

HYDROBLASTING REPORT

The following pages are an evaluation of the benefits of hydroblasting, carried out independently by a US coatings removal contractor. The choice of coatings for the comparative suitability tests was made by the contractor, based on his experience. In the subsequent lab tests, adhesion results for Alocit were outstanding, 80% higher than the next highest results and nearly three times the results for the lowest.



HYDROBLASTING

AN EVALUATION OF HYDRO-BLASTING SURFACE PREPARATION AND INDEPENDENT SUITABILITY TESTING OF COMMERCIAL COATINGS

Dennis McGuire, AMCLEAN Inc., Florida USA

INTRODUCTION

Cost effective ways have to be found to control pollution while at the same time getting the job done. Protecting the environment and the bottom line has become a double edged sword.

Ship repair yards basically have two choices. Comply with the laws that are firmly in place, or violate the state and federal laws that have been passed to protect our environment. Choosing the second option can mean fines and/or imprisonment to the violator. The severity of punishment in the US is highlighted by the \$9.3 million dollar fine to a US West Coast repairer in San Francisco. In addition to the fine, the city of San Francisco took out a civil suit against the shipyard which could result in extra penalties and a clean up cost that might double the fine amount.

The greatest potential a shipyard has for a very large fine is in the illegal disposal of blasting abrasive. The purpose of this paper is to educate the ship repair industry in the total elimination of blasting abrasive for surface preparation.

EQUIPMENT DEVELOPMENT

The development of ultra-high pressure water jetting equipment eliminates many shipyards' needs for abrasives in the future. Ultra-high pressure, as defined by the National Association of Corrosion Engineers (NACE) and the Steel Structures Painting Council (SSPC) is water pressures over 25,000 p.s.i.

SURFACE PREPARATION

Consistently, UHP water jetting will produce a surface finish equal to or better than a dry abrasive blasted surface.

Amclean Inc. a coatings removal contractor

specializing in the removal of Marine Coatings, conducted various controlled laboratory tests. Four steel panels had been soaked in a salt water solution for one week. All four panels were cleaned at 29,000 p.s.i. using a 5 jet rotating nozzle. Each panel was coated with a coating designed for surface tolerant conditions. Geoffrey Byrnes of The Coatings Laboratory Inc. states, "There were no adhesion failures between the coatings and the steel substrate. These test results show adhesion which is therefore equal to or better than that which would have been obtained over an abrasive blast cleaned steel substrate."

SURFACE CLEANLINESS

A comparison between abrasive blasted steel and UHP water-blasted steel.¹

Abrasive blasting is quite effective for creating the initial profile pattern on steel. The perception, however, that rust and contaminants (i.e. salts, chlorides, etc.) are being removed and that the anchor pattern consists of new metal is an illusion.

The US Department of Transportation Maritime Administration has determined cutting rates of abrasives for steel surfaces. For one square foot (929 square centimeters), the average depth of removal is calculated at .0013cm (.005 in). That is, if the abrasive removes the top metal surface in a uniform manner such as a slice or plane, to reveal a new surface, the metal slice will be 13 microns deep. Any corrosion product or contaminant located deeper in the surface, such as a crevice, WILL NOT BE REMOVED. The original surface with its chemical contaminants and rust products is virtually intact.

¹ Frenzel, L.M., "Evaluation of 20,000 p.s.i. Water Jetting for Surface Preparation of Steel Prior to Coating or Recoating". Coastal Science Association, Inc., Kenner Louis.

With UHP jetting systems, rust, heavy layers of polypropylene or plastics, rubber, and energy absorbing mastics and urethanes are sheared and lifted from the metal surface. Oil, grease and salt contaminants are removed completely. The surface profiles are left open, not flattened shut. The visual appearance is opposite, like a photographic negative, to the appearance of an abrasive-blasted surface, appearing dark grey as the flattened, reflective surfaces from abrasive blasting are not formed. This can lead to rejection in the field by an inexperienced paint representative.

Advanced technology, such as scanning electron microscopes and back scatter x-ray methods, reveal, however, that the water-jetted surface is superior to the white-metal surface so commonly specified. Ultra-high pressure water jetting is the only process that will remove the microscopic corrosion initiation sites that is the very beginning of the corrosion process.

COMPATIBLE COATINGS FOR UHP WATER JETTING

The paint manufacturers that participated in the Amclean test were International, Devoe, Wasser and Alocit coatings. All coatings adhered to the steel substrate equal to or better than a dry

abrasive blasted surface. Amclean was not able to test the other companies' paint product in these series of tests. This does not mean that these other companies have not addressed the issue of ultra-high pressure surface preparation. Shipyards can contact their paint supplier and request a coating that is compatible with this process.

PRODUCTION RATES & QUALITY

A shipyard's greatest concern is production. How many square feet can one man produce per hour? When comparing ultra-high pressure water jetting to abrasive blasting, a shipyard will see a noticeable difference in production. On 10-40 mil (250 - 1000 microns) epoxy coatings, UHP water jetting will remove approximately 100 square feet per hour, per man.

The greatest misunderstanding, when comparing production rates is the quality of surface achieved by each method. An abrasive blaster produces a near-white metal surface that has salt contaminants and corrosion trapped below the folds of steel. UHP water jetting, on the other hand, eliminates all salts, removes the corrosion sites, does not fold the steel to trap corrosion, is more productive and produces a surface that cannot be equalled by abrasive blasting.



COST COMPARISONS OF ABRASIVE BLASTING WITH UHP WATER JETTING

Project Vessel = 100,000 square feet of underwater hull (based on 1993 prices).

ABRASIVE BLASTING

Based on 20 pounds of abrasive per sq. ft.	= 1000 tons
Cost of abrasive @ \$50.00 ton	= \$50,000
Non-hazardous cost of disposal @ \$55.00 ton	= \$67,000
* Hazardous Cost of disposal @ \$600. ton	= \$600,000
Cost of containment	= \$25,000
Cost to move abrasive in shipyard	= \$15,000
Man hour Costs = 2500 hours at 40 sq. ft. per hour per man @ \$30.00 hr	= \$75,000
Non-hazardous material approx. cost per sq. ft.	= \$2.32
Hazardous material approx. cost per sq. ft.	= \$7.65

ULTRA-HIGH PRESSURE WATER JETTING

Cost of abrasive	= 0
Non-hazardous cost of disposal 20 x 55 gal. drums at \$30.00 per drum	= \$600
*Hazardous cost of disposal 20 x 55 gal. drums at \$300.00 per drum	= \$6,000
Man Hour Costs = 1000 hours at 100 sq. ft. per hour per man \$30.00 hr.	= \$30,000
Non-hazardous material cost per sq. ft.	= \$.31
Hazardous material cost per sq. ft.	= \$.36

DIRECT COST SAVINGS ON 100,000 SQ. FT. OF SURFACE PREPARATION AT THE SHIPYARD LEVEL

NON-HAZARDOUS MATERIAL

Abrasive blast	= \$232,000
Ultra High Pressure Water Jetting	= \$ 30,600
Total Cost Savings	= \$201,400

HAZARDOUS MATERIAL

Abrasive blast	= \$765,000
Ultra High Pressure Water Jetting	= \$ 36,000
Total Cost Savings	= \$729,000

CONCLUSION

UHP water jetting can solve the environmental problems caused by abrasive blasting. The added benefits of eliminating dust in the workplace will be enjoyed by everyone. Profits will increase due to the elimination of the costs, handling and disposal of abrasive. Costs of containment (scaffolding, tarps, and labour) are eliminated. A welder can work within a few feet of a worker using UHP equipment, without concern for dust or contamination. Collection and treatment of the water does not require any additional equipment to that which is already in place for the treatment of wash water.

It is the duty of the shipyards to suggest to ship owners environmentally sound alternatives for surface preparation. Ultra-high pressure water jetting offers the most promising alternative to abrasive blasting.

SECTION II - TESTING SUITABLE COATINGS

EQUIPMENT, ASSOCIATED SUPPLIES AND PANEL PREPARATION

- A. WOMA 30,000 p.s.i. Water Jetting Equipment, Model Ecomaster 2000, with 5 hole, sapphire reinforced, tip spray gun and allied hoses.
- B. Tap Water, ambient temperature. No inhibitors were added to the tap water to reduce flash rusting on surface of steel panels after being cleaned and allowed to dry.
- C. All four panels were blasted cleaned within 10 minutes from the start of Panel No. 1 to end of Panel No. 4. This time included the positioning of each panel, blasting it and its removal from being clamped onto a steel beam, which was used for supporting the panel during blasting operations. Seventeen minutes after the final panel was blast cleaned, the panels were dry and coating application began.

SECTION III - MATERIALS & METHOD

A - PANELS

Hot-rolled steel. Approximately 5" x 10" x 3/16".

Panels were new steel and were immersed in salt water solution one week prior to being subjected to the 30,000 p.s.i. water blast. Panels were dry (before water blasting began) and showed signs of salt water corrosion.

Each panel was stamped with one number and the panel numbers ranged from 1 to 4.

B - SURFACE TOLERANT COATINGS DATA

1. COMPANY – WASSER

- a) Applied to Panel No. 1
- b) Prime coat – MiO Zinc – a two component, zinc-containing polyurethane, color – grey
- c) Top coat – MC Tar – a single component tar-urethane type, color – black

2. COMPANY – ALOCIT

- a) Applied to Panel No. 2
- b) Prime coat – 28.15 – a two component epoxy, color – grey
- c) Top coat – Aquacoat 28.15 – a two component epoxy, color – white

3. COMPANY – INTERNATIONAL PAINT

- a) Applied to Panel No. 3
- b) Prime coat – Intergard, B Series, Universal FPL-274, a two-component epoxy, color – red
- c) Top Coat – same as prime coat

4. COMPANY - DEVOE

- a) Applied to Panel No. 4
 - b) Prime coat – Bar Rust 235, a two component epoxy, color – buff
 - c) Top coat – same as prime coat but color red
5. All coatings were thoroughly mixed according to their instructions

6. All coatings were brushed applied and all applications were completed within 3 minutes of the start of their application

7. All coatings, except Wasser's MC-Tar, were two component and after mixing the components together, they were allowed to stand ("sweat-in") approximately 35 to 45 minutes before their application to the panels.

8. WFT of each coat applied was measured.

9. Second coat were applied as soon as the surface of the first became dry-to-touch

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Mr Dennis McGuire
Amclean Company
2983 Ravenswood Road
Ft. Lauderdale
FL 33312

Dear Mr McGuire

This correspondence is my attest in viewing the water blast surface preparation of four, mild salt corroded, hot-rolled steel panels along with the mixing and application of selected Surface Tolerant coatings to these panels by Amclean Company's personnel at the WOMA Corporation's facilities, 105 Newfield Road, Raritan Center, Edison, NJ 08837-6793 on March 31, 1993.

The mixing of the prime coats of each of four Surface Tolerant coating systems began at approximately 10.05 a.m. Coatings used in this test are described in Section IV, Materials.

Water blasting of 4 panels, which were immersed in salt water solution one week in order to produce accelerated corrosion on their surfaces, began at 10.26 a.m. The description of the equipment used to water blast these panels can be found in Section III, Equipment, Associated Supplies and Panel Preparation.

The finished blasted surfaces of the panels had no signs, by visual eye examination, of any corrosion material or any degree of mill scale on them, although there were various grey coloured areas in each panel. The greys varied from very light to dark, which is typical of water blasted new, hot-rolled steel. Also noted was, a very light in depth, surface profile on the water blasted surfaces. I could not measure or estimate the depth of this light profile, but a profile did exist.

The type of water used, the time required to water blast these panels and their drying prior to application of the Surface Tolerant coatings can be found in Section III, Equipment, Associated Supplies and Panel Preparation.

Prior to the water blasting operation, each of the Surface Tolerant coatings were mixed according to their instructions. After mixing, each were allowed to stand ("sweat-in") for 35 to 45 minutes before being brush applied to their respective blasted, dried panel. Application by brush of the first coating, Wasser MiO Zinc, started at 10.53 a.m. and the application of the last coating, DeVoe Bar Rust 235-Buff, was completed at 11.05 a.m.

The second or top coat of each coating system was applied as soon as the surface of prime coat of each system became "touch-dry". No previous mixed coatings, used for the prime coats, were used for any of the top coats. All mixes were fresh. Wasser's MC-Tar, a single component, tar urethane type coating was the top coat in their system and it was applied at 11.32 a.m.

The application of the first top coat in the other three systems began at 1.23 p.m. and the last top coat was applied at 1.38 p.m.

During the application of each coat in each coating system, its thickness was measured by a wet film gage.

Pertinent application data for each of the Surface Tolerant coatings can be found in Section V, Table 1.

After the application of the last coating was completed, Dennis McGuire, Kevin Grady and I discussed what laboratory tests were to be run on the coated panels so as to determine the best performing of the four coating systems applied to the 30,000 p.s.i. water blasted panels. At the conclusion of this discussion, the laboratory tests that were decided on are outlined in Section VI, Suggested Tests for Coated Panel Evaluation.

It was also decided that the laboratory that would do the testing on the coated panels would be the S.G. Pinney & Associates, Inc., Port St. Lucie, FL facility. Telephone arrangements for laboratory testing were made between Dennis McGuire and Mr Ray Stone of S.G. Pinney & Associates, Inc. office at Port St. Lucie on March 31, 1993. Dennis agreed to take the panels to Ray Stone's office since Dennis was scheduled to leave New Jersey, on April, 1993, for Ft. Lauderdale, FL.

At the conclusion of the discussion relating to what laboratory tests were to be run and what laboratory would do the testing, I departed from the WOMA Corporation's facilities, and the approximate time of my departure was 2.00 p.m.

Sincerely

Henry R. Stoner

TCL

Mr Dennis McGuire
AMCLEAN
2983 Ravenswood Road
Fort Lauderdale

Dear Mr McGuire

We confirm having received from you four coated test panels.

On unpacking the panels it was noticed that Panel #1, which appeared to have a Zinc Rich primer, had already formed some $\frac{1}{8}$ " blisters; presumably due to Hydrogen released from the primer as a result of reaction between the Zinc and atmospheric moisture.

COATING ADHESION TESTING TO ASTM D 4541 "PULL OFF"

Three aluminium test dollies were glued to each panel using epoxy/polyamide adhesive which was allowed to cure for 24 hours before testing. The following results were obtained:

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|----------|--|------------------|
| Panel #1 | 640, 340 & 291 p.s.i. | Mean 420 p.s.i. |
| | Failure was 100% cohesive within the Zinc primer film | |
| Panel #2 | 1160, 1570 & 860 p.s.i. | Mean 1200 p.s.i. |
| | Failure was 70% between the adhesive and the top coat and 30% cohesive within the grey coating layer below the top coat | |
| Panel #3 | 560, 930, 530 p.s.i. | Mean 670 p.s.i. |
| | Failure was 40% between the adhesive and the top coat and 60% cohesive within the red top coat layer | |
| Panel #4 | 580, 830, 500 p.s.i. | Mean 630 p.s.i. |
| | Failure was 10% between the adhesive and the top coat and 90% cohesive within the grey coating layer below the top coat. | |

All of the failures took place either by cohesive rupture within the coating system or by adhesive failure of the adhesive used to bond the aluminium pull-test dollies to the coating. There were no adhesion failures between the coating and the steel substrate.

These test results show adhesion which is therefore equal to or better than that which would have been obtained over an abrasive blast cleaned steel substrate.

Yours sincerely

Geoffrey B. Byrnes
The Coatings Laboratory Inc.