

SESSION 4:
NEW DEVELOPMENTS IN THERMAL SPRAY COATINGS AND EQUIPMENT

2:35 p.m. – 2:55 p.m.

Dense Ceramic Coatings Produced by Slurry Axial Plasma Spraying

Michael Molnar, Mettech

Dense ceramic coatings are required for emerging applications such as solid oxide fuel cells (SOFCs), plasma erosion-resistant coatings, and new thermal barrier coatings (TBCs), among others. These applications present significant challenges for traditional plasma spraying. Currently, plasma spraying uses powders in the range of 10–150 μm, and the coatings for common applications such as TBCs typically exhibit porosities in the range of 5–15%. Finer powders yield denser coatings with thinner lamellae splats when compared to traditionally sized thermal spray powders. However, feeding issues have prevented standard techniques from producing coatings using powders finer than 10 μm. By suspending these fine powders in liquid and injecting the solid/liquid slurry into the plasma plume, a reliable fine particle spray delivery mechanism that produces highly dense coating structures can be obtained. This paper presents the approach of Mettech to enable dense coatings by using axial feed and a new liquid feed system. A robust slurry coating process was demonstrated by the production of dense coatings primarily for SOFC and plasma erosion resistance applications.

2:55 p.m. – 3:15 p.m.

Cermet and Ceramic Coatings with Novel Thermal Spraying Methods

Junya Kitamura, Kazuto Sato, Nobuaki Kato and Hiroaki Mizuno, Fujimi Incorporated

Thick coatings of WC cermet materials are widely applied by high velocity oxygen fuel spraying (HVOF) due to their excellent mechanical properties. However, the coatings are still inferior to the sintered bulk WC for toughness due to degradation of the feedstock powders, such as decarburization of WC, oxidation and formation of a brittle metal binder by mixing of WC and Co. Novel spraying methods with lower flame temperature, such as cold spraying and warm spraying, are one of the candidates to overcome the problem. Recent studies on cold spraying and warm spraying (modified HVOF) are introduced for the WC-Co coatings in this presentation. Plasma spraying producing high temperature flame jet has been used for ceramic materials. Plasma sprayed ceramic coatings have problems mainly due to their low density (high porosity) that causes lower mechanical properties in general. Suspension plasma spraying (SPS), developed recently, is one of the techniques to attain dense coatings where a suspension with fine ceramic powders of less than 10 micron is fed into the plasma plume. Mechanical and functional properties of yttrium oxide coatings by the SPS are also introduced in this presentation.

3:15 p.m. – 3:35 p.m.

Advanced Vacuum Plasma Spray (VPS) for Rapid and Safe Closeout of Cooling Channels for Liquid Rocket Engine Combustion Chambers

Chris Power, Genie Products

Taking advantage of vacuum plasma spray (VPS) technology for building safe and durable cartridges for high-temperature experiments in space furnaces, NASA's Marshall Space Flight Center (MSFC) and Genie Products, Inc. have been translating this VPS technology to building robust, long-life liquid rocket

engines. A subscale 5K (5000-lb thrust) VPS-formed chamber with a functional gradient material (FGM) hot wall, has now experienced 220 hot firing tests in pristine condition with no blanching (surface pulverization) or cooling channel cracks experienced in standard liquid rocket engines in less than 30 of the same hot firing tests. Normally, the 5K thruster combustion chamber is first VPS formed with a functional gradient material (FGM) hot wall in one continuous VPS operation. Cooling channels, then cut on the outside of the combustion chamber, are filled with a ceramic filler, VPS oversprayed as a closeout, and the filler material removed by etching with a dilute acid. In building and testing larger engines, required by NASA for consideration in the space program, the next step chosen was a 40K (40,000-lb thrust) engine. A 40K thruster designed as a calorimeter was chosen because it could be used for measuring temperatures simultaneously with other NASA propulsion testing. Cooling channels in normal combustion chambers run parallel to the combustion flow. However, cooling channels in calorimeters run circumferentially and must be closed out by first filling the channels with wax and electrodepositing the closeout material around the outside surface. The electrode position process can take up to 12 months to close out the cooling channels on the Space Shuttle main engine. Taking advantage of the VPS process, the cooling channels on the 40K chamber were filled with wax and electrodeposited for five days. The calorimeter combustion chamber was then heated to remove the wax, VPS coated for several hours, and subsequently machined, ready for placing in a support jacket and hot fire testing.

3:35 p.m. – 3:55 p.m. CANCELLED

Shockwave Induced Spraying: A New Cost-Effective Solid-State Spraying Process CANCELLED

Éric Irissou, Jean-Gabriel Legoux- and Christian Moreau, National Research Council Canada

As for cold spray processes, Shockwave Induced Spraying offers the ability to spray materials such as metals, alloys, cermets and polymers with high deposition efficiency and high deposition rate but with a lower gas consumption. The shockwave induced spraying is based on a succession of high-pressure gas pulses that provide the required kinetic energy to particles to form coating. Like cold gas dynamic spraying or cold spray, this technology can produce thick coatings onto a diversity of surfaces at low temperature, avoiding thermal effects such as oxidation, tensile residual stresses, and metallurgical transformations. This session presents the results of materials and process evaluation for coatings of several materials deposited using this new technology. Coating properties are investigated using SEM, bond strength testing, and mechanical testing. Particle velocity and substrate surface temperature are recorded using an optical diagnostics system and ultrafast infrared thermograph, respectively. Deposition efficiencies and critical velocities are determined for all materials and process conditions. The results are compared with typical results obtained with commercial cold spray systems.

3:35 p.m. – 3:55 p.m.

Methods and Effects of Cooling Work Parts During WC-CoCr HVOF Coating

Lisa A. Mercando and Zbig Zurecki, Air Products & Chemicals, Inc.

High-velocity oxygen fuel (HVOF) hardfacing of metallic work parts with WC-Co-type coating offers a performance and cost alternative to toxic chromium (Cr6+) plating. The cost competitiveness of HVOF hardfacing is, nevertheless, a strong function of production rate and deposition efficiency (DE) of feed powder. These are limited by significant heat input into substrate parts taking place during continuous HVOF coating, which necessitates the use of forced air or gas cooling, frequently combined with additional cooling breaks in spraying. Thus, determination of the effect of cooling method on production rate and DE is industrially critical. Prior experiments with nitrogen cryo-aerosol cooling of landing gear during HVOF hardfacing using DJ2600 gun and SM5847 powder have demonstrated doubling of production rates and halving of powder consumption, as compared to those of the conventional air cooling, while depositing improved, less residually stressed WC-10Co-4Cr coatings at increased DE. Present work compares effects of three different cooling methods on DE and substrate temperature during nonstop HVOF coating using JetKote-II Nova gun and JK120H powder: (1) forced air, (2) liquid CO_2, and (3) N2 cryo-aerosol. It is found that the air cooling DE of 45%, measured per ISO 17836/2004, is increased to 48% with liquid CO2 and to 54% with N2 cryo-aerosol. Experimental results will be detailed and explained by the combination of oxidizing potential of cooling gases used and the average substrate temperature during coating.

3:55 p.m. – 4:15 p.m.

Gun Mounts for the Articulated Robot; Fibonacci Comes Through Again

Dale Moody, Plasma Powders and Systems

Many articulated robot gun mounts in use today were originally designed for gantry or X-Y traversing manipulators. The use of these basic mounts results in a constrained operating window for robot motion during thermal spray operations. In addition, articulated robots are often positioned in the thermal spray cell before the gun mount configuration is established. This can also result is a less-than-ideal thermal spray arrangement. The paper discusses the disadvantage of using "Angle Iron" gun mounts and discusses optimum designs. Interestingly enough, the near optimum design is based on the "Golden Triangle," a derivative of the Fibonacci Numbers series. The importance of establishing the gun mount before determining the positioning of the robot in the work area will also be discussed.

4:15 p.m. – Adjournment

CHROME-MOLY STEELS CONFERENCE

The welding of chrome-moly steel goes way back to the days when tubing was oxyacetylene welded to make up the fuselages of the early pre-aluminum airplanes. It all required outstanding precision on the part of the welder. Believe it or not, even though the methods have changed, the welding of 4130 steel still requires utmost precision on the part of the welder. The welding of chrome-moly steels requires great skills from all parties involved. Not just the welding, either.

Heat treatment and nondestructive testing are part and parcel of a successful weld. The 2 ¼Cr-1Mo steels are very popular materials for boilers and pressure vessels where the ASME Code is used to call the shots. More recently, the modified 9Cr-1Mo steel, which was originally developed as the base metal for the Fast Breeder Reactor, is now widely specified through the electric utilities and is moving into the oil and gas industry. To weld any of these steels for the first time, the engineer and the welder actually have to go back to school and start all over again.

The conventional welding processes such as manual arc, several of the semiautomatic, and submerged arc welding processes are all used effectively on 4130, 2 ¼Cr-1Mo and modified 9Cr-1Mo steels. Some of the newer processes like hybrid welding have also become popular. Proper administration of the preheat and/or postweld heat treat operations is most critical.

Tuesday, November 17

9:00 a.m. – 2:40 p.m.

Chairs: Robert R. Irving and Russel Fuchs
Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmembers: $480 • Registration Code: W23

9:00 a.m. – 9:30 a.m.

Welding of the 1¼Cr-½Mo Steels

Ben Pletcher, Welding Engineer/Metallurgist, and Co-author James Brennan, Senior Welding Engineer, Chicago Bridge & Iron Co.

Many of the high-temperature pressure vessels used in refining operations today depend on the use of chrome-moly steels. The requirements for the material and welding have evolved to include temper embrittlement, low-temperature impacts, and low hardness values. The joining of these alloys requires planning, control, and execution in all phases of the welding operation.

9:35 a.m. – 10:05 a.m.

Induction Heating as a Tool for Minimizing the Risk of Weld Cracking

Steve Latvis, Regional Manager, North & South America, Global Pipe Systems, Miller Electric Manufacturing Co.

Relatively new induction heating equipment is finding use in various industries for preheat and stress relief. The technology appears to be more cost effective than either resistance heating or flame heating. Air-cooled equipment is available for temperatures up to 400° F and liquid-cooled equipment for work up to 1450° F.

10:10 a.m. – 10:40 a.m.

A New Advancement in Chrome-Moly Flux Cored Wires

Keith Packard, Welding Engineer, Hobart Brothers Co. Co-author is Joe Bundy, Tubular Wire R&D Engineering Manager

A challenge to meet low-temperature impact toughness properties with gas-shielded flux cored filler metals in chrome-moly applications has led to a new patented technology in flux cored electrode design. This technology can provide impact toughness of 50–100 ft/lb at –40° F. These new filler metals can now provide toughness that far exceeds even shielded metal arc welding or submerged arc welding.

10:45 a.m. – 11:15 a.m.

Welding 4130 Cr-Mo Steel in the Motorsports World

Richard Gostautas, Infrastructure Group Leader, Physical Acoustics Corp.

The fabrication and welding pitfalls of 4130 Cr-Mo when used for motorsports applications. Top fuel dragsters are now exceeding 7,500 HP, and special welding techniques and filler materials will be discussed to avoid weld failures. This interactive talk will highlight the 10 most-asked questions for 4130 Cr-Mo and will assist anyone involved with racing structures or lightweight aircraft.

11:20 a.m. – 11:50 a.m.

The Welding of 2¼ Cr–1 Mo–V: A Challenge

Russel Fuchs, Senior Technical Manager, Bohler Welding Group USA, Inc. Co-authors: Volker Gross and Martin Schmitz-Niederau

The use of 2¼ Cr-1 Mo-V steels (Grade 22V) has become more popular for the fabrication of heavy-wall pressure vessels due to its higher strength and creep resistance as compared to the conventional 2¼ Cr–1 Mo steel. However, it has not been without its share of challenges when it comes to welding. High toughness of the weld deposit is desirable both in the as-welded condition and after PWHT; as-welded in order to handle the component during fabrication without fear of cracking and after PWHT to ensure in-service requirements are satisfied with respect to startup and shutdown. Issues with reheat cracking have been experienced, especially in the highly restrained weldments using the SAW process. Filler metals have been developed to meet these challenges.

11:55 a.m. – 1:00 p.m. Lunch break

1:00 p.m. – 1:30 p.m.

High-Temperature Mechanical Performance of 2¼Cr-1Mo Steel Weldments

Robert W. Warke, Associate Professor of Welding and Materials Joining, LeTourneau University

Experience has demonstrated the relative vulnerability of welded joints to localized creep damage in high-temperature service. An extensive database of weldment test data was assembled and evaluated for a variety of welding processes, joint geometries, heat treatment conditions, and test configurations. Performance trends were assessed in light of base metal data and current design rules for pressure vessels and piping.

1:35 p.m. – 2:05 p.m.

Welding and PWHT of P91 Steel

William F. Newell, President, Euroweld Ltd.

Use of P(T)91 components is experiencing worldwide usage. Premature failures are being encountered due to design, inadequate attention to following procedures, or improper post-weld heat treatment. Heat treatment of both component manufacture and completed welds appears to be the number-one cause of premature failure. Factors that influence these failures will be presented.

2:10 p.m. – 2:40 p.m.

Time of Flight Diffraction Testing

Ronald W. Kruzic, Corporate QA/NDE Consultant, Chicago Bridge & Iron Company

ASME Code Case 2235 is for the use of an ultrasonic examination in lieu of a radiographic examination for pressure vessels and boilers. This talk is concerning the use of this Code Case utilizing the Time of Flight Diffraction technique for examination of coke drums fabricated from Cr-Mo alloys that have been clad with Type 410s stainless steel.

2:40 p.m. – Adjournment

ELECTRON BEAM WELDING CONFERENCE

The American Welding Society, DVS (German Welding Society), and The International Institute of Welding are organizing their first International Electron Beam Welding Conference. This event will be held in conjunction with the FABTECH International & AWS Welding Show. It will include a two-day technical program plus a half-day tutorial sponsored by the Pro-Beam Foundation. IEBW will bring together scientists, engineers and technical personnel from around the globe involved in the research, development, and application of electron beam welding processes.

In addition, on Monday, November 16th from 9:00 a.m. to 3:00 p.m., a free tutorial on electron beam welding is being presented by Pro-Beam Foundation (Germany).

Tuesday, November 17 – Wednesday, November 18

9:00 a.m. – 4:15 p.m.

Chair: Ernest Levert
Member of AWS, FMA, SME, NAM, or PMA: $550
Nonmembers: $685 • Registration Code: W28

Tuesday, November 17

SESSION 1: GENERAL ASSEMBLY

9:00 a.m. – 9:15 a.m.

Welcome Address

9:15 a.m. – 9:45 a.m.

Keynote IIW

EBW Technology Overviews Commission IV Business Plan

Ernest Levert, Chairman IIW Commission IV – Power Beam Processes, Lockheed Martin Corporation (USA)

9:45 a.m. – 10:15 a.m.

Keynote Europe: Europe Business Developments

Current Development of the Electron Beam Technology in Europe

Dr. Phil Thorsten Löwer, pro-beam AG & Co. KGaA (Germany)

The number of producers of electron beam equipment in the world is the highest in Europe. Today, there are CVE in Great Britain; SAF and Techmeta in France; and AWT, pro-beam and Focus in Germany. The concurrence situation in Europe stimulated development work so that nowadays the different firms can offer a large variety of equipment specialized on each application. Due to this situation, the equipment from European sellers takes the highest share in all equipment worldwide.

A typical classification of electron beam machines is made by dividing them into low-voltage and high-voltage machines. 60-kV machines for simple applications are available for low prices as well as for high production, highly automated applications, or in combination with other processes as a complete production cell. 150-kV equipment is used as very flexible equipment, for highly sophisticated applications or on very sensitive products, for example in space and aircraft industry.

The revival of deep penetration welding that more and more is applied in heavy industry, thanks to new capabilities of EB equipment, will also be reported.

10:15 a.m. – 10:30 a.m. – Break

SESSION 2: RESEARCH AND DEVELOPMENT TRENDS

10:30 a.m. – 10:50 a.m.

The Electron Beam as a Tool of Both Nano Science and Micro Technology: From UHV Evaporation to Micro Electron Beam Welding

M. Merkel, K. Wrobel, M. Escher, FOCUS GmbH, Huenstetten, Germany; M .Zobac, I. Vlcek, L. Dupak,Institute of Scientific Instruments of the ASCR, Brno, Czech Republic; F.-H. Roegner, G. Mattausch, A. Reichmann, Fraunhofer Institute for Electron Beam and Plasma Technology, Dresden, Germany.

The electron beam as a highly efficient heating source is well known since its first use for the melting of tantalum at the end of the 19th century. During the first half the last century, its ability to evaporate, to drill, and to weld even refractive metals has been discovered. After the Second World War people started to use these exciting properties for a wide range of industrial applications commercially.

We started to use the electron beam for ultraclean vapor deposition of very small amounts of numerous materials in 1990. Our ultrahigh-vacuum electron beam evaporator is today a standard tool in nanoscience laboratories. We will show how it works together with some application examples.

A growing request for new joining methods applicable to micro technology did encourage us to develop a dedicated micro-electron beam welding machine during the last years. We ended up with a desktop-sized instrument looking more similar to an electron microscope than to a common e-beam welding machine. This is not only a formal difference. Its design philosophy follows a number of technical solutions what are commonly used for scanning electron microscopes. Based on long-term experience on the field of electron optics, it is suitable to match the needs of a wide range of challenging joining tasks: from micromechanical and microsystem technological ones to a lot of precision technological applications, how they are common nowadays, e.g., for medical technology or sensor industry. We will present some examples and will give a brief outlook in terms of the challenges of the future in this field.

10:50 a.m. – 11:10 a.m.

Prediction and Control of Distortion and Residual Stresses in Electron Beam Welding

Nick Bagshaw and Chris Punshon, TWI Ltd.

Electron beam welding is recognized as an attractive method for minimizing distortion during welding, and is used frequently to join parts that are already finally machined or close to finished size. In such cases, before EB welding, it is of great value to be able to estimate the level of accuracy that will be achieved and the dimensional stability of the assembly throughout its service life. This presentation describes the development of a finite element (FE) modeling technique, validated by experiment, for predicting and understanding the development of residual stresses and distortion during EB welding, particularly in circular components. The use of this method for optimization of welding procedures and residual stress mitigation methods is described and illustrated through a number of practical examples.

11:10 a.m. – 11:30 a.m.

Development of Local Vacuum Electron Beam Welding for Rapid Fabrication of Large Structures

Chris Punshon, TWI Ltd.

Electron beam welding is generally carried out in a vacuum chamber, which is an attractive process characteristic offering many advantages in terms of containment, avoidance of contamination, and minimal metallurgical disturbance. To date, however, the necessity to conduct processing in a high-vacuum atmosphere has largely restricted the application of the process to components and structures that can be entirely contained within a vacuum chamber.

This paper describes the innovative development of systems allowing the generation of high-power electron beams for use at "reduced pressure"(~1 mbar), uniquely combined with developments in mobile, local seals. The requirements for sealing and pumping at this pressure are much less onerous than with high-vacuum EBW, thus facilitating the application of the process to much larger structures and components. A number of practical examples are described of how these process developments have been used successfully, illustrating the potential for application in a range of industry sectors and materials.

11:30 a.m. – 11:50 a.m.

Developments in Sub-10kW Electron Beam Equipment, Processes and Monitoring

Bruce Dance, TWI Ltd

When first developed, electron beam process equipment was limited in beam power. Developments in equipment mean that processing is now possible over a huge range of beam powers and qualities. However, despite the possibilities of higher beam powers, a huge amount of commercial EB processing is still carried out at low powers (<10 kW). In addition, although benefitting from modern control systems, the majority of EB process hardware still uses electron gun generator designs that are apparently little changed in the last 20 years, in stark contrast to laser equipment.

This paper reviews electron beam generator performance in relation to common process requirements, as well as the demands of more recently developed EB processes. Beam probing and measurement data are presented. Examples are given in which processes that demand specific beam qualities have been made possible by improved beam generation and control.

11:50 a.m. – 12:10 p.m.

Investigations Relating to Electron Beam Welding of Dissimilar Metal Welds Based on Cast Iron

Karsten Rüthrich, and Martina Mangler, TU Bergakademie Freiberg, Germany; Rolf Zenker, Zenker Consult Mittweida, Germany

The combination of casting and welding in hybrid designs is a very interesting direction of development, especially in the automotive industry. Cast iron materials are either not weldable at all or weldable only with large-scale additional technological measures (preheating, postheating, filler material).

Electron beams are characterized by good deflectability, thus making it possible to realize multispot and/or multiprocess technologies. This means that different processes influencing the thermal regimes in the welding zone may be carried out in one processing step.

First will be presented what EB multi-spot techniques and multiprocess technologies mean and which opportunities are provided by them in connection with welding.

Furthermore, results of investigations relating to multispot welding of dissimilar metal welds based on cast iron (same-type, related-type) and unrelated-type welds of cast iron with steel will be presented. In addition, actual results of welding obtained using multiprocess technologies (pre- and/or postheating) in one processing step will be presented.

12:10 p.m. – 1:10 p.m.

Lunch (Hosted by AWS C7B Committee)

1:10 p.m. – 1:30 p.m.

Joint Tracking with the Electron Beam Offline and Online – An Important Welding Automation Tool

Dr. Michael Mücke and Carsten Scheiblich, All Welding Technologies AG (Germany)

The electron beam is used in electron microscopy to image the smallest of structures. Highly dependent on surface structure, it capitalizes on the angle of backscatter from electrons reflected off the target material. This process is often used for imaging purposes in electron beam welding systems. The viewing advantages over photo-optical methods such as telescopes or CCD cameras include a markedly superior depth of field and elimination of the need to illuminate the target surface. The quality of these images has sufficient resolution for viewing typical joint forms.

The electron beam in EB welding systems is already being employed to identify joints for some welding projects. This process does not require a complete image of the surface. The signal provided by backscattered electrons from a single deflection line perpendicular to the joint is sufficient. The position of the joint can be ascertained by a change in the signal that occurs when the beam is reflected differently off the joint.

This process is customarily used to statically determine the joint position on one or a few points before the welding begins. Errors in the positioning of the target piece are measured and the welding process is adjusted accordingly. Even small tolerances in the assembly of a target piece can be offset. Other processes use a search beam to probe multiple points along the entire course of the joint before welding begins (offline). Measurable deviations from the reference position are saved and corrected during the welding process. In so doing, even residual magnetic fields in the target piece or clamping fixture can be compensated for.

Deflection technology in electron beam welding system hardware and software has seen significant improvements during the past several years. Using deflection frequencies as high as 200 kHz, it is now possible to conduct joint tracking during the welding process (online). The electron beam periodically springs out of the weld pool to perform a nearly continuous scan perpendicular to the weld. It moves far enough forward to take measurements ahead of the melt zone. If the weld focus is not on the surface of the target piece, the focus position is switched to joint identification in order to receive a clear surface joint signal. While the beam continues to weld after rebounding into the weld pool, the CPU calculates the deviation from the programmed reference position and corrects the weld position by deflecting the electron beam.

Examples will be used to illustrate the individual processes. The results document the current state of this technology. A view of prospective opportunities in electron beam process automation will be provided.

1:30 p.m. – 1:50 p.m.

Fast Beam Deflection and Beam Quality– Keys to Economic High Quality Electron Beam Applications

Uwe Clauß, pro-beam AG & Co. KGaA (Germany)

Since its first introduction to the industry the control systems of electron beam machines have gone through an enormous development. With the availability of fast amplifier components and digital beam controllers, the advantages of the electron beam have further increased, making it a truly software-controlled thermal processing tool.

Modern beam controllers enable multi-beam and multi-focus

technologies, where the beam is split in up to 60 or more individual beams. These technologies can reduce the processing time by parallel processing or improve the quality by optimized thermal expansion of the part. Multiprocess technologies, where several processes are performed in one run (e.g., welding and cosmetic treatment), further extend the application range of the electron beam process.

Fast beam deflection in conjunction with electron-optical monitoring is the fundamental component for advanced seam tracking systems. They allow automating the EB application in order to optimize the process costs and improve the quality of the results in a reproducible manner.

The basis for a high quality EB process is the condition of the tool the electron beam itself. By introducing the beam parameter product to the electron beam, reliable information about the quality of the beam can be derived. Implemented into automatic beam alignment systems, repeatable results with high quality can be achieved.

1:50 p.m. – 2:00 p.m. Break

2:00 p.m. – 2:20 p.m.

Reconstitution of Fracture Mechanics Test Specimens by Electron Beam Welding

Peter Petrov, Institute of Electronics

Changes in the material properties due to neutron irradiation are monitored by means of surveillance programs. Specimen surveillance programs for reactor pressure vessel (RPV) materials are among the most important parts of inspection programs that are necessary for realistic evaluation of RPV lifetime.

In nuclear power plants (NPP), Charpy(Cv) specimens are used to assess the RPV embrittlement. The surveillance capsule assemblies in each capsule contain typically 12 Cv and 3 tensile specimens. However, to address future plant life management, especially for older NPPs, it is necessary to obtain more statistics on the pressure vessel embrittlement. Reconstitution technology allows performing additional Cv or fracture toughness tests on a limited amount of available material and can contribute to a better characterization of the material and, therefore, to a better evaluation of the embrittlement degree of RPV steel due to neutron irradiation.

This presentation reports results from reconstitution of Cv-type and CT specimens by electron beam welding. The experiments were carried out using a 15-kW Leybold Heraeus welding unit. The material used in this study is 18MND5 steel. Investigations were made of structural changes of metal in welds and heat-affected zones. Cv impact tests showed good agreement between the original and reconstituted specimens.

2:20 p.m. – 2:40 p.m.

Non-Vacuum Electron Beam Cutting

N. Murray, A. Beniach, R. Konya, Dr. Th. Hassel, Prof. Dr-Ing. Fr.-W. Bach, Institut für Werkstoffkunde (Germany)

The main domain of non-vacuum electron beam (NVEB) technology has so far been high-speed and high-quality joining. It is of great interest to find further uses for this efficient technology. Current research by the NVEB-group of the Institute of Material Science at the Leibniz University of Hannover focuses on the implementation of the NVEB process to the cutting of metal plates. Experiments are conducted on a PTR NVEB welding system with an acceleration voltage of 175 kV and a maximum power of 25 kW. First experiments with this equipment showed that it is possible to cut 20-mm-thick plates of mild steel. A cutting speed of 1 m/min at a beam current of 140 mA was achieved. Despite the well-known widening of the electron beam due to the scattering of the electrons in atmosphere, the resulting face is straight and of high quality, with only little residual melt drops at the lower edge. At the moment, preparations are being done to use a gas jet to blow away molten material from the cutting area to further improve surface finish of the cut. To evaluate the possibilities of expanding the work domain of the NVEB, process experiments will be done using the electron beam for weld preparation and welding within two steps on the same equipment.

2:40 p.m. – 3:00 p.m.

Modeling of Heat Transfer and Fluid Flow during Keyhole Mode Electron Beam Welding

R. Rai, T. A. Palmer, J. W. Elmer, and T. DebRoy, Department of Materials Science and Engineering, Pennsylvania State University; *Lawrence Livermore National Laboratory, Livermore (USA)*

A three-dimensional numerical model of the turbulent heat transfer and fluid flow in keyhole-mode electron beam welding has been developed and validated. In addition to solving for the enhanced heat and mass transport due to turbulence, this model also considers the heat balance at the keyhole walls and the variation of vapor pressure in the keyhole and the keyhole wall temperature with depth. Since the model takes into account these various physical processes, it can be applied to materials with different thermo-physical properties. In this work, the model was validated using several 304L stainless steel welds made at fixed input power but different power densities achieved by variation in the focal spot size, and the calculated and experimental weld geometries were in reasonable agreement. Peclet number calculations show that convective heat transfer is very significant, and computations performed in the presence and absence of convection also demonstrate the important role of convection on the formation of the resulting weld geometry.

3:00 p.m. – 3:20 p.m.

Welding of an Anaesthesia Tank of Aluminum Die Casting with Multi-Jet Electron Beam

O. Krahn, H. Pries, K. Dilger, Institute of Joining- and Welding-Technology of the Technical University (Germany)

The process of aluminum die casting, which produces near-net-shape, complex, and thin-walled prefabricated parts of aluminum, finds more and more applications in all areas of the industry because it has economic advantages compared to other processes in productivity. The technically most-used molding process of aluminum die casting products is fusion welding, which shows multiple problems. The safe production of pore-free weld joints requires an expensive optimization all over the die casting process as well as the choice of a qualified welding process.

An innovative approach to solve these problems is the integration of the electron multi-jet beam welding in the manufacturing chain.

To avoid distortion at small welding seams, high-frequency deflection of the electron beam is used, to connect the welded joint and the local successive fusing in one process step to reduce the porosity. This aided project shows successfully that it is possible to qualify the welding of an anaesthesia tank in normal die casting quality with the electron multijet beam as an economic and applicable operation of mass production for premium, pressure-tight units.

It was shown that an optimization of the welding parameter and

the welding sequence over the multijet electron beam can reduce the porosity of the weld joint under 8%. That puts us in a position to fulfill the technical requirements for medical products.

3:20 p.m. – 3:40 p.m.

Micro Electron Beam Welding of Metal Foils and Wires

Backhaus, Dorfmüller, Dr. Olschok, Prof. Dr.-Ing. Reisgen, ISF - Welding and Joining Institute, RWTH Aachen University

3:40 p.m. – 4:15 p.m.

The Electron Beam as Versatile Tool for the MEMS and Precision Engineering Technology

Dr.-Ing. Klaus Dilger and Prof. Dr.-Ing. Stefan Bohm, Technische Universität Braunschweig; Dr. Th. Löwer and Jan Bärtle, pro-beam AG & Co. KGaA (Germany)

Under the framework of a public-sponsored project, an electron beam-based production line for micro systems was developed and built. Different processes like structuring, joining, material removal, measuring, and visualization can be performed in one installation without tool changes in a precise and flexible manner.

The electron beam is not only providing the machining capabilities, but also the opportunity to observe the workpiece and production steps by the use of backscattered electrons, presenting a flexible tool for quality assurance.

In the last years, detailed studies about micromachining processes using an electron beam were performed on different types of machines, like a scanning electron microscope or conventional electron beam welding machines. But in comparison to these attempts, our micro-electron beam machine is much more stable, more precise, the power is between 1 and 500 Watts, and the beam diameter is less than 50 microns.

The latest results of the machine development and the experiments will be presented.

Wednesday, November 18

SESSION 3: APPLICATION TRENDS

9:00 a.m. – 9:45 a.m.

Keynote Asia: Asia Business Developments
Electron Beam Welding in Japan
Hirosada Irie, The Japan Welding Technology Center

Since the 1970s, considerable research and development in electron beam welding technology have been carried out in Japan. Owing to the long-term recession of the Japanese economy since the 1990's collapse of the bubble and the R&D activities of new technologies — laser technology, FSW — the R&D activities in electron beam welding technology have scarcely been published. However, EBW technology has walked with steady steps in industries. As is well known, the features of EBW are deep penetration and low distortion. Since the bubble collapse, usage of EBW in Japan is completely divided into two extreme fields; that is, one is the construction of heavy-gauge facilities and the other is mass production of small automotive and machine parts. The shipment of EB welding machines for the latter applications has still been active. In big construction, recently, the development of EBW of high-pressure gas pipe and the development of the welding process of overpack (container) for high-level radioactive waste, and others, have been carried out. A brief introduction of electron beam welding technologies in Japan will be presented.

9:45 a.m. – 10:15 a.m.

Keynote America: America Business Developments

Don Powers (Retired – PTR-Precision Technologies, Inc.) (USA)

10:15 a.m. – 10:40 a.m. Break

10:40 a.m. – 11:00 a.m.

Fabrication and Closure Welding of Containers for Long Term Storage of High Level Nuclear Waste Using Reduced Pressure Electron Beam Welding

Jim Dorsch, Ed Savage, Chris Punshon, and Nick Bagshaw, TWI Ltd.

The growing demand for new base-load electricity generation will see an expanding role for nuclear energy as a major component. In consequence, increasing demands will be placed on the safe treatment and storage of high-level nuclear waste (HLW). The current proposal for the USA is currently under review, but it is likely that spent fuel will be stored in a geological repository for a period of the order of a million years. The use of multiple-barriers to safely isolate HLW has been proposed, and the use of welding for fabrication and final closure of the containers considered. This paper describes a program of work carried out to examine the potential benefits of employing local vacuum, reduced-pressure EB welding for both fabrication and sealing of containers for HLW, taking into account the demanding requirements for reliability, productivity, and concerns related to welding-induced distortion and residual stress.

11:00 a.m. – 11:20 a.m.

EB Surface Engineering for High Performance Heat Exchangers

A. L. Buxton, TWI Ltd; R. J. McGlen, Thermacore Europe Ltd.

From aircraft engines to electronic devices, current thermal management systems are limiting product performance. Heat exchanger designs have been constrained by the available production technologies, e.g., machining or chemical etching, but a newly developed electron beam manufacturing process (Surfi-Sculpt) offers the potential to bring about a step-change in heat exchanger efficiency.

An electron beam in conjunction with a sophisticated beam deflection system is used to move material around the surface in a controlled manner to rapidly create a wide variety of complex surface structures, many of which are impossible to produce via any other processing route. New heat exchange surfaces and structures have been modelled to understand how different designs of surface feature can influence the flow behavior over a surface, and a parallel set of wind tunnel tests have been used to verify results. Ultimately this will enable the optimization of surface geometries for heat transfer and allow revolutionary changes in heat exchanger design.

This paper describes the background and scope of a new electron beam manufacturing process. The results of both modeling and wind tunnel testing are presented to demonstrate the impact of this technology on heat exchanger design and efficiency.

11:20 a.m. – 11:40 a.m.

The Use of Filler Metal Shims to Improve Electron Beam Weldability

Daniel Nowak, GE Energy; Gary LaFlamme and John Rugh, PTR-Precision Technologies, Inc.

Electron beam welding is normally considered an autogenous welding process and is typically used to join components with tight-fitting faying surfaces. Welding autogenously using the electron beam is ideal for producing the lowest possible heat input and minimal distortion by virtue of the processes' narrow fusion zone. However, there are materials that cannot be fusion welded autogenously, such as 6000 series aluminum alloys. In these cases, a filler material must be used to change the weld metal chemistry to prevent cracking. The normal method for adding filler metal in conventional arc welding processes is to feed wire into the molten weld pool. This wire feeding method is suitable for the relatively shallow and wide welds produced by conventional non-keyhole welding processes, but it does not provide an adequate distribution of filler metal in the narrow, deep, rapidly solidifying welds produced by the EB welding process. To overcome this lack of filler metal distribution problem, it is possible to preplace shim material between the faying surfaces prior to welding. This provides an even distribution of filler throughout the depth of the weld. However, the electron beam profile needs to be modified to accommodate the wider fusion zone and some of the inconsistencies of a shimmed joint.

This paper presents the use of filler shims in a number of applications in aluminum alloys and 300 series stainless steel. Properties data are also presented for select applications.

11:40 a.m. – 12:00 p.m.

Electron-Beam Welding for Big Science

Dr.-Ing. Wilfried Behr, Zentralabteilung Technologie (ZAT)

The ISF (Institut for Welding Engineering and Joining Technology) at the RWTH Aachen (Aachen University) and the ZAT (Central Department of Technology) at the Forschungszentrum Jülich have worked for decades successfully in the development and application research of the joining technology. The FEZ (Excellency Center for Joining Technology) connects the technical authority of the RWTH Aachen and the Forschungszentrum Jülich. The combined use of personnel and machine resources offers a complete joining technology specialized authority unique in Europe. Both for the industrial site in Germany and in the global competition of the engineer-scientific research, this is very useful, since the FEZ can solve questions made of industry and research as a competent development partner.

The ZAT in the Forschungszentrum Jülich transfers the tasks of the non-university research, development, and manufacturing for research establishments and major items of scientific equipment cooperating world-wide in the FEZ. Current joining tasks, e.g., for the international fusion experiment ITER in Cadarache/F, for the Spallation Neutron Source SNS in Oak Ridge, Tenn., for the research reactor FRM II in München/D and for FAIR (Facility for antiproton and Ion Research) experiment in Darmstadt/D. The section "beam welding technology" of the ZAT can offer the necessary machine equipment and specialized authority to the research partners with its decades of experience in the processing of special metals as ideal development partner. Embedded into the range special joining and inspection technique can the ZAT a comprehensive research and manufacturing service offer, which are necessary to the solution of more complex joining and technical questions. Electron-beam welding is frequent with the solution of these joining technology questions of central importance. Only with the unique characteristics of this process, the almost boundless deflection technology, the outstanding protection of the melt against atmospheric influences by the vacuum and the highly precise power control material can be worked on such as niobium, molybdenum and titanium in addition, copper, and aluminum in the necessary quality.

Noon – 1:20 p.m.

Lunch (Hosted by AWS C7B Committee)

1:20 p.m. – 1:40 p.m.

Electron Beam Welding of Aluminum Alloys for the Automotive and Aircraft Industry

Prof. Dr.-Ing. Stefan Böhm, Christian Börner, Kai Noack, Prof. Dr.-Ing. Klaus Dilger, Institute of Joining and Welding Technique, Technische Universität Braunschweig (Germany)

In an actual project sponsored by the EU, the electron beam is used for the welding of ductile aluminum die cast alloys for crash-optimized lightweight components for the automotive industry and aluminum wrought alloys for helium-proof chassis of aeronautic and aerospace instruments. For welding of ductile aluminum alloys, the challenges are the mechanic-technological joint properties, because ductile aluminum die cast is difficult to cast and so the hydrogen induced porosity is high. For welding of chassis made of aluminum wrought alloys, the shape of the chassis are not symmetrical rotationally, but complicated. The components are made by precision-casting. Here the heat transfer into the material, the welding order, and the start and stop craters are the challenge.

The paper will show how modern electron beam technology is able to fulfill the requirements of the welding tasks using multiple beams and multiple focuses.

1:40 p.m. – 2:00 p.m.

Applications of Electron Beam Diagnostics in Characterizing Low and High Voltage Electron Beam Welders

*K.W. Lachenberg, T.A. Palmer**, A.T. Teruya*, and J.W. Elmer*, Sciaky Inc., * Lawrence Livermore National Laboratory; **Applied Research Laboratory, Pennsylvania State University (USA)*

Over the past two decades, the development of diagnostic tools for characterizing electron beams has been growing in prominence. The Enhanced Modified Faraday Cup (EMFC), developed at Lawrence Livermore National Laboratory (LLNL), provides measurements of the general size and shape of the beam and the power density distribution across its width. This tool has been utilized in a number of common applications, including the characterization of performance for high- and low-voltage electron beam welding machines, the transfer of parameters between welding machines at remote locations, and as a process control tool. Because of its capability to quantify beam characteristics, the EMFC can also prove to be a useful tool in diagnosing differences in machine performance related to differences in machine construction. By employing the EMFC diagnostic tool, the power density distribution of the beam from a given electron beam gun configuration can be determined. This quantitative information can then be used as a baseline for providing a better understanding of how different features of the electron gun or power supply affect the resulting beam power. The use of the diagnostic tool will provide a better understanding of the operation of these machines and prove instrumental in producing improved designs for the next generation of electron beam guns and power supplies without extensive visual and destructive testing.

2:00 p.m. – 2:20 p.m. Break

2:20 p.m. – 2:40 p.m.

Electron Beam Welding – Process, Applications, Equipment and Future Developments

Dr. Schubert, G. PTR-Precision Technologies, Inc. (USA)

This presentation gives a technical overview of unique features of the electron beam welding process. Applications from different types of industries and different materials will be discussed and technical challenges will be highlighted, as well as how they can be solved with the EB process. Weld cross sections of production parts will be shown to demonstrate weld shapes obtainable. In addition, an overview of today's welding equipment will be provided, ranging from universal chamber welding machines to flexible and dedicated production welding machines with short cycle times. Integration of high production welding machines into fully automated production lines will also be reviewed. A brief outlook will be given into future developments.

2:40 p.m. – 3:00 p.m.

New Capabilities for Efficient Application of Electron Beam Welding for the Fabrication of Large-Scale Parts in Series Production

Volker Adam, pro-beam AG & Co. KgaA (Germany)

One domain of the electron beam is the possibility to join finished or near-net-shape machined parts distortion-minimized. This technology was field-tested and applied for more than 50 years for safety-related parts in space, aviation, military and nuclear applications. Simultaneously the technique is predestined for deep penetration welding of wall thicknesses up to 100mm and more. Possibilities in this field have been discussed in the past, but so far, hardly any equipment was available for flexible and economic operations.

Machines and control systems have been continuously developed by pro-beam. As a result, fast and economic machines with chamber volumes up to 600 m3 for welding of large-scale parts with weights above 50 tons are available.

Enormously increasing or fluctuating commodity prices, especially for high-alloyed steels and noble metals, force up the importance of EB-welding in vacuum without filler material. The low energy consumption of modern EB systems, the matured technology, and the high availability of the systems have turned the technology into an economic production method for semi-finished products.

Large-volume cast or forged parts, as well as large-sized sheets can be subdivided into smaller components, faster and better available, and joined economically with high-quality by EB in the vacuum. New applications in the areas of shipbuilding, aviation, and offshore wind power as well as for system and machine building are in pre-series or series production.

The paper reflects the current status of the production and will give future prospects of EB welding in the area of large-scale parts. Besides technical aspects, in particular, economic aspects are discussed.

3:00 p.m. – 3:20 p.m.

Studies on the Electron Beam Welding Behavior of Different Lightweight Materials

Marco Klemm, SZF Stahlzentrum and Rolf Zenker, TU Bergakademie

For modern lightweight design, it is becoming more and more necessary to produce welding constructions of lightweight materials as well as same-type design and also multi-material design. This makes high demands on the welding technologies itself, but also on additional thermal pre- and postprocesses in connection with the welding process.

The electron beam (EB) can meet the requirements for realizing such complex welding tasks. By using high-frequency beam deflection, it is possible to realize multispot welding and/or multiprocess technologies in connection with welding.

The paper deals with results relating to EB welding of several Al and Mg alloys and different combinations of these materials. EB welding was realized without filler materials to connect components up to 25 mm in thickness.

The quality of the weld (porosity, sensitivity to cracking), the microstructure and hardness of the welding seam, and the HAZ and the tensile behavior in comparison to the base materials were investigated.

Same-type and related-type welds of lightweight joints have a good quality and mostly very good properties. In case of unrelated-type welds, the welding results depend on the kinds of welding partners used.

3:20 p.m. – 3:40 p.m.

Electron Beam Weldability of Aluminum-Based Dissimilar Alloy Joints

Michinori Okubo, Toshiyuki Hasegawa, Nihon University, Japan; Nobuyuki ABE, Osaka University, Japan

Aluminum alloy joints of dissimilar composition will give problems due to difference properties. The electron beam machine is 6 kW for high voltage type. Joint configuration is I type and without filler metal. Electron beam welds are produced on dissimilar aluminum alloys of 10 mm in thickness.

Al-Si alloy showed good performance. Main aluminum alloy is extruded Al-Si plate. Combination wrought alloys are Al-Mg, Al-Mg-Si and Al-Zn-Cu alloy plates. Hardness of Al-Si/Al-Mg and Al-Si/Al-Mg-Si weld metals is same level as both alloys. Tensile strength becomes about 200 MPa. In case of Al-Si/Al-Zn-Cu joint, joint elongation is the lowest shown, and they are 80% of the base metal. Impact value shows a tendency to decrease. Micro-segregation of Mg, Si, and Cu in weld metals is recognized for Al-Si/Al-Mg-Si joint.

Nanostructure aluminum alloy have high strength and good performance. The main alloy is nanostructure aluminum alloy. Combination aluminum-based alloys were extruded Al-Si plate and wrought Al-Mg, Al-Mg-Si and Al-Zn-Cu alloy plates. Dissimilar welding for nanostructure aluminum alloy to various aluminum-based alloys by electron beam welding process can be possible and crack-free. But some porosity is recognized in weld metal. As for hardness of the weld metal, they become 107 to 124 HV with each joint. The high-energy-density processes such as electron beam welding are suitable because the heat-affected zone width is very narrow.

3:40 p.m. – 4:00 p.m.

Panel Discussions

WELDING CORROSION-RESISTANT ALLOYS CONFERENCE

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 a 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.

Each presentation will be followed by a five-minute question-and-answer session.

Wednesday, November 18

9:00 a.m. – 4:00 p.m.

Chairs: Robert R. Irving and Ralph Davison
Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmembers: $480 • Registration Code: W24

9:00 a.m. – 9:30 a.m.

Lean Duplex Stainless Steel Chemical Cargo Tanks

Ralph Davison, Vice President, Technical Marketing Resources

A lean duplex stainless 2101 has been developed with low addition of nickel to reduce costs. Low nickel content is compensated by an increase in manganese and nitrogen to ensure a balanced microstructure with approximately equal amounts of ferrite and austenite, for a yield strength more than twice that of 316 and 304 stainless steels. Lean duplex is also resistant to stress corrosion cracking, has better pitting resistance, and is being welded by the gas metal arc process.

9:35 a.m. – 10:05 a.m.

The Thermal Stir Welding Process

Jeff Ding, Aerospace Welding Engineer, NASA Marshall Space Flight Center

Thermal stir welding, developed by NASA's Marshall Space Flight Center, is similar to friction stir welding in that the weld joint is consolidated without liquefying the base material. Unlike FSW, the heating, stirring, and forging elements of the process are decoupled, allowing independent, dynamic control of each process element.

9:30 a.m. – 10:05 a.m.

Friction Stir Welding and Processing

Murray Mahoney, Consultant

The presentation is a general discussion of FSW including metal flow and defect avoidance, temperature gradient issues, lap vs. butt joints, some tool material and tool design considerations, current applications, FSW limitations, benefits such as properties and the solid-state benefits of welding unweldable alloys and zero emissions, all as they apply to Al-, Cu-, and Fe-based alloys. Friction stir processing will also be covered.

10:10 a.m. – 10:40 a.m.

Evaluation of Higher Interpass Temperatures When Welding 304L and 316L Austenitic Material

Matthew Yarmuch, coauthors are Iulian Radu and Ken Armstrong of PCL Industrial Constructors. Yarmuch is Program Leader, Welding Engineering, Advanced Materials Business Unit

A reassessment was made of maximum interpass temperature limits while welding 304L and 316L pressure equipment materials, to significantly improve welding productivity. Higher interpass temperatures can be tolerated without compromising the sensitization-corrosion resistance of the weldment. Not exceeding the critical threshold of "time at the sensitization temperature" is paramount to ensure weldment quality.

10:45 a.m. – 11:15 a.m.

Strip Overlay Weld Cladding of Specialty Stainless Steel Alloys

Frank S. Babish, Technical Manager Welding Products, Sandvik Materials Technology, Welding & Wire Products Division

The presentation covers strip overlay welding of specialty stainless steel alloys using the electroslag welding process, allowing high deposition rates of metallurgically clean weld deposits. Alloys include duplex and superaustenitic alloys. Applications for the nuclear industry will be included.

11:20 a.m. – 11:50 p.m.

Alternative Welding Processes for the Fabrication of Titanium Structures

Nick Kapustka, Applications Engineer, Arc Welding, Lasers & Automation, Edison Welding Institute; coauthors: Suhas Vaze and Chris Conrardy

Work is underway at Edison Welding Institute to make the gas metal arc welding process a useful and effective means for welding Ti-6Al-4V. It was necessary to provide adequate inert gas shielding, arc stability, and contact tip life. Other processes include friction stir welding and hybrid laser welding.

11:50 a.m. – 1:00 p.m. Lunch on your own

1:00 p.m. – 1:30 p.m.

Welding Metallurgy of Duplex Stainless Steels

Damian Kotecki, President, Damian Kotecki Welding Consultants, Inc.

Duplex stainless steel weld metal solidifies as 100% ferrite, and the HAZ near the fusion boundary also forms 100% ferrite. It is essential that austenite nucleates and grows in both areas in order for proper properties to be obtained. The critical role of nitrogen in this process is explained. Then remaining ferrite can transform to undesirable phases such as sigma.

1:35 p.m. – 2:05 p.m.

Explosion Welding to Join Dissimilar Metals

Michael Blakely , Director of Market Development, Dynamic Materials Corp.

Explosion welding focuses on joining both similar and dissimilar metals. A value proposition exists when certain materials are required in specific applications for corrosion resistance, light-weighting or temperature distribution, and solid material is impractical.

2:10 p.m. – 2:40 p.m.

The 200 Series Stainless Steels and the Lean Duplex Stainless Steels: Why They Should Be Considered

Cheryl A. Botti, Manager, Market and Product Development, ATI Allegheny Ludlum

Popularity in the use of 200 series stainless steels where 300 series stainless have been traditionally specified continues. Advantages exist with respect to raw material volatility. This talk will address the issues involved with switching to another grade of stainless steel. The popularity of lean duplex stainless steels to replace 300 series stainless steels also continues to grow.

2:45 p.m. – 3:15 p.m.

PCBN Tools for Friction Stir Welding

Jeff Defalco, Business Manager, ESAB Welding & Cutting Products

With the development of pin tools produced from polycrystalline cubic boron nitride and its associative composites, the range of corrosion-resistant, high-melting-temperature materials joined by FSW has grown, including austenitic and superduplex stainless steels and various nickel-based alloys. Pin tool technology and its impact on joining these alloys is presented.

3:20 p.m. – 3:55 p.m.

Corrosion Resistance of New Ni-Cr-Mo and Ni-Mo-Cr Alloys

Henry J. White, Senior Staff Engineer, Welding Metallurgist, Haynes International, Inc.; Coauthors: N. S. Meck, N. Koon, and P. Manning

Alloys Ni-21Cr-17Mo and Ni-22Mo-17Cr are two new materials from Haynes International for use in the chemical process and oil and gas industries, respectively. We will discuss the corrosion properties of the base materials, arc weldments, and laser weldments, each being exposed to a variety of conditions.

2ND ANNUAL NATIONAL WELDING EDUCATION CONFERENCE

Monday, November

9:15 a.m. – 4:30 p.m.

Conference fee: $149 • Registration Code: W20

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

9:15 a.m. – 9:30 a.m.

Weld-Ed and What It Can Do for You

Discussion is centered on the National Center for Welding Education and Training (Weld-Ed) and its work on promoting welding careers, enhancing curriculum, and development of educator professional development activities.

9:45 a.m. – 10:30 a.m.

Skill Panel Update

What have the Weld-Ed national and regional skill panels uncovered regarding the needs for welding professionals in the future. Includes discussions on where the jobs are, emerging green jobs in the welding industry, and industry growth.

10:30 a.m. – 10:45 a.m. Break

10:45 a.m. – 12:00 p.m.

Best Practices of Welding Educators

Learn from your fellow educators and share tips and techniques in the delivery of welding education.

12:00 p.m. – 1:00 p.m. Lunch and Speaker from Industry

1:00 p.m. – 2:00 p.m.

Advanced Manufacturing and Process Showcase

Industry folks share what products and services they have that can benefit the welding educator and assist in the delivery of instruction.

2:00 p.m. – 2:30 p.m.

Problem-Based Learning Applications and Competency Models

Discussion includes examples of curriculum instructional tools and efforts to create competency models for various welding professions.

2:30 p.m. – 2:45 p.m. Break

2:45 p.m. – 3:35 p.m.

Student Recruitment and Retention

Examples of efforts to promote the welding industry and careers to women, minorities, people with disabilities, and special populations.

3:30 p.m. – 4:15 p.m.

Funding and Grant Opportunities

Assistance will be provided to help educators locate, write for, and secure grant funds for their respective welding programs.

4:15 p.m. – 4:30 p.m.

Wrap-up and Evaluations

SEMINARS

Five unique seminars will give you opportunities to gain practical knowledge on welding and inspection in a lively forum with expert instructors. Seminars are discounted for members of AWS, SME, FMA, NAM, or PMA.

In addition, a two-day Resistance Welding School will be held Nov. 17 and 18.

Monday, November 16

9:00 a.m. – 4:30 p.m.

Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmember: $480

Registration Code: W25

THE WHY AND HOW OF WELDING PROCEDURE SPECIFICATIONS

If you are responsible for planning a welding operation, which of the following items are most critical: base metal, welding process, filler metal, current and range, voltage and travel speed, joint design tolerances, joint and surface preparation, tack welding, welding position, preheat and interpass temperature, or shielding gas? This course provides the answers.

This program will benefit owners, managers, engineers, and supervisors who must qualify, write, or revise their own welding procedure specifications to satisfy codes and contract documents.

Topics covered:

- Proper preparation and qualification of welding procedure specifications
- Selecting and documenting welding variables
- Documenting standard procedure qualification testing for commonly used processes for joining ferrous plate and pipe materials.

You can learn:

- Specifying essential and nonessential variables commonly used in sample AWS, ASME, and API code formats
- Using standards when preparing procedures
- Documenting welding variables and qualification tests
- Avoiding the pitfalls in revising previously qualified procedures.

VISUAL INSPECTION WORKSHOP

Monday, November 16 – Tuesday, November 17

9:00 a.m. – 4:30 p.m.

Member of AWS, FMA, SME, NAM, or PMA: $550
Nonmember: $685
Registration Code: W29

A 16-hour course for CWI exam candidates to review the basic concepts and applications of visual inspection. After a discussion of the limitations and advantages of visual inspection, types of weld data that may be obtained by visual inspection are presented and discussed. Includes the many types of discontinuities encountered during the visual inspection of welds. To help the prospective CWI be better prepared for the Part "B" Practical portion of the exam, common tools used for visual inspection are presented and discussed: a machinist's scale, dial calipers, micrometers, fillet weld gauges, the Palmgren gauge, and the V-WAC Undercut gauge. Students will use these gauges to make measurements on weld replicas. A sample weld specification containing acceptance criteria is presented and discussed, after which students use the specification and visual inspection tools to evaluate the weld replicas using a series of specific questions and scenarios.

By attending, you can learn:

- How to use weld measuring instruments
- Compliance to a specific code
- Dos and don'ts of documentation
- When a discontinuity is OK
- When a defect is rejectable
- Why visual inspection can be the most effective NDE technique

CERTIFIED WELDING SALES REPRESENTATIVE SEMINAR

Monday, November 16 – Wednesday, November 18

9:00 a.m. – 5:00 p.m.

Member of AWS, FMA, SME, NAM, or PMA: $575 Nonmember: $655

Apply at aws.org/certification/CWSR. Designed for the welding distributor and manufacturer sales representatives with the intent of introducing basic welding knowledge. This three-day program is not intended to help the participants become practicing welders, but rather gain an understanding of basic processes and equipment that is generic to all manufacturers. The workshop focuses on safety, fundamental principles of general welding operations and processes, basic arc equipment, shielding gases, consumables, and related components. To qualify, you must be a high school graduate and have two years of experience in direct relation to sales of welding and cutting equipment, supplies and other related services. A study guide will be provided for those registering for the workshop and exam that will provide reading assignments necessary to be successful in the workshop activities. An exam (extra cost) is given on the third day leading to certification as an AWS Certified Welding Sales Representative.

METALLURGY APPLIED TO EVERYDAY WELDING

Tuesday, November 17

9:00 a.m. – 4:30 p.m.

Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmember: $480
Registration Code: W26

Metallurgy of welds in carbon and low-alloy steels doesn't need to be complicated. This short course will help you understand how welding affects the properties of base materials, and how weld defects occur.

Owners, inspectors, engineers, and supervisors who specify welding and need to understand the interaction of base, filler, and welding processes should attend.

ROADMAP THROUGH THE D1.1/D1.1M:2008 STRUCTURAL WELDING CODE–STEEL

Wednesday, November 18

9:00 a.m. – 4:30 p.m.

Member of AWS, FMA, SME, NAM, or PMA: $345
Nonmember: $480
Registration Code: W27

This one-day program provides a comprehensive overview of the new AWS D1.1:2008, *Structural Welding Code — Steel*. Each code section, including General Requirements, Design of Welded Connections, Prequalification, Qualification, Fabrication, Inspection, Stud Welding, and Strengthening and Repair of Existing Structures, will be summarized with emphasis on their interrelationships and usage. In addition, the role of mandatory and nonmandatory annexes will be reviewed, along with tips on using the code Commentary. This program will benefit managers, engineers, supervisors, inspectors, and other decision-makers who need comprehensive understanding of what is, and what is not, covered by AWS D1.1:2008 to improve their job effectiveness.

Attendees must bring their own copy of D1.1:2008, *Structural Welding Code — Steel*. Order it online at *www.awspubs.com* or call (888) 935-3464.

AWS EDUCATION SESSIONS

Free sessions that highlight the latest developments in welding education and training programs.

Tuesday, November 17
9:00 a.m. – 4:00 p.m.

Wednesday, November 18
9:00 a.m – 11:00 a.m

Registration Code: W12 • FREE

Tuesday, November 17

9:00 a.m. – 10:00 a.m.

Competency Model Used to Build a Career Ladder in Welding

Dr. Dave Dickenson, consultant (formerly with The Ohio State University and past president of AWS)

10:00 a.m. – 11:00 a.m.

Plummer Memorial Lecture

11:00 a.m. – 11:45 a.m. CANCELLED

Novel Teaching Approach for Welding Using Augmented Reality

Victor Mata Alegre, Bernd Hillers and Axel Graser, Friedrich Wilhelm Bessel Institute

2:00 p.m. – 2:45 p.m.

Higher Education Update

Prof. S. Suresh Babu, the Ohio State University

2:45 p.m. – 3:30 p.m.

AWS SOS

Monica Pfarr, Corporate Director, Solutions Opportunity Squad, AWS Foundation

3:30 p.m. – 4:00 p.m.

Update on the AWS S.E.N.S.E. and Accreditation Programs

Ed Norman, Education Committee Chair, and Steve Houston, Development Subcommittee Chair

Tuesday, November 17

10:00 a.m. – 11:00 a.m.

Room S213 • FREE

Plummer Memorial Education Lecture

The Plummer Memorial Education Lecture Award has been established by the American Welding Society to recognize an outstanding individual who has made significant contributions to welding education and training, and to recognize Fred L. Plummer's service to the society as president from 1952 to 1954 and executive director from 1957 to1969. The recipient of this award will deliver a lecture and receive this education distinction.

This year's presenter is Professor Jack D. Compton of the College of the Canyons. His topic will be "Teaching Human Development Skills to Welders – 20 Years Later." This talk will be based on the Plummer Lecture given by Richard Sabo 20 years ago, with perspective on what Mr. Sabo proposed in 1989 compared to the art and science of welding education today.

Wednesday, November 18

9:00 a.m. – 9:30 a.m.

Perkins IV Presentation

Steve Parrott, Technology and Engineering Education Principal Consultant, Illinois State Board of Education

9:30 a.m. – 10:00 a.m.

Status on NSF Grant for National Center of Excellence in Welding Training and Education

Ramona Anand, Project Manager, Lorain County Community College/Weld-Ed National Center for Welding Education & Training, Elyria, OH

10:00 a.m. – 10:30 a.m.

Effective Teaching Laboratory

Dr. W. Richard Polanin, Professor and Program Chair, Manufacturing Engineering Technology, Welding Technology, Illinois Central College

10:30 a.m. – 11:00 a.m.

A Recipe for Homegrown Welders

Philip McNew, Pittsburg State

Wednesday, November 18

9:00 a.m. – 11:45 a.m.

FREE

Guidance Counselor Workshop

Monica Pfarr; Dr. Tom Lienert; Sam Gentry; H. Briggs Smith, Director of Career and Technical Education for the Hamilton County Department of Education

Monday, November 16

9:15 a.m. – 4:30 p.m.

Conference fee: $149 – Registration Code: W20

NATIONAL WELDING EDUCATION CONFERENCE

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9:15 a.m. – 9:30 a.m.

Weld-Ed and What It Can Do for You

9:45 a.m. – 10:30 a.m.

Skill Panel Update

10:45 a.m. – 12:00 p.m.

Best Practices of Welding Educators

12:00 p.m. – 1:00 p.m.

Lunch and Speaker from Industry

1:00 p.m. – 2:00 p.m.

Advanced Manufacturing and Process Showcase

2:00 p.m. – 2:30 p.m.

Problem-Based Learning Applications and Competency Models

2:45 p.m. – 3:30 p.m.

Student Recruitment and Retention

3:30 p.m. – 4:15 p.m.

Funding and Grant Opportunities

4:15 p.m. – 4:30 p.m.

Wrap-up and Evaluations

RESISTANCE WELDING SCHOOL

This two-day resistance welding school is sponsored by the American Welding Society and the Resistance Welding Manufacturing Alliance, and conducted by industry specialists. The basics of resistance welding and real-life application of the process are covered. Participants learn at their own pace and discuss specific welding concerns with the instructors. You are invited to bring your own samples for discussion.

Please plan to be present for both days of the school. The program is limited to 100 students. The registration fee includes a copy of the Resistance Welding Manual, *Revised Fourth Edition (a $125 value), and a course binder containing all instructor presentations. Participants will also receive a certificate of completion. In addition, there will be tabletop exhibits both days, demonstrating the latest resistance welding products offered by RWMA-member companies.*

Tuesday, November
7:45 a.m. – 5:30 p.m.

Wednesday, November
8:00 a.m. – 4:00 p.m.
Chair: Bruce Kelly, President, Kelly Welding Solutions, Grand Ledge, Mich.
Member AWS, FMA, SME, NAM, or PMA: $475
Nonmembers: $695 • Registration Code: W30

Tuesday, November 17

7:45 a.m. – 8:00 a.m.

Welcome and Introduction to Resistance Welding

Bill Brafford, Technical Liaison Manager; Tuffaloy Products, Inc., Greer, S.C.

8:00 a.m. – 8:30 a.m.

Basics of Resistance Welding Video – Part I

8:30 a.m. – 11:00 a.m.

Electrodes and Tooling

Bill Brafford, Technical Liaison Manager, Tuffaloy Products, Inc., Greer, S.C.

Focus on the classification, selection, and maintenance of electrodes and fixtures as they pertain to numerous applications. By revealing some problem-solving techniques and suggestions, Bill Brafford will familiarize you with some powerful problem/evaluation/solution techniques that will keep your production process running longer — and operation more efficient.

11:10 a.m. – 12:15 p.m.

Welding Controls

Don Sorenson, Director of Engineering, ENTRON Controls, LLC, Greer, S.C.

This discussion focuses on the selection, descriptions, and applications of welding timers, contactors, and accessories. Packed with a punch, Don Sorenson drives home H = I2 RT in a way you'll never forget. He shows you how this invaluable formula is used in every resistance welding application — every day — every cycle — all the time.

12:15 p.m. – 1:45 p.m.

Lunch Served & Tabletop Exhibits

1:50 p.m. – 2:50 p.m.

Welding Controls (continued...)

Continuation of discussion on the selection, description, and applications of welding timers, contactors, and accessories.

3:00 p.m. – 5:30 p.m.

Electrical Power Systems

Mark Siehling, Vice President, Engineering, RoMan Engineering Services, Grand Rapids, Mich.

This session reviews the descriptions and maintenance of electrical power components and conductors from the weld control to the electrode. This lively presentation has something for everybody. Utilizing several small demonstrations, Mark Siehling helps you understand this very important part of the resistance welding process that will keep you on the edge of your seat.

Wednesday, November 18

7:00 a.m. – 8:00 a.m.

Sign-in

8:00 a.m. – 10:00 a.m.

Welding Processes & Machines

Tim Foley, Sr. Applications Engineer, Automation International, Inc., Danville, Ill.

This session will reinforce the very essence of how the resistance welding process works and how the process relates to each of the four resistance welding processes. This session will be full of application examples from each process and how machinery utilizes the individual components and elements illustrated in the other sessions.

10:15 a.m. – 10:45 a.m.

Basics of Resistance Welding Video – Part II

11:00 a.m. – 12:15 p.m.

Troubleshooting and Maintenance

Bruce Kelly, President, Kelly Welding Solutions, Grand Ledge, Mich.

With more than 30 years' experience in the auto industry, specifying, installing, and troubleshooting resistance welding systems, Bruce Kelly will give you tips on how to find the reasons why welds don't turn out the way you would like. This presentation is filled with real-life examples of problems that baffled maintenance persons.

12:15 p.m. – 1:45 p.m.

Lunch Served & Tabletop Exhibits

1:45 p.m. – 3:45 p.m.

Initial Machine Setup

Robert Matteson, Director – Product Development, Taylor-Winfield, Inc., Brookfield, Ohio

Robert Matteson takes you through the selection and maintenance procedures of proper weld schedules and preventive maintenance programs designed to make your resistance welding operations profitable. Hands-on demonstrations peak this presentation.

3:45 p.m. – 4:00 p.m.

Question and Answer Session

POSTER SESSION

The AWS Poster Session is an integral part of the Professional Program. Graphic displays of technical achievements are presented for close, first-hand examination in the Poster Session. Posters present welding results and related material, which are best communicated visually, as well as research results that call for close study of photomicrographs, tables, systems architecture, or other illustrative materials. Posters are presented in five categories: Students in a High School Welding Program, Students in a Two-Year College or Certificate Program, Undergraduate Students, Graduate Students, and Professionals. Be sure to stop by and observe this year's entries.

During show hours – Outside Professional Program Session Area and on Show Floor near the AWS Skills Competition.

UNDERGRADUATE – STUDENT LEVEL

Comparison of CC and CV Power Supplies for FCAW-G Welding
Jason Livingston, Katelynn Carr, and Kevin Gockenbach, The Ohio State University, Columbus, Ohio

Effect of Preheating on Vibration Welding of Thermoplastics
John Daubert, Andy Thompson, Margaret Zantow, Avraham Benatar, and Sean Flowers, The Ohio State University, Columbus, Ohio

Nickel Alloy Electrodes for Welding 9% Ni Steels
Omar Khan, Dan Whiting and Drew McCord, The Ohio State University, Columbus, Ohio

Larger Diameter Wire Joining for Continuous Wire Feeding
Blake McAllister, Roman Martynyuk, and Richard Brawley, The Ohio State University, Columbus, Ohio

Evaluating Automated Extended Stickout GMAW
Adam O'Brien, Nathan Mandeville, and Joseph Doyle, The Ohio State University, Columbus, Ohio

Process Evaluation of SAW with Strip Electrode
Drew Spears, James McClellan, and Zane Bogosian, The Ohio State University, Columbus, Ohio

Weld Repair of Cracks in Hastelloy-X
Frank Argentine, Jason Hurst, and James Rule, The Ohio State University, Columbus, Ohio

Tool Design Optimization in Friction Stir Welding
Brent Ludwig, Ken Bean Jr., Mitch Plant, Devin Hartshorn, and Scott Grove, Materials Joining Engineer, Longview, Tex.

Resistance Spot Welding of Advanced High Strength Steels
Khristain Clymer, Michel Miller, Andrew O'Loughlin, Michael Liu, J. Davis, and Paul Brugmann, Colorado School of Mines, Golden, Colo.

GRADUATE DEGREE STUDENT LEVEL

Hardness Nanoindentation Study of HAZ in RSW of AHSS
Victor H. Baltazar Hernandez, Norman Y. Zhou, University of Waterloo/Centre for Advanced Materials Joining, Waterloo, Ont., Canada

Integrated Experimental and Numerical System for GMAW Process Monitoring and Control
Julien Chapuis, Fabien Soulie, Laboratoire de Mecanique et Genie Civil (LMGC), Montpellier, France

The Effects of SAW Variables on the Penetration Profile Shapes and CVN Fracture Energies of Pipeline Steels
Joel Pepin, Dr. Hani Henein, and Dr. Douglas Ivey, University of Alberta, Edmonton, Alberta, Canada

AWS VOLUNTEER COMMITTEE MEETINGS

Key: (H) = Chicago Hilton (C) = McCormick Place Convention Center * Events not open to pubic

Saturday, November 14

8:00 a.m. – 5:00 p.m.
Education Committee (H) • Hilton Grand Tradition Room

8:00 a.m – 5:00 p.m.
Membership Committee (H) • Hilton

Sunday, November 15

7:45 a.m. – Noon
Foundation Board (C) • Room N229

1:30 p.m. – 5:30 p.m.
Districts Council (C) • Room N227

2:00 p.m. – 6:00 p.m.
C7B/C7 Committee on Electron Beam Welding and Cutting (H) • Room Hilton 4D

Monday, November 16

7:30 a.m. – 9:00 a.m.
D16 Committee on Robotic and Automatic Welding (C) • Room N131

8:00 a.m. – 5:00 a.m.
D14G Subcommittee on Welding of Rotating Equipment (C) • Room N130

8:00 a.m. – 5:00 a.m.
D15C Subcommittee on Railroad Track Welding (C) • Room N132

9:00 a.m. – Noon
AWS Opening Session & Annual Business Meeting (C) • Room N228

9:30 a.m. – Noon
D14I Subcommittee on Hydraulic Cylinders (C) • Room N131

10:30 a.m. – Noon
Comfort Adams Lecture (C) • Room N228

11:15 a.m. – 1:30 p.m.
AWS Image of Welding Awards (C) • Room N140

1:00 p.m. – 5:00 p.m.
A9 Committee on Computerization of Welding Information (C) • Room N426C

1:00 p.m. – 5:00 p.m.
C5 Committee on Arc Welding and Cutting (C) • Room N427BC

1:00 p.m. – 5:00 p.m.
D14B Subcommittee on Welding Design in Heavy Equipment (C) • Room N131

2:30 p.m.
AWS Fellows Committee (H) • Room Hilton PDR 3

3:00 p.m.
Educational Scholarship Committee (H) • Room Hilton Waldorf

4:00 p.m.
AWS Counselors Committee (H)* • Room Hilton PDR 2

Tuesday, November 17

8:00 a.m. – 10:00 a.m.
B1C Subcommittee on Welding Inspection Handbook (C) • Room N427BC

8:00 a.m. – Noon
D14C Subcommittee on Earthmoving & Construction Equipment (C) • Room N131

8:00 a.m. – Noon
D14E Subcommittee on Welding of Cranes and Presses (C) • Room N426C

8:00 a.m. – 5:00 p.m.
D17D Subcommittee on Resistance Welding in Aerospace Applications (C) • Room N427D

8:00 – Noon
G2C Subcommittee on Nickel Alloys (C) • Room N130

8:00 a.m. – 11:30 a.m.
Welding Handbook Committee (C) • Room N427A

10:00 a.m. – 11:00 a.m.
Brazing & Soldering Manufacturers Committee (C) • Room N132

10:00 a.m. – 11:30 a.m.
Plummer Lecture (C) • Room N128

10:00 a.m. – Noon
B1B Subcommittee on Visual Examination of Welds (C) • Room N427BC

10:00 a.m. – 5:00 p.m.
Global Exchange Forum (formerly PACWI/POCWA) (C) * • Room N140

11:00 a.m. – 1:00 p.m.
C6 Committee on Friction Welding (C) • Room N132

1:00 p.m. – 5:00 p.m.
D14 Committee on Machinery and Equipment (C) • Room N426C

1:00 p.m. – 5:00 p.m.
D17K Subcommittee on Fusion Welding for Aerospace Applications (C) • Room N131

1:30 p.m. – 5:00 p.m.
A5H Subcommittee on Filler Metals and Fluxes for Brazing (C) • Room N130

2:00 p.m. – 5:00 p.m.
B1 Committee/Subcommittees on Inspection (C) • Room N427BC

2:00 p.m. – 5:00 p.m.
C2 Committee on Thermal Spraying (C) • Room N132

2:00 p.m. – 3:00 p.m.
AWS National Nominating Committee (open session) (C) • Room N228

5:30 p.m. – 6:30 p.m.
Technical Papers Committee (C) • Room N137

Wednesday, November 18

8:00 a.m. – 10:00 a.m.
A5K Subcommittee on Titanium and Zirconium Filler Metals (C) • Room N130

8:00 a.m. – 5:00 p.m.
D15A Subcommittee on Freight Cars and Their Materials (C) • Room N132

8:00 a.m. – Noon
D17 Committee on Welding in the Aircraft and Aerospace Industries (C) • Room N131

9:00 a.m. – 5:00 p.m.
D9 Committee on the Welding, Brazing, and Soldering of Sheet Metal (C) • Room N427BC

10:00 a.m. – Noon
G2D Subcommittee on Reactive Alloys (C) • Room N130

10:00 a.m. – 10:30 a.m.
Thomas Lecture (C) • Room N227A

10:30 a.m. – 1:00 p.m.
American Council of the IIW (C) • Room N227A

1:30 p.m.– 5:00 p.m.
C3 Committee and Subcommittees on Brazing and Soldering (C) • Room N130

2:00 p.m. – 7:30 p.m.
Standards Council Professional Development Council Communications Council Role and Missions Committee (rolling meeting format, followed by Board of Directors meeting) (H) • Room Hilton Continental A&B

Thursday, November 19

8:00 a.m. – Noon
Board of Directors – Day 2 (H) • Room Hilton Continental A&B

8:00 a.m. – 5:00 p.m.
C3 Committee and Subcommittees on Brazing and Soldering (H) • Room Hilton Marquette Room

8:00 a.m. – 5:00 p.m.
D15A/D15 Committee on Railroad Welding (H) • Room Hilton 4M

2009 PROFESSIONAL WELDERS COMPETITION

You could win the grand prize of $2500 at the Professional Welders Competition, sponsored by the American Welding Society. The competition will take place during the FABTECH International & AWS Welding Show in Chicago, Illinois.

In addition to the $2,500 grand prize, a $1,000 second prize and a $500 third prize will be awarded, and the top 12 competitors will win an AWS duffel bag. Each participant will receive an AWS Professional Welders Competition T-shirt.

Who should compete?

You should compete if you're proficient in using shielded metal arc welding (SMAW) on steel. Welders – union and nonunion alike – are welcome. To compete, you must be at least 19 years old, sign a form stating that you are a professional welder, and pay the $20 entry fee.

You may bring your own helmet, protective clothing, earplugs, etc., or use those provided at the competition site.

Where and when

The Professional Welders Competition will take place on the show floor (at the FABTECH International & AWS Welding Show in McCormick Place North, 2301 S. Lake Shore Drive, Chicago, Illinois. Compete during show hours on Sunday, November 15 through Tuesday, November 17. To register for the show, please visit *www.aws.org/show*.

The welding competition

The contest is a timed event in which a weld is deposited in a pre-tacked joint. Upon final completion, including cleaning of specimen, the contestant will alert the judge who will stop the clock.

The judges

A team of AWS Certified Welding Inspectors will judge the competition using the criteria for size and appearance of the weld as stated in AWS D1.1/D1.1M, *Structural Welding Code —Steel.*

Competition hours

Sunday, November 15
11:00 a.m. - 4:00 p.m.

Monday, November 16
9:30 a.m. - 4:30 p.m.

Tuesday, November 17
9:30 a.m. - 4:00 p.m.
or until time slots are filled

Wednesday, November 18
Awards ceremony

Results will be announced after final judging at 11:00 a.m. in the competition area.

(Winners need not be present at the awards ceremony.)

To enter the competition

Registration will take place at the Professional Welders Competition booth # 40065 on the show floor Sunday, Monday, and Tuesday.

FABTECH INTERNATIONAL & AWS WELDING SHOW

Introducing

Including METALFORM

November 15 – 18, 2009
McCormick Place, Chicago

SHOW REGISTRATION FORM

- **Register by November 3, 2009 to receive your badge by mail. Register after this date and pick up your badge onsite.**
- **Online registrants will receive an immediate e-mail confirmation. Fax/Mail-in registrants will receive a confirmation within 3 business days.**
- **Register onsite and pay the $50 registration fee.**
- **Students: DO NOT use this form to register. Please call (800) 733-4763 for assistance.**
- **No one under 16 years of age admitted.**

3 EASY WAYS TO REGISTER:

ONLINE: www.fabtechexpo.com
FAX: (708) 344-4444
MAIL TO:
FABTECH/AWS Welding Show
Compusystems
P.O. Box 541
Brookfield, IL 60513-0541 USA

If you register online or via fax, DO NOT mail this form. Photocopy this form for additional registrants.

1. Are you a first-time visitor to the show?

A Yes B No

2. Check if you are a member of:

A AWS C SME E NAM G None of the above
B FMA D PMA F AMT

3. Check your ONE primary job function:

1 Job Shop Owner
2 Corporate Executive
3 Manufacturing Production
4 Manufacturing Engineering
5 Inspector/Tester
6 Product Design & Development
7 Welding Engineer
8 Welder, Welding Operator
9 Welding Management
10 Welding Distributor
11 Purchasing
12 Sales/Marketing
13 Educator/Student
14 Other

4. Indicate the products or services you plan to evaluate at the show:

A Arc Welding
B Assembly
C Bending & Forming
D Brazing & Soldering
E Business Services
F Coil Processing
G Cutting
H Fastening & Joining
I Finishing
J Gases & Gas Equipment
K Hydroforming
L Inspection & Testing
M Job Shop/Contract Mfg.
N Lasers
O Lubrication
P Maintenance & Repair
Q Material Handling
R Metal Suppliers
S Plate & Structural Fabricating
T Press Brakes
U Punching
V Resistance Welding
W Robotics
X Safety & Environmental
Y Saws
Z Software, Machine Controls
AA Stamping
BB Thermal Spraying
CC Tooling
DD Tube & Pipe Fabricating or Welding
EE Tube & Pipe Producing
FF Welding Consumables
GG Welding Machines

5. Check the number of employees at your facility:

0 Less than 20
1 20–49
2 50–99
3 100–249
4 250–499
5 500–999
6 1,000–2,499
7 2,500 and Over

6. Indicate your company's total budget for these products or services during the next 12 months:

A Up to $20,000
B $20,001–$50,000
C $50,001–$200,000
D $200,001–$500,000
E $500,001–$1,000,000
F $1,000,001–$5,000,000
G Over $5,000,000

7. Indicate your purchasing authority:

A Evaluate/Recommend
B Specify
C Approve
D No Role

8. Check the primary industry your company serves:

A Agriculture/Landscaping Equipment
B Aircraft/Aerospace
C Automotive
D Rail
E Shipbuilding/Marine
F Other Transportation
G Architectural, Engineering
H Construction
I HVAC
J Appliance
K Consumer Products
L Electronics/Computers
M Furniture
N Medical/Surgical
O Industrial/Commercial Machinery
P Fabricated Metal/Stampings
Q Chemical & Petroleum
R Alternative Energy
S Mining/Utilities
T Government/Military
U Other Manufacturing
V Education
X Non-Manufacturing

9. Year born: 19__ __

CODE: W01

A FREE EXPO REGISTRATION

Mr. Ms. Mrs. Dr.

PLEASE PRINT - ***One Form per Person***

Name _____

Title _____

BUSINESS ADDRESS REQUIRED:

Company _____

Address _____

Address _____

City/State/Zip _____

Postal Code/Country _____

Phone _____ Ext. _____

Fax _____

E-mail _____

? Please do not use my e-mail communications outside of the show.

Free Special Events

K1) Keynote Mon., Nov. 16 K2) Keynote Tues., Nov. 17

Free Solutions Showcase Sessions

Mon., Nov. 16:	T1	T2	T3
Tues., Nov. 17:	T4	T5	T6
Wed., Nov. 18:	T7	T8	

What Is Thermal Spray? (W10) Sun., Nov. 15
Electron Beam Welding Tutorial (W11) Mon., Nov. 16
Free Education Program (W12) Tues. & Wed., Nov. 17-18

Please call (800) 733-4763 if you require special assistance.

FABTECH INTERNATIONAL & AWS WELDING SHOW including METALFORM

PAID PROGRAMS REGISTRATION FORM

Entry into the exposition is included in paid-event fee.

If faxing this form to register, please fax both sides.

Please indicate your name and member number to receive full pricing benefits.

CODE: W01

Name_____

Company_____

I am a member of: AWS FMA SME PMA NAM Nonmember

Member Number _____

AWS PROGRAMS

National Welding Education Conference
Conference fee $149 (W20) Mon., Nov. 16

One-Day AWS Conferences
AWS/FMA/SME/NAM/PMA Member: $345
Nonmember: $480 includes 2-year AWS membership

Weld Cracking VII: The Heat-Affected Zone
(W21) Mon., Nov. 16

New Developments in Thermal Spray Coatings
(W22) Mon., Nov. 16

Welding of Chrome-Moly Steels
(W23) Tues., Nov. 17

Welding of Corrossion-Resistant Alloys
(W24) Wed., Nov. 18

One-Day Seminars
AWS/FMA/SME/NAM/PMA Member: $345
Nonmember: $480 includes 2-year AWS membership

Why & How of Welding Procedure Specifications
(W25) Mon., Nov. 16

Metallurgy Applied to Everyday Welding
(W26) Tues., Nov. 17

Road Map through the D1.1
(W27) Wed., Nov. 18

Two-Day Electron Beam Conference
AWS/FMA/SME/NAM/PMA Member: $550
Nonmember: $685 includes 2-year AWS membership

International Electron Beam Welding Conference
(W28) Tues. & Wed., Nov. 17-18

Two-Day Visual Inspection Workshop
AWS/FMA/SME/NAM/PMA Member: $550
Nonmember: $685 includes 2-year AWS membership

Visual Inspection Workshop
(W29) Mon. & Tues., Nov. 16-17

RWMA Resistance Welding School
AWS/FMA/SME/NAM/PMA Member: $475
Nonmember: $695 includes 2-year AWS membership
(W30) Tues. & Wed., Nov. 17-18

One-Day Professional Program
AWS/FMA/SME/NAM/PMA Member: $150
Nonmember: $285 includes 2-year AWS membership
(W31) Mon., Nov. 16 (W32) Tues., Nov. 17
(W33) Wed., Nov. 18

Three-Day Professional Program
AWS/FMA/SME/NAM/PMA Member: $225
Nonmember: $360 includes 2-year AWS membership
(W34) Mon.-Wed., Nov. 16-18

Three-Day Student Professional Program
AWS/FMA/SME/NAM/PMA Member: $75
Nonmember: $90 includes 1-year AWS student membership
(W25) Mon.-Wed., Nov. 16-18

AWS Awards/AWS Foundation Recognition Ceremony and Luncheon
$30 luncheon cost
(W13) Tues., Nov. 17

FABTECH EDUCATIONAL SESSIONS

1 Session FMA/AWS/SME/NAM/PMA Member $175; Nonmember $200
2 Sessions FMA/AWS/SME/NAM/PMA Member $305; Nonmember $350
3 Sessions FMA/AWS/SME/NAM/PMA Member $400; Nonmember $470
4-5 Sessions FMA/AWS/SME/NAM/PMA Member $555; Nonmember $645
6-9 Sessions FMA/AWS/SME/NAM/PMA Member $700; Nonmember $800

Select the FABTECH Educational Sessions below you would like to attend. See page 22 for codes. The price for a multiple session purchase is noted at left, and is not combinable with AWS programs above. Do not register for more than one session in each time slot each day as sessions run concurrently. After Oct. 30 and on-site, add $25 to the purchase price of FABTECH Educational Sessions only.

Sun., Nov. 15
PM Sessions: 1:30-3:30 PM
F10) F11) F12)

Mon., Nov. 16
AM Sessions: 8:00-10:00 AM
F20) F21) F22) F23) F24)
S20) S21) S22)

AM Sessions: 10:30 AM-12:30 PM
F30) F31) F32) F33)
F34) ? F35) F36) F37)
S30) S31)

PM Sessions: 1:30-3:30 PM
F40) F41) F42) F43)
F44) F45) S40)

Tues., Nov. 17
AM Sessions: 8:00-10:00 AM
F50) F51) F52) F53) F54)
F55) F56) S50) S51) S52)

AM Sessions: 10:30 AM-12:30 PM
F60) F61) F62) F63) F64)
F65) F66) F67) S60) S61)
S62)

PM Sessions: 1:30-3:30 PM
F70) F71) F72) F73) F74)

Wed., Nov. 18
AM Sessions: 8:00-10:00 AM
F80) F81) F82) F83) S80)
S81)

AM Sessions: 10:30 AM-12:30 PM
F90) F91) S90) S91)

EXHIBITS ONLY
Free if pre-registered. • $50 on-site. Complete the form on other page.

AWS PROGRAMS SUBTOTAL: $_____

FABTECH SESSIONS SUBTOTAL: $_____

TOTAL FEES $_____
Full payment must accompany your registration.

Payment

Forms received without payment will not be processed. Payment due in U.S. Funds.

Check enclosed (checks payable to SME) Total amount due $_____

Authorize charge to my credit account (Complete credit card information below)

CHECK ONE: VISA American Express MasterCard Discover

Name (Please print)

Signature

CCID

Credit Card Number

Expiration Date

Nonmember price for AWS Sessions only (except National Welding Education Conference) includes a two-year AWS Individual Membership. Member benefits include a subscription to the *Welding Journal*, a 25% discount on AWS publications, membership in a local section and more.

Nonmember Student Professional Program price includes a one-year AWS Student Membership.

Cancellation Policy
Cancellations must be made in writing and faxed to Attn: FABTECH Intl & AWS Welding Show Conference Cancellation at (313) 425-3407 no later than Oct. 30, 2009 to receive a full refund minus a $50 administration fee. Cancellations received after this date are non-refundable.

CARRERA™

$200.00 VALUE FOR UNDER $100.00*

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

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SEE US AT THE FABTECH/AWS SHOW BOOTH #32071

For Info go to www.aws.org/ad-Index

Welding Show 2009
Exhibit Highlights

This alphabetical listing of exhibitors in the 2009 AWS Welding Show offers a preview of what they will display in each booth. AWS Sustaining Member Companies are highlighted in color.

A & A Mfg. Co. 13040
2300 S. Calhoun Rd., New Berlin, WI 53151
(800) 298-2066; FAX (262) 786-3280
www.gortite.com

AAF International (American Air Filter) 38088
PO Box 35690, Louisville, KY 40232-5690
(800) 477-1214; FAX (800) 254-3019
www.aafintl.com

AAF® International (American Air Filter) will feature its solutions to complex air-pollution control problems featuring efficient and economical equipment ranging from completely packaged units to large, custom-engineered systems. On display will be bag, cartridge, wet-type, and mist collectors; and portable fume/smoke collectors and arms.

ABB, Inc. 32047
1250 Brown Rd., Auburn Hills, MI 48326
(248) 391-9000; FAX (248) 391-8440
www.us.abb.com

ABB will showcase its industrial robots, modular manufacturing systems, and various services for helping manufacturers improve productivity, product quality, and worker safety.

Abbott Furnace Co. 37011
1068 Trout Run Rd., PO Box 967
St. Marys, PA 15857
(814) 781-6355; FAX (814) 781-7334
www.abbottfurnace.com

Abbott Furnace will promote its continuous mesh belt, cast link belt, pusher, and batch furnaces for high-tech materials. The products include models designed to meet specific process requirements using electric or gas heating for aging, annealing, tempering, austenizing, brazing, carburizing, carbon nitriding, drawing, hardening, nitriding, normalizing, quenching, sintering, steam treating, and stress relieving.

Ace Industrial Products 37050
5043 Farlin Ave., St. Louis, MO 63115
(314) 385-5178; FAX (314) 385-3254
www.aceindustrialproducts.com

Ace Industrial Products will promote its heavy-duty welding fume extractors featuring source-capture portable and mobile equipment, downdraft tables, extraction arms, and general-capture air cleaners for both shop and field work.

ADF Systems Ltd. 13021
PO Box 278, Humboldt, IA 50548
(515) 332-5400; FAX (515) 332-4475
www.adfsys.com

ADF will display its complete line of aqueous parts washers from small batch washers to conveyor washers including specialty washers designed to specific customer requirements.

AEC Technology Srl 38033
Via Leonardo Da Vinci 17
PIVA and CF 01333750196
Campagnola Cremasca 26013, Italy
39-0373-752111; FAX 39-0373-74443
www.aectechnology.it

AEC Technology will introduce its heat treatment equipment and accessories for stress relieving welds using various methods including net/medium frequency induction, the Joule effect, and infrared radiant panels. The target industries are welded construction, petrochemical, refineries, thermoelectrical power, automotive, water treatment, pipeline construction, shipyard, and metal fabrication.

Aero Filter Systems 39070
2615 Holmes St., Kansas City, MO 64108
(816) 842-1773; FAX (816) 531-7403
www.aero-filter.com

AIM, Inc. 2005
502 S. Vista Ave., Addison, IL 60101
(630) 458-0008; FAX (630) 458-0730
www.aimmachines.com

Air Products and Chemicals, Inc. 8075
7201 Hamilton Blvd., Allentown, PA 18195-9642
(800) 654-4567; FAX (800) 272-4449
www.airproducts.com/microbulk

Air Products will showcase its CryoEase microbulk product, which offers a cost-effective, reliable alternative to cylinders for your argon, nitrogen, oxygen, or carbon dioxide needs. Features include specially designed delivery tankers for smaller volume drops in tight access areas and on-site storage systems with turnkey gas delivery installations from point of supply to point of use.

Air Quality Engineering, Inc. 38012
7140 Northland Dr. N., Brooklyn Park, MN 55428
(800) 328-0787; FAX (763) 531-9900
www.air-quality-eng.com

The company will highlight its high-quality air cleaning and purifying equipment specializing in weld fume and mist removal utilizing multiple filtration stages on both the stand-alone and portable units.

Airflow Systems, Inc. 36000
11221 Pagemill Rd., Dallas, TX 75243
(214) 503-8008; FAX (214) 503-9596
www.airflowsystems.com

Ajan Elektronik Servis San Ve 34064
Merkez Mah 67, Sokak No. 3
Sasali-Izmir 35620, Turkey
90232-327-3480; FAX 90232-327-3430
www.ajancnc.com

The company will promote its CNC plasma and oxyfuel cutting, drilling, and pipe-cutting machines at the Show.

Alcotec 34043
411 S. Ebenezer Rd., Florence, SC 29501
(843) 664-4433; FAX (843) 679-5815
www.alcotec.com

AlcoTec Wire will feature aluminum welding wire. As a fully integrated aluminum welding and brazing wire producer, the company has the capabilities to shave, draw, spool, cut, test and distribute its products.

Alfra USA, LLC 7037
120 Prairie Lake Rd., Ste. B
East Dundee, IL 60118-9128
(847) 844-8900; FAX (847) 844-8950
www.alfra.us

Americ Corp. 37084
785 Bonnie Ln., Elk Grove Village, IL 60007
(800) 364-4642; FAX (847) 364-4695
www.americ.com

America Fortune Co. 39065
6600 Sands Point Dr., Ste. 121
Houston, TX 77074-3712
(713) 779-8882; FAX (713) 774-1763
www.americafortune.com

American Friction Welding 33124
115 N. Janacek Rd., Brookfield, WI 53045
(262) 797-8840; FAX (262) 797-9932
www.teamafw.com

American Society for Nondestructive Testing 31057
1711 Arlingate Ln., Columbus, OH 43228
(614) 274-6003; FAX (614) 274-6899
www.asnt.org

American Technical Publishers 38014
10100 Orland Pkwy.
Orland Park, IL 60467-5762
(708) 957-1100; FAX (708) 957-1101
www.go2atp.com

American Torch Tip Co., Inc. 35115
6212 29th St. E., Bradenton, FL 34203
(941) 753-7557; FAX (941) 753-6917
www.americantorchtip.com

American Welding Society 40021
550 NW LeJeune Rd. Miami, FL 33126-5649
(800/305) 443-9353; FAX (305) 443-7559
www.aws.org

The American Welding Society (AWS) was founded in 1919 as a multifaceted, not-for-profit organization with a goal to advance the science, technology, and application of welding and related joining disciplines. AWS will provide a wide array of education and certification programs at the Show. Visit *www.aws.org/show* for details.

AWS Certification. AWS develops and administers a variety of certification programs for welding professionals to help industry identify qualified personnel and provide individuals with meaningful career objectives. The AWS Certified Welding Inspector (CWI) program currently has more than 28,000 CWIs and CAWIs. Since 1976, more than 55,000 have been certified. The AWS CWI program has become the gold standard for weld inspection credentials and has enhanced the careers of many thousands of welding professionals. In

1989, the AWS Certified Welder program was launched to document the qualifications of welders nationwide. The testing facilities used to conduct the qualification procedures are AWS accredited. AWS maintains these certifications and a list of Accredited Test Facilities (ATF) in a National Registry. Welding instructors can earn an important credential through the AWS Certified Welding Educator program implemented in 1991. Other AWS certification programs are the Senior Certified Welding Inspector, Certified Welding Supervisor, Certified Radiographic Interpreter, Certified Welding Fabricator, Certified Robotic Arc Welding, and Certified Welding Sales Representative. All of these programs are offered domestically and many are offered internationally. Stop by the Certification booth to find out why AWS certification may be the right answer for you and your company.

AWS Foundation. Three years ago, the AWS Foundation, Inc., inaugurated the Welding for the Strength of America Capital Campaign to add financial support to assist with the critical shortage of welders in the United States workforce. The effort has two goals: establish additional scholarships to support entry-level students and those already involved in the welding profession; and build funding to support the AWS Welder Workforce Development Program. The predicted 200,000 welder shortage by 2010 must be addressed and AWS has assumed this critical role, but to do so we must have financial support from our industry partners.

Since the start of the AWS Foundation scholarship program in 1991, it has awarded nearly $4.2 million for welder training to more than 3000 students. The awards vary widely but the major emphasis is welder workforce development. For the 2009–2010 academic term, awards were made to more than 390 students for more than $400,000.

The Foundation needs everyone's help to respond at more significant levels of support. To date, it has raised more than $4.4 million, but more money is needed to significantly impact the welder workforce shortage. You and your company, and others who are adversely impacted by the welder shortage are urged to support the AWS Foundation. Call Sam Gentry (800/305) 443-9353, ext. 331, or visit the Foundation's booth #40021. Let us tell you more about how your contribution can assist more welders to enter the workforce. Join the "Welding for the Strength of America" Capital Campaign.

Membership. AWS services nearly 58,000 individual members and more than 1800 corporate members worldwide. Members include engineers, scientists, educators, researchers, welders, inspectors, welding foremen, company executives, and sales associates. Member interests include automatic, semiautomatic, and manual welding, as well as brazing, soldering, ceramics, laminations, robotics, and safety and health issues. Drop by the AWS Membership Booth on the Show floor, sign up for an Individual Membership, and get a popular welding publication (up to a $192 value) at a 90% discount. Browse through the AWS Bookstore and save 25% on more than 300 AWS publications. Save $135 and get a two-year AWS Membership when you sign up for the Professional Program at the Show. Stay informed on the latest products, trends, and technology with 12 issues of the *Welding Journal*. Looking for a job? As an AWS Member, post your résumé on AWS JobFind at *www.awsjobfind.com* absolutely free. Establish valuable partnerships with others in your field by attending local AWS Section meetings and dozens of educational events. Gain a voice in determining the future of your industry by getting involved in one of AWS's 180 technical committees. For depth, detail, and technical insight — AWS has all the answers.

Welding Journal, Inspection Trends,* and *Welding Journal en Español. *Welding Journal* is the official publication of the American Welding Society. This monthly publication contains feature articles on practical and applied welding technology, peer-reviewed welding research, information on AWS activities and programs, and a variety of monthly columns. Industry experts also answer readers' questions regarding stainless steel, aluminum, brazing, and resistance welding. *Inspection Trends* serves the nondestructive examination industry including more than 28,000 AWS Certified Welding Inspectors. It contains timely features on all phases of nondestructive examination, profiles of inspection personnel, and columns that bring the latest industry news and practical answers to inspection questions. *Welding Journal en Español* presents the best features and depart-

ments from the *Welding Journal* in Spanish. The articles are selected for their universal appeal and practicality. The publication also contains original articles that focus on the Latin market.

AMET, Inc. **35035**
355 Dividend Dr., Rexburg, ID 83440
(208) 356-7274; FAX (208) 356-8932
www.ametinc.com

Ampco Metal, Inc. **38075**
4475 N. 124th St., Ste. F, Brookfield, WI 53005
(262) 790-6940; FAX (262) 790-7150
www.ampcometal.com

Ampco Metal will exhibit its copper-alloy arc welding, machined parts, and rod and bar mill products. The products to be featured are aluminum-bronze, nickel-aluminum-bronze, manganese-nickel-aluminum-bronze welding alloys, copper alloy machined parts, and high-conductivity alloys.

Anglo American Enterprise Corp. **8037**
403 Kennedy Blvd., PO Box 10
Somerdale, NJ 08083-0010
(856) 784-8600; FAX (856) 784-0085
www.angloamericantools.com

The company will display its GRIP-ON locking pliers and metal-holding tools, and URKO clamps.

AQC, Inc. **38132**
660 De La Sabliere
Bois des Filion, QC J6Z 4T7, Canada
(450) 621-6661; FAX (450) 621-6677
www.aqcdust.com

Aquasol Corp. **32115**
80 Thompson St., North Tonawanda, NY 14120
(716) 564-8888; FAX (716) 564-8889
www.aquasolcorporation.com

Aquasol will display its products for enhancing purging efficiency, including water-soluble paper and tape, preformed water-soluble purge dams, purge-gas retaining tape, cleaning wipes, fiberglass backing tape, oxygen monitors, and socket weld spacer rings.

Arc Abrasives, Inc. **36057**
PO Box 10, Troy, OH 45373
(937) 335-5607; FAX (937) 339-4969
www.arcabrasives.com

ARC Abrasives will showcase its products and services for weld removal, deburring, flash removal, and metallic surface finishing.

Arc Machines, Inc. **32081**
10500 Orbital Way, Pacoima, CA 91331
(818) 896-9556; FAX (818) 890-3724
www.arcmachines.com

ARCON Welding Equipment LLC **32038**
2203 Northwood Dr., Bldg.10, Salisbury, MD 21801
(888) 512-7266; FAX (410) 572-6027
www.arconweld.com

ARCON Welding Equipment will feature its Workhorse line of portable inverter arc and stud welding machines designed for harsh environments including shipyards, mines, power plants, oil rigs, and paper mills, as well as for fabrication and maintenance operations. Also to be displayed are its complete welding packages for its shielded metal arc, gas tungsten arc, flux cored arc, and stud welding machines.

ArcOne **32071**
85 Independence Dr., Taunton, MA 02780
(508) 884-9600; FAX (508) 884-9666
www.arc1weldsafe.com

ArcOne will display its latest technology in autodarkening welding helmets, inverter power sources, respiratory protection, and head and face protection products. Included will be a new array of hard hats, eyewear, goggles, visors, and respiratory protection.

Arc Products **31043**
1245 30th St., San Diego, CA 92154
(800) 770-0063; FAX (619) 628-1028
www.ap-automation.com

Arc Products will promote its wide range of automated welding products and in-house capabilities, which include electrical and mechanical engineering, fabrication and assembly, its own product line employing joint tracking, torch height control, magnetic arc control, and a complete line of orbital welding equipment. Its product line is available as separate components or completely assembled turnkey welding packages.

Arc Specialties, Inc. **36100**
1730 Stebbins Dr., Houston, TX 77043
(713) 631-7575; FAX (713) 366-0844
www.arcspecialties.com

Arc Specialties will detail its engineering services, process and procedure development, systems integration, service, parts, and train-

ing at its booth. Its specialties, robotics, CNC, and PLC systems will be on display, as well as parts welded using GTA, PTA, SA, and resistance stud welding processes.

Arro-Mark Co. LLC 8031
158 W. Forest Ave., Englewood, NJ 07631
(201) 567-4112; FAX (201) 567-1373
www.arromark.com

Arrow Castings Ltd. 32080
Bow House 3 Brookway
Newbury Berkshire RG14 5RY, UK
44-163-548500; FAX 44-163-548600
www.gasgrab.com

Asiamet, Inc. 30028
9 Evelyn Ct., Syosset, NY 11791
(516) 942-3884; FAX (516) 942-4058
www.asia-met.com

Assembly Magazine 38097
600 Willowbrook Ln., Ste. 610
West Chester, PA 19382
(610) 436-4220; FAX (248) 283-6620
www.assemblymagazine.com

Astro Arc Polysoude, Inc. 36093
24856 Ave. Rockefeller, Valencia, CA 91355
(661) 702-0141; FAX (661) 702-0632
www.astroarc.com

Astro Arc's booth will feature its orbital and mechanized welding solutions, specializing in narrow-gap hot wire GTAW, multiprocess cladding, seam welding machines, and tube, pipe and sheet welding systems.

Atema, Inc. 32046
742 N. Lasalle St., Ste. 400, Chicago, IL 60654
(312) 861-3000; FAX (216) 373-7297
www.atema.com

Atema will highlight its quality-assessment programs that offer distinctive training and management assistance to companies interested in improving their quality management system and meeting various certification requirements.

ATI Garryson 31047
1 Teledyne Pl., La Vergne, TN 37086
(615) 641-4206; FAX (615) 641-4441
www.atigarryson.com

ATI Industrial Automation 33043
1031 Goodworth Dr., Apex, NC 27539
(919) 772-0115; FAX (919) 772-8259
www.ati-ia.com

Atlanta Drive Systems, Inc. 37057
1775 Rte. 34, Ste. D10, Wall Township, NJ 07727
(732) 282-0480; FAX (732) 282-0450
www.atlantadrives.com

Atlanta Drive Systems will feature its linear motion technology, including a wide range of standard rack and pinions and servo-reducers, including both helical and straight (spur) tooth versions, in an assortment of sizes, materials and quality levels, to meet almost any axis drive requirements. Also to be shown will be preloaded zero-backlash rack and pinion drives for ultraprecise positioning and repeatability applications.

Atlantic China Welding Consumables, Inc. 40030
No. 2 Machongkou St., Zigong 643010, China
86-8-135-103627; FAX 86-8-135-103072
www.chinaweld-atlantic.com

Atlas Welding Accessories, Inc. 32070
501 Stephenson Hwy., PO Box 969, Troy, MI 48083
(248) 588-4666; FAX (248) 588-2706
www.atlaswelding.com

Auburn Mfg., Inc. 37007
PO Box 220, Mechanic Falls, ME 04256
(207) 345-8771; FAX (207) 345-3380
www.auburnmfg.com

Automotive Lift & Machinery Corp. (ALM) 32060
200 Benchmark Dr., Streator, IL 61364
(815) 673-5546; FAX (815) 673-2292
www.almcorp.com

ALM will feature its standard and custom-made heavy-duty positioners for welding and assembly operations.

AVS Industries LLC 39075
21 Bellecor Dr., Ste. C., New Castle, DE 19720
(302) 221-1720; FAX (302) 221-1721
www.avsind.com

The company's Silica Fabrics line for protection in welding and cutting environments will be featured at the booth. Four different weights of satin weave silica, in widths up to 60 inches, and fabricated parts made with engineered silica and fiberglass fabrics will be shown to demonstrate the performance versatility of these fabrics. Silica specialty textile products consisting of tapes, ropes, and sleeving will also be shown.

Axelent, Inc. 32033
10499 164th Pl., Ste. B, Orland Park, IL 60467
(708) 745-3130; FAX (708) 745-3125
www.axelentusa.com

Axelent's booth will highlight its modular design, flexible, and versatile safety partitioning and mesh wall systems for robotic and material-handling applications.

B & Bartoni spol SRO 32050
Doubravicka 18, Dolni Cetno 29430, Czech Republic
42-032-6 335 225; 42-032-6 335 942
www.b-bartoni.cz

Bad Dog Tools 6156
PO Box 851, 24 Broadcommon Rd.
Bristol, RI 02809
(800) 252-1330; FAX (401) 253-1377
www.baddogtools.com

Basis Tech Industrial Ltd. 33055
Rm. 905, 9/F Blissful Bldg. 243-247
Des Voex Rd., Central Sheung Wen
Hong Kong 518054
(604) 619-2190; FAX (604) 648-8631
www.basis-tech.net

Basis Tech Industrial will feature its line of professional-quality autodarkening welding helmets designed to meet ANSI and DIN criteria. The company's complete line of CE/ANSI/DIN test equipment will also be displayed.

Behringer Saws, Inc. 13137
721 Hemlock Rd., Morgantown, PA 19543
(610) 286-9777; FAX (610) 286-9699
www.behringersaws.com

Behringer Saws will showcase its sawing and material-handling and productivity-enhancing products designed for corporations, service centers, job shops, and manufacturers. Highlighted will be its Eisele brand of manual, semiautomatic, and automatic circular saws, and the Vernet line of structural fabricating equipment for high-performance drilling, punching, shearing, notching, and marking.

Beijing Aurora Safety & Protection Technology Ltd. 31055
R# 1105 ZhongKe A Bldg. No. 22
ZhongGuanCun Ave., HaiDian Dist.
Beijing 100190, China
86-10-62524522; FAX 86-10-62572030-890
www.aurosfty.com

Beijing Ess Ltd. 33053
Cannes Industrial Park, No. 18
Shuang Qiao Dong Lu,
Chaoyang Dist., Beijing 100121, China
8610-51662600; FAX 8610-52350093
www.steeltailor.com

SteelTailor™ will display its line of CNC cutting machine products currently used in more than 50 countries. Information will also be provided on its 24-h service capabilities.

Beijing Pattison Welding Equipment Co. Ltd. 31005
No. 55 St. Guandongdian
Beijing 100080, China
86-010 63645675; FAX 86-010 63645675

BIBIELLE SpA 37115
Via Cuneo 35, Margarita 12040, Italy
(866) 347-0762; FAX (866) 347-0761
www.bibielle.us

Blastec, Inc. 8085
4965 Atlanta Hwy., Alpharetta, GA 30004
(770) 475-2700; (770) 475-2336
www.blastec.com

Blastec's booth will feature its line of heavy-duty shot blast and surface-preparation equipment designed for fabricators and manufacturers with medium- to high-volume facilities. Designed specifically for the structural market, and both pre- and postfab applications with plate, wide-flange beams, and girders. Very large weldments are a specialty.

Bluco Corp. 37064
3500 Thayer Ct., Aurora, IL 60504
(800) 535-0135; FAX (630) 637-1847
www.bluco.com

Bluco's modular fixturing system for welding features 3-D tables and a complete family of modular elements that can be assembled quickly and accurately to fixture just about any size and type of part will be featured at the Show. The fixtures are ideal for prototypes, short runs, spares, or high volume. In addition to welding, the systems can also be used for fixturing for inspection, assembly, testing, and machining of large parts.

Blue Ocean Global LLC 7158
853 N. Quentin Rd., #313, Palatine, IL 60067
(888) 578-3088; FAX (888) 578-3088
www.blueoceanglobal.net

BMM Welding Material Co. 31070
No. 5 Fangzhuang Lu, Zuanmenwai
Beijing 100078, China
8610-676-49947; FAX 8610-676-44579
www.bjmmt.com

BMM Welding will display its wide assortment of welding wires, rods, bars, and electrodes made from copper, aluminum, nickel, tita-

nium, magnesium, hafnium, zirconium, tungsten, molybdenum, silver, stainless steel, and flux cored wires, carbon gouging electrodes, ceramic nozzles, beads, backings, and other related products.

Bohler Welding Group USA, Inc. 36089
10401 Greenbough Dr., Stafford, TX 77477
(281) 499-1212; FAX (281) 499-4347
www.bohlerweldinggroupusa.com

Stop at the booth to learn about Bohler's electrodes, wires, strip, fluxes, and flux cored wires. On display will be products from its brand names Bohler, T-PUT, Soudokay, and UTP. The company services the needs of the international welding community for petrochemical, power-generation, maintenance, and repair. Representatives will be available to discuss your specific applications, specifications, and needed approvals.

Bolttech Mannings 32114
501 Mosside Blvd., North Versailles, PA 15137
(724) 872-4873; FAX (412) 829-1934
www.bolttech.com

Bolttech Mannings will highlight its on-site heat treating equipment, hydraulic torqueing, tensioning, stud removal, and machining services available worldwide. The products feature medium-frequency induction, high or low voltage resistance, and high-velocity combustion heating technology for pre- and postheating, stress relieving, and heat treating of materials to all standard codes and for special applications.

Bonal Technologies, Inc. 39015
1300 N. Campbell Rd., Royal Oak, MI 48067
(248) 582-0900; FAX (248) 582-0901
www.bonal.com

Bonal Technologies will showcase its subharmonic vibratory technology for metals. Featured will be the Pulse Puddle Arc Welding® equipment and Meta-Lax® 2700-CC computerized stress-relieving equipment.

Bortech Corp. 32065
66 Victoria St., Keene, NH 03431
(603) 358-4030; FAX (603) 358-4007
www.bortech.com

Stop at the booth to see the company's solutions for making fast, high-quality automated circular GMA overlay welds for machine repair, corrosion protection, abrasion resistance, or repetitive circular fabrication applications. The products are designed for cladding bores, outside diameters, flange faces, and conical surfaces. Typical applications include heavy equipment repair, pump and valve repair, and heat exchanger nozzle cladding with bore sizes from ½ in. to 12 ft.

Bosch Power Tool Corp. 40042
1800 W. Central Rd., Mt. Prospect, IL 60056
(224) 232-2584; FAX (224) 232-2611
www.boschtools.com

Bosch will feature its complete line of professional angle grinders, power tools, and accessories at the booth. Featured will be cordless tools, shears, nibblers, and bench-top tools for welding and metal-fabrication shops.

Bowlin Engineering 32054
600 Burlington Rd., Saginaw, TX 76179
(817) 232-2020; FAX (817) 232-4081
www.bowlinengineering.com

Bradford Derustit Corp. 39028
21660 Waterford Dr., Yorba Linda, CA 92887
(877) 899-5315; FAX (877) 285-2080
www.derustit.com

Bradford Derustit will exhibit its metal cleaners, pickling and passivation products, and degreasers at the booth.

Bren, Inc. 7077
8401 Covington Rd., College Grove, TN 37046
(615) 794-6825; FAX (615) 794-7478
www.breninc.com

Broco, Inc. 37089
10868 Bell Ct., Rancho Cucamonga, CA 91730
(909) 483-3222; FAX (909) 483-3233
www.brocoinc.com

Broco and Rankin Industries will display their maintenance and repair welding, cutting, and wear-resistant products at the booth. Highlighted will be Broco's exothermic cutting and underwater welding systems. Rankin Industries will showcase its hardfacing and wear solutions products. A new line of automatic and semiautomatic tungsten carbide vibratory feeder systems for flux cored arc welding application will be presented.

Bruker AXS Handheld 14035
415 N. Quay St., Ste. 1, Kennewick, WA 99336-7783
(509) 783-9850; FAX (509) 735-9696
www.brukerhandheld.com

Bug-O-Systems/ Cypress Welding 35025
161 Hillpointe Dr.,Canonsburg, PA 15317
(412) 331-1776; FAX (412) 331-0383
www.bugo.com

Bug-O Systems/Cypress Welding Equipment, will display the Bug-O All Time Girth Welder, a self-propelled welding system for horizontal welding of field storage tanks, and the new Piper-Bug for pipe welding. Introduced at the Show will be an expanded line of positioners and turning rolls.

Burny & Kaliburn 38003
7550 Hub Pkwy., Cleveland, OH 44125
(216) 524-8800; FAX (216) 642-2199
www.burny.com

Cleveland Motion Controls is a provider of shape cutting systems to machine manufacturers and end users. Displayed at the Show will be the complementary product lines of Burny® and Kaliburn® offering a wide array of conventional and high-current-density plasma cutting systems, including easy-to-use shape-cutting motion-control solutions for plasma, oxyfuel, and waterjet cutting machines, as well as for routing, engraving, and dispensing equipment.

Canada Fujian Powder Metallurgy 30011
570 Hood Rd., Ste. 26, Markham, ON L3R 4G7, Canada
(905) 470-9812; FAX (905) 470-8892
www.fjgoldenstar.com

Car-Ber Testing Services 39017
3257 Holderman Rd., Morris, IL 60450
(800) 592-8378; FAX (800) 693-2036
www.carbertesting.com

Car-Ber Testing Services will spotlight its spe-

Böhler Welding
GROUP

Your Best Choice in Welding Consumables

We manufacture and supply welding consumables for high corrosion and high temperature applications spanning from mild and stainless steel to products for repair and maintenance, hardfacing and brazing, supported by a Technical Sales Organization which has your application answers.

SEE US AT THE FABTECH/AWS SHOW BOOTH #36089

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

Bohler Welding Group USA, Inc.
10401 Greenbough Drive
Stafford, TX 77477
Phone: (281) 499-1212 • (800) 527-0791
Fax: (281) 499-4347

Avesta Welding LLC
3176 Abbott Road
Orchard Park, NY 14127
Phone: (716) 827-4400
Fax: (716) 827-4404

Bohler Welding Group Canada, Ltd.
1555 Bonhill Road, Unit 11
Mississauga, ON L5T 1Y5
Phone: (905) 564-0589 • (888) 725-3593
Fax: (905) 564-2027

www.bohlerweldinggroupusa.com

cialty isolation and hydrotesting services for the oil and gas, petrochemical, power, and pulp and paper industries. Its technicians are trained to cost-effectively cold cut, bevel, isolate, and weld test any size pipe from ¾ to 60 in. diameter.

Carhartt Workwear at Rugged Outfitters **38101**
89 Broadway, Park Ridge, NJ 07656
(201) 379-3102; FAX (201) 326-1053
www.ruggedoutfitters.net

Rugged Outfitters will spotlight its extensive lines of Carhartt and Dickies workwear apparel and footwear. Detailed will be its custom logo embroidery and screen printing services, and volume discount pricing.

CENIT North America, Inc. **13123**
691 N. Squirrel Rd., Ste. 275, Auburn Hills, MI 48326
(248) 276-8540; FAX (248) 856-2478
www.us.cenit-group.com

CENIT will display its latest software offering advanced functionality to robotic offline programming and simulation, NC programming, design automation, and postprocessing.

Cepro Welding Safety LLC **40003**
500 N. Michigan Ave., Ste. 300
Chicago, IL 60611
(312) 321-4767; FAX (312) 321-4767
www.ceproweldingsafety.com

Cerbaco Ltd. **31012**
809 Harrison St., Frenchtown, NJ 08825
(908) 996-1333; FAX (908) 996-0023
www.cerbaco.com

Cerbaco will display samples from its line of 500 configurations of nonmetallic weld backings that permit finished-quality, complete joint penetration welds from one side. Shown will be how the backings eliminate the need for arc gouging or heavy grinding prior to second side welding. Technical staff will be at the booth to offer assistance and free custom design services.

CGW-Camel Grinding Wheels USA **38093**
7525 N. Oak Park Ave., Niles, IL 60714
(800) 447-4248; FAX (800) 447-3731
www.cgwheels.com

C. H. Symington & Co., Inc. **32034**
6063 Frantz Rd,, Ste. 103, Dublin, OH 43017
(614) 766-2602; FAX (614) 766-2715
www.chsymington.com

C. H. Symington & Co. will highlight its air carbon arc gouging torches and a manual, semiautomatic, and fully digital automatic gouging system. Displayed will be an exothermic cutting torch and related consumables; cable connectors, a 600-A ground clamp; plus a new twist-valve bonnet assembly torch.

Changzhou Golden Globe Welding & Cutting Equipment Co. Ltd. **31077**
No. 19 Qianjia Ind. Pk., Qishuyan Dist.
Chaingzhou Jiangs 213011, China
85155525; FAX 88870015
www.czgg.com

Changzhou Golden Globe Welding and Cutting Equipment will display its specialized welding torches and subassemblies. Detailed will be its technical services, advanced processes and equipment, and complete inspection facilities.

Changzhou Huarui Welding & Cutting Equipment Co. Ltd. **31084**
Nanzai Panjia Town
Changzhou Jiangsu 213178, China
86519-8620-1365; FAX 86519-8620-3167
www.huarui-cn.com

Changzhou Huaya Aluminium Co. Ltd. **31075**
Yuzhuang Village, Yaoguan Town
Changzhou 21302, China
86-519 8870 9358; FAX 86-519 8870 9323
www.huaya-cz.com

Chart, Inc. **32074**
407 7th St. NW, New Prague, MN 56071
(952) 758-4484; FAX (952) 758-8275
www.chart-ind.com

Chart will spotlight its broad line of cryogenic and low-temperature products for purification, liquefaction, distribution, storage, and end-use applications of gases including natural gas, helium, nitrogen, argon, oxygen, and carbon dioxide, for applications in the energy, industrial, commercial, and scientific industries.

Chinese Mechanical Engineering Society, The **31082**
2-5-1607 Lianhuaxiaoqu
Haidian Dist., Beijing 100036, China
8610-639-72404; FAX 8610-639-80554
www.essen.cmes.org

Chung I Silver Solder Co. Ltd. 37101
23 Hsin Ai Rd., An-Ping Ind. Pk.
Tainan, Taiwan, ROC 702
8866-291-0706; FAX 8866-263-7167
www.chung-i.com

The company will display samples of its silver brazing alloys and phosphorous copper alloys at the booth.

CK Worldwide 38025
3501 C St. NE, Auburn, WA 98002
(253) 854-5820; FAX (800) 327-5038
www.ckworldwide.com

Clean Air Consultants/ Filter 1 31020
2525 National Dr., Garland, TX 75041
(972) 278-2664; FAX (972) 278-1810
www.filter-1.com

The company will feature its lines of dust-collection and air-cleaning equipment at the Show.

Cleveland Steel Tool Co. 7006
474 E. 105th St, Cleveland, OH 44108
(216) 681-7400; FAX (216) 681-7009
www.clevelandsteeltool.com

Cleveland Steel Tool will show its punches, dies, and shear blades for ironworkers and other punching applications. Information will be provided on the company's same day shipping, 24-hour turnaround on nonstock sizes, and design and engineering capabilities.

Cloos Robotic Welding, Inc. 34133
911 Albion Ave., Schaumburg, IL 60193
(847) 923-9988; FAX (847) 923-9989
www.cloosrobot.com

Cloos will feature its tandem welding technology for customized welding solutions. Highlighted will be tandem welding and laser hybrid welding as implemented into robotic systems.

CM Industries, Inc. 36065
505 Oakwood Rd., Lake Zurich, IL 60047-1534
(847) 550-0033; FAX (847) 550-0444
www.cmindustries.com

CML USA Inc. Ercolina 14021
3100 Research Pkwy., Davenport, IA 52806
(563) 391-7700; FAX (563) 391-7710
www.ercolina-usa.com

Ercolina will display samples of its manufactured tube, pipe and profile bending, and metalworking machinery.

CMW, Inc. 39074
70 S. Gray St., Indianapolis, IN 46201
(317) 345-6810; FAX (317) 715-2120
www.cmwinc.com

COB Industries, Inc. 33126
PO Box 36-1175, Melbourne, FL 32936-1175
(800) 431-1311; FAX (321) 984-8455
www.cob-industries.com

COMEQ, Inc. 9061
PO Box 207, White Marsh, MD 21162
(410) 933-8500; FAX (410) 933-1600
www.comeq.com

COMEQ will show its Geka ironworkers and automated punching systems; Primeline press brakes and shears; and Americor sheet and light plate bending rolls. The company is announcing the addition of Parmigiani angle and plate bending rolls to its family of products.

Computer Engineering, Inc. 39010
509 NW 5th St., Blue Springs, MO 64014
(816) 228-2976; FAX (816) 228-0680
www.computereng.com

Stop by the Computer Engineering booth to learn about its latest welding documentation software and how it can save you time and money.

Computers Unlimited 37017
2407 Montana Ave., Billings, MT 59101
(406) 255-9500; FAX (406) 255-9652
www.cu.net

Visit the booth to learn about the company's TIMS software, a fully integrated application for industrial, specialty gas, and welding supply distributors. Special features include order processing for gases, hardgoods, and rental equipment; inventory and warehouse management; truck dispatching for route and load optimization, and point-of-delivery mobile computers; electronic vendor price updates; document archiving/imaging; and dynamic data analysis tools.

CONCOA, Inc. 38057
1501 Harpers Rd., Virginia Beach, VA 23454
(757) 422-8330; FAX (757) 422-3125
www.concoa.com

CONCOA's booth will feature a line of gas pressure and flow control equipment and delivery systems designed for the industrial fabrication, medical gas distribution, laser, research, and specialty gas industries.

Coral SPA 40046
Corso Europa N. 597
10088 Volpiano, Torino, Italy
39-011 982-2000; FAX 39-011 982-2033
www.coral.eu

Coral will introduce its dust and fume collection systems and an extensive line of portable and central dust collectors and fume extractors, as well as a wide array of extraction arms, both portable and wall mount, for highly effective and efficient removal of airborne contaminants in a wide variety of industrial manufacturing processes.

COR-MET, Inc. 33077
12500 Grand River Rd., Brighton, MI 48116
(810) 227-3251; FAX (810) 227-9266
www.cor-met.com

Coxreels, Inc. 37013
6720 S. Clementine Ct., Tempe, AZ 85283
(800) 269-7335; FAX (800) 229-7335
www.coxreels.com

Coxreels® will display its lines of heavy-duty industrial-grade hose, cord, and cable reels, including spring-retractable hose and cord reels, hand-crank and motor-driven hose, and the EZ-Coil® safety series retractable reels with controlled rewind.

C-Spec 37055
PO Box 5188, Concord, CA 94524
(877) 977-7999; FAX (925) 930-8223
www.weldoffice.com

C-SPEC will exhibit its solutions for welding code compliance featuring its WeldOffice® software for management of welding procedures, welders, and NDE documentation.

CS Unitec, Inc. 35133
22 Harbor Ave., Norwalk, CT 06850
(203) 853-9522; FAX (203) 853-9921
www.csunitec.com

CS Wave, Inc. 37103
150 Industrial Dr., Lexington, OH 44904
(800) 522-0460; FAX (419) 884-1866
www.buckeye-edu.com

Cyl-Tec, Inc. 37051
950 Industrial Dr., Aurora, IL 60506
(630) 844-8800; FAX (630) 844-5100
www.cyl-tec.com

DataWeld, Inc. 37121
1909 Citizens Bank Dr., Bossier City, LA 71111
(318) 746-6111; FAX (318) 746-0323
www.dataweld.com

Davi North America/Promau 11003
5291 Zenith Pkwy., Loves Park, IL 61111
(815) 282-8550; FAX (815) 282-8675
www.davi.com

Delta Computer Systems, Inc. 16081
1818 SE 17th St., Battle Ground, WA 98604-8579
(360) 254-8688; FAX (360) 254-5435
www.deltamotion.com

Delta Computer Systems will showcase its motion controllers for presses and other machines. The company manufactures RMC motion controllers for servohydraulic and servomotor applications featuring fieldbus communications. Equipment is available for single- and multi-axis precise position, speed, and pressure/force applications.

DeWAL Industries, Inc. 30012
PO Box 372, 15 Ray Trainor Dr.
Saunderstown, RI 02874
(401) 789-9736; FAX (401) 783-6780
www.dewal.com

DeWAL Industries will exhibit its line of thermal spray tapes for a variety of applications. The company has years of experience developing uniform, efficient plasma and HVOF tapes, and its products have been qualified by a long list of aircraft engine, automotive, medical, and mission-critical manufacturers.

D/F Machine Specialties, Inc. 32082
1750 Howard Dr., North Mankato, Mn 56003
(507) 625-6200; FAX (507) 625-6203
www.dfmachinespecialties.com

D/F Machine Specialties will display its air-cooled, water-cooled, semiautomatic, automatic, and robotic welding guns and torches for gas metal arc and gas tungsten arc welding. The company also produces machine barrels, euro-connectors, safety mounts, mounting brackets, utility stations, slip-in/threaded contact tips, nozzles, power cables, hoses, casings/conduits, liners, inlets, and adapters, as well as other welding products and consumables. Staff will be on hand to discuss your welding applications.

D&H Machinery, Inc. 3030
723 Phillips Ave., Bldg. D2, Toledo OH 43612-1362
(419) 841-3586; FAX (419) 841-2986
www.dnhmach.com

Diagraph MSP, an ITW Company 34084
5307 Meadowland Pkwy., Marion, IL 62959
(618) 997-1754; FAX (618) 997-1766
www.diagraphmsp.com

SEE US AT THE FABTECH/AWS SHOW BOOTH #37009/36021

Diamond Ground Products, Inc. 37105
2550 Azurite Cir., Newbury Park, CA 91320
(805) 498-3837; FAX (805) 498-9347
www.diamondground.com

Diamond Ground Products will show its tungsten and tungsten preparation products.

Dimplex Thermal Solutions 14015
2625 Emerald Dr., Kalamazoo, MI 49001
(269) 349-6800; FAX (269) 349-8951
www.dimplexthermal.com

Dinse GmbH 37088
Tarpen 36, Hamburg, 22419, Germany
49-40-65875281; FAX 49-40-65875200
www.dinse-gmbh.com

Dinse will display its line of high-quality robotic welding torches, manual welding torches, wire feed systems, and full range of quality consumables.

Direct Wire & Cable 37085
22 Industrial Way, Denver, PA 17517
(717) 336-2842; FAX (717) 336-0505
www.directwire.biz

Dissolvo 39061
12830 S. Dixie Hwy., Bowling Green, OH 43402-9697
(419) 373-4888; FAX (419) 354-0514
www.dissolvo.com

Diversi-Tech, Inc. 39071
2025 52e Ave., Lachine, QC H8T 3C3, Canada
(514) 631-7300; FAX (514) 631-9480
www.diversitech.ca

Donaldson Torit/ Donaldson Co., Inc. 8080
PO Box 1299, Minneapolis, MN 55440-1299
(952) 887-3131; FAX (952) 887-3608
www.donaldsontorit.com

Doringer Cold Saws 8131
13400 Estrella Ave., Gardena, CA 90248
(310) 366-7766; FAX (310) 366-7490
www.doringer.com

Dr. Gold & Co. 40032
Koenigs Allee 72
Duesseldorf, NRW 40212, Germany
49-211- 320518; FAX 49-211-131465
www.carrymate.com

The company will feature its Carrymate® non-slip transport grips, which enable fast, efficient transport of metal, glass, granite, and other materials. They can lift up to 440 lb per pair. The grips are slipproof and enable safe transport.

Drahtzug Stein USA Corp. 33041
197 Bosch Blvd., New Bern, NC 28562
(252) 637-9660; FAX (252) 635-9473
www.drahtzug.com

The Drahtzug Stein booth will showcase the company's seamless flux cored and metal cored welding wires. Information will be provided on its facility in North Carolina. The company is a member of Drahtzug Stein Holding, a 68-year-old firm headquartered in Germany.

Dr. Shrink, Inc. 7068
315 Washington St., Manistee, MI 49660
(231) 723-2685; FAX (231) 723-9586
www.dr-shrink.com

DualDraw LLC 33028
5900 E. 58th Ave., Unit A
Commerce City, CO 80022
(303) 853-4083; FAX (303) 853-4086
www.dualdraw.com

DualDraw will exhibit its indoor air quality equipment featuring downdraft tables and booths. The equipment's airflow design maximizes capture of harmful particulates such as welding smoke, grinding dust, and fumes.

Durum USA 30035
11133 I-45 S., Bldg. I, Conroe, TX 77302
(936) 539-2630; FAX (936) 539-2470
www.durumusa.com

Durum will exhibit its Durmat® hardfacing products, including welding powders (plasma transferred arc and laser), rods, wires and electrodes used in deep drilling, steel, foundries, glass, mining, dredging, agriculture, textiles, chemical, aluminum, excavation, pump manufacture and repair, and many other industries. The company also offers plasma transferred arc torches and welding systems.

Dynatorch, Inc. 34106
3530 Starnes Dr., Paducah, KY 42003
(270) 442-0560; FAX (270) 442-1722
www.dynatorch.com

Dynatorch will display its plasma and oxyfuel CNC cutting machines for plate and tube fabrication, which are available with many features and in multiple sizes. These low-cost, high-power-density servo-drive systems feature Animatics smart motors. Retrofitted CNC drive systems are also available.

Easy Burs 32006
23 Commerce Rd., Ste. A, Fairfield, NJ 07004
(973) 575-7879; FAX (973) 575-6307
www.easyburs.com

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Premium Performance Made Simple

Introducing the new 3M™ Speedglas™ 100 Welding Helmet, offering bold designs, exceptional performance and affordable value. The desires of our welding customers constantly evolve, and 3M welding helmets are continually enhanced to meet those desires. The new Speedglas 100 series welding helmet delivers outstanding protection, comfort and performance with seven distinctive graphic designs.

The highly affordable Speedglas 100 welding helmet offers excellent optical quality and reliable light-to-dark switching. It can be used with most arc welding processes, such as stick (MMA), MIG/MAG and many TIG applications. It's also an ideal "entry level" auto-darkening helmet for occasional users, such as hobbyists, farmers and maintenance or construction workers.

For more information on the Speedglas 100 welding helmet, please contact your local 3M representative, call 1-800-328-1667, or visit www.Speedglas.com.

3M

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

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COMPANY OF TEXAS

WELD POSITIONING EQUIPMENT SINCE 1967

Tank Turning Rolls, Welding Positioners, Welding Head Manipulators, Work Holding Chucks, Portable Burning Equipment

With over 40 years experience in manufacturing, equipment restoration, and the distribution of the highest quality weld positioning equipment, Weldwire Company of Texas Inc., is the premier source for all of your weld positioning needs.

WPT Series Positioner w/ optional VPC Series Work Holding Chuck

The Weldmaster LD Series Manipulator Standard with variable speed horizontal and vertical lift

Welding Head Manipulator Flux Recovery and Feed Tank System

WWRD & WWRI Heavy Duty Tank Turning Rolls
160 ton capacity shown

XL Series Portable Plate Cutting Machine

WELDWIRE COMPANY OF TEXAS

www.weldwire-tx.com | 800-877-6381 | 713-691-6381

6353 Big Oaks Drive Conroe, TX 77385— PO Box 130243 The Woodlands, TX 77393

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

Econco/CPI **6014**
1318 Commerce Ave., Woodland, CA 95776
(800) 532-6626; FAX (530) 666-7760
www.econco.com

Econco will showcase its technology for rebuilding the radio-frequency power tubes used in CO_2 lasers. The company promptly ships these economical tubes from its extensive inventory to get your laser up and running quickly. Information will also be provided on the company's 3000-h warranty.

Edwards Mfg Co. **13091**
1107 Sykes St., Albert Lea, MN 56007
(507) 373-8206; FAX (507) 373-9433
www.edwardsironworkers.com

Edwards will showcase its full line of high-quality, low-maintenance hydraulic ironworking machines, and associated tooling and accessories used in the steel fabrication industry. The ironworkers can punch, shear, notch, and brake mild steel plate, bar stock, and angle. Information will be provided on the company's wide range of accessories that can fabricate rod, square stock, sheet metal, and pipe.

E. H. Wachs Co. **38070**
600 Knightsbridge Pkwy., Lincolnshire, IL 60069
(847) 537-8800; FAX (847) 520-1147
www.wachsco.com

Wachs will feature its diverse line of portable pipe construction and maintenance tools for cutting, squaring, beveling, facing pipe, tube and vessels of all sizes and schedules under all conditions and environments. Additional information will be provided on its rental/lease options, on-site training, custom machine design, and manufacturing of special application machines.

Electron Beam Technologies, Inc. **33047**
1275 Harvard Dr., Kankakee, IL 60901
(815) 935-2211; FAX (815) 935-8605
www.electronbeam.com

Electron Beam Technologies will exhibit its bulk electrode accessories that make use and conversion of large wire packs fast and easy. Conduits, domes, and connectors will be demonstrated. Engineers will be on hand to discuss conduits systems and OEM composite cable designs.

Enco **13001**
PO Box 357, Farmingdale, NY 11735
(800) 873-3626; FAX (800) 965-5857
www.use-enco.com

The Enco booth will feature some of the more than 90,000 items displayed in its master catalog of machines, tools, and shop supplies.

Environmental Air Solutions **38036**
2220 Jessica Ln., Coralville, IA 52241
(319) 358-7794; FAX (319) 248-0345
www.keeptheheat.com

Environmental Air Soluions will exhibit its KeepTheHeat™ air-to-air heat exchanger that provides shop ventilation without losing heat.

ErgotecH, Inc. **13116**
11 Old Newtown Rd., Ste. 1, Danbury, CT 06810-4201
(203) 790-4100; FAX: (203) 790-4445
www.ergotechinc.com

The ErgotecH booth will showcase its innovative, ergonomically designed factory equipment. Products include a family of compact, simple-to-use, battery-powered lift/transporters; a family of electric vertical telescopic lift columns that brings the work to the workers' comfort height; and three families of multi-axis work positioners that allow each operator to create a safe and comfortable work position in any work environment, even when handling loads up to 13,000 lb.

ESAB Welding & Cutting Products **34043**
411 S. Ebenezer Rd., Florence, SC 29501-7916
(800) 372-2123; FAX (843) 664-5607
www.esabna.com

ESAB Welding & Cutting Products will display its lines of welding and cutting equipment and filler metals. The company's product range includes small and large gantry shape-cutting machines with oxyfuel, plasma, laser, and waterjet processes; arc welding equipment, automated welding lines; plasma cutting machines; gas apparatus; and filler metals.

ESAB Welding & Cutting Trailer **40075**
411 S. Ebenezer Rd., Florence, SC 29501-7916
(843) 679-5823; FAX (843) 664-5607
www.esabna.com

ESAB will exhibit its new PowerCut 900 manual cutting package for simplified operation and reduced setup time; the new CaddyTig 2200i portable welding machine designed to produce quality gas tungsten arc and shielded metal arc welds in a variety of materials; and a variety of products for mechanized arc cutting, automation, and submerged arc welding.

ESCO Tool Co. 4064
75 October Hill Rd., Holliston, MA 01746
(508) 429-4441; FAX (508) 429-2811
www.escotool.com

ESCO Tool will exhibit its Millhog portable end-prep tools and abrasive saws for cutting and machining pipe and tube in preparation for welding. A broad range of the products will be displayed and demonstrated.

Essen Trade Shows 40034
1500 Front St., Ste. B1
Yorktown Heights, NY 10598
(914) 962-1310; FAX (914) 962-1320
www.essentradeshows.com

Essen Trade Shows, the U.S. representative of Messe Essen GmbH, will provide information on the Schweissen & Schneiden trade show, the world's largest international welding, joining, cutting, and surfacing trade show. The show, which features more than 1000 exhibitors from 40 countries, is held every four years in Essen, Germany. Messe Essen also organizes the Schweissen & Schneiden shows in Russia, China, and India.

EST Group, Inc. 12070
2701 Township Line Rd., Hatfield, PA 19440
(215) 721-1100; FAX (215) 721-1101
estgroup.cwfc.com

EST Group, a business unit of Curtiss-Wright Flow Control Company, will feature its range of life-cycle products and services for shell and tube heat exchangers, condensers, pipes, piping systems, and pressure vessels for the power generation, refining, petrochemical, fine chemical, and pharmaceuticals industries.

Everlast Power Equipment 33107
2317 Cecilia St., San Francisco, CA 94116
(650) 588-8588; FAX: (650) 588-8817
www.everlastwelders.com

EWI (Edison Welding Institute) 39078
1250 Arthur E. Adams Dr., Columbus, OH 43221
(614) 688-5000; FAX (614) 688-5001
www.ewi.org

The EWI booth will offer information on this engineering and technology organization dedicated to materials joining and allied technologies. Personnel will be on hand to detail the applied research, manufacturing support, and strategic services the organization provides to nearly 2800 member company locations in the aerospace, automotive, defense, energy and chemical, government, heavy manufacturing, and electronics industries.

Factory Cat 12104
PO Box 368, Racine, WI 53401
(262) 681-3583; FAX (262) 681-3753
www.factorycat.com

FANUC Robotics America, Inc. 33003
3900 W. Hamlin Rd., Rochester Hills, MI 48309
(248) 377-7000; FAX (248) 276-4227
www.fanucrobotics.com

FANUC Robotics America will feature its industrial robots, simulation packages, application software, controls, and integrated vision products. The company offers more than 200 robot variations, which have been installed in a wide range of industries including aerospace, alternative energy, automotive, consumer goods, food, pharmaceuticals, and medical devices.

FastCut CNC, Inc. 34012
2841 Bowers Pl., Kamloops, BC V1S 1W5, Canada
(250) 314-0580; FAX (250) 314-0590
www.fastcutcnc.com

Fein Power Tools, Inc. 34115
1030 Alcon St., Pittsburgh, PA 15220
(800) 441-9878; FAX (412) 922-8767
www.feinus.com

Fein will exhibit its GRIT modular belt grinders as well as basic belt grinders and mounted modules designed and engineered for specific tasks within the entire application range. On display will be GRIT GX models constructed for use in small workshops and GRIT GI models designed for industrial use.

Felton Brushes Ltd. 37129
29 Harriet St., Hamilton, ON L8R 2E5, Canada
(905) 522-3811; FAX (905) 522-4057
www.feltonbrushes.com

Felton Brushes will exhibit its line of wire power brushes and strip brushes.

Ferris State University 40039
915 Campus Dr., Swan Bldg. Rm 108
Big Rapids, MI 49307
(231) 591-2511; FAX (231) 591-2407
www.ferris.edu

Ferris State will provide information on its nationally recognized Welding Engineering Technology BS degree program, which is designed to produce plant-level welding engineering technology graduates who are involved in the concept, design, and engineering of weldments and implementation of welding processes. This overall knowledge of weldments, combined with the ability to engineer welding and joining systems, produces graduates who are in great demand and well compensated.

Fibre-Metal by Honeywell **36083**
2000 Plainfield Pike, Cranston, RI 02921
(401) 275-2427; FAX (810) 958-2429
www.northsafety.com

Flame Technologies, Inc. **39111**
PO Box 1776, Cedar Park, TX 78630
(512) 219-8481; FAX (512) 219-8477
www.flametechnologies.com

Flame Tech will feature its point-of-purchase packaging, including welding, cutting, and brazing outfits packaged in heavy-duty canvas tool bags. The bags provide contractors storage for cutting attachments, torch handles, cutting/welding tips, and other tools and equipment. Other new products to be featured include cutting kits, tote-a-torch kits, flow gauges, and specialty regulators.

Flex-North America, Inc. **38099**
13057 W. Center Rd., Ste. 6, Omaha, NE 68144
(402) 933-7759; FAX (402) 933-7729
www.flexna.com

Flowdrill, Inc. **4032**
2820A Breckenridge Ind. Ct., St. Louis, MO 63144-2811
(314) 968-1134; FAX (314) 968-1510
www.flowdrill.com

The Flowdrill booth will showcase its process for using the friction generated from the combined rotational and downward forces of a special tool to produce bushings in metal tubing and flat stock. This friction transforms the material into a plastic state, allowing formation of a bushing from the displaced material. The height of this bushing is three to four times the original material thickness. Typical cycle times run 1 to 3 s.

Flowdynamics, Inc., dba Purge Plugs **39007**
909 S. Cucamonga Ave., Ste. 102, Ontario, CA 91761
(909) 930-5522; FAX (909) 930-5599
www.purgeplugs.com

Flowdynamics will show its plugs with rubber seals that are inserted into tubing or pipe to aid in the purging process for welding.

Frommelt Safety Products **37065**
8900 N. Arbon Dr., Milwaukee, WI 53223
(414) 362-6379; FAX (414) 355-9248
www.frommeltsafety.com

Frommelt Safety Products will highlight its manual and automated doors and guards for robotic cells and machine areas, as well as welding screens, curtains, blankets, and perimeter fencing. The company's pneumatic- and electric-driven guards are designed to protect workers from flying debris, entry into harmful areas, and weld flash.

Fronius USA LLC **35043**
10421 Citation Dr., Ste. 1100, Brighton, MI 48116
(810) 220-4414; FAX (810) 220-4424
www.fronius-usa.com

Fronius will feature its high-frequency welding technology. Products range from compact GMAW mchines and GTAW equipment to complex automated welding systems and spot welding machines.

Fusion, Inc. **38020**
4658 E. 355th St., Willoughby, OH 44094
(440) 946-3300; FAX (440) 602-8761
www.fusion-inc.com

Fusion will display its automated equipment for production brazing and soldering. Information will be provided on the company's process approach to automating applications, which consists of three key ingredients: paste alloys, application equipment, and automatic machines.

F. W. Gartner **30025**
25 Southbelt Ind. Dr., Houston, TX 77047
(713) 225-0010; FAX (713) 229-9841
www.fwgts.com

F. W. Gartner will highlight its thermal spraying, laser cladding, machining, and grinding services. The company also offers an in-house metallographic lab, stress relieving (vibration and heat treat), and on-site third-party testing.

GBC Industrial Tools **33002**
Via Artigiani 17, Torbiato di Adro (BS) 25030, Italy
39-030-7451154; FAX 39-030-7356629
www.gbcindustrialtools.com

GBC Industrial Tools will show its portable pipe cold cutting and/or bevelling machines, plate cold bevelling machines, pipe cold bevelling machines, and hydraulic torque wrenches.

General Tool **38098**
2025 Alton Pkwy., Irvine, CA 92606
(949) 428-2010; FAX (949) 428-0409
www.gtdiamond.com

General Tool will display its products for metal removal. The company adheres diamonds to the outer face and edge of a substrate material. The diamond material is retained under extreme load. The tools will benefit heavy grinding users through improved throughput, less downtime, and less hazardous operations.

Genie Products **30006**
PO Box 1028, Rosman, NC 28772
(828) 862-4772; FAX (828) 877-3480
www.genieproducts.com

Genie Products will showcase its high-quality replacement parts for the thermal spray industry, and powdered metals and tapes. Also shown will be the GTV line of turnkey thermal spray systems and laser cladding powder feeders. Information will be available regarding the company's experienced design engineering staff who are available to work with customers on adaptations of parts or special projects.

Genstar Technologies Co. Inc. (GENTEC) **31025**
4525 Edison Ave., Chino, CA 91710
(909) 606-2726; FAX (909) 606-6485
www.genstartech.com

Genstar will feature its line of cutting and

welding machines, high-quality pressure regulators, fittings, valves, welding apparatus, and various gas control and handling devices.

Goffs Enterprises **32008**
1228 Hickory St., Pewaukee, WI 53072
(800) 234-0337; FAX (800) 959-0170
www.industrialcurtains.com

Goffs' booth will feature its custom-made, flame-retardant weld curtains and screens that are designed to withstand tough shop environments and that block 100% UV light. The weld screens are constructed with a strong, lightweight, extruded aluminum frame. Welding curtains create a retractable barrier that glides on a track and roller system to contain welding fumes and contaminants as needed.

Golden Eagle Minmetals (Beijing) Welding Materials Co. **31082**
No. 7th Fusheng Rd., Shahe Changping Dist.
Beijing 102206, China
86-10-80718648; FAX 86-10-80722991
www.alloywelding.com.cn

Goodtime Industry Ltd. **31071**
Linheli Rd., Tongzhou Dist, Beijing 101101, China
86-10-807-229-91; FAX 86-10-807229-93
www.goodtime.com

Goss, Inc. **38046**
1511 Rte. 8, Glenshaw, PA 15116
(412) 486-6100; FAX (412) 486-6844
www.gossonline.com

GOSS will feature its complete line of cutting, welding, brazing, soldering, and heating tools that can be used in a variety of applications.

Gudel, Inc. **37035**
4881 Runway Blvd., Ann Arbor, MI 48108
(734) 214-0000; FAX (734) 214-9000
www.gudel.com

Gullco International **36003**
21568 Alexander Rd., Oakwood Village, OH 44146
(440) 439-8333; FAX (440) 439-3634

Gullco will exhibit its line of automatic welding carriages, cutting carriages, welding automation, and accessories. Information will be provided on its company-owned branches in Canada, United States, United Kingdom, India, Australia, and China, as well as its extensive worldwide distributor network.

Haco-Atlantic, Inc. **12117**
11629 N. Houston Rosslyn Rd., Houston, TX 77086
(281) 445-3985; FAX (281) 445-3989
www.hacoatlantic.com

Haco-Atlantic will show its new line of plasma cutting machines as well as its line of sheet metal fabricating equipment. The high-quality machines feature the latest CNC controls and CAD/CAM cutting and nesting software.

Harbert's Products Inc./Allied Flux Reclaiming Ltd. **36122**
PO Box 418, 501 S. Cedar Ln.
Greencastle, PA 17225-0418
(800) 377-3103; FAX (717) 597-1717
www.recycleflux.com

The Harbert's Products and Allied Flux Reclaiming booth will detail their cost-effective, custom closed-loop SAW flux and slag crushing, reclaiming, and recycling services. Third party testing is available for all welding code applications.

Harper Trucks, Inc. **39106**
1522 S. Florence St., Wichita, KS 67209
(800) 835-4099; FAX (316) 942-8508
www.harpertrucks.com

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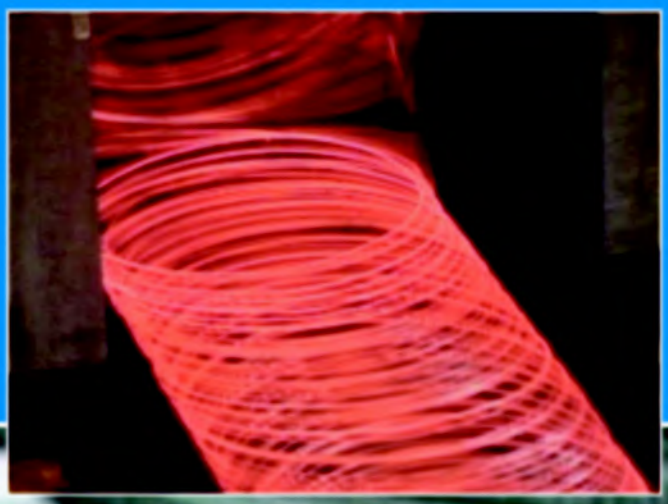

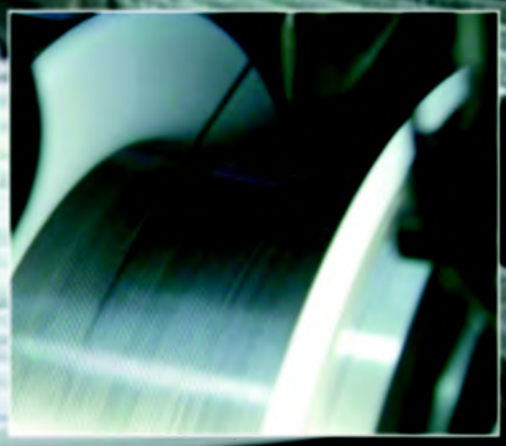

Kobelco is one of the major steel mills in the world. Unlike our competitors, we have a stronger bind and commitment with who supplies the most important raw materials. It means Kobelco can not only control the quality from raw materials to finished products, but also can achieve stable cost and stable supply of products. As a result, most of our customers have not seen a single default product for over 20 years. Kobelco is your right choice for long term success. We will continuously provide consistent, high quality products, spool after spool. Call us now for availability in your area.

KOBELCO

KOBELCO WELDING OF AMERICA INC.
4755 Alpine Dr., Suite 250
Stafford, Texas 77477
281-240-5600 Fax: 281-240-5625
www.kobelcowelding.com

SEE US AT THE FABTECH/AWS SHOW BOOTH #34034

2010 CO-LOCATED WEMCO / RWMA ANNUAL MEETING

Palm Beach Gardens, Florida
March 11-13, 2010

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

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

Emily DeRocco, President, Manufacturing Institute, an affiliate of the National Association of Manufacturers

Dr. David Cole, Chairman, Center for Automotive Research

Martin Quinn, President, Thermadyne Holdings Corporation

Alan Beaulieu, Principal and Economist, Institute for Trend Research

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

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

For more information or to register contact:
Susan Hopkins at **susan@aws.org** or **800-443-9353, ext. 295**

WEMCO
Welding Equipment Manufacturers Committee

RWMA

Harris Products Group, The 37025
4501 Quality Pl., Mason, OH 45040
(513) 754-2000; FAX (513) 754-8778
www.harrisproductsgroup.com

The Harris Products Group, a Lincoln Electric company, will showcase its cutting, welding, brazing, and soldering equipment, and consumables and gas distribution systems

Haynes Wire Co. 37099
PO Box 677, 158 N. Egerton Rd.
Mountain Home, NC 28758
(828) 692-5791; FAX (828) 697-9818
www.haynesintl.com

H. C. Starck, Inc. 30020
45 Industrial Pl., Newton, MA 02461
(617) 630-5800; FAX (617) 630-5879
www.hcstarck.com

HE & M Saw, Inc. 12091
4065 S. Main, Pryor, OK 74361
(918) 825-4821; FAX (918) 825-4824
www.hemsaw.com

HE & M Saw will highlight its line of more than 70 models of production band saws for the metalworking industry. Products include vertical, horizontal, plate, and double-column saws with capacities ranging from 12 × 12 to 80 ×80, as well as material handling tables and metalworking fluids.

Heck Industries 7060
PO Box 425, Hartland, MI 48353
(810) 632-5400; FAX (810) 632-6640
www.heckind.net

Hermes Abrasives Ltd. 31050
524 Viking Dr.,Virginia Beach, VA 23452
(757) 486-6623; FAX (800) 243-7637
www.hermesabrasives.com

Hermes Abrasives will display its industrial-grade coated abrasive products for a wide variety of wet or dry metalworking applications.

Heron Machine & Electric Industrial Ltd. 31009
#9 Fengying Rd., Taiping Econ & Tech Chonghua
Guangzhou, Guangdong 510990, China
86-20-87815075; FAX 86-20-87813346
www.heronwelder.com

HG Farley Laser Lab USA, Inc. 11027
4635 Colt Rd., Rockford, IL 61109-2609
(815) 874-1400; FAX (815) 874-1700
www.farleylaserlab.com

HKS Prozesstechnik GmbH 31033
Heinrich Damerow Strasse 2
Halle D-06120, Germany
49345-683-090; FAX 49345-683-0949
www.hks-prozesstechnik.de

HKS-Prozesstechnik will exhibit its professional monitoring and measuring systems that provide high-quality welding results. The company's measuring systems for welding are developed as a robust series of devises independent from any welding machine or robot.

H&M Pipe Beveling Machine Co., Inc. 38042
311 E. 3rd St., Tulsa, OK 74120
(918) 582-9984; FAX (918) 582-9989
www.hmpipe.com

Hobart Brothers Co. 34071
101 Trade Square East, Troy, OH 45373
(937) 332-4000; FAX (937) 332-5224
www.hobartbrothers.com

Hobart Brothers will show its line of welding filler metals marketed under the brand names Hobart, Tri-Mark, McKay, and Corex.

Hobart Institute of Welding Technology 34074
400 Trade Square East, Troy, OH 45373
(800) 332-9448; FAX (937) 332-5200
www.welding.org

Hobart Institute of Welding Technology offers advanced training in all major welding processes. Services include 1- to 36-week skill-development courses for the new student, as well as certifications and/or technical training for welders looking to advance their skills. Information will also be available on its customized training programs, which are available on- or off-site. The organization also offers a wide selection of welding training and educational materials.

Hotfoil EHS, Inc. 32076
2960 E. State St., Ext., Hamilton, NJ 08619
(609) 588-0900; FAX (609) 588-8333
www.hotfoilehs.com

Hougen Manufacturing, Inc. 12090
3001 Hougen Dr., Swartz Creek, MI 48473
(800) 426-7818; FAX (810) 635-8277
www.hougen.com

Hougen Manufacturing will feature its full line of portable magnetic drills, Rotabroach annu-

lar cutting tools, and other hole-making products for use in fabrication, production, and maintenance applications. The products can be used on site or in the shop to help make holes easier, faster, and safely.

HTM Sensors 31053
8651 Buffalo Ave., Niagara Falls, NY 14304
(800) 644-1756; FAX (888) 283-2127
www.htm-sensors.com

HTM Sensors will show its durable, long-lasting MetalHead sensors that are designed to reduce long-term downtime costs as well as its line of standard sensors.

Hyd-Mech Group Ltd. 11097
PO Box 1659 Stn. Main
Woodstock, ON, N4S 0A9 Canada
(519) 537-2103; FAX (519) 539-5126
www.hydmech.com

Hypertherm, Inc. 36021/31014
PO Box 5010, Hanover, NH 03755
(603) 643-3441; FAX (603) 643-5352
www.hypertherm.com

Hypertherm will showcase its advanced plasma cutting systems, including the HyPerformance HPR400XD, which has two new motion control systems, and the latest MTC software that takes plasma cutting to a new level. Staff will be on hand to explain how many of the things you thought weren't possible with plasma, now are.

Hyundai Welding Products 32093
215 Satellite Blvd. NE, Ste. 300, Suwanee, GA 30024
(770) 614-7577; FAX (770) 614-6636
www.hyundaiwelding.com

IBEDA/Superflash 38065
Compressed Gas Equipment, Inc.
28825 Ranney Pkwy., Westlake, OH 44145
(888) 327-7306; FAX (440) 871-9964
www.oxyfuelsafety.com

Igus, Inc. 7046
50 N. Broadway, East Providence, RI 02914
(800) 521-2747; FAX (401) 438-7270
www.igus.com

IHT Automation GmbH & Co. KG 40006
Bahnhofsdr 63, Baden Baden, Germany 76532
49-7221-39419; FAX 49-7221-39470
www.iht-automation.com

IHT Automation will showcase its German-made clearance control systems for plasma and oxyfuel cutting machines. Experienced staff will be on hand to share their expertise.

II VI Infrared 7043
375 Saxonburg Blvd., Saxonburg, PA 16056
(724) 352-1504; FAX (724) 352-4980
www.iiviinfrared.com

II-VI infrared will highlight its CO_2 laser optics for industrial, medical, thermal imaging, and other applications. Products on display will include conventional and diamond-turned products such as lenses, mirrors, nozzles, windows, partial reflectors, beam splitters, phase retarders, rhombs, beam expanders, polarizers, wave plates, and modulators. Its infrared materials include ZnSe, ZnS, and ZnS Multi-Spectral.

IMPACT 37054
1750 New York Ave. NW, Washington, DC 20006
(202) 393-1147; FAX (202) 393-1507
www.impact-net.org

The IMPACT booth will provide literature and information about its activities as a labor management Taft Hartley Trust with the primary mission to expand job opportunities for Union Ironworkers and their signatory contractors through progressive and innovative labor management cooperative programs.

IMPACT Engineering, Inc. 32092
500 E. Biddle St., Jackson, MI 49203
(517) 789-0098; FAX (517) 789-1038
www.impactwelding.com

IMPACT Engineering will show its arc weld monitoring equipment, including the ARCAgent™ arc weld monitoring products that offer solutions for manual, fixed, and robotic welding. The products provide procedure qualification, auditing, missing weld detection, process control, and weld fault detection.

Indura SA 39037
18020 Brenridge Dr., Brandy Station, VA 22714
(866) 328-3171; FAX (562) 530-3444
www.indura.net

Industrial Gases/Allcryo 38103
21500 Sharp Rd., Montgomery, TX 77316
(936) 441-8333; FAX (936) 597-5550
www.allcryo.com

Industrial Training Zone 39035
PO Box 686, Farmingdale, NJ 07727
(732) 938-2000; FAX (732) 774-8573
www.labvolt.com

In-House Solutions, Inc. 32014
240A Holiday Inn Dr., Cambridge, ON N3C 3X4, Canada
(800) 529-5517; FAX (519) 658-1335
www.inhousesolutions.com

In-House Solutions will highlight its robotic software, support, tutorials, and training for CNC manufacturing industries and educational facilities. Featured will be Robotmaster, a CAD/CAM based off-line programming software for 6- to 8-axis robots that seamlessly integrates robot programming, simulation, and code generation inside Mastercam X to deliver quicker robot programming. Applications including rrimming, deburring, deflashing, grinding, and mold machining.

Inframat Corp. 30031
156-J River Rd., Willington, CT 06279
(860) 487-3838; FAX (860) 429-5911
www.inframat.com

Inframat will highlight its advancements using nanomaterial and nanosurface technologies. Its core product offerings include nanomaterials, industrial nanocoatings, biomedical nanocoatings, and embedded nanomagnetics. The company holds more than 30 patents and has cultivated its nanotechnology applications, particularly in industrial nanocoatings.

Innerspec Technologies 4012
4004 Murray Pl., Lynchburg, VA 24501-5004
(434) 948-1306; FAX (434) 948-1313
www.innerspec.com

Innerspec Technologies will feature its ultrasonic electromagnetic acoustic transducer (EMAT) technology for nondestructive testing of metallic parts and components. Staff will be on hand to explain the technology's advantages, which include the fact it does not require couplant, is unaffected by surface conditions, permits easier deployment of probes , and can generate unique wave modes.

Innov-X Systems 4035
100 Sylvan Rd., Ste. 100, Woburn, MA 01801-1882
(781) 938-5005; FAX (781) 938-0128
www.innovx.com

Instrument Technology, Inc. 37015
PO Box 381, Westfield, MA 01086
(413) 562-3606; FAX (413) 568-9809
www.scopes.com

Interactive Safety Products, Inc. 39081
9825-A Northcross Center Ct., Huntersville, NC 28078
(704) 664-7377; FAX (704) 664-7316
www.helmetsystems.com

International Thermal Spray Association 30015
208 3rd St., Fairport Harbor, OH 44077
(440) 357-5400; FAX (440) 357-5430
www.thermalspray.org

The International Thermal Spray Association is a professional trade organization dedicated to expanding the use of thermal spray technologies for the benefit of industry and society.

International Training Institute 40047
601 N. Fairfax St., Ste. 240, Alexandria, VA 22314
(703) 624-0892; FAX (503) 408-5899
www.sheetmetal-iti.org

International Welding Technologies, Inc. 32025
2650 Egg Harbor Rd., Lindenwold, NJ 08021
(856) 435-8004; FAX (856) 435-4004
www.internationalwelding.com

International Welding Technologies will highlight its complete line of stud welding equipment and fasteners.

InterTest, Inc. 31065
303 Rte. 94, Columbia, NJ 07832
(908) 496-8008; FAX (908) 496-8004
www.intertest.com

The InterTest booth will show the company's line of specialized vision products, remote visual inspection tools, and nondestructive testing equipment including borescopes and fiberscopes. The company offers its remote visual inspection products under the iShot Imaging brand.

IPG Photonics 35021
50 Old Webster Rd., Oxford, MA 01540
(508) 373-1100; FAX (508) 373-1103
www.ipgphotonics.com

IPG Photonics will exhibit its high-power fiber lasers and amplifiers. Products include active fiber lasers, direct diodes, and amplifiers operating at 0.72 microns. Industrial lasers operating at 1 micron are available in sizes ranging from 10 W to > 50 kW for use in a wide range of applications such as materials processing, telecommunications, and medical, and feature low beam divergence; air cooling; high electrical efficiency; a compact, rugged package; and long diode life.

ITW Dykem 34076
805 E Old Hwy. 56, Olathe, KS 66061
(800) 443-9536; FAX (800) 323-9536
www.dykem.com

ITW Dykem will exhibit its SCRUBS®, DYKEM®, and DYMON® products. The industrial DYKEM® line includes marking products ranging from TEXPEN®/DALO® metal markers, BRITEMARK® paint markers, STEEL BLUE® layout fluids, and a full range of staining colors.

Jackson Safety 32043
1859 Bowles Ave., Ste. 200, Fenton, MO 63026
(800) 237-4192; FAX (800) 338-4003
www.jacksonsafety.com

Kimberly-Clark Professional and Jackson Safety are now one company. The Jackson Safety brand will offer a wide range of products from welding helmets to autodarkening technology, trusted by welders for their value and distinctive safety features. It also will offer a comprehensive range of personal protective equipment, welding safety products, and work zone solutions.

Jancy Engineering, Inc. 5091
2735 Hickory Grove Rd., Davenport, IA 52804
(563) 391-1300; FAX (563) 391-2323
www.jancy.com

Jancy will introduce USA101. This drill offers many new and improved features, such as a motor almost twice as powerful as before and an included coolant system with positive slug ejection. The new machine and other Slugger product offerings will be actively demonstrated at its booth.

Jayesh Industries Ltd. 32029
605-10 Krushal Commercial Complex
G.M. Road Amar Mahal, Chembur(W)
Mumbai, Maharashtra, India 400 089
91-22-4074 9990; FAX 91-22-6703 9990
www.jayeshgroup.com

Jayesh Group will highlight ferro alloys, metals, minerals, and chemicals for the welding electrode industry, steel plants, and foundries.

JAZ USA Inc. & Bullard Abrasives, Inc. 35121
6 Carol Dr., Lincoln, RI 02865
(877) 529-8721; FAX (877) 529-3291
www.jazusa.com

JAZ USA, a wholly owned subsidiary of JAZ-ZUBIAURRE, S.A., will offer a wide range of industrial power, tube, hand scratch, and engineered brushes for application needs.

Jetline Engineering 34078
15 Goodyear, Irvine, CA 92618
(949) 951-1515; FAX (949) 951-9237
www.jetline.com

Jinan North Welding Tools Co. Ltd. 32102
North Qiyi Rd., Beiyuan St.
Jinan Shandong, China 250033
86531-889-62088; FAX 86531-889-74170
www.north-weld.com

The company, a professional welding gun manufacturer in China, will feature products, spool guns, and welding positioners.

Jingyu Welding & Cutting Co. Ltd. 31083
Mayao Rd. Dondsheng Vlg
Mahang Hutang Wujin, Changzhou, China 213162
86-519-86706120; FAX 86-519-86701045
www.jingyuwelding.com

As a manufacturer of welding and cutting products, the company will display GTA, GMA, and plasma torches along with spare parts, electrode holders, gouging torches, earth clamps, amphenol plugs, and welding masks.

J. Irizar & Co. Ltd. 34024
3123 43 Ave. NW, Edmonton, AB, Canada T6T 1C7
(780) 450-6695; FAX (780) 485-6677
www.jirizar.com

J. Irizar & Co. will showcase its rotating and positioning equipment.

John Tillman Co. 33089
1300 W. Artesia Blvd., Compton, CA 90220
(310) 764-0110; FAX (310) 764-2700
www.jtillman.com

Tillman will highlight the welding protective items it supplies including gloves, clothing, blankets, screens, and accessories.

Joysun Abrasives Co. Ltd. 38051
No. 129 Fifth Ave. East Hangh
Economy & Technology Development
Zhengzhou Hnn, China 450016
86371-676-22389; FAX 86371-676-22388
www.joysunabrasives.com

JP Nissen Co. 37021
2544 Fairhill Ave., Glenside, PA 19038
(215) 886-2025; FAX (215) 886-0707
www.nissenmarkers.com

Arcos 625 Takes High Nickel Alloy Quality to Extremes

Arcos, ***The Standard of Excellence in Covered Electrodes and Bare Wire***, offers two outstanding welding products designed to withstand critical temperature extremes.

Arcos 625 and Arcos 1N12 (625) are nickel-chromium-molybdenum products which are designed to be virtually immune to chloride-ion stress-cracking. They feature moderate strength, good fabricability and excellent oxidation resistance. Each is military-approved and provides superior corrosion resistance, over a range of temperatures from cryogenic to extremely elevated (up to 1,800°F).

Arcos 625 is ideal for welding alloys 625, 601, 802 and 9% nickel. This wire is well suited for welding piping systems and reactor components in the power generation industry and for high temperature service in a wide variety of other engineering applications.

Arcos 1N12 (625) is utilized for welding alloys such as 625, 800, 801, 825 and 600. This covered electrode is the smart choice for applications including petrochemical plants, reactor components, furnace equipment, heat exchangers and offshore marine environments.

To learn about the many advantages of specifying Arcos 625 and Arcos 1N12, call us today at **800-233-8460** or visit our website at **www.arcos.us**.

Arcos Industries, LLC
One Arcos Drive • Mt. Carmel, PA 17851
Phone: (570) 339-5200 • Fax: (570) 339-5206

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WorldWide Insurance Services, Inc.

www.worldclassbenefits.com/aws

J & S Machine, Inc. 3101
W6009 490th Ave., Ellsworth, WI 54011
(715) 273-3376
www.jsmachine.com

J & S Machine, a distributor of YLM and TRE C bending machines, will have a new product demonstration of an all-electric multistack CNC rotary bender with autoloader highlighting the easy-to-use flexible software package. A Windows based CNC roll bender will demonstrate its repeatability and flexibility as well as several sawing options that are offered.

Kamman Group 32032
501-7 C Wing Bhaveshwar Plaza
LBS Marg, Mumbai, Maharashtra, India 400086
91-22-25003802; FAX 91-22-25000225
www.kammangroup.com

Kamman Group will feature its processed metals, ferro alloys, minerals, and chemicals in powder form mainly for the welding electrode and hardfacing industries requirements, providing critical raw materials in customized sizes.

Kawasaki Robotics (USA), Inc. 34098
28140 Lakeview Dr., Wixom, MI 48393
(248) 446-4100; FAX (248) 446-4200
www.kawasakirobotics.com

Kawasaki Robotics, a supplier of robots and systems, will debut the new R-Series Robots and "E" Controller. Reliability and speed, together with a simple-to-use teach pendant, provide a good combination. Also, maintenance is simple with modular components and easy onboard diagnostics.

Kemper America, Inc. 34047
5910 Shiloh Rd. E., Ste. 110, Alpharetta, GA 30005
(770) 416-7070; FAX (770) 828-0643
www.kemperamerica.com

Keystone Fasteners 39029
409 Parkway View Dr., Pittsburgh, PA 15205
(412) 787-5970; FAX (412) 788-6627
www.keystonefastening.com

The company will have a complete range of capacitor discharge (CD) and drawn-arc (ARC) stud welding systems from portable hand-held models to fully automated CNC production machines for high-volume applications.

Kice Industries, Inc. 32100
5500 Mill Heights Dr., Park City, KS 67219
(316) 744-7151; FAX (316) 267-0515
www.kice.com

Kinetic Cutting Systems 5130
304 W. Prospect Rd., Ste. F, Fort Collins, CO 80526
(970) 498-8441; FAX (970) 498-8451
www.kineticusa.com

The company will display the new Kinetic K5000XMC plasma cutting and drilling machine with a 108 × 44 processing envelope. This machine has been engineered to enable extra milling capacity. Also, it now enables milling, drilling, and automated plasma bevel cutting with the Hypertherm HPR400XD and oxyfuel cutting in one operation.

Kiswel USA, Inc. 35089
7950 Dixie Hwy., Ste. 1, Florence, KY 41042
(859) 371-0070; FAX (859) 371-5210
www.kiswelweldingproducts.com

KLINGSPOR Abrasives, Inc. 8049
2555 Tate Blvd. SE, Hickory, NC 28602-1445
(800) 645-5555; FAX (888) 524-2775
www.klingspor.com

KLINGSPOR will offer a wide variety of coated and bonded abrasives including belts, sheets, discs, and items for the metal, woodworking, solid surface, and fiberglass industries.

Kobelco Welding of America, Inc. 34034
4755 Alpine Rd., Ste. 250, Stafford, TX 77477
(281) 240-5600; FAX (281) 240-5625
www.kobelcowelding.com

Koduct Co. Ltd. 37125
3175-10 Meongji-Dong Gangseo Gu
Korea, Busan 618-815
82051-3174490; FAX 82051-3174492
www.koduct.co.kr

Koike Aronson, Inc. 34021
635 West Main St., PO Box 307, Arcade, NY 14009
(800) 252-5232; FAX (585) 457-3517
www.koike.com

Koike Aronson/Ransome, a supplier of cutting machines, welding positioning equipment, portable welding and cutting machines, and gas apparatus, will be featuring a new dual-side-drive, plasma and oxyfuel cutting machine called the Plate-Pro Extreme. There will also be multiple new products exhibited and demonstrated from each of its product lines.

Koyo Giken, Inc. 8101
4020-4 Tana, Sagamihara City, Japan 229-1124
81-42-760-4306; FAX 81-42-760-4309
www.koyogiken.co.jp

Koyo Giken, a designing and engineering

company for industrial welding machines, will exhibit MYSPOT. This patented table spot welding machine is for the precision sheet metal industry.

KUKA Robotics Corp. 33115
22500 Key Dr., Clinton Township, MI 48036
(586) 465-8817; FAX (586) 465-8717
www.kukarobotics.com

KUKA Robotics will be demonstrating welding solutions live in its booth. Visitors can learn how to decrease cycle times, increase throughput, quality, and uptime with robotic automation.

Label Solutions, Inc. 33103
677 George St., Marshfield, MO 65706
(417) 859-6850; FAX (417) 859-6851
www.labelsmadeeasy.com

Laboratory Testing, Inc. 12109
2331 Topaz Dr., Hatfield, PA 19440-1936
(800) 219-9095; FAX (800) 219-9096
www.labtesting.com

Laboratory Testing will showcase its materials and nondestructive testing, specimen machining, failure analysis, dimensional inspection, and calibration services. Its expertise is in metals testing and the chemical analysis of powdered metals, ores, ferroalloys, composites, ceramics, and metals. NIST-traceable dimensional, pressure, force, torque, mass, and vacuum calibration along with field services will be provided.

LA-CO Industries/Markal 37003
1201 Pratt Blvd., Elk Grove Village, IL 60007
(800) 621-4025; FAX (800) 448-5436
www.markal.com

La-Co/Markal® will feature a complete line of high-performance paint markers and marking products designed to meet difficult industrial marking applications. From the originators of the B® Paintstik®, Markal® will offer the industrial professional permanent and temporary marking products including solid paint, liquid paint, felt-tip ink, and metal markers, plus temperature indicators.

Lantek Sheet Metal Solutions 6076
2737 S. Broadway Ave., Ste. 104, Tyler, TX 75701
(903) 258-9422; FAX (903) 258-9425
www.lantek-systems.com

Lapco Mfg., Inc. 31024
98 Glenwood St., Morgan City, LA 70380
(985) 385-5380; FAX (985) 384-5081
www.lapcomfg.com

Laser Cladding Services Ltd. 31058
5675 Guhn Rd., Houston, TX 77040
(800) 856-8082; FAX (713) 996-8841
www.lasercladding.com

Laser Mechanisms, Inc. 11020
25325 Regency Dr., Novi, MI 48375
(248) 474-9480; FAX (248) 474-9277
www.lasermech.com

Laser Mechanisms will exhibit its laser beam delivery components and articulated arm systems including its new FiberCut processing head. Engineered for 3-dimensional robotic cutting with a fiber-coupled laser, FiberCut is a compact, low moving mass head that minimizes inertia transfer to the robot support arm.

Laserage Technology Corp. 6064
3021 N. Delany Rd., Waukegan, IL 60087-1826
(847) 249-5900; FAX (847) 336-1103
www.laserage.com

Laserage will provide various laser capabilities including using custom designed CO_2, Nd:YAG, and fiber laser systems that can cut, drill, scribe, weld, and heat treat a wide variety of materials to user specifications including ceramics, composites, plastics, glass, rubber, metal, and most materials. Also, the company's product capabilities include electronic substrates and aerospace flight critical and custom cable assemblies.

LaserStar Technologies Corp. 12020
1 Industrial Ct., Riverside, RI 02915-5218
(401) 438-1500; FAX (401) 434-7260
www.laserstar.net

LENOX 12122
301 Chestnut St., East Longmeadow, MA 01028
(800) 628-3030; FAX (413) 525-8867
www.lenoxtools.com

Liburdi Dimetrics Corp. 37110
400 Highway 6 N., Dundas, ON, Canada L9H 7K4
(905) 689-0734; FAX (905) 689-0739
www.liburdi.com

Liburdi Dimetrics will display its range of orbital welding products using advanced technologies. Liburdi Automation will showcase its high-precision, vision-based LAWS, Dabber®, and Pulsweld® power sources; multiaxis articulated motion systems; and controllers for applications in turbine, aerospace, nuclear, industrial, and automotive industries.

Lincoln Electric Co. 36043
22801 Saint Clair Ave., Cleveland, OH 44117
(216) 481-8100; FAX (216) 486-1751
www.lincolnelectric.com

Lincoln Electric will display its arc welding

products; robotic arc welding systems; equipment for fume extraction as well as plasma and oxyfuel cutting; and brazing and soldering alloys.

LORD Corp. 32089
111 Lord Dr., Cary, NC 27511
(919) 468-5981; FAX (919) 859-2739
www.lord.com

The company will showcase its structural bonding adhesives that replace/reduce rivets, tape, bolts, screws, and welding. These high-strength adhesives bond a variety of dissimilar materials, thin-gauge metals, composite, plastic, wood, rubber, and glass. Also, they are formulated to provide good performance and design flexibility.

LS Industries, Inc. 8114
710 E. 17th St. N., Wichita, KS 67214
(316) 265-7997; FAX (316) 265-0013
www.lsindustries.com

Lucas-Milhaupt, Inc. – A Handy & Harman Co. 32002
5656 S. Pennsylvania Ave., Cudahy, WI 53110
(414) 769-6000; FAX (414) 769-1093
www.lucasmilhaupt.com

Lucas-Milhaupt will highlight its metal joining products and services such as alloys, fluxes, automated equipment, product design, training, and technical assistance. In addition, the company will offer its brazing and soldering materials for the electrical/electronic, appliance, and transportation markets.

Luvata Ohio, Inc. 32020
1376 Pittsburgh Dr., Delaware, OH 43015
(740) 363-1981; FAX (740) 368-4348
www.luvata.com

Magestic Systems, Inc. 6054
205 Fairview Ave., Westwood, NJ 07675
(201) 263-0090; FAX (201) 263-0091
www.magestic.com

Magestic Systems will feature enterprise software developments, material and process optimization across all CNC cutting and laser projection applications, and a wide variety of turnkey solutions that assist manufacturers through the entire process of taking a design and turning it into a product.

Magnatech LP 36053
6 Kripes Rd., East Granby, CT 06026
(860) 653-2573; FAX (860) 653-0486
www.magnatechllc.com

Magnatech will display equipment for orbital tube/pipe welding applications. A wide range of models provide the precision, consistency, and high-duty cycle of GTAW/FCAW machine welding. The Tubemaster power source with Autoprogram will be demonstrated welding sanitary stainless tubing. The company's Pipemaster, for multipass welding, is the result of a 3-year development in digital technology.

Magswitch Technology, Inc. 36132
621 Southpark Dr., Ste. 1900, Littleton, CO 80120
(303) 468-0662; FAX (303) 690-8144
www.magswitch.com.au

Magswitch will exhibit patented technology to turn permanent rare earth magnets on and off. This allows for controlling strong magnets that change the nature of metal working. Precise positioning, easy and safe handling, simple removal, shedding debris, and three-dimensional setups are all fast.

Manufacturing Solutions, Inc. 38050
9485 College St., Beaumont, TX 77707
(409) 842-4404; FAX (409) 842-9445
www.msi-tx.com

At this company's booth, visitors can see its ChamferMate pipe beveler machine a weld bevel on heavy-wall pipe in under 12 s. Machines will be available for ½- to 8-in. pipe. Standard 37½ deg, J bevels, and special angles can be machined. MSI also manufactures bar shears, marking machines, parts feeders, and custom designed machinery.

Manufacturing Technology, Inc. 33035
1702 W. Washington St., South Bend, IN 46628
(574) 233-9490; FAX (574) 233-9489
www.mtiwelding.com

Manufacturing Technology has added friction stir welding to its solid-state welding family through the acquisition of Transformation Technologies. It will exhibit stir, inertia, direct drive, linear, radial, and resistance welding technologies.

Marvel Mfg. Co. 14131
3501 Marvel Dr., Oshkosh, WI 54902
(920) 236-7200; FAX (920) 236-7209
www.sawing.com

Master Magnetics, Inc. 38038
747 S. Gilbert St., Castle Rock, CO 80104
(888) 293-9399; FAX (800) 874-8268
www.magnetsource.com

Matheson Tri-Gas, Inc. 38110
166 Keystone Dr., Montgomeryville, PA 18936
(215) 687-1009; FAX (215) 641-2714
www.mathesontrigas.com

Mathey Dearman, Inc. 33065
PO Box 472110, Tulsa, OK 74147
(918) 447-1288; FAX (918) 447-0188
www.mathey.com

Matuschek Welding Products, Inc. 39080
42378 Yearego Dr., Sterling Heights, MI 48314
(586) 991-2434; FAX (586) 991-2438
www.matuschek.com

The company will showcase the weld quality benefits of its real-time Master® adaptive control technology for resistance spot welding. Also, displayed will be its mid- and high-frequency inverter power supplies for sheet metal welding and microwelding including precision weld heads and hand-held process analyzers. The company's controllers offer adaptive feedback, QC software solutions, tolerance band control, and fault alert capabilities.

Maxal, Inc. 34072
1631 International Dr., Traverse City, MI 49686
(231) 933-1234; FAX (231) 933-6110
www.maxalinc.com

Mecco Marking & Traceability 12043
PO Box 5004, Cranberry Township, PA 16066
(724) 779-9555; FAX (724) 779-9556
www.mecco.com

Mecco Marking & Traceability will offer current innovations in laser and dot peen direct part marking for traceability, verification, and part identification. Its products feature 2-D data matrix capabilities.

Medi-Rub USA 37058
10 Cedar Dr., Mills River, NC 28759
(843) 372-1011; FAX (508) 819-3002
www.medirubusa.com

MegaFab Whitney/Piranha/Bertsch 9003
3 Compound Dr., Hutchinson, KS 67502
(620) 727-8403; FAX (877) 349-6902
www.megafab.com

Meltric Corp. 38011
4640 W. Ironwood Dr., Franklin, WI 53132
(414) 817-6160; FAX (414) 817-6161
www.meltric.com

Mercer Abrasives 38080
300 Suburban Ave., Deer Park, NY 11729
(800) 221-5202; FAX (631) 243-3209
www.mercerabrasives.com

Messer Cutting Systems 9108
W141 N9427 Fountain Blvd.
Menomonee Falls, WI 53051
(262) 255-5520; FAX (262) 255-5170
www.mg-systems-welding.com

The company will display its plasma, oxyfuel, and laser cutting machines.

Meta Vision Systems, Inc. 38034
8084 Rte. Transcanadienne
Saint-Laurent, QC, Canada H4S 1M5
(800) 661-0140; FAX (514) 333-8636
www.meta-mvs.com

Metabo Corp. 39077
1231 Wilson Dr., West Chester, PA 19380
(800) 638-2264; FAX (800) 638-2261
www.metabousa.com

Metallisation Ltd. 30032
Pear Tree Ln., Dudley, UK DY2 0XH
44-138-4252464; FAX 44-138-4237196
www.metallisation.com

Metallisation will highlight its thermal spray products.

Micro Air Clean Air Systems 7074
PO Box 1138, Wichita, KS 67201-1138
(316) 946-5875; FAX (316) 219-2995
www.microaironline.com

Micro Air will offer its complete line of industrial air cleaners; dust, portable, and mist collectors; downdraft tables; clean air booths; and source capture arms. Also, the company will be introducing its new line of MISTMAX extended life, high-efficiency mist collectors. All equipment is built to fit user's specific needs, fabricated to boost productivity, and increase safety.

Midalloy 31021
630 Axminister Dr., Fenton, MO 63026
(800) 776-3300; FAX (636) 349-2240
www.midalloy.com

Miller Electric Mfg. Co. 34071
1635 W. Spencer St., PO Box 1079, Appleton, WI 54912
(800) 426-4553; FAX (877) 327-8132
www.millerwelds.com

Miller Electric Mfg. will exhibit its arc welding, plasma cutting, and welding safety equipment for fabrication, manufacturing, general metalworking, construction, maintenance, and other applications.

MK Products, Inc. 39093
16882 Armstrong Ave., Irvine, CA 92606
(949) 863-1234; FAX (949) 474-1428
www.mkproducts.com

Motoman, Inc. 35065
805 Liberty Ln., West Carrollton, OH 45449
(937) 847-6200; FAX (937) 847-3288
www.motoman.com

Motoman will feature several new robots. The SDA10 dual-arm robot with human-like flexibility is ideally suited for assembly, part transfer, machine tending, packaging, and other handling tasks that formerly could only be done by people. The highly flexible, 7-axis VA1400 robot and the slim, 6-axis MA1400 welding robot are both good for use in high-density workcells with multiple robots working in close proximity as well as for applications requiring access to parts in tight spots.

MPT Industries 38016
85 Franklin Rd., 6-B Hamilton Business Park
Dover, NJ 07801
(973) 989-9220; FAX (973) 989-9234
www.mptindustries.com

The company will display its chemical resistant and oxygen safe thread sealants and lubricants that are compatible with many aggressive chemicals over a wide temperature range. Features include nonflammable, nonmigrating, nontoxic, odorless, oxygen compatible, waterproof, antigalling, antiseize, dielectric, and chemically inert. It will also show high-performance, long-lasting multipurpose lubricants/penetrants and waterproof grease.

MultiCam, Inc. 9105
PO Box 612048, DFW Airport, TX 75261
(972) 929-4070; FAX (972) 929-4071
www.multicam.com

MultiCam will feature CNC router, laser, plasma, water jet, and knife cutting machines. Its open architecture systems will work seamlessly with virtually all industry standard CAD/CAM and nested-based software.

Nation Coating Systems, Inc. 30017
501 Shotwell Dr., Franklin, OH 45005
(937) 746-7632; FAX (937) 746-7658
www.nationcoatingsystems.com

NCS, a thermal spray company, will showcase metal and ceramic coatings on all types of products. These vary from aircraft to race cars and even wind mills for new power generation.

National Center for Advanced Manufacturing (NCAM) 39011
13800 Old Gentilly Rd., Bldg. 420, Rm. 200
New Orleans, LA 70129
(504) 257-0969; FAX (504) 257-5456
www.ncamlp.org

NCAM is a governmental/business/academic partnership (including NASA, State of Louisiana, University of New Orleans) located at NASA's Michoud Assembly Facility in New Orleans that promotes the use of advanced manufacturing technologies and research for industrial applications. Its equipment includes a large-scale friction stir welding system with 6-axes of motion weld head and self-reacting pin tool technology. Other equipment includes fiber placement (composites) machines as well as high-speed machining and NDE systems.

National Standard LLC 38089
1631 Lake St., Niles, MI 49120
(800) 777-1618; FAX (269) 683-6249
www.nationalstandard.com

National Standard will be introducing its Tru-Core flux cored welding wire line of products as well as the Smart Pak bulk weld wire package, which is 100% recyclable as corrugated (no staples or metal rings) with the added feature of being able to accommodate the three primary wire payout systems — direct pull, round cone, and square base with round cone.

Nederman, Inc. 38047
6330 Commerce Dr., Westland, MI 48185
(734) 729-3344; FAX (734) 729-3358
www.nedermanusa.com

Nederman, a company focused on providing solutions for a cleaner and safer work environment, will highlight products used in capturing and filtering welding smoke, extracting and filtration of particles from cutting and grinding, filtration, and cleaning of oil mist. In addition, a complete line of hose and cable reels for air/water and electricity delivery will be shown.

Nelson Stud Welding 35105
7900 W. Ridge Rd., Elyria, OH 44035
(440) 329-0400; FAX (440) 329-0492
www.nelsonstudwelding.com

New Fire Co. Ltd. 38053
Room 101, No. 88, Branch Ln. 2
XiuYan Rd., Pudong, Shanghai, China 201315
86-216-8197031; FAX 86-216-8197211
www.newfire.biz

New Fire will offer industrial thermal insulating, welding, and cutting and safety protector products.

Ningbo Kimpin Industrial Pte. Ltd. 31080
6 Fl., No. 10 Bldg., North Bank Fortune Center
Ningbo, China 315020
86-574-87321223; FAX 86-574-0873242
www.kimpin.com

Ningbo Powerway Group Co. Ltd. 38074
Yunlong Town Yinzhou District, China 315135
86574-83004660; FAX 86574-88349958
www.pwalloy.com

Ningbo Yinzhou Qisheng Welding Tools Plant 31085
No. 2116 Ningheng S. Rd.
Hengxi Town Yinzhou Area, Ningbo, China 315131
86-574 8806 1005; FAX 86-574 8806 0908

The company will feature cutting and welding nozzles.

Nitto Kohki USA, Inc. 7102
4525 Turnberry Dr., Hanover Park, IL 60133
(630) 924-9393; FAX (630) 924-0303
www.nittokohki.com

Non-Destructive Testing Group 31039
8181 Broadmoor Ave. SE, Caledonia, MI 49316
(616) 891-3570; FAX (616) 891-3565
www.nondestructivetesting.com

Non-Destructive Testing Services will provide an array of inspection and testing methods to

the manufacturing industry. The company specializes in a full range of NDE methods, quality assurance, and physical testing, also providing both in-house inspection along with mobile units. Some of the industries it serves include automotive, chemical, castings/forgings, wind energy, medical, and electronics.

Nordfab Ducting 32016
150 Transit Ave., Thomasville, NC 27360
(800) 532-0830; FAX (336) 889-7873
www.nordfab.com

North Carolinas Southeast 13011
PO Box 2556, Elizabethtown, NC 28337
(910) 862-8511; FAX (910) 862-1482
www.ncse.org

Nova-Tech Engineering LLC 39013
20818 44th Ave. W., Ste. 201, Lynnwood, WA 98036
(425) 245-7000; FAX (425) 245-7099
www.stirwelding.com

Nu-Age Plant Services/Fusion Welding Solutions 37090
5750 Marathon Dr., Ste. B, Jackson, MI 49201
(517) 990-0665; FAX (517) 990-0663
www.nu-age.com

Nu-Age Plant Services, along with Fusion Welding Solutions, are weld cell and plant service providers. Its services and products will include dry ice blasting machine sales and service, weld engineering and robotic weld cell maintenance services, and weld cell support equipment sales.

Nutron Nameplate, Inc. 8079
PO Box 487, North Olmsted, OH 44070
(888) 737-5052; FAX (440) 777-6664
www.nutronnameplate.com

The company will introduce FMA safety council approved ISO/ANSI equipment safety signage. Individual and kits signage will also be available.

Ohio Nut & Bolt Co., The 39083
33 Lou Groza Blvd., Berea, OH 44017
(800) 362-0291; FAX (216) 267-3228
www.on-b.com

Ohio Nut & Bolt, a manufacturer of resistance and spot weld fasteners, will offer five different sizes of its FH style leveler with dogpoint adjustment on the terminal end. It will also now offer its RW style weld screws, with a ring projection, in 1022 heat-treatable carbon steel. Its factory direct source, Buckeye Fasteners, will now offer a ¾ × 10 hex, piloted, projection weld nut as a stock item.

OKI Bering 36115
9901 Princeton Glendale Rd., Cincinnati, OH 45246
(513) 341-4002; FAX (513) 341-4903
www.oki-bering.com

Olympus 38043
48 Woerd Ave., Ste. 105, Waltham, MA 02453
(781) 419-3625; FAX (781) 419-3980
www.olympus-ims.com

Olympus will provide ultrasonic testing, phased array, eddy current, remote visual inspection, and high-speed video and related support technologies. These can be used to survey the quality and integrity of construction welds such as those in pipelines and bridges, as well as sheet metal spot welds and certain other weld geometries found in manufacturing.

OR Lasertechnology, Inc. 12026
1420 Howard St., Elk Grove Village, IL 60007-2221
(847) 593-5711; FAX (847) 593-5752
www.or-laser.de

Orbitalum Tools GmbH 34088
15 Goodyear St., Irvine, CA 92618
(949) 951-1515; FAX (949) 544-7988
www.orbitalum.com

Osborn-JacksonLea 39052
5401 Hamilton Ave., Cleveland, OH 44114
(216) 361-1900; FAX (216) 361-1430
www.osborn.com

Osborn/JacksonLea-Jason Finishing Group will feature a full finishing product line including Novoflex flexible honing tools, Uni-Lok® composite disc brushes, ATB™ brushes, Fascut composite wheel brushes, Softool® insert hones, PCD diamond super-abrasive brushes, fine blanking brushes, NOTIFLEX®, coated abrasive tools, spiral brushes and rollers, Sisal, a wide variety of wire and abrasive nylon wheel, cup, internal and end brushes, maintenance brushes, buffs, compounds, abrasive belts, flap wheels, nonwoven products, cleaners, and specialty chemicals.

Oskar Air Products, Inc. 34042
95 Cypress Dr., Youngsville, NC 27596
(919) 570-2862; FAX (919) 562-7182
www.oskarsales.com

Oskar Air Products will display durable, easy-to-use fume extraction and filtration products.

Oxford Alloys, Inc. 39039
2632 Tee Dr., Baton Rouge, LA 70814
(225) 273-4800; FAX (225) 273-4814
www.oxfordalloys.com

Oxford Alloys will feature its broad range of in-stock welding wire and electrodes including nickel alloys, stainless steel, titanium, aluminum, bronze alloys, and low-alloy steel. Representatives will be available to discuss the company's online web tool as well as same day shipping capabilities from its three strategically located distribution centers.

Oxylance Corp. 32088
PO Box 310280, Birmingham, AL 35231
(205) 322-9906; FAX (205) 322-4808
www.oxylance.com

PacMont, Inc. 38054
18855 Chessington Pl., Rowland Heights, CA 91748
(626) 839-1443; FAX (626) 964-0158

Pador Marketing Group 34110
655 32nd Ave., Ste. 201, Lachine, QC, Canada H8T 3G6
(514) 634-0861; FAX (514) 634-9736
www.pador.com

Pador Marketing Group, a distributor of tools for pipe shops, will showcase the Rotoweld 2000 welding work station, Vernon pipe cutting and profiling machine, Wortelboer pipe end beveling machine, and team welding positioners and grippers.

Pandjiris, Inc. 37047
5151 Northrup Ave., Saint Louis, MO 63110
(314) 776-6893; FAX (314) 776-8763
www.pandjiris.com

Pandjiris will offer the following complete line of standard positioning equipment: positioners, turning rolls, manipulators, slides and swivels, seamers, side beams and carriages, headstocks and tailstocks, turntables, and 3 o'clock welding machines. The company will

Quality aluminum welding starts with a quality filler metal – material with the consistency, feedability, surface finish and cleanliness required to produce welds with aesthetic appeal and x-ray quality. Welders around the world find their solution for quality in AlcoTec aluminum wire, the choice of experts and the number one provider of aluminum wire worldwide. With AlcoTec, in addition to top-quality wire, you receive continued support after the sale. The experienced AlcoTec staff is always ready to assist with welding problems, help improve your manufacturing techniques or develop new welding procedures.

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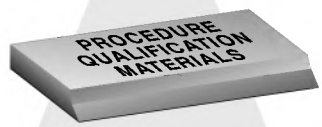

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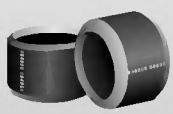

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also offer engineering expertise to provide complete turnkey systems designed and manufactured to meet users needs across a wide range of industries.

Pangborn Corp. 9136
4630 Coates Dr., Fairburn, GA 30213
(404) 665-5700; FAX (404) 665-5701
www.pangborn.com

This OEM will exhibit descaling, peening, and surface preparation equipment for various market segments.

Parker domnick hunter 30030/7109
5900 Northwoods Pkwy., Ste. B, Charlotte, NC 28269
(800) 345-8462; FAX (704) 921-1960
www.domnickhunter.com

The company will feature closed loop Hyperchill Thermal Spray Chillers that feature a fully prepackaged system (4-in-1 design including chiller, pump, tank, and by-pass), acceptance of a wide range of water temperatures and fluctuating water flows, environmentally friendly R407C refrigerant, and compliant scroll compressors combined with other integral components to provide a cycling feature that yields high energy savings.

Pat Mooney, Inc. 5135
502 S. Westgate St., Addison, IL 60101
(630) 543-6222; FAX (630) 543-5584
www.patmooneysaws.com

PDS Bartech, Inc. 33025
2519 E. Southmore Ave., Pasadena, TX 77502
(800) 950-8489; FAX (713) 472-6804
www.pdsbartech.com

The company will highlight its heat treating equipment and parts.

Pearl Abrasive Co. 33111
6210 Garfield Ave., Commerce, CA 90040
(800) 969-5561; FAX (562) 928-3857
www.pearlabrasive.com

Pearl Abrasive will supply bonded and coated abrasives, diamond blades, cup wheels, core bits, and polishing pads. It will also offer a complete line of tile and masonry saws, and surface preparation equipment. Plus, it will carry dust containment products and the new Tuscan Leveling System.

Peddinghaus Corp. 12079
300 N. Washington Ave., Bradley, IL 60915
(815) 937-3800; FAX (815) 937-4003
www.peddinghaus.com

Peddinghaus will display its machine tool technology for structural steel and plate fabrication.

Pennsylvania College of Technology 40043
One College Ave., Williamsport, PA 17701-5799
(800) 367-9222; FAX (570) 320-5264
www.pct.edu

Permadur Industries, Inc. 33031
186 Route 206 S., Hillsborough, NJ 08844
(800) 392-0146; FAX (908) 359-9773
www.permadur.com

The company will exhibit patented electrically controlled permanent lifting magnets, custom built magnet and vacuum lifting systems, and load positioners.

PFERD, Inc. 36111
30 Jytek Dr., Leominster, MA 01453
(978) 840-6420; FAX (978) 840-1274
www.pferdusa.com

PFERD, the U.S. subsidiary of August Rüggeberg & Co., will feature its single-source solutions for hand finishing, grinding, cutting, and specialty applications.

Phoenix International, Inc. 31003
8711 W. Port Ave., Milwaukee, WI 53224
(414) 973-3434; FAX (414) 973-3210
www.phx-international.com

Phoenix International will showcase Safetube rod canisters, its durable DryRod ovens, and the company's booth will feature its line of portable and bench rod ovens along with its new 40HT high-temperature rebaking oven.

Pipe Fitters Local Union #597 35071
10850 187th St., Mokena, IL 60448
(708) 326-9240; FAX (708) 326-9241

Plasma Automation, Inc. 36071
1801 Artic Ave., Bohemia, NY 11716
(631) 563-7234; FAX (631) 563-7239
www.plasma-automation.com

Plasma Automation will feature the Monarch heavy-duty precision plasma cutting system offering cutting applications from sheet metal to plate, structural steel to I-beam, angle iron, channel, and tubing. It will also be displaying a custom cut-to-length and roll forming line. Vicon ViSoft software demonstrations will be ongoing throughout the show.

Plasma Coatings, a Division of American Roller Co. 30013
1440 13th Ave., Union Grove, WI 53182
(262) 878-2445; FAX (262) 878-3893
www.plasmacoatings.com

Plasma Coatings will highlight its incorporated thermal technologies with polymer science resulting in a blend of surface property characteristics.

Plasma Craft, Inc. 37119
2829 Avalon Ave., Muscle Shoals, AL 35661
(256) 381-2366; FAX (256) 381-5181
www.plasmacraft.com

The company will offer its repair and retrofit services to the CNC plate cutting industry.

PlymoVent North American 32000
115 Melrich Rd., Cranbury, NJ 08512
(800) 644-0911; FAX (609) 655-0569
www.plymovent.com

Polymet Corp. 30024
10073 Commerce Park Dr., Cincinnati, OH 45246
(513) 874-3586; FAX (513) 874-2880
www.polymet.us

The company will exhibit its high-performance wire for hardfacing, welding, and thermal spraying.

Praxair, Inc. 34093
7000 High Grove Blvd., Burr Ridge, IL 60527
(630) 320-4133; FAX (630) 320-4508
www.praxair.com

Precitec, Inc. 12034
28043 Center Oaks Ct., Wixom, MI 48393
(248) 446-8100; FAX (248) 446-9409
www.precitec.us

Precitec will display mechanical, optical, and electronic components and systems designed for material processing using lasers as well as process control and monitoring.

Preco, Inc. 12003
500 Laser Dr., Somerset, WI 54025
(715) 247-3285; FAX (715) 247-5650
www.precoinc.com

Preston-Eastin, Inc. 35093
5341 E. Independence St., Tulsa, OK 74115
(918) 834-5591; FAX (918) 834-5595
www.prestoneastin.com

Primax Mfg. & Trading, Inc./ Caiman Gloves 39033
9078 Rosecrans Ave., Bellflower, CA 90706
(562) 272-2762; FAX (562) 272-2761
www.caimangloves.com

Primax/Caiman® Gloves will provide personal protective equipment. Its Revolution®/Kontour™ welding gloves, M.A.G. Multi-Activity Gloves, Boarhide® protective garments, and Heatrac® winter/outdoor sport gloves possess good quality, aesthetic appeal, comfort, and performance. At its booth, the new styles will be 21 Revolution® and Black Gold Deerskin Revolution® welding gloves.

Process Equipment Co. 33021
6555 S. State Rte. 202, Tipp City, OH 45371
(937) 667-7105; FAX (937) 667-2591
www.processeq.com

PECo will showcase assembly systems, robotic cells, material handling, custom automation, and lean cell systems. The company will also offer build to print machines and fabrication services as well as systems for welding, part marking, eddy current/leak testing, and special machines.

Profax/Lenco 33099
1603 N. Main St., Pearland, TX 77581
(281) 485-6258; FAX (281) 485-8030
www.profax-lenco.com

Profax & Lenco will highlight its manual welding accessories, GMA guns and consumables, GTA torches and consumables, arc gouging torches and carbons, and all types of welding machine repair parts. Its new products will include a straight line track cutting machine, hand operated pipe beveler, ceramic backing tape, water soluble purge paper, and a line of positioners, turning rolls, and manipulator.

Project Tool & Die, Inc. 13104
6955 Danyeur Rd., Redding, CA 96001
(530) 243-8903; FAX (530) 243-8914
www.projecttoolanddie.com

Project Tool and Die will feature tooling for pipe, tubing, and extrusions. End notching, piercing, trimming, cut off, flattening, and mandrel dies will also be shown or samples from these dies. Typical end users are furniture, automotive, motorcycle, scaffolding, livestock, fencing, wrought iron, exercise, medical, and aircraft manufactures and industries.

Pullmax, Inc. 9091
2255 Lois Dr., Ste. 1, Rolling Meadows, IL 60008-4100
(847) 952-9977; FAX (847) 952-9988
www.pullmaxinc.com

Qingdao Yidian Plastic Welding Equipment Co. Ltd. 37107
No. 126 Ningxia Rd., Shinan Dist.
Qingdao Shandong, China
86-532-85732973; FAX 86-532-85732923
www.qdyidian.com

Quality Welding Products, Inc. 33039
PO Box 60467, King of Prussia, PA 19406
(610) 331-1607; FAX (610) 783-0446
www.qwpinc.net

QWP offers its customers technical service and products for the pickling and passivation of stainless, nickel, aluminum, titanium, copper, and carbon steel. The company will introduce 2001T, a fast and easy pickling paste; and a new small pickling spray kit.

Raajratna Stainless Wire (USA), Inc. 40012
1212 E. Algonquin Rd., Apt. 2P
Schaumburg, IL 60173
(847) 485-8210; FAX (847) 485-8254
www.raajratna.com

Raajratna Stainless will highlight its stainless steel wires for various industrial sectors in more than 50 countries around the globe.

Radyne Corp. 32110
211 W. Boden St., Milwaukee, WI 53207
(414) 481-8360; FAX (414) 481-8303
www.radyne.com

Radyne will showcase its energy and cost-efficient induction heating technologies for brazing silver and copper; fluxless brazing of stainless steel; and heat-treating solutions from simple benchtop units to complete automated turnkey systems. The company's modular integrated FlexScan can be fitted with robotics or manually loaded/unloaded.

Rankin Industries 37089
8745 Production Ave., San Diego, CA 92121
(858) 684-5000; FAX (858) 684-5008

Ready Welder/Weldstone 37059
4769 E. Wesley Dr., Anaheim, CA 92807
(800) 465-9184; FAX (714) 970-0800
www.weldstone.net

Red Onyx Industrial Products LLC 38006
3418 CR 6 E, Unit 3, Elkhart, IN 46514
(877) 234-WELD; FAX (574) 975-2899
www.red-onyx.com

Reis Robotics USA, Inc. 38021
1320 Holmes Rd., Elgin, IL 60123
(847) 741-9500; FAX (847) 741-9914
www.reisroboticsusa.com

Reis Robotics will feature its expertise in providing, planning, and executing turnkey solutions in all major application fields.

Resistance Welding Manufacturing Alliance (RWMA) 40007
550 NW LeJeune Rd., Miami, FL 33126
(305) 443-9353; FAX (305) 442-7451
www.aws.org/rwma

RWMA is a standing committee within the American Welding Society. Since 1935, it has been the authoritative source of information and experience for the resistance welding industry. It offers a host of benefits to its members. At its booth, visitors can meet with members who will discuss any technical questions dealing with the resistance welding process.

Revco Industries, Inc. 38064
10747 Norwalk Blvd., Santa Fe Springs, CA 90670
(800) 527-3826; FAX (800) 738-2690
www.blackstallion.com

Revco Industries will showcase its Black Stallion and BSX product lines of welding and safety gloves, protective FR and leather apparel, as well as its high-temperature products, fire blankets, welding screens, and accessories.

Rex Cut Products Co. 32042
PO Box 2109, Fall River, MA 02722
(800) 225-8182; FAX (800) 638-8501
www.rexcut.com

Rhino Industry, Inc. 38008
PO Box 91055, Long Beach, CA 90809-1055
(888) 651-0899; FAX (562) 961-8387
www.rhinowelders.com

Rhino will feature its high-quality welding machines and accessories, as well as its reliable services.

RJL Global 39076
1360 Middleburg Rd., Naperville, IL 60540
(630) 369-8154; FAX (630) 563-2826
www.rjlglobal.com

Robinson Technical Int. Corp. 31008
158 Lodi St., Hackensack, NJ 07601
(201) 488-7018; FAX (201) 488-1668
www.rti-abrasive.com

Robinson will feature its cut-off and grinding

wheels, sand papers, and wire brushes used in fabrication, foundry, shipbuilding, automotive, railroad, and construction industries. The company will also highlight its DIY products in a variety of packaging.

Rolled Alloys 40016
125 W. Sterns Rd., Temperance, MI 48182
(800) 521-0332; FAX (734) 847-6917
www.rolledalloys.com

Rose Plastic USA LP 39047
PO Box 698, California, PA 15419
(724) 938-8530; FAX (724) 938-8532
www.rose-plastic.us

Rosler Metal Finishing USA 11021
1551 Denso Rd., Battle Creek, MI 49037
(269) 441-3000; FAX (269) 441-3001
www.rosler.us

Roueche Co. LLC, The 33120
2305 Dodson Ave., Chattanooga, TN 37406
(423) 622-6694; FAX (423) 622-6695
www.trcwelding.com

Saar Hartmetall USA LLC 37033/4079
1009 Mary Laidley Dr., Covington, KY 41017
(859) 331-8770; FAX (859) 331-8771
www.shmusa.com

Saf T Cart 33071
PO Box 1869, Clarksdale, MS 38614
(662) 624-6492; FAX (662) 627-1640
www.saftcart.com

Saint-Gobain Coating Solutions 30018
4702 Route 982, Latrobe, PA 15650
(724) 539-6077; FAX (724) 539-6070
www.coatingsolutions.saint-gobain.com

Saint-Gobain, a manufacturer of equipment and consumables, will feature its Rokide® spray systems, plasma spray and plasma transferred arc systems, and a wide range of consumables in the form of powders, flexible cords, and Rokide® rods and wires.

Saint Louis Metallizing 30002
4123 Sarpy Ave., Saint Louis, MO 63110
(314) 531-5253; FAX (314) 531-4706
www.stlmetallizing.com

Saint Louis Metallizing will offer its expertise in developing and applying thermal spray coatings in metal, ceramic, and carbide forms to minimize wear and corrosion.

Sakura of America 40020
30780 San Clemente St., Hayward, CA 94544
(800) 776-6257; FAX (510) 475-0973
www.sakuraofamerica.com

Sakura of America specializes in manufacturing markers and writing instruments. The company will highlight Solid Marker,™ which marks through grease, oil, rust, dust, water, and underwater, and comes in a variety of colors, including a glow-in-the-dark version.

Sandvik Materials Technology 33081
982 Griffin Pond Rd., Clarks Summit, PA 18411
(800) 359-9442; FAX (570) 585-7686
www.smt.sandvik.com/nafta

Sandvik Materials Technology is a fully integrated manufacturer of stainless and nickel alloy welding consumables, as well as consumables for special alloys such as duplex and superaustenitics. The company will feature a modified lower nickel stainless steel grade that can be used to substitute grades 308L and 309L, and a modified stainless 400 Series alloy with superior high-temperature resistance for automotive exhaust systems.

Sanpo Publications, Inc. 31059
1-11 Kanda Sakuma-cho
Chiyoda-ku, Tokyo, Japan 101-0025
81-3-3258-6411; FAX 81-3-3258-8430
www.sanpo-pub-co.jp

Saru Silver Alloys Private Ltd. 38011
3 Saru Nagar Sardhana Rd.
Meerut Uttar Pradesh, India 250001
91-121-555433; FAX 91-121-2555515
www.sarusilver.com

Sciaky, Inc. 39053
4915 West 67th St., Chicago, IL 60638
(708) 594-3800; FAX (708) 594-9213
www.sciaky.com

Sciaky will showcase its electron beam (EB), resistance, and arc welding systems for aerospace and manufacturing, as well as its expertise in free form fabrication technology and advanced contract welding services.

Scotchman Industries, Inc. 9097
PO Box 850, Philip, SD 57567-0850
(605) 859-2542; FAX (605) 859-2499
www.scotchman.com

Scotchman will feature hydraulic ironworkers, component tool, fully integrated, single and dual operator; circular cold saws and band saws, manual to fully automatic; measuring systems; and feed systems to turn your machine into an automatic push feed system.

Secoa Technology 37052
205 Bear Creek Rd., Dalton, GA 30721
(706) 272-0133; FAX (706) 272-0135
www.secoatech.com

Secoa Technology specializes in high-performance coatings, including weld spatter release coatings and wear resistant coatings and platings. The company will feature live welding demonstrations to show the properties of SDFC weld spatter release coating, and its new weld nozzle coating for more welds between cleaning.

Sellstrom Manufacturing Co. 36047
1 Sellstrom Dr., Palatine, IL 60067
(847) 358-2000; FAX (847) 358-8564
www.sellstrom.com

Sellstrom will showcase its safety and personal protective equipment, including the new Impulse MAGSENSE autodarkening filter that features the latest in magnetic technology, the new DP4 Plasma Faceshield, and 17 SpatterGuard high-temperature fabrics that meet the new ANSI/FM 4950 Standard.

Servo-Robot, Inc. 31035
1370 Rue Hocquart
Saint-Bruno, QC, Canada J3V 6E1
(450) 653-7868; FAX (450) 653-7869
www.servorobot.com

Servo-Robot will feature its advanced 3-D laser vision sensing devices for robotic and automated laser vision systems, and process monitoring tools to provide real-time joint tracking, adaptive control, and visual inspection of welded components. The company will also display its new products AUTOTRAC/WT for simplified automated wind tower SAW, active video process supervision for improved weld process monitoring, and rapid seam finding using new SMART sensors.

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www.awsweldmex.com

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marcela.ordaz@tradeshowconsult.com

Servore Co. 31046
410-3 Tojin-ri Cheong Buk-myeon
Pyeongtaek, Kyeonggi-do, Korea 451-831
82-31-684 6952; FAX 82-31-684 6954
www.servore.com

Shanghai Gonglue Machinery & Elect Tech Co. Ltd. 31079
Rm. 1302, No. 14, Lane 1673
Zhangyang Rd., Shanghai, China 200135
8621-5821-1886; FAX 8621-5821-6371
www.xunweld.com

Gonglue will feature a full range of agglomerated flux, wire, and strip. Products include mild steel and low-alloy steel flux and wire, stainless steel and nickel alloy wire, and strip for SAW and ESW. The flux is approved by ABS, LR, DNV, GL, and BV.

Sherwin, Inc. 33037
5530 Borwick Ave., South Gate, CA 90280
(562) 861-6324; FAX (562) 923-8370
www.sherwininc.com

Shop Data Systems, Inc. 8120/12084
712 E. Walnut St., Garland, TX 75040-6608
(972) 494-2719; FAX (972) 272-7062
www.shopdata.com

Shop Data Systems will focus on its CAD/CAM sofware for all aspects of metal fabrication from the simple to the complex.

SigmaTEK Systems LLC 7070/8003
1445 Kemper Meadow Dr., Cincinnati, OH 45240
(513) 595-2018; FAX (513) 674-0009
www.sigmanest.com

SmartTCP, Inc. 34065
26602 Haggerty Rd., Farmington Hills, MI 48331
(248) 994-1041; FAX (248) 994-1042
www.smarttcp.com

SmartTCP will highlight its robotic welding solution for steel fabrications in small batch production. The gantry welding system is a turnkey solution that automates both the robot programming and the weld production, making it possible for job-shops and manufacturers to optimize the fabrication of high mix low volume parts.

Soutec Ltd. 38096
24387 Halsted Rd., Suite A
Farmington Hills, MI 48335
(248) 876-8181; FAX (248) 615-2092
www.soutec.com

Soutec, Prinzing, and Spiral-Helix has combined forces to bring support for machines to form tubes and fittings on manual or automated roll former and bending machines. Expertise to automate manufacturing lines capable of producing up to 12 parts a minute will be offered.

Spanco, Inc. 7085
604 Hemlock Rd., Morgantown, PA 19543
(610) 286-7200; FAX (610) 286-0085
www.spanco.com

Spanco will feature its gantry cranes, jib cranes, workstation bridge cranes, and Rigid Lifelines fall protection systems

Special Metals Welding Products Co. 37071
1401 Burris Rd., Newton, NC 28658
(828) 465-0352; FAX (828) 464-8993
www.specialmetalswelding.com

Special Metals Welding Products will hightlight its experise as a developer and manufacturer of nickel-based welding consumables for joining nickel alloys, high-performance steels, cast irons, and dissimilar metals as well as overlaying on steel for corrosion or erosion protection. Products include Monel, Inconel, Inco-weld, NI-Rod, Incoloy, and Incoflux.

Standard Resistance Welder Co. 40008
PO Box 268, 7833 Conners Rd., Winston, GA 30187
(770) 949-2479; FAX (770) 489-1826
www.srwelder.com

StandPoint 31034
1722 Montreal Circle, Ste. A, Tucker, GA 30084
(770) 270-4800; FAX (770) 270-4900
www.standpointgroup.com

Steiner Industries 37070
5801 N. Tripp Ave., Chicago, IL 60646
(773) 588-3444; FAX (773) 588-3450
www.steinerindustries.com

Stork Materials Technology 30010
51229 Century Ct., Wixom, MI 48393
(248) 960-4900; FAX (248) 960-4970
www.storksmt.com/crs

Stork Materials Technology will offer its expertise in weld failure analysis, welder training/procedure qualification, development of weld procedures, weld quality analysis, as well as materials testing and engineering services. Stork Cellramic specializes in engineered coatings that enhance performance and solve issues related to wear, traction, release, temperature, corrosion, and electrical resistance.

Stork Thermal Equipment 31030
21-24 Slaidburn Crescent
Southport Merseyside, UK PR9 9YF
44-170-4 215600; FAX 44-170-4 215601
www.stork.com/ste

Stork Thermal Equipment will feature its heat treatment equipment and furnaces, which offer versatility and simplicity of operation. Sales engineers will be available to discuss your requirements and provide an after sales support.

Strong Hand Tools 35111
7141 Paramount Blvd., Pico Rivera, CA 90660
(800) 989-5244; FAX (562) 949-4875
www.stronghandtools.com

Strong Hand Tools will demonstrate its new BuildPro modular welding tables and modular fixturing kits for the efficient holding, locating, and positioning of fixtures. Also, the company will feature its Adjust-O magnets with on/off Switches, 4-in-1 sliding arm clamps with removable/reversible clamp arm, and 3-axes fixture vises.

Suhner Industrial Products 31000
100 Anderson Rd., Rome, GA 30161
(706) 235-8046; FAX (706) 235-8045
www.suhner.com

Sulzer Metco US, Inc. 30003
1101 Prospect Ave., Westbury, NY 11590
(516) 338-2422; FAX (516) 338-2414
www.sulzermetco.com

Sumner Manufacturing Co., Inc. 34070
7514 Alabonson Rd., Houston, TX 77088
(281) 999-6900; FAX (281) 999-6966
www.sumner.com

For info go to www.aws.org/ad-index

Sumner Manufacturing, with expertise in pipe and material handling, will show a group of new products including welding setup tools to increase productivity and safety.

Superheat FGH Services, Inc. **31042**
680 Industrial Park Rd., Evans, GA 30809
(706) 790-5353; FAX (706) 790-3383
www.superheatfgh.com

Superheat will share its expertise as an industrial heat-treatment service provider.

Superior Abrasives, Inc. **38081**
4800 Wadsworth Rd., Dayton, OH 45414
(800) 235-9123; FAX (800) 841-3441
www.superiorabrasives.com

Super Abrasives will feature its coated and nonwoven abrasives for grinding, polishing, and finishing.

Superior Products, Inc. **37133**
3786 Ridge Rd., Cleveland, OH 44144
(216) 651-9400; FAX (216) 651-4071
www.superiorprod.com

Superior Products, a manufacture of gas management systems, will introduce the new versions of its Mighty-Max automatic changeover manifold with two new versions for laser assist gases. Also, the company will show its new line of cryogenic hoses, pressure relief valves, and cryogenic connections.

Swagelok Co. **32105**
31400 Aurora Rd., Solon, OH 44139
(440) 649-5648; FAX (440) 349-5970
www.swagelok.com

Sweetwater Economic Development Association **8116**
1400 Dewar Dr., Ste. 205A, Rock Springs, WY 82901
(307) 352-6874; FAX (307) 352-6876
www.sweda.net

Synetik Design **39051**
14b Marcel-Lépine, Saint-Jacques
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(450) 839-2400; FAX (450) 839-1032
www.synetik-di.com

Synetik will feature ergonomic seating solutions designed to enhance safety and productivity for welding, aeronautics, mining, institutional, pharmaceutical, food, transportation, and industrial use.

TAFA, Inc. **30021**
146 Pembroke Rd., Concord, NH 03301
(603) 224-9585; FAX (603) 225-4342
www.praxair.com/thermalspray

TDC Filter Manufacturing, Inc. **31007**
2 Territorial Ct., Bolingbrook, IL 60440
(800) 424-1910; FAX (630) 410-6201
www.tdcfilter.com

TDC Filter will feature its SmartCart and standard and custom filters for all dust collection processes.

Team Industries, Inc. **39021**
PO Box 350, Kaukauna, WI 54130
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Team Industries will feature its generation III and generation IV hydraulically-elevated welding positioners and grippers, which provide a complete workstation to improve weld

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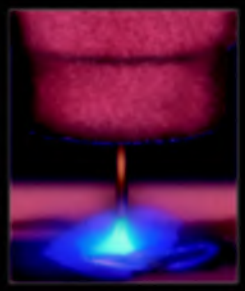

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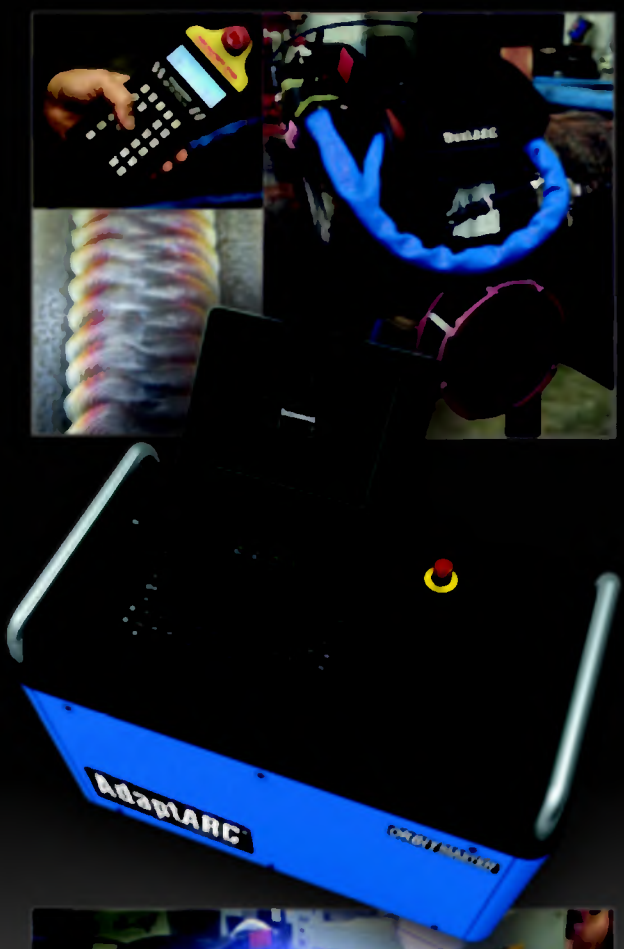

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Membership in AWS is a great way to nurture your professional development. Whether you're just starting out or a veteran welder, you'll benefit from becoming a member. **Join today!**

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American Welding Society

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TEC Torch Co., Inc. 39089
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www.tectorch.com

Techalloy Welding Products 36104
2310 Chesapeake Ave., Baltimore, MD 21222
(410) 633-9300; FAX (410) 633-2033
www.techalloy.com

Technogenia, Inc. 37080
708 Old Montgomery Rd., Conroe, TX 77301
(936) 441-4770; FAX (936) 539-4760
www.technogenia.com

Technogenia will highlight its hardfacing products for protecting parts against wear. The company will feature its tungsten carbide powder Spherotene, which can be applied as a thermal spray, using an oxyfuel torch or by laser.

TECMEN Electronics Co. Ltd 31074
Bldg. D. No. 21 N. Liuzhou Rd.
XiaoLiu Industry Park, Nanjing, China 210031
8625-85551955; FAX 8625-85551933
www.tecmen.cn

Tecmen will showcase its autodarkening welding helmets with ANSI, CSA, and CE approvals.

Texas State Technical College 40041
3801 Campus Dr., Waco, TX 76705
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Thermadyne Industries, Inc. 34046
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www.thermadyne.com

Thermadyne and its family of companies — Victor®, Thermal Dynamics®, Thermal Arc ®, Arcair®, Tweco®, TurboTorch®, Stoody®, and Cigweld® — will feature its metal cutting and welding equipment and consumables.

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Thermion will feature its arc spray equipment, offering full turnkey arc spray systems with parts, service, tech support/training, consumables, and wire/materials.

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(978) 670-7460; FAX (978) 670-7430
www.thermo.com/niton

Thermo Scientific Niton will showcase its XL3t Series XRF analyzers with GOLDD technology for in-house QA/QC of alloy materials, coating and plating thickness verification, and PMI of machined and fabricated parts. Immediate, nondestructive chemical analysis and alloy grade identification is provided.

3M Occupational Health & Environmental Safety Div. 35047
Bldg. 235-2W-70, St. Paul, MN 55144
(651) 736-1751; FAX (651) 736-6677
www.3m.com/occsafety

Tianjin Jinlong Welding Material Co. Ltd. 31076
Yuantian Rd., Changsheng St.
Gegu Town, Jinnan District, Tianjin, China 300352
8622-286-95656; FAX 8622-286-86879
www.jinlongweld.com

Tianjin Jinlong will feature its copper alloy welding wires, including deoxidized copper, silicon bronze, aluminum bronze, nickel aluminum bronze, phospher bronze, nickel silvers, tin brass, and iron brass.

Tianjin Xinsen Welding Materials Co. Ltd 31088
Huyuan Town, Shuangjie Zhen Beichen Dist.
Tianjin, China 300400
86-22-26972630; FAX 86-22-26972720
www.xinsenwelding.com

Tianjin Xinsen will showcase its copper alloy welding wires, brass brazing alloys, flux-coated brazing alloys, flux, and nickel-based welding wires.

Titus Flux Inc./American Welding & Flux 38079
1575 Hwy. 411 N., Ste. 401, Cartersville, GA 30121
(770) 386-1412; FAX (770) 386-1412
www.titusflux.com

The company will feature its submerged arc welding flux and consumables, as well as flux reclamation.

TJ Snow Co. 33000
PO Box 22847, Chattanooga, TN 37422
(423) 894-6234; FAX (423) 308-3187
www.tjsnow.com

Toolmen Corp. 13035
878 Westinghouse Rd., Georgetown, TX 78626
(512) 863-9685; FAX (888) 866-4910
www.toolmen1.com

Toolmen will feature advanced CNC welding, cutting, and cladding machines with dynamic force and pressure control and the ability to utilize vision systems to provide real-time adaptive feed back to the machine control enabling adjustments for quality control.

Torchmate 38127
280 S. Rock Blvd., Ste. 150, Reno, NV 89502
(775) 673-2200; FAX (775) 673-2206
www.torchmate.com

Tregaskiss 34071
2570 N. Talbot Rd., Windsor, ON, Canada N0R 1L0
(519) 737-3000; FAX (519) 737-1530
www.tregaskiss.com

Tregaskiss will showcase its gas metal arc welding (GMAW) guns and peripherals, including its TOUGH GUN manual, robotic guns and peripherals, TGX GMAW guns, and TOUGH GARD antispatter.

Trendex Information Systems, Inc. 37083
2367 Guenette St., Saint-Laurent
QC, Canada H4R 2E9
(514) 333-6373; FAX (514) 333-5705
www.trendexsys.com

Trendex will highlight Gastrend, its accounting and cylinder control software designed for the welding supply distributor. Demonstrations will show the user how to control accounts receivable, accounts payable, general ledger, and inventory, including cylinder control.

Tri Tool, Inc. 32021
3041 Sunrise Blvd., Rancho Cordova, CA 95742
(800) 345-5015; FAX (916) 288-6160
www.tritool.com

Tri Tool will highlight its complete line of pipe weld preparation machines, as well as custom designed machinery for special applications.

Trion, Inc. 31013
101 McNeill Rd., Sanford, NC 27330
(919) 777-6341; FAX (919) 777-6399
www.trioninc.com

Trion will feature air cleaning systems, mist collectors, and pollution control equipment for industrial metalworking applications, including electrostatic precipitators, media air cleaners, and cartridge dust collectors for OSHA and EPA compliance.

Triple Crown Products 39043
814 Ela Ave., Waterford, WI 53185
(800) 619-1110; FAX (262) 534-7879
www.crownquality.com

Triple Crown Products is a full service safety gear, apparel, cap, uniform, and ad specialty company will highlight personalized products with company names by silk screening, embroidered emblems, or direct embroidery.

TRUMPF, Inc. 6001/6013
111 Hyde Rd., Farmington, CT 06032
(860) 255-6000; FAX (860) 255-6424
www.us.trumpf.com

Trumpf will premier the TruLaser 1030, its newest laser cutting system, and the TruLaser 3030. There will be demonstrations of the new TruLaser Tube 7000 tube processing machine; the TruBend 7036, an ergonomic press brake; and the new TruPunch 5000 punching machine. Also on display will be the new fiber laser marking system, and TruDisk laser and portable power tools.

TS Distributors 39019
4404 Windfern Rd., Houston, TX 77041
(832) 467-5400; FAX (832) 467-5455
www.tsdistributors.com

TS Distributors is a metal fabrication supply center with ornamental metals, gate operators, tools, equipment, supplies, hardware, and accessories for all your metal fabrication needs. The company will also promote its new line of welder's apparel and accessories.

Tulsa Welding School 31036
2545 E. 11th St., Tulsa, OK 74104
(918) 587-6789; FAX (918) 587-8170
www.weldingschool.com

TWI Ltd. 39098
Granta Park, Great Abington,
Cambridge, UK CB21 6AL
44 1223 899000; FAX 44 1223 892588
www.twi.co.uk

TWI is one of the world's foremost research and technology organizations, providing technical support in joining and technologies such as material science, structural integrity, NDT, surfacing, electronic packaging, and cutting. Services include contract R&D, technical information, consultancy, standards drafting, training and qualification, and engineering software.

U-Mark, Inc. 7075
102 Iowa Ave., Belleville, IL 62220
(618) 235-7500; FAX (877) 235-2945
www.umarkers.com

U-Mark will introduce its new Metalhead, a refillable paint marker designed to mark on metals; and AP-1, a valve action, permanent ink marker that marks on anything, dries in ten seconds and is environmentally friendly.

Uniquecoat Technologies LLC 30009
1070 Merchants Ln., Oilville, VA 23129
(804) 784-0997; FAX (804) 784-9097
www.uniquecoat.com

Uniquecoat Technologies will feature its thermal spray equipment to apply metals and carbides. The company will also highlight its services as a thermal spray shop where parts are sprayed on a contract basis with coatings that include tungsten carbide, chrome carbide, stainless steel, stellite, copper, and many more.

United Abrasives, Inc./SAIT 40024
185 Boston Post Rd., Willimantic, CT 06226
(860) 456-7131; FAX (860) 456-8341
www.unitedabrasives.com

United Abrasives will feature its full line of bonded abrasives, including grinding wheels, cutting wheels, cup wheels, cones, plugs, and a host of similar bonded products. The company will also show its wide variety of sanding sheets, belts, rolls, flap discs, fiber, and PSA discs, as well as wire brushes, nonwoven abrasives, tungsten carbide burs, diamond wheels, and a full line of accessories.

Universal Drilling & Cutting Equipment 8109
974 N. Du Page Ave., Lombard, IL 60148
(630) 495-9940; FAX (630) 495-9941
www.unibor.com

The company will showcase its annular cutting tools, magnetic drills, and custom drilling solutions. Demonstrations will be performed, and giveaways of free annular cutting tools will be made daily.

Uniweld Products, Inc. 39003
2850 Ravenswood Rd., Ft. Lauderdale, FL 33312
(954) 584-2000; FAX (954) 334-2882
www.uniweld.com

Uniweld will feature its quality tools, offering tech tips to assist you in working more efficiently and safer.

Vanguard Machinery International LLC 33133
14309 Sommermeyer St., Houston, TX 77041
(713) 462-5800; FAX (713) 462-7775
www.vanguardmachinery.com

Vent-A-Fume (Vent-A-Kiln Corp.) 37077
51 Botsford Pl., Buffalo, NY 14216
(716) 876-2023; FAX (716) 876-4383
www.ventafume.com

Viking Blast & Wash Systems 7049
3810 N. Toben St., Wichita, KS 67226
(800) 835-1096; FAX (316) 634-6658
www.vikingcorporation.com

Viking Blast & Wash will highlight its full line of industrial cleaning equipment including airless shot blast systems, parts washers, and vibratory degreasers to clean and remove mill

THERE ARE MANY REASONS WHY WE HAVE EARNED THE TRUST OF OUR CLIENTS. THE MOST IMPORTANT... WE CARE...

Since 1984 INDURA cares about manufacturing top quality mig wire ER70S-6, maintaining the most strict quality and care for the enviroment (ISO 14001).

We care on training and assisting our distributors to implement technological solutio ns to its customers, to be more efficient and profitable. Our client's challenges become our challenges.

With warehouses strategically located troughtout the country, INDURA cares on timely, efficient, and cost-effective distribution, so our customers may devote their time, capital and resources to their core business and those things they do best. INDURA mig wire is delivered just in time.

INDURA wire is annually approved by: American Bureau of Shipping, Loyd's Register of Shipping, Bureau Veritas, Germanisher Lloyd's. Det Norske Veritas, Canadian Welding Bureau.

Sustaining Member of American Welding Society

Contact Info

Indura S.A.
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Brandy Station
Virginia 22714
USA

Toll Free: 866 - 328 3171
Email. mmadrid@indura.net

www.indura.us

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

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A Chilean Company

American Welding Society®

Become certified in robotic arc welding and join the ranks of the elite in the robotics industry

Welding robots have been in use in the manufacturing industry since the late 1970s using technology developed in the manual and mechanized welding processes. As these robots and the systems used to control them gained industry acceptance, it became evident that the success of robotic arc welding would depend on specially qualified personnel.

AWS understands that the certification of individuals in robotic arc welding is important to the industry and has developed a program that defines the requirements for personnel to be considered qualified to test for certification. (Based on the AWS QC19 standard and AWS D16.4 specification).

Depending on the level of experience, individuals who pass a written exam and performance test can be certified as either **Robotic Arc Welding Technicians** or **Operators**.

For more information regarding this program, including those companies interested in becoming an AWS Approved Test Center, visit our website today at **www.aws.org/certification/CRAW** or call **(800)443-9353, ext. 211**. Email **flopez@aws.org**.

To schedule training and testing to become Certified in Robotic Arc Welding, contact one of these AWS Approved Test Centers.

Colorado // Wolf Robotics // **4600 Innovation Drive** // Fort Collins, CO 80525 // **(970) 225-7736**

Michigan // ABB, Inc. // **1250 Brown Road** // Auburn Hills, MI 48326 // **(248) 391-8421**

Ohio // The Lincoln Electric Co. // **22800 Saint Clair Ave.** // Cleveland, OH 44117 // **(216) 383-8542**

Wisconsin // Milwaukee Area Technical College // **1200 South 71st Street** // West Allis, WI 53214 // **(414) 456-5454**

SEMINAR/EXAM SCHEDULE

Week of:	AWS Approved Test Center	Week of:	AWS Approved Test Center
12/14/2009	ABB, Inc., Auburn Hills, Mich.	4/19/2010	Wolf Robotics, Ft. Collins, Colo.
12/14/2009	Wolf Robotics, Ft. Collins, Colo.	5/3/2010	ABB, Inc., Auburn Hills, Mich.
1/25/2010	Wolf Robotics, Ft. Collins, Colo.	6/7/2010	ABB, Inc., Auburn Hills, Mich.
2/1/2010	ABB, Inc., Auburn Hills, Mich.	8/2/2010	ABB, Inc., Auburn Hills, Mich.
3/1/2010	ABB, Inc., Auburn Hills, Mich.	10/4/2010	ABB, Inc., Auburn Hills, Mich.
3/1/2010	The Lincoln Electric Co., Cleveland, Ohio	10/25/2010	The Lincoln Electric Co., Cleveland, Ohio
3/8/2010	Wolf Robotics, Ft. Collins, Colo.	11/1/2010	ABB, Inc., Auburn Hills, Mich.
4/5/2010	ABB, Inc., Auburn Hills, Mich.	12/6/2010	ABB, Inc., Auburn Hills, Mich.

scale, dirt, and rust for preparing parts for painting or other finishing operations.

Vitronic Machine Vision **37093**
11900 Plantside Dr., Ste. G, Louisville, KY 40299
(502) 266-2699; FAX (502) 266-2695
www.vitronic.com

Vitronic will feature its 3-D weld joint inspection system for inspection of welded, adhesive, and brazed joints. The fully automatic inspection process includes automatic rework and documentation of results for quality assurance.

VPL Chemicals Pvt. Ltd. **32106**
No. 27, Behind "The Club," Nayandahalli, Mysore Rd.
Bangalore, India 560039
91-80-2860-5670; FAX 91-80-2860-1336
www.vplchemicals.com

VPL Chemicals will feature its temperature indicator crayons, temperature indicating labels, infrared thermometers, and metal markers.

Walker Magnetics **8171**
20 Rockdale St., Worcester, MA 01606
(508) 853-3232; FAX (508) 852-8649
www.walkermagnet.com

Walker Magnetics will feature its magnets and magnet systems for plate, tubing, and bundle handling. Cutting table magnet systems will be emphasized, and the company stocks standard lifting magnets and builds customized systems suited to the application.

Walter Surface Technologies **30063**
810 Day Hill Rd., Windsor, CT 06095
(860) 298-1100; FAX (860) 298-1113
www.walter.com

Walter Surface Technologies will highlight its services for professionals who work with metal components and surfaces. The solutions range from surface conditioning, shaping, and preparation to surface finishing, cleaning, and protection. The technologies include abrasive systems, chemical cleaners, lubricants, and biotechnology.

Washington Alloy Co. **38000**
7010 Reames Rd., Ste. G, Charlotte NC 28216
(888) 522-8296; FAX (704) 598-6672
www.weldingwire.com

Wayne Trail Technologies — VIL Laser Systems **35021**
203 E. Park St., PO Box 257, Fort Loramie, OH 45845
(937) 295-2120; FAX (937) 295-2642
www.waynetrail.com

Wayne Trail Technologies will offer its expertise in automation and system solutions to a wide variety of markets and technology segments, including laser processing, robotics/welding/fixturing, press room, tube bending and fabricating, hydroform and structural frame, system integration, and build-to-print manufacturing services.

Weartech International, Inc. **38077**
13032 Park St., Santa Fe Springs, CA 90670
(562) 698-7847; FAX (562) 945-5664
www.weartech.net

Weartech International will feature its cobalt- and nickel-based wear, corrosion, and high-temperature resistant alloys. The line includes all types of hardfacing consumables, such as rods, electrodes, wires, and powders. The company also offers cast solid alloy parts and machining and hardfacing services.

Weil Engineering North America LLC **5107**
1180 E. Big Beaver Rd., Troy, MI 48083
(248) 743-1200; FAX (248) 743-1201
www.weilengineering.com

Weil Engineering will offer solutions for welding including complete laser welding systems for the automotive, trucking, and general industries. The company also manufactures roll-forming and tube cutting machines.

Weiler Corp. **38002**
1 Weiler Dr., Cresco, PA 18326
(570) 595-7495; FAX (570) 595-5980
www.weilercorp.com

Weiler will emphasize its line of brushes and abrasives for the fabrication and welding industry, including the power brush line, wire wheel, and cup end and tube brushes, Roughneck® weld cleaning products, Tiger® flap discs, and Vortec Pro flap discs. The newly introduced Vortec Pro line of general purpose bonded abrasives for metal cleaning, grinding, deburring, and finishing will be highlighted.

Weld Engineering Co., Inc. **37043**
34 Fruit St., Shrewsbury, MA 01545
(508) 842-2224; FAX (508) 842-3893
www.weldengineering.com

Weld Engineering will display its complete line of medium-and heavy-duty submerged arc

flux handling systems, including air and electric powered automatic, portable, and tractor units. The company will also empahsize its advanced pressure feed and recovery systems, and flux rebake and holding ovens. Live demonstrations of flux recovery will be taking place continuously.

Weld-Aid Products **38071**
14650 Dequindre St., Detroit, MI 48212
(313) 883-6977; FAX (313) 883-4930
www.weldaid.com

Weld-Ed National Center **40035**
1005 N. Abbe Rd., Elyria, OH 44035
(440) 366-7027; FAX (440) 366-4624
www.weld-ed.org

Weldlogic, Inc. **4008**
2550 Azurite Cir., Newbury Park, CA 91320
(805) 498-4004; FAX (805) 498-1761
www.weldlogic.com

Weld-Tech APS **32127**
Hjortevaenget 6, Viby SJ, Denmark 4130
45-461-9 4647; FAX 45-461-9 4642
www.weld-tech.com

Weld-Tech will feature its wide variety of clamps, a flange leveler, a foldable marking tool for pipes and bends, several types of purge gas equipment, and oxygen monitors.

Weldas Co. **32064**
128 Seaboard Ln., Franklin, TN 37067
(800) 524-0162; FAX (615) 377-3635
www.weldas.com

Weldcoa **33061**
335 E. Sullivan Rd., Aurora, IL 60505
(630) 806-2000; FAX (630) 806-2001
www.weldcoa.com

Weldcoa will showcase its automated cylinder filling equipment, material handling, and gas filling equipment for welding supply and gas distributors.

Weldcraft **34071**
2741 N. Roemer Rd., Appleton, WI 54911
(920) 882-6800; FAX (920) 882-6840

Weldcraft will feature its GTAW torches and accessories, including the Crafter Series, MicroTig, Quick Connect System, and WP Series.

Weldindustry AS **39009**
PO Box 670, N-5403 Stord, Norway 5403
47-93 -49 97 80; FAX 47 92 17 62 55
www.weldindustry.com

The company will feature its welding documentation software WeldEye®, which includes qualifications, reporting, documentation, and traceability. WeldEye® can be integrated with other systems in your organization.

Welding Alloys Group **36061**
8535 Dixie Hwy., Florence, KY 41042
(859) 525-0165; FAX (859) 525-9094
www.welding-alloys.com

Welding Alloys will highlight its tubular welding wires and automatic welding equipment for welding and hardfacing applications.

Welding Equipment Manufacturers Committee (WEMCO) **40005**
550 NW LeJeune Rd., Miami, FL 33126
(800) 443-9353; FAX (305) 442-7451
www.aws.org/wemco

The Welding Equipment Manufacturers Committee (WEMCO) is a standing committee of the American Welding Society (AWS) that is dedicated to providing a common voice to the welding industry, government bodies, and technical organizations worldwide. The committee provides value-added information and services to welding industry end-users, distributors, and manufacturers, as well as promotes coalitions between AWS and other industry organizations. WEMCO hosts one of welding industry's most effective and beneficial annual events that is filled with unparallel networking opportunities for you and your organization.

Weldsale Co. LLC **33024**
2151 Dreer St., Philadelphia, PA 19125
(215) 739-7474; FAX (215) 426-1260
www.weldsale.com

Weldsale will promote its platen and flame clear pyramids for flame and plasma cutting tables. Weld, bend, straighten, cut, heat, grind, glue, drill, hammer, twist, screw, and assemble on the company's platen, bolted together or used individually.

Weldship Corp. **38029**
225 W. 2nd St., Bethlehem, PA 18015
(610) 861-7330; FAX (610) 861-5175
www.weldship.com

Wendt LLP **14078**
PO Box 666, 1322 Garfield St., Wabash, IN 46992
(800) 272-6346; FAX (260) 563-7533
www.wendtrigging.com

Wendt USA LLC **38107**
259 Chicago St., Buffalo, NY 14204
(866) 335-3527; FAX (866) 336-3527
www.wendtusa.com

Wendt USA will feature its abrasive, finishing, and polishing products for metal fabrication in wheel or disc form for use on common tools. The line include abrasive, nonwoven, and felt versions for grinding, blending, and polishing up to a mirror finishin a wide range of sizes and specifications.

Wenling Wanshun Electromechanics Manufacture Co. **33011**
Chengxi Industrial Zone
Wenling Zhejiang, China 317525
86-576-86191296; FAX 86-576-86191290
www.zjwanshun.com

Wenling Wanshun Electromechanics Manufacture will exhibit various power sources including welding machines for SMAW, GMAW, and GTAW, cutting machines, and battery chargers.

West Cryogenics, Inc. **32098**
17301 E. Fm 1097 Rd., Willis, TX 77378
(800) 820-3004; FAX (936) 856-0432
www.westcryogenics.com

Western Enterprises **32003**
875 Bassett Rd., Westlake, OH 44145
(800) 783-7890; FAX (440) 835-8283
www.westernenterprises.com

Western Enterprises will highlight its line of products used in the control, transmission, and storage of compressed gases for industrial, medical and specialty gas applications.

Williams Metals and Welding Alloys, Inc. 37079
125 Strafford Ave., Ste. 108, Wayne, PA 19087
(610) 225-0105; FAX (610) 225-0208
www.wmwa.net

The company is a distributor of nonferrous metals and welding filler metals, with cut metals and machined finished parts available.

Wire Crafters, Inc. 32012
6208 Strawberry Ln., Louisville, KY 40214
(502) 363-6691; FAX (502) 361-3857
www.wirecrafters.com

Wire Crafters will feature its ANSI/RIA compliant machine perimeter guarding RapidWire-HD, the new RapidGuard and its new line of stainless steel partitions for the food, beverage, pharmacutical, and medical markets.

Witt Gas Controls 34030
1230 Peachtree St. NE, Ste. 3100, Atlanta, GA 30309
(888) 948-8427; FAX (877) 948-8427
www.wittgas.com

Witt will showcase its gas safety and gas control equipment. Products for oxyfuel safety, gas blending for welding shield gases, and related equipment will be on display.

Wolf Robotics 35046
4600 Innovation Dr., Fort Collins, CO 80525
(970) 225-7600; FAX (970) 225-7700
www.wolfrobotics.com

Wolf Robotics will offer its expertise as a robotic metalworking integrator offering standard cells and custom engineered systems for arc welding and cutting, machine tending, material handling, and material removal applications.

Wolverine Joining Technologies 39063
235 Kilvert St., Warwick, RI 02886
(800) 225-2130; FAX (401) 739-9555
www.silvaloy.com

Wolverine Joining Technologies will feature its brazing, soldering, and specialty alloys, including its high silver brazing alloys Silvaloy. Company capabilities include cast, melt, roll, extrude, wire, rod and ring forming, preform stamping, strip, and a metallurgical laboratory.

World Engineering Xchange (WEX) 40025
2671 W. 81st St., Hialeah, FL 33016
(305) 826-6192; FAX (305) 826-6195
www.awspubs.com

WEX sells American Welding Society codes and publications. Stop by to purchase.

York Portable Machine Tools 38058
1641 17th Ave., Campbell River, BC V9W 4L5
(250) 287-7716; FAX (250) 287-8362
www.yorkmachine.com

Yunnan Hengyu Optical Electronics Co. (Optech Co.) 31078
Jinding Scien-Tech Garden, Xuefu Rd.
Kunming, Yunnan, China 650033
86-871-5380185; FAX 86-871-5389404
www.optech.cn

Yunnan Hengyu will show its CE- and ANSI-approved autodarkening welding helmets.

Zhengzhou Anxin Abrasives Co. Ltd. 37081
No. 68 Kexuedadao, Zhengzhou, China 450002
86-371-63751616; FAX 86-371-6782-6977

Zibo TAA Welding Co. Ltd. 31089
No. 2 Mengshui, Industrial Development Zone
Zibo Shandong, China 255318,
86-533-688 0353; FAX 86-533-688 9358
www.taa.net.cn

Zibo TAA will showcase its CO2 gas-shielded welding wire, and submerged arc welding wire, which passed ISO 9001:2000 requirements.

ZJ Industries, Inc. 37111
125 W. Factory Rd., Addison, IL 60101
(630) 543-6655; FAX (630) 543-6644
www.zjindustriesinc.com

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

ICALEO®, 28th Int'l Congress on Applications of Lasers & Electro-Optics. Nov. 2–5, Hilton in the Walt Disney World Resort®, Orlando, Fla. Visit *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, P. R. 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, call (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.*

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

♦ **New Developments in Thermal Spray Coatings, Processes, and Applications Conf.** Nov. 16, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, call (800/305) 443-9353, ext. 455; or visit *www.aws.org.*

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

♦ **Welding Chrome-Moly Steels Conf.** Nov. 17, Chicago, Ill. Held during the FABTECH International & AWS Welding Show. Contact American Welding Society, call (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, call (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 Penn Well, call Jan Simpson (918) 831-9736. Visit *www.power-gen.com.*

Int'l Hardware Fair Cologne 2010. Feb. 28–March 3, 2010, Cologne, Germany. Visit *www.hardwarefair.com.*

PICALO 2010, Pacific Int'l Conf. on Applications of Lasers and Optics. March 23–25, 2010, Shangri-La Hotel, Wuhan, P. R. China. Visit *www.laserinstitute.org.*

WESTEC 2010. March 23–25, 2010, Los Angeles Convention Center, Los Angeles, Calif. Visit *www.westeconline.com.*

Micromanufacturing & Nanomanufacturing Conf. and Exhibits. April 14, 15, 2010, Hilton Phoenix, East/Mesa, Mesa, Ariz. Visit *www.sme.org/micro* and *www.sme.org/nanomanufacturing.*

The Japan Int'l Welding Show 2010. April 21–24, 2010, Tokyo Big Sight, Tokyo, Japan. Organized by The Japan Welding Engineering Society and Sampo Publications. Visit *www.weldingshow.jp/english.*

AWS Detroit Sheet Metal Welding Conf. XIV. May 11–14, 2010 VisTaTech Center, Livonia (Detroit), Mich. Contact American Welding Society Detroit Section at *smwc@awsdetroit.org,* or visit *www.awsdetroit.org.*

Montreal Manufacturing Technology Show. May 17–19, 2010, Place Bonaventure, Montreal, Que., Canada. Visit *www.mmts.ca.*

Rapid Conf. & Expo and 3-D Imaging Conf. May 18–20, 2010, Disneyland Resort Anaheim, Anaheim, Calif. Visit *www.sme.org/rapid.*

EASTEC 2010. May 25–27, 2010, Eastern States Exposition, West Springfield, Mass. Visit *www.easteconline.com.*

SME Annual Conf., Bridging the Gaps. June 6–10, 2010, Sheraton Music City, Nashville, Tenn. Visit *www.sme.org/conference.*

♦ **LÖT 2010, 9th Int'l Conf. on Brazing, High-Temperature Brazing, and Diffusion Bonding.** June 15–17, 2010, 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.*

MS&T 2010, Materials Science & Technology. Oct. 17–21, 2010, Houston, Tex. Cosponsored by NACE, AIST, ASM Int'l, TMS, and ACerS. Visit *www.nace.org.*

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

♦ **FABTECH International & AWS Welding Show** including **METALFORM.** Nov. 2–4, 2010, Georgia World Congress Center, Atlanta, Ga. This show is the largest event in North America dedicated to showcasing the full spectrum of metal forming, fabricating, tube and pipe, welding equipment, and technology. Contact American Welding Society, (800/305) 443-9353, ext. 455; or visit *www.aws.org.*

13th Int'l Symposium on Tubular Structures. Dec. 15–17, 2010, Hong Kong. Sponsored by the Subcommission for Tubular Structures XV-E of the IIW. Visit *www.hku.hk/civil/ISTS13/.*

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

♦ **Fray Int'l Symposium on Metals and Materials Processing in a Clean Environment.** Dec. 4–7, 2011, Hilton Cancun Golf & Spa Resort, Cancun, Mexico. Sponsored by the American Welding Society and many other technical organizations. Visit *www.flogen.com/FraySymposium,* or e-mail Chairman Florian Kongoli *fkongoli@flogen.com.*

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Educational Opportunities

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

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.*

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.*

Brazing School. May 11–13, 2010, Wall Colmonoy Aerobraze Division, Cincinnati, Ohio. Contact Lydia Lee (248) 585-6400, ext. 252; *lydialee@wallcolmonoy.com;* or visit *www.wallcolmonoy.com.*

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

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

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

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

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

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.*

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.*

Geometric Dimensioning & Tolerancing Seminar. Nov. 30, Dec. 1, Chicago, Ill.; Dec. 3, 4, St. Louis, Mo. Visit *www.hightechnology seminars.com.*

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

Inspection Courses on ultrasonic, eddy current, radiography, dye penetrant, magnetic particle, and visual at Levels 1–3. Meet SNT-TC-1A and NAS-410 requirements. Contact TEST NDT, LLC, (714) 255-1500, *www.testndt.com.*

Laser Safety Online Courses. Courses include Medical Laser Safety Officer, Laser Safety Training for Physicians, Industrial Laser Safety, and Laser Safety in Educational Institutions. Contact Laser Institute of America, (800) 345-3737, or visit *www.laserinstitute.org.*

Laser Safety Training Courses. Courses based on ANSI Z136.1, *Safe Use of Lasers,* presented in Orlando, Fla., or at customer's site. Contact Laser Institute of America, (800) 345-3737, *www.laserinstitute.org.*

Machine Safeguarding Seminars. Contact Rockford Systems, Inc., (800) 922-7533, *www.rockfordsystems.com.*

Machining and Grinding Courses. Contact TechSolve, *www.TechSolve.org.*

Motorsports Welding School Advanced Materials Courses. Cleveland, Ohio. Dec. 7–11. Contact The Lincoln Electric Co., *www.lincolnelectric.com.*

Motorsports Welding School Basic Materials Courses. Cleveland, Ohio. Nov. 9–13, Nov. 30–Dec. 4. Contact The Lincoln Electric Co., *www.lincolnelectric.com.*

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

NDE and CWI/CWE Courses and Exams. Allentown, Pa., and at customers' locations. Contact Welder Training and Testing Institute, (800) 223-9884, *www.wtti.edu.*

Plastics Welding School. A two-day, hands-on course for certification to European DVS-approved plastics welding standards for hot gas and extrusion techniques. Contact Malcom Hot Air Systems, *www.plasticweldingtools.com.*

Preparation for AWS Certified Welding Inspector/Educator Exam and Exam. Two-week-long courses beginning Jan. 11, Feb. 22, April 12, May 17, June 21, Aug. 9, Sept. 20, Nov. 1, and Nov. 29, 2010. Contact Hobart Institute of Welding Technology, Troy, Ohio; (800) 332-9448; *hiwt@welding.org; www.welding.org.*

Preparation for AWS Certified Welding Supervisor Exam and Exam. One-week-long course begins May 3, and Oct. 18, 2010. Contact Hobart Institute of Welding Technology, Troy, Ohio; (800) 332-9448; *hiwt@welding.org; www.welding.org.*

Protective Coatings Training and Certification Courses. At various locations and online. Contact The Society for Protective Coatings. Call (877) 281-7772, *www.sspc.org.*

Shielded Metal Arc Welding of 2-in. Pipe in the 6G Position — Uphill. Troy, Ohio. Contact Hobart Institute of Welding Technology, (800) 332-9448, *www.welding.org.*

Structural Welding: Design and Specification Seminars and AWS D1.1, *Structural Welding Code — Steel.* Contact Steel Structures Technology Center, *www.steelstructures.com,* (248) 893-0132.

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
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
Fresno, CA	Jan. 10-15, 2010	Jan. 16, 2010
Beaumont, TX	Jan. 10-15	Jan. 16
Corpus Christi, TX	EXAM ONLY	Jan. 23
Miami, FL	Jan. 24-29	Jan. 30
Albuquerque, NM	Jan. 31-Feb.5	Feb. 6
Pittsburgh, PA	Jan. 31-Feb.5	Feb. 6
Denver, CO	Jan. 31-Feb.5	Feb. 6
Seattle, WA	Jan. 31-Feb.5	Feb. 6
Miami, FL	**EXAM ONLY**	**Feb. 25**
Birmingham, AL	Feb. 21-26	Feb. 27
Long Beach, CA	Feb. 21-26	Feb. 27
Milwaukee, WI	Feb. 28-Mar. 5	Mar. 6
Atlanta, GA	Feb. 28-Mar. 5	Mar. 6
San Diego, CA	Feb. 28-Mar. 5	Mar. 6
Houston, TX	Mar. 7-12	Mar. 13
Norfolk, VA	Mar. 7-12	Mar. 13
Perrysburg, OH	EXAM ONLY	Mar. 13
Indianapolis, IN	Mar. 14-19	Mar. 20
Portland, OR	Mar. 14-19	Mar. 20
Miami, FL	EXAM ONLY	Mar. 18
Rochester, NY	EXAM ONLY	Mar. 20
Corpus Christi, TX	EXAM ONLY	Mar. 20
Boston, MA	Mar. 21-26	Mar. 27
Phoenix, AZ	Mar. 21-26	Mar. 27
Anchorage, AK	Mar. 21-26	Mar. 27
Chicago, IL	Mar. 21-26	Mar. 27
York, PA	EXAM ONLY	Mar. 27
Miami, FL	Mar. 28-Apr. 2	Apr. 3
Dallas, TX	Apr. 11-16	Apr. 17
Knoxville, TN	EXAM ONLY	Apr. 17
Springfield, MO	Apr. 18-23	Apr. 24
Mobile, AL	EXAM ONLY	Apr. 24
St. Louis, MO	EXAM ONLY	Apr. 24
Portland, ME	Apr. 25-30	May 1
Las Vegas, NV	Apr. 25-30	May 1
Waco, TX	EXAM ONLY	May 1
Baton Rouge, LA	May 2-7	May 8
San Francisco, CA	May 2-7	May 8
Nashville, TN	May 9-14	May 15
Jacksonville, FL	May 9-14	May 15
Baltimore, MD	May 9-14	May 15
Corpus Christi, TX	EXAM ONLY	May 15
Detroit, MI	May 16-21	May 22
Miami, FL	May 16-21	May 22
Albuquerque, NM	May 16-21	May 22
Long Beach, CA	EXAM ONLY	May 29
Spokane, WA	Jun. 6-11	Jun. 12
Oklahoma City, OK	Jun. 6-11	Jun. 12
Birmingham, AL	Jun. 6-11	Jun. 12
Miami	EXAM ONLY	Jun. 17
Hartford, CT	Jun. 13-18	Jun. 19
Pittsburgh, PA	Jun. 13-18	Jun. 19
Beaumont, TX	Jun. 13-18	Jun. 19
Corpus Christi, TX	EXAM ONLY	Jul. 10

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.

9-Year Recertification Seminar for CWI/SCWI

Location	Seminar Dates	Exam Date
New Orleans, LA	Jan. 11-16, 2010	NO EXAM
Denver, CO	Feb. 22-27	NO EXAM
Dallas, TX	Mar. 15-20	NO EXAM
Miami, FL	Apr. 12-17	NO EXAM
Sacramento, CA	May 3-8	NO EXAM
Pittsburgh, PA	Jun. 7-12	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
Atlanta, GA	Jan. 25-29, 2010	Jan. 30, 2010
New Orleans, LA	Apr. 19-23	Apr. 24
Minneapolis, MN	Jul. 19-23	Jul. 24
Miami, FL	Sept. 13-17	Sept. 18

CWS exams are also given at all CWI exam sites.

Certified Radiographic Interpreter (CRI)

Location	Seminar Dates	Exam Date
Miami, FL	Feb. 1-5, 2010	Feb. 6, 2010
Miami, FL	Mar. 8-12	Mar. 13
Miami, FL	Apr. 19-23	Apr. 24
Miami. FL	Jun. 21-25	Jun. 26
Miami, FL	Jul. 26-30	Jul. 31

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
Chicago, IL	Nov. 16-18	Nov. 18
Los Angeles, CA	Jan. 27-29, 2010	Jan. 29, 2010
Miami, FL	Feb. 24-26	Feb. 26
Houston, TX	Mar. 31-Apr. 2	Apr. 2
Miami, FL	May 5-7	May 7
Chicago, IL	Jun. 9-11	Jun. 11
Miami, FL	Aug. 25-27	Aug. 27

CWSR exams will also be given at CWI exam sites.

Certified Welding Educator (CWE)

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

Senior Certified Welding Inspector (SCWI)

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

Certified Welding Engineer (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	Dec. 14	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Dec. 14	(970) 225-7736
Wolf Robotics, Ft. Collins, CO	Jan. 25	(970) 225-7736
ABB, Inc., Auburn Hills, MI	Feb. 1	(248) 391-8421
ABB, Inc., Auburn Hills, MI	Mar. 1	(248) 391-8421
Lincoln Electric, Cleveland, OH	Mar. 1	(216) 383-8542
Wolf Robotics, Ft. Collins, CO	Mar. 8	(970) 225-7736
ABB, Inc., Auburn Hills, MI	Apr. 5	(248) 391-8421
Wolf Robotics, Ft. Collins, CO	Apr. 19	(970) 225-7736

International CWI Courses and Exams

Please visit *http://www.aws.org/certification/inter_contact.html*

American Welding Society®

Air Carbon Arc Gouging

In the air carbon arc gouging process, the variables that require attention are electrode diameter and type, amperage, voltage, air pressure and flow rate, travel speed, electrode push angle, electrode extension, and the base metal used. The functions of these variables are summarized in Table 1.

For gouging of ferrous metals, the electrode should be held so that a maximum of 178 mm (7 in.) extends from the cutting torch — Fig. 1. For nonferrous metals, the extension should be reduced to 76.5 mm (3 in.).

Before striking the arc, turn the air jet on and grip the cutting torch as shown in Fig. 1. The electrode slopes back from the direction of travel with the air jet behind the electrode. When used with the proper operating conditions, the air jet sweeps beneath the electrode end and removes all molten metal. You can strike the arc by lightly touching the electrode to the workpiece. Maintain a short arc by progressing in the direction of the cut fast enough to keep up with the metal removal. The steadiness of progression controls the smoothness of the resulting cut surface.

Table 2 shows the current ranges for commonly used air carbon arc gouging electrodes. The actual current used for a given electrode size depends on the operating conditions. These include the material being cut, type of cut, cutting speed, cutting position, and required cut quality. Follow the manufacturer's recommendations for the operation and maintenance of the equipment and use of consumable materials.

When using jointed carbon electrodes, it is important to strike the arc with the open or blunt end of the electrode. You'll understand the reason for this when the electrode has been almost completely consumed and is approaching the jointed section. If you had struck the arc on the tapered end of the electrode, the jointed section would consist of a tapered end surrounded by a loose red-hot sleeve of carbon. This hot sleeve tends to be ejected violently from the gouging arc and, like weld spatter, can cause burns or set combustibles on fire. When the arc is struck with the open (blunt) end of the electrode and the electrode is consumed to the jointed section, the sleeve forms part of the incoming electrode and is restrained from violent ejection.

When gouging a workpiece in the vertical position, the operation should be performed downhill to allow gravity to help remove the molten metal. In the horizontal position, gouging can be performed either to the right or left, but should always be done in the forehand direction.

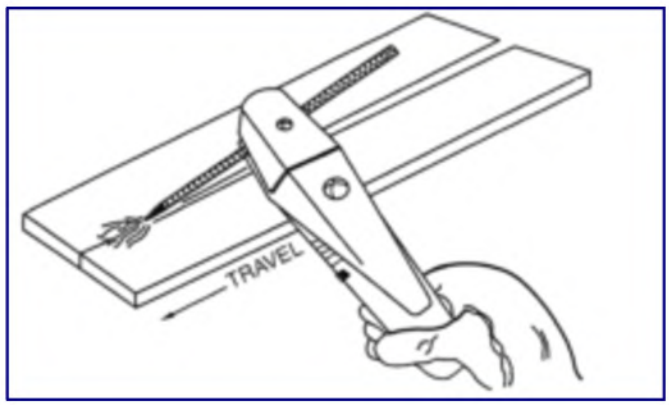

Fig. 1 — Manual air carbon arc gouging in the flat position.

Table 1 — Primary Variables for Air Carbon Arc Gouging

Variable	Function
Electrode diameter	Determines the size of the groove.
Amperage	Determined by the diameter of the electrode being used. It is the current flow that melts the base metal.
Voltage	The electric potential behind the amperage, or the arc force. Voltage is set on constant-voltage power sources and is determined by arc length on constant-current power sources.
Air pressure and flow rate	The means for removal of the molten metal.
Travel speed	Determines the depth and quality of finished grooves.
Electrode travel and work angle	Can determine the groove shape.
Electrode extension	Affects metal removal rates and quality of groove.
Base metal	Determines selection of parameters for other variables.

Table 2 — Suggested Current Ranges for Commonly Used Air Carbon Arc Gouging Electrodes

Electrode Diameter		Direct-Current Electrode with DCEP[a], A		Alternating-Current Electrode with AC, A		Alternating-Current Electrode with DCEN[b], A	
mm	in.	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
4.0	5/32	90	150	—	—	—	—
4.8	3/16	150	200	150	200	150	180
6.4	1/4	200	400	200	300	200	250
7.9	5/16	250	450	—	—	—	—
9.5	3/8	350	600	300	500	300	400
12.7	1/2	600	1000	400	600	400	500
15.9	5/8	800	1200	—	—	—	—
19.1	3/4	1200	1600	—	—	—	—
25.4	1	1800	2200	—	—	—	—

(a) Direct current electrode positive.
(b) Direct current electrode negative.

Excerpted from the *Welding Handbook,* Vol. 2, ninth edition, and AWS C5.3:2000, *Recommended Practices for Air Carbon Arc Gouging and Cutting.*

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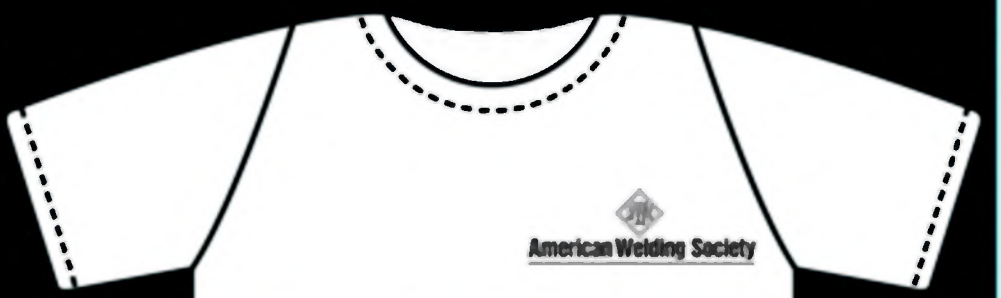

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POSTER ABSTRACT SUBMITTAL
Annual FABTECH International & AWS Welding Show

Atlanta, GA – November 2-4, 2010

(Complete a separate submittal for each poster.)

Primary Author (Full Name):

School/Company:

Mailing Address:

City: **State/Province:** **Zip/Mail Code:** **Country:**

Email:

Poster Title (max. 50 characters):

Poster Subtitle (max. 50 characters):

Co-Author(s):

Name (Full Name):
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City:
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Poster Requirements and Selection Criteria:

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

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

Criteria by category as follows:

(A) Student

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

(B) Student

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

(C) Student

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

(D) Professional

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

(E) High School

- Junior or Senior high school students enrolled in a welding concentration at the time of submittal.
- Presentation should represent technical concepts and application to the welding industry.
- Practical application and creativity are important and should be demonstrated.

Check the category that applies:

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

Poster Title (max. 50 characters):

Poster Subtitle (max. 50 characters):

Abstract:

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

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

.

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

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

MUST BE RECEIVED NO LATER THAN April 16, 2010

BY HOWARD M. WOODWARD

Chicago to Host FABTECH Int'l & AWS Welding Show

While you're in Chicago for the FABTECH International & AWS Welding Show, Nov. 15–18, be sure to include some time to enjoy the attractions unique to the area.

A good starting point is to visit the city's official tourism site *www.explorechicago.org*, before you leave on your trip, or call toll-free (877) 244-2246 with questions or to get ideas.

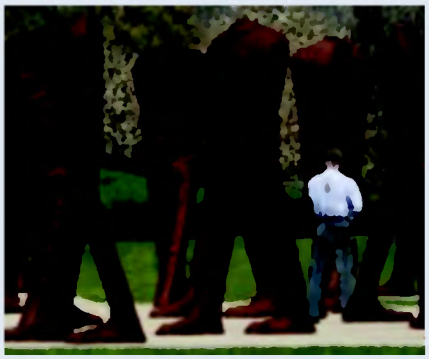
On the Web site, check out the **Go Chicago Card™** sold for various prices, or the $69 **CityPass Chicago Card,** valid for 9 days. This card saves $60 on admissions to five top attractions: **Field Museum, Adler Planetarium, Shedd Aquarium, Museum of Science and Industry,** and a Fast Pass to either **John Hancock Observatory,** or **Skydeck Chicago.** Myriad tours and cruise **Easy Print-and-Go Tickets** can be purchased at a discount online to save you time and money.

Chicago's newest attraction is **Skydeck Chicago,** opened July 2 on the 103rd floor of the **Willis Tower**. Visitors walk out onto an all-glass 4.3-ft-wide **The Ledge** where they can look straight down 1353 ft to **Wacker Dr.** It's open every day 10 AM to 8 PM. Prepurchase the $30 Fast Pass tickets to buck the lines.

A year-round mecca for natives and tourists alike are the many attractions in the 24-acre **Millennium Park**. Visit the **Jay Pritzker Pavilion and Great Lawn** outdoor concert venue featuring a unique overhead trellis sound system that replicates an indoor concert hall sound experience. Stroll around the interactive **Crown Fountain** and the stainless steel **Cloud Gate Sculpture** at **AT&T Plaza.**

The pensive ***Agora*** sculpture "populates" the southwest side of **Grant Park.** It features 106, cast iron, 9-ft-tall, handmolded, headless, human torsos, "walking" in various directions. Installed in 2006, artist **Magdalena Abakanowicz** and the **Polish Ministry of Culture** presented the $2.5-million art works to the city as a gift for permanent display.

For a change, navigate between key points by **water taxi,** or see the sights on a river or **Lake Michigan cruise**.



Shown are a few of the 106 cast iron torsos that silently patrol a corner of Grant Park as part of the Agora *permanent art exhibit.*

The Adler Planetarium's landmark sun dial frames Chicago's skyline from across Lake Michigan.

The Jay Pritzker Pavilion and Great Lawn in Millennium Park features a superb overhead sound system.

As Chicago River cruise ship passengers look up at the Willis Tower, its Skydeck Chicago visitors look down from the 103rd floor. Photos © City of Chicago/GRC.

Errata D1.6

AWS D1.6/D1.6M:2007
Structural Welding Code — Stainless Steel

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

Page 132, Subclause 6.15.10(1) — Incorrect reference to annex.

Change reference from:
"(see Annex H Figure H-1)" to
"(see Annex O Figure O-1)".

Official Interpretation D14.3

Subject: Height or Width of Planar-Type Discontinuity
Code Edition: D14.3/D14.3M:2005
Code Provision: Paragraph 9.5.1.7 (2)
AWS Log: D14.3-05-I02

Inquiry: Are the terms "height" and "width" as used in Paragraph 9.5.1.7 (2) [i.e., "less than 25% of joint penetration in height or width"] descriptive of the orientation of the discontinuity? That is, for horizontally inclined planar-type discontinuities, the term "width" would apply and for vertically inclined planar-type discontinuities the term "height" would apply.

Response:
Yes. The terms "height" and "width" as used in Paragraph 9.5.1.7 (2) are descriptive of the orientation of the discontinuity. That is, for horizontally oriented planar-type discontinuities, the term "width" would apply and for vertically oriented planar-type discontinuities, the term" height" would apply.

Revised Standard Approved by ANSI

A5.22/A5.22M:2010, *Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods.* Approved 8/27/09.

A5.29/A5.29M:2010, *Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.* Approved 9/18/09.

New Standards Projects

Development work has begun on the following standards. Stakeholders include manufacturers, welders, CWIs, and engineers. Interested individuals are invited to contribute to the development of these documents. For information, contact Selvis Morales, (800/305) 443-9353, ext. 313.

B2.1-1-019-94-AMD1, *Standard Welding Procedure Specification (WPS) for CO_2 Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), ⅛ through 1½ Inch Thick, E70T-1 and E71T-1, As-Welded Condition.*

B2.1-1-020-94-AMD1, *Standard Welding Procedure Specification (WPS) for 75% Ar/25% CO_2 Shielded Flux Cored Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), ⅛ through 1½ Inch Thick, E70T-1 and E71T-1, As-Welded or PWHT Condition.*

Standards for Public Review

A5.11/A5.11M:200X, *Specification for Nickel and Nickel-Alloy Welding Electrodes for Shielded Metal Arc Welding.* Revised — $25. 11/16/09.

F2.2:2001 (R200X), *Lens Shade Selector.* Reaffirmed — $25. 11/2/09.

G1.2M/G1.2:1999 (R200X), *Specification for Standardized Ultrasonic Welding Test Specimen for Thermoplastics.* Reaffirmed — $25. 11/2/09.

AWS was approved as an accredited standards-preparing organization by the American National Standards Institute (ANSI) in 1979. AWS rules, as approved by ANSI, require that all standards be open to public review for comment during the approval process. The public review expiration dates are shown for the above standards. Contact Rosalinda O'Neill, *roneill@aws.org;* (800/305) 443-9353, ext. 451, to order draft copies.

ISO Draft Standards for Public Review

ISO/DIS 25239-1.2 — *Friction stir welding — Aluminum – Part 1: Vocabulary*

ISO/DIS 25239-2.2 — *Friction stir welding — Aluminum — Part 2: Design of weld joints*

ISO/DIS 25239-3.2 — *Friction stir welding — Aluminum — Part 3: Qualification of welding operators*

ISO/DIS 25239-4.2 — *Friction stir welding — Aluminum — Part 4: Specification and qualification of welding procedures*

ISO/DIS 25239-5.2 — *Friction stir welding — Aluminum — Part 5: Quality and inspection requirements*

Copies of the above draft standards are available for review and comment through your national standards body, which in the United States is ANSI, 25 W. 43rd St., 4th Fl., New York, NY 10036; (212) 642-4900. Send comments regarding ISO documents to your national standards body.

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

Recently Published Standards

C4.2/C4.2M:2009, *Recommended Practices for Safe Oxyfuel Gas Cutting Torch Operation,* supersedes the 2006 edition. The 62-page document describes the oxyfuel gas cutting process and latest procedures and safety requirements, using terminology compatible with ISO documents. Illustrated are torch and nozzle configurations and examples of production-cut surfaces. The standard makes use of both U.S. Customary Units and the International System of Units (SI). List price is $68, $52 for AWS members.

D18.1/D18.1M:2009, *Specification for Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications,* supersedes the 1999 edition. It includes SI (metric) units as well as U.S. customary units, and enhancements to the sections on welding procedure qualifications and qualification records. The 34-page document specifies requirements for gas tungsten arc welding of austenitic stainless steel tube and pipe at least ¼ in. (6 mm) diameter in the fabrication of sanitary processing systems for handling products for human and animal consumption. It may also be applied to maintenance of food processing equipment and addresses procedure and performance qualification, fabrication, visual examination requirements, and documentation. List price is $52, $42 for AWS members.

D18.2:2009, *Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube,* is a laminated sheet with a two-page instruction sheet. It features color photographs showing degrees of discoloration on the inside of an austenitic stainless steel tube with increasing amounts of oxygen in the backing shielding gas. It is suitable as a specifying tool and visual examination guide. The list price is $40, $30 for AWS members.

D14.5/14.5M:2009, *Specification for Welding Presses and Press Components,* supersedes the 1997 edition. The 158-page standard presents tables and figures that provide manufacturers, fabricators, and repair companies with the minimum acceptable requirements for fabrication, modification, and repair of cyclical press components. The requirements for procedure and welder qualification, workmanship, and prequalified weld joints are emphasized. The standard makes use of both U.S. Customary Units and the International System of Units (SI). The list price is $104, $78 for AWS members.

All AWS publications can be purchased from World Engineering Exchange, Ltd., *www.awspubs.com; orders@awspubs.com;*

Kotecki and Ludwig Honored for Technical Committee Services

Matt Lucas (left in both photos), chairman of the AWS Technical Activities Committee (TAC), is shown presenting service certificates of appreciation to **Damian J. Kotecki** (left), and **Michael J. Ludwig,** chief welding engineer at Bath Iron Works.

Ludwig's award is for his services as chairman of the D3 Committee on Welding in Marine Construction. His term will expire December 31.

Kotecki's certificate recognizes his services since 1989 in numerous Technical Activities Committee positions. His term as member at large will expire at the end of the year.

toll-free (888) 934-3464 (U.S. or Canada); (305) 824-1177; FAX (305) 826-6195.

Technical Committee Meetings

All AWS technical committee meetings are open to the public. To attend a meeting, call the committee secretary, (800/305) 443-9353, at the extension shown. The following meetings will be held at the FABTECH International & AWS Welding Show in Chicago, Ill.

Nov. 15, C7 Committee on High Energy Beam Welding and Cutting. R. Starks (304).

Nov. 15, C7B Subcommittee on Electron Beam Welding and Cutting. R. Starks (304).

Nov. 16, D14B Subcommittee on General Design and Practices. M. Rubin (215).

Nov. 16, D14G Subcommittee on Welding of Rotating Equipment. M. Rubin (215).

Nov. 16, D14I Subcommittee on Hydraulic Cylinders. M. Rubin (215).

Nov. 16, D15C Subcommittee on Track Welding. R. Starks (304).

Nov. 16, D16 Committee on Robotic and Automatic Welding. M. Rubin (215).

Nov. 17, A5H Subcommittee on Filler Metals and Fluxes for Brazing. S. Borrero (334).

Nov. 17, B1 Committee on Methods of Inspection. B. McGrath (311).

Nov. 17, B1B Subcommittee on Visual Examination of Welds. B. McGrath (311).

Nov. 17, B1C Standing Task Group on the Welding Inspection Handbook. B. McGrath (311).

Nov. 17, C2 Committee on Thermal Spraying. R. Starks (304).

Nov. 17, C6 Committee on Friction Welding. R. Starks (304).

Nov. 17, D14 Committee on Machinery and Equipment. M. Rubin (215).

Nov. 17, D14C Subcommittee on Earthmoving and Construction Equipment. M. Rubin (215).

Nov. 17, D14E Subcommittee on Welding of Presses and Industrial and Mill Cranes. M. Rubin (215).

Nov. 17, D17D Subcommittee on Resistance Welding. M. Rubin (215).

Nov. 17, D17K Subcommittee on Fusion Welding. M. Rubin (215).

Nov. 17, G2C Subcommittee on Nickel Alloys. S. Borrero (334).

Nov. 18, A5K Subcommittee on Titanium and Zirconium Filler Metals. S. Borrero (334).

Nov. 18, D17 Committee on Welding in the Aircraft and Aerospace Industries. M. Rubin (215).

Nov. 18, G2D Subcommittee on Reactive Alloys. S. Borrero (334).

Nov. 18, 19, C3 Committee and Subcommittees on Brazing and Soldering. S. Borrero (334).

Nov. 18, 19, D15A Subcommittee on Freight Cars and Their Materials. R. Starks (304).

Nov. 19, D15 Committee on Railroad Welding. R. Starks (304).

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

Thermal Spraying

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

Welding Sales Representatives

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

Robotic and Automatic Welding

Volunteers are sought to participate on the D16 Committee on Robotic and Automatic Welding. Its documents include **D16.1,** *Specification for Robotic Arc Welding Safety;* **D16.2,** *Guide for Components of Robotic and Automatic Arc Welding Installations;* **D16.3,** *Risk Assessment Guide for Robotic Arc Welding;* **D16.4,** *Specification for Qualification of Robotic Arc Welding Personnel.* Persons engaged in robotic welding operations and suppliers of equipment who want to contribute their expertise to the preparation of one or more of these documents are urged to contact Matt Rubin, *mrubin@aws.org;* (800/305) 443-9353, ext. 215, or visit *www.aws.org/1UQ4* to submit your member application online.

Vietnam Company Explores Certification Opportunities

On August 31, representatives from LILAMA 1 and WELDTEC Corp. of Vietnam visited AWS headquarters in Miami, Fla., to discuss possible international certification and accreditation opportunities. During the visit, LILAMA 1 joined the AWS Sustaining Membership Program. Shown are (from left) Ray Shook, AWS executive director; Le Huy Cam, vice president, WELDTEC group, with his wife Thanh; and Priti Jain, AWS director, international business & certification programs.

Middle East Accredited Test Facility Honors AWS Officials

Shown (from left) are Cassie Burrell, AWS deputy executive director; Priti Jain, AWS director, international business & certification programs; Hamad Saif Mohammed Al Salmeen Al Mansouri, deputy chairman, Al Salmeen Group; and Haitham Anwar Akkila, managing director, Middle East Industrial Training Institute (MEITI), a member of the Al Salmeen Group, in Abu Dhabi, UAE. Chairman Mansouri is shown presenting Burrell and Jain a distinctive plaque to commemorate their visit August 16 following an AWS Middle East Agents business meeting. MEITI is an AWS International Agent and an AWS Accredited Test Facility.

Notice of Annual Meeting of the American Welding Society

The Annual Meeting of the members of the American Welding Society will be held on Monday, Nov. 16, 2009, beginning at 9:00 AM at McCormick Place, Chicago, Ill. The regular business of the Society will be conducted, including election of officers and ten members of the Board of Directors. Any business properly brought before the membership will be considered.

First Seminar to Certify Welding Sales Representatives Held at AWS Headquarters

Ed Bohnart and David Diaz jointly led the first (beta) Certified Welding Sales Representative Seminar, Sept. 9–11, at AWS headquarters in Miami, Fla.

Twenty representatives from across the United States involved in welding distributor and manufacturer sales roles participated in the class that was designed to reinforce basic knowledge of processes and equipment that are generic to all sales representatives.

Following the 20 hours of instruction, the group participated in the beta exam. With a minimum passing score of 70%, the participants will receive the recently released AWS Welding Sales Representative Certification. This new certification is equivalent in importance to the other AWS certifications programs. It identifies industry qualifications and raises the bar of expectations, challenges candidates to take additional training to expand their capabilities, and encourages employers to upgrade their personnel.

The certificate holders who meet this higher level of achievement and exceed the performance of noncertified personnel serve both as good examples and motivators to others for becoming certified to fulfill a broad industry need. The participants were Todd Taranto, Wesco; Rob Koczur, Maine Oxy; Shannon McDonald, Technical Alloy and Industrial Gases; Mark Bradley, AWI Supply; Jim Norris, American Welding and Gas; Richard DePue, Certified Welding and Testing; Gregory W. Pierce, Wesco; Doug Stauffer, GTS-Wesco; David Padgett, Bohler Welding Group; Earl Pearson, Sky Oxygen; Cliff Zeiger, Midalloy; Charles Tom Hoffman, Ann Arbor Welding Supply; Dan Jochman, Weld Specialty; Mike Billington, ILMO Products; Marty Pickett, Technical Alloy and Industrial Gas; Gilly Burrion, Florida Gas Welding; Tim Howard and Charles Odom, Wesco Gas and Welding Supply; Peter Howe, managing director, AWS technical operations; and Frank Lopez del Rincon, senior coordinator, AWS Certification Dept.

Member-Get-A-Member Campaign

Shown are the member standings as of Sept. 16. See page 161 in this *Welding Journal* for campaign rules and prize list, or visit *www.aws.org/mgm*. Call the AWS Membership Dept. (800/305) 443-9353, ext. 480, if you have questions about your MGM status.

Winner's Circle

Sponsored 20+ new members.
The superscript notes the number of times Winner's Circle status has been achieved since June 1, 1999.

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

President's Guild

Sponsored 20 or more new members.

V. Craven, Pascagoula — 39

President's Roundtable

Sponsored 9–19 new members.

R. Ellenbecker, Fox Valley — 15
H. Thompson, New Orleans — 9

President's Club

Sponsored 3–8 new members.

D. Berger, New Orleans — 5
S. Keskar, India — 4
E. Ravelo, International — 4
T. Morris, Tulsa — 3

President's Honor Roll

Sponsored 2 new members.

J. Barber, Connecticut
G. Burrion, South Florida
J. Compton, San Fernando Valley
R. Davis, Utah
G. Euliano, Northwestern Pennsylvania
M. Haynes, Niagara Frontier
J. Hope, Puget Sound
D. Mandina, New Orleans
V. Matthews, Cleveland
T. Rowe, Tulsa
M. Rudden, Colorado

Student Member Sponsors

C. Rogers, San Antonio — 49
D. Berger, New Orleans — 35
J. Morash, Boston — 27
S. Burdge, Stark Central — 20
R. Evans, Siouxland — 20
E. Norman, Ozark — 20
V. Facchiano, Lehigh Valley — 19
A. Duron, New Orleans — 18
G. Seese, Johnstown-Altoona — 16
A. Stute, Madison-Beloit — 15
R. Munns, Utah — 14
S. Kuntz, Pittsburgh — 10
R. Rummel, Central Texas — 10
D. Zabel, SE Nebraska — 10
B. Benyon, Johnstown-Altoona — 10
W. Garrett, Olympic — 7
D. Vranich, North Florida — 6
J. Fitzpatrick, Arizona — 4
S. Hansen, SE Nebraska — 4
S. Hensen, Spokane — 4
D. Kowalski, Pittsburgh — 4
S. MacKenzie, Northern Michigan — 4
J. Boyer, Lancaster — 3
N. Carlson, Idaho/Montana — 3
E. Hinojosa, L.A./Inland Empire — 3
R. Hutchison, Long Beach/Or. Cty. — 3
G. Kimprell, St. Louis — 3

New AWS Supporters

Supporting Companies

Bolton Power Ltd.
Froghall, Stoke-on-Trent
Staffordshire ST10 2HA, UK

EagleSpan Steel Structures, LLC
102 W. Fourth St.
Loveland, CO 80537

F K Fab Group, LLC
1907 Engineers Rd.
Belle Chasse, LA 70037

Educational Institutions

Arizona Automotive Institute
6829 N. 46th Ave.
Glendale, AZ 85301

Escuela de Soldadura AGA
Km. 11.5 Via Daule, PO Box 09-01-5828
Guayaquil, Guayas, Ecuador

Marshfield High School
10th and Ingersol
Coos Bay, OR 97420

Mingus Union High School
1801 E. Fir St.
Cottonwood, AZ 86326

Plumbers and Pipefitters Local 25 JATC
4612 46th Ave.
Rock Island, IL 61201

Pueblo Community College
900 W. Orman Ave.
Pueblo, CO 81004

Roma Independent School District
2021 N. U.S. Hwy. 83
PO Box 187
Roma, TX 78584

Texas A & M University
5000 Tamu
College Station, TX 77843

Affiliate Companies

Industrial Repairs and Services LLC
1358 Hwy. 91
Elizabethton, TN 37643

Military Systems Group, Inc.
736 Fesslers Ln.
Nashville, IN 37210

Runding, LLC
90 Greendale Dr.
Oak Ridge, NJ 07438

AWS Membership

Member Grades	As of 10/01/09
Sustaining	508
Supporting	316
Educational	503
Affiliate	464
Welding distributor	48
Total corporate members	**1,839**
Individual members	52,574
Student + transitional members	6,049
Total members	**58,623**

District and Section Awards Announced

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

George Fairbanks, District 9 director, has named the following for this award:

Randy Sutton — Morgan City Section
William New — Morgan City Section
Charlie Lewis — Acadiana Section
Marcie Jacquet — Acadiana Section
Leslie Bertrand — Acadiana Section
John Angers — Acadiana Section
R. V. Schmidt — Baton Rouge Section
H. Sumrall — Baton Rouge Section

Mace Harris, District 15 director, has nominated the following for this award:

Mike Hanson — Northwest Section
Todd Bridigum — Northwest Section
Dan Johnson — Northwest Section
Paul Carter — Northwest Section
Tom Baldwin — Arrowhead Section
Loren Kantola — Arrowhead Section
Doug Mroz — Arrowhead Section
Joel Ziegler — Northern Plains Section
Brent Smith — Northern Plains Section

The West Tennessee Section, Dist. 8, has announced the following awards:

Rodney Russell, Section Meritorious
Jimmy Kee, Section Educator
Bill Jackson, Section CWI

You're Invited to the AWS Foundation Raffle

While planning your visit to the FABTECH International & AWS Welding Show in Chicago, Ill., Nov. 15–18, schedule some time to stop by the AWS Foundation Booth 40021.

You'll learn about the Foundation's various scholarship programs, the Solutions Opportunity Squad (SOS), and its other activities, plus have a chance to participate in the Foundation's daily raffles.

Contact Nazdhia Prado-Pulido, *nprado-pulido@aws.org;* (800/305) 443-9353, ext. 250, for more information.

Inspection Trends Wins Journalism Award

The Editor's Note column for *Inspection Trends,* the AWS magazine published quarterly for AWS Certified Welding Inspectors, recently earned a bronze award in the Editor's Column category of the 2009 Tabbie Awards.

Regarding the winning entry from *Inspection Trends*, the judges made the following comment: "Certification and education are critical issues in any industry, and Editor Mary Ruth Johnsen makes a compelling case for the need to increase education in one particular area of the welding industry."

The Tabbies, which are presented by Trade Association Business Publications International (TABPI), recognize excellence in trade, association, and business publications.

The organization's goal is to bring together editors working for English-language publications worldwide, and encourage a common dedication to editorial ethics and excellence.

This year's Tabbie Awards recorded nearly 500 entries worldwide, with contributions submitted from the United States, Canada, United Kingdom, Australia, France, China, The Netherlands, Singapore, South Africa, Germany, and India.

SECTION NEWS

Green & White Mountains Section executives shown taking a break are (sitting) Jennifer Eastly and Jim Reid, and (standing, from left) Pearly Lund, Ernie Plumb, Garry Buckley, Chairman Geoff Putnam, Phil Witteman, Ray Hendersen, District 1 Director Russ Norris, Jerry Ouellette, John Steel, and Howard Knowlton.

Shown are the attendees at the District 2 conference held June 6.

District 1

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

CENTRAL MASS./ RHODE ISLAND

JULY 14

Activity: The Central Massachusetts/ Rhode Island Section held its first executive committee meeting for the year at Pub 99 Restaurant in Fairhaven, Mass. **Paul Mendez,** scholarship and AWS Foundation representative, presented **Brendon Pequita** a Section T-shirt in appreciation for his first year of service to the Section as a vice chairman.

GREEN & WHITE MOUNTAINS

AUGUST 30

Activity: The Section's executive committee held a meeting to discuss finances and the upcoming meeting schedule. Attending were District 1 Director **Russ Norris,** Chair **Geoff Putnam, Jennifer Eastly, Jim Reid, Pearly Lund, Ernie Plumb, Garry Buckley, Phil Witteman, Ray Hendersen, Jerry Ouellette, John Steel,** and **Howard Knowlton.** The meeting was held at Cuttings Gate Inn Bed and Breakfast in Shrewsbury, Vt.

District 2

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

Shown at the Central Mass./R.I. Section meeting are (from left) Paul Mendez, Brendon Pequita, and Chairman Douglas Desrochers.

Lancaster Section members are shown during their tour of Highland Tank.

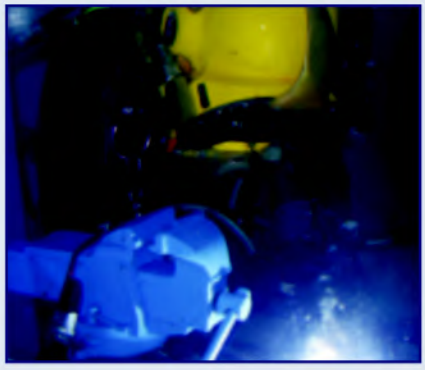

Shown at the District 2 conference are Philadelphia Section Chair Gary Atherton (left) and New Jersey Section Treasurer Alfred Fleury.


Harland Thompson (left), incoming District 2 Director, chats with Ken Stockton, District 2 director, at the District conference.


Congressman Joe Sestak (left) is shown with Kevin Throgmorton, Philadelphia Section secretary, at the February activity.


Sergio Smith (left) accepts an appreciation plaque for hosting the South Carolina Section's underwater welding event from Steve Mattson, District 5 director.


Terry Perez, AWS staff representative, chats with Gary Atherton, Philadelphia Section chair, at the District 2 conference.


Steve Mattson, District 5 director, demonstrates safe underwater welding techniques at the South Carolina Section program.

District 2 Conference

JUNE 6

Activity: The District 2 conference was hosted by the Philadelphia Section. President was **Ken Stockton,** District 2 director, who introduced **Harland Thompson** as the incoming District 2 director. Thompson is currently vice chair of the Long Island Section.

PHILADELPHIA

FEBRUARY 2

Activity: The Section members attended the Pennsylvania 7th Congressional District Education and the Economy Summit. The speakers included Congressman **Joe Sestak,** a promoter of welding education, and **Deborah Mathias,** director, Bureau of Early Learning Services, Pennsylvania Dept. of Education.

District 3

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

LANCASTER

AUGUST 25

Activity: The Section members toured the Highland Tank manufacturing facilities in Manheim, Pa. The facility produces steel storage tanks for gasoline and other fuels and chemicals. **Bob Hurley,** production supervisor, conducted the program.

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

SOUTH CAROLINA

SEPTEMBER 17

Speaker: **David Sharp,** instructor; and **Sergio Smith,** president

Affiliation: International Diving Institute

Topic: Underwater welding safety, techniques, equipment, electrode prep, and machine settings

Activity: District 5 Director **Steve Mattson** suited up and performed the underwater welding demonstrations for Section members, guests, and Trident Technical College welding students. This past summer, Mattson developed his underwater welding skills at the institute with instructors **Sergio Smith** and **David Sharp.** The event was held at the institute in Charleston, S.C.

SOUTH FLORIDA

SEPTEMBER

Activity: The Section has launched its completely redesigned Web site. The address is *www.awssoflasection.com.* It features a variety of interesting pages featuring news, photos, upcoming meetings, and even some valuable "Free Stuff." Other Sections should visit this site to get ideas about starting or upgrading their own Web sites. **Gilly Burrion,** Section chair, said, "We expect the upcoming year will be an exciting one and urge everyone to participate so we can share our knowledge of this great and unique welding industry." Upcoming meetings will include Hollywood Iron Works, U.S. Coast Guard, a laser cutting demo, Lincoln Electric welding simulation, and a talk by a NASCAR engineer for the Section's members and student welders.

Steve Mattson (center), District 5 director, suited up to demonstrate safe underwater welding techniques at the South Carolina Section program. Mattson is shown with his underwater welding instructors David Sharp (left) and Sergio Smith.

District 6

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

District 7

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

District 8

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

CHATTANOOGA

SEPTEMBER 15

Speaker: **Bill Zielke,** consultant for failure analysis, metallurgy, and welding
Affiliation: Zielke Associates
Topic: Temporary repair of a superheat outlet header using the temperbead technique

Activity: **Bill Brooks** received his Life Member certificate for 35 years of service to the Society. **Don Russell,** long-time Section treasurer and scholarship chair, announced his promotion within Komatsu and his need to leave the Section in order to relocate to South Carolina. The program was held at the TVA Sequoyah Training Center in Chattanooga, Tenn.

Bill Zielke discussed repair techniques for the Chattanooga Section members and guests.

Bill Brooks (left) receives his Life Member certificate from Don Russell, Chattanooga Section treasurer and scholarship chair.

GREATER HUNTSVILLE

AUGUST 20

Activity: The Section members held a meeting to discuss the next season's activities schedule and details of the welding scholarship program and courses offered by the local college. The program was held at Marshall Technical School in Guntersville, Ala.

District 9

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

BATON ROUGE

SEPTEMBER 17

Activity: More than 50 Section members and guests met at the Stupp Corp. pipe mill recently built in Baker, La., to study the manufacture and inspection of API spiral pipe. The presenters included **Ed Scram,** senior vice president; **Ron Spencer,** manager of nondestructive testing; and **Hayden Hilling,** production manager. Following the talks, the group toured the facility to see the CNC bending rolls, GMAW tack welding machines, and twin multielectrode CNC SAW final welding operation. Gold Member certificates were presented to **Harry Sumrall** and **R. V. Schmidt** for their fifty years of service to the Society. **George Yelvaton** accepted the award on Schmidt's behalf.

District 10

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

MAHONING VALLEY

AUGUST 7

Activity: Section hosted its 34th annual Jim Best golf outing at Knoll Run Golf Course in Lowellville, Ohio. The organizing golf committee members were **Carl Ford, Nick Ambrosini,** and **Leon Stitt.** The prizes were donated by Airgas Great Lakes, Hypertherm, and Norton Abrasives. The hole sponsors included Airgas,

Shown at the Baton Rouge Section program are (from left) Treasurer Tom Shelton, Chair Markkevin Spencer, George Yelvaton, Harry Sumrall, Jim Falgout, and George Fairbanks, District 9 director.

Baton Rouge Section members toured Stupp Corp. in September.

The Mahoning Valley golf outing committee members are (from left) Carl Ford, Nick Ambrosini, and Leon Stitt.

Detroit Section Chair Mark Rotary (right) is shown with Victor Matthews, AWS president.

Avesta, Brilex Industries, Cedar Steel, Cor-Met, Columbiana Boiler, C&K Welding & Supply, Diamond Steel, Garland Welding, Falcon Foundry, Hobart Brothers, Kobelco, Lincoln Electric, Northeast Fabricators, Specialty Fab., Spectrochemical Testing, Steel & Alloy Specialists, Stoody, United Abrasives/Sait, Valley National Gas, Western Pennsylvania Steel Fabricating, Youngstown Oxygen & Welding Supply, and Praxair.

District 11

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

DETROIT

SEPTEMBER 10
Speaker: **Victor Matthews,** AWS president
Affiliation: The Lincoln Electric Co.
Topic: The importance of welding
Activity: The Section hosted its old timers' and students' night event at RoMan Engineering Services in Livonia, Mich. Section appreciation awards were given to RoMan Engineering, ATI, and Dengensha America for their continued support. **William Straith** and **Robert Caraway** received Gold Member certificates for 50 years of service to the Society. **Alfred Sievers, Jim Osborne,** and **Stephean Skrobot** received Life Member certificates for 35 years of service; **Robert Wilcox, Michael Blaess,** and **James Coster** received Silver Member certificates for 25 years of service. Scholarship awards were presented to 33 students totaling $38,000.

WESTERN MICHIGAN

MAY 8
Speaker: **Steve Andrassy**
Affiliation: Dengensha America
Topic: Stud welding
Activity: **Harold Hankes** was presented the Life Member certificate for 35 years of service to the Society.

Detroit Section old timers include (from left) Alfred Sievers, Jim Osborne, William Straith, Robert Caraway, and Robert Wilcox, with Awards Chair Bill McLaughlin, AWS President Victor Matthews, and Mark Rotary, chairman.

AWS President Vic Matthews (far right, rear) poses with the 33 welding scholarship winners at the Detroit Section program.

Shown at the Chicago Section program are (from left) Jim Greer, a past AWS president; Chairman Hank Sima; and speaker Roger Hirsch.

Western Michigan Section Chair Matt Post (left) presents Harold Hankes his Life Member award.

Speaker Steve Andrassy (left) is shown with Matt Post, Western Michigan Section chair.

District 12

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

District 13

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

CHICAGO

SEPTEMBER 9

Speaker: **Roger Hirsch,** president
Affiliation: Unitrol Electronics
Topic: Resistance welding and safety concerns when using spot welding equipment
Activity: The event was held at Bohemian Crystal Restaurant in Westmont, Ill. **Jim Greer,** an AWS past president, attended the program.

Iowa Section members are shown during their tour of Kelderman Mfg. in September.

Shown at the Kansas City Section meeting are (from left) Vice Chair Sarah Hurt, Dennis Wright, Michael Williams, Dave McKenzie, Chair Jason Miles, speaker Walt Gilliam, and Mike Vincent, vice chair.

Donald Koleson addressed the students at the St. Louis Section program in April.

Kansas City Vice Chair Sarah Hurt presents a speaker gift to Walter Gilliam.

District 16 Director David Landon (left) presents Rick Guffrey with the CWI of the Year Award.

District 14

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

ST. LOUIS

APRIL 9

Speaker: **Donald Koleson,** dean (ret.)
Affiliation: Southwestern Illinois Community College
Topic: Occupational programs presented at the college
Activity: This students' night program, featuring a scholarship awards presentation, was held at the Granite City, Ill., Elks Club for 90 attendees.

District 15

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

ARROWHEAD

SEPTEMBER 17

Activity: Chairman **Loren Kantola** conducted an executive committee meeting at Goodfella's Restaurant in Eveleth, Minn. Attending were Vice Chairs **Robert Krog** and **Allan Kliewer; Doug Mroz,** treasurer; **Tom Baldwin,** technical representative, consultant, and librarian; and charter member **Ervin Stoch.** Stoch was presented the Section Meritorious Award for his many years of loyal service to the Society and the Arrowhead Section. The discussion included plans for forming an AWS Student Chapter.

District 16

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

IOWA

SEPTEMBER 15

Activity: The Section members toured the Kelderman Manufacturing facilities in Oskaloosa, Iowa. The company manufactures air-ride systems and agricultural equipment and accessories. **David Landon,** District 16 director, presented **Rick Guffrey** with the Dalton E. Hamilton Memorial Section CWI of the Year Award.

KANSAS CITY

SEPTEMBER 15

Speaker: **Walter Gilliam,** area supervisor
Affiliation: Davis Calibration
Topic: The history of calibration and its importance in industry
Activity: The meeting was held at the Jumping Catfish Restaurant in Lee's Summit, Mo.

Honoring Al Marin (center) are his family members and (far left) John Mendoza, AWS vice president; and Vice Chair Steve Sigler (far right) with John Bray, District 18 director, standing next to him.

District 17

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

OKLAHOMA CITY

SEPTEMBER 10

Speaker: **Cathy Lightcap,** safety specialist
Affiliation: Airgas Mid-South, Tulsa
Topic: Safety and safety equipment
Activity: Students from the Kiowa County Technical School attended the program. The meeting was held at Hometown Buffet in Oklahoma City, Okla.

Kiowa County Technical School welders attended the Oklahoma City Section program.

District 18

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

HOUSTON

SEPTEMBER 16

Speaker: **Fred Schweighardt,** senior business development specialist
Affiliation: Air Liquide
Topic: The effects of shielding gas on the welding process and an introduction to shielding gas physics
Activity: The program was held at Brady's Landing in Houston, Tex.

SAN ANTONIO

SEPTEMBER 8

Speaker: **Virgil Martinez,** operations manager
Affiliation: All American Inspections
Topic: An introduction to NDT
Activity: District 18 Director **John Bray** presented **Howard Thomas** the AWS Meritorious Service Award. Bray also honored **Al Marin** with a special gift in recognition of his 48 years of service to the San Antonio Section. The members of the recently chartered Floresville High School Student Chapter were introduced to the membership.

Houston Section Secretary Derek Stelly (left) is shown with speaker Fred Schweighardt.

District 19

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

San Francisco Section past chairs are (from left) Tom Smeltzer, Benjamin Bisconer, Mike Urioste, Sharon Jones, Dale Phillips, Lüsa Pine, Andre Lopez, and Omar Shair-Ali.

Shown at the District 20 conference are (standing, from left) Jim Corbin, Carl Schiner, Bob Teuscher, Dean Mitchell, Jesse Grantham, Rhenda Mayo, Danny MacCallum, Paul Tremblay, and Lee Corn. Front row (from left) are Russell Rux, Pierrette Gorman, District 20 Director Bill Komlos, and Richard "Woody" Cook.

District 20

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

District 20 Conference

JUNE 12

Activity: The conference was chaired by **William Komlos,** District 20 director. More than $7500 in scholarships were awarded. **Rhenda Mayo,** director, AWS Membership Services, attended the event. The program included a tour of L&H Industrial Inc., in Gillette, Wyo., a manufacturer of equipment for the mining, railroad, oil, and gas industries.

District 21

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

District 22

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

SAN FRANCISCO

SEPTEMBER 2

Speaker: **David DeBlasio,** operational advisor, manager of safety and regulatory compliance

Affiliation: Gayle Mfg. Co.

Topic: Structural steel fabrication at Gayle

Activity: About 60 members and guests attended this past chairmen's night banquet. District 22 Director **Dale Flood** presented Section Meritorious Awards to **Sharon Jones** and **Jerry Azzaro;** District Meritorious Awards to **Tom Smeltzer** and **Liisa Pine;** Section Dalton E. Hamilton Memorial CWI of the Year Awards to **David Aultman** and **Brian Rodgers;** and the Section Private Sector Award to **Liisa Pine.** The program was held at Spenger's Restaurant in Berkeley, Calif.

The members of the recently chartered Floresville High School Student Chapter pose at the San Antonio Section program.

Shown at the San Francisco Section meeting are (from left) District 22 Director Dale Flood, Chair Tom Smeltzer, David DeBlasio, and Andy Stoll.

Guide to AWS Services

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

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

ADMINISTRATION
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Senior Associate Executive Director
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Associate Executive Director Accounting
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Executive Assistant for Board Services
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Director, Human Resources
Dora A. Shade.. *dshade@aws.org* .....(235)

INT'L INSTITUTE of WELDING
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Provides liaison services with other national and international professional societies and standards organizations.

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

CONVENTION and EXPOSITIONS
Senior Associate Executive Director
Jeff Weber.. *jweber@aws.org* .....(246)

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

Brazing and Soldering Manufacturers' Committee
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RWMA — Resistance Welding Manufacturing Alliance
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Susan Hopkins.. *susan@aws.org* .....(295)

WEMCO — Welding Equipment Manufacturers Committee
Manager
Natalie Tapley.. *tapley@aws.org* .....(444)

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Welding Journal
Publisher
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Society and Section News Editor
Howard Woodward..*woodward@aws.org* .(244)

Welding Handbook
Welding Handbook Editor
Annette O'Brien.. *aobrien@aws.org* .....(303)
Publishes *Welding Journal*, the Society's monthly magazine, *Inspection Trends*, *Welding Handbook*, and books on general welding subjects.

MARKETING COMMUNICATIONS
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Webmaster
Angela Miller..*amiller@aws.org* .....(456)

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Director
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Serves as a liaison between Section members and AWS headquarters. Informs members about AWS benefits and activities.

CERTIFICATION SERVICES
Department Information .....(273)

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

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

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Managing Director
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Director, Education Services Administration and Convention Operations
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Coordinates AWS awards and AWS Fellow and Counselor nominees.

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

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

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

Technical Publications
AWS publishes about 200 documents widely used throughout the welding industry.
Senior Manager
Rosalinda O'Neill.. *roneill@aws.org* .....(451)

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

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

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

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

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

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

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

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

Nominees for National Office

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

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

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

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

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

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

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

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

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

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

Honorary Meritorious Awards

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

William Irrgang Memorial Award

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

Honorary Membership Award

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

National Meritorious Certificate Award

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

International Meritorious Certificate Award

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

AWS Mission Statement

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

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

Industrial Lift Magnets Detailed in Brochure

The company's complete line of industrial lifting magnets is presented in a 24-page brochure. Included are permanent magnet models with lift capacities up to 10,000 lb, electromagnets with capacities to 59,000 lb, and descriptions of complete systems including lift beams with multiple magnets and controls. Numerous photographs show a variety of applications from heavy industry to small tool shop. All models include complete specifications, size and working dimensions, with dimensioned mechanical drawings. The specific product lines detailed are the SafeHold® series of permanent magnets that turn off and on manually or automatically, and the Selecto® continuous-duty electromagnets for 110-V operation. Also detailed are bipolar magnets for pipe handling, and round units for processing scrap steel. Several pages detail the company's lines of fixed- and variable-voltage rectifiers. Call

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— continued on page 168

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habits while using circular saws; *Miter Saw Safety* — a 15-min video that addresses safety procedures when using a miter saw; and *Power Tool Accidents — They Can Be Prevented* — a 19-min video that addresses the importance of keeping the work area safe, electrical safety, developing good personal work habits, and proper tool use and care. The video includes interviews with ER physicians, people injured while using power tools, and safety experts. Each video may be viewed with either an English or Spanish sound track. Also available are downloadable publications *Safety Is Specific,* a compilation of rules and safe practices for using power tools; and *A Teacher's Reference Guide to Power Tool Safety,* a 24-page brochure featuring lesson plans, student activities, quizzes, support materials, and references to additional information for each power tool category. Other features on the site are a glossary of power tool terms, *PTI Procedure for Determining Power Tool Horsepower,* and *PTI Lab Test Procedure for Determining Stated Relative Torque Measurement for Corded and Cordless Drills, Drill/Drivers, and Screwdrivers,* a safety maintenance checklist, and other valuable information. Hard copies of the documents and DVD copies of the videos may be ordered on the site.

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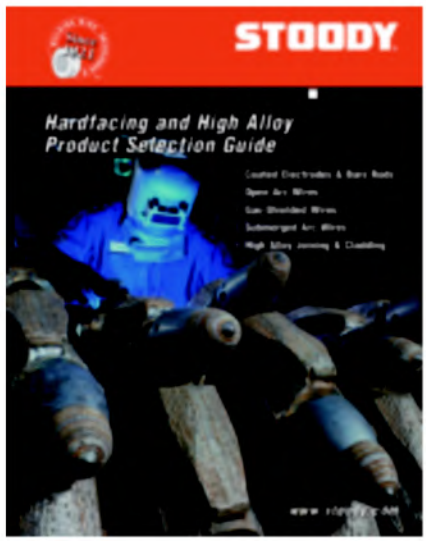
The 60-page, full-color *Hardfacing and High Alloy Selection Guide* presents complete product descriptions, technical specifications, photographs, recommended uses, and ordering information for the company's



lines of welding, buildup, and hardfacing electrodes and wires. The products are presented in four groups: coated electrodes and bare rods; open-arc and gas-shielded wires; submerged arc wires; and high-alloy joining and cladding wires and electrodes. Detailed are hardfacing products for manual, semiautomatic, and automatic applications in the earthmoving, mining, oil drilling, and other industries that cope with moderate to severe metal-to-metal and metal-to-earth impact or abrasion, high temperatures, and/or corrosion. The PDF catalog can be viewed and downloaded from the Web site.

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Caplugs
www.caplugs.com
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Shot Peening Guide Updated

Shot Peening, A Dynamic Application and Its Future is available in volume 1 and soon to be released updated volume 2. The second edition includes four additional chapters and four new authors. Included are the inputs from 22 experts in the shot peening field representing 11 countries. Topics include an introduction to peening and its theory, peening intensity, effects of peening, Almen saturation curves, peening coverage, exposure time, troubleshooting, process documentation, masking solutions, workpiece fixtures, shape and size inspection of peening media, cut wire, cast steel shot, ceramic media, specifications, shaded strips, audits by third parties, peening equipment components, flap peening, and numerous other topics. These books and additional literature addressing metal finishing can be reviewed and ordered from the Web site.

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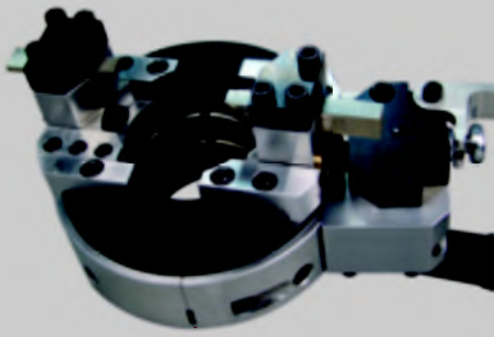

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Hypertherm Announces Marketing Manager

Reese Madden

Hypertherm, Hanover, N.H., a supplier of metal-cutting technology, has named **Reese Madden** manager of North American marketing. Previously, Madden was marketing manager overseeing the company's Powermax systems.

Adept Technology Designates Sales Director

Rush LaSelle

Adept Technology, Inc., Pleasanton, Calif., a provider of intelligent vision-guided robotics, has appointed **Rush LaSelle** director of global sales and marketing. LaSelle has 20 years of experience in the field, most recently as general manager for FANUC Robotics America, Inc.

Davis Calibration Appoints Chief Information Officer

Davis Calibration, Baltimore, Md., has appointed **John Meighan** chief information officer. With more than 17 years of experience in the industry, Meighan most recently served as chief technology officer for OneWorld Lab.

Abrisa Names President

Abrisa, Inc., Santa Paula, Calif., a supplier of industrial glass fabrication products and precision thin-film optical coatings, has named **Jim Veler** president and chief executive officer. Prior to joining the company, Veler was vice president and general manager of Agilent Technologies' Wireless Manufacturing Organization based in Santa Rosa, Calif.

Jim Veler

Obituary

Laurence Harvey Kissler

Laurence Harvey Kissler, 83, a past president of the Gases and Welding Distributors Association (GAWDA), died Sept. 25 at his home in Boise, Idaho. After high school, Kissler enlisted in the U.S. Air Force for four years during WWII. Following discharge, he attended Washington State University where he received

— continued on page 172

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NEWS OF THE INDUSTRY

— continued from page 12

L.B. Foster Awarded Denton County Transportation Authority Rail Contract

L.B. Foster Co., Pittsburgh, Pa., has been awarded a $7.6 million contract for 115-lb rail for installation on the 21-mile A-Train transit project linking Denton and Carrollton, Tex. Shipments of 4599 tons of 1600-ft welded rail and 573 tons of 80-ft stick rail were delivered to the North Texas Rail Group, a contractor joint venture between Herzog Contracting Corp. and Archer Western Contractors. The first shipment totaling 3066 tons of welded 115-lb rail was delivered by L.B. Foster's company-owned weld trains and unloaded July 1. The final shipment of 1533 tons of welded rail was delivered and unloaded August 1. Shown is anchoring ribbon rail to be removed from train. (Photo courtesy of L.B. Foster Co.)

U.S. Navy Finds No Risk from Improper Welds on Virginia Class Submarines

The U.S. Navy recently approved Northrop Grumman Shipbuilding (NGSB) and General Dynamics Electric Boat's findings/actions to address the use of improper weld filler metal on Virginia Class submarines. This included NGSB reviewing its welding procedures and inspection criteria to bound the issue to nonnuclear corrosion-resistant steel (CRES) pipes completed between January 2000 and 2008; inspections of CRES piping located within ship-critical systems that found a low number of copper-contaminated welds, and those were replaced; and NGSB revising shipyard practices on control of welding materials.

Also, the Navy conducted a 16-month in-depth review of the shipbuilders' findings. According to a statement, it "is satisfied that our people and platforms are not at risk due to this issue." Both NGSB and General Dynamics Electric Boat conducted analysis and testing that demonstrates the low probability of improper welds occurring aboard submarines; improper welds are unlikely to fail during the ship's operational life; and should a weld fail it would leak but not break, thereby alerting the crew in time to address the issue before the weld degraded further.

Industry Notes

- An online induction heating resource page launched by **Miller Electric Mfg. Co.**, Appleton, Wis., includes process descriptions, applications with setup suggestions, case studies, and time-to-temperature calculators for pipe/plate applications.
- Automation supplier **ixmation COX systems** relocated its USA/Chicago-based operations into a new 80,000-sq-ft facility located within the Roselle Commerce Center in Roselle, Ill.
- **The Wagner Companies**, Milwaukee, Wis., a manufacturer of handrail fittings and metal products for architectural and industrial applications, received ISO 9001:2008 Certification.
- A 2009 award of sales achievement was presented to **ICON Machine Tool Inc.**, St. Louis, Mo., at **TRUMPF Inc.'s** recent annual distributor meeting in Farmington, Conn.
- **RathGibson** has been awarded ISO 9001:2000 management system and Pressure Equipment Directive certifications for its North Branch, N.J., manufacturing plant.
- **Adept Technology, Inc.**, Pleasanton, Calif., a provider of intelligent vision-guided robotics, has signed **Nihon Kizai** as its newest distributor to cover the Japanese market.
- **Lincoln Electric Automation** launched an updated Web site at *www.lincolnelectric.com/automated-solutions* for users to view expanded capabilities, services, and support. A highlight is a virtual tour of its new Automation Division in Cleveland, Ohio.

PERSONNEL

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a degree in business and a master's degree in economics. He married in 1950 then began a 17-year career with the Linde Division of Union Carbide where he served as a salesman in the Pacific Northwest, area manager in Salt Lake City, assistant regional manager in Chicago, and as New England regional manager based in Boston. In 1968, he moved to Boise with his wife and four children where they purchased the welding supply division of Nordling Auto Parts Co. (Norco). He built the company into the largest privately owned company of its kind that currently has more than 50 outlets in seven northwestern states. Norco

Laurence Kissler

was cited by *Welding Distributor Magazine* as an outstanding distributor in 1978. In 1979, Kissler was named Small Businessman of the Year in the state of Idaho. He was elected president of the National Welding Supply Association in 1986. In 1992, Norco received the Blue Chip Enterprise Award for efficiency and leadership from the National Chamber of Commerce, Connecticut Mutual, and *Nation's Business Magazine;* and in 1995, his company was honored as the Family Business of the Year. They built the Kissler Family Chapel at St. Luke's Regional Medical Center and the Kissler Family Library at St. Alphonsus Regional Medical Center. The Kissler Family Foundation, established in 1998, funded by Norco stock, was founded "to support healthcare organizations and providers, support education, and the betterment of humankind." Carrying on his father's tradition, son, Jim, currently Norco CEO, served as GAWDA president in 2003. Kissler is survived by his wife, Frances; children, Jim, Laura, Karen, and Marlene; and nine grandchildren.

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Atlanta, GA - November 2 – 4, 2010

Submission Deadline: March 31, 2010

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Answer the following about this paper

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What are the welding/Joining processes used?

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What is the main emphasis of this paper? Process Oriented ☐ Materials Oriented ☐ Modeling ☐

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Has material in this paper ever been published or presented previously? Yes ☐ No☐

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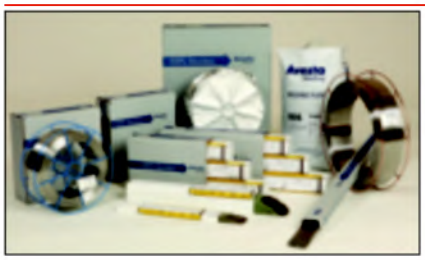

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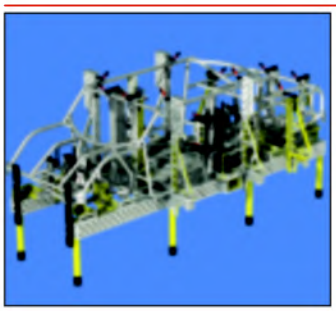

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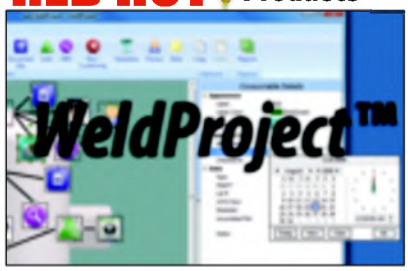

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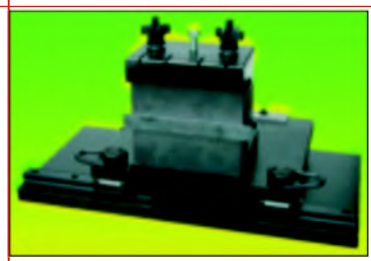

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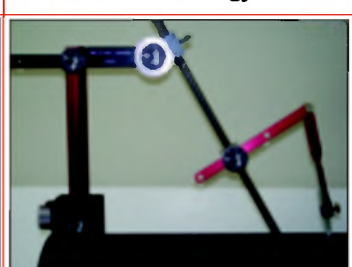

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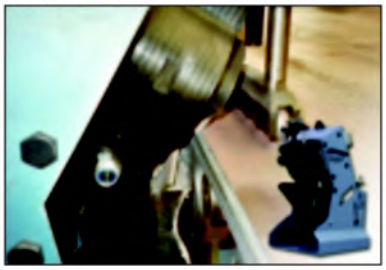
The Multi-Hole Imager is Flange Wizard® Tools' newest layout tool. The strong "on and off" magnet makes positioning on a round, flat, or irregular surface a lot easier. The Multi-Hole Imager will layout round or elongated holes (ellipse) on flat material or pipe to match laterals at 90 degrees or at compound angles. The Imager is a great tool for structural and pipe layout projects and will be available November 2009.

Flange Wizard® Tools
2140 Santa Fe St.
Santa Ana, CA 92705
wizard@flangewizard.com
www.flangewizard.com



Kbm Bevelling Machine 10 Feet Per Minute

Gullco's KBM self propelled bevellers operate at 10 feet (3 meters) per minute. These bevellers produce clean machined bevel angles of 22 1/2 through 55 degrees with no thermal distortion on stainless steel and aluminum. All KBM bevellers can be supplied with an exclusive adjustable height, self aligning, spring loaded caster wheel assembly maintaining a uniform bevel and consistent root face.

See Us at Fabtech/AWS Booth #36003

Gullco International Inc.
Cleveland Ohio
(440) 439-8333
Fax: (440) 439-3634
ussales@gullco.com

Weld Shaver

Heck Industries has added a new hand held weld shaver to their line of fabricating equipment. The new weld shaver uses standard carbide inserts in a milling cutter to shave weld beads flush to a work piece. Used for cleaning butt welds and corner welds. The weld shaver will remove only the weld and not damage surrounding materials such as conventional grinding of joints. The 2 horsepower Model WS-625 will quickly remove welds at 6-8 feet per minute.For more information and a catalog please contact Heck Industries.

Heck Industries
(800) 886-5418
Fax: (810) 632-6640
www.heckind.net

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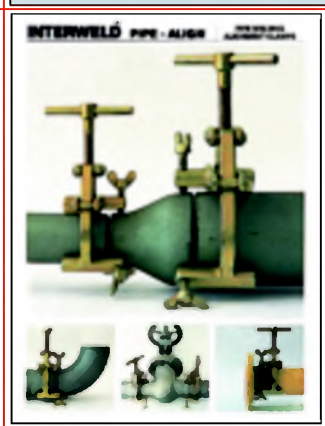

Intercon Pipe Welding Clamps

Intercon pipe welding clamps ensure a quick and precise alignment, resulting in high quality weld placements. The wing bolts contain stainless ball bearings for minimal marring. These clamps are available in electro-plated forged steel or forged stainless steel. The "third arm" for every welder is available in 5 sizes. Contact us for FREE info and quote.

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FAX: (604) 946-5340
E-mail: sales@intercononline.com
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Visit the HIWT Website

Visit us at www.welding.org. Our website explains in detail the wide range of welding classes offered by the Hobart Institute of Welding Technology. More than 25 separate welding courses are described with course objective, content and testing requirements. The 2009/2010 course schedule, training rates, and enrollment forms are all available.

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Hobart Institute of Welding Technology
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(800) 332-9448
Fax: (937) 332-5200
www.welding.org

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New Catalog From J.P. Nissen

J. P. Nissen's new full color catalog describes its full line of markers for all metalworking purposes. The markers will write on all surfaces: wet, dry, oily, or rusty. In addition to Nissen's permanent paint markers, they offer markers removable with water, detergent or in the pickling bath. All markers are guaranteed for life.

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www.nissenmarkers.com

Welding Training Curriculum Available

Complete training programs including DVDs, instructor guides, and student workbooks. Newly offered in 2009 is Shielded Metal Arc Welding Pipe 2-inch and Shielded Metal Arc Welding Pipe 6-inch. To see a complete line of curriculum offerings including GTAW, SMAW, GMAW, and FCAW, you can shop online at www.welding.org or request a printed training materials catalog.

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New Pferd Polifan® Curve gives more precise grinding of fillet welds with a totally new flap wheel design, the innovative POLIFAN® CURVE SG-PLUS just introduced by PFERD INC, is a major step forward in the precision grinding of fillet welds on steel and stainless steel workpieces. Its unique radial shape allows for aggressive grinding with not only the bottom and edge of the flap disc but also with the top edge as well. These work-saving advantages increase the rate of stock removal while extending tool life and offering a level of precision not possible before.

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New Tungsten Carbide Flexible Cord

Saint-Gobain Coating Solutions introduces a new tungsten carbide flexible cord called Hardkarb Co12. When sprayed with our flame spray units, you obtain a tough and dense coating that has superior resistance to abrasion, erosion, sliding wear and corrosion. This product is well suited for a variety of applications including but not limited to pump housings, reciprocating and rotating machine parts, exhaust fans and other process equipment.

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National Bronze & Metals, Inc. (NBM) is a leading manufacturer and master distributor of brass, bronze, and copper alloys. Dedicating a portion of its 10 million pound inventory to RWMA copper based alloys (class 1 through class 5), NBM has made available alloys such as: C17200/C17510 (beryllium copper), C18000 (copper chromium nickel silicon), C18150 (copper chromium zirconium), C18200 (chromium copper), C15000 (zirconium copper), C95300 (aluminum bronze). Our headquarters is conveniently located in Houston, Texas, and stock for use in resistance welding applications is ready for immediate shipment in various shapes and forgings.

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Welding Electrodes Catalog

Select-Arc offers an expanded catalog which describes the company's complete line of premium flux cored and metal cored carbon steel, low alloy, stainless steel, nickel alloy and hard-surfacing welding electrodes. This 88-page catalog includes comparability charts, welding parameters, deposition rates, agency approvals and Select-Arc packaging options.

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Fort Loramie, OH 45845-0259
(800) 341-5215
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www.select-arc.com

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E-mail: sellstrom@sellstrom.com
www.sellstrom.com

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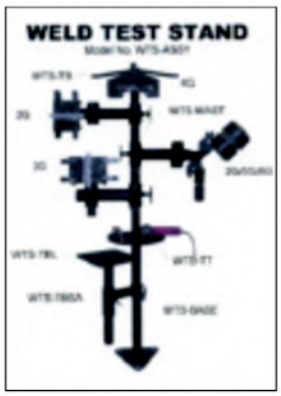


Weld Test Stand

The Weld Test Stand allows for quick, secure clamping and positioning of pipe or plate test assemblies. All position pipe fixtures will hold up to 1-1/2" thickness without backing and can be placed in any position. Pipe and plate fixtures are also sold separately without the stand and may be held securely in a bench vise or adapted to existing stands. Shipped unassembled, the Weld Test Stand weighs approximately 85 pounds.

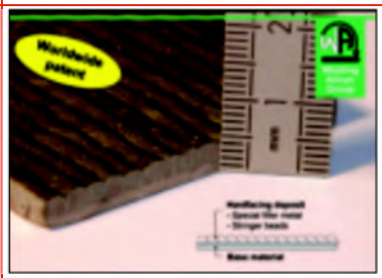
Triangle Engineering Inc.
6 Industrial Way
Hanover, MA 02339
(781) 878-1500
Fax: (781) 878-2547
Website: www.trieng.com

SmartTCP Automatic Welding for Small Batch Production

SmartTCP robotic welding solution for steel fabrications in small batch production reduces the need for expert welders, improves time to market, and increases production volume and quality. The gantry welding system is a turnkey solution that automates both the robot programming and the weld production, making it possible for job-shops and manufacturers to optimize the fabrication of high mix low volume parts.

See Us at Fabtech/AWS Booth #34065

SmartTCP Inc.
26602 Haggerty Rd.
Farmington Hills, MI 48331
(248) 994-1041
Fax: (248) 994-1042
www.smarttcp.com



Hard*lite*™: the ultra-thin composite wear plate

Welding Alloys Hard*lite*™ features an extremely refined micro-structure with high volume of chromium carbides alloying an ultra high wear resistance. 68 HRC is achieved through the company's unique patented process. Applications include cones, endless screws, tubes, armoring app., crushers, classifiers, fans...in steelmaking, cement ind., quarries, agriculture, and thermal power stations...Ask WA's team at booth #36061.

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(859) 525-0165
Fax: (859) 525-9094
aurelien.petit@welding-alloys.com (ref AWS Mag.)
www.welding-alloys.com

Optrel e680 The Ultimate in Comfort, Style and Versatility

The Optrel e680 auto-darkening welding helmet is the perfect choice for virtually any welding operation. A lightweight design, individual adjustment options and ergonomic fit combine to provide the ultimate in comfort and control. Add to that high quality optics, an expanded field of view, and "Read Red" color recognition technology and you get a "must-have" for the professional welder.

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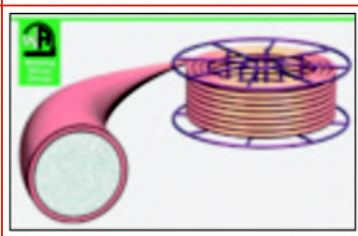

ROBOFIL R71: Seamless Copper Coated Wire for FCAW

Welding Alloys has developed ROBOFIL R71, a seamless copper coated welding wire (E71T-1M/E71T-1). With this new product, the company brings to the welding industry a great flux-cored wire, rutile and with fast freezing slag for all positional welding. In addition the wire features no moisture pick-up, a huge advantage for applications in mixed and hot-humid states. Ask WA's team at booth #36061.

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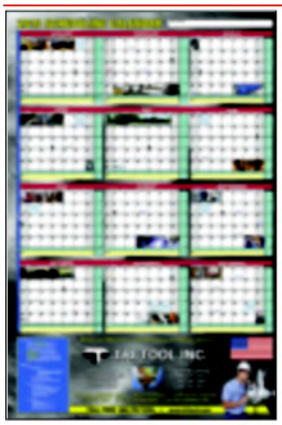
(859) 525-0165
Fax: (859) 525-9094
aurelien.petit@welding-alloys.com (ref AWS Mag.)
www.welding-alloys.com



Free 2010 Plant Maintenance Scheduling Calendar

Tri Tool Inc. is once again offering their free color 24" X 36" wall calendar for 2010 designed for plant maintenance scheduling. Call (888)TRI TOOL Toll Free and get your calendar while supplies last.

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Our line of PTA products now includes PTA systems, torches and powders. The systems can run both hand-held and machine torches, which provides flexibility for various uses in your job shop. Our torches are very sturdy and easy to maintain. The composite Tungsten Carbide powders available from Durum USA are especially suitable for high wear applications.

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NEW 4140 Alloy Steel Electrode

Applications: The 4140 E14 electrode is typically used to build up all types of dies, forgings, castings, and other machine parts made from medium carbon, low alloy steels. It may also be used for joining thin sections of AISI 4140 materials.

Hardness: 32-40 Rc as welded, Flame hardenable to 58 Rc.

Classification: AISI 4140.

COR-MET Inc.
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(810) 227-3251
sales@cor-met.com
www.cor-met.com

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The DEFECTOMAT CI FOERSTER's Latest Windows® Based Instrument

The CI features an optional 2nd channel evaluation for multi-frequency testing to differentiate ID/OD defects or an absolute channel to detect open weld conditions. When paired with the LSM-180 utilizing segmented coils, it offers the best solution for testing welded ferromagnetic tubing. All defects are marked, documented and outputs are available for sorting purposes. See the CI in action at the FABTECH/AWS Welding Show.

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Athlete series high precision cutting machine can be integrated with high precision plasma cutting system to achieve unequal cutting quality. The drive mechanism uses a precision gear reducer that offers low-clearance with backlash less than 2 arc minutes. It can be equipped with other optional accessories such as laser point positioning pneumatic clamping device, torch height control, etc.

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What defines *excellence* in welding sales?

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

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

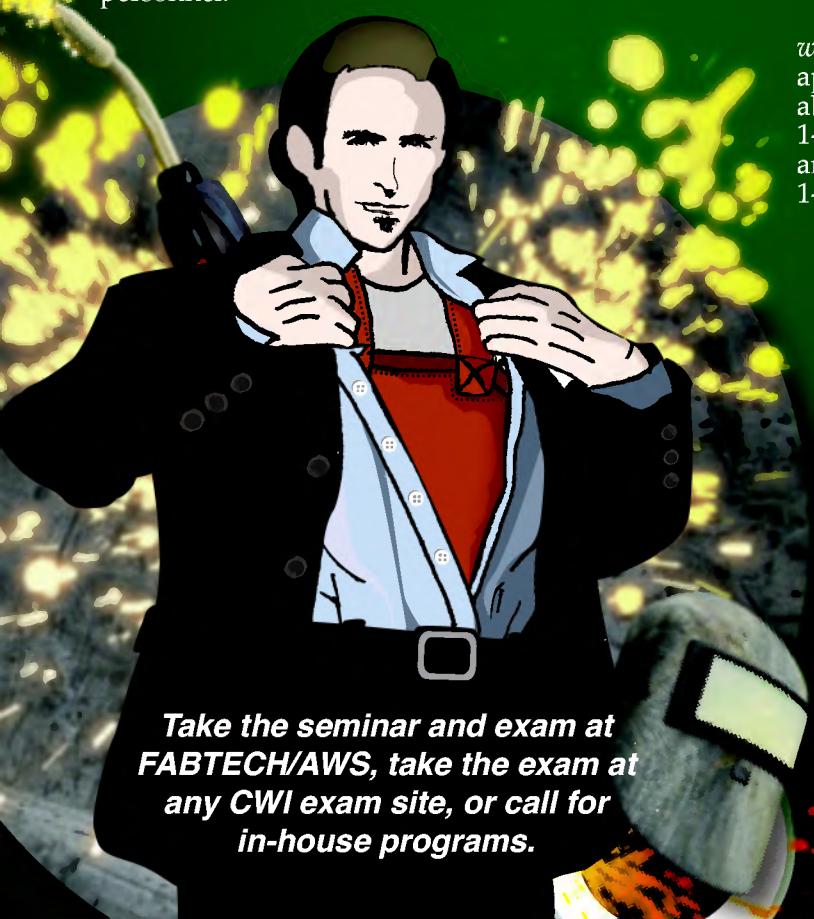
You are there for them when they want to try new solutions. You are there when they struggle to improve their welding quality and productivity. You are there to help provide a safe workplace.

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

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

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

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



Take the seminar and exam at FABTECH/AWS, take the exam at any CWI exam site, or call for in-house programs.

Examination topics will establish your level of knowledge concerning five arc welding processes, brazing and soldering, cutting, safety in processes and gas cylinder handling, AWS filler metal classifications, shielding gas applications, welding terminology, ventilation, electrical requirements for power sources, and welding procedures and their qualification.

The optional seminar will not only prepare you for the exam, it can also enhance your professional knowledge, especially as you network with your peers in a stimulating, interactive classroom environment. You'll receive a study guide and valuable reference books that you can keep: *Welding Handbook* volumes 1 & 2, AWS A5.32 *Specification for Welding Shielding Gases*, and ANSI Z49.1 *Safety in Welding, Cutting, and Allied Processes*.

Prerequisites for the AWS Certified Welding Sales Representative program include a high school diploma or equivalent and at least five years' experience in an occupational function in direct relation to the sales of welding equipment, cutting equipment, and supplies and other related services; *OR* at least two years' of the same experience *PLUS* a training certificate of completion for welding processes.

Completion of the AWS Certified Welding Sales Representative seminar fulfills this training certificate requirement…so by taking the seminar, a sales representative with between two and five years' relevant experience would be qualified to take the exam.

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

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

www.aws.org/CWSR

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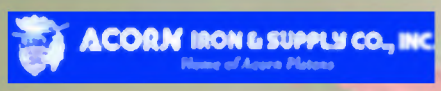


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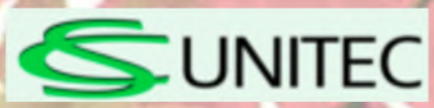
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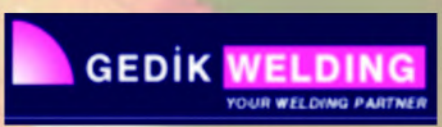
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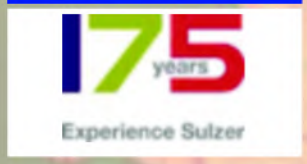
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SUPPLEMENT TO THE *WELDING JOURNAL*, NOVEMBER 2009
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Al-to-Mg Friction Stir Welding: Effect of Positions of Al and Mg with Respect to the Welding Tool

The heat input and joint strength can be significantly affected by the positions of Al and Mg relative to the tool, and lap joint welding can be modified to double the joint strength

BY V. FIROUZDOR AND S. KOU

ABSTRACT

Dissimilar-metal welding has been identified as a top priority in materials joining technologies recently, such as welding Mg to Al or steel to reduce weight. Friction stir welding (FSW) is superior to fusion welding for joining dissimilar metals. Al-to-Mg FSW has been investigated frequently, but the basic issue of how the positions of Al and Mg with respect to the welding tool affect the joint strength is still not understood. In the present study, this issue was investigated in butt and lap FSW, and conventional lap FSW was modified to improve the joint strength. 6061 Al and AZ31 Mg, the two most widely used Al and Mg alloys, were selected. In butt FSW, Al was either on the advancing or retreating side of the tool with the tool shifted to Al, Mg, or neither. In lap FSW, on the other hand, Al was either at the top or bottom with deep or shallow pin penetration into the bottom. A significant effect of material position on the joint strength was demonstrated in butt, conventional lap, and modified lap FSW, affecting the joint strength by a factor of two or more. The highest joint strength in modified lap FSW doubled that in conventional dissimilar metal lap FSW and matched that in similar-metal lap FSW of AZ31 Mg to itself. How material position affects the heat input was predicted and confirmed by temperature measurements during FSW. A new color etching procedure was developed to show Al, Mg, Al_3Mg_2, and $Al_{12}Mg_{17}$ in different colors, clearly revealing the microstructure and material flow. The effect of material position on the heat input, material flow, and metallic bonding was used to explain how material position affects the joint strength. Increasing the heat input can increase liquation (i.e., liquid formation, even though FSW is solid-state welding) and hence cracking and brittle Al_3Mg_2 and $Al_{12}Mg_{17}$ to severely weaken the joint. The material position that reduces the heat input was suggested, which can be used to increase the joint strength as long as the heat input is still high enough for sufficient plastic material flow to prevent channels.

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Introduction

The recent surveys conducted by the Joining and Welding Research Institute (JWRT) of Japan (Ref. 1) and the Edison Welding Institute (EWI) in the United States (Ref. 2) have both identified the welding of dissimilar metals as a top priority in materials joining technologies, for instance, Al to steel or Al to Mg for weight reduction, and Al to Cu for electric connections. Recently, friction stir welding (FSW) (Ref. 3) has been used to join dissimilar metals by plunging the pin at the bottom of a rotating tool into the workpiece and traversing it along the joint to cause metallic bonding by stirring and mixing the metals together.

KEYWORDS

Aluminum
Butt Joint
Dissimilar Metals
Friction Stir Welding
Lap Joint
Magnesium

Since Al and Mg alloys are both soft and similar in melting point, in an Al-to-Mg butt FSW, Al has been either on the advancing or retreating side of the rotating tool with tool offset to either Al or Mg. As for Al-to-Mg FSW of a lap joint, in the only study so far (Ref. 4), Al has been at the top but not the bottom. So, the effect of material position on the joint strength has not been studied in Al-to-Mg FSW in a lap joint.

Al-to-Mg FSW has been investigated frequently (Refs. 4–16) as shown in Table 1. In FSW of a butt joint Sato et al. (Ref. 10) and Zettler et al. (Refs. 12, 13) both found Mg on the advancing side better but not McLean (Ref. 5). McLean et al. (Ref. 5) and Yan et al. (Ref. 11) both found tool offset to Mg better. When the effect of material position on the joint strength was discussed, material flow, intermetallic compounds, and cracks were mentioned but not the heat input. In butt joint FSW without tool offset, Zettler et al. (Refs. 12, 13) observed higher peak temperatures when Al was on the advancing side. In double-pass FSW of a butt joint, Somasekharan et al. (Refs. 8, 9) observed complex intercalated microstructures in the stir zone with recrystallized lamellar-like shear bands rich in either Mg or Al. In Al-on-Mg FSW of a lap joint, Chen et al. (Ref. 4) kept the pin tip at an unspecified close distance above the Mg. Even though the pin never touched the Mg, a thick "conversion zone" containing brittle intermetallic compounds ($Al_{12}Mg_{17}$, Al_3Mg_2, and Mg_2Si) still existed between the stir zone and Mg to weaken the joint.

The present study investigates the effect

Table 1 — FSW of Al Alloys to AZ31 Mg

	Al Alloy	Butt Joint		Lap Joint		Welding Parameters
		Advancing Side	Tool Offset	Top	Pin Tip	
McLean (Ref. 5)	5083 Al	Al (visually better), Mg	Mg (visually better), Al			300–400 rev/min 60–100 mm/min
Hirano (Ref. 6)	1050 Al	unspecified	unspecified			1500–3000 rev/min 200–800 mm/min
Okamura (Ref. 7)	1050 Al	Mg	none			unspecified
Somasekharan (Refs. 8, 9)	6061 Al	Al, Mg	Al, Mg			800 rev/min 90 mm/min
Sato (Ref. 10)	1050 Al	Al (failed), Mg (didn't)	none			2450 rev/min 90 mm/min
Yan (Ref. 11)	1060 Al	Al	Mg (strongest), Al, none			200–1000 rev/min 19–75 mm/min
Zettler (Refs. 12, 13)	6040 Al	Mg (stronger), Al	none			1400 rev/min 200–225 mm/min
Kwon (Ref. 14)	5052 Al	Al	none			800–1600 rev/min 300 mm/min
Kostka (Ref. 15)	6040 Al	Al	none			1400 rev/min 225 mm/min
Liu (Ref. 16)	2024 Al	Al	none			2500 rev/min 45 mm/min
Chen (Ref. 4)	Al-7.5Si			Al	above Mg	1500 rev/min 20–80 mm/min

Table 2 — Composition of Workpiece Materials (wt-%)

	Si	Cu	Mn	Mg	Cr	Zn	Ti	Fe	Al
6061 Al	0.62	0.28	0.08	0.89	0.19	0.02	0.01	0.52	bal
AZ31	—	—	0.5	bal	—	1.0	—	—	3.0

of material position on the heat input, material flow, and joint strength in Al-to-Mg FSW, considering the effect of the heat input on intermetallic compounds, and cracks in butt joint welding, conventional lap joint welding (both single- and dual-pass), and modified lap joint welding (both single- and dual-pass). In view of the large number of combinations, the travel speed and the rotation speed were fixed in order to focus on the effect of material position. The effect of the travel and rotation speeds will be discussed in a follow-up paper elsewhere.

Experimental Procedure

6061 Al was welded to AZ31B Mg by FSW. Their nominal chemical compositions are listed in Table 2. As a reference for comparison, AZ31 Mg was welded to itself and so was 6061 Al. Coupons were cut from 1.6-mm-thick sheets of AZ31 Mg alloy and 6061-T6 Al alloy. They were cleaned with a stainless steel brush to remove surface oxides. A Lagun FTV-1 milling machine (2.2 kW or 3 hp) was used for FSW with tools prepared from a H13 tool steel. The tool shoulder was 10 mm in diameter and concave. The pin was 4 mm in diameter and threaded. For welding of the butt joint, the pin length was 1.3 mm. For lap joint welding, both conventional and modified, the pin length was 1.5 mm. Additional conventional lap joint welding was also conducted with a longer pin length of 2.3 mm. The tool was rotated counterclockwise when viewed from above, and tilted 3 deg forward. The workpieces were clamped down tight with four steel fingers located 10 mm away from the weld interface. The tool was cleaned after each welding pass by plunging into a fresh piece of 6061 Al, which removed the material stuck on the tool from previous welds.

Two different rotation speeds, 1400 and 800 rev/min, were used initially. Except for one weld, the joint strength was significantly lower with 800 rev/min. The rotation speed was fixed at 1400 rev/min in all subsequent experiments. The travel speed was 38 mm/min.

Butt Joint Welding

The workpiece dimensions are shown in Fig. 1A. The welding conditions are listed in Table 3. AZ31 Mg was either on

the advancing or retreating side of the tool. The tool axis was positioned along the joint (no offset) or shifted 1.5 mm (1.5 mm offset) to either 6061 Al or AZ31 Mg.

Lap Joint Welding

The workpiece dimensions are shown in Fig. 1B. The welding conditions are listed in Table 4. The weld in the lap joint was positioned along the centerline of the 38-mm-wide overlap. Conventional dual-pass welding of the lap joint was similar in material position except that a second pass was made from the opposite side such that its centerline was 10 mm away from the centerline of the first pass. The purpose was to determine how much the joint strength could be increased by making a second pass. The welding conditions are listed in Table 5.

Single-pass modified lap joint welding is shown in Fig. 1C and the welding conditions in Table 6. A small piece of the bottom sheet material, 76 mm long, 19 mm wide, and 1.6 mm thick, was butt joint welded to the top sheet with pin penetration into the bottom sheet. The 19-mm width of the small piece was mainly for the space required for clamping instead of welding. When AZ31 Mg was on the top, whether it was the top sheet or the small piece, it was placed on the advancing side of the tool. This was because, as will be shown subsequently, butt joint welds were significantly weaker with 6061 Al on the advancing side. Modified dual-pass lap joint welding was similar in material position except a second pass was made from the opposite side, again with its centerline 10 mm away from that of the first pass. The welding conditions are listed in Table 7.

Tensile Testing

The joint strength was determined by tensile testing normal to the weld. Welded coupons were cut in the direction normal to the weld into 12-mm-wide tensile specimens. The edges of the tensile specimens were polished smooth with 320-grit grinding paper. For lap joint welds, a 1.6-mm-thick sheet was placed at each end of the tensile specimen to initially align the specimen with the loading direction. A Sintech tensile testing machine was used, and the speed of the crosshead movement was 1 mm/min. Two to four specimens from welds made under the same condition were tested.

Temperature Measurements

A computer-based data acquisition system was used along with K-type thermocouples for temperature measurements at 100 Hz during FSW. The thermocouple, with a stainless steel sheath of 0.5 mm outer diameter, was placed in a 0.5 × 0.5 mm groove at the workpiece surface that ends 3 mm away from the path of the tool axis. In FSW of both conventional and modified lap joints, the grooves were at the top surface of the lower sheet. In FSW of the butt joint, on the other hand, they were at the bottom surface of the workpiece.

Weld Microstructure

Transverse weld cross sections were prepared by polishing and etching in three steps. The first step was to etch the samples with a solution consisting of 10 mL acetic acid, 10 mL distilled water, and 6 g picric acid in 100 mL ethanol for 10 s (to reveal the AZ31 part of the microstructure). The second step was to etch them with a solution consisting of 20 g NaOH in 100 mL distilled water for 40 s (to reveal the grain structure in 6061 Al). The final step was to dip them in a solution consisting of 4 g $KMnO_4$ and 2 g NaOH in 100 mL dis-

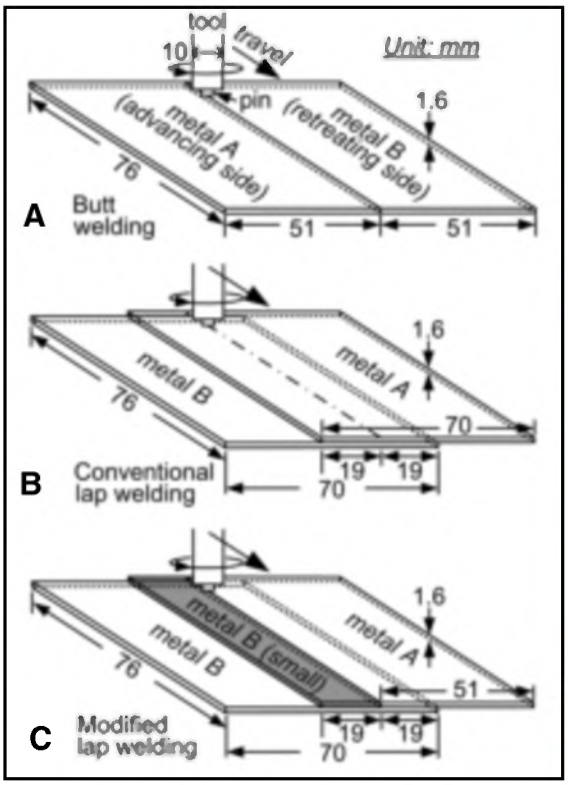

Fig. 1 — Friction stir welding of metal A to metal B. A — Butt joint; B — conventional lap joint; C — modified lap joint (butt joint welding a small piece of metal B to metal A with pin penetration into bottom metal B). Advancing side — material pushed forward by tool; retreating side — material pushed backward.

Table 3 — Welds in Butt Joint

#	Joint	Rotation Speed (rev/min)	Travel Speed (mm/min)	Pin Length (mm)	Tool Offset (mm)	Tensile Load (N)	Standard Deviation (±N)
B-1	Al to Al	1400	38	1.3	0	3109	19
B-2	Mg to Mg	1400	38	1.3	0	2580	102
B-3	Mg (ret) to Al (adv)	1400	38	1.3	0	1318	249
B-4	Al (ret) to Mg (adv)	800	38	1.3	0	1337	247
B-5	Al (ret) to Mg (adv)	1400	38	1.3	0	2055	274
B-6	Al (ret) to Mg (adv)	800	38	1.3	1.5 into Mg	2590	73
B-7	Al (ret) to Mg (adv)	1400	38	1.3	1.5 into Mg	2109	217
B-8	Al (adv) to Mg (ret)	1400	38	1.3	1.5 into Mg	<400	—
B-9	Al (ret) to Mg (adv)	800	38	1.3	1.5 into Al	<400	—
B-10	Al (ret) to Mg (adv)	1400	38	1.3	1.5 into Al	1589	—
B-11	Mg (ret) to Al (adv)	1400	38	1.3	1.5 into Al	<400	—

Table 4 — Single-Pass Welds in a Conventional Lap Joint

#	Joint	Rotation Speed (rev/min)	Travel Speed (mm/min)	Pin Length (mm)	Tensile Load (N)	Standard Deviation (±N)
CL-5	Al to Al	1400	38	1.5	3356	54
CL-6	Mg to Mg	1400	38	1.5	2463	190
CL-1	Al (top) to Mg (bottom)	1400	38	1.5	862	25
CL-2	Mg (top) to Al (bottom)	1400	38	1.5	1077	6
CL-3	Al (top) to Mg (bottom)	1400	38	2.3	554	5
CL-4	Mg (top) to Al (bottom)	1400	38	2.3	978	90

Table 5 — Dual-Pass Welds in a Conventional Lap Joint

#	Joint	Rotation Speed (rev/min)	Travel Speed (mm/min)	Pin Length (mm)	Tensile Load (N)	Standard Deviation (±N)
CL-7	Top: Mg and 1st pass; Bottom: Al and 2nd pass	1400	38	1.5	2269	31

Table 6 — Single-Pass Welds in a Modified Lap Joint

#	Joint	Rotation Speed (rev/min)	Travel Speed (mm/min)	Pin Length (mm)	Tool Offset at Top	Tensile Load (N)	Standard Deviation (±N)
ML-5	Top: Al (ret) and small Mg (adv); Bottom: Mg	800	38	1.5	1.5 into small Mg	1808	8
ML-1	Top: Al (ret) and small Mg (adv); Bottom: Mg	1400	38	1.5	1.5 into small Mg	2711	235
ML-2	Top: Mg (adv) and small Al (ret); Bottom: Al	1400	38	1.5	1.5 into small Al	1434	14
ML-3	Top: Mg (adv) and small Al (ret); Bottom: Al	1400	38	1.5	0	993	98
ML-4	Top: Al (ret) and small Mg (adv); Bottom: Mg	1400	38	1.5	0	1797	136

tilled water for 10 s (to make Al colorful). A 2-step etching procedure was used by Somasekharan et al. (Ref. 9) for color metallography of butt joint welds between AZ91D Mg and 6061 Al. The 3-step etching procedure showed Al, Mg, Al_3Mg_2, and $Al_{12}Mg_{17}$ all in different colors.

A JEOL JSM-6100 scanning electron microscope with energy-dispersive spectroscopy (EDS) was used for chemical composition measurements. A Hi-Star 2-D X-ray diffractometer with an area detector was used to identify the intermetallic compounds.

Results and Discussion

The experimental results are summarized in Tables 3–7. Due to space limitations, the microstructure of six representative welds will be shown here. The remaining welds will be shown elsewhere.

Al-Mg Phase Diagram

For convenience of discussion, the binary Al-Mg phase diagram (Ref. 17) is shown in Fig. 2. There are two eutectics. The first one is between the Al-rich phase

(Al) and Al_3Mg_2, which is essentially Al_3Mg_2, and the second between the Mg-rich phase (Mg) and $Al_{12}Mg_{17}$. Both eutectic temperatures, 450°C for the former and 437°C for the latter, are far below the melting points of Al (660°C) and Mg (650°C).

According to the Al-Mg phase diagram shown in Fig. 2, when Al and Mg are heated together such as during FSW, intermetallic compounds Al_3Mg_2 and $Al_{12}Mg_{17}$ can form, the former on the Al side and the latter on the Mg side. Upon further heating, the eutectic reaction Mg + $Al_{12}Mg_{17} \rightarrow$ L occurs at the eutectic temperature 437°C and the eutectic reaction Al + $Al_3Mg_2 \rightarrow$ L at the eutectic temperature 450°C. This liquid formation is called constitutional liquation (Refs. 10, 18–21). At room temperature Al_3Mg_2 contains about 37 wt-% Mg and $Al_{12}Mg_{17}$ about 57 wt-% Mg. The eutectic temperatures 437° and 450°C are more than 200°C below the melting point of either Al or Mg, and they can be reached easily during Al-to-Mg FSW to form liquid films along the interface between Al and Mg. Upon cooling, the two eutectic reactions are reversed, and Al_3Mg_2 and $Al_{12}Mg_{17}$ form from the liquid L.

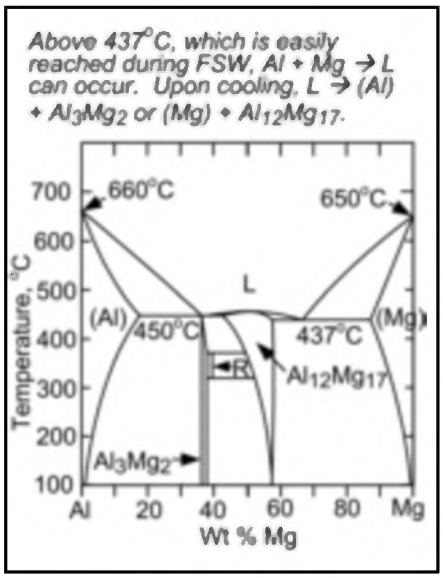

Fig. 2 — Al-Mg phase diagram (Ref. 17) explaining liquid formation (i.e., liquation) in Al-to-Mg FSW.

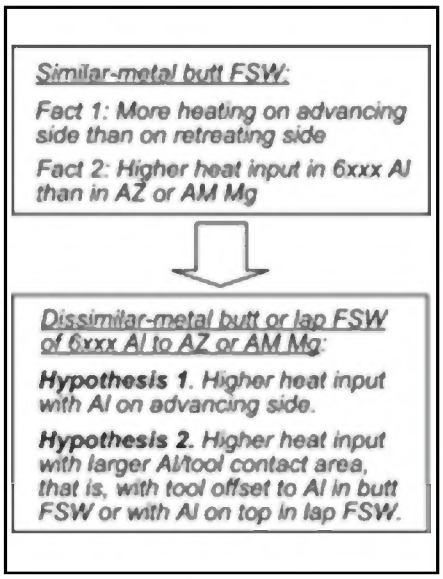

Fig. 3 — Hypotheses on heat input in FSW between 6xxx Al alloy and AZ (Mg-Al-Zn) or AM (Mg-Al-Mn) Mg alloy.

Hypotheses on Heat Input in FSW

In order to explain the effect of material position on the joint strength, the effect of material position on the heat input will be discussed first. This is because liquation increases with increasing heat input (Ref. 20). The more liquation becomes, the more liquid films can form along grain boundaries and, in the case of Al-to-Mg FSW, the Al/Mg interface. Since the liquid films weaken the Al/Mg interface, cracking can occur along the interface under the shearing force by the tool.

Figure 3 shows two hypotheses made based on two facts regarding the heat input in FSW. Fact 1 is as follows: In similar-metal butt joint FSW, more heating occurs on the advancing side than the retreating side. Both computer simulations and temperature measurements (Refs. 22–25) have shown higher peak temperatures on the advancing side. As mentioned previously, the advancing side is the side where material is pushed forward by the rotating tool, while the retreating side is the side where material is pushed backward. Using FSW with a milling machine as an example, the rotating tool is stationary and the workpiece material "flows" in the direction opposite to the welding direction. On the advancing side, the tool rotates in the opposite direction of workpiece flow, while on the retreating side it rotates in the same direction. Consequently, the material on the advancing side tends to experience greater shearing and heating than that on the retreating side.

For a lower conductivity material such as 304 stainless steel, as pointed out by Nandan et al. (Ref. 23), the temperature on the advancing side can be as much as 100°C higher than on the retreating side. For a higher conductivity material such as an Al or Mg alloy, the difference is smaller. However, the liquation (eutectic) temperatures are rather low (437° and 450°C). Furthermore, a relatively small temperature increase can significantly increase the fraction of liquid, that is, the extent of liquation. For instance, according to the Al-Mg phase diagram (Fig. 2), a material with 60 wt-% Mg and 40 wt-% Al has a melting temperature range of only about 10°C. Thus, this material begins to liquate at the eutectic temperature 437°C and melts completely at about 447°C.

Fact 2 is as follows: In similar-metal butt joint FSW, more heating occurs in 6xxx Al alloys than in AZ (Mg-Al-Zn) or AM (Mg-Al-Mn) Mg alloys. In similar-

Table 7 — Dual-Pass Welds in a Modified Lap Joint

#	Joint	Rotation Speed (rev/min)	Travel Speed (mm/min)	Pin Length (mm)	Tool Offset (mm)	Tensile Load (N)	Standard Deviation (±N)
ML-6	Top: Al (ret) and small Mg (adv); Bottom: Mg (adv) and small Al (ret)	1400	38	1.5	1.5 into small Mg and small Al	4530	87
ML-7	Top: Al (ret) and small Mg (adv); Bottom: Mg (adv) and small Al (ret)	1400	38	1.5	0	3559	116

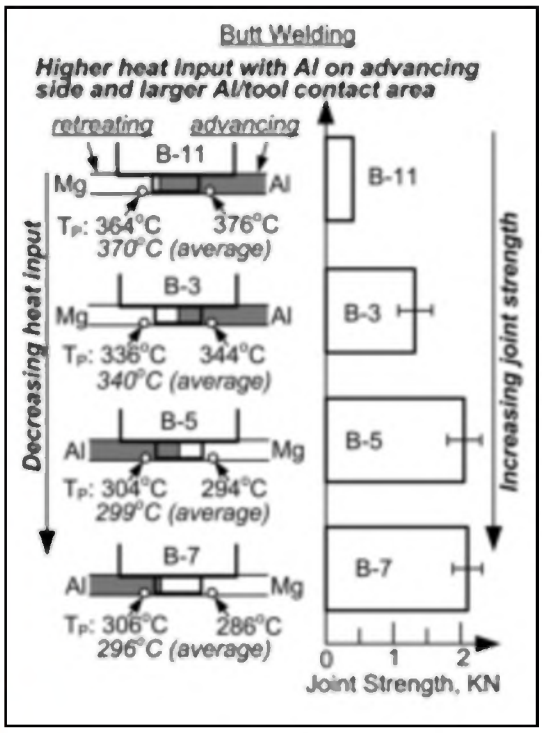

Fig. 4 — Effect of material position on joint strength and heat input in butt joint FSW of AZ31 Mg and 6061 Al. The thermocouples are 3 mm away from the path of the tool axis and 0.25 mm above the bottom surface of the workpiece.

metal butt joint FSW, Zettler et al. (Ref. 12) observed higher peak temperatures (100°C higher on the advancing side and 80°C on the retreating side, both at 10 mm from the joint line) in 6040 Al than in AZ31 Mg. Similar trends have been observed in the following three studies on similar-metal friction stir spot welding (FSSW), where heat is generated by a rotating but stationary tool. Gerlich et al. (Ref. 26) observed in the stir zone at the tool shoulder a higher peak temperature (about 80°C higher) in 6111 Al than in AZ91 Mg. Su et al. (Ref. 27) observed a higher torque and heat input (almost three times higher heat input) in 6061 Al than in AM60 Mg. Yang et al. (Ref. 21) observed a higher torque and heat input (twice higher heat input) in 6061 Al than in AZ91 Mg.

Fact 2, perhaps, can be further explained as follows. First, Yang et al. (Ref. 21) have shown in similar-metal FSSW that AZ and AM Mg can liquate much more easily than 6xxx Al. In AZ and AM Mg (and most other Mg alloys because Al is the most widely used alloying element in Mg alloys) $Al_{12}Mg_{17}$ is present to react with the surrounding Mg-rich matrix to form liquid at 437°C — Fig. 2. The liquid films at interface between the tool and the stir zone can cause tool slippage, while those along grain boundaries within the stir zone can decrease its resistance to tool rotation. Consequently, the torque and the work it does, which contributes to nearly all of the heat input, are significantly lower in welding AZ and AM Mg than 6xxx Al (Refs. 21, 27). Second, with its face-centered cubic (fcc) structure, Al has more slip planes available for deformation than Mg, which is hexagonal close-packed (hcp) in structure. Thus, as compared to Mg, Al is more deformable. Zettler et al. (Ref. 12) noted in similar-metal butt joint FSW that the stir zone was twice as big in cross section in 6040 Al than in AZ31 Mg, which perhaps suggests more heating by viscous dissipation in the former. Maybe computer simulation can show if heat generation is higher in 6061 Al or AZ31 Mg.

Based on the two facts, two hypotheses can be made regarding dissimilar-metal FSW of 6xxx Al to AZ or AM Mg with the same tool at the same rotation speed and travel speed. Hypothesis 1 is as follows: A higher heat input can be expected in FSW of the butt joint with Al on the advancing side. Hypothesis 2 is as follows: A higher heat input can be expected with a larger Al/tool contact area. A larger Al/tool contact area can exist in the following two cases: first, with tool offset to Al in butt joint FSW and, second, with Al on the top in lap joint FSW. Regarding the first case, the difference can be expected to be more significant with Al on the advancing side in view of Hypothesis 1. These hypotheses will be used subsequently to explain the effect of material position on the heat input in Al-to-Mg FSW.

Butt Joint Welding

The effect of material position on the joint strength in butt joint FSW is shown in Fig. 4. First, material position has a significant effect on the joint strength; the difference can be a factor of four. Second, the joint strength is higher with AZ31 Mg on the advancing side. Third, increasing tool offset to AZ31 Mg improves the joint strength (the three butt welds in Table 2 made at 800 rev/min show the same trend).

As shown in Table 1, Sato et al. (Ref. 10) and Zettler et al. (Ref. 12) both found AZ31 Mg on the advancing side better, which is consistent with the present study. Both McLean et al. (Ref. 5) and Yan et al. (Ref. 11) found tool offset to AZ31 Mg better, which is also consistent with the present study except AZ31 Mg was put on the retreating side by Yan et al. (Ref. 11).

Based on the two hypotheses mentioned previously, with the same tool at the same rotation speed and travel speed, the effect of material position on the heat input in Al-to-Mg butt joint FSW can be predicted as shown by the arrow indicating the direction of decreasing heat input in Fig. 4. First, the heat input can be higher in FSW of the butt joint with Al on the advancing side (welds B-11 and B-3) than with Al on the retreating side (welds B-5 and B-7). Second, with Al on the advancing side, the heat input can be higher with tool offset to Al (weld B-11) than without any offset (weld B-3). Third, the heat input can be lower with tool offset to Mg (weld B-7) than without any offset (weld B-5), but the difference is likely smaller because Al is on the retreating side.

As shown in Fig. 4, the measured peak temperatures are in agreement with the prediction. The thermocouples were 3 mm away from the path of the tool axis and 0.25 mm above the bottom surface of the workpiece. As mentioned previously, in butt joint FSW of 6040 Al to AZ31 Mg without tool offset, Zettler et al. (Ref. 12) observed higher peak temperatures (50°C higher on the advancing side and 30°C on the retreating side) with 6040 Al on the advancing side, which are consistent with welds B-3 and B-5 in Fig. 4. Although these higher peak temperatures were not explained or used to explain the joint strength, the study of Zettler et al. (Ref. 12) was very interesting and shed much light for the present study.

Figure 5 compares the thermal cycles measured in welds B-7 and B-11. In weld B-11, where Al is on the advancing side, the peak temperature is 376°C on the advancing side and 364°C on the retreating side, the average being 370°C. In weld B-7, where Mg is on the advancing side, the peak temperature is 286°C on the advancing side and 306°C on the retreating side, the average being 296°C, which is 74°C lower than the average peak temperature of 370°C in weld B-11. In similar-metal butt joint FSW, as mentioned previously, the peak temperature is higher on the advancing side. However, weld B-7 (and weld B-5 as well) shows that this can be reversed in a FSW dissimilar-metal butt joint.

Now the effect of material position on the heat input can be compared with the effect of material position on the joint strength to see if they correlate with each other. As shown in Fig. 4, weld B-11 is significantly weaker than weld B-3, weld B-3 is significantly weaker than weld B-5, and weld B-5 is similar to weld B-7 in strength. A similar pattern exists in the measured average temperatures. Thus, a close correlation seems to exist between increasing heat input and decreasing joint strength. It is well known that the extent of liqua-

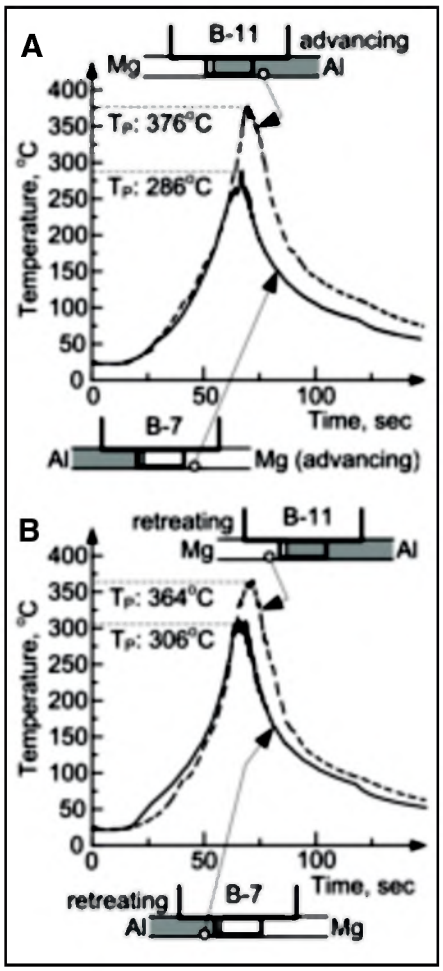

Fig. 5 — Thermal cycles measured for welds B-7 and B-11 in butt joints. The thermocouples are 3 mm away from the path of the tool axis and 0.25 mm above the bottom surface of the workpiece.

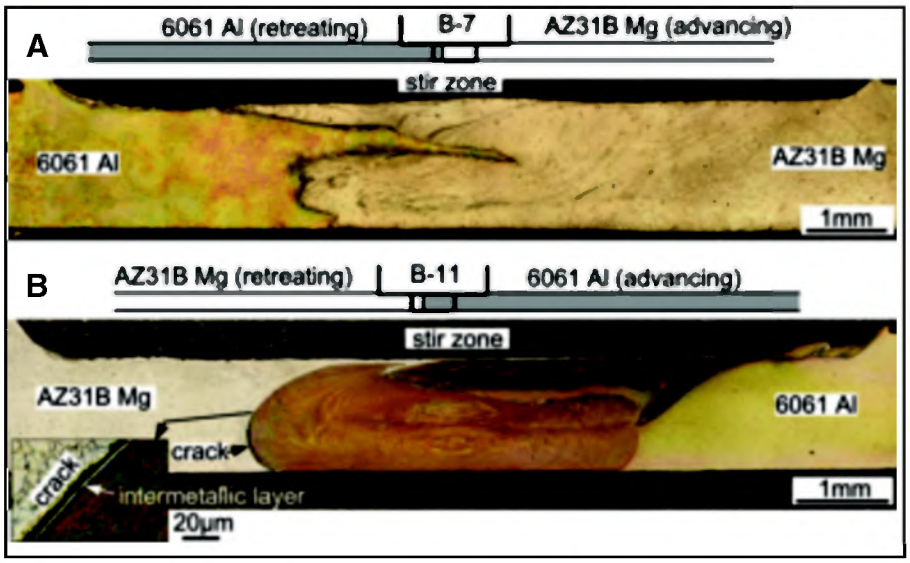

Fig. 6 — Transverse cross sections of welds in butt joints. A — Weld B-7; B — weld B-11.

tion increases with increasing heat input or temperature (Ref. 20). With more liquation, more liquid can form along the Al/Mg interface to promote cracking under the shearing action of the tool and form brittle intermetallics both along the interface and grain boundaries inside the stir zone upon cooling. The joint strength can be significantly reduced.

Although Fig. 4 can explain how material position can affect the joint strength through the heat input and hence liquation, other factors may also affect the joint strength. For instance, interlocking between Mg and Al can improve the joint strength, so can similar-metal bonding (such as Al-to-Al and Mg-to-Mg, as will be shown subsequently in modified lap welding). On the other hand, excessive mixing between Al and Mg can provide more interface area for Al to react with Mg to cause liquation and decrease the joint strength.

Figure 6 compares the transverse cross sections of welds B-7 and weld B-11. The Al/tool contact area in weld B-7 is the same as the Mg/tool contact area in weld B-11. In weld B-7 Al penetrates deep into the stir zone, which can promote interlocking and improve the joint strength. However, there is no Mg penetration into the stir zone in weld B-11. In fact, a long open crack exists along the interface between Mg and the stir zone over half the thickness of the workpiece. There might be two reasons for the differences. First, with its good deformability Al can move to the back of the rotating tool from the retreating side even though shearing is less there than the advancing side. Zhang (Ref. 28) has shown by computer simulation that material particles at the advancing side can enter into the retreating side but not the other way around. With its lower deformability, however, Mg is less able to move far away from the retreating side. Second, the higher heat input and hence liquation in weld B-11 could have caused a continuous liquid film to exist along the interface between Mg and the stir zone over half the thickness of the workpiece. The slippage caused by the liquid film could have kept Mg from being dragged deep into the stir zone. The large open crack and the continuous intermetallic layer along the interface both suggest liquation there. The crack caused weld B-11 to break even before tensile testing. Thus, lack of interlocking caused by unfavorable material flow and more liquation caused by the higher heat input could have both contributed to the low joint strength of weld B-11.

The microstructure of weld B-3 (to be shown elsewhere due to space limitations) indicated heavy liquation within the stir zone due to relatively high heating and excessive mixing between Al and Mg caused by zero offset (equal volume of Al and Mg exposed to the pin).

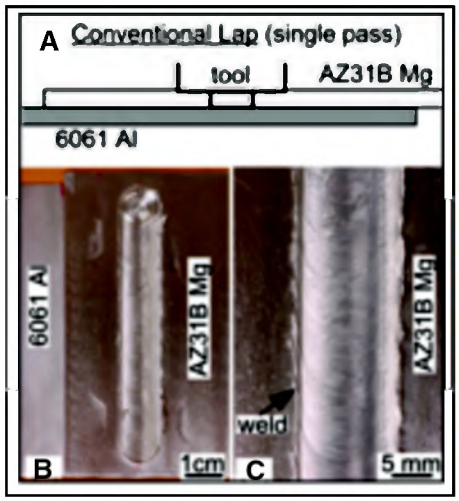

Fig. 7 — Single-pass weld in a conventional lap joint (CL-2) with AZ31 Mg on top of 6061 Al. A — Material position; B — top view overall; C — top view enlarged.

Single-Pass Conventional Lap Joint

Figure 7 shows a single-pass weld in a conventional lap joint with AZ31 Mg on the top (CL-2). The effect of material position on the joint strength is shown in Fig. 8. First, material position has a significant effect on the joint strength. The difference can be a factor of two. Second, the strength is higher with AZ31 Mg on the top. Third, the strength is higher with the 1.5-mm pin length than with 2.3 mm. Fourth, for dissimilar-metal FSW between AZ31 Mg and 6061 Al, the highest strength in a conventional lap joint weld (CL-2) is much lower than that in a butt joint weld (B-7 in Fig. 4), only about one half. Butt joint welds are stronger mainly because lap joint welds are subjected to shearing/peeling forces during tensile testing, while butt joint welds are not.

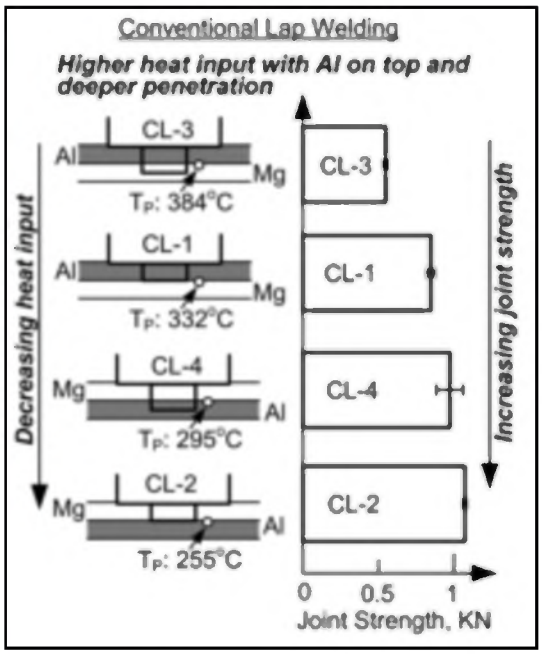

Fig. 8 — Effect of material position on joint strength and heat input in conventional lap joint FSW of AZ31 Mg and 6061 Al. The thermocouples are 3 mm away from the path of the tool axis and 0.25 mm below the top surface of the lower sheet.

travel speed, a higher heat input can be expected with a larger Al/tool contact area, that is, with 6xxx Al on the top to increase the Al/tool contact area. Thus, a higher heat input can be expected in welds CL-3 and CL-1 than in welds CL-4 and CL-2. With a longer pin penetrating into the lower sheet, a higher heat input can be expected in weld CL-3 than weld CL-1 and in weld CL-4 than weld CL-2.

To verify that the heat input is higher with Al on the top and with a longer pin, temperature measurements were conducted. The thermocouples were located 3 mm away from the path of the tool axis and 0.25 mm below the top surface of the lower sheet. As shown in Fig. 8, the peak temperature is 77°C higher with 6061 Al on the top (weld CL-1) than at the bottom (weld CL-2). Thus, this confirms the higher heat input in Al-to-Mg lap joint FSW is with Al on the top. Furthermore, the peak temperatures are higher with a longer pin, that is, 52°C higher in weld CL-3 than CL-1 and 40°C higher in weld CL-4 than CL-2. The authors are unaware of any similar data for lap joint FSW published previously. The data of Gerlich et al. (Ref. 26) were for FSSW of 6111 Al to AZ91 Mg, where the peak temperature measured in the stir zone near the tool shoulder was about 90°C higher with 6111 Al at the top. Since no tensile testing was conducted by Gerlich et al. (Ref. 26), the temperature measurement was not used to explain the effect of material position on the joint strength.

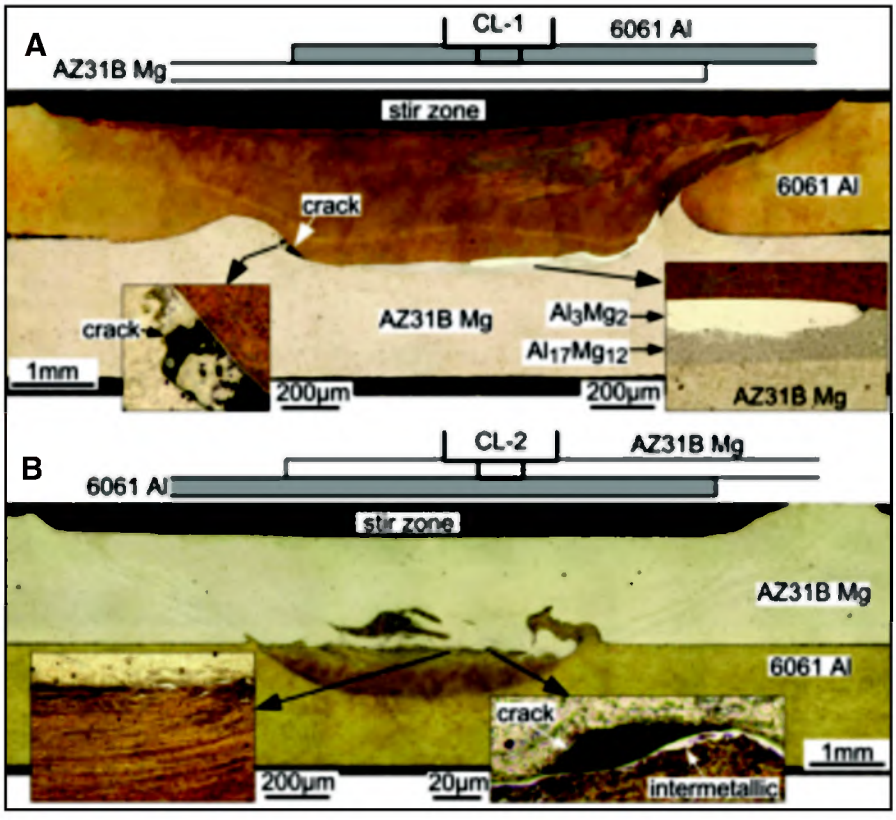

Fig. 9 — Transverse cross sections of welds in conventional lap joints. A — Weld CL-1; B — weld CL-2.

The effect of material position on the heat input in conventional lap joint FSW of 6xxx Al to AZ or AM Mg is predicted in Fig. 8. According to Hypothesis 2, with the same tool at the same rotation speed and

Figure 9 shows the transverse cross sections of welds CL-1 and CL-2. In weld CL-1 (Fig. 9A) thick intermetallic compounds and a crack are present along the interface between the Al stir zone and AZ31 Mg at the bottom. The brittle intermetallics and crack must have contributed to the low joint strength of the weld. As mentioned previously, in lap joint FSW Chen et al. (Ref. 4) observed a very thick layer of intermetallics at the interface between Al-7.5Si (top) and AZ31 Mg (bottom) even though the pin never touched AZ31 Mg. Thus, slight or no pin penetration into AZ31 Mg does not really matter much. Instead, putting AZ31 Mg on the top might work better (as shown by weld CL-2).

Energy-dispersive X-ray (EDX) analysis showed the lighter layer next to 6061 Al (inset on right) contained about 39 wt-% Mg, which is close to the 37 wt-% Mg for Al_3Mg_2. The darker layer next to AZ31 Mg contained about 63 wt-% Mg, which is reasonably close to the 57 wt-% Mg for $Al_{12}Mg_{17}$. Electron probe microanalysis (EPMA) confirmed the compositions. X-ray diffraction (XRD) also confirmed the presence of $Al_{12}Mg_{17}$ and Al_3Mg_2. This is consistent with the report of Liu et al. (Ref. 29) on an Al/Mg diffusion couple annealed at 420°C for 4 h. By EPMA and the Al-Mg phase diagram, they identified an Al_3Mg_2 sublayer on the Al side and an $Al_{12}Mg_{17}$ sublayer on the Mg side.

The intermetallic layers in weld CL-1 (Fig. 9A) suggest that heating during FSW was high enough to cause Al and Mg to react with each other and form liquid along the interface, that is, constitutional liquation. The Mg near the Al stir zone does not appear to be stirred (no flow lines visible in AZ31 Mg in inset on right), possibly because of the lower deformability of Mg or tool slippage by liquid films formed by liquation or both. Upon cooling, $Al_{12}Mg_{17}$ and Al_3Mg_2 formed from the liquid by eutectic reactions — Fig. 2.

EDX showed the particle inside the crack at the interface (inset on left in Fig. 9A) contained about 60 wt-% Mg, close to the 57 wt-% Mg of $Al_{12}Mg_{17}$. This suggests that liquation occurred here and the liquid film caused the stir zone to be separated from AZ31 Mg under shearing by the rotating tool. It is worth mentioning that in FSW cavities can form in the stir zone by material flow without liquation. With a longer pin (2.3 mm instead of 1.5

mm) to penetrate deeper into AZ31 Mg, that is, in weld CL-3, much more intermetallics formed at the interface near the pin tip due to more heating (52°C higher peak temperature as shown in Fig. 8). Due to space limitations, the microstructure will be shown elsewhere.

In weld CL-2 (Fig. 9B) the intermetallics are thinner and cracks smaller and shorter along the interface between the Mg stir zone and the 6061 Al at the bottom. The region of 6061 Al next to the Mg stir zone appears to be well stirred (flow lines visible in inset on left). All these suggest that, as compared to weld CL-1, liquation was significantly less, consistent with the lower heat input in weld CL-2 (77°C lower peak temperature as shown in Fig. 8). With a longer pin to penetrate deeper into 6061 Al than in weld CL-2, that is, in weld CL-4, more cracks and intermetallics formed at the interface near the pin tip due to more heating (40°C higher peak temperature as shown in Fig. 8). Due to space limitations, the microstructure will be shown elsewhere.

Single-Pass Weld in Modified Lap Joint

In order to improve the strength of Al-to-Mg welds, a conventional lap joint was modified. Figure 10 compares FSW of dissimilar metals A and B in a conventional lap joint with the proposed modified lap joint. With conventional lap joint welding (Fig. 10A), metal A is placed on top of metal B. As mentioned previously, with only slight or even no pin penetration into metal B, metals A and B can still react with each other and form a rather thick layer of intermetallics at the interface. With the modified lap joint (Fig. 10B), metal A is still placed on top of metal B but with a small piece of metal B next to it. With tool offset to the small piece B, weak A-to-B lap joint FSW can be minimized and stronger A-to-A or B-to-B lap joint FSW can be maximized. Metal A can be 6061 Al and metal B AZ31 Mg or vice versa.

Figure 11 shows a single-pass modified lap joint weld with AZ31 Mg and a small piece of 6061 Al at the top (ML-2). As mentioned previously (Fig. 10), modified lap joint welding involves both butt and lap joint welding. In light of the butt joint welding result (Fig. 4), all welds were made with AZ31 Mg on the advancing side, either as the top sheet or the small piece at the top.

The effect of material position on the joint strength in single-pass FSW in the modified lap joint is shown in Fig. 12. First, material position has a significant effect on the joint strength, and the difference can be a factor of two to three. Second, the strength is highest in the weld (ML-1) with a tool offset to the small piece of AZ31 Mg. This is consistent with

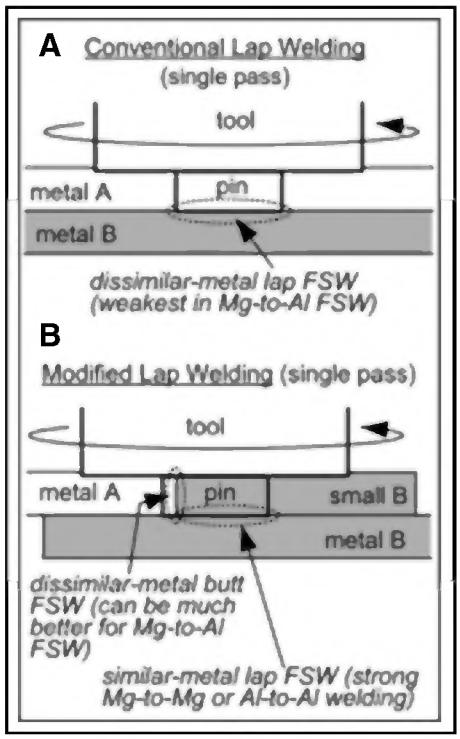

Fig. 10 — Single-pass FSW of metal A to metal B in a lap joint. A — Conventional lap joint; B — modified lap joint (by butt joint welding a small piece of metal B to metal A with pin penetration into bottom metal B).

the butt joint welding result — Fig. 4. This also allows much Mg-to-Mg lap joint welding, which is much stronger than Al-to-Mg lap joint welding because of the absence of cracks and intermetallics. Third, weld ML-1 (2,711N) matched in strength the similar-metal lap joint weld CL-6 (2,463N as shown in Table 3) between AZ31 Mg and itself.

Figure 13 compares the tensile test curves of the best single-pass conventional lap joint weld CL-2 and the best single-pass modified lap joint weld ML-1. Weld ML-1 failed at a significantly higher strength and elongation than weld CL-2.

The effect of material position on the heat input with a FSW in a modified lap joint is predicted in Fig. 12. According to Hypothesis 2, with the same tool at the same rotation speed and travel speed, a higher heat input can be expected with a larger Al/tool contact area. Since the contact area between Al and the tool (shoulder and pin) decreases in the order of ML-2, ML-3, ML-4, and ML-1, the heat input can be expected to decrease in the same order. This prediction is confirmed by the peak temperatures measured during FSW. The thermocouples were on the advancing side and located 3 mm away from the path of the tool axis and 0.25 mm below the top surface of the lower sheet. Going from weld ML-3 to weld ML-4, the bottom sheet changes from 6061 Al to AZ31 Mg, which is lower in thermal conductivity (167 vs. 96 W/m°C). The fact that the peak temperature still decreases suggests the effect of thermal conductivity difference is not very significant.

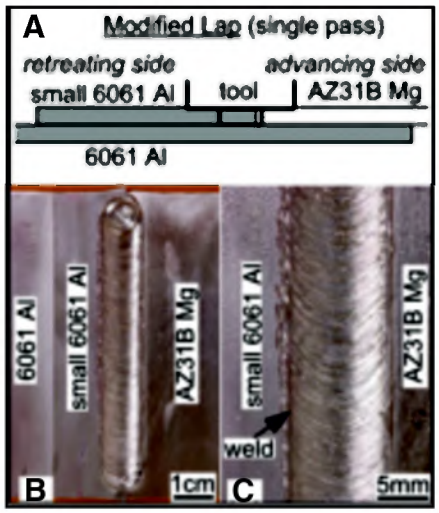

Fig. 11 — Single-pass weld in a modified lap joint (ML-2) with AZ31 Mg on top of 6061 Al. A — Material position; B — top view overall; C — top view enlarged.

Figure 14 shows the transverse cross sections of welds ML-3 and ML-1. In weld ML-3 (Fig. 14A) Al and Mg interpenetrate deep into each other, and this can be expected to promote interlocking and improve the joint strength. Unfortunately, the heat input was relatively high (Fig. 12), and it caused much liquation and a long crack along most of the Mg-Al interface (see insets). Under the shearing/peeling action inherent during tensile testing of lap joint welds, the crack can open up easily and lead to premature failure. In weld ML-1 (Fig. 14B), however, there was significantly less heating (Fig. 12) to cause liquation. Furthermore, strong Mg-to-Mg metallic bonding exists at the interface between the stir zone and the bottom sheet without cracks or intermetallics. By the way, the light gray straight lines in AZ31 Mg are twin lines instead of scratches left on the sample due to poor polishing.

As compared to weld ML-3, weld ML-2 allows more of stronger Al-to-Al lap joint welding and less of weaker Al-to-Mg lap joint welding. This can explain why weld ML-2 is stronger than weld ML-3. As shown in Fig. 12 the joint strength increases in the order of ML-3, ML-2, ML-4, and ML-1. That is, weld ML-2 is stronger than weld ML-3 in spite of the higher heat input in the former.

In production, a weld such as ML-1 can be prepared as follows. 6061 Al sheets, AZ31 Mg sheets, and small AZ31 Mg sheets can be sheared with parallel edges to the predetermined width. With 6061 Al on top of AZ31 Mg and positioned, both can be clamped down simultaneously from one side. After putting the small AZ31 Mg

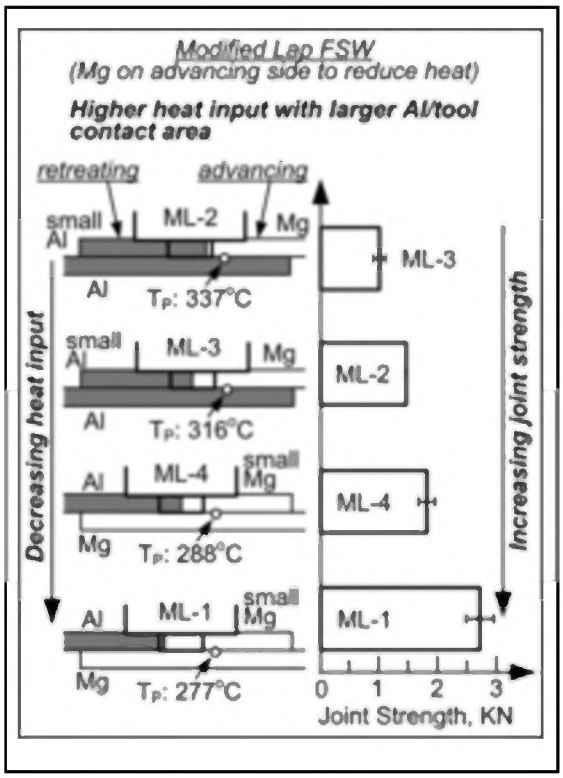

Fig. 12 — Effect of material position on joint strength and heat input in FSW of AZ31 Mg and 6061 Al in a modified lap joint. The thermocouples are 3 mm away from the path of the tool axis and 0.25 mm below the top surface of the lower sheet.

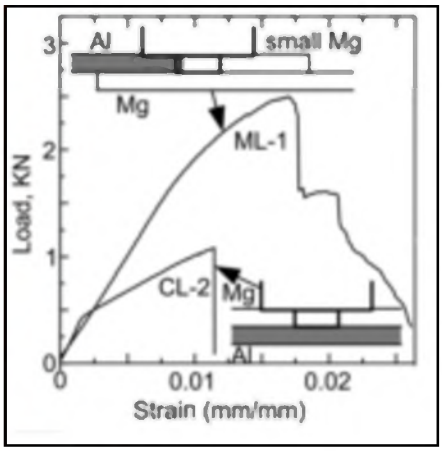

Fig. 13 — Tensile test curves of single-pass weld in conventional lap joint CL-2 and single-pass weld in modified lap joint ML-1 between AZ31 Mg and 6061 Al.

next to 6061 Al and clamping down from the opposite side, the lateral position of the joint line relative to the pin can be fine adjusted just like in butt joint welding. Since the small AZ31 Mg is free to move, its close fitup with 6061 Al is guaranteed regardless how precise the dimensions of the sheets are. The small AZ31 Mg can then be butt joint welded to 6061 Al with pin penetration into the backing plate. This, in fact, can be easier to do than ordinary butt joint FSW because pin penetration into the backing plate does not have to be carefully avoided.

Dual-Pass Weld in Lap Joint

Figure 15 shows the effect of material position on the strength of dual-pass welds in a lap joint made between AZ31 Mg and 6061 Al. For modified lap joint welds, AZ31 Mg was on the advancing side in each pass. Weld ML-6 is stronger than weld ML-7. The first pass (top) in weld ML-6 is equivalent to the single-pass weld ML-1 (Fig. 12), and that in weld ML-7 to the single-pass weld ML-4. Since weld ML-1 is stronger than weld ML-4, the first pass in the dual-pass weld can be expected to be stronger in weld ML-6 than in weld ML-7. The second pass (bottom) in weld ML-6 is equivalent to the single-pass weld ML-2 (Fig. 12), and that in weld ML-7 to the single-pass weld ML-3. Since weld ML-2 is stronger than weld ML-3, the second pass in the dual-pass weld can also be expected to be stronger in weld ML-6 than in weld ML-7.

Weld ML-6 is stronger than the dual-pass conventional lap joint weld CL-7 by a factor of about two. This significant difference is consistent with the results shown previously in Fig. 13, where the single-pass modified lap joint weld ML-1 is also about twice stronger than the single-pass conventional lap joint weld CL-2. The tensile test curves of welds CL-7 and ML-6 are shown in Fig. 16. Weld ML-6 fails at a much higher strain as well as load. Weld CL-7 failed through the weld as all other cases, but weld ML-6 failed in the 6061 Al base metal. This is the advantage of a dual-pass weld in the modified lap joint since failure in the base metal is an assurance of strong metallic bonding.

Further Discussion

How the material position affects the joint strength of the resultant weld depends significantly on how it affects the heat input and material flow during FSW, both of which affect the formation of defects and hence the joint strength. At lower travel speeds and higher rotation speeds, more heat is generated to cause liquation, and hence, cracking and intermetallic compounds to weaken the resultant weld. So, the heat input is likely to play a bigger role than material flow. At higher travel speeds and lower rotation speeds, on the other hand, less heat is generated to cause liquation. However, the materials may not be warm enough for sufficient plastic flow to keep channels from forming and weakening the resultant weld. So, material flow is likely to play a bigger role than the heat input.

In the present study, the travel speed 38 mm/min is low and the rotation speed 1400 rev/min intermediate. The results indicate that the heat input plays a bigger role than material flow in most cases. In a follow-up study much higher travel speeds are used to further examine material flow vs. the heat input.

Conclusions

Within the range of experimental conditions in the present study, the following conclusions, which can be useful for structure design in FSW of 6xxx Al to AZ or AM Mg, can be drawn:

1) Welding in a conventional lap joint of metal A at top to metal B at bottom can be modified to improve the joint strength by butt joint welding a small piece of metal B to metal A with pin penetration into the metal B at the bottom (which can be easier to do than ordinary butt joint welding because pin penetration into the backing plate is not a problem here). The highest joint strength in FSW of Al-to-Mg in the modified lap joint can double that in the conventional lap joint and match that in FSW of Mg to Mg in a lap joint. This is because similar-metal metallic bonding, which is stronger than dissimilar-metal metallic bonding, can exist over most of the interface between the stir zone and the bottom piece in a modified lap joint weld.

2) A significant effect of material position on the joint strength has been demonstrated in FSW of Al-to-Mg in butt, conventional lap, and modified lap joints, affecting the joint strength by a factor of two or more.

3) The effect of material position on the heat input has been predicted and confirmed with temperature measurements during FSW of Al-to-Mg in butt, lap, and modified lap joints. This helps better understand the effect of material position on the joint strength because a higher heat input increases the formation of liquid, and hence, cracks and brittle intermetallic compounds.

4) If the heat input is higher in FSW of A-to-A than of B-to-B under identical welding conditions, the heat input in FSW of A-to-B can be higher with A on the advancing side (in butt joint) and with a larger A/tool contact area (that is, with tool offset to A in the butt joint or with A at the top in the lap joint).

5) A three-step color etching procedure has been developed to show Mg, Al, Al_3Mg_2, and $Al_{12}Mg_{17}$ all in different col-

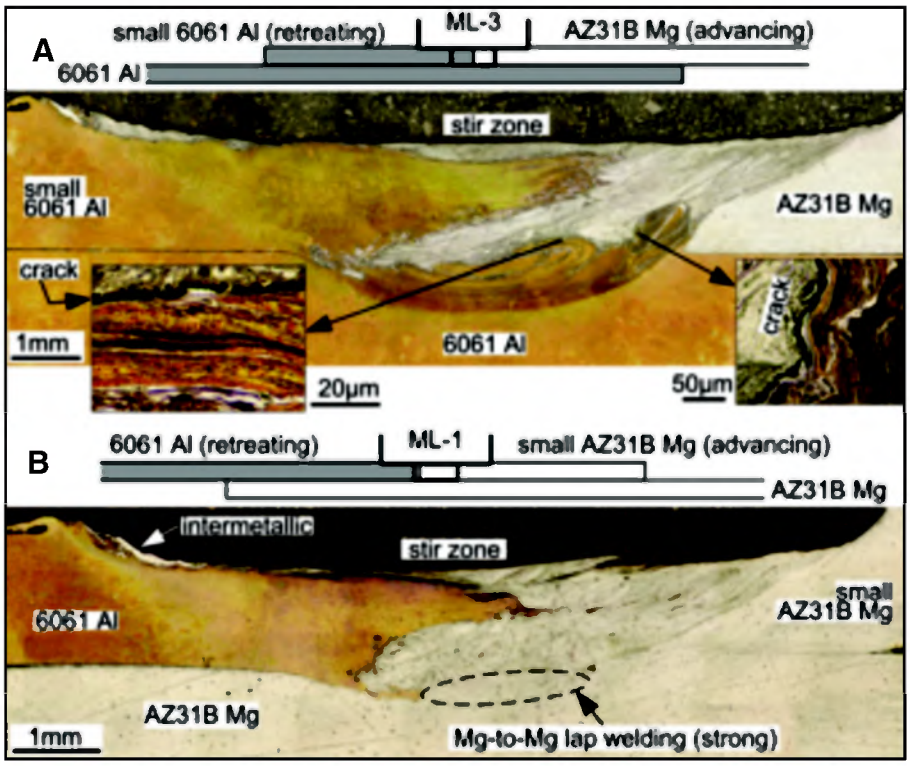

Fig. 14 — Transverse cross sections of welds in modified lap joint. A — Weld ML-3; B — weld ML-1. In B the gray straight lines in AZ31 Mg are twin lines instead of scratches from polishing.

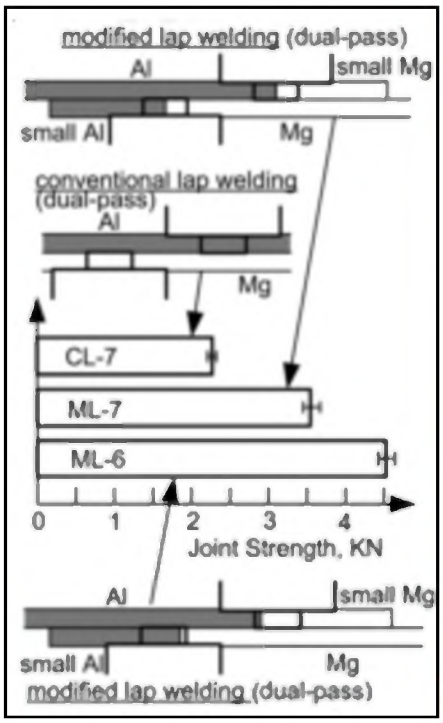

Fig. 15 — Effect of material position on strength of dual-pass welds in lap joint between AZ31 Mg and 6061 Al.

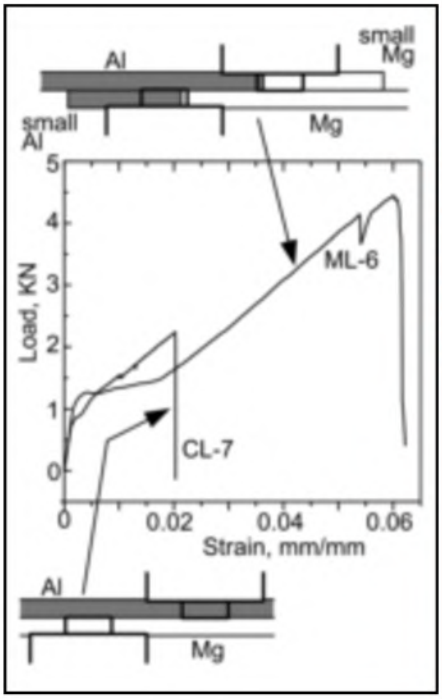

Fig. 16 — Tensile test curves of dual-pass weld CL-7 in conventional lap joint and dual-pass weld ML-6 between AZ31 Mg and 6061 Al in modified lap joint.

ors, thus enabling clear interpretation of the microstructural constituents, material flow, mixing, and evidence of liquation.

6) Material position that favors a lower heat input can be used to increase the joint strength (as long as the heat input is not too low, e.g., at high travel speeds or low rotation speeds, to maintain sufficient plastic material flow to prevent channels from forming and weakening the resultant weld).

7) In FSW of 6xxx Al to AZ or AM Mg in a butt joint the following material position favors a lower heat input: Mg on the advancing side and Al on the retreating side, with tool offset to Mg.

8) In FSW of 6xxx Al to AZ or AM Mg in a conventional lap joint the following material position favors a lower heat input: Mg on the top and Al at the bottom, with slight (e.g., 0.1 mm) pin penetration into Al.

9) In FSW of 6xxx Al to AZ or AM Mg in a modified lap joint the following material position favors a lower heat input: Mg at the bottom, Al on the top on the retreating side, and a small piece of Mg on the top on the advancing side, to which the tool offsets.

Acknowledgment

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Microstructural and Mechanical Characterization of Friction Stir Butt Joint Welded 63% Cu-37% Zn Brass Plate

This study showed that sound joints without defects can be produced in a large array of weld parameters including numerous rotational and traverse speeds

BY G. ÇAM, S. MISTIKOGLU, AND M. PAKDIL

ABSTRACT

A recently developed solid-state joining technique, namely friction stir welding (FSW), has been well demonstrated to produce joints with better joint performances in Al alloys, particularly in difficult-to-weld grades, than those obtained in more conventional fusion welding processes. The technique has already been implemented with joining Al alloys in various production lines such as shipbuilding, automobile, high-speed train manufacturing, and aviation industries.

In this study, the applicability of friction stir welding to 63% Cu-37% Zn brass plate has been investigated. The joint performance values were determined by conducting optical microscopy, microhardness measurements, and mechanical testing (e.g., tensile and bend tests). The effects of the tool rotational speed (i.e., 1250 and 1600 rev/min) and the welding speed on the joint performance were determined. The best joint performances were obtained at a rotational speed of 1600 rev/min with a welding speed of 225 mm/min.

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Introduction

Friction stir welding (FSW) is a solid-state joining technique developed by The Welding Institute (TWI), Abington, UK, in the early 1990s (Refs. 1–12). In this method, the stirring tool rotating at a high rate is plunged into the clamped plates causing friction. The heat caused by the friction results in an intense local heating that does not melt the plates to be joined, but plasticizes the material around the tool. The shoulder of the tool provides additional frictional heat to the workpieces as well as preventing the plasticized material from being expelled from the weld. Then the rotating tool moves along the plates transfering the softened material around itself, stirring the plates together. The plasticized material is pressed downward by the tool shoulder, preventing the material from flowing out from the surface, as schematically shown in several publications (Refs. 1–12).

It has been well demonstrated that this joining technology produces low-distortion, high-quality, low-cost welds in Al alloys, even for those that are not weldable with conventional fusion welding processes (Refs. 1–12). The current industrial applications include ship panels, the frame of high-speed trains, the suspension of cars, and fuel tanks of spacecrafts. Although the process has been well established in joining low-melting-point Al alloys, there are limited data on joining other materials such as Mg, Ti, and Cu alloys, and mild steels (Refs. 12–16).

The most important drawbacks of the implication of fusion welding to brasses are high distortion in thin plates and loss of strength in the fusion zone due to the evaporation of Zn (Ref. 12). These problems are not expected to be encountered in friction stir welding, which is a low energy input method owing to its solid-state nature. Early studies (Refs. 12–16) have shown that Cu and Cu alloys can be successfully friction stir welded with grain refinement in the stir zone (SZ), which is achieved in the case in friction stir welding of Al alloys and steels (Refs. 17–22). Distortion-free butt joints with comparable mechanical properties to base plates can be achieved in friction stir welding brass plates. However, the weld parameters play an important role on the heat input during joining, thus on the joint performance. As already mentioned, there are only a few reports thus far concerning the applicability of this method to brasses (Refs. 12–16). Thus, the objective of this work is to investigate the applicability of this welding technique to a 3-mm-thick 63% Cu-37% Zn brass plate. The effects of rotational speed (i.e., 1250 and 1600 rev/min) and weld traverse speed on the joint performance were also studied.

KEYWORDS

Friction Stir Welding
Brass
Grain Refinement
Duplex Microstructure
Joint Performance

Experimental Procedure

63% Cu-37% Zn brass plate (designated as 63/37 brass hereafter) was fric-

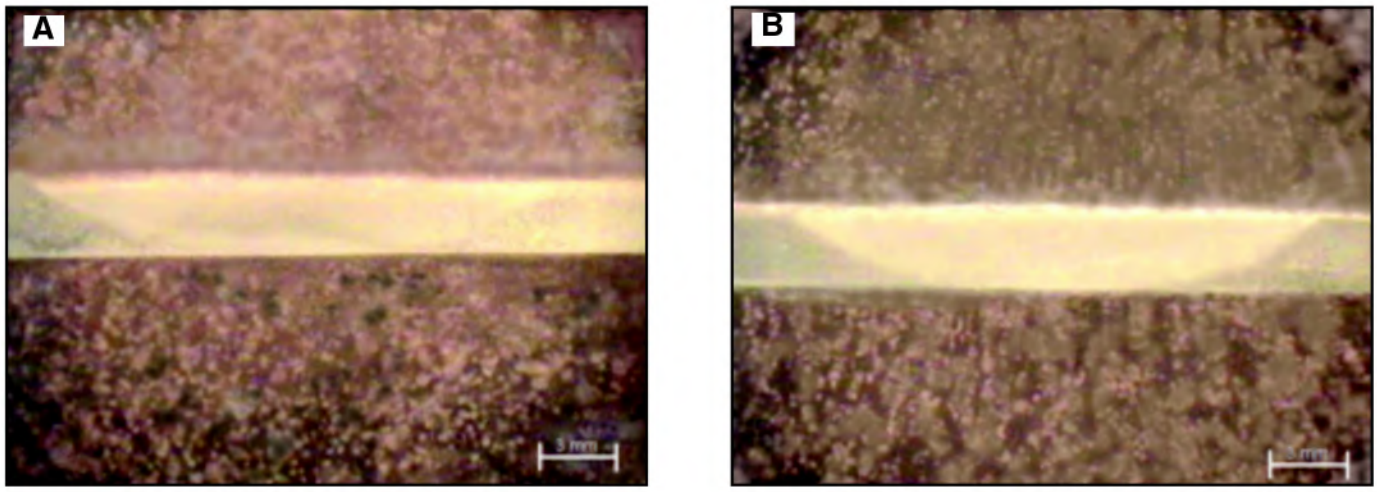

Fig. 1 — Optical macrographs showing the stirred zones (SZ) of the 63/37 brass joints obtained at a rotational speed of 1250 rev/min. Traverse speeds are as follows: A — 100 mm/min; B — 125 mm/min. The plate thickness is 3 mm.

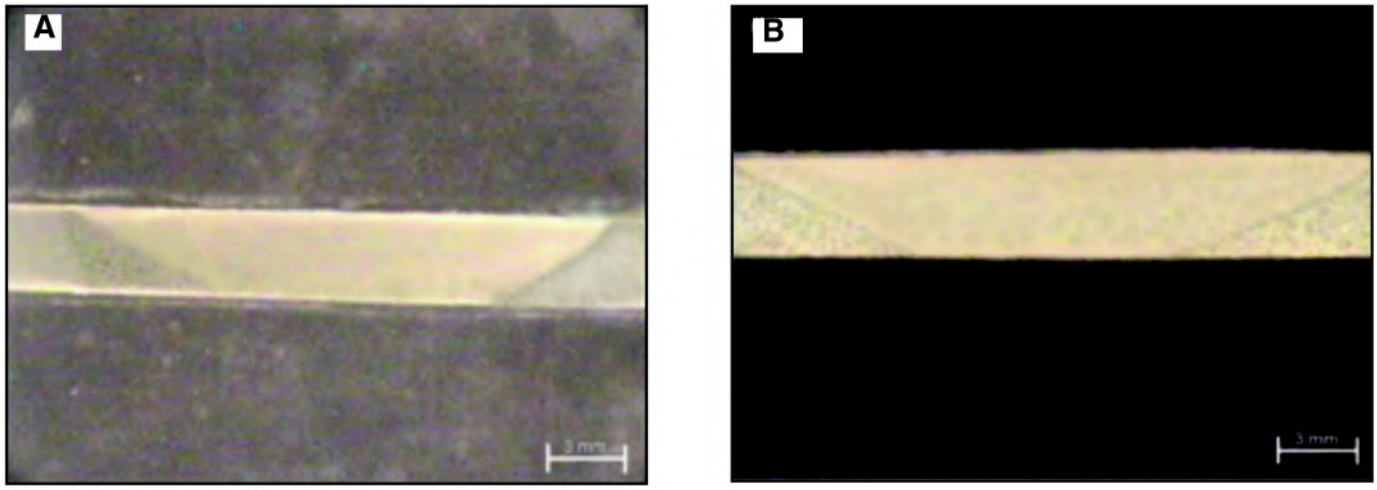

Fig. 2 — Optical macrographs showing the stirred zones (SZ) of the 63/37 brass joints obtained at a rotational speed of 1600 rev/min. Traverse speeds are as follows: A — 175 mm/min; B — 200 mm/min. The plate thickness is 3 mm.

tion stir butt joint welded. The brass plate used in this study has a dual-phase microstructure consisting of α + β phases (called α + β brass). The plate was 3 mm thick and friction stir welding trials were performed with different traverse speeds at two different tool rotational speeds, i.e., 1250 and 1600 rev/min. A conical tool made of a hot work steel, X32CrMo3 3, was used in the trials. The tool root diameter was chosen at 4 mm, and the tip diameter was 3 mm. Its penetration depth was 2.8 mm. The reason for selecting a slightly conical tool was to determine whether it is possible to employ higher rotational and travel speeds by increasing the surface area of the tool, thus increasing the frictional heat produced. The tool used was a pin type with nonstandard helical threads, and its tip was rounded. The joining trials were made using a vertical milling machine.

Metallography specimens were extracted from the welded plates for microstructural observations. Metallography specimens were polished with an alumina solution (the grain size was 0.3 μm) and then etched using a solution of 15-mL HCl (32%), 2.5-g $FeCl_3 \cdot 6H_2O$, and 100-mL distilled water. A detailed microstructural observation was conducted for each welded plate using optical microscopy to determine the presence of any weld defect and the microstructural evolution within the stirred zone. All the optical micrographs are taken from the midsections of the joints in the thickness direction. Furthermore, microhardness measurements were conducted on each welded plate to determine hardness variations across the stirred zones.

Moreover, standard flat tensile specimens (3 × 12.5 × 60 mm) were extracted from both base plates and all welded plates (minimum three specimens) and tested at room temperature (loading rate was 10 mm/min) to determine the joint performances, as schematically shown in an earlier publication (Ref. 12). Two nonstandard bending specimens (20 mm wide and 200 mm long) were also extracted from each welded plate (Ref. 12). Both specimens were bent up to 180 deg, one with the weld root outside and the other with the weld root inside, to determine whether cracking does or does not occur in both bending conditions.

Results and Discussion

Microstructure and Microhardness

Optical microscopy revealed that no porosity or other defects (such as kissing-bond) exist in the stirred zones of all the joints produced — Figs. 1, 2. The sound weld nugget indicates that the varying traverse speeds are convenient to achieve defect-free joints for 63/37 brass plate at

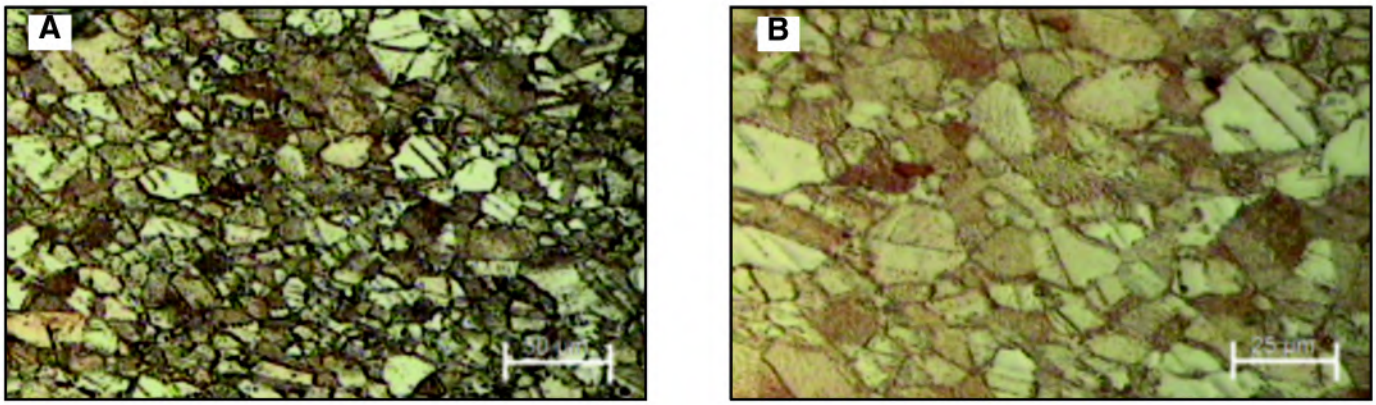

Fig. 3 — Optical micrographs showing the microstructure of 63/37 brass plate used in this study. A — Overall view; B — higher magnification.

Table 1 — Comparison of the Tensile Test Results of the Base Plate and the Joints Produced (in some cases only three specimens were available while four specimens were tested in other cases)

Specimen	0.2% Proof Stress, MPa	Tensile Strength, MPa	Elongation, %	Strength Performance (SP*), %	Ductility Performance (DP**), %	Fracture Location
Base Plate	270; 265; 271 **(267)**	374; 378; 375 **(376)**	28; 29; 27 **(28)**	—	—	—
FSW (100 mm/min at 1250 rev/min)	220; 214 208; 221 **(216)**	364; 365 361; 366 **(364)**	22; 19 17; 14 **(18)**	97; 97 96; 97 **(97)**	79; 68 61; 50 **(65)**	HAZ, HAZ HAZ, BM
FSW (125 mm/min at 1250 rev/min)	224; 227; 223 **(225)**	398; 388; 393 **(393)**	27; 21; 23 **(24)**	106; 103; 105 **(105)**	96; 75; 82 **(84)**	HAZ, HAZ HAZ, BM
FSW (150 mm/min at 1250 rev/min)	228; 118; 220 **(189)**	320; 153; 351 **(333)**	6; 1; 10 **(3)**	85; 41; 93 **(73)**	21; 4; 36 **(20)**	WZ
FSW (175 mm/min at 1600 rev/min)	209; 205 226; 222 **(216)**	390; 395 389; 396 **(393)**	24; 24 21; 23 **(23)**	104; 105 103; 105 **(104)**	86; 86 75; 82 **(82)**	HAZ
FSW (200 mm/min at 1600 rev/min)	224; 221; 218 **(221)**	375; 390; 384 **(383)**	16; 21; 19 **(19)**	100; 104; 102 **(102)**	57; 75; 68 **(67)**	WZ
FSW (225 mm/min at 1600 rev/min)	220; 226 232; 232 **(228)**	395; 398 399; 417 **(402)**	21; 22 21; 27 **(23)**	105; 106 106; 111 **(107)**	75; 79 75; 96 **(81)**	WZ

*SP = tensile strength of weld/tensile strength of the base plate average x 100
**DP = % $Elongation_{(weld)}$/% $Elongation_{(base\ plate\ average)}$ x 100
WZ: weld zone; HAZ: heat-affected zone; BM: base plate
Bold numbers in parentheses indicate the average values

both rotational speeds used in friction stir welding trials (i.e., 1250 and 1600 rev/min). Although defect-free joints can be produced for 63/37 brass plate with a wide range of rotational and traverse speeds, the alteration of heat input with varying weld parameters is expected to affect the grain size in the stirred zone, and thus the mechanical performance of the joint.

The microstructure of the base plate (63/37 brass) is duplex consisting of $\alpha + \beta$ phases — Fig. 3. The friction stir welding resulted in a grain refinement within the stir zone in all the joints produced (Figs. 4, 5), which is also the case in friction stir welding Al alloys and steels (Refs. 17–22). However, the degree of grain refinement depends on the heat input applied to the plates during friction stir welding.

At a given rotational speed, the finer grains are generally formed within the stir zones of the joints at higher traverse speeds due to the reduction in heat input. This can be seen clearly in Figs. 4A–C and 5A–C. The finest grain size was observed in the stir zone of the joint produced with a traverse speed of 150 mm/min, which is the highest welding speed among all the traverse speeds used, at the rotational speed of 1250 rev/min — Fig. 4C. On the other hand, no further grain refinement was observed with further increase in traverse speed beyond 200 mm/min at the rotational speed of 1600 rev/min — Fig. 4D–F. Furthermore, a grain coarsening in the SZ of the joint produced at a traverse speed of 225 mm/min was observed as seen in Fig. 4F, which is due to the higher

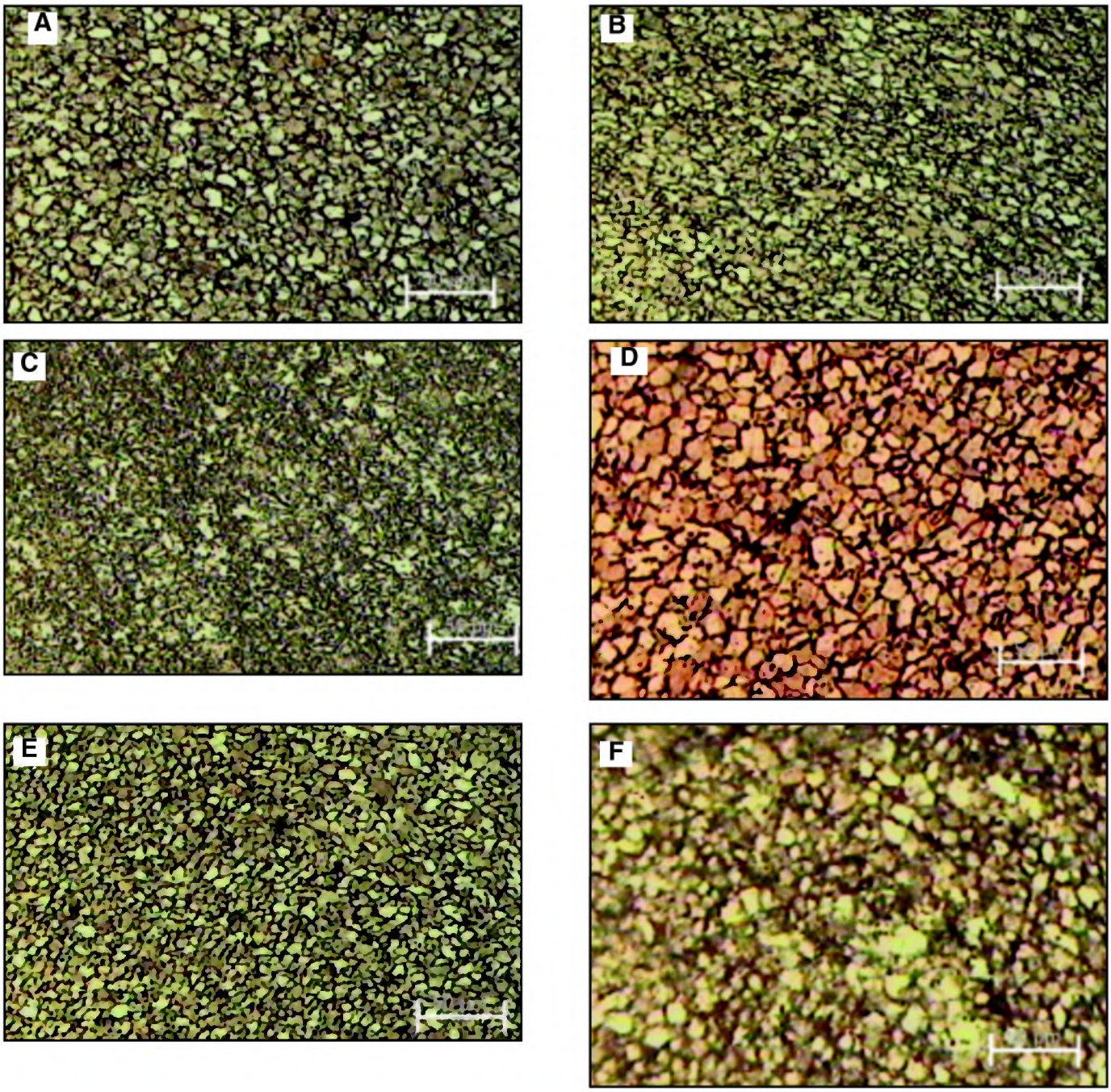

Fig. 4 — Optical micrographs showing the stirred zones (SZ) of the joints obtained with the following weld parameters: A — 1250 rev/min (100 mm/min); B — 1250 rev/min (125 mm/min); C — 1250 rev/min (150 mm/min); D — 1600 rev/min (175 mm/min); E — 1600 rev/min (200 mm/min); and F — 1600 rev/min (225 mm/min). Note the grain refinement in the SZ.

peak temperature the plate exposed during welding. This is believed to be due to a deeper plunging of the stirring tool in this trial although no measurement of the vertical force was made during the trials conducted in this work.

The finer grain sizes than those observed in this work were reported for Cu-40% Zn brass plate in the literature (Ref. 14). The reason for this is the much higher traverse speeds used (i.e., 500 to 2000 mm/min at tool rotational speeds of 1000 and 1500 rev/min), resulting in a much finer grain size in the stirred zone due to the lower heat input in higher traverse speeds.

A microstructure consisting of duplex α and β phases was observed in the stir zones of all the joints produced — Fig. 5A–E. However, a distinct duplex microstructure with intermixed fine and coarse grains was observed from the joint produced with a traverse speed of 150 mm/min at the rotational rate of 1250 rev/min — Fig. 5C.

The hardness variations across the weld zones of the joints produced at rotational speeds of 1250 and 1600 rev/min are given in Figs. 6 and 7, respectively. A hardness drop of about 30–40 HV was observed within the weld zone of all the joints produced, indicating that the joints are strength undermatched. The minimum hardness values lie at the heat-affected zones (HAZs) of most of the joints obtained — Figs. 6, 7. It can also be clearly seen from Fig. 6 that the width of weld zone (SZ + HAZ) becomes narrower as the traverse speed increases at a rotational speed of 1250 rev/min, which is expected due to the decrease in the heat input applied to the plates as the traverse

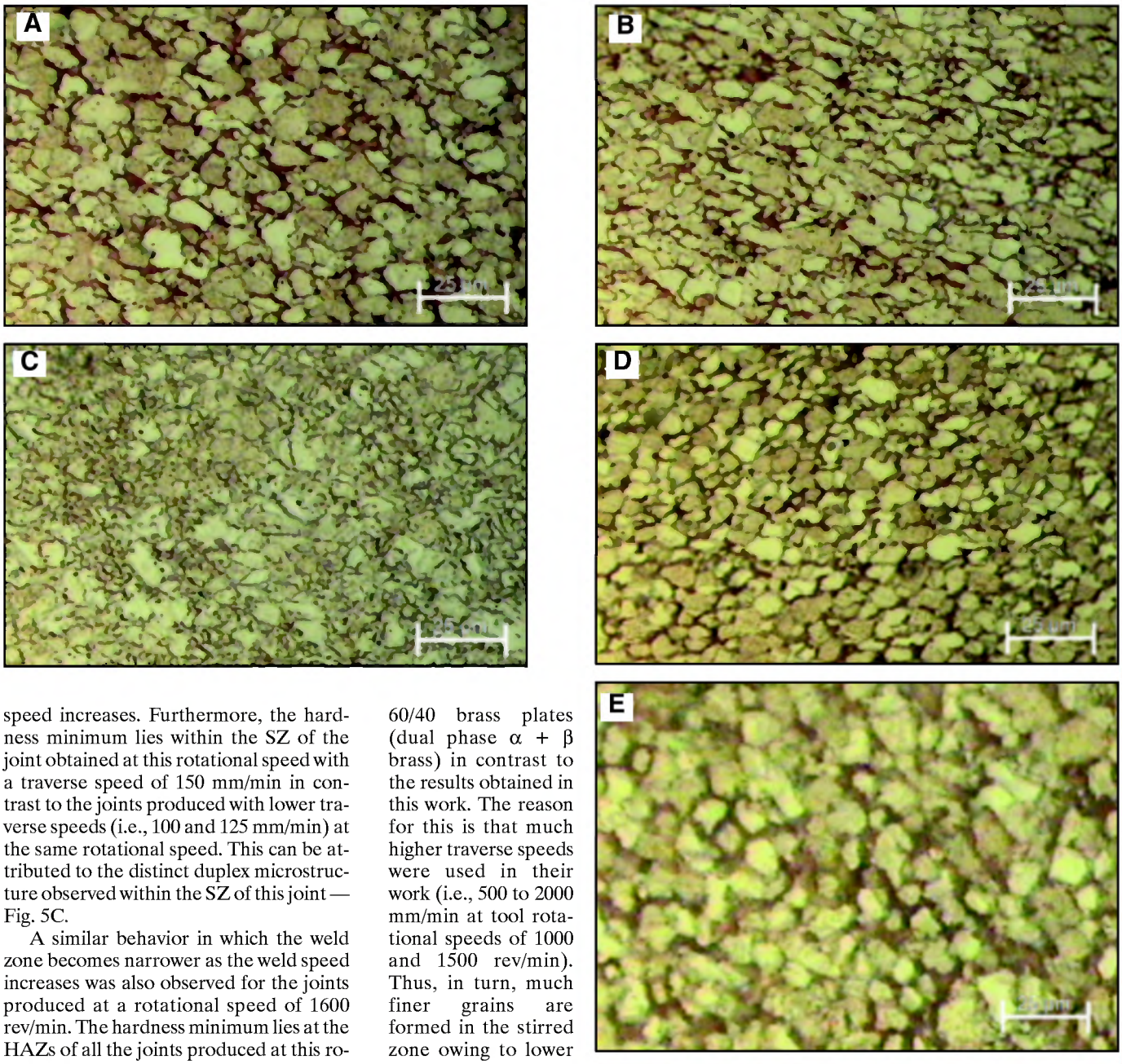

Fig. 5 — Optical micrographs showing the stirred zones (SZ) of the joints obtained with the following weld parameters: A — 1250 rev/min (100 mm/min); B — 1250 rev/min (125 mm/min); C — 1250 rev/min (150 mm/min); D — 1600 rev/min (200 mm/min); and E — 1600 rev/min (225 mm/min.) Note the grain refinement in the SZ.

speed increases. Furthermore, the hardness minimum lies within the SZ of the joint obtained at this rotational speed with a traverse speed of 150 mm/min in contrast to the joints produced with lower traverse speeds (i.e., 100 and 125 mm/min) at the same rotational speed. This can be attributed to the distinct duplex microstructure observed within the SZ of this joint — Fig. 5C.

A similar behavior in which the weld zone becomes narrower as the weld speed increases was also observed for the joints produced at a rotational speed of 1600 rev/min. The hardness minimum lies at the HAZs of all the joints produced at this rotational speed. Furthermore, it was also observed from the joints obtained at the rotation rate of 1600 rev/min that the hardness drop within the stir zone becomes less significant as the traverse speed increased from 175 to 200 mm/min — Fig. 7. Further increase in the traverse speed beyond that apparently did not restore the hardness decrease. These results are in good agreement with the microstructural observations (Fig. 4) in which grain coarsening was detected when the traverse speed was increased beyond that of 200 mm/min at the rotational speed of 1600 rev/min.

However, hardness increases in the stirred zones of the joints for Cu-40% Zn brass plate were reported in the literature (Ref. 14). Park et al. (Ref. 14) observed a pronounced hardness increase in the stirred zone of the friction stir welded 60/40 brass plates (dual phase $\alpha + \beta$ brass) in contrast to the results obtained in this work. The reason for this is that much higher traverse speeds were used in their work (i.e., 500 to 2000 mm/min at tool rotational speeds of 1000 and 1500 rev/min). Thus, in turn, much finer grains are formed in the stirred zone owing to lower heat inputs in higher traverse speeds. On the other hand, as in the case in this work, Lee and Jung (Ref. 13) reported that a hardness decrease in the stirred zone of pure copper may also take place when lower traverse speeds (i.e., 61 mm/min at a tool rotational speed of 1250 rev/min) are used.

Joint Performance

Tensile test results of the specimens extracted from the base plate and friction stir welded plates and the joint efficiency values obtained are summarized in Table 1.

Figures 8 and 9 illustrate the comparison of the stress-strain curves of the specimens extracted from the base plate and welded plates produced at both rotational speeds employed in this study, i.e., 1250 and 1600 rev/min. As seen from Table 1 and Fig. 8, the best combination of mechanical properties for a rotational speed of 1250 rev/min was obtained from the joint produced with a traverse speed of 125 mm/min. The strength and ductility performances for this joint were 105 and 84%, respectively.

The specimens extracted from the joints produced at the rotational speed of 1250 rev/min failed either in the HAZ or base material (BM), except for the specimens produced with a traverse speed of 150

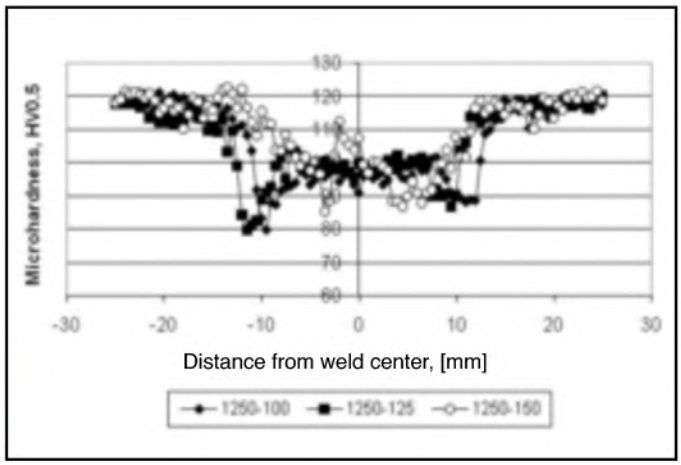

Fig. 6 — Hardness profiles of the joints produced at a rotational speed of 1250 rev/min with different traverse speeds (i.e., 100, 125, and 150 mm/min).

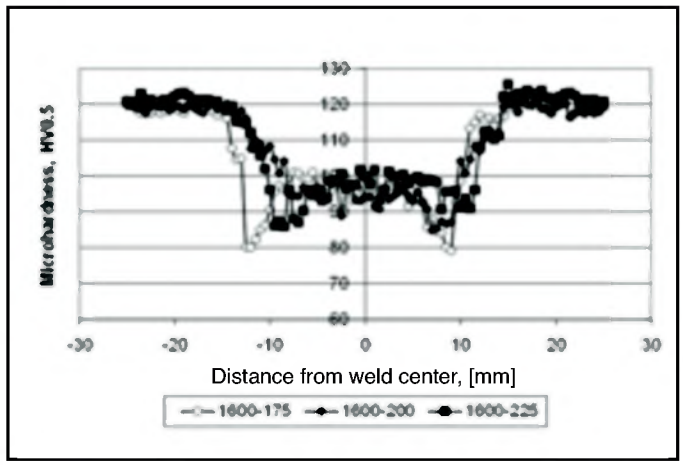

Fig. 7 — Hardness profiles of the joints produced at a rotational speed of 1600 rev/min with different traverse speeds (i.e., 175, 200, and 225 mm/min).

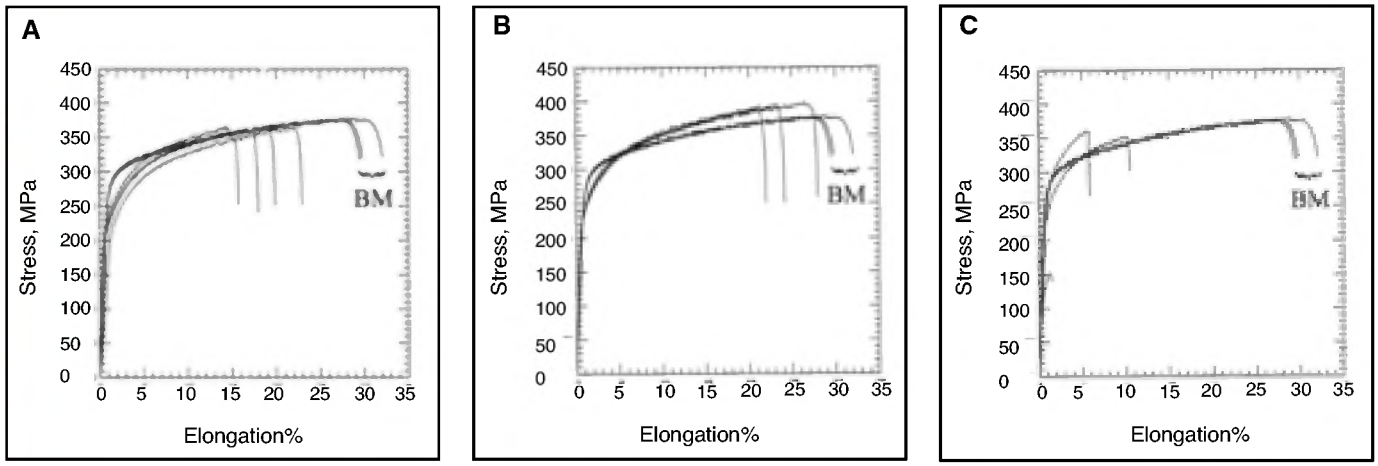

Fig. 8 — Comparison of stress-strain curves obtained from the base plate and joints produced at a rotational speed of 1250 rev/min with different traverse speeds. A — 100 mm/min; B — 125 mm/min; and C — 150 mm/min. (BM = base material.)

mm/min that failed in the weld zone (WZ). Moreover, the joint produced at the rotation rate of 1250 rev/min with a weld speed of 150 mm/min exhibited far much lower elongation values than the joints produced with lower traverse speeds at this rotation rate — Table 1 and Fig. 8. This is thought to be due to the distinct duplex microstructure within the SZ of this joint — Fig. 5C.

The plates used were cold-rolled prior to joining, and the cold work hardening effect diminishes due to the heating of the plate during welding, which results in loss of hardness in the weld zone (in the SZ and HAZ regions). Thus, the strength of the joints is slightly lower than that of the base plates. It is apparently due to the grain refinement taking place within the stir zone, partly restoring the strength. While the grain refinement takes place within the SZ, restoring the hardness loss to some extent depends on the heat input, the hardness decreases at the HAZs due to the loss of cold work hardening. Thus, except for the joint produced at the rotational speed of 1250 rev/min with a traverse speed of 150 mm/min, all other joints produced in this study exhibit minimum hardness values at the HAZ, resulting in the failure of the tensile specimens at this region.

The lowest ductility performance (i.e., 27%) was obtained from the joint produced at this rotational speed (1250 rev/min) with a traverse speed of 150 mm/min. This result is reasonable since the failure takes place within the SZ of this joint, possibly due to the evolution of a distinct duplex microstructure within this region, which is apparently brittle. Furthermore, it is believed that the weld speed of 150 mm/min was too high at the rotational speed of 1250 rev/min for a formation of strong metallurgical bonding between the extruded layers during friction stir welding. Although no defects were observed within the weld region of this joint, it is believed that there might be some defects. This indicates that the welding speed of 150 mm/min was inconvenient at this rotational speed for obtaining a sound joint.

On the other hand, the strength and ductility performances of the joints produced at the rotational speed of 1600 rev/min with all the traverse speeds used were reasonably high and comparable to those of the base plate, as seen from Table 1 and Figs. 9, 10, except the ductility performance of the joint produced with a traverse speed of 200 mm/min (i.e., 67%). There is no clear indication why the ductility performance of this joint is low, although it exhibited the finest grain size in the SZ — Fig. 4. It may possibly be due to the microstructural variations. Moreover, the strength performance of this joint is higher than the other joints produced at the same rotation rate with lower traverse speeds although the grain size is slightly coarser. The grain size affects the strength of the SZ. However, the strength of the HAZ is affected by the heat input applied during joining, which softens the cold-worked material in this region as well as the SZ. The heat input is clearly lower in the joint produced with this higher traverse speed (i.e., 225 mm/min), thus this may result in a slightly higher transverse tensile strength obtained.

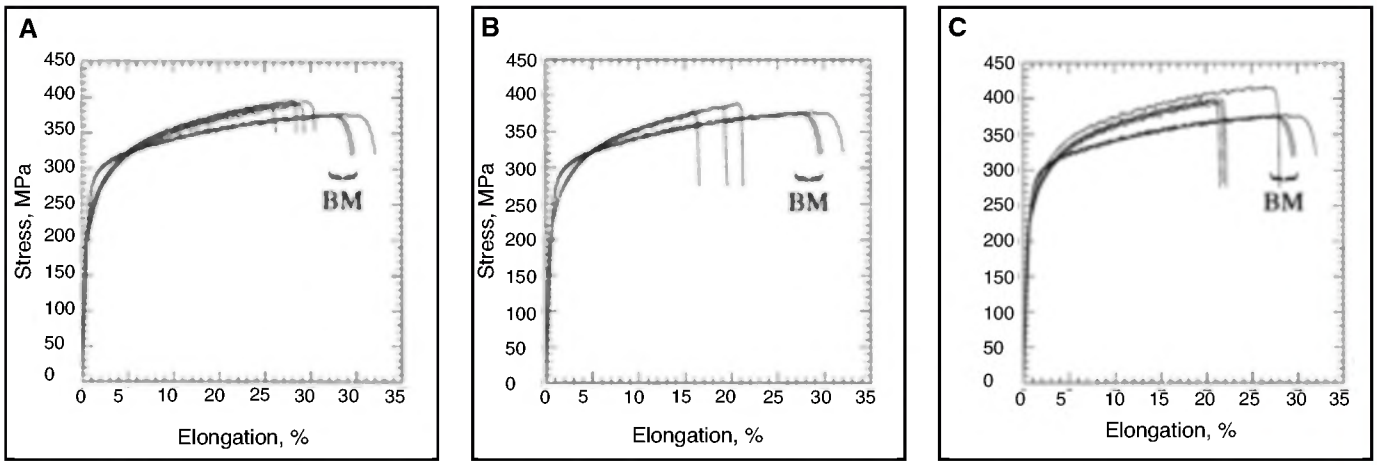

Fig. 9 — Comparison of stress-strain curves obtained from the base plate and joints produced at a rotational speed of 1600 rev/min with different traverse speeds. A — 175 mm/min; B — 200 mm/min; and C — 225 mm/min. (BM = base material.)

Although no further grain refinement was observed beyond the traverse speed of 200 mm/min at the rotation rate of 1600 rev/min, the highest strength and ductility performances were obtained for the joint produced with a traverse speed of 225 mm/min, i.e., 107 and 81%, respectively. These joint performance values are reasonably high, indicating that the joint quality is sufficient. The joints produced with the other traverse speeds (i.e., 175 and 200 mm/min) are also reasonable, indicating that the higher tool rotational speed (i.e., 1600 rev/min) results in better joint performances for the brass plate studied.

The ductility performances (up to 85%) obtained in this work were much higher than those reported for friction stir welded Cu-40% Zn brass plate in the literature, i.e., down to 35% (Ref. 14). However, the strength and hardness values obtained in this work are much lower than those reported for the Cu-40% Zn brass joints in the literature (Ref. 14). As explained earlier, the reason for this is that much higher traverse speeds were used in their work (i.e., 500 to 2000 mm/min at tool rotational speeds of 1000 and 1500 rev/min). Thus, in turn, much finer grains are formed in the stirred zone owing to lower heat inputs in higher traverse speeds leading to highly strength-overmatched joints. The other reason for the higher strength values is the smaller diameter of the tool shoulder they used, i.e., 12 mm, than the one used in this work, namely 20 mm. The diameter of the shoulder is one of the factors determining the heat input applied to the plates during the friction stir welding process.

The low ductility performance is typical for these joints where the hardness minimum lies within the weld region (i.e., slight strength undermatching). There are several reports on the performance of the strength undermatching and overmatching joints exhibiting lower elongation values compared to the base material counterparts in the literature (Refs. 23–25) due to the confined plasticity within the weld region and plastic deformation taking place only in the BM, respectively. Highly strength-overmatched joints, on the other hand, exhibit higher strength performance values owing to the fact that ductility and strength are inversely proportional (Ref. 14). Thus, it can be concluded from these results that when higher strength values are required, then higher rotational and traverse speeds should be employed, whereas lower rotational and traverse speeds should be preferred when higher ductility performances are required.

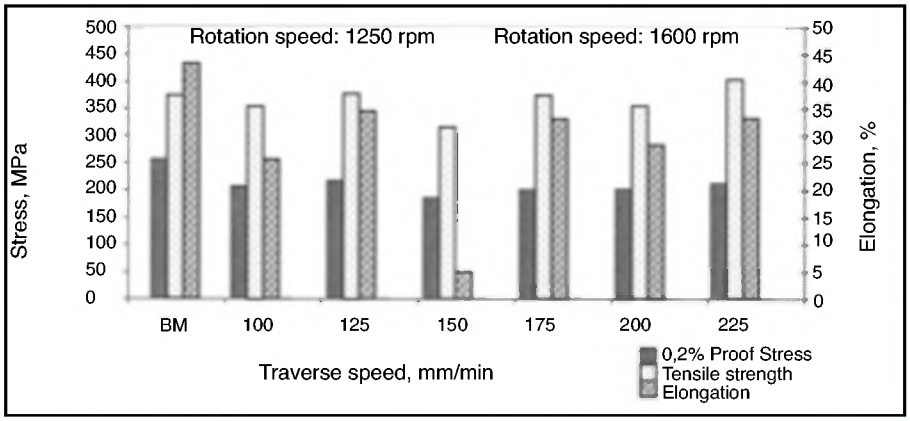

Fig. 10 — Summary of tensile test results.

The results of bending tests conducted are also in accordance with the tensile test results. No cracking was observed in the bend testing of the joints. The bend specimens extracted from all the joints exhibited no cracking during the bend tests in both testing conditions (weld root inside or outside), indicating that the joints are reasonably sound.

Conclusions

The following conclusions have been drawn from the present study:

- 63/37 brass plates can be successfully friction stir butt joint welded. Sound joints without any defect can readily be produced in a large window of weld parameters (i.e., using various rotational and traverse speeds). No porosity or other weld defect was observed in the stirred zones of the joints produced.
- Grain refinement was obtained in the stir zones of all the joints produced. As expected, it was demonstrated that the lower the heat input during welding the finer the grain size in the stir zone.
- A hardness drop was observed in the stir zone of all the joints produced, indicating that the joints are strength undermatched.
- All the 63/37 brass joints produced exhibited good mechanical performance values comparable to those of the base plate, except the one produced at a rotational speed of 1250 with a traverse speed of 150 mm/min that displayed an unacceptably low ductility performance. Better results were obtained from the joints produced with the higher rotational speed used, i.e., 1600 rev/min.
- The best combination of strength and ductility performances was obtained from

the joint produced at the tool rotational speed of 1600 rev/min with a traverse speed of 225 mm/min, i.e., 107 and 81%, respectively.

- The joint produced at the tool rotational speed of 1250 rev/min with a traverse speed of 125 mm/min also exhibited very high strength and ductility performance values, i.e., 105 and 84%, respectively.
- The other joints produced also displayed reasonable strength and ductility performances, except the one produced with a weld speed of 150 mm/min at the rotational speed of 1250 rev/min.
- All the joints produced, except the one produced with a weld speed of 150 mm/min at the rotational speed of 1250 rev/min, exhibited higher or comparable strength values to that of the base plate apparently owing to the grain refinement within the weld zone.
- The results suggest that the 63/37 brass plates can be defect-free joined by friction stir welding with a wide range of weld parameters.
- It can also be concluded from the results obtained that when higher strength values are required from the joints, then higher rotational and traverse speeds should be employed in friction stir welding of these dual-phase brass plates. On the other hand, lower rotational and traverse speeds should be preferred when higher ductility performances are required.

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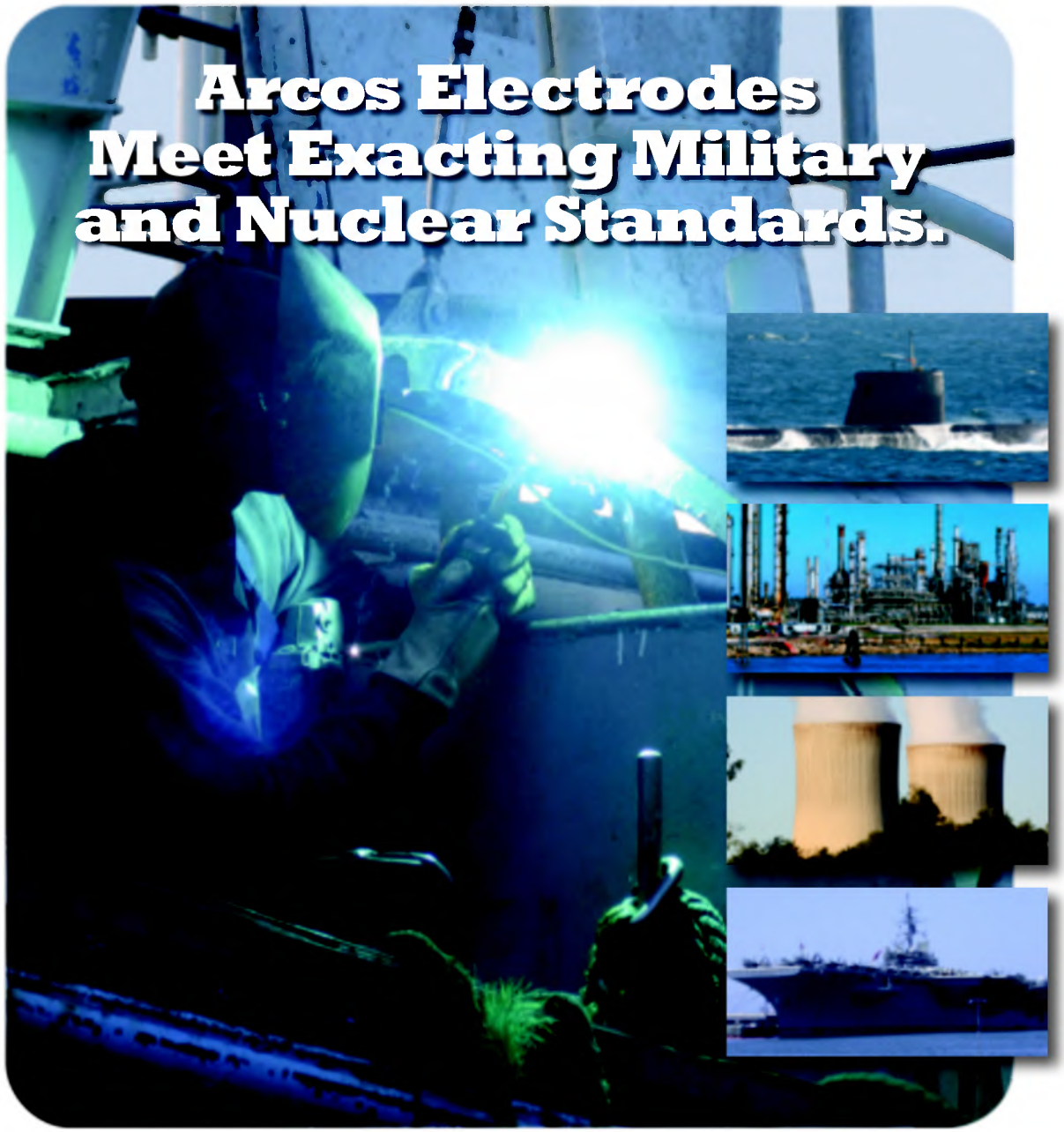

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