Preparing Offshore Platforms with Ultra-High Pressure Abrasive Blasting—Basics and Cases

R. Godoy, Meaux Surface Protection, Inc., Lafayette, LA, USA, and A.W. Momber, Muehlhan AG, Hamburg, Germany

Like other kinds of work on offshore platforms, surface preparation is challenging. Remote access, the aggressive environment, the risks to worker safety, and the complexity of the structures are just a few obstacles. Ultra-high pressure abrasive blasting (UHPAB), a relatively new method of surface preparation, is developing a promising track record for surface preparation on offshore platforms. After a brief review of the UHPAB equipment and test results on coating adhesion to surfaces cleaned with the equipment, the authors describe positive experiences with the UHPAB method in the offshore industry, mainly on drilling rigs, offshore oil and gas extraction platforms, semi-submersible rigs, and jack-up units. Data on efficiency, economy, quality and job organization are also reported.

The Method and Equipment
According to ISO 12944-4, a surface preparation method is defined as "any method that prepares a surface for subsequent coating processes.” Surface prepa-
In the second state, the abrasive-air mixture is accelerated again by a high-speed water jet. The resulting three-phase flow (solid particles, air, water) is then directed at the steel surface at very high speeds, up to 500 m/s.

The basic equipment for UHPAB includes UHP water pumps, compressors and blast pots, UHPAB nozzles, and a control module.

The UHP water pumps are horizontal triplex plunger pumps. A 10-foot sea container holds either one or two pumps (Fig. 1a); one pump supplies two nozzles. A water flow rate between 4 l/min and 10 l/min is delivered to each nozzle; the water pressure can be adjusted between 150 bar and 2,500 bar (15 and 250 MPa, or 2250 and 37,500 psi).

Compressors and blast pots are conventional equipment. Typical air pressure ranges between 7 and 18 bar (105 and 125 psi). Copper slag is often the preferred blasting abrasive for UHPAB. The UHPAB nozzles are specially designed. The control module, mounted directly to the nozzle, allows for the set-up of four different surface treatments: (i) abrasive, air, and water (UHPAB); (ii) abrasive and air (AB); (iii) water and air (UHP); and (iv) air only (for drying).

Auxiliary equipment includes the following: a mobile saltwater treatment device; a suspension pump; and a solid-liquid separator for the slurry of abrasive, removed paint, and water. The saltwater treatment device allows for the use of sea water and brackish water for blasting and jetting processes, and it generates drinking water as well as desalinated water (Fig. 1b). Its capacity is about 60 tons of water per day. It is described in detail in Reference 3.
Surface Quality Test Program

To assess the qualities of surfaces generated during UHPAB, extensive tests were performed under the supervision of the Germanischer Lloyd, Hamburg. Three surface preparation methods—AB, UHP, and UHPAB—were utilized, and the performances of five typical organic coating systems for maritime applications were evaluated. The tests and measurements included salt-spray tests, condensation tests, water immersion tests, adhesion tests, surface profile measurements, delamination at an artificial scribe, measurements of electrical conductivity of a test liquid extracted from the prepared steel substrate, salt contamination tests, and assessments of amounts of dust remaining on the steel after surface preparation.

The measurements of salt contamination are shown in Fig. 2 (lower left graph). The UHPAB noticeably reduced the chloride concentration in the extracted test liquid (samples taken with the Bresle test). The same trend was observed for the electrical conductivity of the test liquid (which expresses the total amount of dissolved substances). The water in the UHPAB jet flowed over the surface and into pores and flaws at high speed, and it washed the majority of the dissolved salts away. The profile parameters are displayed in Fig. 2 (lower right graph). They were at high levels for AB and UHPAB ($R_{\lambda_5}=60$ to $65 \, \mu m$), but were rather low for UHP. This was due to the solid particles involved in AB and UHPAB.

The upper right graph in Fig. 2 shows the results of delamination measurements at artificial scribes after the neutral salt spray test. UHPAB noticeably reduced delamination. The rather poor performance of coatings on AB-treated substrates was, as SEM images have shown, probably due to contamination from abrasive debris, which could have occurred if the substrate was not fine-cleaned after blasting. In the case of UHPAB, all debris was flushed away by the high-speed water flow. Pull-off tests exhibited excellent results for UHPAB with almost no adhesion failures (Fig. 2, upper left graph).

Based on the result of these studies, the classification society Germanischer Lloyd issued the following quality certification: “PZ 00015 HH: UHPAB for repair works in shipbuilding and steel construction, Germanischer Lloyd AG, Hamburg, March 2004.”

**Fig. 2: Results of surface quality assessment and of coating performance.**
JOTUN

Protective Coatings

Aker H-6
the world’s largest
drilling rig

Kashagan – Caspian Sea
the world’s largest
offshore oilfield

Afsin-Elbistan
the world’s major
power plant

Jotun protects
the world’s major structures
combining innovation,
expertise and reliability

For more information see
www.jotun.com/us

Jotun Paints, Inc.
P.O. Box 159 Belle Chasse, LA 70037 USA
Phone: (800) 229-3530 Fax: (504) 394-3726

Click our Reader e-Card at paintsquare.com/eic
Application of UHPAB to Offshore Structures

General Aspects

Offshore structures may be divided into several types: onshore, fixed platform, jack-up rig, semi submersible rig, drill ship, tension leg platform, floating production system, (e.g., FPSOs). Of these types of offshore structures, UHPAB has been used mainly and with promising results on jack-up rigs, semi submersible rigs, and tension leg platforms. UHPAB has a number of advantages that make it suitable for use under offshore conditions:

• very low dust emissions,
• low abrasive consumption,
• low water consumption,
• low energy (fuel) consumption,
• high productivity,
• high cleaning efficiency,
• sufficient surface profile, and
• excellent adhesion of coatings to substrate.

As with other methods, UHPAB’s productivity depends largely on environmental and work conditions, especially the structure to be cleaned, its size, accessibility, job organization, and equipment parameters.

We gained excellent experience with the use of UHPAB for removing coatings from pipe systems—production rates were as high as 10 m²/h per nozzle; and bundle holders, bridges, and armatures were not damaged because the method does not cause abrasive to rebound. Geometrically complex structures, such as girders, legs, and beams, reduced productivity—but this trend holds for any blasting method.

Maintenance Work on Jack Ups and Semi Submersibles

Jack ups and semi submersible platforms usually go into dock for repair and maintenance jobs. Figure 3 shows a structure prepared with UHPAB, as does the photo on the opening page of this article. Table 1 lists a selection of projects. Jobs to be done included the following:

• removal of deteriorated paint systems;
• removal of heavy rust;
• removal of barnacles and other marine growth;
• surface preparation for re-coating and;
• cleaning of weld seams and accessories.

Case History: Offshore Work on East Cameron 46

The platform is a six pile (fixed) platform in the Gulf of Mexico. Some details are shown in Fig. 4. The scope of work on this project was to blast clean and paint a total of 1,500 m², including the six legs to the waterline (380 m²), and the waterline and boat landing (1,120 m²). The legs were dry abrasive blast cleaned to SSPC-SP 10, Near-White, for comparison purposes. Our dry blasting equipment included an eight-ton blast pot, one 825-cfm compressor, and a 900-cfm aftercooler. Silica sand was used at an air pressure of 110 to 125 psi at the nozzle. The waterline and the boat landing were prepared to an SSPC-SP 10 with UHPAB equipment described earlier. A five-man crew completed the project within 28 days. The distribution of hours (in percentages) based on method and task is given in Table 2.

Safety consumed 4% of the hours based on a 12 hour day in both. Half an hour was spent in the morning to hold a safety meeting on the activities to be performed that day. Rigging times were very close despite the different type of rigging used in each area. The legs were worked using spider baskets; the waterline was worked using cables and boards. However,

Table 1: Jack-Ups and Semi-Submersibles Done with UHPAB

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Job Location</th>
<th>Area in m²</th>
<th>Reduced* Time in %</th>
<th>Reduced* Abrasives in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global High Island</td>
<td>Jack-up</td>
<td>Legs</td>
<td>3,100</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Glomar High Island II</td>
<td>Jack-up</td>
<td>Drill deck</td>
<td>820</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pride of Pennsylvania</td>
<td>Jack-up</td>
<td>Legs</td>
<td>4,100</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Global High Island IV</td>
<td>Jack-up</td>
<td>Legs</td>
<td>2,000</td>
<td>26</td>
<td>49</td>
</tr>
<tr>
<td>Glomar Arctic IV</td>
<td>Semi-submersible</td>
<td>Deck, piping</td>
<td>3,500</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>West Menang</td>
<td>Semi-submersible</td>
<td>Deck, wall</td>
<td>12,500</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Maersk Jutlander</td>
<td>Drilling rig</td>
<td>Deck, piping</td>
<td>10,300</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Atwood Eagle</td>
<td>Drilling rig</td>
<td>Legs, deck</td>
<td>22,000</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

*Compared to conventional dry blast cleaning

Continued
PPG Protective & Marine Coatings

PPG High Performance Coatings and Ameron Coatings are now **PPG Protective & Marine Coatings**, providing even greater products and services to meet your offshore needs.

- Corrosion and Weather-Resistant Coatings
- Long-Term Color and Gloss Retention
- Proven Performance
- Global Distribution Network
- Recognized Brands
  - Amerlock®
  - Dimetco®
  - PSX®
  - Pitt-Chair®
  - Amercoat®

PPG Protective & Marine Coatings stand up to the toughest offshore conditions. To learn more about our products or services we invite you to contact your PPG representative.
that UHPAB was more effective than conventional dry blast cleaning. UHP was used on rotating equipment.

Case History: Offshore Work on Anadarko

This project featured the preparation and protection of 6,400 m² of steel on two structures, located about 30 miles into the Gulf of Mexico (Figs. 5 and 6). The structures are two eight-pile fixed platforms, one of which produces oil and gas. The other structure is outfitted with compressors, generators, separators and related equipment to process the oil and gas from this field and other adjoining fields. The work assignment was to blast clean and paint the process equipment located next to all of the rotating equipment on the process platform, and to prepare and paint the rotating equipment without shutting down the facility or damaging the equipment. The existing coating on the structure had exceeded its expected life and was failing in some areas due to age.

Table 2: Time Comparison by Work Codes at East Cameron 46

<table>
<thead>
<tr>
<th>Work Code</th>
<th>Dry Blast Cleaning</th>
<th>UHPAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>3.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Rigging</td>
<td>13.5</td>
<td>16.4</td>
</tr>
<tr>
<td>Cleaning</td>
<td>8.2</td>
<td>12.0</td>
</tr>
<tr>
<td>Blasting</td>
<td>41.9</td>
<td>25.7</td>
</tr>
<tr>
<td>Painting</td>
<td>25.4</td>
<td>31.4</td>
</tr>
<tr>
<td>Weather</td>
<td>0</td>
<td>6.1</td>
</tr>
<tr>
<td>Delays</td>
<td>5.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Other</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3: Utilization of Working Hours at Anadarko

<table>
<thead>
<tr>
<th>Category</th>
<th>Utilization in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>4</td>
</tr>
<tr>
<td>Rigging</td>
<td>19</td>
</tr>
<tr>
<td>Cleaning</td>
<td>23</td>
</tr>
<tr>
<td>Surface preparation</td>
<td>15</td>
</tr>
<tr>
<td>Painting</td>
<td>26</td>
</tr>
<tr>
<td>Weather delays</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

if analyzed on a production/man-hour basis, it appeared that moving a spider every time a new area was be worked on was more time consuming than rigging cables and boards. The production rate of rigging and moving a spider, on this particular project, was about 40% slower than cables and boards.

Relative cleaning time spent was higher for UHPAB in this particular project than for AB. After UHPAB it was necessary to rinse the blasted area in order to remove the spent abrasive that otherwise could have adhered to the wet steel. After dry blast cleaning, it is necessary to blow down the steel to remove dust from blasting debris. Sometimes, when a dry blasted area was blown down with air, the same area had to be blown down more than once because the dust would migrate to areas previously cleaned. With UHPAB, washing was started from top to bottom and was not needed more than once.

The value-adding capacity of UHPAB was realized during blast cleaning. The distribution of hours shows that 41.9% of the time was used to dry blast the legs, as opposed to 25.7% of the time used to UHPAB the waterline. In absolute numbers, dry blast cleaning produced 1.3 m²/man-h, and UHPAB produced 4.4 m²/man-h. These numbers show a 220% improvement on the blasting speed. The specific abrasive consumption rate was 1.7 times higher for dry blast cleaning compared to UHPAB. The only variable that could not be accounted for on this particular comparison was related to the fact that the legs were blasted from spider baskets and the waterline was blasted from cables and boards. Once again, the experience showed that working from cables and boards was more productive than working out of spiders. Despite this productivity difference related to the method used to access the steel, the increased production and the reduction in abrasive consumption proved that UHPAB was more effective than conventional dry blast cleaning. UHP was used on rotating equipment.

Contd...
InnerArmor: Breakthrough Technology for Inside Coating

The state of the art in inside coating... InnerArmor™ is a major advance: a patented new way to put an extremely hard, smooth, chemically inert coating on the inside of virtually everything—from small parts to industrial pipe.

Virtually impenetrable—by design, InnerArmor coatings are amorphous. They have no grain structure and no porosity. Like glass, they go on smoothly and evenly. And without pinholes. The result: a virtually impenetrable barrier against corrosion and erosion.

Solving problems, reducing costs, InnerArmor technology provides new solutions to age-old problems in many industries—from oil and gas to chemical processing.

Whether you’re fighting corrosion, erosion, or wear, in your pipelines or in your systems, InnerArmor can help you win the battle, increase uptime and significantly reduce your costs.

To learn more, go to our website. Or call us at (925) 524-1020, ext. 192.
Setting the Standard for

Surface Cleaning Equipment all over the World

Abrasive transport and recovery equipment. Vacuum and/or mechanical.
Ventilation systems. Portable and stationary.

Dehumidifiers. Adsorption or refrigerated.

Blast room design & installation. Equipment for complete blast and paint room installations.

Call us and benefit from more than 3 decades of experience...

MUNKEBO
PRODUCTION A/S
www.munkebo.com
Dust, created by dry blast cleaning, was not acceptable because of the rotating equipment in the area and because of the amount of activity from platform personnel in the area. Therefore, only UHPAB and UHP were used. All of the equipment was monitored and maintained constantly by Anadarko employees to ensure that oil and gas flowed without interruptions. The owner wanted to make sure that the job was performed to the best surface standards possible, with the steel free from corrosion and chlorides, and with an anchor profile of 2.5 to 3 mils to ensure the longest life possible for the paint system.

A six man crew—one foreman, three blaster/painters, and two helpers—was assigned to work 12 to 14 hours per day, 7 days a week. Crew changes were scheduled weekly, with 50% of the crew being rotated every week. The surface preparation took place until 2:00 or 3:00 pm each day, depending on daylight and weather conditions, and an inspector then approved the surface. Once enough area had been blast cleaned and primed, a stripe coat was applied followed by a second coat and a topcoat.

The inspector at the site made the decision to perform the surface preparation on a spot and sweep basis. This decision was made once the inspector noticed that some existing paint had good adhesion and we noticed the amount of effort necessary to remove the existing coating. The areas that were show-
ing rust were blast cleaned to a near-white standard. The areas where the existing coating was in good condition were swept until sound coating was exposed.

The crew prepared a total of 2,080 m² — 1,770 m² with UHPAB on decks and process equipment and 293 m² with UHP (on the compressors). By separating the hours used for each type of surface preparation, it was found that the costs of surface preparation were 112% higher for UHP. This comparison is valid for surface preparation only, not including rigging, painting, cleaning, etc. Based on these figures, the use of UHPAB did save about 50% of the average costs.

If the surface prepared had been structural steel only, as opposed to process equipment with many flanges, nuts, bolts, etc., UHPAB would have been even more cost efficient. At areas where equipment protection would have increased the price of the project significantly or alternative methods of surface preparation would have been necessary in order to reduce the risk of damaging rotating equipment, UHPAB was performing the job at the same or lower costs as dry blast cleaning. Table 3 shows the utilization of working hours.

The amount for rigging was higher than normal because finished products needed to be protected from overspray from different colors of finish coat. Special attention was given to ensure that abrasive material was not left on the deck, in case an operational upset contaminated the spent abrasive with oil, creating hazardous waste.

The feedback from the parties involved in the project was as follows. Personnel on the platform were pleased with not having to deal with dust issues and potential damage to their equipment. The inspection company was satisfied with the quality of surface preparation achieved; the anchor profile was acceptable (Ry5=65 µm); and the chloride content on the steel was almost non-existent. The paint manufacturer performed
pull-off tests on the primer, as per ASTM D4541, in areas where UHPAB was utilized. All of the dolly tests failed at 4 MPa, and the failure was always located in the glue. Coating adhesion was not tested over surfaces prepared by UHP because UHPAB was new to the customer, and that is the process that the customer and painting company were concerned about.

**Summary**

UHPAB has proven to be a very suitable method for cost-effective and environmentally sensitive surface preparation of steel structures in the offshore industry. Jobs performed on dock locations as well as offshore have verified the capability of the method under site conditions.

**References**