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Paper

WATERJETTING AND THE WORLD OF COATINGS REMOVAL

Lydia M. Frenzel, Ph.D.
Advisory Council
Vancouver, WA, USA

ABSTRACT

This presentation covers three areas: 1) An update on the adoption of Standards for Wet Abrasive Blast Cleaning and new methodology- How has Wet Abrasive Blast Cleaning been received? 2) The adoption of Waterjetting in New Build in Brazil- How did the country regulators, coatings manufacturers, and contractors cooperate to bring about adoption? 3) The current revision for the Organization of International Standards (ISO) to resolve long standing differences.

1. WET ABRASIVE BLAST CLEANING

NACE International (NACE) and Society of Protective Coatings (SSPC) started a wet abrasive blast (WAB) cleaning standard in 1985. This effort waxed and waned depending upon the environmental consciousness of fugitive dust which escaped the boundaries of the project, and concern about the health and safety of the blaster. The Joint SSPC Surface Preparation Standard/NACE Standard Practice for Wet Abrasive Blast Cleaning restarted in 2005 when Mühlhan Surface Protection International GmbH Hamburg (Mühlhan) began to use wet abrasive blast methodology globally and purchased companies in the USA. The five standards were approved for publication in August 2015, and published in 2016.

The standards followed the naming and numbering of the Blast Cleaning:

- SSPC-SP 5 (WAB)/NACE WAB-1; White Metal Wet Abrasive Blast Cleaning
- SSPC-SP 10 (WAB)/NACE WAB-2; Near-White Metal Wet Abrasive Blast Cleaning
- SSPC-SP 6 (WAB)/NACE WAB-3; Commercial Wet Abrasive Blast Cleaning
- SSPC-SP 14 (WAB)/NACE WAB-8; Industrial Wet Abrasive Blast Cleaning
- SSPC-SP 7 (WAB)/NACE WAB-4; Brush-Off Wet Abrasive Blast Cleaning

The above standards are primarily VISUAL standards. They are based on the methodology that abrasives will abrade the substrate and move towards an uniform appearance. All of the standards require: "when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose coating."

White Metal, Near-White Metal, and Commercial Blast cleaning do not allow for retention of tightly adherent previous rust, coatings, or foreign matter. Industrial Wet Abrasive Blast Cleaning allows: Traces of tightly adherent mill scale, rust, and coating residues are permitted to remain on up to 10% of each unit area of the surface. Brush-Off Wet Abrasive Blast Cleaning allows: Tightly adherent mill scale, rust, and coating may remain on the surface. Essentially the US describes three "shades of gray." The language takes precedence over photographic illustrations.

The International Organization for Standardization (ISO) does not have a separate International Standard series for Wet Abrasive Blast Cleaning. The methodology is included with standards on abrasive blast-cleaning; ie ISO 8501, 8502, 8503, and 8504 series. The ISO surface preparation standards started as a pictorial selection with words describing the photographs.

1.1. History

I have been working on Standards in the United States since 1985. The development, and completion, of standards depends somewhat on the acceptance and market push of the equipment manufacturers. Methods of WAB have been around since the 1940's. The simplest is the addition of a radial water head to conventional dry abrasive blast nozzles or the addition of an abrasive head to the pressure washer (or water blaster) nozzle. While we started the WAB standards in 1985, the methodology was considered muddy and required additional effort to clean up the substrate and site. Contractors would use it, but decided that it was too much trouble to clean up afterwards, and to rinse down the substrates. There was little demand for a WAB standard.

When Mühlan introduced the µ Jet technology into the USA, the interest in WAB standards increased. Mühlan purchased contracting companies, went after projects,published papers, sponsored conferences, and advertised in NACE and SSPC journals. At the same time, there

were environmental restrictions on dust control. The USA felt that it was being left behind; the standards started being developed. However, Mühlan held its technology tightly. Other WAB methods evolved for pressure washers and water blasters, but the technologies still had the clean-up problems. As only one company held the technology under licensing agreements, the μ Jet, using abrasive injected into ultra-high pressure (AI-UHP WJ) nozzle, did not become widespread. The standard development languished as the dry abrasive blast technology remained dominate in the USA.

1.2 Adoption of Standard Language

More recently, Graco Inc., and to a lesser extent Clemco Co., purchased wet abrasive blast cleaning technology that was based upon a minimal use of water. Graco is an equipment manufacturer which is dominate in the US coatings market. People paid attention when Graco demonstrated and marketed their equipment. The WAB standards came back to the attention of SSPC and NACE.

The water and abrasive are mixed back in the blast pot so they travel as a mixture down the line. The minimal amount of water means there is very little, to no, water effluent. This technology required new blast pots and specialized equipment, but looked familiar to the contractors. This minimal water concept had been presented earlier, and tested by the USA Navy and found effective. However, prior equipment just wasn't robust enough for heavy commercial use. In 2017, it remains to be seen if the current equipment will last on commercial sites. My understanding, and this is based upon personal conversations, not hard market data, that there was a spike in buying the Graco, and other WAB equipment, then the sales settled out. The newer WAB equipment did not replace dry conventional blast cleaning.

However, some of the older equipment, which has been proven to hold together, is being adopted more. The USA is continually facing more stringent controls on fugitive dust and effects on safety and health of the blasters. Beryllium is found in some abrasives; there are new pending federal regulations concerning the level of beryllium (OHSA). Beryllium exposure affects approximately 11,500 workers in construction and shipyards, and approximately 62,000 workers over all. (REF. 1)

Wet Abrasive Blast Cleaning remains a solution to the problem- how to create a profile (anchor pattern) but reduce the fugitive dust. Once they were published, the WAB standards have been adopted without much discussion.

The standards use both rust-back and flash rust terms. The coatings industry has a problem discerning between "rust back" and "flash rust." This is a subject within itself. (REF. 2) This discernment is perpetuated by the dehumidification sector and by the lack of "rust-back" within the ISO definitions. These are the definitions within the USA when surface preparation is being performed.

FLASH RUST

(1) An oxidation product that forms as a wetted carbon steel substrate dries. This is different than RUST-BACK (2) Appearance of rust spots on the surface of newly-applied water-borne film during the drying phase. (ref. 3)

RUST-BACK (RERUSTING)

Rusting that occurs when freshly exposed, dry, bare steel is exposed to conditions of high humidity, moisture, or a corrosive atmosphere. It is the term used when steel cleaned by dry abrasive blasting,

power tools, or wet abrasive blasting begins to rust after the steel surface has completely dried. This is different than FLASH RUST. Rust Back is the rapid rusting of a carbon steel substrate where there is no visible water involved. (REF 3)

2. ADOPTION OF WATERJETTING IN SHIPYARDS FOR NEW BUILD

When Waterjetting was introduced to the coatings maintenance industry, ships were falling apart at sea because of corrosion; chemical plants were rusting away; Europe had recognized that they had to reduce air emissions and the huge waste stream of spent abrasive. Waterjetting, particularly if the water could be recycled, solve most of the problems for maintenance, not new build. UHP WJ was becoming mobile; rotating nozzle heads were developed to cover more area. WJ penetrated about 10-15% of the sectors which could benefit from the removal of chemicals from the substrate, and then faced a push-back from the contractors who had invested capitol in conventional dry abrasive blast equipment and labor. In the US, although regulations were adopted; they were not vigorously enforced. As an industry, we face ping-pong environmental regulations.

Waterjet removal of coatings has been limited to maintenance or rehabilitation as coatings and linings generally require a texture or anchor profile. Within the USA, this is still the case. However, Brazil has adopted WJ for newbuild and maintenance after a 20 year development process.

Will this happen in the United States? I would like to say "Yes." However, it will take stricter enforcement before our industry changes. In other countries, the industry just rolls up its sleeves and work towards a continuous improvement with expenditures in operations, training, and equipment. Waterjetting is used extensively in Portugal, Singapore, Germany, and Brazil. In the USA, the industry tends to challenge new regulations and wait for the administration to change.

What was the sequence in Brazil that cause a shift? A detailed paper by Nuno Capriano is found in the Journal of Protective Coatings and Linings, July, p. 42, 2015. (REF 4)

Brazil stopped using sandblasting around 1995, and looked towards UHP WJ after seeing adoption in Singapore. Brazil and Singapore produce floating production storage and offloading (FPSO) vessels. The industry brought together the research center of Petrobras with the coating manufacturers to produce paint for application over wet and lesser-prepared or flash-rusted surfaces. The commercial paints had to be certified by the International Maritime Organization (IMO) for use in water ballast tanks to meet type approval in 2008 for "Performance Standard for Protective Coatings (PSPC). (REF. 5) In the meantime, health and safety regulations became stricter. Then an existing shipyard Estaleiro Atlantico Sul Shipyard (EAS) was converted to UHP WJ to build SuezMax and Aframax vessels. Then a new Shipyard, Engevix Construcoes Oceanicas (Ecovix) was built with UHP WJ as their main surface preparation method.

The UHP WJ is used for then on at the block stage. The IMO PSPC- complaint universal coating system can be used over UHP WJ, including over weld seams and primer. Nuno Capriano's articles and presentations only mention a Sherwin-Williams Duraplate® surface tolerant coating as being type approved for IMO PSPC regulations.

For new build, the steel plate is put through an automatic blast equipment to produce the surface profile, and primer is applied. No open-air abrasive blasting is done. Small pieces are sent to the SY with preconstruction primer. For maintenance, WJ is used to remove the existing coatings and corrosion.

Key to this adoption is the wet surface tolerant coating system. The wet surface tolerant coating is flexible in terms of the final surface preparation condition, weather conditions, ease of application and thickness build. The surfaces are washed down before painting to assure a reduced (or free) salt contamination.

Thus far, EAS has built 20 SuezMax and Aframax Tankers. Ecovix does >95% of its platforms with UHP WJ. They use abrasive blasting for the small items- valves, pipe racks, brackets. Surface tolerant paints (STP) are used on 90% of the surfaces. However, the intermediate and top coats can be other conventional systems, if they comply with the coating specifications of Petrobras. Over 850,000 square meters (nine-million square feet) have been waterjetted and painted. Figure 1 illustrates the typical specification.

Figure 1 Typical UHP WJ surface

Welds and damages are water jetted to WJ 2. Good condition shop primer is not removed. It is waterjetted to WJ 4.

The production rate ranges from 8 to 16 m^2/hour/operator (86 to 172 ft^2) outside the need to treat weld burn areas and construction damage.

Ecovix has 8 UHP WJ blast cabins, and 21 UHP WJ pumps so that they can drive 42 nozzles. There are also 6 diesel-powered 40,000 psi two-gun pumps. There is a full water recovery and recycling system. The water recovery system can treat 20-25 cubic meters (5283-6604 gal) per hour. All of the effluent (100%) is recycled within the manufacturer's parameters and reused. At this site, the shipyard has save millions of dollars on water consumption and external water treatment/dumping. It took two years to developed the recycling system. The effluent treatment consists of: heavy solids filtration, disinfection, coagulation, pH adjustment, flocculation; a sand filter with activated carbon; cationic resin filter to decrease water hardness, and reverse osmosis to reduce water conductivity.

Table 1 data collected from the Brazilian Shipyards.

Courtesy of Nuno Cipriano
Presented at SSPC 2017, January GreenCoat Conference, FL

	10,000 m^2	
Time Expenditure	**UHP WJ**	**Abrasive Blast**
Surface Preparation	60 hr	85 hr
Drying/cleaning	20 hr	30 hr
Coating	8-10 hr	8-10 hr
Quantities	**UHP WJ**	**Abrasive Blast**
Days to complete	5-7	7-10
Manhours	9000-11000	12000-16000
UHP Machines	5	0
Compressors	1	6-8
Dehumidifiers	0	3
Residues	~550 m^3 of water	~500 tons of abrasive
Operation Costs Ratio	**UHP WJ**	**Abrasive Blast**
Manhours	1	1.3 – 1.4
Maintenance Costs	1.1	1
PPE	1.2	1
Residues Disposal	0.03 to 0.05	1

Table 2 Ship Yard data

supplied by Bruce Toews, Sherwin Williams, from another country.

Shipyard Data	Abrasive Blast	UHP WJ	3000 m^2 (31,292 ft^2)
Man Hours	5034.25	3443.5	
UHP Machine	2 units	24 unit	6 units for 4 days UHP
Compressor (unit)	26	0	6 units for 10 days AB
Dehumidifier (unit)	15	6	1 unit for 10 days-AB 1 unit for 7 days-UHP
Vaccuum	18	0	6 unit for 10 days pick up grit
Blasting Grit	150 tons	0	50 kg/m2 x 3000 m2
Disposal of Grit	150 tons	0	Based on $30/ton
No of days schedule	12	7	

The conversion to UHP WJ has proven cost and production effective. The shipyard is cleaner; they have the ability to do simultaneous work of different natures 24 hours a day; they are not dependent upon ambient conditions. They have zero or near zero ambient controls required during painting. On safety, UHP WJ is dangerous, but offers fewer overall health risks due to the absence of abrasive media. Their safety record is greatly improved. They developed an extensive training protocol. The nozzle operators are required to wear personal protection equipment designed for UHP WJ.

3. ISO INTERNATIONAL STANDARDS

ISO 8501-4 ”Initial Surface Conditions, preparation grades and flash rust grades in connection with high-pressure water jetting” was adopted in 1999 and reviewed in 2006. The standard is a combination of text and illustrative photographs. It did not include the highest level of cleanliness Wa 3 which would be nominally equivalent to Sa 3 or WJ-1, clean to bare substrate. A more detailed discussion is found in Frenzel 2012 paper (REF. 6).

In June 2017, ISO 8501-4 came up for standard review and the TC 35/SC 12/WG 02 met for discussion. They resolved to include Wa 3. Frenzel is currently revising text and proposing photographs so that the highest level of cleanliness will be included. Difficulty arises because the original language was based upon abrasive blast cleaning which moves to a more uniform appearance as the substrate is abraded whereas carbon steel substrates that are WJ cleaned reveal the difference in texture (anchor profile) and variations in color of the carbon steel under the previous coatings and corrosion. If the coating is intact, the revealed carbon steel substrate is uniform; if the coating has been broached or if there is heavy corrosion, the revealed carbon steel substrate is none uniform in color and texture. Whether or not the revision is accepted is in the future.

4. SUMMARY

A. The WAB standards have been issued and are accepted.
B. Countries other than the USA have adopted WJ for coatings removal in new build with the advent of International Maritime Organization certification of coatings and installation of water recycling systems.
C. These countries have found the combination of abrasive blast to create the profile where needed and UHP WJ to be cost effective.
D. Language and photographs for the inclusion of Wa3 into ISO 8501-4 is underway.

5. REFERENCES

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Please contact the author if you would like copies of the cited references.