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Paper

HOW TO INSPECT FOR FLASH RUST

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Abstract

At the Fleet Corrosion Control Conference in San Diego in June 2007, almost every paper on corrosion control cited a problem with "flash rust." During the past 10 years, the US Navy, National Shipbuilding Research Program (NSRP), and Small Business Innovative Research (SBIR) programs have funded studies to characterize "flash rust". The basic education and training of "how to inspect" has not been addressed. On-site conflicts arise between certified, but inexperienced, inspectors and experienced, but not necessarily certified, contractors and workers. The conflicts arise primarily in areas where manual guns without vacuum are used for stripping. This paper will cover the major points of the manual "How to inspect Flash Rust" that was released in February 2009 with funds from the National Shipbuilding Research Program.

1. INTRODUCTION

High pressure water has been used to remove slag from steel mills since the late 1940's. However, Surface Preparation by high pressure waterjetting was introduced in the mid -1980's as the advent of piston driven high pressure pumps operating at 20,000 psi became available. The stream of water was finally focused enough to remove rust and retained coating systems.

This newer method of secondary surface preparation was perceived as green because it reduced the largest waste stream, spent grit, in the shipyards. When needed, the water can be collected, the solids filtered out, and the water is reused or could be brought back to drinking water quality.

In 1994, the US Navy demonstrated a Robotic system developed by Pratt and Whitney under the ManTech program. At the same time, International Paint issued in-house photos for "flash rust" that is generated by manual waterjet cleaning on steel structures. Jotun and Hempel also issued photos shortly thereafter. SSPC and NACE issued a joint written standard, which had been under preparation since 1985, in 1995. Funded by NSRP program, photos were developed for SSPC and NACE visual standards. SSPC-NACE photos were taken about the same time as the Hempel photos, but publication was delayed until the consensus process was completed. ISO then issued 8501-4 which uses a subset of the International Paint and Hempel photos.

All guides are to be used in the same manner. All lead to the same answer!

SSPC-VIS No. 4 NACE VIS 7, ISO 8501-4, International Paint Hydroblasting photos, and Hempel photos do not illustrate two areas of conflict.

- 1) an example of lightly wiping
- 2) an example of the surface after excess flash rust with loose rust dust has been mitigated by pressure washing.

The SSPC-NACE task groups responsible for the standards knew this, but the paint manufacturers and the field personnel discussion concluded that the IP "flash rust" photos were sufficient. Owners, contractors, and coating manufacturers on commercial projects could resolve conflicts and work out difficulties easily.

However, if the two parties are not amenable to resolving conflicts, then the wipe method becomes a dispute. This has proven to be the case for inexperienced, but certified, inspectors. The NSRP SP-3 Project "Surface Preparation QA/QC Process Improvement" released in December 2007 identified "Flash rusting is perceived to have **relatively low impact on service life.**" "Determining the degree of flash rusting had the **highest probability of dispute.**" The real cost of disputes is "stand-around" time for dispute participants and the work crew. This "highest probability of dispute" led the Navy into identifying "flash rust" as a Cumbersome Work Practice. Ref. 1

With respect to training material, International Paint photos remain the primary training material for flash rust. SSPC and NACE have included those same photos in their inspector certification course.

NSRP SP-3 funded new training materials. Over the course of the project, a stand-alone training manual transformed into supplemental material for SSPC VIS-4. This material is suitable for use by international marine organizations, ISO standards, NACE, SSPC standards, and supplement to coatings manufacturers photographs.

2. DEFINITIONS

The author assumes that the reader will have access to NACE, SSPC, ISO, or coatings manufacturer's literature.

“Flash Rust” is the rust that occurs from the time the waterjet (WJ) or wet abrasive blast (WAB) cleaning process starts to the time the water used for the cleaning process dries. Flash rust often looks like a rust bloom.

With the exception of stainless steel surfaces, any steel surface may show flash rust within 0.5 hour or longer, depending on environmental conditions, after cleaning by water. Flash rust has the appearance of rust bloom. Flash rust quickly changes the appearance of the cleaned surface and may be reduced or eliminated by physical or chemical methods. The color of the flash rust may vary depending on the age and composition of the steel and the time-of-wetness of the substrate prior to drying. With time, the flash rust changes from a yellow-brown, well adherent, light rust to a red-brown, loosely adherent, heavy rust.

“Rust-Back” is used in dry abrasive blast standards (SSPC SP-5, SP-10, SP-6, SP-7). Rust-Back occurs on surfaces that appear to be dry. Rust Back is the rust that occurs when **DRY**, bare steel is exposed to conditions of high humidity, moisture, or a corrosive atmosphere.

“Rust Bloom” is somewhat uniform rust spread evenly over a large section of the surface. Rust Bloom is a generic description. The observer doesn't know if it originates from flash rust or rust-back.

Often in shipyards, the surface that is waterjet cleaned will be allowed to sit for days before paint is applied. This can lead to a mix of the initial “flash rust” and “rust back” that is formed over a period of time. Generally the participants designate the mixture of “flash rust” and “rust back” as “flash rust.” Figure 1. Coatings manufacturers will designate the level of Flash Rust that is acceptable for the coating in a specific environment.

Inspecting for “Flash rust” is not rocket science.

It is deceptively simple or deceptively hard, because the decision is subjective.

- Prior to painting, look at the rust bloom on the steel.
- Find out the environmental history-if there was rain, pressure washing, waterjet cleaning, or no water involved at all.
- If there is no water involved, you reject the “Rust-Back.”
- If there is water involved in the surface cleaning, you place VIS-4 up to the surface next to the rust and make an initial judgment concerning light, moderate, and heavy.

- If necessary, you wipe the “Flash Rust” to continue the determination between light, moderate, and heavy.
- Be consistent in the determination methods.
- Mitigate the flash rust to the amount required by the project specifications.

There is no one definitive type of “flash rust.” Different techniques on the same day will lead to different appearances. How much “Flash Rust” is formed is directly related to time of wetness. Engineering controls and project scheduling are key in reducing the time of wetness. Fig. 2

“Light (L) Flash Rust”: A surface that, when viewed without magnification, exhibits small quantities of a rust layer through which the steel substrate may be observed. The rust or discoloration may be evenly distributed or present in patches, but it is tightly adherent and not easily removed by lightly wiping with a cloth.

There is almost always a slight color transferred to the cloth.

“Moderate (M) Flash Rust”: A surface which, when viewed without magnification, exhibits a layer of rust that obscures the original steel surface. The rust layer may be evenly distributed or present in patches, but it is reasonably well adherent and leaves light marks on a cloth that is lightly wiped over the surface.

International Paint (1994) Commentary

When viewed without magnification, a layer of light tan-brown rust will obscure the original metallic surface. This layer may be evenly distributed or patchy in appearance, but it will be heavy enough to mark objects brushed against it.

The inspector should expect to see that some of the loose “rust dust” will be transferred to a cloth wipe.

“Heavy (H) Flash Rust”

A surface which, when viewed without magnification, exhibits a layer of heavy rust that hides the initial surface condition completely. The rust may be evenly distributed or present in patches, but the rust is loosely adherent, easily comes off, and leaves significant marks on a cloth that is lightly wiped over the surface.

International Paint (1994) Commentary

When viewed without magnification, a heavy layer of dark tan-brown rust will completely obscure the original metallic surface. This layer of rust will be loosely adherent and will easily mark objects brushed against it.

The inspector should expect to see large quantities of color transferred to a cloth wipe.

Hempel has further descriptions of Flash Rust determined by swiping with a hand and the use of pressure sensitive tape. They are useful as they provide additional information about dark loose rust dust that has formed under the upper brown rust dust.

3. USE OF VIS GUIDES

3.1 Initial Condition

- **Determine the initial condition of the steel before the flash rust forms.**
- Initial condition is illustrated as painted or unpainted steel.
- Select a photograph that is similar to the initial condition

3.2 Visual Cleanliness Fig. 3

- Immediately after the cleaning, before the surface has flash rusted, (it might still be wet), evaluate the degree of Visual Cleaning. Fig. 3

The visual cleaning evaluation often occurs while the surface is still wet

3.3 Flash Rust Fig. 3

- **Prior to painting, compare the flash-rusted surface with the flash rust photographs.**

Wipe or use tape as a further determination.

3.3 Procedure for Evaluation in VIS-4 Fig 4.

When do you evaluate the Flash Rust?

- Flash rust and the substrate (surface) condition are evaluated at or before the time of painting.
- Look at the Project Documents to determine the length of time that can lapse between inspection points and paint application.
- Plan your inspection of flash rust so that the paint can be applied during the time periods allowed by the project documents between the inspection points and application.
- If the surface conditions change between time of inspection and time of painting, then typically this Change is a “stop” or “hold” point. This requirement that the substrate condition remain the same between inspection and application is true also for dry abrasive blasting.
- Prior to painting, compare the flash-rusted surface with the flash rust photographs.
- Wipe or use tape as a further determination.
- Prior to painting, the degree of flash rust must be in accordance with the contract specifications.

4. FOUR WAYS to LIGHTLY WIPE the SURFACE

- Wipe with hand **
- Wipe with cloth held in hand
- Wipe with cloth in a swatch
- Wipe with cloth around a brush

ALL METHODS LEAD TO SAME CONCLUSIONS.

4.1 Wipe with Hand

** SSPC SP-12 and VIS-4 describe the use of a cloth in the definitions. While wiping with a hand is often done in the field, it should not be encouraged as the hand and fingers can leave a residue, such as sweat, on the substrate.

Different clothes might give different “pick-up” results. Cloth will “stick” to the metal tips- so be consistent in the type of material. If lint deposition is a concern, consider other evaluation methods. Consider using lint-free cloth wipes from laboratory supply

Whatever method you chose -BE CONSISTENT!

Wipe or Sweep with a Cloth around a brush

- Develop a consistent routine
- Use consistent materials
- Use a consistent viewing angle and lighting.
- Interpretations must have clean agreement between the coatings manufacturer, person doing the work (contractor), person accepting the work (owner), and the third party inspector.
- Prepare a pre-start panel and get agreement. (optional but good idea)

Be consistent with the type of cloth.

Swipe the cloth across the surface in one motion with light pressure.

- Light Pressure
- Consistent length of path
- Consistent type of cloth
 - Keep your supply of “evaluation” cloth wipes separate from the bin of everyday cloth wipes.

4.2 Hand Cloth Wipe or Sweep Procedure Fig. 5, 6, 7, 8

- Make a bundle of cloth in your hand.
- Swipe the dry cloth across the surface.
- Make one swipe, up or down or sideways with the cloth touching the surface.
- Try to avoid pressing the fingers against the surface.

4.3 Swatch Wipe Procedure Fig. 9

NACE Level 3 CIP Barry McCoy from Surface Technologies Corp. contributed this “Swatch” test as it is consistent from project-to-project and easily taught.

- Make a “swatch” or wad of the dry cloth. Tape the tail to make a handle.
- Lightly wipe the swatch once over the surface. This path was about 3 inches (7.5 cm)
- Be consistent in type of cloth, path length, and swipe up or down or sideways.
- This results in a wiping motion without pressure points from individual fingers.

4.4 Brush Wipe Procedure Fig 10, 11, 12

This method was developed by Pete Judt of Todd Pacific Shipyard.

Sweep the surface with a Cloth wrapped around a brush

- Use a Standard cloth and standard brush.
- Wrap cloth around a paint brush. Swipe the cloth across the surface.
- Define the amount of pressure
 - Brush as if painting a door
- Define the amount of contact- **single** stroke (for example 4 inches (10 cm))
- Define direction- pull down, pull up, or single stroke sideways
- BE CONSISTENT with length of path and type of cloth!
- Be consistent with the amount of surface you are wiping.

4.5 Summary of Three Methods Fig. 13, 14

1. All Methods lead to the same conclusions.
 - None
 - Light
 - Moderate
 - Heavy
2. Adopt the method with which you feel most comfortable and that is portable to different projects and sites.
3. Be consistent.

5. PRESSURE WASHING TO REMOVE EXCESS FLASH RUST Fig 15, 16

What happens if there is too much Flash Rust prior to painting? Prior to the application of paint, the substrate must meet the procurement specifications. Typical field remediation includes:

- Pressure washing
- Broom brushing
- Blowing off with pressurized air
- Solvent cloth or dry cloth wiping
- Vacuum

Upon polling contractors, it appears that pressure washing is the preferred practice. The appearance after pressure washing when the surface dries will be DIFFERENT; rust dust is washed away. Typically the surface has a darker appearance. The metallic sheen might disappear. The standard pictures in VIS-4 do not provide illustrations of pressure-washed surfaces.

5.1 After Pressure Washing, Inspect the Area.

Note that the loose dust is removed. However, the stains on the right have remained. The inspector, contractor, paint manufacturers, and owners (all the responsible parties in a coatings project) should locate the streaked areas and obvious runs. There is a reason for the heavy flash rust. Normally it is an area where the drying is slow. While this inspection module doesn't address other surface preparations, certainly the effect of weld splatter, thermal degradation, and chemical contamination should be considered.

All the defects generally can be seen. There are stains, but NO loose rust dust. This substrate is dry- but it is overall darker than the original substrate. The illustrated surface is dry within 5 minutes. The standard pictures in VIS-4 do not provide these types of illustrations of pressure-washed surfaces.

6. PRESSURE SENSITIVE TAPE TEST FOR QUANTITY Fig. 17

The Pressure Sensitive Tape Test described by Hempel is a modification of ISO 8502-3 (Pressure Sensitive Tape test for dust) and is not mentioned in VIS-4. The tape test can be used as a permanent record. If lint deposition is a concern, the project specification may require use of a different technique to determine the level of flash rust, such as the pressure-sensitive tape test. Those responsible for establishing the requirements and those responsible for performing the work can agree to the use of a different technique to determine the level of flash rust

Place a piece of tape (as specified in ASTM D 3359) in a length of at least 5 cm (2 in) on the surface and rub thoroughly with a fingertip—not a nail—to make the tape adhere firmly. Peel off the tape and place it on a piece of white paper for reference. Repeat this process 9 additional times (for a total of 10 tests) using a fresh piece of tape each time and apply the tape to the same spot. Assess the appearance of the tape and the surface.

The results from the pressure sensitive tape test lead to the same conclusions as the wipe tests.

7. SUMMARY OF MAJOR POINTS

A. Flash Rust is the rust that occurs from the time the waterjetting process starts to the time the water used for the waterjetting process dries.

B. Based on the subjective methods, Flash Rust is classified as

- a. None
- b. Light
- c. Moderate
- d. Heavy

C. The quantity of Flash Rust is controlled by Project Planning during the removal Process, as the water is drying, and keeping the exposed bare metal time to a minimum. Stripe coat as the coatings is being removed.

D. Remove excess loose Flash Rust prior to Painting

E. **ALL of the VISUAL GUIDES are used in the SAME WAY!**

■ Look at the flash rust

- straight on,
- within arm's length,
- in good lighting,
- prior to painting.

■ Allow time to remove, if necessary, excess loose flash rust prior to painting

Look at the surface and decide if you can see through the rust or if it obscures the surface. Make sure that the rust is not splotchy black.

Look at the color. The color is affected by the age and type of steel and, in the field, certainly might appear differently than the descriptive terms.

F. Determine Quantity of loose rust dust. Assess the amount of loose Rust Dust.

- Cloth Wipe in hand
- Cloth Swatch in hand
- Cloth around a Brush
- Tape

G. **All METHODS LEAD TO THE SAME CONCLUSIONS.**

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Applied Research Lab- Penn State	CleanerTimes
Hydrochem Industrial Services	Sarafina
Parker Polyflex	Alcoa
International Paint	Stolt Nielson Tanker
Hempel	National Surface Treatment Center
Jotun	Society of Protective Coatings (SSPC)
PPG Protective & Marine Coatings	NACE International
General Shipyards	

9. REFERENCES

1. Elzly Technology Corporation, Corrosion Correctors, LLC, Todd Pacific Shipyards, Inc., NSRP SP-3 Project “Surface Preparation QA/QC Process Improvement” December 31 2007, available from www.nsdp.org

10. GRAPHICS



Figure 1 Flash Rust and Rust Back

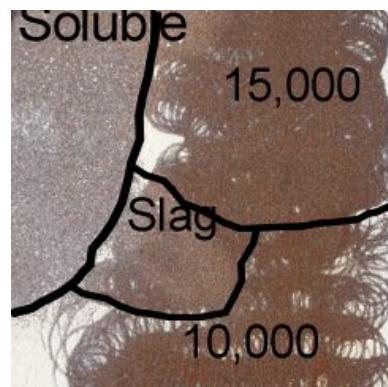


Figure 2 Four different techniques on same plate



Figure 3 Initial Condition and Prior to Painting



Figure 4 Moderate Flash Rust Courtesy of Ault and Cogswell, NSRP



Figure 5 Cloth Wipe- Light Flash Rust Area



Figure 6 Light Flash Rust. Fingertips met the surfaces. Small color transference.



Figure 7 Moderate Flash Rust. Hand Wipe. Note: Tape test on upper left. There is no black rust under the lighter brown rust.



Figure 8 Heavy Flash Rust. Black rust under the light brown rust. The surface is obscured. A layer of RUST SCALE has not formed



Figure 9 Swatch Test. Light, Moderate, Heavy



Figure 10 Wrap Cloth Around Brush. Brush once as if painting a door.



Figure 11 Brush Test. A little color is transferred.



Figure 12 Moderate Rust.- little to no black rust under the brown rust Comparison of Light, Moderate, and Heavy Flash Rust.



Figure 13 Moderate Flash Rust, Swatch and Brush Wipes



Figure 14 Heavy Flash Rust Comparison Swatch, Brush, wipe



Figure 15 Pressure Washing of Heavy Flash Rust. Result- continue with stains, but no loose rust dust. Results are “Light.”



Figure 16 Wipe Test on Heavily Stained & Heavy Flash Rust Area before and after Pressure Washing. After Pressure Wash- there is very little faint color on cloth

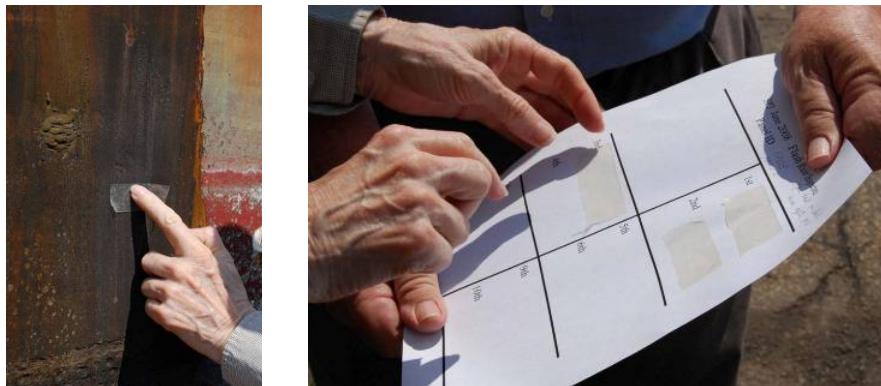


Figure 17 Pressure Sensitive Tape Test on the “heavy flash rust surface” after pressure washing, indicates no color transference or dust.