

**Engineering and Technical Services
for Joint Group on Pollution Prevention
(JG-PP) Projects**

C-17 Field Evaluation Report:

**Inspection of Aircraft
for Validation of Alternatives to
Chromate-Containing Primer Coatings
for Aircraft Exterior Mold Line Skins**

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1. INTRODUCTION

The Joint Logistics Commanders (JLC) and Headquarters National Aeronautics and Space Administration (NASA) co-chartered the Joint Group on Pollution Prevention (JG-PP) to coordinate joint service/agency activities affecting pollution prevention issues identified during system and component acquisition and sustainment processes. The primary objectives of the JG-PP are to:

- Reduce or eliminate the use of hazardous materials (HazMats) at manufacturing, remanufacturing, and sustainment locations
- Avoid duplication of efforts in actions required to reduce or eliminate HazMats through joint service cooperation and technology sharing.

JG-PP projects typically involve an original equipment manufacturer (OEM) producing multiple defense systems for more than one of the Services, as well as at least one depot servicing one or more of the defense systems. JG-PP technical representatives for each project begin by selecting a target HazMat that is used in the production or sustainment processes and may cause environmental and/or worker health concerns. Project participants then identify alternative technologies for evaluation.

At the Boeing Military Aircraft and Missile Systems Group pilot site (B-A&M) located in St. Louis, Missouri (formerly McDonnell Douglas Aerospace), chromium in primer coatings was identified as the target HazMat to be eliminated or reduced. The chromate primers are applied to aircraft exterior mold line skins by wet-spray coating. The main substrate is aluminum alloy that has been anodized or chromate conversion coated, but other substrates such as steel, carbon epoxy, and titanium are also present on aircraft exterior surfaces and will be coated by these primers.

The project technical representatives reached consensus on the critical technical and performance requirements that an alternative must satisfy to be qualified for use in the identified application. These requirements were documented in the *Joint Test Protocol (MD-P-1-1) for Validation of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins*, dated December 23, 1997. The *Potential Alternatives Report (MD-A-1-1) for Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins*, dated May 1, 1998, provides a list of alternatives recommended for testing.

The testing was executed in three phases: two phases of laboratory testing and one of field evaluation. The *Joint Test Report (MD-R-1-1) for Laboratory Validation (Testing) of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins*, dated February 24, 1998, documents the laboratory testing accomplished on the potential alternatives. The results of the laboratory testing were analyzed to select a limited number of nonchromate primers to be applied to operating aircraft to allow further evaluation of the nonchromate primers. After examining the test panels and analyzing the

test results, the project participants selected Dexter Aerospace Materials 10PW22-2/ECW-119 and PRC-DeSoto EWAE118A/B for field evaluations on operating aircraft.

2. BACKGROUND ON OPERATIONAL TESTING

As part of the JG-PP and Boeing effort to identify suitable nonchromate primers for aircraft exterior mold line skins, nonchromate primer has been applied to portions of operating aircraft to evaluate its performance. The following text and sketches document the results of the PRC-DeSoto nonchromate primer performance on aircraft #93-0602. The aircraft was painted at the Boeing Aerospace Support Center (BASC), Kelly AFB, TX in July 2000. The nonchrome primer test area consists of the upper surface of the right-hand wing, the engine nacelles on the right-hand wing and the emergency crew door on the forward fuselage. The remainder of the aircraft was primed with the original production chromated primer and opposite hand surfaces on the left side will serve as the control.

Two fuel cell covers on the upper surface of each wing and the emergency crew door were stripped to the substrate to evaluate the primer on bare metal surfaces. All of the painted exterior surfaces of the aircraft were scuff sanded to remove loose and oxidized topcoat prior to moving the aircraft to the paint hangar. Paint around locations where the substrate was exposed, primarily fasteners, was sanded to remove any loose paint and feathered at the edges. After sanding the aircraft was detergent washed and rinsed with tap water. All of the bare metal surfaces, including the fuel cell test covers and emergency door, were chromate conversion coated with Alodine 1200S and rinsed with tap water.

In addition to inspecting the aircraft for the list of paint defects outlined in the joint test protocol the C-17 will also be monitored for color and gloss changes at each inspection. The topcoat used on the C-17 is an advanced performance topcoat that improves ultraviolet (UV) resistance to reduce chalking. Laboratory testing has shown that primer may affect UV resistance performance of the topcoat and it was deemed important to monitor in the operational environment. Initial readings were taken after painting to serve as the base line and will be compared to readings taken at each subsequent inspection.

The operational test plan specifies that the first inspection be performed between 50 and 100 flight hours and six-month intervals there after. This FER documents the performance of the PRC-DeSoto EWAE118 nonchromate primer at the first six-month inspection. The aircraft is stationed at McChord Air Force base near Tacoma Washington.

Table 1. Inspection Data for C-17 Test Aircraft

Aircraft #	Date Painted	Flight Hours When Painted	Flight Hours on 27 Dec. 2000	Flight Hours Since Painted
93-0602	July, 2000	5332.2	5706.8	374.6

The inspection team for this inspection included:
Steve Finley, Air Force, Coatings Technology Integration Office
Larry Triplett, B-A&M

Larry Triplett, B-A&M prepared these inspection results and summary.

3. INSPECTION RESULTS

3.1 Left-Hand Wing, Chromate Control Primer

There were minor defects seen on the upper surface of the left-hand wing. An area of peeling paint on the inboard flap noted in the last report was approximately three inches in diameter at the previous inspection and has now increased in size plus two additional areas were noted nearby. (See in Figure 1) The failure mode was primer to substrate but the defect area was not observed to be bare prior to painting at the depot, indicating the failure was with previously applied primer.

A second defect area was cracked and lifted paint on the outboard upper wing over a sealant joint. (See in Figure 1) The failure was at the interface of previously applied primer.

Figure 1 also identifies locations where the gloss and color readings were taken and locations of the stripped test covers. Each gloss and color reading location are numbered and results are shown in Table 2.

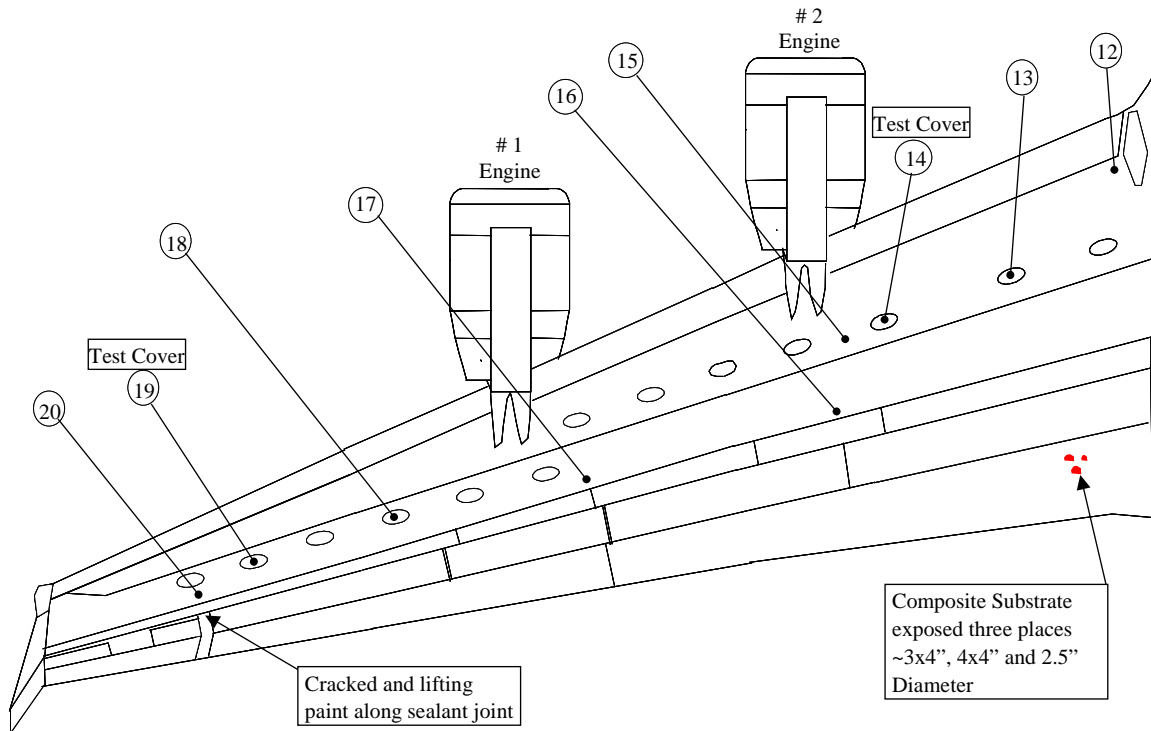
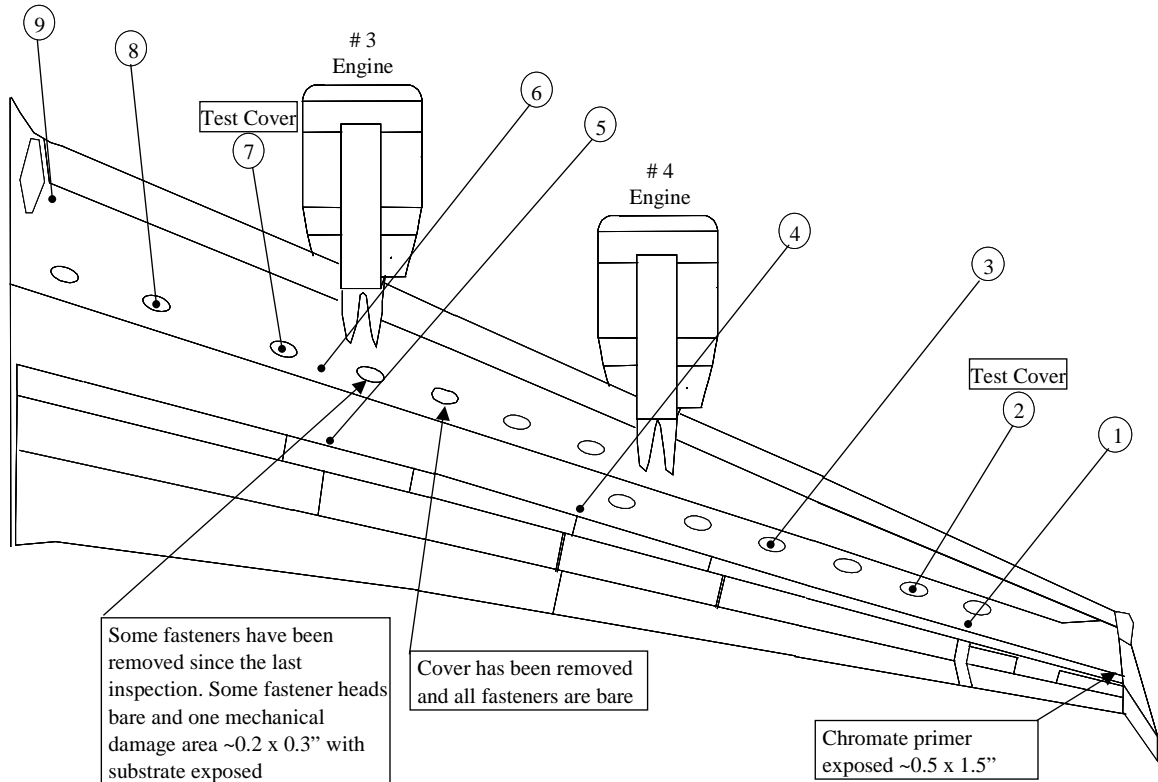


Figure 1. Left-Hand Wing Looking Down

3.2 Right Hand Wing, Nonchrome Test Primer

There were no defects on the upper surface of the right-hand wing attributable to the nonchrome primer. Three defect areas are shown in Figure 2 but all were due to mechanical damage or failure at an interface other than the nonchrome primer.

Figure 2 also identifies locations where the gloss and color readings were taken and depicts the location of the stripped test covers. Each gloss and color reading



location are numbered and results are shown in Table 2.

Figure 2. Right Hand Wing Looking Down

3.3 Engine Pylons Nacelles

Two defects were found on the engine pylons and nacelles. An area of peeling paint around a sealant joint on the outboard side of the # 2 engine pylon was noted at the last inspection and has not significantly changed. The approximate total area of bare substrate is seven square inches. The substrate is titanium and the sealant is a high temperature silicone sealant. (Ref. Fig. 3) The second area was a scratch,

due to mechanical damage, on the #4 engine nacelle. A close examination was not performed but the substrate was exposed approximately 0.5 x 1.0 inch. (Ref Fig. 4)

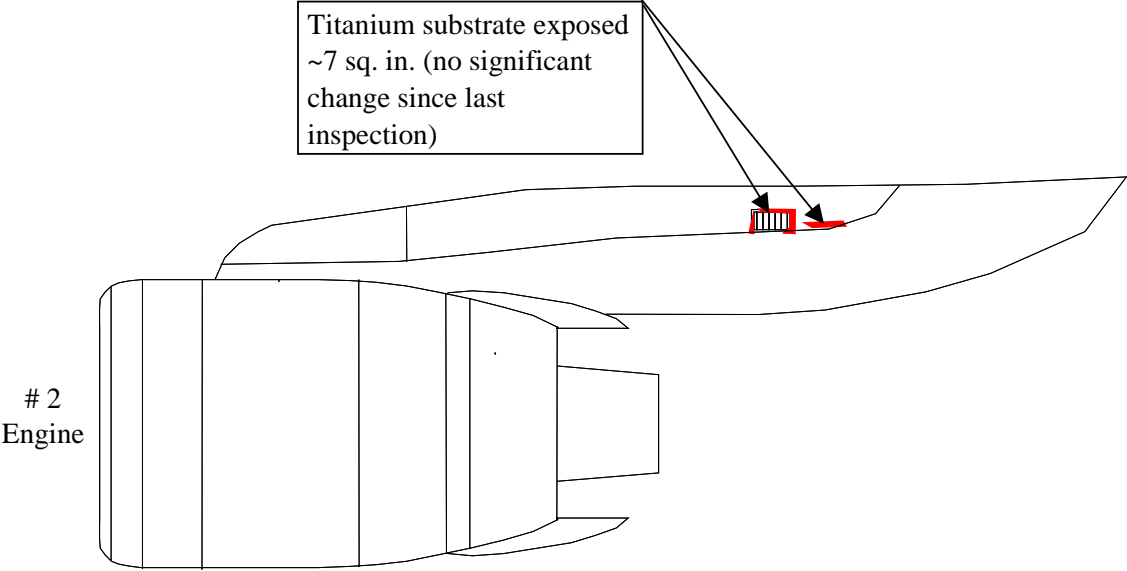


Figure 3. Left Hand, #2 Engine Nacelle Looking Inboard

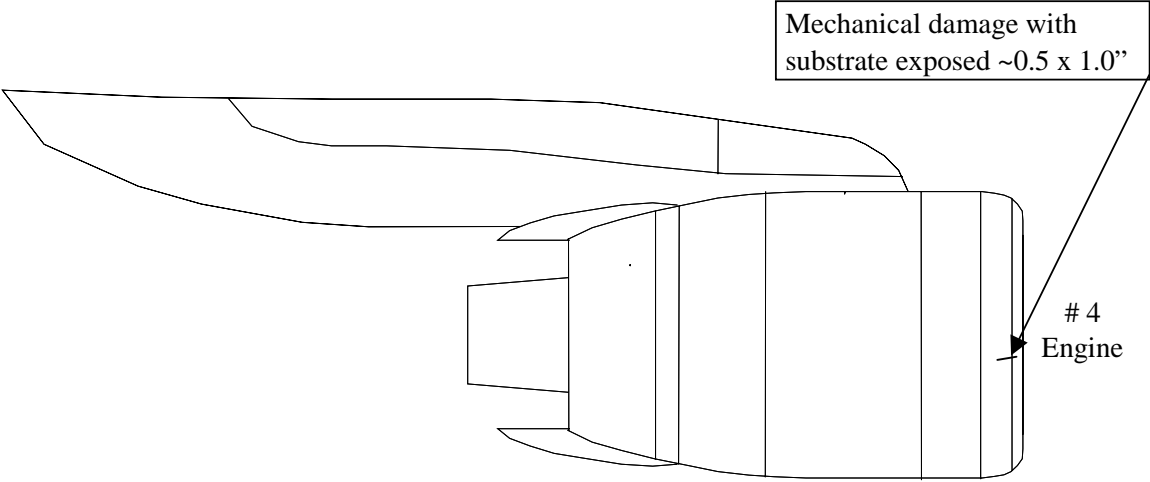


Figure 4. Left Hand, #2 Engine Nacelle Looking Inboard

3.4 Emergency Door

One scratch, due to mechanical damage was noted on the emergency crew door. The scratch was approximately two inches long varying in depth from marring the topcoat to exposing the substrate.

Figure 5 identifies locations where the gloss and color readings were taken. Each gloss and color reading location are numbered and the results are shown in Table 2.

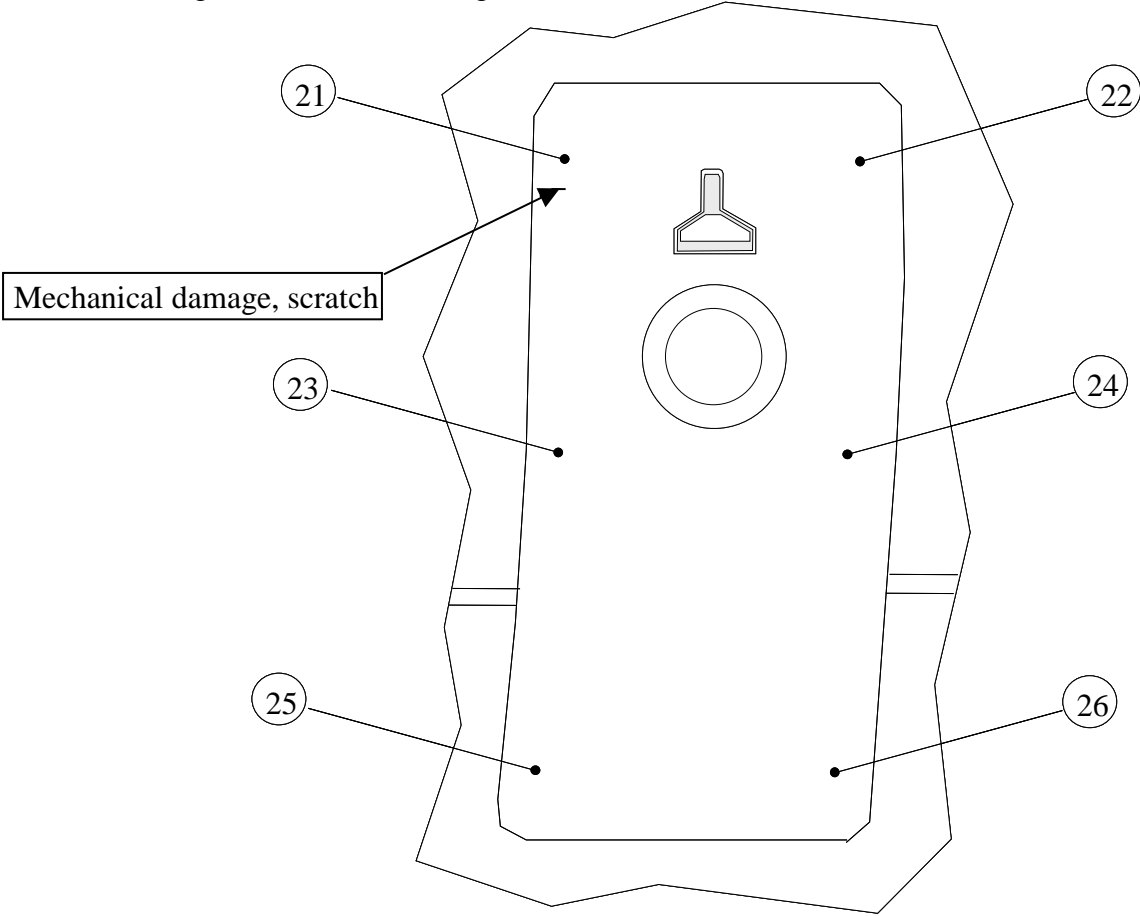


Figure 5. Emergency Door Right-hand Forward Fuselage, Looking Inboard

Color and gloss readings were recorded at the same locations as those taken after initial painting. Table 2 documents the differences between the initial color readings and those recorded during this inspection. The gloss readings are actual readings taken during the inspection.

Table 2. Color and Gloss Data

	Location	Color Readings*				Gloss	
		ΔL	Δa	Δb	ΔE	60°	85°
1	RT Wing	-0.66	0.13	0.45	0.81	3.4	4.9
2	RT Wing	-0.90	0.06	0.46	1.01	3.5	5.3
3	RT Wing	-0.91	0.12	0.56	1.08	3.5	5.3
4	RT Wing	-1.16	0.11	0.70	1.36	3.1	4.4
5	RT Wing	-1.11	0.12	0.69	1.31	3.8	6.3
6	RT Wing	-0.92	0.05	0.46	1.03	4.4	7.6
7	RT Wing	-1.23	0.10	0.62	1.38	3.8	6.3
8	RT Wing	-1.13	0.16	0.59	1.28	3.2	5.1
9	RT Wing	-1.54	0.22	0.83	1.76	2.8	4.5
12	LFT Wing	-1.33	0.16	0.79	1.56	2.5	4.3
13	LFT Wing	-0.80	0.09	0.62	1.02	2.7	2.3
14	LFT Wing	-1.12	0.20	0.55	1.26	2.5	3.9
15	LFT Wing	-1.17	0.12	0.60	1.32	2.8	4.2
16	LFT Wing	-1.05	0.09	0.55	1.19	2.8	4.3
17	LFT Wing	-1.24	0.13	0.53	1.35	2.4	4.0
18	LFT Wing	-0.93	0.17	0.52	1.08	2.4	3.5
19	LFT Wing	-1.16	0.23	0.55	1.30	2.0	2.9
20	LFT Wing	-1.00	0.17	0.58	1.17	2.5	4.1
21	Emg Door	-0.33	0.08	0.09	0.35	2.4	3.9
22	Emg Door	-0.19	-0.02	0.08	0.21	2.3	3.5
23	Emg Door	-0.21	0.04	0.17	0.27	2.4	3.5
24	Emg Door	-0.03	0.10	0.09	0.14	2.1	4.1
25	Emg Door	-0.09	0.07	0.11	0.16	2.0	6.9
26	Emg Door	-0.24	0.10	0.09	0.28	2.0	5.9

* Deltas are differences between the initial readings after painting and inspection readings.

4. SUMMARY

Only minor paint defects were observed on the test portions of the aircraft and none were related to the test primer. Mechanical damage areas and fasteners with paint missing after removal were noted and will be monitored for corrosion at future inspections. Color and gloss readings were not significantly different between the test and control surfaces indicating that the test primer is not adversely affecting the topcoat.