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

Field Evaluation Report XVIII:

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

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EXECUTIVE SUMMARY

At the Boeing Company Military Aircraft and Missile Systems Group pilot site (formerly McDonnell Douglas Aerospace) located in St. Louis, Missouri, chromium in primer coatings was identified as the target hazardous material 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 participants selected Dexter Aerospace Materials/Crown Metro Aerospace 10PW22-2/ECW-119 and PRC-DeSoto (formerly Spraylat Corporation) EWAE118 A/B for field evaluations on operating aircraft and missile canisters.

Eight F/A-18 aircraft were used for the field evaluations, including aircraft BUNO 164268. Aircraft #164268 was painted at Naval Aviation Depot North Island, San Diego, California in October 1997. Much of the metal substrate was chemically stripped and the composite surfaces were scuff sanded to remove all but a minimal thickness of paint before priming and repainting. Primer was applied to the stripped surfaces as the first step of the depot maintenance cycle. PRC-DeSoto EWAE118 A/B, MIL-P-85582 Type II, Class N, nonchromate primer was applied to the right-hand side of F/A-18 #164268. The left-hand side was primed with chromate MIL-P-85582 Type II Class C1 primer (Deft 44-GN-8A). After completion of depot maintenance the aircraft was washed, sanded, and primed over the entire surface of the aircraft (tie-coat) prior to topcoat application. The nonchromate primer was applied as a tie-coat on the surfaces previously receiving nonchromate primer before topcoating. Chromate primer was used as tie-coat on the opposite side. The topcoats applied after tie-coat application were MIL-C-85285 products manufactured by Deft.

F/A-18 aircraft #164268 was inspected on January 13, 2000 at Marine Corps Air Station Beaufort, Beaufort, South Carolina. This aircraft has much more corrosion and more severe corrosion than the three aircraft stationed at Oceana, Virginia (see FER XVII). There were also more corrosion sites and more severe corrosion on the nonchromate primer (right) side. Most of the corrosion was filiform-type corrosion initiated at the edge of fasteners and at the edge of skins. Some of the more severe corrosion on the leading edge extension (LEX) was up to 0.8-inch wide on the nonchromate primer side. There were paint adhesion failures on the upper right-hand LEX with primer lifting from the substrate. Chromate conversion coating was evident on the skin and no corrosion was observed where the paint had peeled. Surface area of peeling paint was approximately 10-12 square inches. As reported in the May 1999 inspection there were multiple blisters on the right-hand of the fuselage above the engine bay. There was no corrosion associated with the blisters and this defect has not been seen on other test aircraft.

Corrosion on F/A-18 aircraft is routinely repaired at the operational level whenever it appears. Any corrosion, including the corrosion occurring on each side of this aircraft, requires repair per Navy maintenance procedures. Paint repairs are expected to be performed on both the right (nonchromate primer) side and the left (chromate primer) side of this aircraft before the next inspection.

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

10PW22-2/ECW-119 and PRC-DeSoto (formerly Spraylat Corporation) EWAE118 A/B for field evaluations on operating aircraft.

A total of seventeen test units were fielded to evaluate operational performance of nonchromate primer. Test units consist of two F-15s, eight F/A-18s, four T-45s, one AV-8B aircraft, and two Harpoon missile canisters. Field evaluation reports (FERs) are written after each inspection. This FER documents the performance of the PRC-DeSoto nonchromate primer on F/A-18 aircraft #164268 as inspected on January 13, 2000 at Marine Corps Air Station (MCAS) Beaufort, Beaufort, South Carolina. 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-PP 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 following text and sketches document the results of the two-year inspection results for aircraft BUNO 164268. This aircraft was painted at Naval Aviation Depot (NADEP) North Island, San Diego, California in October, 1997.

Much of the metal substrates of the aircraft was chemically stripped and the composite surfaces were scuff sanded to remove all but a minimal thickness of paint before priming and repainting.

Primer was applied to the stripped surfaces as the first step of the depot maintenance cycle. PRC-DeSoto EWAE118 A/B, MIL-P-85582 Type II, Class N, nonchromate primer was applied to the right-hand side of 164261 and 164206. The left-hand side was primed with chromate MIL-P-85582 Type II Class C1 primer (Deft 44-GN-8A).

After completion of depot maintenance the aircraft was washed, sanded, and primed over the entire surface of the aircraft (tie-coat) prior to topcoat application. The nonchromate primer was applied as a tie-coat on the surfaces previously receiving nonchromate primer before topcoating. Chromate primer was used as tie-coat on the opposite side. The topcoats applied after tie-coat application were MIL-C-85285 products manufactured by Deft.

Table 1. Test Aircraft Data

Aircraft BUNO	Date of Final Painting	Date Inspected	Aircraft Location	Total Flight Hours When Primed	Total Flight Hours When Inspected	Flight Hours Since Primed
164268	Oct 97	01-13-00	Beaufort	2569	3626	1057

These inspection results and summary were prepared by Larry Triplett, B-A&M, and submitted for review by Tim Woods, NADEP North Island, David Pulley, Naval Air Warfare Center (NAWC), and F. D. Kisor, representing Wright Laboratories, Wright Patterson Air Force Base, prior to public release.

3. INSPECTION RESULTS

Aircraft #164268 was inspected on January 13, 2000 at MCAS Beaufort, South Carolina. There are no inspection details provided on the wing surfaces and horizontal and vertical stabilizers since they are primarily composites and were not stripped before painting.

In previous inspection reports areas with touch-up was recorded on the inspection sheets but due to the numerous touch-up locations over the past two years a decision was made to only list corrosion and other paint defects. Minimal touch-up has been performed since the last inspection in May 1999 and many of the defects from the previous inspections were present with no apparent repairs.

Several areas of corrosion were identified on the sides and upper surfaces mainly around fasteners and at the periphery of some skins as shown in the attached figures. The most prevalent corrosion type was filiform corrosion initiating at the fasteners or the edge of the skins but pitting or surface corrosion was also present. Most corrosion sites were minor and extended less than one-eighth inch from initiation points but more severe corrosion, up to 0.8-inch wide was present on the right-hand (nonchromate primer) side.

There were significant differences between the right and left-hand leading edge extensions (LEXs) with more corrosion sites and much more severe corrosion on the nonchromate side (see Figure 1 and Figure 7). The number of corrosion sites on the nose barrel was greater on the chromate side, however the corrosion on the nonchromate side was more severe.

A breakdown of corrosion sites is shown below. Each corrosion site identified in the sketches typically contain more than one corrosion point. For example, if two fasteners in a row or five fasteners in row have corrosion they were grouped as a corrosion site.

Table 2. Corrosion Sites, Right Side versus Left Side

BUNO	Right-side	Left-side
164268	37	27

Reference Figures 1-7 for locations of corrosion.

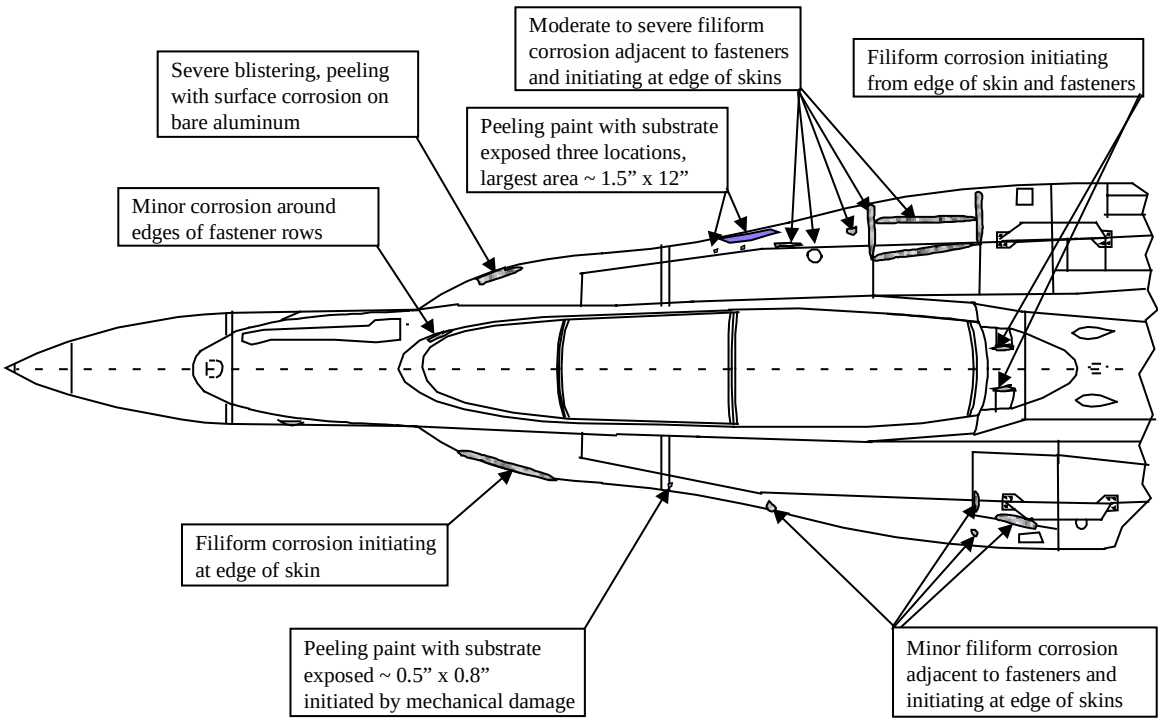

Figure 1. F/A-18 #164268, View Looking Down at Forward Fuselage

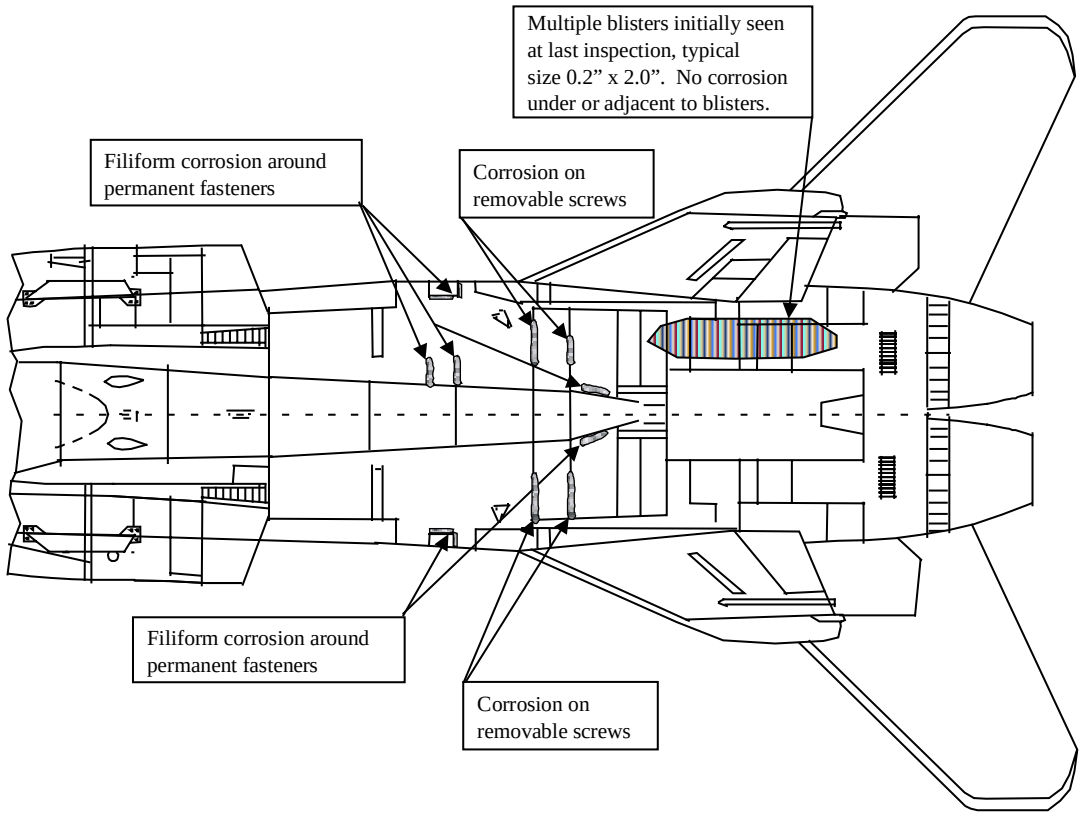

Figure 2. F/A-18 #164268, View Looking Down at Aft Fuselage

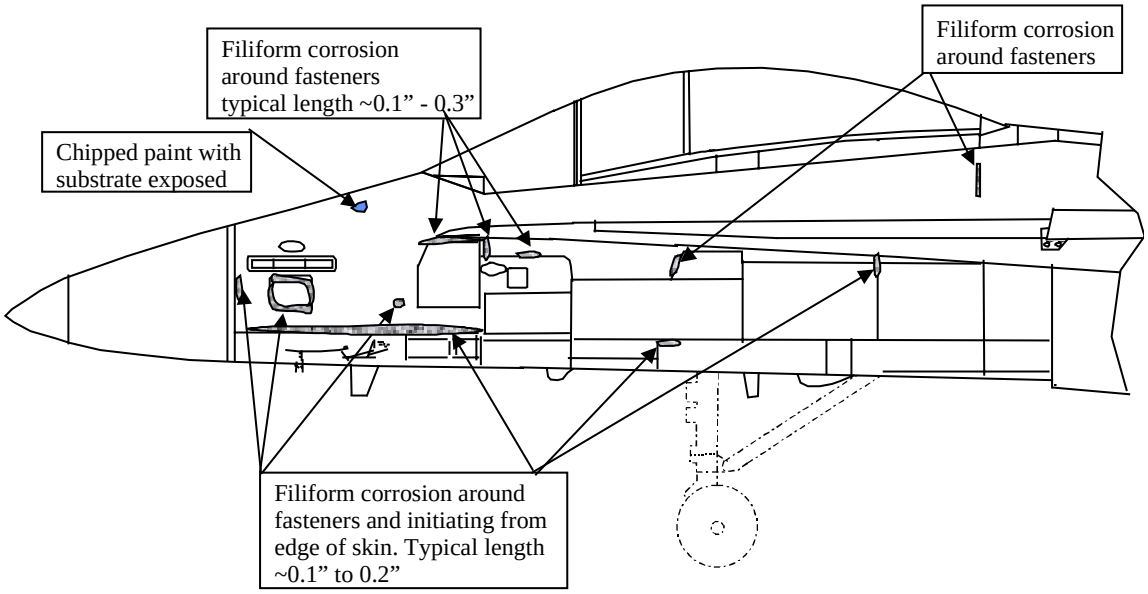

Figure 3. F/A-18 #164268, Left-Hand View of Forward Fuselage

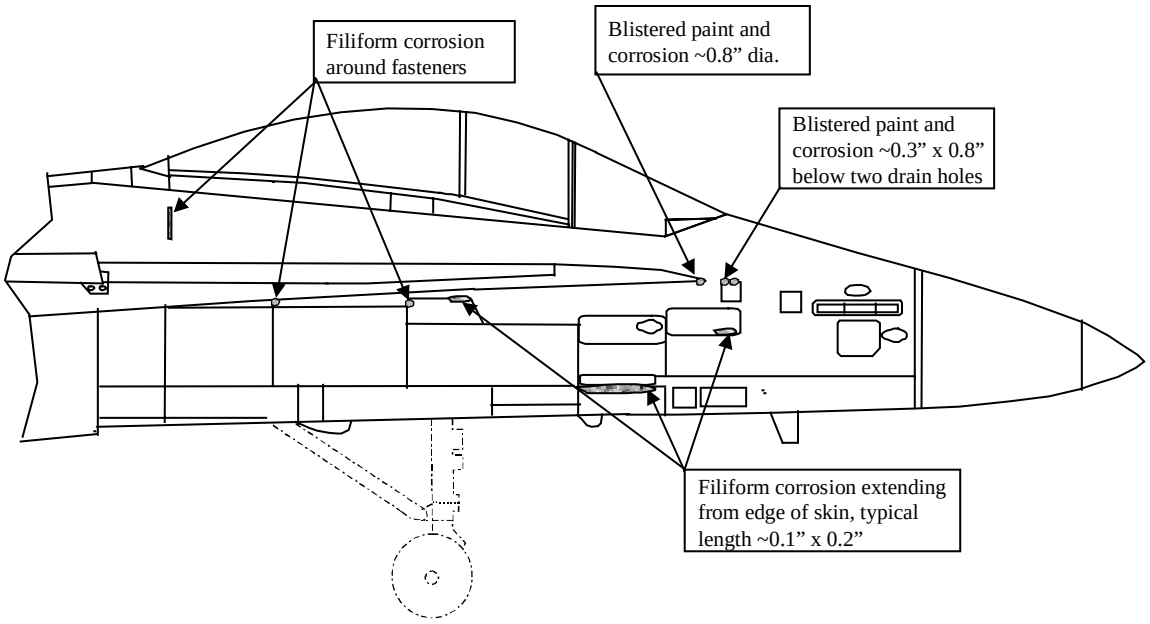

Figure 4. F/A-18 #164268, Right-Hand View of Forward Fuselage

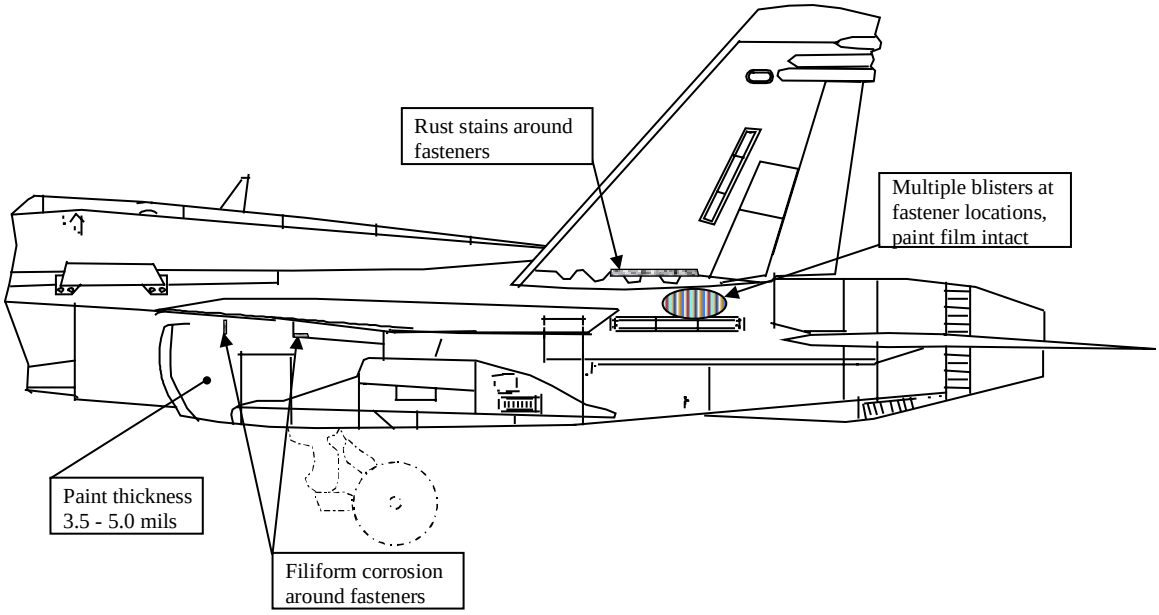

Figure 5. F/A-18 #164268, Left-Hand View of Aft Fuselage

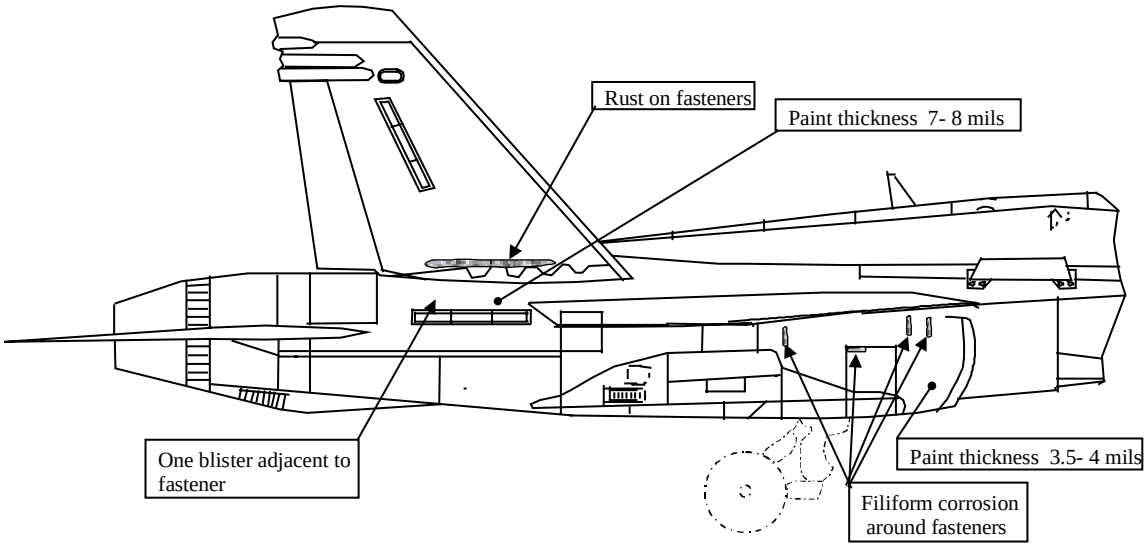

Figure 6. F/A-18 #164268, Right-Hand View of Aft Fuselage

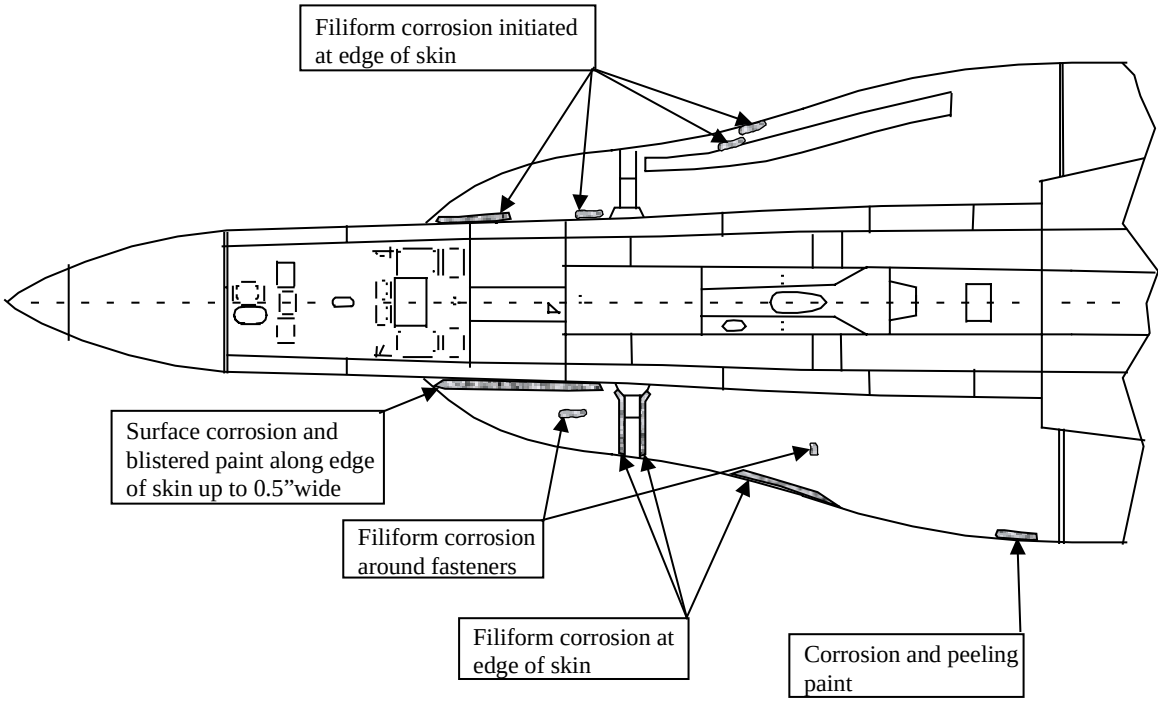

Figure 7. F/A-18 #164268, View Looking Up at Forward Fuselage

4. SUMMARY

This aircraft has much more corrosion and more severe corrosion than the three aircraft stationed at Oceana, Virginia (see FER XVII). There were also more corrosion sites and more severe corrosion on the nonchromate primer (right) side. Most of the corrosion was filiform-type corrosion initiated at the edge of fasteners and at the edge of skins. Some of the more severe corrosion on the LEX was up to 0.8-inch wide on the nonchromate primer side.

There were paint adhesion failures on the upper right-hand LEX with primer lifting from the substrate. Chromate conversion coating was evident on the skin and no corrosion was observed where the paint had peeled. Surface area of peeling paint was approximately 10-12 square inches.

As reported in the May 1999 inspection there were multiple blisters on the right-hand of the fuselage above the engine bay. There was no corrosion associated with the blisters and this defect has not been seen on other test aircraft.

Corrosion on F/A-18 aircraft is routinely repaired at the operational level whenever it appears. Any corrosion, including the corrosion occurring on each side of this aircraft, requires repair per Navy maintenance procedures. Paint repairs are expected to be performed on both the right (nonchromate primer) side and the left (chromate primer) side of this aircraft before the next inspection.