WELDING JOURNAL

JUNE 2026



Robotics Redefine Tank Welding

Material Solutions for Shipbuilding

Laser Welding Takes the Helm

IN THIS ISSUE: AWS FINANCIALS ■ WELDING SUMMIT COUNTDOWN ■ COMMITTEES CONVENE AT HEADQUARTERS

JUNE 2026 | VOLUME 105 | NUMBER 6

CONTENTS

FEATURES

56 Shipbuilders Navigate Tank Welding*
Learn about a robot cell that performs fabrication operations remotely
A. A. Ugarte

60 Selecting Materials and Filler Metals for Commercial Shipbuilding
This article explores approval requirements, toughness considerations, and operating parameters for joining commonly used marine structural steels
M. Underwood and R. O'Dell

62 Smart Abrasive Choices to Offset Labor Gaps in Shipbuilding
Select the right abrasives to deliver a boost to the bottom line
A. Shumate

66 High-Powered Laser Welding in Shipbuilding
Pure laser welding can transform shipbuilding by increasing productivity, reducing distortion, and advancing industry adoption
Z. Sanders

CONFERENCE COUNTDOWN

72 Level Up Your Welding Career at This Year's AWS Welding Summit
The Society's annual conference is only two months away

STANDARDS ACTION

76 Standard Welding Procedure Specifications for Naval Applications
How preapproved AWS/NAVSEA documents help cut time and costs in Navy shipbuilding
H. Castner

DEPARTMENTS

5 Editorial
8 News of the Industry
14 Aluminum Q&A
16 Education 411
18 Product & Print Spotlight
22 AWS Financial Statement
70 Seminar Schedule
74 Coming Events
77 Society News
79 Standards Developments
85 Guide to AWS Services
86 Section News
109 Classifieds
109 Advertiser Index

CONTENTS

JUNE 2026 | VOLUME 105 | NUMBER 6

WELDING JOURNAL RESEARCH SUPPLEMENT

151-s

Residual Copper Effects on Toughness of GMAW Low-Carbon Steel

This research supplement looks at the effects of copper on low-carbon steel

H. Geerlings et al.

161-s

Improved Weldability for Laser Welding Press-Hardened Steel via Thinning Coating — Part 2: Al Enrichment Inhibition Technique

This paper builds upon Part I to ensure stable welds on Al-Si-coated press-hardened steel

Z. Q. Jin et al.



On the cover: A shipbuilder at Huntington Ingalls Industries (HII) Newport News Shipbuilding division. (Photo by Ashley Cowan/HII.)

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Focused Growth and Customer Excellence



Mary Bihrle
AWS Treasurer

In 2025, financial markets delivered another solid year despite an unsettled economic backdrop. Inflation continued to ease, allowing the Federal Reserve to begin a gradual shift toward lower interest rates, while economic growth proved more resilient than many had anticipated. The year was marked by heightened geopolitical tensions and the longest U.S. government shutdown in history, which temporarily weighed on confidence. Even so, consumer spending remained firm, corporate earnings held up, and economic performance ultimately exceeded early-year expectations.

Equity markets reflected that resilience. The S&P 500 finished the year up 17.9%, its third consecutive year of double-digit gains. Importantly, those gains were driven primarily by strong earnings growth rather than expanding valuations. While parts of the manufacturing sector faced ongoing headwinds, the broader financial environment remained supportive of long-term investment and disciplined strategic planning.

Against this backdrop, 2025 stands out as a meaningful year for AWS. The Society reached new milestones in both revenue and investment while remaining focused on what matters most — serving our members and customers. By focusing on the "vital few" priorities, AWS grew deliberately, invested with purpose, and delivered stronger outcomes across the organization. This disciplined approach positioned AWS to capitalize on opportunities while continuing to build long-term financial strength.

AWS operating revenues for 2025 reached a new high, totaling $50.7 million and marking the first time the Society has surpassed $50 million in annual revenue. This represents an increase of $6.9 million, or 15.7%, over 2024. Growth was primarily driven by the release of AWS D1.1/D1.1M:2025, *Structural Welding Code — Steel*, as part of its five-year publication cycle, along with strong performance from other publications and improved royalty and distribution arrangements. The Chicago FABTECH show also contributed to the increase.

The AWS surplus for 2025 totaled $10.4 million, an increase of $2.6 million, or 33.4%, compared to the previous year. The higher surplus was driven primarily by revenue growth across core programs.

The 2025 AWS reserve fund was $157.4 million, an increase of $28.4 million, or 22%, over 2024, driven by market gains combined with transfers from operations totaling $6.4 million.

The AWS Foundation's assets increased by $23.7 million, or 17.5%, to $158.7 million. This was mainly attributed to market gains, as well as a $6.4 million transfer from operations.

Underlying these financial results is a clear strategic focus. In 2025, AWS remained anchored to three pillars — customer success, operational excellence, and defend and leverage the core — with execution guided by a disciplined focus on the vital few priorities. Customer excellence, in particular, shaped decision-making across the organization. This means more than providing responsive service; it means designing experiences that are seamless, proactive, and grounded in listening to customer feedback at every touchpoint. Throughout the year, AWS continued shifting from an inward focus to one centered on trust, partnership, and measurable value for those we serve.

That focus informed both near-term actions and long-term investments. AWS advanced major system and process improvements, strengthened global program delivery, expanded international activity, and continued development of future-ready offerings such as new certification programs and the multiyear Certified Welding Inspector (CWI) redesign, slated for release in 2027. Each initiative was prioritized not for scale alone, but for its ability to better meet customer needs and support sustainable growth.

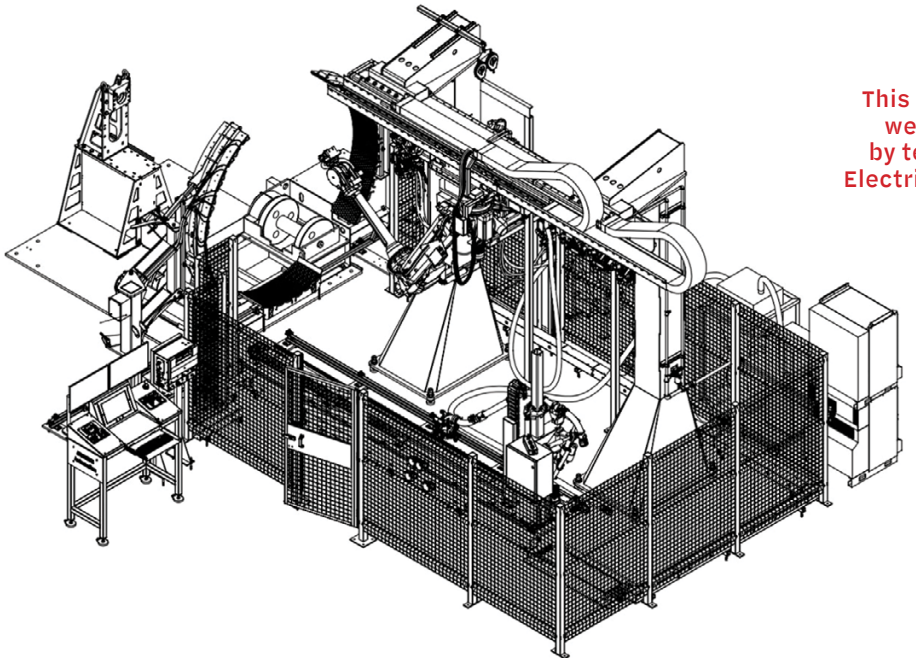
In closing, 2025 was a special year for AWS, one marked by record financial performance, purposeful investment, and meaningful progress toward customer excellence. By staying focused on what matters most, the Society is well positioned to navigate uncertainty, deliver value with every interaction, and continue advancing its mission on behalf of members and the welding industry. WJ

"2025 stands out as a meaningful year for AWS. The Society reached new milestones in both revenue and investment while remaining focused on what matters most — serving our members and customers."

BY ALEXANDER ALFONSO UGARTE

Shipbuilders Navigate TANK WELDING

In this case study, deploying robotic processes solves a historical challenge



This schematic shows the tank welding robot cell developed by teams at General Dynamics Electric Boat and a local vendor.

Last September, General Dynamics Electric Boat (EB) completed its first tank closure head interior weld using a tank welding robot cell at the Quonset Point facility in Rhode Island, achieving 100% satisfactory results in volumetric inspection. The facility, initially established to provide off-site support to EB's Groton, Conn., shipyard, also manufactures major submarine components. This milestone represents an advancement in welder safety by eliminating the need for personnel to enter confined spaces while maintaining quality results.

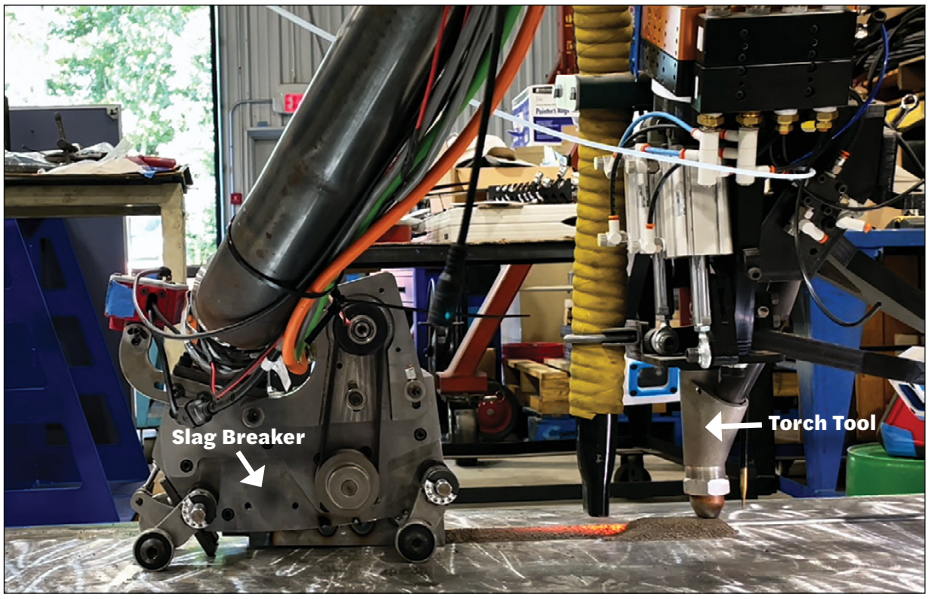
Putting the Operator First

Historically, welding interior tank joints required shipbuilders to physically enter the tank through an approximately 1.5-ft-diameter opening into a confined space while facing extreme temperatures — internal temperatures can reach up to 300°F — and rotating equipment. To be safe, shipbuilders use air-fed respirators and take frequent breaks. To improve safety conditions, teams started working together on a solution that would remove the shipbuilder from the tank without compromising the weldment.

Robotic Innovation in Action

Designed as an industrial robotic system, the tank welding robot cell performs fabrication operations remotely. This includes welding, wire brushing, grinding, temperature monitoring, slag breaking and removal, vacuuming flux, and visual welder quality examination.

Operators control these processes from a remote console, supported by multiple live-view monitors that provide full visibility of the operation. Automated entry and exit routines reduce the risk of collision, and intuitive controls allow operators to achieve high-quality results without extensive robotic programming experience.



As the tank turns during welding, the slag breaker stays 9–15 in. behind the torch to remove excess flux and slag.

Deep Diving into Tools

While all operations can be controlled from the remote console, extensive development was still needed to create tools to replace the welder inside the tank.

1 The first step was developing a method for the robot to switch between tools. The solution: ATI Industrial Automation creates robotic tool changers that automatically lock together and carry payloads via two mating parts — a master side and a tool side. These robotic tool changers served as the basis for this system, with each tool equipped with a tool-side part and the robotic arm with a master-side part. After solving this critical first step, the team shifted its focus to developing each tool.

2 The torch tool, PT-100 flux tank, and slag breaker form the foundation for the system's welding operations. The torch tool utilizes the same torch model as the conventional method but with a modified geometry. The flux tank is essential to the system for flux delivery, holding 100 lb of granular flux. The conventional method used flux hoppers that held 10–15 lb of granular flux, employing gravity to feed it into the groove. Because the robot arm would have to rotate all six axes to fit the torch tool inside the entrance, a gravity-fed hopper wouldn't be satisfactory. The flux tank now supports air-fed flux delivery, where flux is delivered via an air hose from the tank to the groove.

3 Submerged arc welding uses granular flux to shield the arc. This process results in the formation of slag on the weld metal that must be removed before subsequent passes. With a person inside the tank, the removal process was relatively straightforward, as they would manually break and remove it. Not all the flux was consumed, so welders brought a vacuum hose into the tank and removed all excess flux. To complete this process, the slag breaker is intended to remove excess flux and slag as the torch welds. The slag breaker is manually driven into the tank via a pendant. Once in the proper location, a signal is sent to the robot indicating that the torch tool entry routine may be safely executed when directed by the shipbuilder.

Designed as an industrial robotic system, the tank welding robot cell performs fabrication operations remotely . . . Operators control these processes from a remote console, supported by multiple live-view monitors that provide full visibility of the operation.



The control console has three viewing monitors. The center touch screen is for the human-machine interface.

When selected, the robot follows the entry routine into the tank, stopping the torch at the programmed point above the welding location. At this point, the shipbuilder takes full control to guide the torch into the proper position before welding. As the torch welds, the slag breaker, equipped with an industrial vacuum and steel hammers, sits 9–15 in. behind the torch, breaking and vacuuming excess flux and slag.

4 Upon finishing a weld pass, the weld must be cleaned with a wire brush, and any visible defects must be ground out. Two additional tools, the wire brush and robotic grinding tool, were designed and built to complete these tasks; they're essentially identical with different end effectors. Both are equipped with calibrated force sensors for material removal with similar robotic functions, barring some minor differences (for example, the wire brush tool can complete a full circular pass around the entire weld).

5 Once the weld is cleaned, the operator must verify there are no visible defects before preparing for the next weld pass. Without the ability to look inside the tank, the examination and vacuum tools were developed to ensure proper welder workmanship examination. They're equipped with two cameras, one with a macro lens for a clear view of the weld and a vacuum to clean up grinding grit or flux that wasn't removed beforehand. If there are no visible defects, the operator can prepare for the next weld pass by checking the groove temperature with the thermocouple tool, which features a spring-loaded angle adjustment to conform to either side of the groove and utilizes contact pyrometers for accurate temperature readings. If the temperature is within the allowable welding range, the operator can repeat the welding cycle.

Steering the Ship

The highest priority when designing the control console and human-machine interface (HMI) was simplicity. The control console has two sections for physical buttons; the left-hand side is for slag breaker controls and the right-hand side is for robotic controls. There are also three viewing monitors; one is used for the slag breaker and the other two are for the cameras on each tool.

The HMI is also straightforward. The home screen offers different options. The operator first logs in with their badge number and selects the correct tank size. At any point, operators may select the cell status screen to ensure everything is working as intended. This screen displays all checks related to each tool, and each check will light up green if it's applicable and satisfied. They will then select the tool selection option, which serves as the hub for all robotic

tools and allows starting and stopping all robotic programs. Each tool also has its own tool screen. Navigation between tools and screens is clear-cut, ensuring operators can operate the robot efficiently.

Pushing the Robot to the Limit

EB had been welding tanks using the conventional method for years, but when this changed, thorough verification was required to ensure that all aspects of the tank welding robot cell maintained the quality needed.

TESTING TAKES OFF

The torch tool and slag breaker underwent testing simultaneously. Although only the torch geometry was altered, verification that the weld had not changed was required. Suboptimal parameters were initially selected, which produced difficult-to-detach slag. The slag breaker performed well under rigorous testing and had no issues once parameters conducive to welding were selected.

The thermocouple tool was tested at the lower and upper bounds of the production temperature range. It was compared against three precalibrated thermocouples as a control. The accuracy and precision of the thermocouple tool were then verified with this testing.

FLUX TANK TESTING

The flux tank required the most testing because air-fed flux delivery was novel to EB. Gravity-fed flux hoppers were the only method for delivering flux into a joint, so there were concerns that an air hose would introduce moisture into the flux and, by extension, into the weld. A test plan was executed to replicate the flux consumed in a shift under extreme conditions experienced in the shipyard (80% relative humidity at 80°F), as well as an extended 14-hour time study under the same conditions. Samples were collected about every 30 minutes for the eight simulated weld passes, then every two hours at 8, 10, 12, and 14 hours. For the simulated weld passes, samples were taken from the first and last flux to exit the hose, as well as from the top of the flux tank, as air would accumulate there and potentially collect a higher level of moisture. For the extended time study, flux was collected from the top of the flux tank and the first portion of the hose to exit, because those areas had the highest potential to absorb moisture from air accumulation or from remaining in the hose. All flux sample test results recorded a moisture content below the maximum allowable percentage, and the use of the flux tank was permitted for shipyard use.

Setting Sail

The last branch of testing combined all previous testing using a mockup of a tank. This had an identical geometry to the ones in production, with a groove to test all aspects of the robot. Before implementation, this mockup was completely welded by those involved in the development, as well as the future operators of the system.

Final tweaks were made at the operators' request, and after extensive testing, the system was ready for implementation. WJ

Acknowledgments

This project reflects collaboration across EB's operations, engineering, maintenance, planning, and leadership teams, as well as a local vendor partnership with Arcrite Automation.

Key contributors included Alexander Ugarte, welding engineering advanced concepts; Vincent Mangino, welding engineering advanced concepts supervisor; Terry McKeen, work center planning and readiness; Morgan DeVane, robotics engineering — maintenance; Thomas Faucher, industrial engineering; Brett Mauldin, welding operations area superintendent; Mike Tanzi, welding operations area superintendent; Jeffrey Palumbo, welding operations supervisor; Derek McKee, robotics engineering supervisor; Zachary Frank, robotics engineering; Sam Baker and Chris Olsen, Arcrite Automation; and Steve Fuqua, NAVSEA PMS 397. In addition, EB Volumetric Welders Zachary Dumont and Shawn Novo were the first operators to utilize this technology in submarine production.

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Commercial shipbuilders within the United States must follow requirements set by the American Bureau of Shipbuilding or other governing bodies for welding operator certification, materials, welding processes, filler metals, and more.

SELECTING MATERIALS AND FILLER METALS FOR COMMERCIAL SHIPBUILDING

BY MATT UNDERWOOD AND RYAN O'DELL

How classification rules, structural steel grades, and welding processes influence consumable selection in production shipyards

The core objective of commercial shipyards is to enable high volume production across a wide range of vessels, including barges, tugs, tankers, dredges, oil supply ships, support ships, and more. While the designs of these vessels are simpler than those of military ships, care must be taken throughout the welding operation to ensure the integrity and safety of the structures. Specifically, commercial shipbuilders in the United States must comply with requirements set by the American Bureau of Shipbuilding (ABS) or other governing bodies for welding operator certification, materials, and welding procedure specifications covering joint design, welding processes, techniques, and filler metals. All filler metals used in shipbuilding applications must be certified through rigorous testing and selected for the specific material. For many common materials, multiple options may be available.

Common Steels Used in Commercial Shipbuilding

ABS Grades AH36, DH36, and EH36 high-strength shipbuilding steels are among the most common materials used by commercial shipbuilders, with aluminum, stainless steel, and copper-nickel utilized for a variety of internal components.

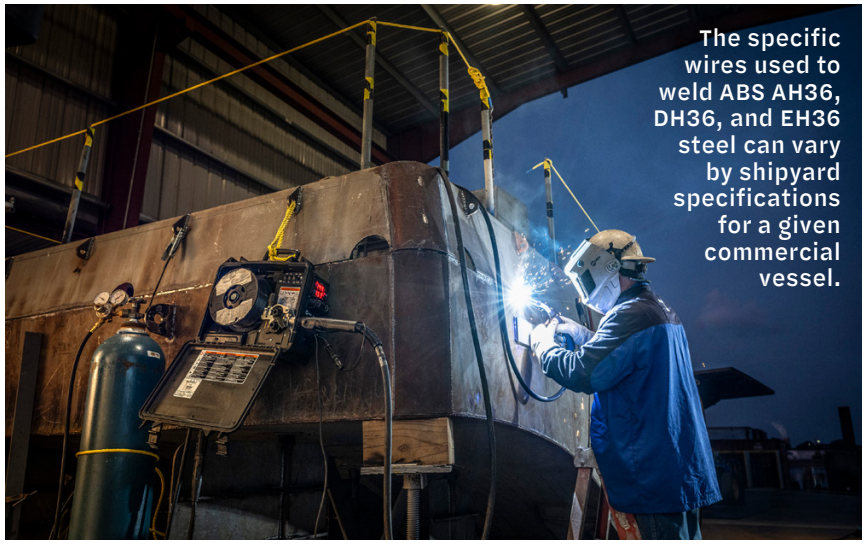
AH36, DH36, and EH36 steels are known for their excellent weldability and toughness. All three feature an ultimate tensile strength of 71

to 90 ksi (490 to 620 MPa), a yield strength of 51 ksi (352 MPa), and an elongation of 21%. The key difference between the steels is the temperature at which they pass a Charpy V-notch impact test. AH36 is tested at 32°F (0°C); DH36 is tested at –4°F (–20°C); and EH36 is tested at –40°F (–40°C).

Welding Processes and Filler Metal Selection

Commercial shipbuilders use both AH36 and DH36 steel for building ship hulls, but they can also be used for upper decks and bulkheads on cargo and container ships, as well as tankers. When manually welded, both materials require a 70-ksi flux cored arc welding (FCAW) wire. Welding wires for shipbuilding applications carry designations that differ from those used in other applications, and several can be used to weld AH36 and DH36 steel. A filler metal with an ABS 3YSA H10 classification would be an option for welding these steels and is similar to AWS E71T-1C H8 or E71T-1M H8 wire. The ABS 3YSA H10 wires can be certified for use with either 100% CO_2 shielding gas or a 75% argon/25% CO_2 mix, operating on direct current electrode positive (DCEP). By ABS certifications, this filler metal can be used in all positions. For 0.045- and 0.052-in.-diameter wires, parameters range from approximately 170 to 250 A and 23 to 26 V. A 1⁄16-in.-diameter wire would also operate in a window of approximately 23 to 26 V but at higher amperage ranges of around 180 to 275 A.

For large panels, both AH36 and DH36 steel can also be welded using the submerged arc welding (SAW) process on a panel line coupled with a gantry system or subarc tractor. Commercial shipyards typically use a solid SAW wire, and one with an ABS 3YM classification is an option. The wire would be coupled with the filler-metal manufacturer's recommended flux for that wire. The ABS 3YM-classified wire is similar to an AWS EM12K classification and operates between 200 and 900 A and 29 and 42 V, depending on the wire diameter, which ranges from 5⁄64 to 5⁄32 in.



The specific wires used to weld ABS AH36, DH36, and EH36 steel can vary by shipyard specifications for a given commercial vessel.

Because of its low-temperature toughness, ABS EH36 steel is used for the construction of hulls for commercial vessels that will encounter severe, even Arctic, water temperatures. An ABS 4YSA H5 FCAW wire (similar to an AWS E71T-1CJ H8) is an option for welding with 100% CO_2 shielding gas in all positions and operates on DCEP. Welding with a 0.045- or 0.052-in.-diameter wire requires around 100 to 250 A, while a 1⁄16-in.-diameter wire operates between approximately 150 and 275 A. The voltages for all three diameters range from 23 to 27 V. Another wire option is an ABS 5Y400 H5 classification, which uses a 75% argon and 25% CO_2 shielding gas mixture and also operates on DCEP for all-position welding. It is like an AWS E71T-1MJ H4 FCAW wire and operates in an approximate range of 200 to 240 A and 25 to 26 V for 0.045- or 0.052- and 1⁄16-in.-diameter wires.

ABS EH36 steel can also be welded using the SAW process, especially for large plates, again with a panel line and gantry system or subarc tractor. An ABS 4YM classification solid wire would be suitable, as would an ABS 3YM solid wire. Cored or composite electrodes, such as ABS 4M H10 (similar to an AWS EC1 filler metal), are also an option for SAW of ABS EH36 steel. Among these options, the approved flux/wire combination determines low-temperature toughness, depending on whether it's a neutral or active flux. Neutral fluxes will provide better overall mechanical properties.

Takeaways

The specific FCAW or SAW wires used to weld ABS AH36, DH36, and EH36 steel can vary by shipyard specifications for a given commercial vessel. Some may prefer to standardize their filler metal selection to simplify inventory, while others may look to achieve different mechanical properties for various ship components. Some commercial shipyards may also consider selecting a filler metal that provides good weldability and a wide operating window to help new operators achieve high-quality welds and reduce costly rework. Whichever the case, the aim is to construct commercial vessels that can withstand low temperatures while being safely operated. WJ

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