Plastometrex

CASE STUDY

The Road to Certification: DEEP Manufacturing's Journey with PIP Testing in WAAM Pressure Vessel Manufacturing

DEEP® Manufacturing

Plastometrex DEEP Manufacturing

How DEEP Manufacturing is pushing the boundaries of additive manufacturing

DEEP Manufacturing is a specialist in Wire Arc Additive Manufacturing (WAAM) and hybrid manufacturing for safety-critical, high-integrity structures. The company was established by its parent organisation, DEEP, to overcome the long lead times associated with forging and casting for large, custom subsea pressure vessels for human occupancy.

While DEEP's mission focuses on enabling humans to live and work underwater, DEEP Manufacturing was created as the industrial capability to deliver the certified hardware required to make that ambition possible. In developing large-format WAAM for pressure-retaining structures, the business has since evolved into a standalone advanced manufacturing company serving subsea, maritime, aerospace, energy and defence sectors.

However, deploying WAAM in safety-critical applications requires rigorous material qualification. Additively manufactured components must demonstrate consistent, predictable mechanical performance across complex builds.

To meet this need, DEEP Manufacturing have embraced innovative material characterisation in the form of Profilometry-based Indentation Plastometry (PIP Testing). With PIP Testing, the team at DEEP Manufacturing can accelerate the development of their next-generation pressure vessels while also setting new benchmarks for safety and performance in the AM landscape in a variety of sectors.

Unlocking WAAM's Potential: How PIP Testing Accelerates DEEP's Material Development.

WAAM builds are deposited layer-by-layer, with complex thermal cycles that can create heterogeneous microstructures and potential property variation across a component. Heat accumulation, deposition path, and build geometry can all influence the mechanical properties in different regions of a part. This complexity becomes even greater when exploring transitions from one material composition to another.

To navigate these challenges, DEEP Manufacturing incorporated PIP Testing into their testing workflows. Unlike traditional methods which demand large, precisely machined samples and lengthy preparation, PIP can generate stress-strain curves from small, irregularly shaped specimens in minutes.

At DEEP Manufacturing, the method is being leveraged to support the rapid development of their wire arc manufactured pressure vessels in several critical ways:

1. Accelerate research and development for optimising WAAM process parameters, evaluating new material combinations, and understanding the impact of various build strategies on the final component's performance.

2. Map material properties across large, complex WAAM structures to identify any inhomogeneity and ensure consistent performance throughout the entire component.

3. Enhance insights into WAAM builds through detailed stress-strain data, including yield strength and work hardening. This data is critical for validating simulation models and refining their manufacturing processes.

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When we started exploring WAAM for pressure vessels, we knew the technology had huge potential, but we also knew the certification process would be one of our biggest hurdles.

PIP Testing has given us a way to answer tough questions about our material properties quickly and with confidence.

Harry Thompson
Technical Director,
DEEP Manufacturing

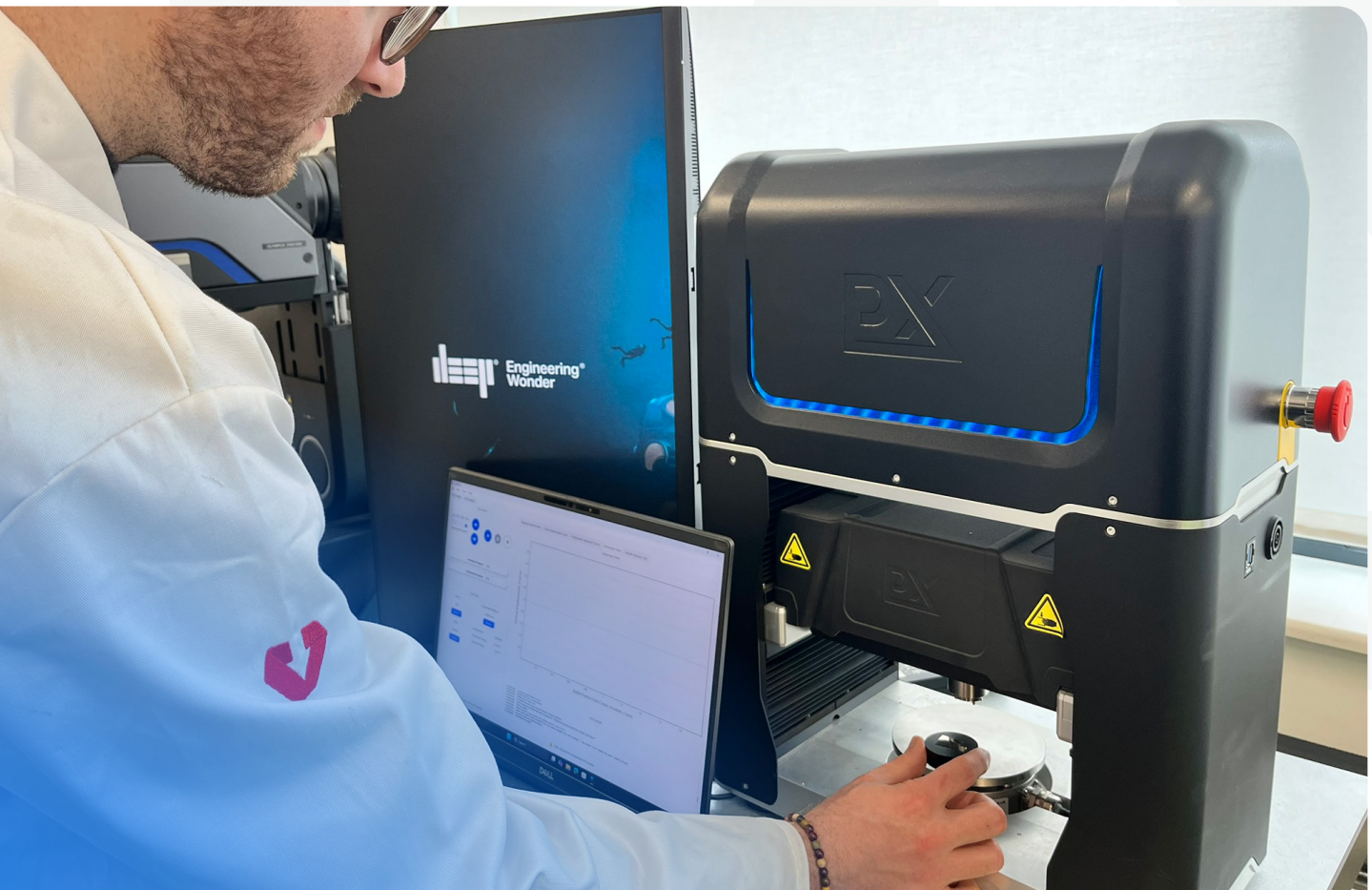
Beyond Development: The Path to Qualification and Unlocking New Frontiers

DEEP Manufacturing's relentless pursuit of innovation recently culminated in a monumental achievement: the company was awarded "Approval of Manufacture" (AoM) by DNV, the world's leading classification society in the maritime industry, for their groundbreaking use of WAAM in the production of steel pressure vessels for human occupancy.

Gaining AoM required meeting some of the most demanding mechanical qualification requirements in the industry. By deploying PIP throughout the development, DEEP Manufacturing were able to have performed far more testing than previously possible and gained extensive insights into any variation that might exist throughout a component. When DEEP Manufacturing was ready to start the formal test campaign for the verification of its vessels, they could be confident that the parts created would meet the highest standards.

Looking ahead, the potential for PIP Testing extends beyond process development. With the recent publication of ASTM E3499-35 Standard Test Method for Indentation Plastometry of Metallic Materials, a key building block is now in place for increased adoption. With an internationally recognised framework in place to control testing, organisations like DEEP Manufacturing can more seriously consider the case for using PIP to verify material performance in regulated applications.

The ability of PIP to provide highly localised mechanical property data aligns with the rigorous demands of certification bodies in proving data on real build geometries, rather relying solely on witness coupons. The complementary data generated could provide additional reassurance on performance in safety critical applications.



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There’s a lot riding on the performance of these vessels. Every test we run is part of proving — not just to the regulators but to ourselves — that our manufacturing process delivers industry-leading results.

The PLX-Benchtop has made that process faster, more accurate, and far less of a bottleneck.

Dr Afif Batal
Material & Process Development Engineer, DEEP Manufacturing

Driving Innovation, Ensuring Safety, and Redefining Manufacturing.

By integrating PIP Testing via the PLX-Benchtop system into their development workflow, DEEP Manufacturing has accelerated their R&D cycles, gained insights into their WAAM processes, and ultimately moved closer to commercialising certified, safety-critical additive manufactured components.

The journey of DEEP Manufacturing, supported by PIP and the PLX-Benchtop, illustrates a critical step forward in bridging the gap between advanced manufacturing capabilities and the stringent demands of regulatory approval, building confidence in the future of additive manufacturing for novel, challenging, and safety-critical applications.

Explore how you can accelerate material development and qualification with PIP on the PLX-Benchtop.

LEARN MORE

“Our collaboration with DEEP Manufacturing embodies the spirit of innovation and shared commitment to excellence. Seeing how DEEP Manufacturing is leveraging the PLX-Benchtop to advance such a critical application reaffirms the profound impact our technology has on enabling safer, more efficient manufacturing processes for the future.”

Dr Henry Begg
Applications Engineering Manager Plastometrex