

“The Long-Term Effects of Surface Preparation: Evaluating ISO 12944-9 In Offshore Coating Application With Waterjetting And Decontamination Chemical”

Jerry Woodson, P.E.
Woodson Engineering
621 Chadbourne Ct
Houston, TX 77079
USA

Alex Petkas, PhD
HoldTight Solutions, Inc.
3100 Timmons Ln, #260
Houston, TX 77027
USA

ABSTRACT

A team assembled by a major oil company designed a test program to assess the difference in coating performance between dry abrasive blasting and Waterjetting as surface preparation methods. They were also interested in determining whether using flash rust preventing, decontamination chemical in conjunction with various applications had any effect on coating performance. A glass flake epoxy was used. Panels were treated with 262 MPa (38,000 PSI) Waterjetting, Dry Garnet Blast + Power wash, in both cases with and without a decontamination chemical. Another set of panels was sprayed with ASTM D1141³ seawater salt spray after treatment and then coated.

The 300 mm X 600 mm coated panels were saw cut into smaller panels. Some were subjected to per ISO 20340¹ Ageing Procedure Annex A and ISO 2812-2⁵ Seawater Immersion. Others were submitted to ASTM G 50⁴ long-term field exposure test over 5 years. In both cases, when the decontamination chemical was used, no significant difference in coating performance was detected, including in panels exposed to light seawater mist spray before coating application. The scribed waterjetted panels exhibited more undercreep than abrasive blasted panels, but this undercreep only began to develop after two years.

Key words: surface preparation, waterjetting, glass flake epoxy, epoxy, flash rust, salt removal, chloride test, ISO 20340, ASTM G 50, ISO 12944-9, scribe test, pull test

INTRODUCTION

The Problem

Offshore assets such as drilling rigs, production platforms, and wind turbines present challenges for corrosion prevention maintenance. The primary defense against atmospheric corrosion on structural steel in offshore saltwater environments is a protective coating system.

Several factors cause protective coatings to degrade rapidly: besides wearing and damage encountered in installation and use, ultraviolet light breaks down the organic resins and corrosive seawater causes under creep at any breaks in the coating. Maintenance coating for offshore atmospheric systems can therefore be necessary as early as the second year.

However, a practical challenge occurs in the maintenance process. On offshore structures space is limited and very expensive. Priority goes to crews operating and maintaining drilling or production equipment, and providing housing, food, living, and working space for them. There is little extra space for personnel or equipment that perform occasional maintenance activities like painting. Thus, procedures that reduce the amount of equipment or supplies required, or otherwise reduce the strain on the limited space on offshore structures provide a benefit to operators.

Dry abrasive blasting, for a long time the industry standard, requires large amounts of abrasive grit supplies, and often extensive containment systems to trap used abrasive to recycle it and/or prevent it from causing health and safety hazards. Dry grit blasting also has other disadvantages offshore. Rust scale on offshore assets usually contains elevated levels of soluble salts, and dry abrasive blasting leaves a layer of corrosion product that is not readily visible with the naked eye, nor removed with brushing and blowing.

Field test methods show that the salt level in marine rust scale before abrasive blasting or water jetting can be 50-100 $\mu\text{g}/\text{cm}^2$. The same methods show that the residual salt left after dry abrasive blasting heavy, salt-laden rust scale can exceed 10 $\mu\text{g}/\text{cm}^2$.

A coating applied over dust inhering in the anchor profile will absorb most of it so that the coating can adhere to the steel. These dust particles once absorbed can alter the PVC (pigment volume concentration) of the formulation at the critical coating/substrate interface. Some of the dust is not absorbed or encapsulated and remains between substrate and coating, thus becoming initiation points for coating failure.

Water is an effective tool for removing this dust, dissolving, and washing away residual salts to provide a cleaner surface for painting. UHP (Ultra-High-Pressure) water jetting has gained in popularity in recent years in offshore coating maintenance work because of its practical advantages over dry grit blasting. It requires less physical containment, and no abrasive needs to be supplied.

Additionally, UHP waterjetting, at pressures of 206 MPa (30,000 psi) and above, is effective at removing corrosion product and dust from the anchor profile of previously coated surfaces. It also removes soluble salts more effectively than dry blasting. However, UHP waterjetting can cause rapid rusting on steel surfaces. In offshore situations, where salt levels are high and recontamination from atmospheric salts (ocean spray, airborne salts) is rapid, this is especially concerning.

Various chemicals have historically been introduced to prevent flash rust typically caused when water is introduced into the surface preparation process. These have included potassium nitrate, phosphoric acid solutions, and amines. One widely available decontamination chemical (DC) product based around an amine formulation has achieved widespread acceptance in the industry as a component of the surface preparation process.

However, long-term testing of the effects of this product on coating performance has been difficult to obtain or has remained in proprietary data files of companies. Additionally, the chemical's effect on marine life has been a concern for operators, since runoff from waterjetting is typically allowed to drain into the sea, and containment might otherwise be costly.

The Solution

A team consisting of researchers from a major oil company and an independent consultant developed a testing procedure to evaluate the long-term effectiveness of UHP Waterjetting vs. conventional dry grit blasting as a surface preparation for offshore applications.

Panels were prepared and subjected to ISO 20340¹ cyclical testing in 2015. Mild carbon steel panels were prepared to a standard of NACE 1 / SSPC SP5. The surface preparation methods employed in preparing the panels are detailed in a 2017 NACE paper.² The steel used was AISI 1018 Steel, cold drawn plate. Profile was 3.1 to 3.9 mils (79µm to 99 µm).

The toxicity of the chemical was also tested according to the requirements of EPA-821-R-02-012 and found to be well within acceptable thresholds, even if used at many times the recommended concentration.

The same panels (different sections) were then subjected to an ASTM G 50⁴ 5-year atmospheric test at NASA Beachside Corrosion Test Site (BCTS), at the Kennedy Space Center, in Florida. They were tested periodically with 50mm scribe lines as specified in ISO 20340¹, and adhesion testing per ASTM D4541⁶.

The purpose of the present paper is to summarize the results of the ASTM G 50⁴ 5-year atmospheric testing program and encourage further scientific and technical evaluation of the ISO 12944⁷ standard test procedures. ISO 12944⁷ replaced and superseded ISO 20340¹ in 2019.

EXPERIMENTAL PROCEDURE

I. Panel Preparation Method

To provide context for the 5-year atmospheric testing program for maintenance coating, we summarize here the method of panel preparation used in 2015.

Six panels were prepared using a leading glass flake epoxy coating

Sample #	Surface Prep	Coating
1-1	38,000psi Waterjet + decontamination chemical (DC)	glass flake Epoxy
2-1*	38,000psi Waterjet	glass flake Epoxy
3-1	38,000psi Waterjet + DC + Seawater Mist	glass flake Epoxy
4-1	Dry Garnet Blast + Power wash w/ DC	glass flake Epoxy
5-1*	Dry Garnet Blast + Power wash	glass flake Epoxy
6-1	Dry Garnet Blast + Power wash, DC , + Seawater Mist	glass flake Epoxy

*Indicates panels that flash rusted before the coating was applied.

The color of the glass flake epoxy used was **white**.

Pre-Rusting

The panels were first blasted with 36 grit garnet and then sprayed with salt water several times each day for two weeks. This caused a heavy salt-laden rust scale to develop. The goal was to simulate offshore marine rust before maintenance coating.

Surface Preparation

The panels, labeled 1-1, 2-1, 3-1, 4-1, 5-1, and 6-1 were then treated as follows:

Panel 1-1

- Water Jet with the widely available industry decontamination chemical (DC) applied afterward in a power wash.
- Coating later the same day.

(This represents the ideal condition envisioned by the oil company for its maintenance coating offshore.)

Panel 2-1

- Water Jet only
- Coating later the same day

(This represents the sub-optimal, problematic case with only UHP, in which the surface typically flash rusts before coating)

Panel 3-1

- Water Jet, with DC, applied in power wash afterward. The surface was allowed to dry.
- The surface was then sprayed with ASTM D1141³ Synthetic Seawater.
- Coating later the same day.

(This simulates re-contamination by salt spray offshore.)



Figure 1: panels being UHP blasted

Panel 4-1

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- Dry Garnet Blast, DC applied in power wash afterward.
- Coating later the same day

(This represents the best-case scenario for surface preparation using conventional dry garnet methods)

Panel 5-1

- Dry Garnet Blast, power wash afterward
- Coating later the same day

(This simulates a less preferable method for removing some soluble salts before coating)

Panel 6-1

- Dry Garnet Blast, DC applied in power wash afterward
- The surface was then sprayed with ASTM D1141³ Synthetic Seawater.
- Coating later same day

(This again simulates re-contamination by salt spray offshore.)

After coating, the original 300 mm X 600 mm (12" X 24") panels were cut into four pieces. One large 300 mm X 400 mm (12" X 16") piece from each was sent to the NASA BCTS facility described above for atmospheric testing. Three each smaller 75mm X 150mm (3"x6") panels were submitted for laboratory testing per ISO 20340¹.

Figure 2: prepared panel



This method of preparation and then cutting and dividing was employed so that the panels subjected to ISO 20340¹ and the long-term atmospheric testing would be prepared in as uniform a manner as possible, allowing for more rigorous analysis and comparison of the results of both test methods.

Before being sent to their respective testing facilities, the panels were edge coated with a **yellow** epoxy, to seal the edges and protect them for transit. This contrasted with the **white** epoxy of the surface subjected to rigorous testing.