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Welding Educators and Schools Spark Attention

Welding Structural Steel

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On the cover: Position your head adjacent to the joint to see the electrode and its relationship to the weld pool. (Credit: ESAB Welding & Cutting Products.)

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Changes in the New AWS D1.1 Code

Tom Schlafly
Former Chair of the AWS D1Q Subcommittee on Steel

Phil Torchio
Current Chair of the AWS D1Q Subcommittee on Steel

The first new edition in five years of the American Welding Society's (AWS's) D1.1/D1.1M:2020, *Structural Welding Code — Steel*, has just been published and may provide an immediate shock to many users. It's available for purchase at *pubs.aws.org*.

A lot has changed. The first change most people will notice is that it has been reorganized. This is not change for change's sake, but rather, a conscious effort to make the code clearer through putting clauses in a more rational order — an order that is consistent with other AWS codes. To accomplish this, many editorial changes have been made, including moving essential information out of the appendices in the back of the code to the front. Normative References now reside in Clause 2. Terms and Definitions specific to this standard are now in Clause 3. Endeavoring to unify the format of the structural welding codes, clauses are now introduced by a scope and are divided into parts to simplify reader understanding/use.

This has resulted in a shift of all clauses after Clause 1, General Requirements, in the 2015 edition to new locations in the 2020 code. A two-clause number shift applies to Design through Stud Welding; in other words, former Clauses 2–7 are now Clauses 4–9. Tubular Structures has moved from Clause 9 to Clause 10. Strengthening and Repair of Existing Structures is now Clause 11.

The appendix letter identifications have also shifted with the move of Normative References, Definitions, and Annex A Effective Throat to Clauses 2, 3, and 4, respectively. Perhaps our best suggestion is to tab the foreword of the code starting on page xiii, which provides a roadmap of new locations for the code provisions.

In addition to the above listed changes, new specific editorial and substantive changes have been made, as outlined below.

• Clause 4, Design, has moved the Annex A fillet weld effective throat illustration to Figure 4.1.

• Clause 5, Prequalification of Welding Procedure Specifications (WPSs), has been editorially reordered to more closely follow a logical sequence a contractor would follow in writing a prequalified WPS. This results in renumbering the clause content, tables, and figures to follow the order they are referenced in the clause. D1.1/D1.1M:2015, Table 3.7 Prequalified WPS Variables, now Table 5.2, has been retitled Essential Variables for Prequalified WPSs. The tolerances for variables are separated from the list of variables.

Substantive changes in Clause 5 include adding new materials to Table 5.3 Approved Base Metals for Prequalified WPSs and new Table 5.7 Prequalified WPS Shielding Gas Options for GMAW Electrodes Conforming to AWS A5.18/A5.18M.

• Clause 6, Qualification, adds requirements for WPS qualification using waveform-controlled processes, and welder qualification retest requirements have been clarified. Qualification sections have been added to clarify there are various methods to qualify partial joint penetration welds. There are also new provisions for qualifying WPSs with Charpy V-notch (CVN) toughness, including a new method for locating the CVN specimens, and CVN testing requirements have been added to Table 6.6.

• Clause 7, Fabrication, has revised provisions for weld restoration of base metal with mislocated holes.

• Clause 8, Inspection, has revised requirements for welding inspection personnel qualification, engineer's responsibilities regarding inspection, digital radiography, digital unsharpness, and ultrasonic testing attenuation factor determination.

• Clause 9, Stud Welding, has a new requirement for manufacturer's identification marks on headed studs and deformed bars and rewritten provisions to the contractor's option for fillet welding studs.

• Clause 10, Tubular Structures, has removed provisions for calculating static strength of welded tubular connections, and designers are directed to ANSI/AISC 360 and AISC Design Guide No. 24.

• While phased array ultrasonic testing (PAUT) was added to D1.5M/D1.5:2015, *Bridge Welding Code*, it has now been included in the new edition of D1.1. The requirements for using PAUT can be found in Annex H. There is also new commentary for this.

• Annex R contains modified provisions for preliminary design of circular tube connections that were previously contained in the tubular structures clause.

Thousands of volunteer and staff hours have been devoted to the review of this important code to improve its usability and accuracy. The committee has now turned its attention to the next edition due in 2025.

If you have a concern about the code or a revision you would like to propose, contact Jennifer Molin at *jmolin@aws.org* for the form to complete. The subcommittee is always looking for dedicated volunteers. In particular, the Design, Materials, Prequalification, and Stud Welding Task Groups are looking for new members. Apply by completing the application at *aws.org/library/doclib/Technical-Committee-Application.pdf*. WJ

"Thousands of volunteer and staff hours have been devoted to the review of this important code to improve its usability and accuracy. The committee has now turned its attention to the next edition due in 2025."

National Welding Month: Highlighting Industry Pros

Gain insight from three early-to-mid-career welders

BY COREY STULCE

We're looking at a 2.4 million worker shortage of manufacturing professionals by 2028 (Ref. 1), which is one of the reasons why recognizing National Welding Month is more meaningful than ever.

Now is the time to examine why the percentage of qualified welders is shrinking and what can be done. The manufacturing industry isn't going anywhere. Its practices evolve with emerging technologies, and it remains an essential component of most other enterprises.

Let's look to the present to offer hope and protection for the future.

Fig. 1 — From left, Brian Thessen, Tom Hammer, and Ernest Coolong are journeyman metal welders for Axenics, a contract manufacturer in New England.

Educating on the Possibilities

Three early-to-mid-career welders, Tom Hammer, Ernest Coolong, and Brian Thessen, are a testament to what welding can do for you. The trio make up the core team who solve problems with difficult-to-achieve welds at Axenics, a more than 40-year-old contract manufacturer in New England — Fig. 1. They focus on high-accuracy weldments using gas tungsten arc welding (GTAW). This process is considered to yield welds of the highest quality and purity, while also being one of the most challenging to master due to its intricate nature.

When asked why younger generations are not entering the trades, Hammer centered on pay. "Often, the big thing for them is the money isn't always there. Why be a welder if you get really good only to make 70 grand per year and can make way more than that sitting at a computer? It's hard to take that differential."

But this perception isn't entirely correct. There are welding jobs out there with great benefits and pay, but sometimes you have to chase the work. There's also the option of becoming an independent contractor, although that requires its own discipline to find success.

Coolong pointed at the work environment when asked why less kids are joining the welding industry.

"We're lucky that, at Axenics, we have a good environment, it's climate-controlled, and we are not micromanaged...there are different atmospheres in different shops. It is important to address the concerns of people not wanting to get into welding. Sure, you can go work in an office and that might be a better environment for you — and it might not. It all comes back to the culture of the company and where your priorities lie," Coolong said.

Enticing Generation Z

The generation entering the workforce today, born after 1996 and dubbed Gen Z, has always known digital technology, has spent a larger percentage of their life in front of a screen, and is, therefore, hardwired to expect to make a living in front of a screen.

"The biggest problem we have in filling the trades is that kids want to be on a computer all the time, and don't want to aim for physical jobs," Welder Tom Hammer said.

Another characteristic associated with Gen Z is they expect instant gratification, which generally goes against manufacturing principles, and especially the intricate and gained-through-experience skills needed to master GTAW — Fig. 2. However, with hard work and know-how come additional opportunities.

"We paid our dues, did our time chasing jobs, sometimes going to one, a shut down (a big plant that temporarily closes so repairs or additions can be made), then going after another

[job]," Thessen said. "As we got more experience, our skill level got higher, and now we can do high-tolerance welds with minimal room for error. Some people see this and don't realize they have to put the work in."

Defying Stereotypes

There's a longtime stereotype that students who are attracted to shop class and later trade schools do so because they're not as intellectually savvy as others and are settling for what they can get. This is simply not true.

The melding of old-school manufacturing techniques with smarter machinery means tomorrow's workforce needs to have those hands-on skills as well as digital technology know-how. For example, newer welding machines integrate artificial intelligence, so the machine can sense if you have the right angle and can correct it. If you're traveling at the wrong speed, it can also notify you. If the distance from the workpiece to the torch is off, it will pick up the voltage that dropped or alert the welder to get closer.

Be Aware of Your Opportunities

Perhaps the biggest challenge is a lack of knowledge about the options students have today. For example, only 27% of parents consider manufacturing a viable career option for their school-age children (Ref. 2).

By visiting *careersinwelding.com*, a wealth of information can be found, from why you should become a welder to available scholarships.

Coolong summed it up: "Just watch that movie, *Office Space*; that dude was miserable in his cubicle. At the end, he loves being outside, working with his hands."

Youthful Revelations

All three welders discovered their love for the art as students. For example, Hammer was motivated by his relatable high school welding teacher.

"My favorite teacher in high school was Anthony Hanna, who taught metals. He's really down to earth, and had his own welding business on the side. He ended up teaching at Manchester Community College (MCC), so I got to follow him there," Hammer said. "Welding always clicked with me. Experimenting with it in high school classes made me want to understand it better. Halfway through school, my first job was working on aircraft parts."

Coincidently, Thessen also teaches welding at MCC in Manchester, N.H., where Hanna still instructs. At 18, Thessen landed in a program for future manufacturers, and quickly worked to pass a structural welding certification test, giving him opportunities to advance his career and make more money. He earned a degree at MCC, and the educators there were so impressed, he was asked to stay as an adjunct welding instructor.

Coolong was drawn to welding as a kid because he saw how it allowed him to merge his different interests.

"I always enjoyed art class and shop," Coolong said. "I grew up in a mill town. Someone donated a 4-foot saw blade to the school, and a student was going to use that piece of metal to cut out the school's mascot to display on the football field. He didn't end up doing it, so I traced it and played with a cutting torch to make it. It married two things I love, working with my hands and making art. I quickly discovered that welding could fix some of the mistakes made while working with metal."

Coolong added, "There's something to be said for building something that's tangible."

The Value of Hands-On Work

All three welders agreed students would benefit from exposure to hands-on work, as many have not had the opportunity to discover a talent and potential passion for it.

"It's very fulfilling to produce high-quality welds that can only be complete when done correctly," Coolong added. "Sometimes it takes a bit of 'magic' to fix it."

"There's a sense of pride, too," Hammer said. "Think of people who weld on bridges, then get to cross over that bridge. 'I was the one that welded a third of this bridge, and hundreds of thousands of people cross this bridge every month.' Those welds are completed to the maximum scrutinizing detail, and are not being performed by a machine."

Welding's Artistic Attributes

Thessen utilizes the "cool factor" of welding to entice students to take classes — Fig. 3. He has also inspired more young women to take an interest in the craft.

"You get to manipulate lightning with welding and play with fire when working with metal and really see the sparks fly," he said. "Metal is also very malleable. You can really transform it with heat and electricity, and take metal and turn it into whatever you imagine. You can change its color, its hardness, shape, create fulcrums and levers — the possibilities are endless."

Motivation Matters

Coolong said there are opportunities for young welders to learn exactly

Fig. 2 — GTAW is possibly the most physically challenging manual welding process to perfect, as it requires the constant use of all four of the welder's extremities.

what drives their passion while starting out in entry-level roles.

"It does depend on the kind of leeway a company gives you. Maybe you work for a company that lets you tinker on some personal work during your lunch break. You can save up, get a welder [welding machine], and do stuff at home. Make some art and sell it on Etsy," he said. "The artistic side I found was to make my weld bead look perfect every time."

Abstract GTAW

Also on the artistic side, Thessen said he prefers abstract GTAW because it allows the welder and inner artist to come together to create something that is one-of-a-kind and mind-expanding.

"One hundred different people can see 100 different things," Thessen said of the favorite art pieces he's created.

He does nonabstract work, too.

"I made a bird. The feathers are little knives welded onto a bigger knife that is the wing, to give it dimension. I [also] did a very icky-looking mosquito with a drill bit for a needle. In my mind, if it was alive, it could punch holes in your gas tank and suck out the fuel," Thessen added.

Parting Thoughts

Whether welding for art, technology, problem solving, or more hands-on purposes, the trade takes a variety of competencies and challenges you to always be learning and advancing your skills. For example, intricate weldments performed by GTAW on stainless steel help complete components that go into life-saving devices in a variety of health fields. And when opportunities begin to run out in other industries, students can still look to manufacturing as a viable option for a lifelong career.

Journeyman Welders Coolong, Hammer, and Thessen fuse the points that protecting the future of welding is learning from what has worked well in the past: education, mentorship, and appreciation.

Fig. 3 — Welder Tom Hammer assists Welder Brian Thessen as he performs GTAW on a large stainless steel tube. The art of GTAW produces exceptionally high-quality, refined, and superior welds.

Happy National Welding Month. To check out American Welding Society discounts, see the below sidebar. WJ

References

1. *2018 skills gap in manufacturing study*. Deloitte and The Manufacturing Institute. *deloitte.com/us/en/pages/manufacturing/articles/future-of-manufacturing-skills-gap-study.html*

2. Heflin, J. 2020. Industry wants parents to stop steering children away from manufacturing. *washingtonexaminer.com/news/industry-wants-parents-to-stop-steering-children-away-from-manufacturing*

COREY STULCE (corey@savoirfaire-us.com) *is the content strategist at Savoir Faire Marketing/Communications, Manchester, N.H.*

AWS Special Offerings for National Welding Month

National Welding Month takes place in April and not only recognizes but also reflects on the impact welding has on our daily life.

To mark this month in 2020, the American Welding Society (AWS), Miami, Fla., is providing additional promotions, as outlined below.

Foundation. The Foundation will again offer 50% off job postings at *jobsinwelding.com* during the months of April and May.

Membership. Join AWS between now and the end of National Welding Month, and the $12 initiation fee will be waived. You will also be eligible to receive a free hat. To participate in this offer, do the following:

1. Join AWS as a new member by submitting an online application at *my.aws.org*, or downloading and sending a completed application available through *aws.org/about/page/national-welding-month* with payment made to AWS World Headquarters. You may also call AWS at (800) 443-9353 to join, and mention this offer to have the initiation fee waived.

2. Go to *surveymonkey.com/r/NewAWS_April2020* and sign up to receive your hat.

At the end of April, all entries will be verified, and gifts will be shipped. Gifts will be sent on a first-come, first-served basis while supplies last. New members outside of the United States may be asked to pay shipping fees.

In addition, to learn more about National Welding Month, be sure to visit *aws.org/about/page/national-welding-month*. A host of important information is there, including key resources, ways to get involved, and much more.

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- D17.1, *Aerospace*
- Magnetic Particle Testing (MT Dry Powder Yoke Method)
- Penetrant Testing (PT Type II- Method C)
- ASME Pressure Vessel Section IX, Pressure Piping B31.1 and B31.3
- ASME Pressure Vessel Section VIII, Div. 1 and Section IX
- Structural Bolting Inspection
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