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

Field Evaluation Report IX:

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

February 16, 1999

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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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. JG-APP has become the Joint Group on Pollution Prevention (JG-PP) to accommodate an expanded focus to address sustainment needs.

The Joint Logistics Commanders (JLC) and Headquarters National Aeronautics and Space Administration (NASA) co-chartered 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 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 EWAE118A/B for field evaluations on operating aircraft.

This field evaluation report documents the performance of the Dexter 10PW22-2/ECW-119 nonchromate primer on two F-15 aircraft at Tyndall Air Force Base, Panama City, Florida. Both aircraft, #79-011 and #81-024, are assigned to the Aerial Education and Training Command.

2. BACKGROUND ON OPERATIONAL TESTING

As part of the JG-PP and Boeing Company Aircraft & Missiles (B-A&M) 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 following text and sketches document the results of the Dexter nonchromate primer performance on aircraft #79-011 and #81-024. Both aircraft were painted at Warner Robins Air Logistics Center (WR-ALC) in the summer of 1997.

All exterior surfaces of two aircraft, except for composite and honeycomb components, were stripped with type 5 plastic media followed by light hand sanding prior to entering the paint booth.

Dexter 10PW22-2/ECW-119 nonchromate primer was applied to the upper and lower surfaces of the right-hand wing. The remainder of the aircraft was primed with chromate MIL-P-23377 primer (Deft 02-Y-40). The topcoats applied were MIL-C-85285 products manufactured by Deft.

Table 1. Inspection Data for F-15 Test Aircraft

Aircraft #	Date Painted	Total Flight Hours on Jan 26, 1999	Flight Hours Since Painted
81-024	June, 1997	4,264.0	317.7
79-011	August, 1997	5,053.5	337.7

The inspection team included:
John Stephens, WR-ALC/LFEFS
John Lindsey, Air Force Research Laboratories (AFRL/MLS-OLR)
Gene Bishop, AFRL/MLS-OLR
Jim Muller, Naval Air Systems Command (NAVAIR)
Larry Garrett, WR-ALC/TIEDM
F.D. Kisor, AFRL-WL/MLSS
Larry Gold, Dexter Corporation
Larry Triplett, B-A&M

Larry Triplett, B-A&M, prepared these inspection results and summary. This report was reviewed for accuracy by the remaining inspection team prior to public distribution.

3. INSPECTION RESULTS

The upper and lower surfaces of both wings on both aircraft were inspected. Most of the paint defects noted on aircraft #81-024 at the last inspection had been touched-up with primer and topcoat. No repainting or touch-up was noted on aircraft #79-011 since the first inspection performed in January 1998. Defect areas that were documented in the previous inspections were reinspected and results recorded. The sketches shown in Figures 1 through 8 provide the locations and descriptions of the defects.

3.1. Inspection Results for Aircraft #81-024

Inspection results are detailed below for the left and right wings of aircraft #81-024. The left-hand wing of aircraft #81-024 was primed with chromate primer, and the right-hand wing of aircraft #81-024 was primed with nonchromate primer.

3.1.1. Inspection Results for the Left-Hand Wing

New defects found on the upper surface of the wing since the last inspection were minor corrosion on the steel stems of some blind fasteners, additional exposed fastener heads and additional areas of chipped paint. Paint and primer were missing from several fasteners that did not appear to have been removed and covers that were removed had exposed fastener heads and chipped paint around the fasteners.

There was only one new area of peeling paint on the lower titanium skins and the two areas noted in the January inspection did not appreciably increase in size. The exposed aluminum substrate on the leading edge noted in the last inspection has been repaired with chromate primer and topcoat. (Ref. Figures 1 and 2)

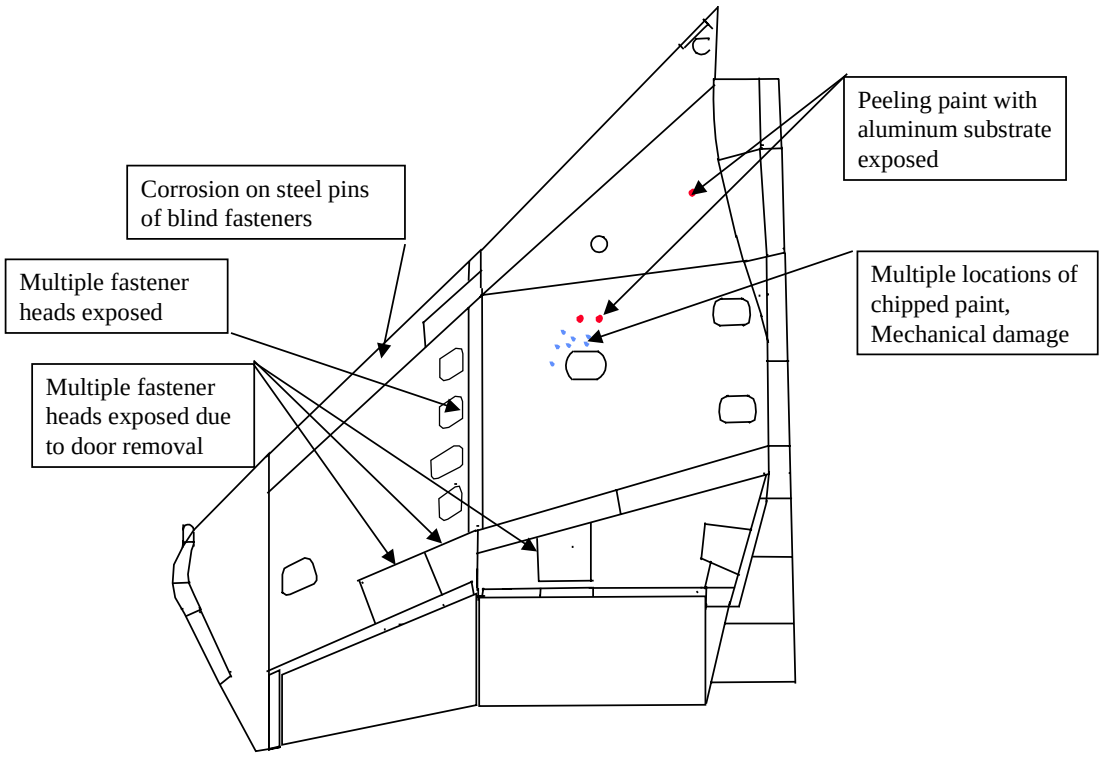

Figure 1. F-15 #81-024, Left-Hand Wing Looking Down

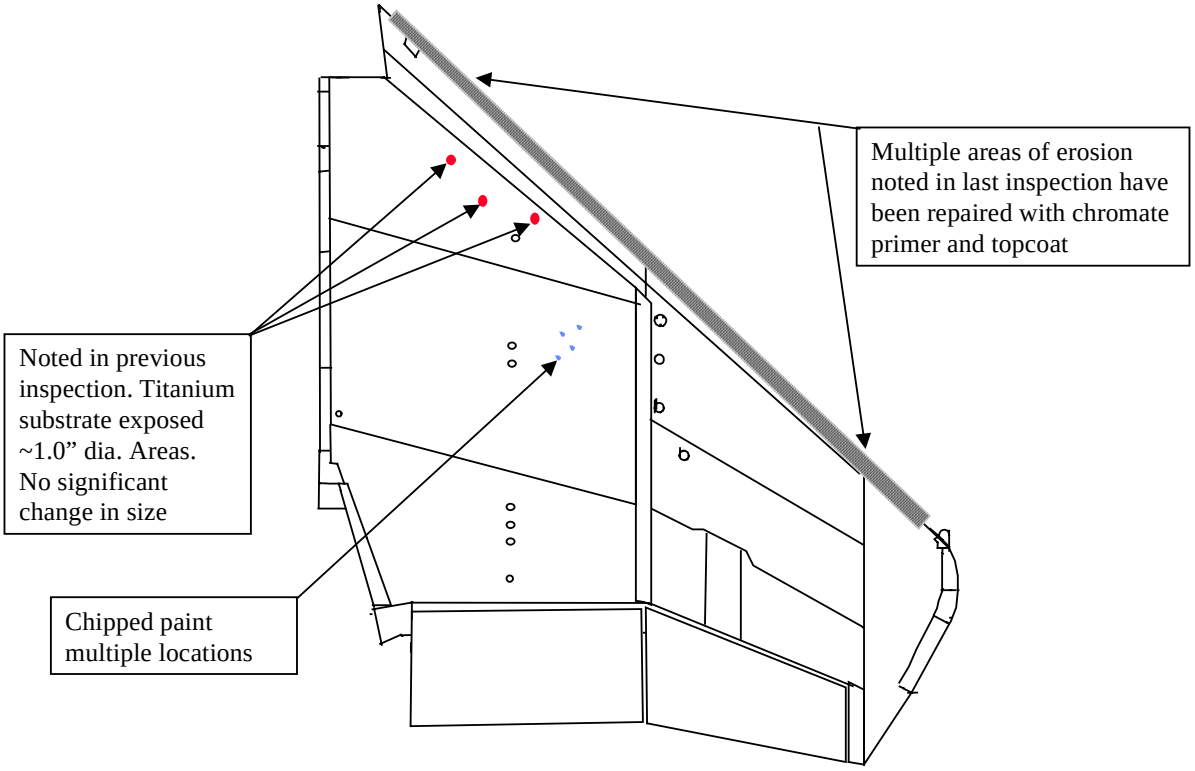

Figure 2. F-15 #81-024, Left-Hand Wing Looking Up

3.1.2. Inspection Results for the Right-Hand Wing

New defects on the upper surface of the wing include minor corrosion on the steel stems of some blind fasteners and additional exposed fasteners since the last inspection. There were more exposed fastener heads than on the left wing. Paint and primer had peeled from several fasteners with chipped paint around the fasteners due to fastener removal.

Multiple areas of peeling paint were noted on the lower titanium wing skins when inspected in July. The squadron has repaired most of the peeling paint areas with chromate primer and topcoat. Two of the repair locations have begun to peel since repair. New areas of peeling paint have also started on the titanium skins.

Additional areas of peeling primer, approximately one half to one inch in diameter have appeared on the lower surface of the aluminum wing tip. Most of the defects were on and adjacent to fasteners but two small areas were also noted on the wing tip skin. The leading edge skin has been repainted since the last inspection with chromate primer and topcoat. (Ref. Figures 3 and 4)

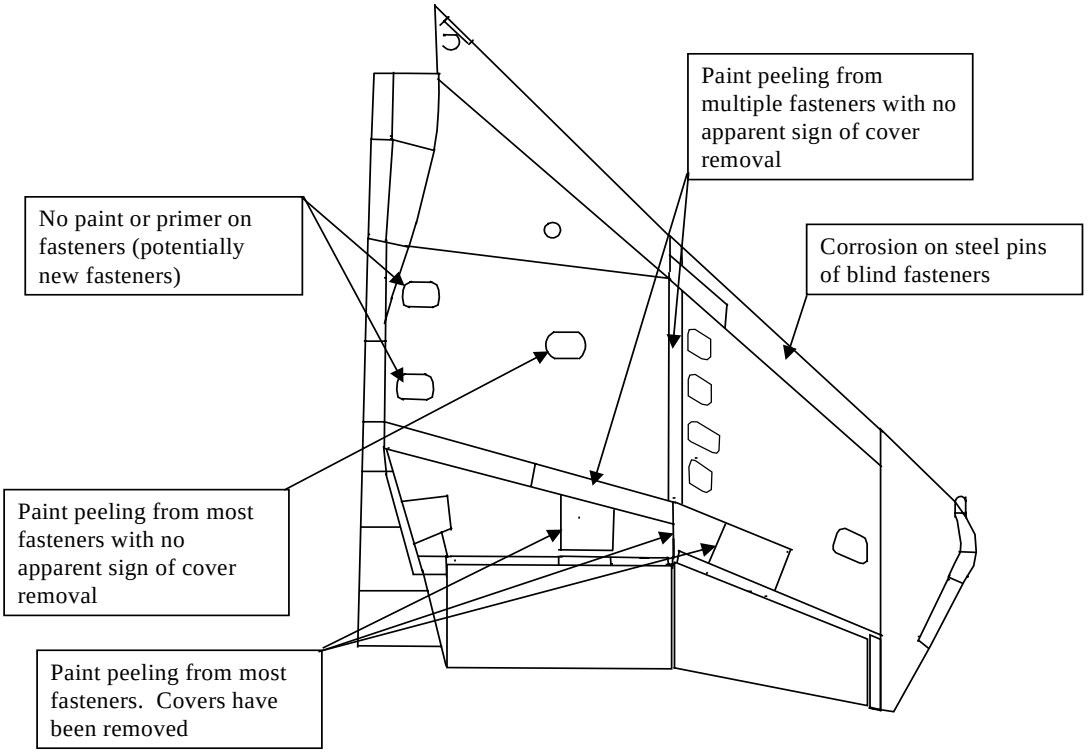

Figure 3. F-15 #81-024, Right-Hand Wing Looking Down

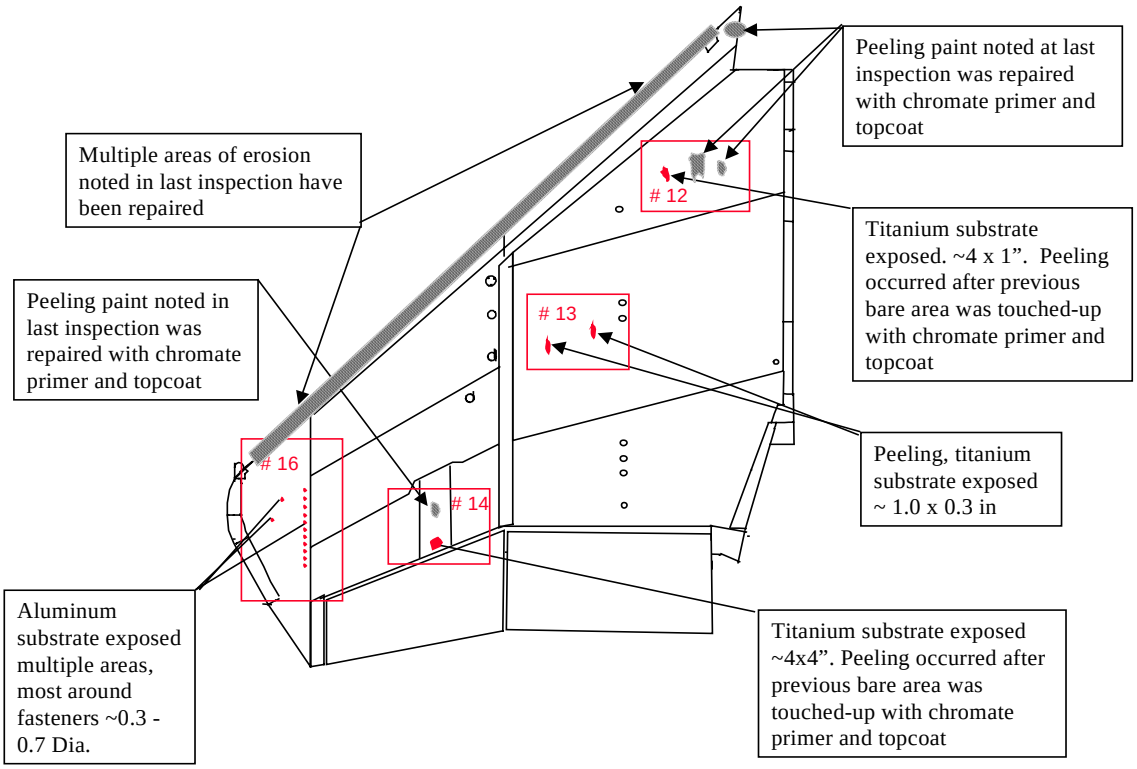

Figure 4. F-15 #81-024, Right-Hand Wing Looking Up

3.2. Inspection Results for Aircraft #79-011

Inspection results are detailed below for the left and right wings of aircraft #79-011. The left-hand wing of aircraft #79-011 was primed with chromate primer, and the right-hand wing of aircraft #79-011 was primed with nonchromate primer.

3.2.1. Inspection Results for the Left-Hand Wing

Multiple areas of chipped paint were noted on the outboard panel and inboard panels of the upper wing surface. These areas were likely initiated by mechanical damage. Paint and primer were missing from several fasteners with chipped paint around the fasteners due to fastener removal.

There were additional areas of exposed aluminum substrate on the leading edge and the areas noted in the previous inspection have increased in size, likely due to erosion. Approximately 60% of the leading edge had exposed substrate due to erosion. The leading edge erosion was evident on the upper and lower views but is only depicted in the view looking up. (Ref. Figures 5 and 6)

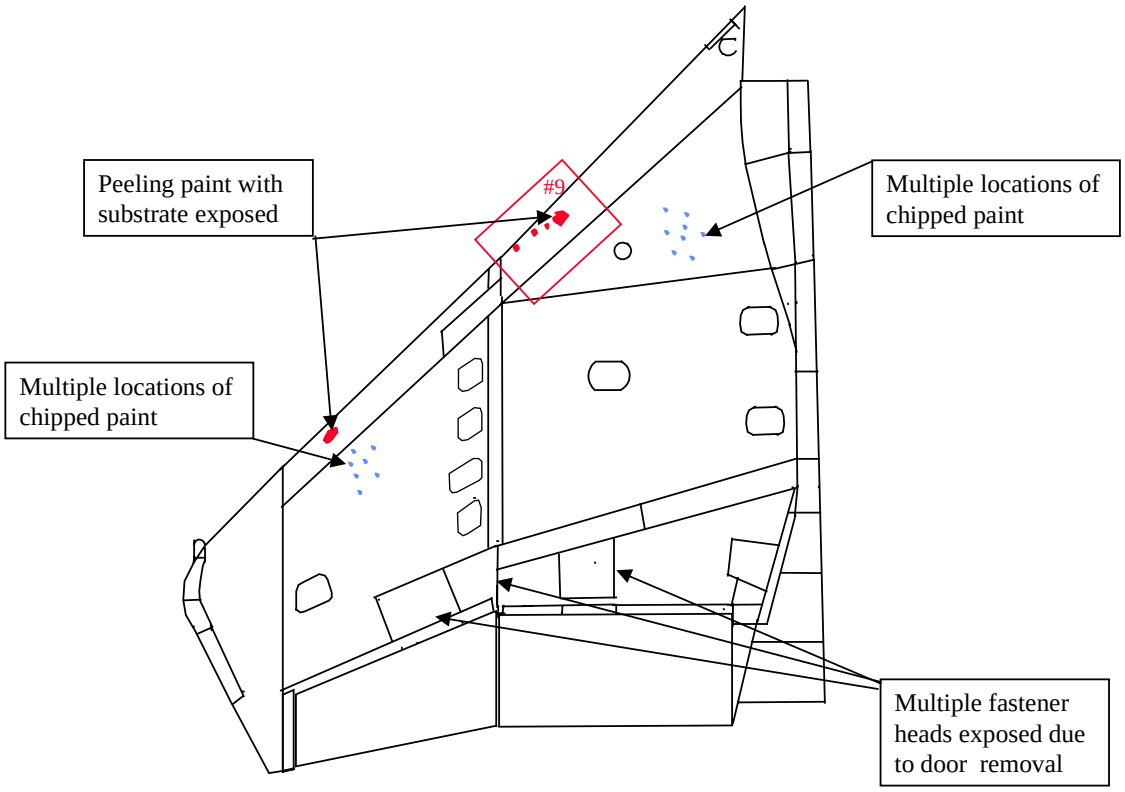

Figure 5. F-15 #79-011, Left-Hand Wing Looking Down

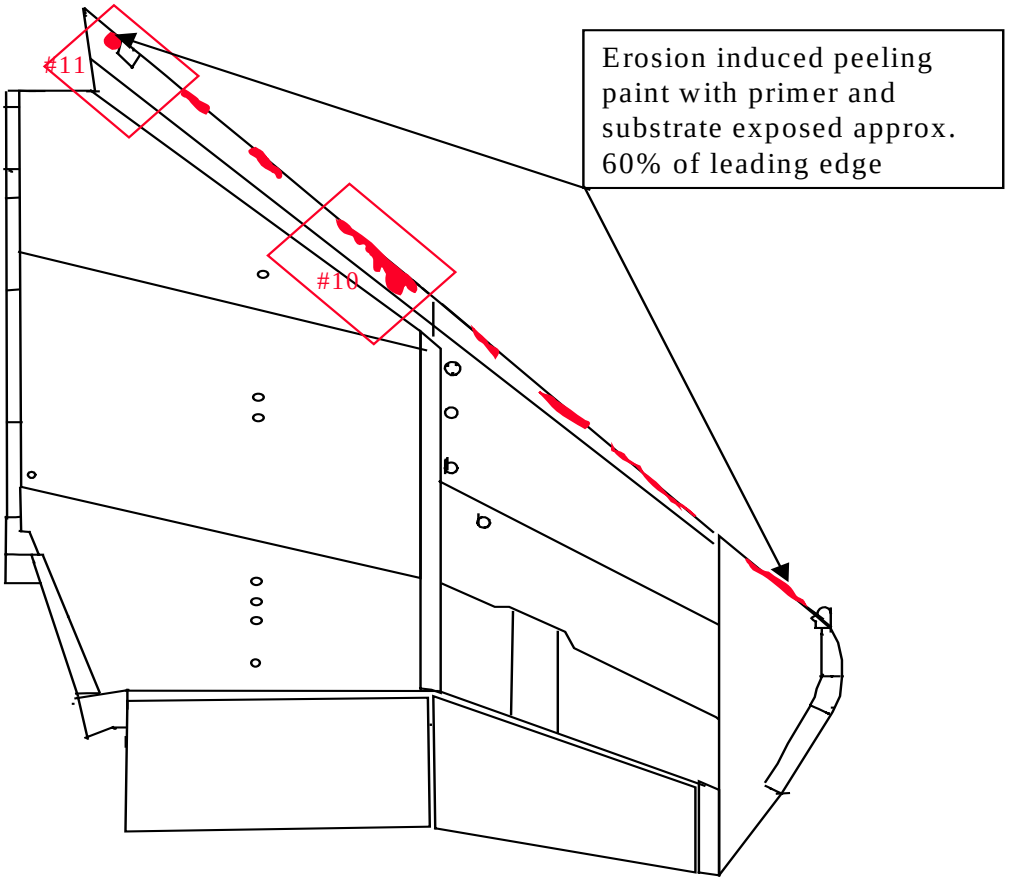

Figure 6. F-15 #79-011, Left-Hand Wing Looking Up

3.2.2. Inspection Results for the Right-Hand Wing

Paint and primer was missing from several fasteners with chipped paint around the fasteners due to fastener removal as noted in the last inspection. There were also several exposed fastener heads that showed no indication of having been removed.

The lower wing surface had large areas of peeling paint on the titanium skins near the pylon fittings. There were also small areas of paint peeling on aluminum substrates at permanent or non-removable fastener locations that have increased slightly since the last inspection.

Leading edge erosion was evident on approximately 60% of the wing with the degree of failure similar to the left-hand wing. The leading edge erosion was evident on the upper and lower views but only depicted in the view looking up. (Ref. Figures 7 and 8)

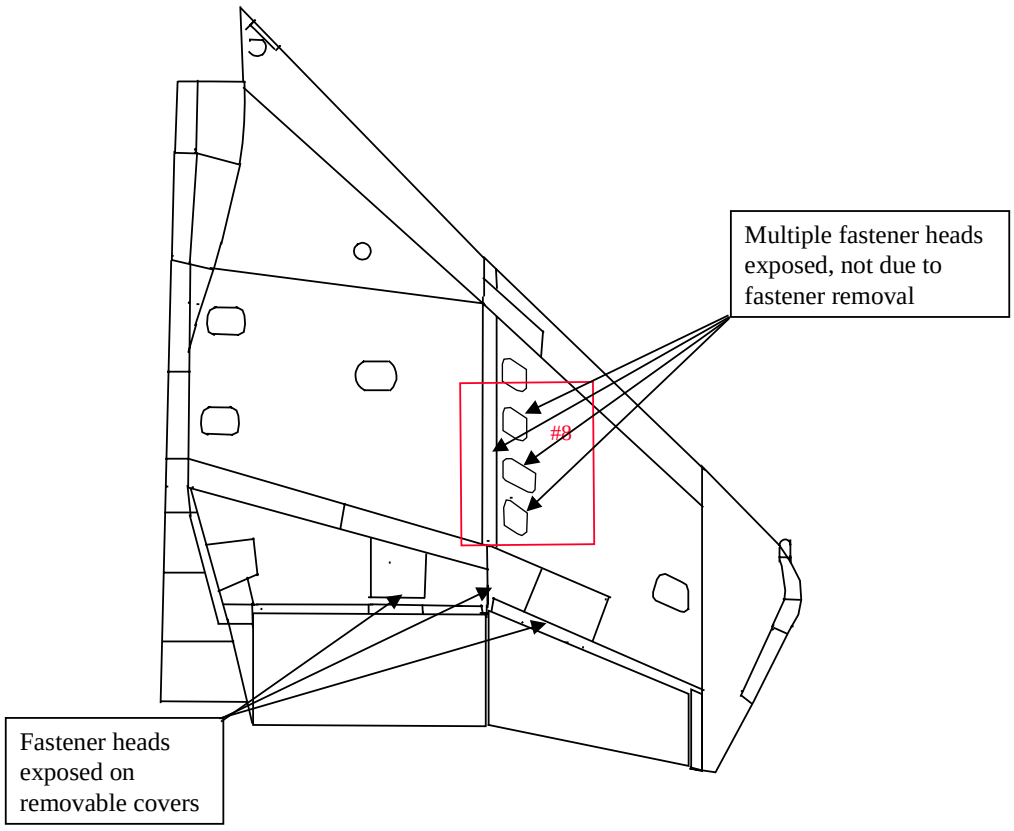

Figure 7. F-15 #79-011, Right-Hand Wing Looking Down

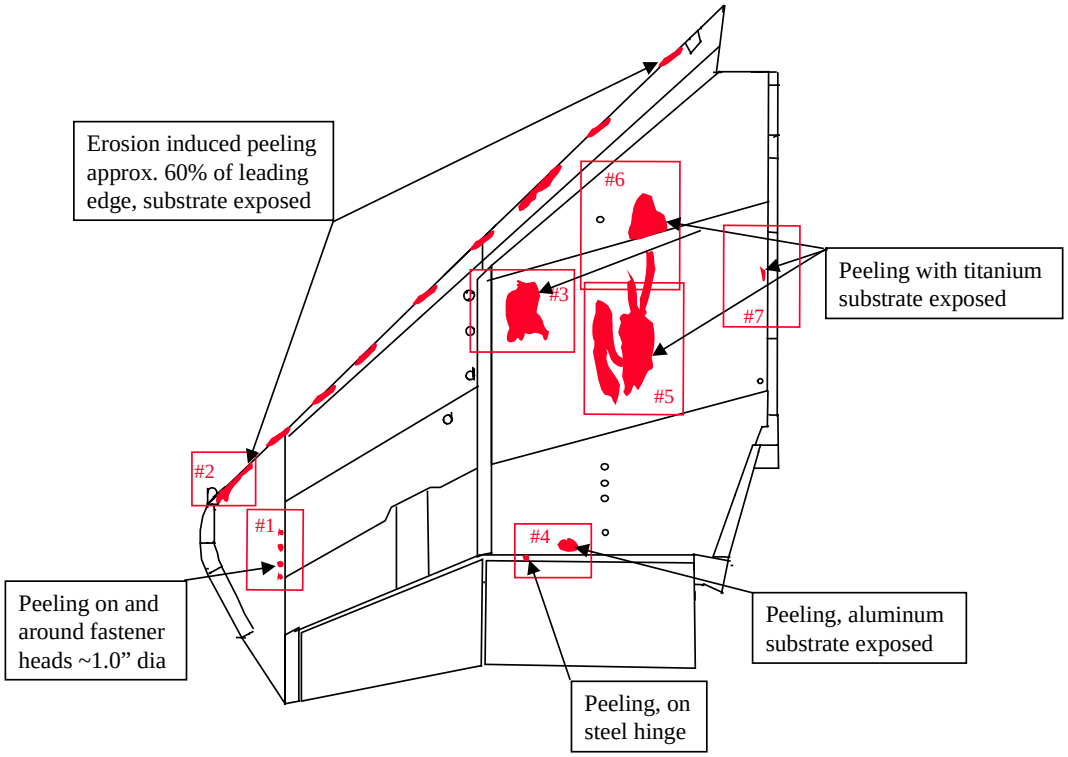

Figure 8. F-15 #79-011, Left-Hand Wing Looking Up

4. SUMMARY

Based on the inspection results of both aircraft there is clearly better adhesion with the chromate solvent-borne control primer to the titanium skins and to certain areas of the aluminum skins on the underside of the wing. The quantity and severity of adhesion defects on the titanium surfaces were considerably greater with the water-reducible nonchromate primer. The aluminum surfaces also had more areas of chipped or peeling paint on the lower wing surfaces that were primed with the nonchromate primer.

Erosion resistance of the nonchromate primer on the previous inspections appeared to be better than that of the chromate primer. However, paint failure due to erosion on aircraft #79-024 is now approximately equal on both wings. Leading edge erosion on aircraft #81-024 has been repaired since the last inspection and the leading edge repair coating was intact.

The water-reducible nonchromate primer used on these two aircraft does not have satisfactory adhesion performance on the lower wing surfaces. However, the upper surfaces of both aircraft have equivalent adhesion performance on aluminum surfaces and there was no aluminum corrosion found. There was also more paint peeling from IVD-coated steel fastener heads on the wings with nonchromate primer.

As previously stated, the lower wing surfaces are exhibiting adhesion problems on titanium and aluminum while the upper surfaces are not. Pre-paint preparation should be considered as a potential causal factor in those failures. Lower wing surfaces are inherently more contaminated with fuel and other fluids and are more difficult to clean. Adhesion failures of water-reducible primers are more common than with solventborne primers when applied over contamination.

The squadron, F-15 engineering, and Air Force Corrosion Office representatives all agreed that aircraft #79-011 should be repaired with the nonchromate primer to maintain the test objective. Dexter has agreed to furnish the necessary primer to the squadron for repairs.