Engineering and Technical Services for Joint Group on Acquisition Pollution Prevention (JG-APP) Pilot Projects

Field Evaluation Report IV:

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

September 14, 1998

Contract No. DAAA21-93-C-0046
Task No. N.072
CDRL No. B001

Prepared by
National Defense Center for Environmental Excellence (NDCEE)

Operated by Concurrent Technologies Corporation

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Joint Logistics Commanders (JLC) chartered the Joint Group on Acquisition Pollution Prevention (JG-APP) to coordinate joint service activities affecting pollution prevention issues identified during a weapon system's acquisition process. The primary objectives of JG-APP are to:

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

The focus of JG-APP is on original equipment manufacturer (OEM) design, manufacturing, and remanufacturing locations, with subsequent technology transfer to Department of Defense Sustainment Community locations.

The OEMs currently participating in the JG-APP process produce multiple defense systems for more than one of the tri-services. JG-APP technical representatives for each project begin by selecting a target HazMat that is used in the OEM's production process and may cause environmental and/or worker health concerns.

At the Boeing Company Aircraft & Missiles pilot site 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/Crown Metro Aerospace 10PW22-2/ECW-119 and Spraylat Corporation EWAE118 for field evaluations on operating aircraft.

This field evaluation report documents the second inspection of two F-15s being used for the operational testing. The first inspection of these two F-15s was performed on January 27, 1998, and documented in the *Field Evaluation Report I: Inspection of Aircraft for Validation of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins*, dated May 22, 1998. The results of all field evaluations will be consolidated and reported in a subsequent JTR, *Joint Test Report (MD-R-1-2) for Field Evaluation and Validation of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins* (in preparation).

2. BACKGROUND ON OPERATIONAL TESTING

As part of the JG-APP and Boeing effort to identify suitable nonchromate primers for application to aircraft exterior mold line skins, nonchromate primer has been applied to portions of operating aircraft by wet-spray techniques. The text and sketches in Section 3 document the second inspections of the two nonchromate primer test F-15 aircraft at Tyndall Air Force Base, Florida (Tyndall AFB). These aircraft, F-15 numbers 81-024 and 79-011, are assigned to the Aerial Education and Training Command (AETC). They were inspected on July 28, 1998. The inspection team included:

- John Lindsey, Wright Laboratory (WL-MLS/OL)
- Larry Garrett, Warner-Robins Air Logistics Center (WR-ALC)
- John Stephens, Warner-Robins Air Logistics Center (WR-ALC/LFEFS)
- Captain Leon Perkowski, Air Force Research Laboratory (AFRL/MLQE)
- Dr. Ray Wells, Air Force Research Laboratory (AFRL/MLQR)
- Sheryl Wyatt, ARA at Tyndall Air Force Base
- F. D. Kisor, representing Wright Laboratory Materials Directorate
- Will Estes, Dexter Aerospace Materials/Crown Metro Aerospace
- Larry Triplett, Boeing Company, McDonnell Aircraft & Missile Systems

The two F-15 aircraft were painted at WR-ALC in late June and late August of 1997. Dexter/Crown Metro 10PW-22-2/ECW-119 nonchromate primer was applied on the upper and lower surfaces of the right wings, and the remainder of each aircraft was primed with chromate MIL-P-23377 primer. The topcoats applied were MIL-P-85285 products manufactured by Deft.

Table 1. Inspection Data for F-15 Test Aircraft

Aircraft #	Date Painted	Total Flight Hours on July 28, 1998	Flight Hours Since Painted
81-024	June, 1997	4152.2	205.9
79-011	August, 1997	4924.1	208.3

The inspection results and summary were prepared by Larry Triplett.

3. INSPECTION RESULTS

No repainting or touch-up was noted on the two aircraft since the first inspection performed in January 1998. Defect areas that were documented in the first inspection were reinspected to determine if they have changed.

3.1. Inspection Results for F-15 #81-024

No new defects were found on the upper surface of the left wing since the last inspection. Topcoat and primer were missing from several fasteners with chipped paint around the fasteners due to fastener removal. There was only one new area of peeling paint on the lower titanium skins and the two areas noted in the January inspection had not appreciably increased in size. Additional areas of aluminum substrate were exposed on the leading edge and the areas noted in the previous inspection had increased in size, likely due to erosion. Figures 1 and 2 show the locations of the observed coating defects.

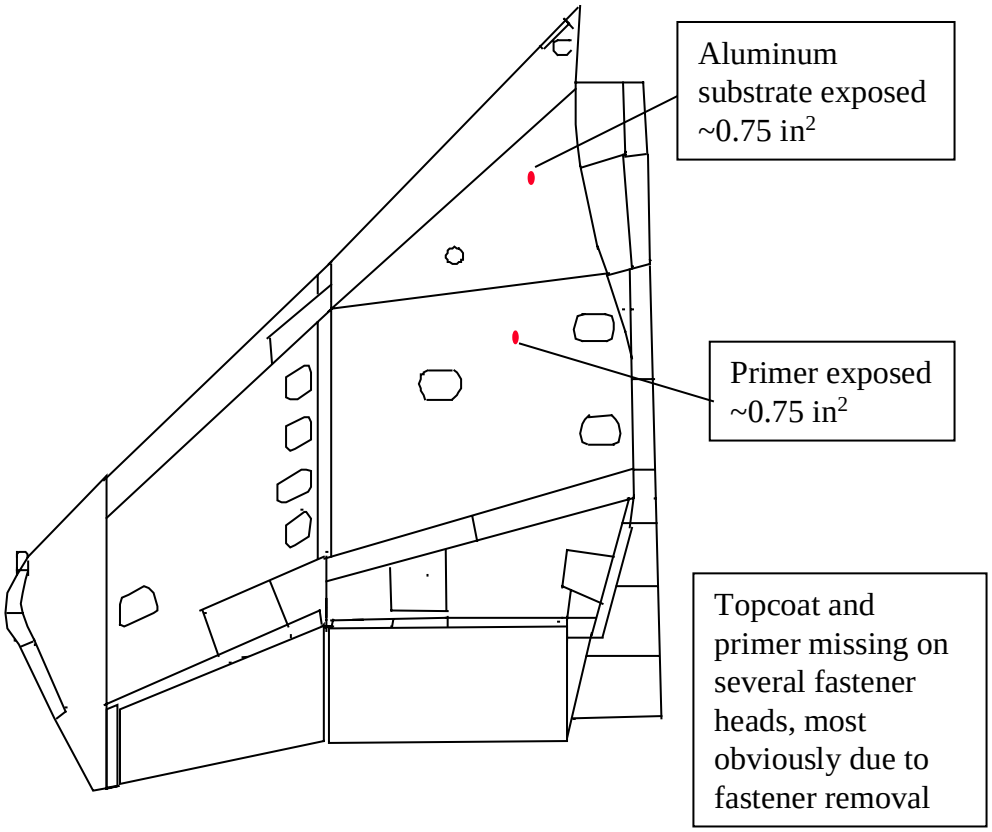

Figure 1. F-15 #81-024, View Looking Down, Left Wing

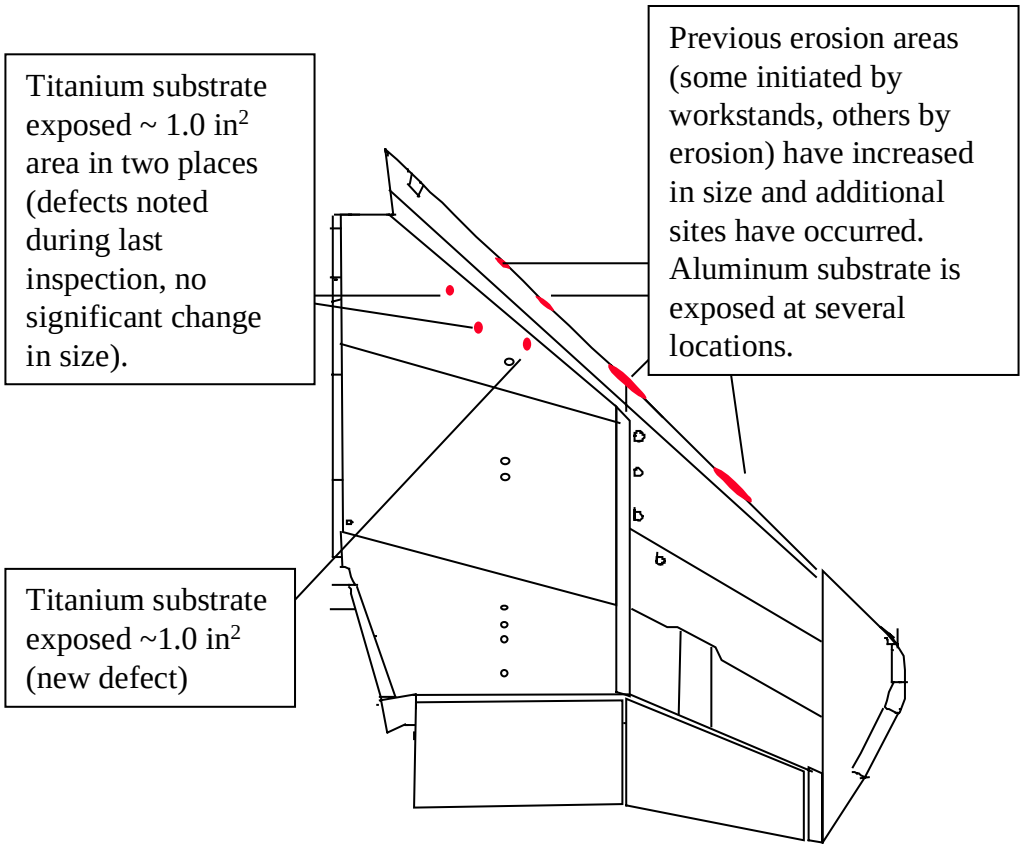

Figure 2. F-15 #81-024, View Looking Up, Left Wing

No new defects were observed on the upper surface of the right wing since the last inspection. Topcoat and primer were missing from several fasteners with chipped paint around the fasteners due to fastener removal. Multiple areas of peeling paint had been found on the lower titanium wing skins during the January inspection; many of these peeling paint areas had increased in size. New areas of peeling paint were also observed on the lower titanium skins. Small areas of peeling primer (approximately 0.5 inch in diameter) have appeared on the lower surface of the wing on aluminum substrates. Most defects are on and adjacent to fasteners but two small areas were also noted on the wing tip skin. Only one defect noted on the leading edge appeared to have been initiated by mechanical damage. Figures 3 and 4 show the locations of the observed coating defects.

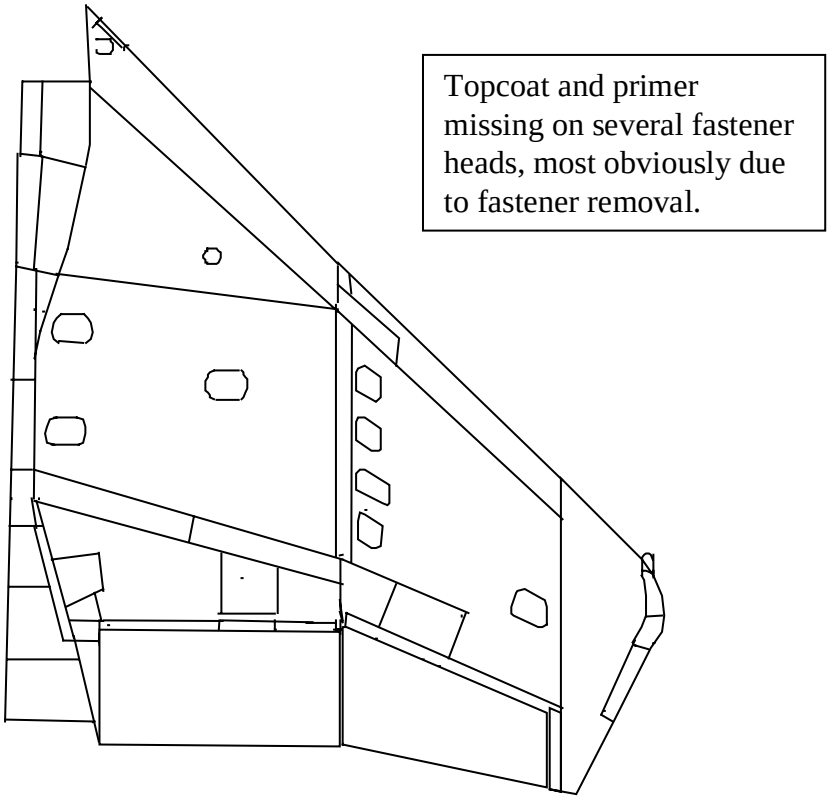

Figure 3. F-15 #81-024, View Looking Down, Right Wing

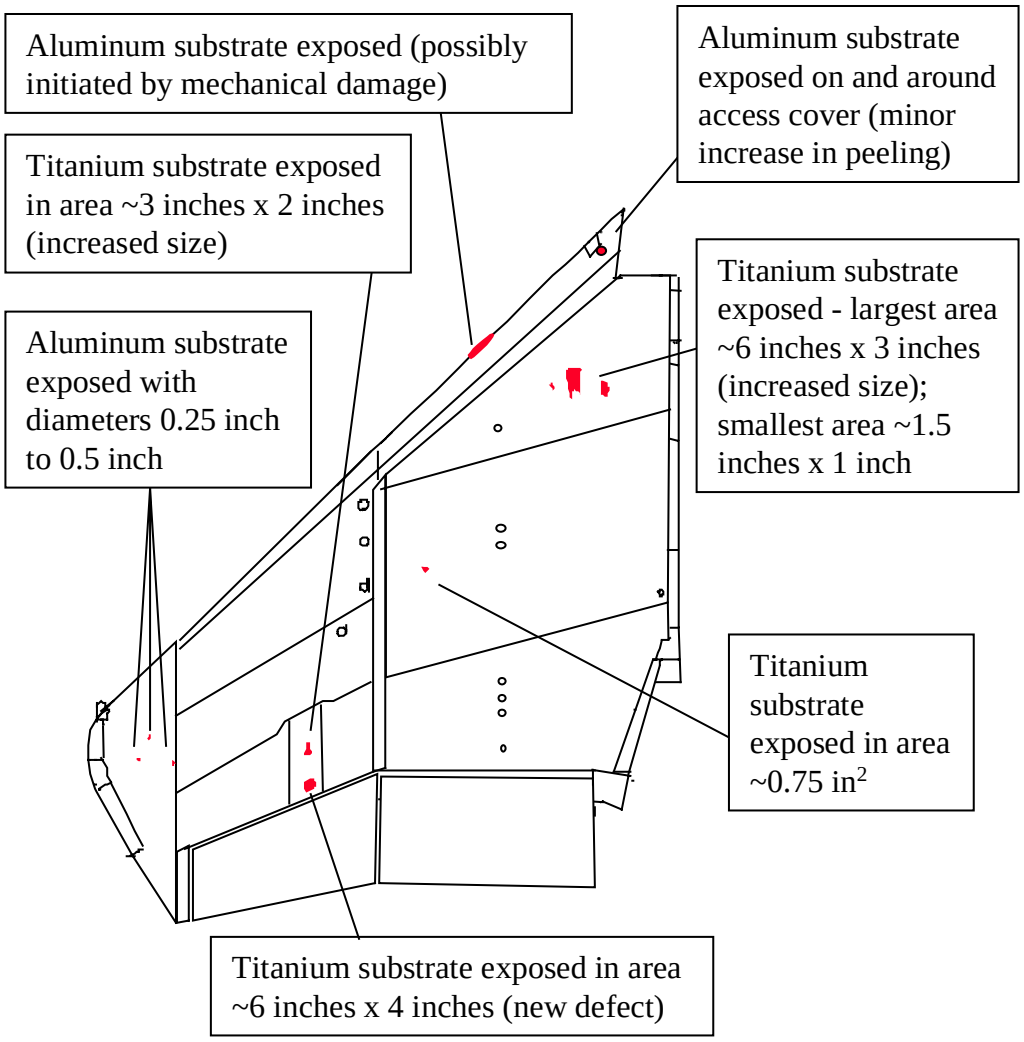

Figure 4. F-15 #81-024, View Looking Up, Right Wing

In addition, peeling primer was also observed where the nonchromate and chromate primers intersect at the fuselage below the right wing. Both primers are peeling in this area, indicating that poor surface preparation may contribute to the peeling.

3.2. Inspection Results for F-15 #79-011

Multiple areas of chipped paint were found on the outboard panel and two areas on an inboard panel of the upper surface of the left wing. These areas were probably initiated by mechanical damage. Topcoat and primer were missing from several fasteners with chipped paint around the fasteners due to fastener removal. No new areas of peeling paint on the titanium surfaces of the lower wing appeared since the January inspection. One area at the splice of the inner and outer skins

had a new rust-colored stain at a fastener location. Additional areas of aluminum substrate were exposed on the leading edge and the areas noted in the previous inspection had increased in size, likely due to erosion. Figures 5 and 6 show the locations of the observed coating defects.

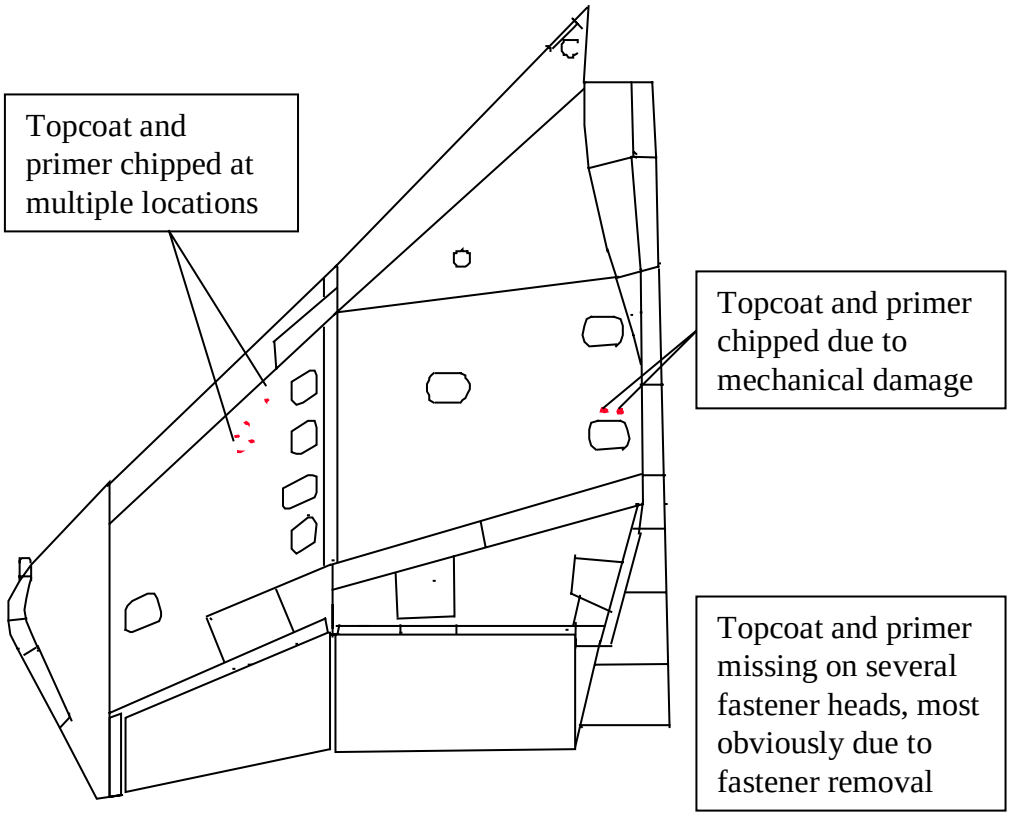

Figure 5. F-15 #79-011, View Looking Down, Left Wing

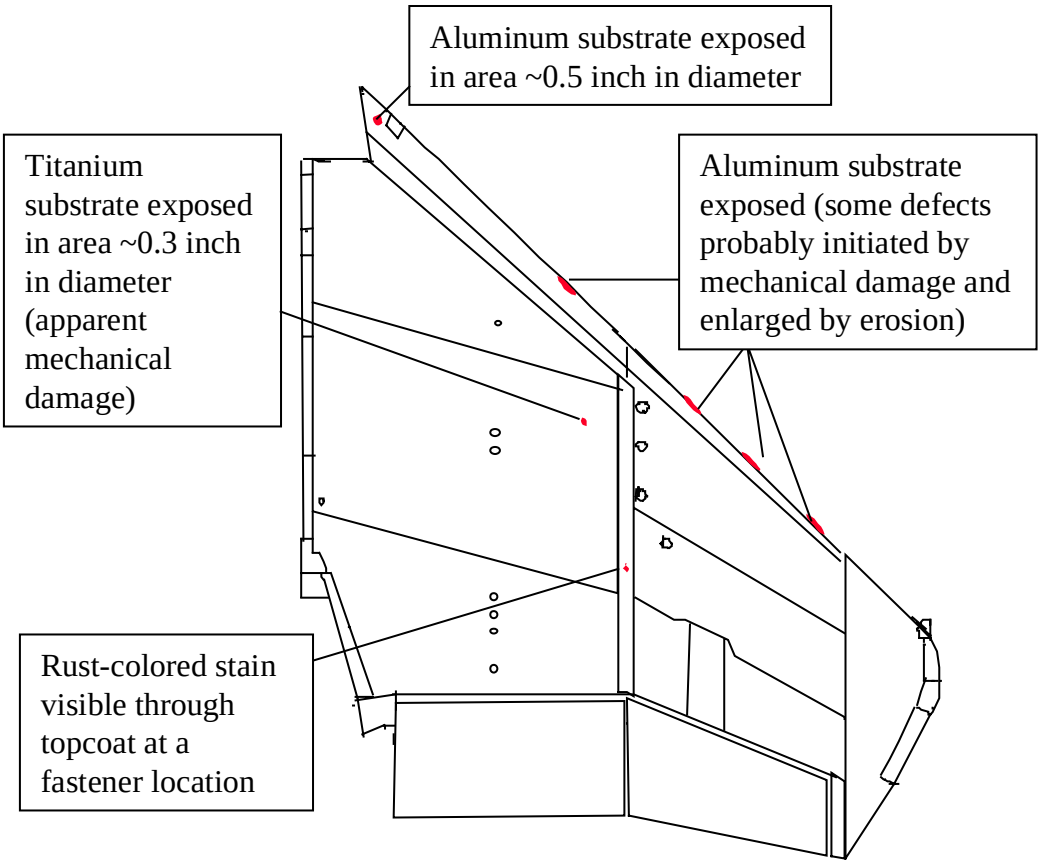

Figure 6. F-15 #79-011, View Looking Up, Left Wing

No new defects were observed on the upper surface of the right wing since the last inspection. Topcoat and primer were missing from several fasteners with chipped paint around the fasteners due to fastener removal. Seven new areas of peeling paint were identified at this inspection on titanium and aluminum skins. Adhesion defects were much more severe on titanium than on aluminum. In addition, small areas of peeling paint on aluminum substrates at permanent or non-removable fastener locations were observed. No defects were noted on the leading edge of the right wing except at the inboard marker light; this defect was likely initiated when the light was removed. Figures 7 and 8 show the locations of the observed coating defects.

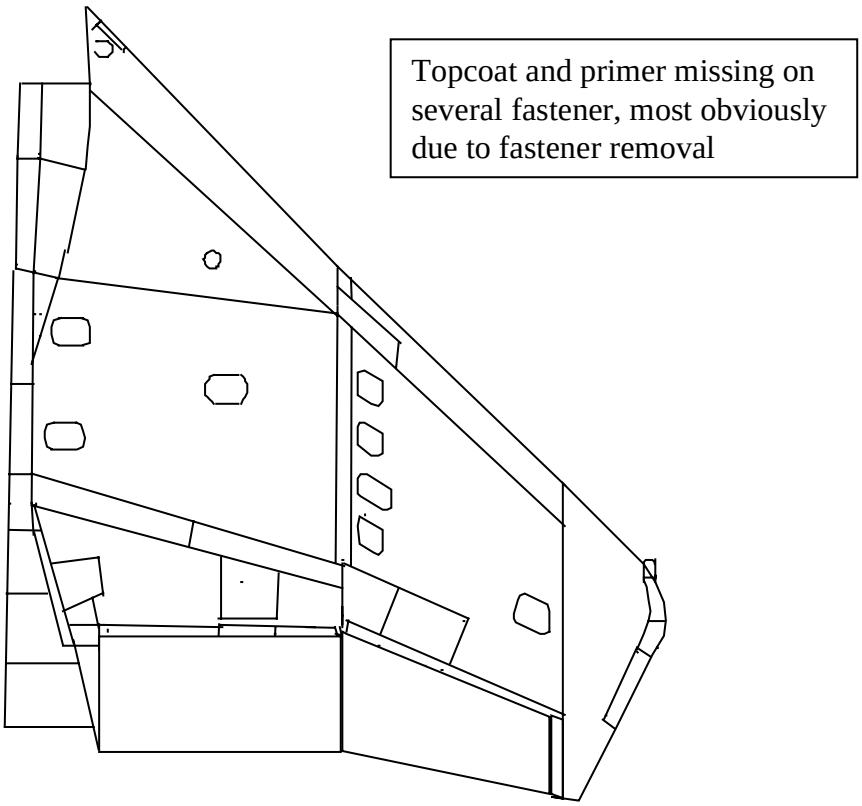

Figure 7. F-15 #79-011, View Looking Down, Right Wing

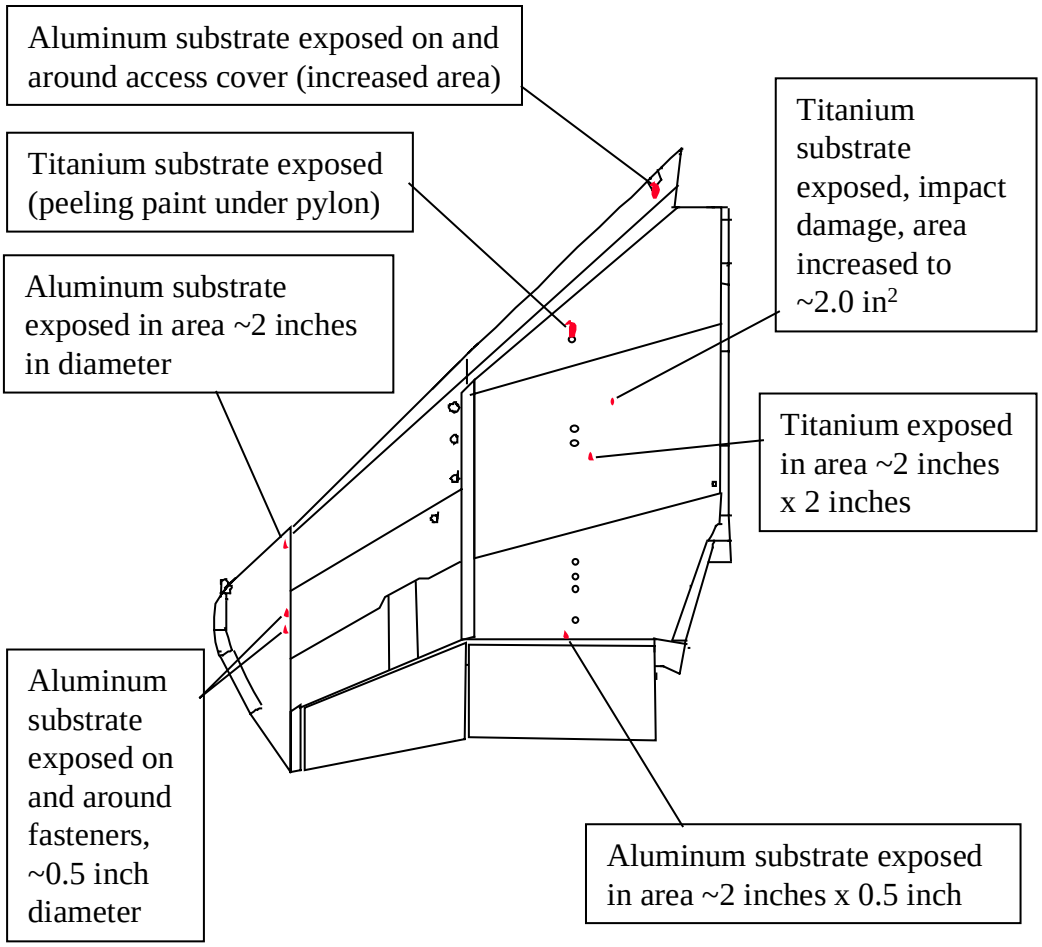

Figure 8. F-15 #79-011, View Looking Up, Right Wing

4. SUMMARY

Erosion resistance of the nonchromate primer appears to be better than the chromate primer, based on the number and severity of defects. Some of the defect areas on leading edges were likely initiated by workstand damage but the propagation of those areas and initiation of others was due to erosion.

Based on the inspections of both aircraft, the control solventborne chromate primer adheres to the titanium skins better than the waterborne nonchromate primer. The quantity and severity of defects on the titanium surfaces were greater with the waterborne nonchromate primer than with the solventborne chromate primer. Nonchromate primer applied to aluminum on the lower wing surfaces also had more areas of chipped or peeling paint then the analogous areas coated with chromate primer.

The waterborne nonchromate primer used on these two aircraft is not adhering as well as the solventborne chromate primer on the lower wing surfaces. The same primers applied to the upper surfaces of both aircraft have exhibited equivalent performance. The fact that adhesion problems are occurring on the lower wing surfaces and not the upper surfaces require the consideration that pre-paint preparation may have contributed to those failures. Lower wing surfaces are inherently more contaminated with fuel and other fluids and are more difficult to clean, while waterborne primers are more sensitive to surface contamination than solventborne primers.

It is recommended that the coating defects on the right wings be touched up with nonchromate primer.