

**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**

**29 June 2001**



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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, 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 for further evaluation. After examining the test panels and analyzing the test results, the project participants selected Akzo Nobel (formerly Dexter Aerospace) 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 second six-month inspection. The aircraft was initially stationed at McChord AFB near Tacoma WA and is now assigned to Altus AFB, Oklahoma.

**Table 1. Inspection Data for C-17 Test Aircraft**

<b>Aircraft #</b>	<b>Date Painted</b>	<b>Flight Hours When Painted</b>	<b>Flight Hours June 2001</b>	<b>Flight Hours Since Painted</b>
93-0602	July, 2000	5332.2	6337.6	1005.4

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

### 3. INSPECTION RESULTS

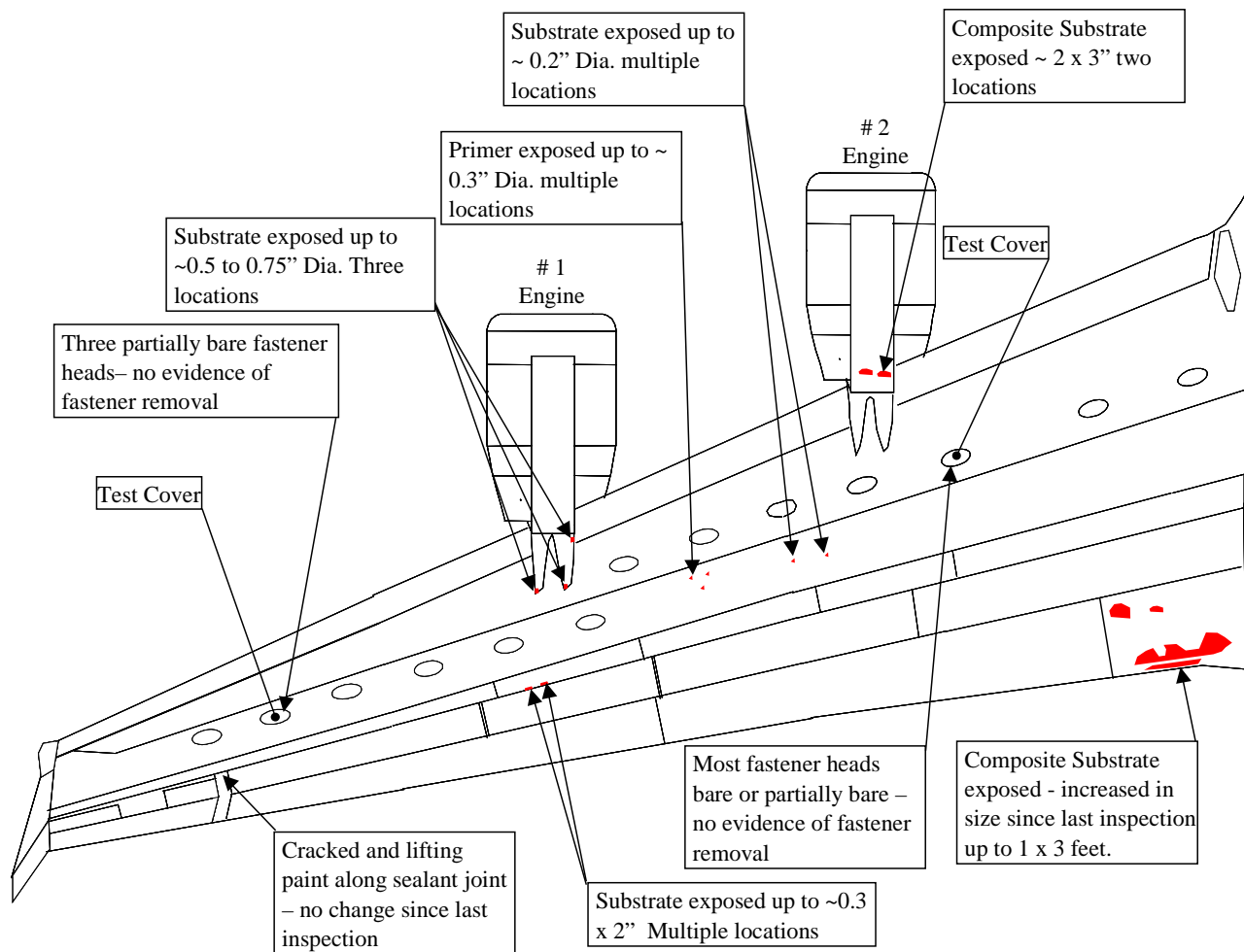
#### 3.1 Left-Hand Wing, Chromate Control Primer

Most of the defects seen on the upper surface of the left-hand wing were minor with the exception of an area of peeling paint on the inboard flap. Peeling paint was noted on the flap at the last inspection but has now increased in size by a significant amount (Ref. 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.

The cracked and lifted paint on the outboard upper wing over a sealant joint identified at the first inspection has not significantly changed. The failure was at the interface of previously applied primer to substrate.

New defect areas of chipped or peeling paint approximately 0.3" diameter was noted on the wing skins. Some were primer to substrate and some were topcoat to primer. Three areas of primer to metal substrate up to approximately 0.5 to 0.75" diameter were noted on the #1 engine to wing fairing and two areas up to 2" x 3" primer to composite peeling on the #2 engine fairing. All defects are shown in Figure 1.

Figure 3 identifies locations where the gloss readings were taken and locations of the stripped test covers. Each gloss reading location is numbered and results are shown in Table 2. Different color equipment was used to take color readings at this inspection and due to a variance of readings the data is not included in this report. Color readings will be taken at the final inspection with the previously used color meter.



**Figure 1. Left-Hand Wing Looking Down**

### 3.2 Right Hand Wing, Nonchrome Test Primer

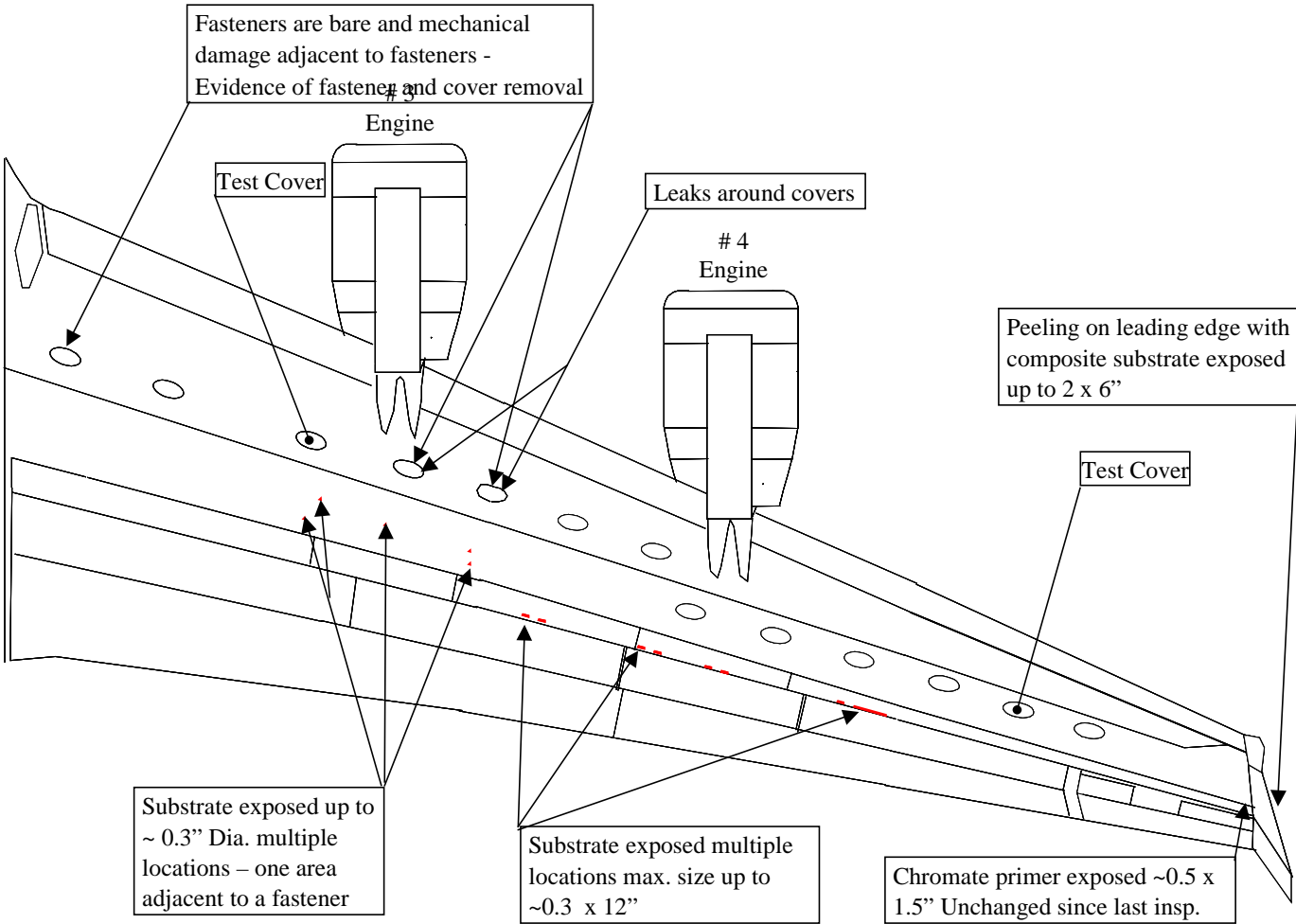
New defects on the upper surface of the right-hand wing consist of small areas of chipped or peeling paint approximately 0.3" diameter. Without peeling away more paint it was not possible to tell if it was the nonchrome primer that was peeling from the substrate or a previously applied primer. At the final inspection in December a chip of the coating will be removed to ascertain the failure interface.

There were multiple areas of peeling paint to the substrate along the flap seals in the same locations as on the control side but larger in size, up to approximately 0.3 x 12 inches. There was no evidence of peeling on the flap seals prior to applying the nonchrome primer indicating that the failure is at the previously applied primer to substrate interface.

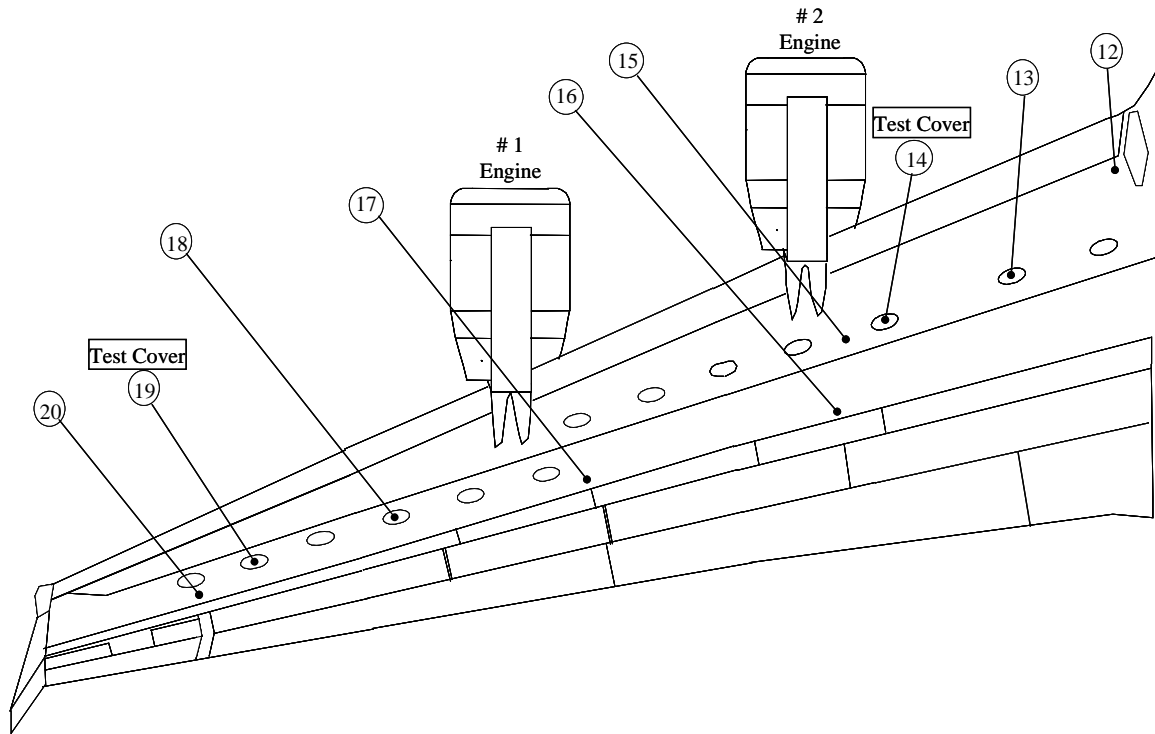
Peeling paint was also noted on the leading edge of the winglet. The winglet was mostly bare prior to priming at the depot and the failure is nonchrome primer to composite substrate.

All of the defects areas are noted in Figure 2.

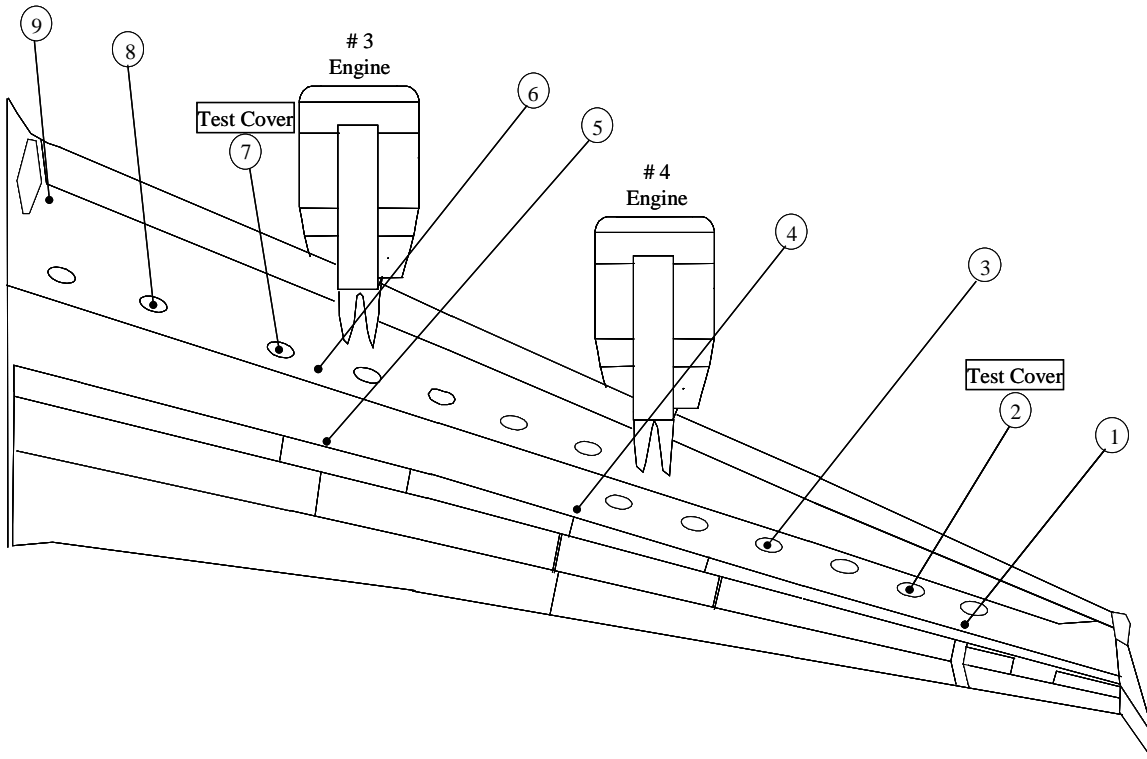
Figure 4 identifies locations where the gloss readings were taken and locations of the stripped test covers. Each gloss reading location is numbered and results are shown in Table 2. Different color equipment was used to take color readings at this inspection and due to a variance of readings the data is not included in this report. Color readings will be taken at the final inspection with the previously used color meter.



**Figure 2. Right Hand Wing Looking Down**



**Figure 3. Left-Hand Wing Gloss Locations**



**Figure 4. Right-Hand Wing Gloss Locations**

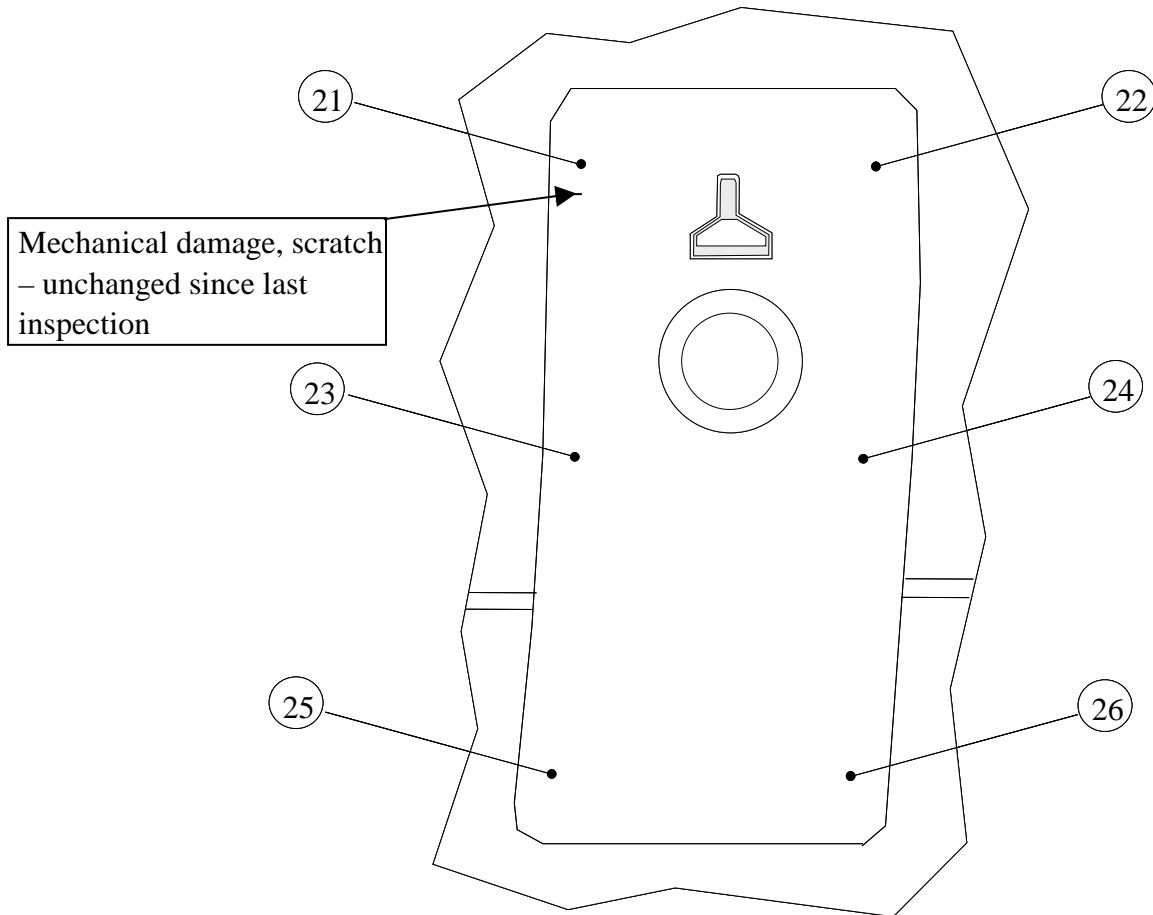
### 3.3 Engine Pylons Nacelles

The area of peeling paint around a sealant joint on the outboard side of the # 2 engine pylon noted in the last inspection was touched up since the last inspection. The paint did not match well but the substrate was coated.

### 3.4 Emergency Door

One scratch, due to mechanical damage noted at the last inspection is unchanged. The scratch is approximately two inches long varying in depth from marring the topcoat to exposing the substrate.

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



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

Gloss readings were recorded at the same locations as those taken after initial painting. Table 2 documents the actual gloss readings taken during the inspection.

**Table 2. Gloss Data**

	Location	Gloss		Delta from Initial	
		60°	85°	60°	85°
1	RT Wing	3.3	5.1	0.9	0.1
2	RT Wing	2.5	5.4	1.9	0.2
3	RT Wing	2.4	5.3	2.0	0.2
4	RT Wing	3.1	5.1	1.2	0.6
5	RT Wing	3.7	6.1	0.9	0.2
6	RT Wing	3.8	6.1	1.1	0.6
7	RT Wing	3.7	6.2	1.0	0.2
8	RT Wing	3.2	5.2	0.7	-0.1
9	RT Wing	2.8	4.7	0.5	-0.5
12	LFT Wing	2.4	4.0	0.8	-0.1
13	LFT Wing	2.7	4.1	1.1	-0.2
14	LFT Wing	2.4	4.3	0.6	-0.4
15	LFT Wing	2.6	4.1	1.1	0.7
16	LFT Wing	2.8	4.5	0.8	0.2
17	LFT Wing	2.2	4.2	0.8	0.0
18	LFT Wing	1.7	2.9	0.6	-0.1
19	LFT Wing	2.1	3.4	0.5	0.0
20	LFT Wing	2.5	4.8	0.5	-0.7
21	Emg Door	2.2	4.1	0.1	-0.8
22	Emg Door	2.3	4.1	0.1	-0.8
23	Emg Door	2.0	3.8	0.2	0.1
24	Emg Door	2.0	4.0	0.3	-0.6
25	Emg Door	1.9	7.0	0.2	-0.1
26	Emg Door	1.9	6.3	0.0	-1.0

\* Deltas are differences between the initial readings after painting and readings recorded at this inspection.

#### 4. SUMMARY

Similar defects were observed on the test portions and control portions of the aircraft. Mechanical damage areas and fasteners with paint missing after removal were noted and will be monitored for corrosion at future inspections. New defects noted at this inspection were chipped or peeling paint near the center of each wing. The areas were small. Approximately 0.3” diameter, most of which were failures at the substrate or to primer. The largest defect was peeling paint on the inboard flap on the left-hand or control side, which has grown considerably since the last inspection.

Gloss readings were not significantly different between the test and control surfaces and have not significantly changed since the last inspection.