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Surface Preparation of Stainless Steel Prior to Painting

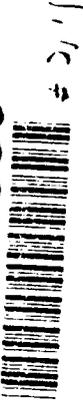
by

Dario A. Emeric and Christopher E. Miller

Report Date

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Surface Preparation of Stainless Steel Prior to Painting

by
Dario A. Emeric and Christopher E. Miller



US Army Belvoir RD&E Center
Fort Belvoir, Virginia 22060-5606

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Preface

Military specification MIL-T-704, *Treatment and painting of materiel*, requires the passivation of corrosion-resisting steel surfaces before painting. It also states surfaces to be painted shall be treated with wash primer conforming to DOD-P-15328, *Primer (wash) pretreatment (Formula No. 117 for metals), metric*, or MIL-C-8514, *Coating compound, metal pretreatment, resin-acid*.

Federal, state and city environmental and/or health regulations may prohibit the use of hexavalent chromium—one of the components of the passivating formulation used for the treatment of corrosion-resisting steels. Many companies are not passivating the corrosion-resisting steels before the application of the wash primer.

Based on the above, we started a laboratory investigation to determine if the elimination of the passivating procedure will have an adverse effect on the camouflage paint system. From the information obtained, we should be able to recommend whether or not to delete the passivating paragraph or procedure from MIL-T-704 and other applicable documents.

Section I

Test Standards and Equipment

This section presents test standards and equipment used for the evaluation of painting stainless steel with and without passivation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

B117	Standard method of salt spray (fog) testing
D610	Standard method of evaluating degree of rusting of painted steel surfaces
D714	Standard method of evaluating degree of blistering of paints
D1654	Standard method for evaluation of painted or coated specimens subjected to corrosive environments
D3170	Standard test method for chip resistance of coatings
D3359	Standard method for measuring adhesion by tape test

FEDERAL TEST METHOD STANDARD (FTMS)

141, Method	
6301.2	Adhesion (wet) tape test

EQUIPMENT USED

Binks Spray Gun, Model 2001, Binks Manufacturing Company
Coatings Scribe, Model 13-378, Fisher Scientific
Cold Temperature Chamber (cold box), Model #TM-35, B-M-A Inc.
Gravelometer, Model #QGR, Q-Panel Company
Harshaw Salt Fog Cabinet, Model #22, Harshaw Chemical Company
High strength, pressure-sensitive tape
Roller, 2 kg, 4 1/2 in long, rubber-coated

Section II

Test Procedures and Observations

All stainless steel samples were cleaned with a 0.1% solution of Triton X-100 and vapor degreased to assure a water-break free surface. Nine of the cleaned, degreased samples were sandblasted to obtain a 2 to 4 mil profile. Samples A through D were wash primed (DOD-P-15328) to a thickness of 0.3 mil and primed (MIL-P-53022) to a thickness of 1.0 mil.

PREPARATION

The sample preparation listed below was followed using three panels per test procedure:

1. Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).
2. Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).
3. Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).
4. Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).
5. Clean, sandblast, clean, and prime (MIL-P-53022).
6. Clean and prime (MIL-P-53022).

WET ADHESION TEST

Wet adhesion testing was performed according to Federal Test Method Standard (FTMS) 141, Method 6301.2, *Adhesion (wet) tape test*. Panels were immersed in deionized water for 24 hours. Once removed, a diamond grid pattern consisting of four intersecting lines was scribed through the paint film in two areas on each panel. Adhesive tape was then applied using a 2-kilometer roller. Once in place for 90 seconds, it was removed using a smooth, uniform motion. (NOTE: No further testing was done of samples that failed the wet adhesion test.)

After the panels were immersed in distilled water for 24 hours according to FTMS 141, Method 6301.2, they were evaluated according to ASTM D3359, *Standard method for measuring adhesion by tape test*. Results are shown below in Table 1. All the samples passed the wet adhesion test.

Table 1. Wet Adhesion Results

Panel No.	ASTM D3359 Rating	Panel No.	ASTM D3359 Rating
1A	5A	1D	5A
2A	5A	2D	5A
3A	5A	3D	5A
1B	5A	1E	5A
2B	5A	2E	5A
3B	5A	3E	5A
1C	5A	1F	0A
2C	5A	2F	0A
3C	5A	3F	0A

Key:

- A - Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).
- B - Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).
- C - Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).
- D - Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).
- E - Clean, sandblast, clean, and prime (MIL-P-53022).
- F - Clean and prime (MIL-P-53022).

SALT SPRAY RESISTANCE TEST

Salt spray testing was performed in accordance with ASTM B117, *Standard method of salt spray (fog) testing*. The bottoms of the panels were scribed with a diamond grid pattern consisting of four intersecting lines. Next, the panels were placed in the Harshaw salt fog cabinet for 2,000 hours. After exposure, the unscribed region of the panels was evaluated according to ASTM D610, *Standard method of evaluating degree of rusting of painted steel surfaces*, while the scribed regions were evaluated according to ASTM D1654, *Standard method for evaluation of painted or coated specimens subjected to corrosive environments*. Table 2 presents results.

Table 2. Salt Spray Results (2,000 hours)

(Note: These samples went through the Wet Adhesion Test before the Salt Spray Exposure Test.)

Panel No.	ASTM D610 Rating	ASTM D1654 Rating	Panel No.	ASTM D610 Rating	ASTM D1654 Rating
1A	10	10	1C	10	10
2A	10	10	2C	10	10
3A	10	10	3C	10	10
1B	10	10	1D	10	10
2B	10	10	2D	10	10
3B	10	10	3D	10	10
			6E	10	10

Key:

A - Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

B - Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

C - Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

D - Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

E - Clean, sandblast, clean, and prime (MIL-P-53022).

F - Clean and prime (MIL-P-53022).

GRAVELOMETER TEST/SALT SPRAY TEST

Impact by the gravelometer was performed according to ASTM D3170, *Standard test method for chip resistance of coatings*. After the panels were painted and cured, they were placed in the cold temperature chamber and cooled to -30°F for 2 hours before testing. The temperature was 10°F colder than the test temperature of -20°F. As specified in ASTM D3170, the 10-second warm-up period accounted for the time it took to remove a panel from the cold box and begin the gravelometer test. The upper half of the panels was impinged with 1 pint of gravel (between 3/8 and 5/8 inch in size) projected at a pressure of 70 ±3 pounds per square inch (psi). The impinged samples were placed in the salt spray cabinet for 336 hours. Tables 3 and 4 present results.

Table 3. Gravelometer Results

(Note: Two readings (upper and lower half) were made on the panel. From the corrosion viewpoint, 9B is superior to 6A.)

Panel No.	ASTM D3170 Rating	Panel No.	ASTM D3170 Rating
4A	6A & 8B	4C	6A & 9B
5A	6A & 9B	5C	6A & 9B
4B	6A & 8B	4D	6A & 9B
5B	6A & 9B	5D	6A & 9B
		6E	6A & 9B

Key:

A - Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

B - Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

C - Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

D - Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

E - Clean, sandblast, clean, and prime (MIL-P-53022).

F - Clean and prime (MIL-P-53022).

Table 4. Salt Spray Results (336 Hours)

(Note: These samples went through the Gravelometer Test before the Salt Spray Exposure Test.)

Panel No.	ASTM D610 Rating	ASTM D1654 Rating	Panel No.	ASTM D610 Rating	ASTM D1654 Rating
4A	10	10	4C	10	10
5A	10	10	5C	10	10
4B	10	10	4D	10	10
4B	10	10	4D	10	10
			6E	10	10

Key:

A - Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

B - Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

C - Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

D - Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

E - Clean, sandblast, clean, and prime (MIL-P-53022).

F - Clean and prime (MIL-P-53022).

OUTDOOR EXPOSURE TEST

The outdoor exposure took place behind our laboratory at Fort Belvoir, VA. Prior to exposure, the panels were top-coated (MIL-C-53039), and they were allowed to cure for 7 days. They were scribed using a diamond grid pattern consisting of four intersecting lines through the paint film on the bottom half of each panel. The scribed panels were placed on a rack at a 30° angle from the horizontal, facing south, for six months. Results are given in Table 5.

Table 5. Outdoor Test Results

(Note: These samples were sprayed weekly with a 5% salt spray solution.)

Panel No.	ASTM D610 Rating	ASTM D1654 Rating	Panel No.	ASTM D610 Rating	ASTM D1654 Rating
6A	10	10	6C	10	10
7A	10	10	7C	10	10
8A	10	10	8C	10	10
6B	10	10	6D	10	10
7B	10	10	7D	10	10
8B	10	10	2D	10	10
			6E	10	10

Key:

A - Clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

B - Clean, sandblast, clean, wash prime (DOD-P-15328), and prime (MIL-P-53022).

C - Clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

D - Clean, sandblast, clean, passivate (QQ-P-35), wash prime (DOD-P-15328), and prime (MIL-P-53022).

E - Clean, sandblast, clean, and prime (MIL-P-53022).

F - Clean and prime (MIL-P-53022).

Section III

Test Conclusions and Recommendations

CONCLUSIONS

This work evaluated the effect of passivation and/or sandblasting before painting stainless steel as required by MIL-T-704. According to the test results, if a conversion coating (wash primer) is used, there may not be a need for sandblasting or for passivation of the surface to have adhesion of the coating to the substrate.

RECOMMENDATIONS

Based on these preliminary test results and environmental requirements, it is recommended that consideration be given to the elimination of the passivation requirement for stainless steel. It is also recommended that more extensive work be conducted to verify these findings.

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