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

Field Evaluation Report XI:

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

May 19, 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 Military Aircraft and Missile Systems Group 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 (FER) documents repair of the coating system on the wings of 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. Paint repairs on aircraft #81-024 were documented by personnel in the corrosion facility at Tyndall and summarized in this report. The paint repairs on aircraft #79-011 described in this FER were witnessed by Larry Triplett, Boeing Military Aircraft and Missile Systems Group (B-A&M). Larry Triplett also prepared this report.

2. BACKGROUND ON OPERATIONAL TESTING

As part of the JG-PP and 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 repair of the coating system on aircraft #79-011 and #81-024.

Both aircraft were originally 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 waterborne nonchromate primer was applied to the upper and lower surfaces of the right-hand wing of each aircraft. The remainder of each aircraft was primed with chromate MIL-P-23377 primer (Deft 02-Y-40). The topcoats applied were MIL-C-85285 products manufactured by Deft.

As previously reported (FER I dated May 22, 1998; FER IV dated September 14, 1998; and FER IX dated February 16, 1999) both aircraft have had paint defects that warrant repair to maintain the integrity of the coating system. Both aircraft had paint erosion on leading edges of both wings and minor adhesion failures on the surfaces painted with chromate primer. The right-hand wings, painted with nonchromate primer, exhibited more severe adhesion failures primarily but not exclusively on the titanium surfaces.

3. INSPECTION AND PAINT REPAIR

The wing surfaces of both aircraft were inspected for paint defects and touched-up as necessary.

3.1. Inspection and Paint Repair for Aircraft #81-024

F-15 #81-024 was moved to the paint facility on March 19, 1999 for full exterior overcoating by the aircraft maintenance contractor (Lockheed Martin). Both wings were visually evaluated prior to and during the repairs and the coating condition was recorded by Lockheed Martin employees. The Lockheed Martin evaluation was summarized for this report.

Similar coating failures with exposed substrate were observed on the upper surfaces of the left and right wings, as shown in Figures 1 and 3. The leading edges also appeared to be similar in severity of coating failures. Both wings had been previously touched-up by the squadron with topcoat only, without primer. Previously touched-up areas were sanded to remove the paint to the substrate to expose sound original coating with minimal expansion of the previous bare areas. The left-hand wing had been primed with MIL-P-23377G chromate primer while the right-hand wing had been primed with Dexter nonchromate primer.

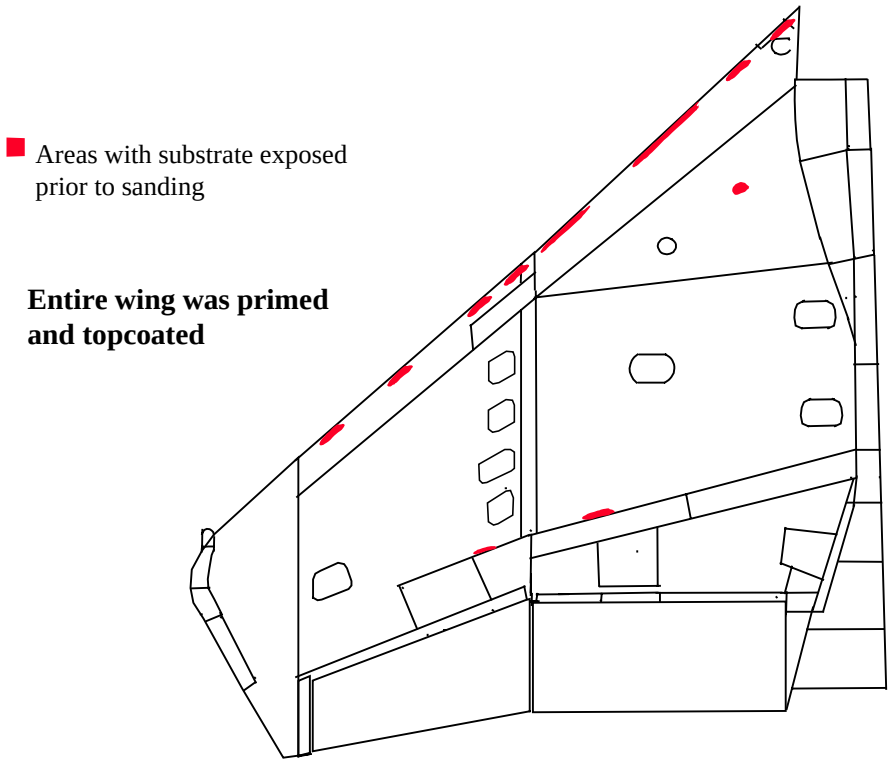

Figure 1. F-15 #81-024, Left-Hand Wing Looking Down

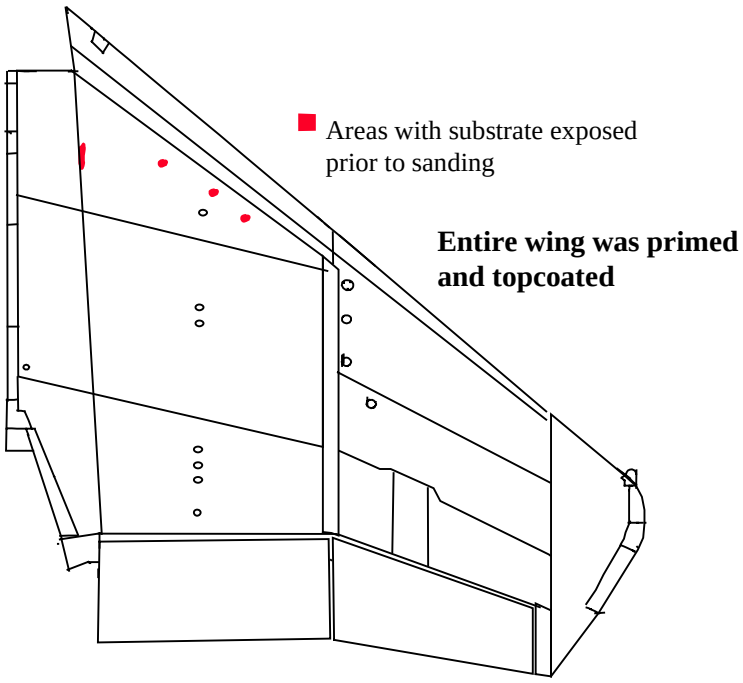

Figure 2. F-15 #81-024, Left-Hand Wing Looking Up

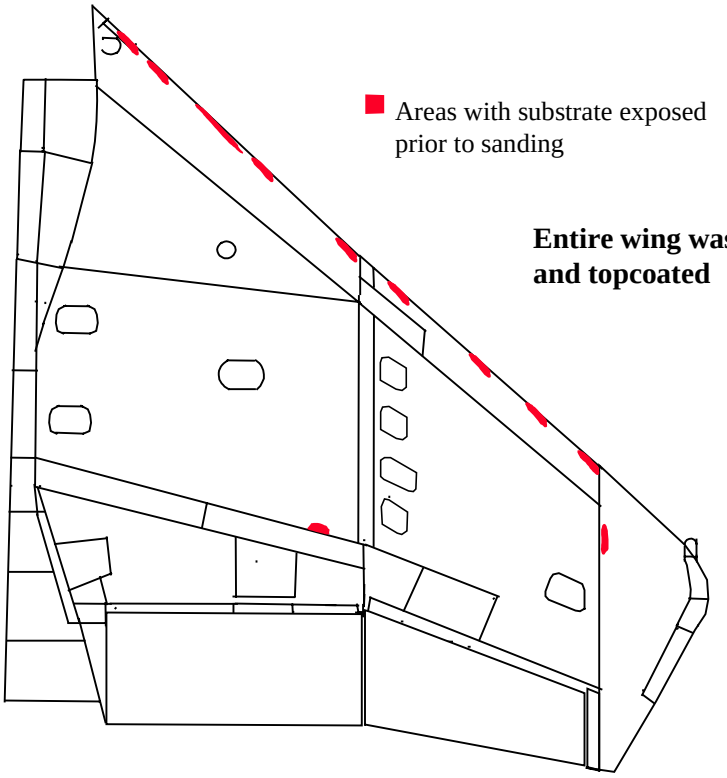

Figure 3. F-15 #81-024, Right-Hand Wing Looking Down

Lower wing surfaces had the most extensive coating failures (see Figure 4). The largest areas of coating failure were on the titanium skins and most coincided with fuel seepage areas. When feathering the failed paint areas, poorly adhered paint was also mechanically removed until sound coating was encountered.

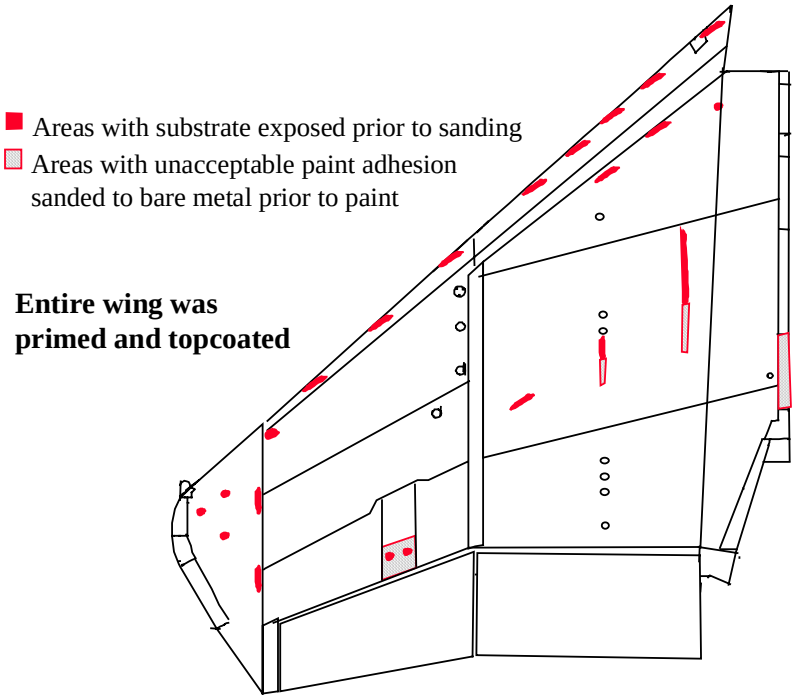

Figure 4. F-15 #81-024, Right-Hand Wing Looking Up

Areas with evidence of fuel or hydraulic fluid seepage were cleaned with DS-104 wipe solvent followed by denatured alcohol. They were then treated with MIL-C-81706 chromate conversion coating. All bare substrate areas on the right-hand wing were primed with Dexter 10PW22-2/ECW119 followed by a tie coat over the entire right wing. A similar process was followed on the left wing using MIL-C-23377G, Type I, Class C high-solids chromate primer. Two coats of MIL-C-85285B topcoat were subsequently applied over the entire surface of both wings and the remainder of the aircraft.

3.2 Inspection and Paint Repair for Aircraft #79-011

The aircraft was moved to the paint facility on April 5, 1999 for repairs of defective paint areas by the aircraft maintenance contractor (Lockheed Martin). Both wings were visually evaluated and repairs were documented during the preparation and painting process.

Most paint defects on the left wing, which had been primed with MIL-C-23377G chromate primer, were confined to the leading edge (see Figures 5 and 6). In preparation for coating system repair, the upper surface of the left wing was masked except for the leading edge skins. Substrate or primer was exposed over approximately 60% of the leading edge. Erosion areas were sanded with DA sanders using 180 grit paper to feather the edges. The remainder of the leading edge was sanded to remove only oxidized topcoat. After sanding the surfaces were solvent wiped with DS-104. All bare areas were treated with MIL-C-81706 chromate conversion coating, rinsed, and allowed to dry. MIL-C-23377G, Type I, Class C high-solids chromate primer was applied approximately one mil thick over the bare substrate areas and as a tie coat over the remaining portions of the leading edge. Two coats of MIL-C-85285B topcoat were subsequently applied over the entire leading edge.

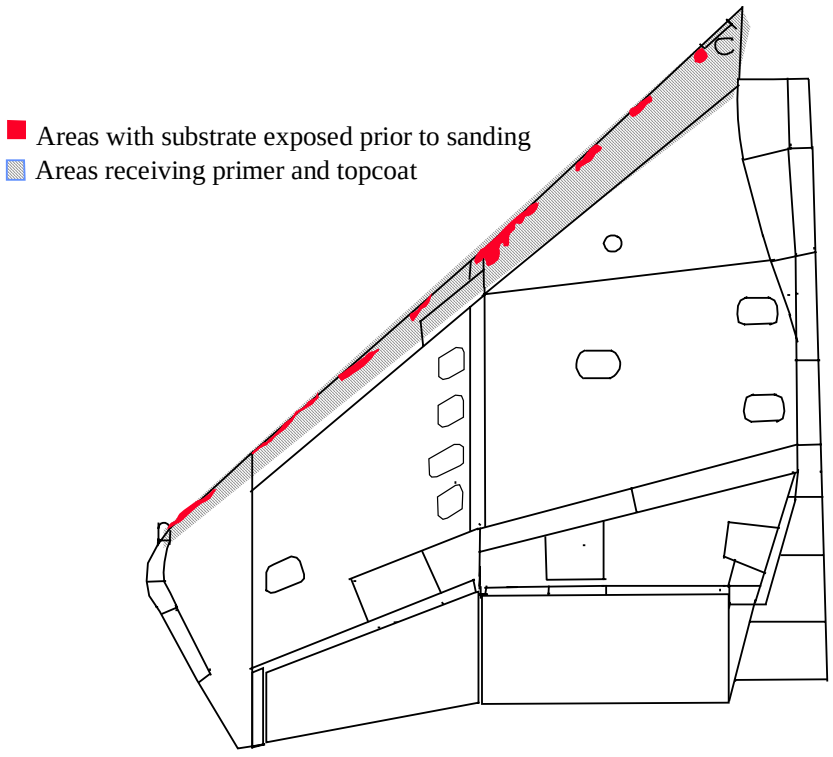

Figure 5. F-15 #79-011, Left-Hand Wing Looking Down

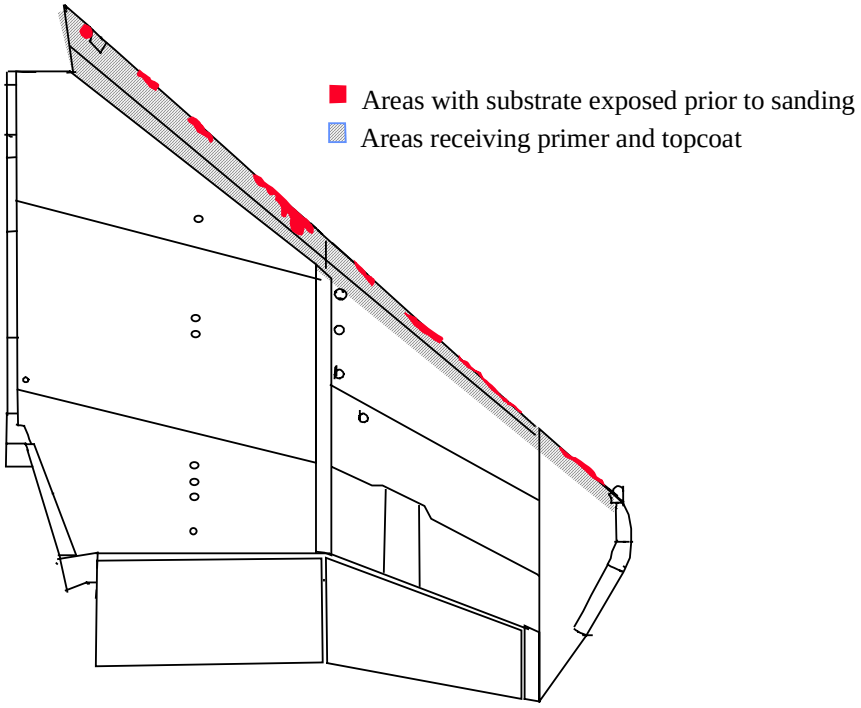

Figure 6. F-15 #79-011, Left-Hand Wing Looking Up

Paint defects on the upper surface and the leading edge of the right-hand wing were similar to those on the left-hand wing (see Figure 7). In preparation for coating system repair, the upper surface of the right wing was masked except for the leading edge skins. Substrate or primer was exposed over approximately 60% of the leading edge. Erosion areas were sanded with DA sanders using 180 grit paper to feather the edges. The remainder of the leading edge was sanded to remove only oxidized topcoat. After sanding the surfaces were solvent wiped with DS-104. All bare areas were treated with MIL-C-81706 chromate conversion coating, rinsed, and allowed to dry. Dexter 10PW22-2/ECW119 waterborne nonchromate primer was applied approximately one mil thick over the bare substrate areas and as a tie coat over the remaining portions of the leading edge. Two coats of MIL-C-85285B topcoat were subsequently applied over the entire leading edge.

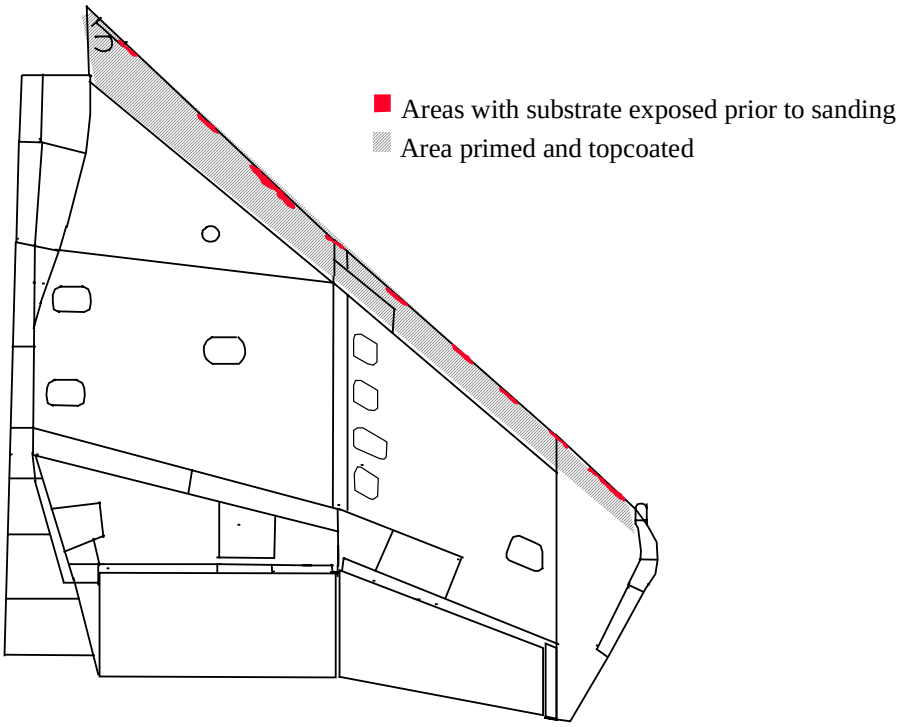

Figure 7. F-15 #79-011, Right-Hand Wing Looking Down

The lower surface of the right-hand wing had extensive coating failures with large areas of substrate exposed (see Figure 8) when the aircraft entered the paint facility. The paint adjacent to the bare areas was obviously not well adhered and large areas were easily removed with plastic scrapers. When the paint could not be removed with scrapers it was feathered with DA sanders using 180 grit paper.

Titanium surfaces were cleaned with DS-104 and denatured alcohol followed by MIL-C-81706 conversion coating. A water-break-free surface could not be obtained and the surface was sanded with DA sanders using 220 grit paper followed by a methyl ethyl ketone (MEK) wipe. MIL-C-81706 conversion coating was reapplied and constantly agitated with abrasive pads for forty minutes followed by a tap water rinse and water-break check. The surface was initially water-break-free but quickly became contaminated with fuel around the pylon attach points and at some skin joints. A decision was made to proceed with primer application and wipe the contaminated areas immediately prior to priming.

Dexter nonchromate primer, base 10PW22-2 batch # 90121009 and activator ECW119 batch #90141010, was mixed and allowed to stand for 15 minutes. Prior to priming the contaminated areas on the lower wing surfaces were wiped with MEK to remove fuel contamination. A light coat of Dexter primer was applied to the leading edge and the entire lower surface of the right-hand wing.

"Fisheyes" (a non-continuous film) immediately formed at the areas wiped with MEK.

The nonchromate primer was allowed to dry for two hours and areas showing signs of contamination were sanded and wiped to remove sanding dust. A second coat of primer was applied to sanded areas and all other surfaces where the metal substrate had been exposed. The second coat of primer also exhibited "fisheyes" at the contaminated areas but no further action was suggested since a film of primer did cover substrate. The areas were documented and the nonchromate primer was allowed to cure for two hours prior to coating with two coats of MIL-C-85285B topcoat.

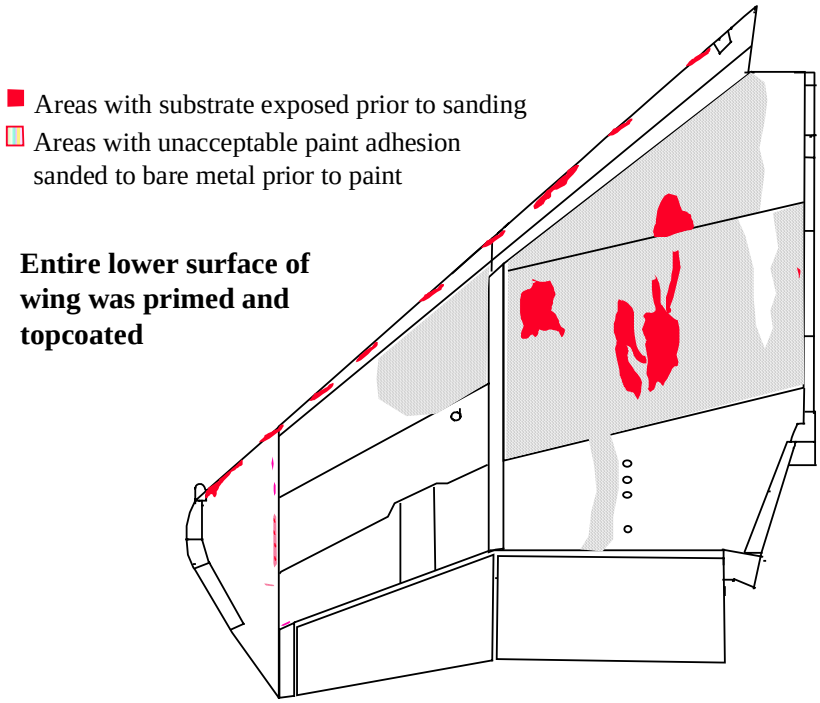

Figure 8. F-15 #79-011, Right-Hand Wing Looking Up

4. SUMMARY

Similar primer performance was observed between the chromate and nonchromate primer on the upper wing and leading edges. There were gross adhesion failures of the nonchromate primer on the lower wing titanium and aluminum surfaces. There were also areas with good adhesion even on the titanium skins, which indicates that acceptable adhesion of the nonchromate primer to titanium is possible. Sporadic adhesion suggests that surface preparation was the primary factor for failure, but adhesion of the waterborne (nonchromate) primer is clearly not as robust as the solventborne (high-solids chromate) primer on contaminated surfaces.

There is some concern that the surfaces that could not be kept clean for painting, due to fuel seepage, will fail prematurely. These surfaces were documented with photographs for future inspections.