

UHP WATERJETTING – THE OLDEST - NEW METHOD FOR SURFACE PREPARATION  
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**ABSTRACT**

With the growing concerns over change in Federal regulations, and the increase in waste disposal costs, the oil and gas maintenance industry is in need of an alternative solution to fit these specifications. They are in need of an innovative tactic that is controlled, safe, predictable, and most importantly, able to provide an ultra-clean surface that meets the set industry performance standards.

Little do most people know, this solution we are all looking for was created in the early 1800s, and used by coal miners as a method to remove loose debris and coal. This solution is the use of water pressure to remove contaminants and various materials. The method has evolved since the early 1800s to now use ultra-high-pressure water to effectively remove coatings and contaminants from surfaces. The process is now known as UHP Waterjetting. In 1994, the US Navy embraced this method as a means to reduce waste streams, and provide a solution to ships breaking up at sea because of corrosion.

Surface preparation techniques have evolved with the acceptance of UHP waterjetting (UHP WJ). The new technique has proven to provide benefits in not only workflow, but also in the overall project's pocketbook as well. With quality requirements rising and budgets for maintenance activities decreasing, UHP WJ has become the ideal surface preparation solution.

With abrasive users still hesitant to make the change to water, this paper aims to provide you with a wealth of knowledge surrounding the topic and more details on one popular method of utilizing this solution, remote controlled robotics.

**WHAT IS UHP WATERJETTING?**

UHP WJ is a surface preparation technique that uses ultra-high-pressure water (greater than 30,000 psi, 2,000 bar or 200 MPa) to remove various coatings, contamination, chlorides (salts) and corrosion. The process uses pure, chloride-free water to remove unwanted materials and leave behind an ultra-clean, rust-free surface at a WJ-1 to WJ-4 SSPC/NACE standards. Unlike abrasive blasting, water cleans from the bottom up leaving the original profile intact. Abrasive blasting harms the original profile and causes material to be jammed into the profile and not completely evacuated like UHP WJ. This method is best used when removing heavy rust, heavy elastomeric coatings, thick urethanes, fiberglass filled paints, salts, lead based paint and ice breaker coatings. Water pressure at this rate simply shears off coatings and contaminants revealing an optimal surface for coating performance.



UHP hand lance waterjetting on a ship hull.

### **COMMON CONCERNS SURROUNDING WATER**

To begin, let's address two of the more common concerns surrounding UHP Waterjetting (UHP WJ) in general. Rust and surface appearance have many myths surrounding them and have caused many contractors, owners and operators to stray away from water. Like in most instances, there is more to the story.

1. The first flag that is always raised is that water causes “New Flash Rust”. We are not here to argue that it is not true, after abrasive or UHP WJ surface preparation, if any harmful salts are left on a bare substrate you can expect rust. However, UHP WJ, using clean non-contaminated water, will leave behind no invisible contaminants such as salts or chlorides. Therefore, this surface will not rust for thousands of hours even at 100% relative humidity. Leaving you a ultra-clean surface with the original profile intact. In some instances, waterjetting will leave behind a uniform light brown iron oxide. This is what the waterjetting community refers to as “Good Rust”, which coating manufacturers will accept as acceptable for coatings. “Good Rust” is a clean, uniform, tightly adherent, light brown rust-iron oxide - without hidden salts. Coating manufacturers will not let you paint over “Bad Rust”. This is localized corrosion cells that are easily identifiable by a black, splotchy liquid that is forming. The fact that UHP waterjetting removes all invisible contaminants is all maintenance experts need to know when deciding whether to move forward with UHP WJ.
2. The next flag that is always raised is that the surface is not a shiny, “White Metal”, finish like you see with abrasive blasting. First we must understand why an abrasive blasted surface is shiny in the first place. The reason for “White Metal” is that the abrasives, in maintenance, are removing the coatings along with a portion of the original profile. The

original blast material was sand which fractures during the blast cleaning process. The fractured sand dust left behind is light colored and reflects the sunlight; hence “white metal” to describe the surface. Secondly, some abrasive removal processes will form a plateau of metal which also reflects light. The abrasive blast process exposes bare metal for this first time and makes the original profile, giving it a shiny appearance. The negative here, certainly during maintenance or rehabilitation, is that the abrasive process is removing portions of the original profile which in turn is harming the maximum potential for adhesion of the new coatings. UHP waterjetting does not remove any of the original profile, which is why you can expect a near “white metal” finish. However, this near “white metal” finish has zero salts or chlorides, the original profile that was approved the first go around, and is recognized as a WJ1 – WJ4 SSPC/NACE standards. The surface is typically dull gray rather than shiny white because the fractured sand dust and embedded abrasive is removed which shows every imperfection including where there was under-coat corrosion. If you look at the final performance result of UHP waterjetting, rather than the aesthetic, you will see the process provides a superior method to abrasive blasting for surface preparation during maintenance.

### **BENEFITS OF UHP WATERJETTING ROBOTICS**

Driven by the benefits of UHP waterjetting (UHP WJ), service providers have begun to specialize in being a service provider of turnkey UHP WJ solutions for contractors and owners worldwide. A solution that is becoming more and more common is the use of remote controlled robotics for UHP WJ surface preparation. This new tactic started around 1994, long before abrasive blasting tested the process. With its many benefits, the industry has accepted remotely controlled equipment as a safer and more efficient way to provide customers an ultra-clean surface with the following benefits.

1. **Safer Operations**

UHP WJ robotics is putting technicians further out of harm’s way, and safely planted on the ground. The solution’s medium is pure water rather than the hazardous abrasive grit. Grit can cause dangerous dust clouds that are harmful for workers to inhale causing health concerns for technicians. There is no need for breathing quality air to a mask except for special cases. Grit also can find its way into ventilation ducts, motor parts, pumps and other important systems within plants and facilities causing major damage from loose abrasive particles.

2. **Lower Costs**

Because only pure water is used to remove coatings with UHP WJ, there is no need for abrasive. Eliminating the need for collection, containment and the disposal of abrasive can save you up to \$300 per hour, per blaster. Less equipment and no extra clean up means smaller budgets for the customer.

3. **Reduced Overall Project Time**

Utilizing UHP robotics, service providers are able to remove coatings at a rate of up to 750 sq. ft. per hour, depending on coating thickness. Removal of coatings with water instead of grit allows for other work to be completed during surface prep operations. Steel/mechanical welders, electrical, and painting applications are able to be performed

concurrently right behind the robotic crawler. This means projects are completed in less time, saving refiners and owners the most on projects.

4. **Produces A Cleaner Surface**

A cleaner surface means reapplied coatings will last longer - plain and simple. The UHP WJ robotics will remove all coatings and contaminants leaving the surface at a WJ-1 to WJ-4 SSPC/NACE standards with the original profile intact. Corrosion products are removed from deep into the profile pits and leave your surface with zero water-soluble salts, chlorides and other contaminants to provide a ultra-clean surface for the new coatings to be applied.

5. **Eco-friendly Process**

Starting in the 1970's, environmental compliance has been gaining more and more attention. Grit blasting's detrimental impact to our environment has positioned UHP WJ to be accepted and recognized as the leading choice in surface preparation with minimal waste and environmental impact. With advancements in filtration systems, service providers are able to return the used water from UHP WJ production back to clean water that in most cases can be disposed into ditches, sewers, etc. Therefore, reducing the amount of waste astronomically as compared to abrasives. In fact, when projects are finished, in most cases, the effluent water meets common drinking water standards.



UHP robotic crawler operating on a storage tank exterior wall.

**WHERE IS UHP WATERJETTING ROBOTICS BEING USED?**

UHP waterjetting (UHP WJ) has proven to be an efficient and effective manner to achieve surface preparation goals. Secondary surface preparation utilizing UHP WJ is currently being used across many different industries in maintenance or rehabilitation. Whether preparing the surface of an above ground storage terminal inland or a helipad offshore, UHP WJ has proven to

be a worthy alternative to abrasive blasting. Below is a list of different industries and how UHP WJ Robotics is benefitting each one.

1. **Petrochemical Plants, Storage Terminals & Refineries**

A common use for these industries is for above ground storage tank (internal & external surfaces) maintenance to remove coatings, specialty liners, rubber lining and fiberglass. The UHP WJ robot's ability to move efficiently around the internal and exterior surfaces of tanks reducing project time has caught the eyes of contractors and owners alike. Robotic systems that utilize vacuum systems contain all the waste from production. Therefore projects have no clean up which significantly reduces budgets for cleanup crews. In most cases, after running the waste water through a modern filtration system, you are able to dispose effluent water right into dikes, ditches, water systems, water the lawn, etc., which reduces waste disposal significantly as well. Using remote controlled operations keeps technicians on the ground rather than on man lifts, which increases safety on projects and helps stay away from incidents.

2. **Offshore Platforms & Drilling**

A common use for offshore industries is the maintenance of rigs, ships and helipads. Utilizing watermakers, you can forget about the need to bring abrasive offshore. The service providers are able to take raw water right out of the natural body of water and use it for surface preparation. Using modern filtration systems, the effluent water can then be dispensed back into the body of water with no worry of environmental impact or contamination. Not having the need for abrasive equipment significantly reduces the total job footprint allowing more room for other operations. Concurrent work can also continue during UHP WJ operations keeping other operations moving forward. The smaller job footprint and no harmful impact on the environment makes UHP WJ Robotics a great solution for your offshore surface preparation needs.

3. **Shipyards**

A common use for shipyards is the maintenance of ship decks and hulls. Service providers offer robotic crawlers that carry themselves around the ship's hull and deck using a vacuum system. Therefore you will have no need for man lifts or scaffolding giving it the upper hand to abrasive blasting. Keeping shipyards clean, the system calls for little to no clean up or waste disposal after operations are completed. With much other work needed to be done on boat maintenance while in dry dock, contractors using UHP WJ robotics can continue tasks such as hot work and painting while the system is still in operation.

## **EXAMPLES OF UHP WATERJETTING IN ACTION**

This method of surface preparation has years of experience and countless success stories conquering difficult tasks. Lets take a look at a few instances where, in tricky situations, UHP WJ was able to solve a unique surface preparation hurdle.

## **#1 – Asbestos & Lead Based Coating Removal**

**Task at Hand:** The project's scope of work was to abate lead and asbestos coatings on the shell of a 150" diameter x 48 ' tall storage tank for a major refiner in the Midwest. The tank had been insulated with spray foam which had already been removed by the coatings contractor, leaving an asbestos filled mastic and lead based paint on the surface. Initial efforts to remove the coatings by scraping the heavier mastic and then utilizing a chemical remover to remove the remaining coatings were taking too long. Also, the additional cost of containment and disposal were of concern. This is when the contractor decided to deploy a self-contained robotic system to finish the job.

**Surface Preparation Solution:** The contractor decided to use a remote-operated robotic waterjetting crawler. This particular robot used a vacuum system to attached itself to the surface for waterjetting operations. The system used a UHP pump that delivers ultra-high pressure water to clean the surface, known as UHP waterjetting. After surface prep, the water was pulled back into the system, utilizing the same vacuum, and ran through a filtration system. The water discharged from the system was able to be disposed of into near by drainage systems, free of lead and asbestos.

**Results:** The remote-operated robotic waterjetting crawler was able to complete the job at 325 sq. ft. per hour, and provide a WJ-1 Standard (white metal, ultra-clean) surface with zero-chlorides. The surface behind the crawler was immediately ready to coatings, which enabled the contractor to clean and cover more surface each day. Hazardous waste was significantly reduced, leaving behind only four (4) 55-gallon drums of paint chips that were to be disposed of. The return-to-service schedule was shortened by weeks which in turn provided tremendous cost savings for the refinery.

**Summary:** UHP waterjetting was able to take a complicated hazardous coatings project and remove many safety and operational concerns. The surface was delivered to the specified surface clarity, and with no harmful dust clouds, the painting contractor was able to operate simultaneously behind the robot to cover more surface each day. The project had zero safety incidents and saved the refinery significant costs through disposal and timeline efficiencies.

## **#2 - Coatings Removal on LNG Tank (4)**

**Task at Hand:** Strip and repaint the exterior of a 14,000,000 gallon [53,000,000 li Liquefied Natural Gas (LNG) double-walled tank. The tank stands 125 ft.[38 m] tall and has a diameter of 180 ft [55 m]. Therefore, the contractor needed to surface prep 85,000 sq. ft [7897 sq. m] of a 12 – 18-mil [305 to 457 micron] coating system. Because the tank is a double-hull tanker with a pressurized interior tank, the project had no tolerance for "hot work" to avoid the danger of explosions. The existing paint was 15 years old and had light rust breakthrough covering about 80-90% of the surface. The overarching goal of the project was to provide a recoated surface that would last the owner 20 years.

**Surface Preparation Solution:** Because of safety, environmental concerns and the nature of the project, the contractor selected UHP WJ as their surface preparation solution. The contractor used one (1) remote controlled robotics system, four (4) UHP WJ pumps, eight (8) hand lance guns, assorted hoses, one (1) vacuum truck, one (1) 20 yard vacuum box, three (3) man lifts and



one (1) 250 cfm air compressor. The robotics system would handle the large flat areas on the tank and the hand lances would take care of the areas of the tank not accessible by the robot. The two equipment [325 sq. meter] systems are able to work concurrently to increase production rates.

**Results:** The job went off without a hitch. The contractor was able to waterjet an estimated 4-5 hours per day with around 3-5 hours per day spent moving lines, inspecting progress, and performing other house-keeping chores. The contractor was able to clean as much as 3,500 sq. ft. per day but averaged around 2,000 sq. ft. [186 sq. m] within the 4-5 hours of production time. Around 100,000 gallons of water [378,000 L] was used for the project, which was then filtered and released back to the utility company. The project was initially scoped to be done in 2 phases, but after the utility company recognized how efficiently the project was being completed, they authorized the completion on the entire tank in one season.

**Summary:** UHP waterjetting was able to effectively and efficiently perform surface preparation on the LNG tank while under safety and environmental scrutiny. The contractor was able to complete the job in less time than expected and leave a smaller impact on the job site and the environment. Using less equipment and having had little to no disposal costs, the contractor was provided a premium surface with a smaller budget attached. Making UHP waterjetting the easy choice for projects of this specification.

### **#3 – Coatings Repair on Thames Barrier (3)**

**Task at Hand:** A ship has struck the Thames Barrier flood control gates located in London. These gates protect the metropolitan London area from dangerous surge tides that threaten the area. The ship caused significant damage to the coatings which needed to be fixed quickly before the risk of permanent corrosion damage occurred. The contractor needed to be able to provide a fast solution that was able to work while the gate stayed in operation. Since the gate was over water, the solution needed to have no environmental pollution or potential release into the waterways.

**Surface Preparation Solution:** The contractor elected to use a UHP WJ robotics system using a vacuum crawler that contained all cleaning waste. The robot used 40,000 psi [2750 bar, 280 MPa] provided by the UHP pump to remove the coatings from the surface. Then the attached vacuum was able to collect all waste from the surface prep and deliver it into a remote vacuum skid. The effluent water would then be filtered and prepared for disposal. Because the project could not interfere with gate operation, minimal equipment was loaded onto a barge and moored at the base of the gate. The complete system consisted of a UHP pump, vacuum skid, remote crawler, generator, air compressor, and tankage. The use of a filter system was also used for effluent water so that it could then be returned to the Environment Agency's water system. All operation were done from the deck of the barge so that the flood gates could stay in operation.

**Results:** The UHP WJ system provided an environmentally safe surface preparation method. Being in a high salt environmental, the system was still able to remove all contaminants and provide a superior surface for coatings. The job was completed quickly and without having to take the flood gates out of service.

**Summary:** Utilizing a Robotic UHP waterjetting system, the contractor was able to provide the owner a minimal invasive solution to tackle their surface preparation need and not interrupt operations of the flood gate. The vacuum capabilities of robotic system were able to contain all waste from the project, preventing all debris from falling into London's waterways.

### **IN CONCLUSION**

With proven cases of success and standards put in place, UHP waterjetting is well on its way to becoming the obvious choice for surface preparation. The method's ability to remove all invisible contaminants from the surface is what you should take from this paper. The fact that the process will save you money and time are an added bonus. The goal of any surface preparation project is to provide an ultra-clean surface for coatings to be applied. If we concentrate on this small aspect of surface prep, then UHP waterjetting is the obvious choice for any contractor or owner striving for success in their surface preparation operations. The process's ability to blast away contaminants and not harm the original profile gives it the upper hand to its competitor abrasive blasting.

The surface preparation industry has begun the transition into UHP waterjetting and has accepted it as a proven method. Environmental and safety benefits of UHP waterjetting have caused many countries to begin to ban abrasive blasting because of its detrimental environmental and health concerns. Which leads one to believe that the United States is not too far behind from taking action as well. With innovative solutions such as UHP waterjetting robotics available, contractors are having a hard time not wanting to hear more about how it can solve their problems. Dr. Lydia Frenzel said it best, "Water Is True Grit". The surface preparation industry is changing, and it's going to continue to change as more and more technological advances arise with UHP waterjetting. Are you part of the future, or will you be left behind?

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