

Enhancing Infrastructure

Maintenance, repair and upgrade of pressure vessels



Distillation Units ←

Reactors ←

Coke Drums ←

Alkylation Units ←

High-Pressure Separators ←

Digesters ←



Engineered solutions are being demanded more and more to increase product yields and improve plant operational reliability. With our **Unifuse**[®] technology, AZZWSI[®] can deliver a repair and/or upgrade a wide range of pressure vessels such as distillation units, reactors, coke drums, digesters and high-pressure separators.

AZZWSI repair on a Distillation Unit

With European headquarters in Hellevoetsluis, The Netherlands, we are dedicated to providing safe, efficient and timely services to our customers. We understand the complexity and technical demands of the Refining market with unrivaled knowledge and expertise gained over 30 years.

There are many potential problems affecting vessels such as wall thinning, pitting, cracking and corrosion/erosion issues. Due to our

automated weld overlay technology, AZZ WSI offers a repair or upgrade that can be implemented quickly and lasts forever.

We also work closely with our customers in the petrochemical, chemical and the pulp and paper industries, helping them to anticipate and react to challenges quickly, and provide tailored solutions that precisely match their requirements.

The largest global automated repair provider

There are a number of vital challenges that the industry faces. Each problem requires an individual solution that is based on our extensive refinery experience gained in all regions of the world, as shown in the table below.

Challenges	Solutions
Extend operational lifespan and enhance asset performance	We solve the cause of the problem with a permanent repair, thus avoiding the need for replacement by utilizing our automated weld overlay repair solution.
Improve asset mechanical integrity	Reinforce, upgrade or structurally repair an asset, combining our proven engineering and implementation experience with our automated weld overlay technology.
Reduce maintenance costs	Permanent, long-term repair adjusted to expected operational conditions could mean less maintenance (spot repairs) required in subsequent outages. We have the capacity to respond to short lead times, tight schedules and have a 24/7 manufacturing capability.
Consistent quality according to standards	Quality assurance and control comes as standard in all our solutions, with ASME and EN certifications for our automated welding and fully trained, specialist workforce.
Issues in challenging materials, locations, geometries and environments	We offer total engineering support that includes tooling design, metallurgical consultation, Finite Element Analysis (FEA), welding process design, and mock-up capabilities.
Meeting turnaround safety requirements	Attention and commitment to HSE standards is one of our core values and drives all our projects and solutions, as well as our leadership and teams during each stage of a project.
Reduced inspection demands	Permanent, expertly repaired surface solutions reduce the maintenance time required for inspections as the number of spot repairs are reduced.

Failure mode of the asset

Assets function in hostile operating environments and, combined with the need to reduce the environmental impact of production, this increases the corrosion and erosion of process equipment, and critical boiler, drum and vessel components.

A range of common failures affects the reliability of the asset and the safe operation of the plant.

Common failures	Observed damage
<p>Corrosion</p> <ul style="list-style-type: none"> ■ Sulfate corrosion ■ Naphthenic acid corrosion ■ HCl and HF corrosion ■ Ammine corrosion ■ Corrosion under insulation <p>Stress Corrosion Cracking (SCC)</p> <ul style="list-style-type: none"> ■ Chloride/alkaline/ammonia/sulfide SCC ■ Hydrogen-induced cracking (HIC) <p>Cyclic stress</p> <ul style="list-style-type: none"> ■ Low-cycle thermal fatigue ■ Vessel skirt stress risers ■ Penetration-related stress risers <p>Uncontrolled event</p> <ul style="list-style-type: none"> ■ Localized fire ■ Environmental damage ■ Uncontrolled process excursions 	<ul style="list-style-type: none"> ■ Reduction of pressure boundary thickness/wall thinning ■ Pressure boundary surface damage/pitting ■ Base metal contamination ■ Sub-surface cracking ■ Boundary weld cracking ■ Skirt attachment cracking ■ Localized cracking ■ Base metal damage ■ Structural instability/bulges ■ Localized accelerated corrosion



Bulging



Full circumferential skirt cracks



Corrosion/Erosion

We have proven products, experienced personnel and high-quality systems that deliver the definitive solution to these observed damages. In particular, **Unifuse** technology is central to the successful, long-lasting repair of essential customer assets throughout the Energy industry worldwide.

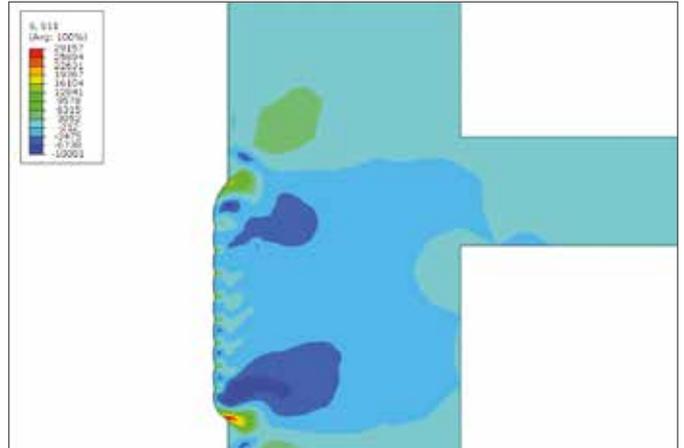
The AZZ WSI Unifuse process

AZZ WSI has over 30 years' experience in the protection of vessels using the **Unifuse** technology.

We utilize **Unifuse** automated welding technology to structurally repair, upgrade and reinforce assets to deliver long-term, reliable performance, which is a key objective for the mechanical integrity of critical refinery components.



Automated weld overlay using the **Unifuse** process



Radial residual stress prediction

Horizontal weld overlay results in a low dilution that is critical for the success of corrosion protection of the overlay. Other characteristics of this process are a small heat-affected zone and minimal distortion.

Comparing our horizontal process with the vertical down practice, specifically for pressure vessel application, the horizontal method avoids the higher – and localized – heat input that results in higher temperature gradients during the cooling phase of the weld process.

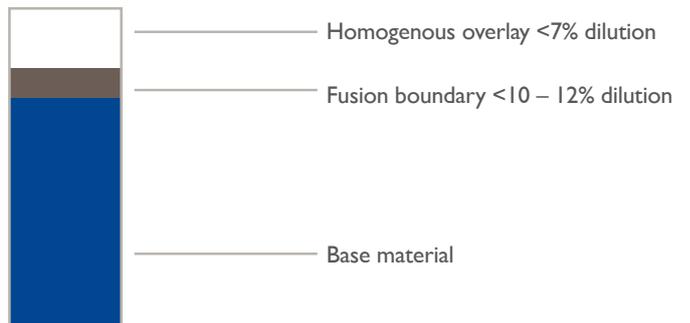
Therefore, it is possible to avoid the typically high risk of localized buckling in the shell due to the combination of a localized great heat input and the axial compressive stress developed from external loads (structural loads) acting on the vessel at the time of welding.

A horizontal weld overlay applied along the 360° area of a vessel results in a homogeneous heat input and, therefore, in a lower temperature gradient and minimal distortion risk.

The **Unifuse** process enables us to increase wall thickness to restore the pressure boundary and to apply an improved metallurgy to reduce the effects of erosion and corrosion, thereby delivering consistent quality by assuring the lowest dilution and distortion possible. This process also allows customers to control their schedule by keeping occupational risk as low as possible.



Smooth surface finish



Schematic illustration of a cross-section

Project assessment

The first stage of the process is to perform a complete assessment of the challenges faced by the customer. We provide a detailed evaluation of the situation, taking into account the customer's desired end result for safety, schedule and quality. This thorough assessment, performed by our world-class teams, enables us to propose the most suitable and efficient solution for the customer, beginning with an engineering evaluation completed by our corrosion metallurgists and welding engineers.



Shaded plot of vacuum column predicted diametric shrinkage



Mock-up for automatic weld overlay



- Working on various levels
- Ventilation plan
- Scaffolding
- High safety level

Pre-process evaluation

The Health, Safety and Environment plan



Workforce is fully equipped with necessary safety materials

A detailed plan covering all health, safety and environment issues supports everything we do from analysis to implementation.

Total compliance with Health, Safety and Environment (HSE) standards is fundamental to all our operations. We base all our training, procedures, onsite activities and manufacturing processes on adhering to the strictest HSE standards. AZZWSI is certified to SCC Petrochemical and we are renowned for maintaining the highest safety standards in the industry today.

Our qualified HSE Supervisors evaluate the scope of work to ensure that our planning anticipates and reduces risk as much as possible and that implementation is carried out in accordance with all the applicable safety rules. Our safety plan includes a full risk assessment that reflects the appropriate certifications, planning, responsibilities, training and the task risk analysis.

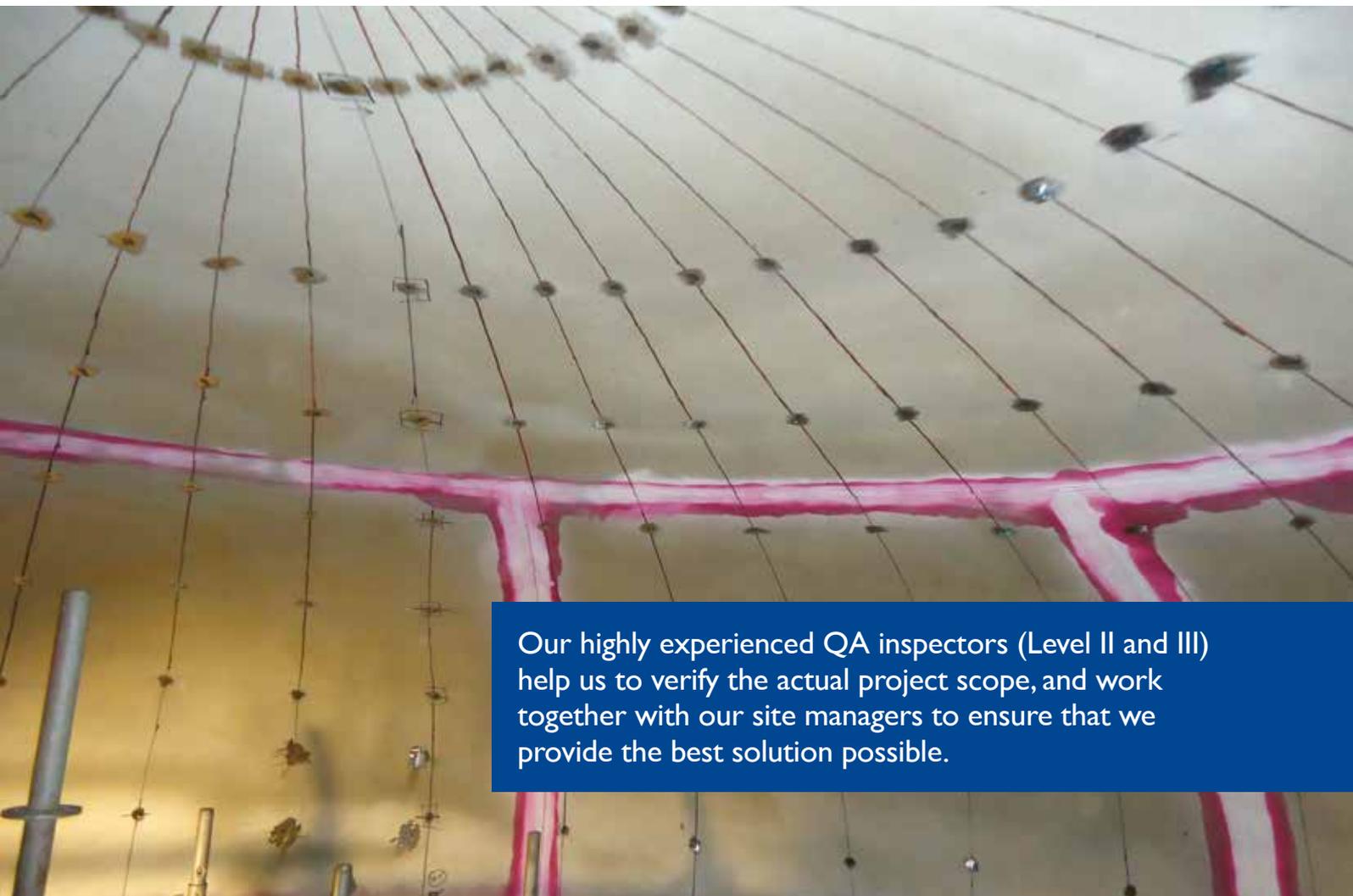
Pre-job site inspections

We take care to deliver all services to a high level of safety, quality and in the agreed time. Our projects are executed using highly experienced, trained and certified personnel at all levels, from site managers to welders.

During the evaluation phase of the project, we normally perform a pre-job site visit with key implementation and technical personnel, which helps us to clarify the best solution from a practical viewpoint with the various parties involved. This enables us to confirm that the best solution has been offered and gives a better vision of the actual site situation and how to further optimize our execution plan and schedule.



Pre-job site inspection



Our highly experienced QA inspectors (Level II and III) help us to verify the actual project scope, and work together with our site managers to ensure that we provide the best solution possible.

Dye penetrant inspection

Automated weld overlay on site

Following the results of our comprehensive analysis, inspections and safety planning, we then implement the various types of welding procedures to solve the customer's specific problem, as described in the following sections. This methodical process results in our ability to provide the best solution for the customer's particular asset failure.

In case there is existing cladding or weld overlay on the vessel, this needs to be carefully removed by the gouging process. Automated weld overlay allows for the application of a consistent layer of new metal, fully fused to the original base material. Wall thickness can be restored (build-up) for structural reinforcement and the unit material can be upgraded for consistent corrosion resistance.



Corrosion-resistant weld overlay

Unifuse weld overlay for both build-up and corrosion resistance

Our automated process has the ability to recover thickness lost by weld build-up and can also be applied to provide an appropriate material upgrade for a localized corrosion problem by assuring a high-quality deposit. Our primary focus is to provide permanent repair solutions that solve the root cause of the problem and extend the operational lifespan of the asset.



Weld overlay on spheres and domes

Overlay on an overhead position

We lead the industry in the enhancement of the mechanical integrity even if the repair is in an overhead position. Crucially, we have the capability to operate safely in some of the most inaccessible areas, such as domes and spheres. This industry-leading expertise ensures a high-quality build-up and corrosion-resistant weld overlay.



Nozzle overlay

Onsite automated nozzle repair

With our fully automated technology, we offer solutions for corrosion issues in nozzles from 24 inches down to 2 inches in diameter, delivering the same high-quality deposit, thus avoiding expensive replacement costs.



Orbital welding

Repair of through-wall cracks in head to shell circumferential welds

Our orbital welding capabilities, combined with a narrow groove preparation, allows us to perform a high-quality welding joint on assets such as pipes, pigtails, and tube replacement in a relatively short schedule. Orbital welding allows us to control all parameters to achieve a high-quality, flawless joint, especially for thick-section components.



Structural reinforcement

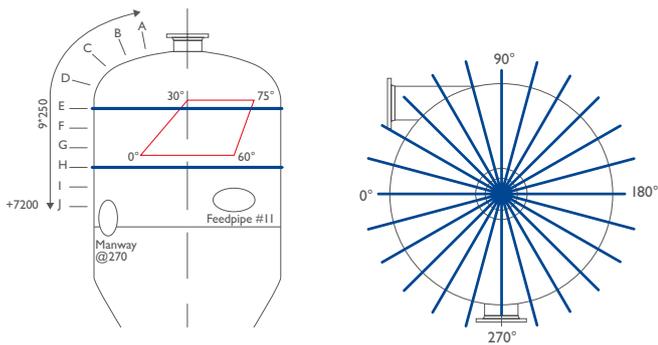
Including tapering for avoiding further stress

We offer structural repair of components and reinforce assets to extend the asset lifetime. Adding a tailored, designed structural reinforcement can successfully repair cracks, welding seams and other mechanical damage resulting from fatigue.

Quality Assurance

Once the welding program has been completed, we perform a post-inspection to ensure that the quality of work has been carried out to the highest industry standards as agreed with the customer.

Our rigorous Quality Assurance (QA) program determines the highest standards for all welding procedures and also ensures maximum quality levels are achieved throughout the entire project.



Example of out-of-roundness evaluation

Our inspectors produce a comprehensive report of the completed work.

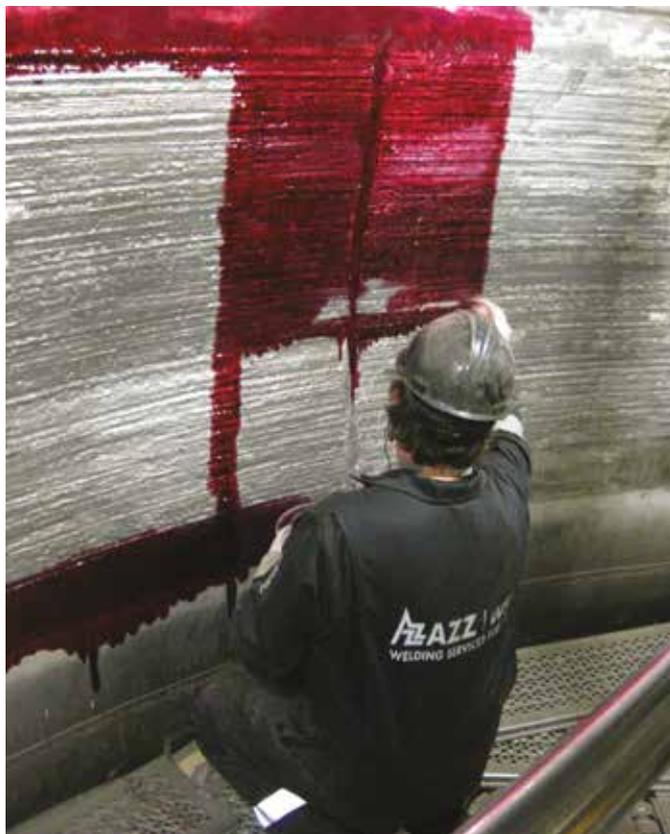
Our typical report includes the following Non Destructive Testing (NDT) activities performed by our onsite QA managers

- UT, VT prior to overlay
- Random during overlay application
- UT, VT, PMI and PT after completion of overlay
- Out-of-roundness prior to overlay and after overlay completion

All AZZ WSI craftsmen are qualified to EN 287-1 and EN ISO 14732 or ASME and the work scopes are performed in accordance with the requirements of PED 97/23/CE and applicable design and manufacturing codes for pressure equipment.

We have a Quality Assurance Program certified to EN-ISO 3834-3, AD-Merkblatt HP0 (TRB 200), TRD 201 and ASME U & S.

All welding procedures meet the requirements of EN-ISO 15614-1 and 7 and/or EN 288 and TÜV Merkblatt I 156/1166 or ASME BPVC.



Weld overlay PT inspection



PMI/FN inspection using XRF



Thickness measurement



AZZWSI develops and delivers specialized maintenance through automated weld repair solutions, combined with advanced technologies, engineering capabilities, and equipment. Whether it is a solution for the upgrade of a coke drum, vacuum crude tower, column, alkylation unit, reactor tube, high-pressure separator, digester or cat cracker, we have the commitment and proven industry track record to meet and resolve the most difficult mechanical integrity challenges.

Optimal protection for digesters

To protect digesters, alloys such as 309 and 312 steel have been successfully used for more than 30 years. Our **Unifuse** patented process for applying 309 and 312 alloys allows us to achieve a weld overlay free of solidification cracks. This process is typically applied horizontally, thereby assuring a constant Cr concentration (typically >25%) across the overlay. In addition, the old cladding must be removed by means of gouging.

When schedule is crucial

The vertical down welding process is much faster than the horizontal process, though there is a high heat input and temperature gradient related to this process; therefore, there is a high risk of dilution and possible distortion.

However, our engineering department can carefully design an appropriate vertical down process by taking into consideration different factors such as wall thickness, ambient conditions, and heat sinks (insulation vs. natural/forced convection) to avoid this associated risk and deliver a better schedule whilst keeping the quality as high as possible.



AZZWSI offers a unique, fully automated repair solution for the Nozzle ID covering a range from 2 to 24 inches

Welding overlay vs. other solutions

There are many different methods used to repair damaged mechanical components. Above all, the decision criteria will define the method chosen.

	Unifuse weld overlay	Total replacement	Section replacement	Strip/sheet lining
Nominal thickness recovery (build-up)	+	+	+	-
Material upgrade (corrosion protection)	+	+	+	+
Structural reinforcement	+	+	+	-
Lifetime extension	+	+	+	-
Maintaining schedule	+	-	-	-
Low safety risk	+	-	-	+
Emergency response	+	-	-	+
Inspection accuracy	+	+	+	-
Long lead time	+	-	-	+
Heavy lifting needed	-	+	+	-
Pressure test mandatory	-	+	+	-

Enhancing Infrastructure



AZZ WSI® is a specialized global services company offering innovative maintenance through automatic weld repair solutions that extend the lifetime and maximize the value of our customers' assets in the Energy industry.

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