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Teardown Evaluation of a 1993 Beechcraft Model 1900D Airplane

June 2008

Final Report

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16. Abstract

To determine if potential continuing airworthiness problems exist for the small airplane fleet as a function of the aging process, the Federal Aviation Administration established a two-phase research program to conduct a destructive evaluation of four aged airplanes (two Cessna 402s, a Piper Navajo Chieftain, and a Beechcraft 1900D) used in commuter service. The intent of the program was to provide insight into the condition of a typical aged airplane, to see if a correlation exists between its maintenance history and current condition from a safety of flight perspective, and to generalize recommendations on inspection programs and airplane condition to the entire small airplane fleet, as opposed to making specific recommendations on a particular model. This document provides findings on the teardown evaluation of a 1993 Beechcraft model 1900D. The results provide information for use in future investigations into the aged small airplane fleet and determine if additional research is required to address specific problems observed (if any). The destructive evaluation of the commuter-class airplane was separated into two main tasks: (1) inspection of the airframe, airplane systems, and wiring and (2) teardown examination of the airframe, airplane systems, and wiring. During the inspection phase, four subtasks were performed: a survey of the airplane maintenance records, visual inspection of the airframe, airplane structural systems, and circuit breakers. The teardown examination involved disassembly of the airframe and major airplane sections, a structural assessment using alternative nondestructive inspection techniques, and microscopic examination of critical structural areas. As part of the destructive evaluation, inspections and laboratory tests were also performed on the circuit breakers of the airplane to assess the condition and degradation of electrical circuits in small airplane and to evaluate maintenance procedures. Specific observations are made regarding findings discovered during the teardown evaluation on the particular airplane selected.

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LIST OF ACRONYMS

AAIP	Approved Airplane Inspection Program Records
ACTT	Airplane Total Time
AD	Airworthiness Directive
ASTM	American Society for Testing and Materials
ATA	Air Transport Association of America
BL	Body Line
CAR	Civil Air Regulations
CFR	Code of Federal Regulations
Corr	Corrosion
D	Depth
ETSS	Eddy Current Surface Scan
FAA	Federal Aviation Administration
FS	Fuselage station
HSS	Horizontal stabilizer station
JASC	Joint Aircraft System/Component
LBL	Left body line
LWS	Left wing station
MT	Magnetic particle
MOI	Magneto optic image
N/A	Not Applicable
NDI	Nondestructive inspection
NIAR	National Institute for Aviation Research
NTSB	National Transportation Safety Board
OC	Open Circuit
P/N	Part Number
PT	Liquid penetrant
RBL	Right body line
REPS	Raytheon Electronic Publication System
RWS	Right wing station
SAIB	Special Airworthiness Information Bulletin
SB	Service Bulletin
SC	Safety Communiqué
SDR	Service Difficulty Reports
SEM	Scanning electron microscope
SIM	Structural Inspection Manual
S/N	Serial number
VS	Vertical stabilizer
VSS	Vertical stabilizer station
VT	Visual (inspection)
WL	Water line
WS	Wing station

EXECUTIVE SUMMARY

To determine if potential continuing airworthiness problems exist for the small airplane fleet as a function of the aging process, the Federal Aviation Administration established a two-phase research program to conduct a destructive evaluation of four aged airplanes (two Cessna 402s, a Piper Navajo Chieftain, and a Beechcraft Model 1900D) used in commuter service. The intent of the program was to provide insight into the condition of a typical aged airplane, to see if a correlation exists between its maintenance history and current condition from a safety of flight perspective, and to generalize recommendations on inspection programs and airplane condition to the entire small airplane fleet, as opposed to making specific recommendations on a particular model. This document provides findings on the teardown evaluation of a 1993 Beechcraft Model 1900D. The results provide information for use in future investigations into the aged small airplane fleet and determine if additional research is required to address specific problems observed (if any). The destructive evaluation of the commuter-class airplane was separated into two main tasks: (1) inspection of the airframe, airplane systems, and wiring, and (2) teardown examination of the airframe, airplane systems, and wiring. During the inspection phase, three subtasks were performed: (1) survey of the airplane maintenance records, (2) visual inspection of the airframe structure, and (3) performance of Beechcraft 1900D Structural Inspection Manual (SIM). The teardown examination consisted of four subtasks: (1) disassembly of the airframe and major airplane sections, (2) structural assessment using alternative nondestructive inspection (NDI) techniques, (3) post-NDI, and (4) microscopic examination to include fractographic analysis of critical structural areas. The functionality and performance of circuit breakers were also assessed.

During the routine visual inspections, noteworthy findings included corrosion on all antenna surfaces of the top and bottom fuselage. Numerous small cracks were discovered throughout the fuselage and wing, however, nothing significant was noted. Minor damage such as chipped paint, scratches, dents, and gouges were found on the fuselage, wing, and tail; however, all findings were considered to be irrelevant towards the airworthiness of the airplane.

Two hundred twenty-one separate visual inspections, including NDI, were performed on the Beechcraft 1900D with the intent of finding every possible visual flaw on the airplane. The inspection concentration was structural only. Due to the airplane having a pressurized fuselage and using the Beechcraft 1900D SIM, the inspection team looked very closely at every structural component for cracks, corrosion, or defects that had the potential to affect airworthiness. This inspection methodology led to a noteworthy number of relevant documented flaws. One hundred fourteen inspection areas are listed in the wing section of the SIM, 65 in the fuselage, and 42 in the empennage group. Of these areas, only 49 of 194 findings were determined to be noteworthy and were classified as relevant, while the remaining 145 findings were deemed minor and irrelevant by qualified airframe inspectors.

A structural assessment using alternative NDI techniques was performed on the fuselage, wing, and horizontal and vertical stabilizer spars in an effort to identify additional embedded defects in the primary structure prior to disassembly. Two indications were discovered on the fuselage using the magneto optic imager (MOI). No crack indications were identified using the sliding probe on the left and right wing forward and rear spars. Two crack indications were identified

on the horizontal stabilizer front and rear spars using the MOI, and one sliding probe crack indication was documented on a vertical stabilizer rib.

During the teardown examination, of the 1432 parts inspected, 172 defects were identified and characterized. There were 13 areas of corrosion and 1 damaged area identified on the left wing. Sixteen areas of corrosion were noted on the right wing, along with 15 areas of corrosion and 4 cracks on the center wing. Light to light scattered corrosion was observed on the surface of many of the wing's main spar cap assembly components, two large cracks were also identified on the center wing angle brackets. There were 28 cracks recorded on the fuselage, along with 76 areas of corrosion, 11 instances of wear, and several occurrences of other minor damage. Multiple cracks were noted in each of the following areas: escape hatch gussets, seat track support assemblies, bonded skins, cargo doorframe assembly, floorboard support structure, doorframe doublers, and forward fuselage angles. Multiple areas of corrosion were found on the seat track support assemblies, tail cargo doorframe, and various areas of minor wear and damage. Two areas of corrosion, three cracks, and one area of other damage were reported on the horizontal stabilizer. The cracks occurred on tee sections of the leading-edge skin assemblies, while light scattered corrosion was observed on the components of the spar cap assemblies. Two cracks and one area of wear were recorded and characterized on the vertical stabilizer. Multiple cracks occurred on the vertical stabilizer front rib.

1. INTRODUCTION.

Economic and market conditions of present day aviation companies are requiring the use of airplanes far beyond their original design life objectives. The aging airplane concern exists for all types of airplanes, including commercial, military, and general aviation. The concern is being amplified as more companies use aged airplanes and rely on standard inspection practices for a guarantee of airworthiness assurance. Standard practices to ensure continuing airworthiness include scheduled inspection and maintenance tasks contained in service manuals: Instructions for Continued Airworthiness, Airworthiness Directives (AD), and Service Bulletins (SB). These practices are not just limited to structural integrity, but also extend to wiring and systems integrity. These initiatives have provided timely preventative maintenance recommendations that permit continued safe operation of aging airplanes until retirement from service for economic reasons.

1.1 BACKGROUND.

Although the general public is primarily concerned with the airworthiness of commercial airplanes, which is where most research funding resources and efforts have been focused, a growing concern also exists in the small airplane fleet. While numerous investigations are being conducted on the aging aspects of large transport and military airplanes, limited resources are being expended to understand the aging aspects of the small airplane fleet. Investigations performed on large transport and military airplanes have focused on the structural integrity as well as wiring and systems-related aging concerns. The results of these investigations can benefit a similar research program that investigates the same issues on small airplanes.

The reliability and maintenance of electrical wiring and electrical components in aging airplanes have also become a major concern for the aviation industry. The Federal Aviation Administration (FAA) and Aging Transport Systems Rulemaking Advisory Committee have been working to assess the condition of electrical wiring and the effectiveness of wiring maintenance procedures. However, their efforts have been primarily focused on larger commercial transport airplanes thus far. Due to the large number of smaller airplanes in service, a need for examining the condition of wiring, electrical components, and maintenance procedures for these smaller airplanes exists.

Small airplanes are generally classified as general aviation airplanes. When one mentions general aviation, the traditional image usually involves a four-passenger airplane like a Cessna 172; however, general aviation covers a wide range of airplanes. In the context of this program, a general aviation airplane is defined as a Title 14 Code of Federal Regulations (CFR) Part 23 (or predecessor Civil Air Regulations [CAR] 3) airplane, which includes normal, utility, acrobatic, and commuter category airplanes. This classification includes airplanes operating in the commuter, cargo, or taxi service capacity under 14 CFR Part 135 or Part 121. The 1993 Beechcraft Model 1900D operates under Part 121. The general aviation fleet includes approximately 210,000 fixed-wing airplanes with about 71% being single-engine piston airplanes, 10% being multiengine piston airplanes, 10% being experimental airplanes, and 9% being classified as turboprop, jet, glider, or lighter-than-air. Usage of the general aviation fleet is categorized as follows: 60% for personal use, 21% for business use, 6% for instruction, 4% for

aerial application/observation, 3% for commuter service, 2% for public use, and 4% for other usage.

Due to the large number of general aviation airplanes and their wide usage, the aging aspects of these airplanes must be addressed. In September 2002, the FAA Small Airplane Directorate and William J. Hughes Technical Center established a research program to begin addressing the aging concerns regarding small airplanes. The main purpose for this program was to provide insight into the condition of a typical aged small airplane and determine if a correlation exists between its maintenance history and the airplane's apparent condition. The research program is primarily conducted by the Aging Airplane Research Laboratory at the National Institute for Aviation Research (NIAR), Wichita State University. The major objective of this research program focuses on the integrity and aging aspects of small airplanes.

This research program was divided into two phases, Phase I and Phase II. Phase I, which was completed in September 2004, involved the comprehensive teardown of two Cessna 402 airplanes (A and C models). To achieve the level of inquiry desired, the airplanes were each assessed during two phases of research. The Inspection Phase included a survey of the airplane maintenance records, visual inspection of the airplane structure, systems, and wiring, and supplemental nondestructive inspection (NDI) targeted at specific airframe structural components. The Teardown Phase consisted of detailed structural disassembly, visual inspection of the internal structure and critical system components, wiring tests to determine condition, a structural assessment using alternative NDI techniques, and microscopic/fractographic examinations of suspect and critical structural areas.

Phase II of the research program expands on and attempts to validate the results of the Phase I teardown examination. Phase II also involved the inspection and teardown examination of two additional airplanes, a Piper Navajo Chieftain and a Beechcraft 1900D, in an effort to generalize recommendations on inspection programs and airplane condition to the entire small airplane fleet, as opposed to making specific recommendations on the Cessna 402 fleet alone.

Like Phase I, the tasks for Phase II were divided into the inspection phase and teardown phase. For the Beechcraft 1900D, the inspection phase consisted of a survey of the airplane maintenance records, visual inspection of the airframe structural components, systems, a thorough structural inspection, using traditional NDI techniques to target specific airframe locations, known as principal structural elements. The teardown phase consisted of the removal of major airplane sections, a structural assessment using NDI techniques, circuit breaker tests, detailed disassembly, microscopic examination, and fractographic analysis of fracture faces to determine failure mode.

1.2 RESEARCH OBJECTIVES.

Much of the current concern related to aging effects on airplanes involves calendar age as opposed to flight hours. For instance, deterioration of structural components, wiring, aging effects on airplane systems (control systems, seals, cables, etc.), and corrosion are calendar related, and these effects may possibly be a continued safety of flight concern. For example, approximately 60,000 small airplanes are presently on the U.S. Registry that are older than 50 years and some of these areas mentioned have never been inspected due to inaccessibility. Major

attachment fittings, such as wing attachment fittings, are typically never removed and inspected, as well as structural component subjected to cracks and corrosion due to fatigue factor. These areas of concern are the areas that this research program primarily focuses on in order to begin addressing and providing insight into the aging small airplane fleet. The wiring and system components issues have been addressed through previous inspections conducted within this program. An intense structural teardown of the Beechcraft 1900D will provide updated information and analysis concerning how aging effects are prevalent to the aging airplane community.

The research program has a short-term objective, to be achieved over 2 years during Phase I, and a long-term objective, to be achieved over a 5-year period during Phase I and Phase II. The short-term objective is to determine if potential continuing airworthiness problems exist for the small airplane fleet as a function of the aging process. The long-term objective is to establish guidance in order to ensure that current maintenance programs of small airplanes are providing acceptable levels of continued airworthiness.

Achievement of the short-term objective should determine if generic degradation indicators exist in the small airplane fleet. These indicators will likely include structural (cracking and corrosion); electrical systems or wiring; airplane systems, such as fuel, hydraulic, pneumatic, mechanical, and flight control; and maintenance, service, and inspection quality. Determination of generic degradation indicators will assist in providing initial generic inspection guidance, such as:

- Do maintenance inspection programs address all areas of concern appropriately?
- What is being found in areas that normal maintenance would not see?
- Are additional inspection criteria required for aged airplanes?
- Should specialized one-time inspections at some age be required?
- Should inspections and maintenance programs become more extensive as the airplane ages?

To achieve the research objectives in Phase I of the program, a destructive evaluation was conducted on two aged airplanes (both Cessna 402 models (A and C)) used in commuter service. The intent of the program was not to provide statistical evidence for guideline development for inspection, but to provide insight into the condition of a typical aged airplane and to see if a correlation exists between its maintenance history and current condition from a safety of flight perspective. This program documented findings in a summary report for use in future investigations into the aged small airplane fleet and to determine if additional research is required to address specific problems observed (if any). Specific observations were made regarding the particular airplane selected, and generic recommendations were provided that are applicable to the small airplane fleet.

To achieve the long-term objectives of the research program, Phase II involves conducting an extensive teardown evaluation on a Piper Navajo Chieftain and a Beechcraft 1900D airplane.

The results from these teardown examinations will allow small airplane fleet-wide conclusions to be drawn regarding the problems facing the small airplane fleet due to the aging process. Recommendations for guidance on maintenance programs to provide acceptable levels of continued airworthiness on aging small airplanes will also be provided.

1.3 TECHNICAL APPROACH.

The destructive evaluation of this commuter class airplane was divided into two main tasks: (1) inspection of the airframe structural components, and (2) teardown examination of the entire airframe structures. Each section below describes the airplane selected for teardown evaluation and the subtasks conducted during the inspection and teardown phases.

1.3.1 Airplane Selection.

The Beechcraft 1900D was selected because it is representative of a large portion of the mid-size airplane commuter fleet and for its pressurized fuselage. This particular airplane operated as a passenger carrier in the commercial sector for a period of 10 years, it shares many design commonalities with other mid-size, twin-engine turboprop airplanes such as the one shown in figure 1. The manufacturer specifications are listed in table 1. The design concepts of both systems (mechanical, electrical, and flight controls) and pressurized structures (layout and materials) are similar model-to-model and manufacturer-to-manufacturer. Therefore, findings from the destructive evaluation of the Beechcraft 1900D would be applicable to all small airplane models regardless of manufacturer.

The Beechcraft 1900D serial number (S/N) UE-0066, tail number N856CA, which was used in commuter operations, was selected for destructive evaluation. The twin-turboprop engine airplane had 15,203.6 total airframe hours and recorded 23,260 cycles with a current registration. Maintenance records, logbooks, the airworthiness directive compliance list, and FAA form 337s were included with the purchase of this airplane.

Figure 1. 1993 Beechcraft 1900D

Table 1. Airplane Specifications

Number of Engines	2
Airplane type	Turboprop
Passenger capacity (maximum)	19
Range (in miles)	860
Cruising speed (mph)	303
Payload capacity (lb)	4000
Wingspan	54.5
Length	57.9
Height	14.9
Takeoff weight (lb)	15245
Cabin type	Pressurized

1.3.2 Inspection Phase.

During the inspection phase, three subtasks were performed: (1) a survey of the airplane maintenance records, (2) a routine visual inspections of the airframe as prescribed by the Beechcraft 1900D Maintenance Manual, and (3) a routine visual inspection to include NDI of all accessible airplane structures per the Beechcraft 1900D Structural Inspection Manual (SIM). The maintenance records survey provided information on the airplane maintenance history for correlation of maintenance practices to airplane condition, while the inspections determined the condition of the airplane based on normal maintenance activity.

1.3.3 Teardown Examination Phase.

This research program focused on the destructive evaluation of a commuter class airplane, yet a nondestructive evaluation was also conducted according to recommended practices prior to the destructive evaluation. The teardown examination involved disassembly of the airframe and major airplane sections, inspection of the airplane structural components, a structural assessment using alternative NDI techniques, laboratory circuit breaker testing, microscopic examination of critical and suspect areas, and fractographic analysis of cracks to determine origin and failure mode. All airplane system components and wiring were removed prior to disassembly, allowing full access to all critical structural areas on the airplane. The structural assessment using alternative NDI techniques was conducted on primary structure prior to disassembly. The microscopic examination of suspect and critical structural areas provided verification and detailed quantification of the extent of damage found during the supplemental inspections, structural assessment using alternative NDI techniques, and disassembly of the entire airframe. Fractographic analysis was used to determine the failure mode of selected cracks.

2. INSPECTION PHASE.

The inspection phase of the Beechcraft 1900D airplane teardown established the current condition of the airplane through a (1) survey of the airplane maintenance records, (2) routine visual inspections per the Beechcraft 1900D SIM, and (3) routine structural inspections of all accessible structures and area check procedures as outlined in the SIM. These inspections allowed the NIAR team to determine which flaws could be found in the field during normal maintenance activity. The routine visual inspections were prescribed for specific airframe structures only. The visual and structural inspections consisted of NDIs targeted at specific primary structural locations on the airframe. The NIAR team performed a complete visual and NDI with the assistance of the Beechcraft 1900D SIM, Raytheon residence engineering, and technical support. The primary structural locations inspected during the inspection phase were determined through a review of the applicable fleet-wide ADs, SBs, Service Difficulty Reports (SDRs), and engineering knowledge of the airplane structure. Detailed inspection procedures were developed for each structural inspection location. Upon completion of the inspections, the NIAR team made an effort to correlate airplane condition with airplane usage and maintenance history through the survey of airplane maintenance records and a review of the Beechcraft 1900D airplane SDRs.

2.1 SURVEY OF AIRPLANE MAINTENANCE RECORDS.

A survey of the airplane maintenance records took place in an attempt to correlate airplane condition with airplane usage and maintenance history. Maintenance logbooks, SBs, ADs, and FAA form 337s for major repairs and modifications were reviewed in this survey. The survey of the airplane records for the Beechcraft 1900D, serial number UE-0066, was completed using data obtained from the following resources:

- Airframe logbooks
- Approved Airplane Inspection Program records (AAIP)
- FAA Registry databases
- National Transportation Safety Board (NTSB) databases
- Beechcraft 1900D Maintenance Manual and SIMs

Since leaving the production line (1993), this airplane was registered under one tail number (N856CA) to one owner/operator with no title changes. The airplane accumulated 15,203.6 total airframe hours and recorded 23,260 cycles during its 10-year operation. The acquisition dates and owner/operator information was obtained from Raytheon Aircraft Company. The airplane was operated as an airliner on the east coast assigned to CommutAir.

2.1.1 Airworthiness Directives.

The ADs obtained from the FAA database that are applicable to this model of airplanes and relative to this research project are summarized in table 2. Detailed descriptions of each AD are located in appendix A. Table 2 also includes the date of compliance for serial number UE-0066, the compliance airplane total time (ACTT), the applicability to this particular serial number, and the compliance interval. (Note: UE-0066 did not comply with some of the ADs listed in table 2 due to being removed from service before the required compliance date.)

Table 2. Airworthiness Directives

AD Number	Compliance Date	Compliance ACTT	Applicability	Interval
94-20-05	10/27/1994	2106.2	Applicable	Once
95-02-17	1/27/1995	2635.8	Applicable	Once
95-02-18	4/20/1995	3130.0	Superseded	Recurring
95-14-02			Applicable	Once
95-26-14	2/8/1996	4890.4	Applicable	Once
96-09-13			Applicable	Recurring
96-15-01	7/11/1996	5784.0	Applicable	Once
96-22-12			Applicable	Once
97-03-01			Applicable	Once
97-06-06	N/A by S/N	N/A by S/N	N/A by S/N	N/A by S/N
97-10-14	7/1/1994		Applicable	Once
97-14-16	4/18/1998	9574.5	Superseded	Once
97-15-13 R2			Applicable	Once
97-17-08	N/A by S/N	N/A by S/N	N/A by S/N	N/A by S/N
97-25-03			Applicable	Once
97-26-15			Applicable	Once
98-09-12			Applicable	Once
98-13-11			Applicable	Once
98-21-20	12/10/1998		Applicable	Once
98-25-10			Applicable	Once
98-26-16	2/5/1999		Applicable	Once
99-01-03	2/20/1999	11368.7	Applicable	Once
99-04-08			Applicable	Once
99-09-15			Applicable	Once
99-12-07			Applicable	Once
99-16-12			Applicable	Once
99-18-15	N/A by S/N	N/A by S/N	Applicable	Once

Table 2. Airworthiness Directives (Continued)

AD Number	Compliance Date	Compliance ACTT	Applicability	Interval
2000-19-04			Applicable	Once
2000-20-07			Applicable	Once
2001-04-05	N/A by S/N	N/A by S/N	N/A by S/N	N/A by S/N
2001-11-03			Applicable	Once
2001-18-07			Applicable	Once
2001-22-16			Applicable	Recurring
2002-23-11	4/30/2003	15203.6	Applicable	Once
2003-03-18	4/30/2003	15203.6	Applicable	Once
2003-04-26			Applicable	Recurring
2003-09-12			Applicable	Recurring
2003-20-10			Applicable	Recurring

Table 3 provides the following information regarding applicable SBs: requested compliance date, description, compliance method, actual compliance date, and ACTT.

Table 3. Service Bulletins

SB Number	Requested Compliance Date	Description	Compliance	Actual Compliance Date	ACTT
11-2610	04/1995	Placards and Markings—Fire Extinguisher Placard Installation	Kit No. 129-5019-1	4/14/1995	3044.7
11-2741 Rev 1	02/1997	Placards and Markings—New Exterior Operating Instruction Placards for the Airstair Door and 1900D Emergency Exits	Kit No. 129-5030-1	2/27/1997	
21-2634	09/1995	Environmental/Air Conditioning—Addition of Drain Hole to Environmental Bleed Air System Accumulators	Next Detailed Inspection	9/13/1996	
21-2669	01/1996	Environmental/Air Conditioning—Air Cycle Machine Modification	Kit No. 129-5023-1	10/31/1997	8463.2
21-2684	05/1996	Environmental/Air Conditioning—Environmental Bleed Air System Accumulator Modification	Next Detailed Inspection	9/13/1996	

Table 3. Service Bulletins (Continued)

SB Number	Requested Compliance Date	Description	Compliance	Actual Compliance Date	ACTT
23-2643	08/1996	Communications—Nose Avionics Wire Harness and Radio Switching Panel Inspection/Repair, and A017 Circuit Board Replacement	AD 98-19-12	9/13/1996	
24-2500	08/1993	Electrical Power—DC Power Panel Connection Plug—KLC Relay Sensor Switch Wiring Modification	Optional	8/27/1994	
24-2543	03/1994	Electrical Power—Annunciator DIM Control Wiring Modification	Recommended	5/14/1994	
24-2566	04/1995	Electrical Power—Hot Battery Bus Wiring Harness Convoluted Tubing Inspection/Repair/Replacement	AD 94-20-05	1/28/1996	
24-3092	04/1998	Avionics—Display Processor Unit DPU-84/UMT-14B Cooling Fan Fuse Replacement	AD 2001-11-03	6/12/1998	9805.7
25-2556 Rev 1	02/1995	Equipment/Furnishings—Cabin Partition Support Improvement	Kit No. 129-5007-1 S	2/8/1996	
27-2512 Rev 1	12/1994	Flight Controls—Increase in Maximum Flap Extension Speed	ASAP, no later than next 500 flight hours	4/6/1995	
27-3038	03/2000	Stabilizers—Inspection of Rudder Torque Shaft Support Bearing Retention Nut for Thread Engagement	ASAP, no later than next 90 days	3/30/2000	
27-3397	01/2001	Flight Controls—Flap Flexible Shaft Assembly Inspection	AD 2001-18-07	4/13/2001	15203.6
28-3299	12/1999	Fuel—Wing Fuel Quantity Wiring Harness Attachment Improvement and Wing Fuel Tank Wiring Harness Conduit Sealing	AD 2000-19-04	9/24/2000	
31-2618	09/1995	Indicator/Recording Systems—Removal of Fairchild 15625 Trip and Date Encoder	Optional	1/20/1996	
35-3233	12/1998	Oxygen—Replacement of Cabin Oxygen Mask Lanyards	Kit No. 280041-00	1/2/1999	
36-2591	12/1994	Pneumatic—Installation/ Modification of Pneumatic System Plumbing	Kit No. 129-9010-1	12/2/1995	

Table 3. Service Bulletins (Continued)

SB Number	Requested Compliance Date	Description	Compliance	Actual Compliance Date	ACTT
52-2572	07/1996	Doors—Modification of Airstair Door Handle and Latch Housing	AD 97-15-13	9/13/1996	
52-2740 Rev 1	06/1997	Doors—Emergency Exit Door Handle Mechanism Modification and Interior/Exterior Placard Installation	AD 98-26-16	9/2/1997	
52-3417	11/2000	Doors—Replacement of the Upper Anchor Brackets for the Airstair Door Forward and Aft Handrail Cables	Next routine inspection, no later than 100 flight hours or 14 days	12/19/2000	15203.6
53-2626	10/1996	Fuselage Radome Weather Seal Modification	Next scheduled inspection	6/23/1997	
55-2651	01/1996	Stabilizers—Stabilon Attachment Angles Inspection/Replacement	AD 97-10-14	7/1/1997	
57-2608	08/1995	Wings—Left Hand Aileron Trim Tab Actuator Servicing Improvement Modification	AD 99-16-12	12/2/1995	
57-3101	05/1999	Wings—Aft Inboard Wing Improved Water Drainage	Within next 1200 flight hours	10/5/1999	
71-2255 Rev 10	04/1990	Powerplant—Inspection of P/N 114-910025-1, 118-910025-1, 118-910025-37, 118-910025-121 & 129-910032-79 Engine Truss Assemblies for Fatigue Cracks and their Replacement with P/N 129-910047 Truss Assembly	Kit - 144-9045-5	6/11/1997	
71-3144 Rev 1	05/1998	Powerplant—Model 1900 Series Engine Truss Inspection and Rework	AD 2001-22-16	11/21/1998	
71-3144 Rev 2	05/1998	Powerplant—Model 1900 Series Engine Truss Inspection and Rework	AD 2001-22-16	7/3/2001	
71-3144 Rev 3	04/1999	Powerplant—Model 1900 Series Engine Truss Inspection and Rework	Kit 129-9017-1	10/31/1998	9805.7
76-2714	06/1997	Engine Controls—Ground Fine Switch Modification	Kit No. 129-5200-1	9/5/1997	8298.5
78-2686	06/1996	Exhaust—Right Hand Exhaust Stack Replacement for Left and Right Engines	Kit No. 129-9013-1	9/13/1996	

ASAP = As soon as possible
DC = Direct current

2.1.2 Major Repairs and Alterations.

Table 4 lists all major repairs or alterations documented on FAA form 337 specific to serial number UE-0066, that were contained in the airplane records or in the ADs from the CAR.

Table 4. Major Repairs and Alterations

Date	Description
05/12/2002	Rudder crack repair
12/16/1998	Horizontal stabilizer main spar center web repair
11/21/1999	Reinforced upper forward truss cowling support
05/28/1998	Accelerometer wiring modification
05/22/1998	Fuselage skin crack repair fuselage station 213.250
01/30/1996	Passenger address modification
03/18/1994	Fuselage repair at ice shields

2.1.3 Minor Repairs and Alterations.

Table 5 lists the significant minor repairs and alterations not listed as major repairs or alterations on FAA form 337 specific to tail number N856CA.

The items listed below were found in the maintenance records and consist of replaced or repaired items. These items were not pertinent to this examination and are listed for information only.

- 12/1/1992—Landing gear strut housing, part number 40273-00, replaced.
- 3/25/1998—Cracked right main landing gear side brace attachment, part number 40294-00, replaced.
- 6/15/1998—Spar splice reinforcement plate and kit 766-641 installed in accordance with AD 98-09-25.
- 12/7/1998—Elevator stop bolts, part number 71533-02, replaced.
- 1/10/1999—New bulkheads, part numbers 41050-08 and 41112-08, at fuselage stations (FS) 220.2 and FS 236.7.
- 4/5/2000—New elevator spars, part numbers 40075-20 and 40075-21, and elevator butt rib kit 766-642 were installed in accordance with AD 99-12-05, SB 998A, and SB 1008.

Table 5. Minor Repairs and Alterations

Date	Description
05/15/2002	Rudder cracked and repaired (337s)
06/26/2001	Right top cowl outboard/inboard land angles cracked (P/N 118-910028-31,-32)
06/28/2001	Left oil cooler bulkhead worn FS 243.75 (P/N 118-910048-2)
06/27/2001	Left oil cooler cowl angle cracked (P/N 118-910048-9)
08/01/2002	Right nacelle web assembly cracked (P/N 129-910034-35, P/N 118-910022-121)
08/13/2001	Right engine web assembly broken (P/N 118-910022-15)
08/15/2002	Lower forward spar cap corrosion in fuel tank LWS 124.58
05/15/2002	Lower aft spar corrosion in fuel tank LBL 114.25
05/15/2002	J-Stringer corrosion in fuel tank LBL 114.25
05/15/2002	Lower forward spar cap corrosion in fuel tank RWS 124.58
05/15/2002	J-Stringer corrosion in fuel tank RBL 114.25
05/27/1998	Field service kit 129-3008-1
11/21/1998	Right and left engine truss mounts cracked
11/06/1998	Left flap cracked
12/16/1998	Horizontal stabilizer main spar center web cracked
05/14/1998	Left wheel well fender bracket cracked
05/14/1998	Right wheel well fender bracket cracked
05/14/1998	Top VHF antenna doubler installed
05/15/1998	Doubler installed horizontal stabilizer forward center spar
05/15/1998	Vertical stabilizer top nose rib cracked
05/15/1998	Vertical stabilizer angles cracked
05/20/1998	Right wheel well fender cracked
05/01/1998	Flap repair
12/03/1994	Right stabilon cracked
06/16/1995	Right outboard flap cracked
04/18/1996	Left outboard flap replacement
08/02/2000	Right outboard flap actuator bracket broken
08/11/2000	Left outboard flap cracked
09/11/2000	Winglet delaminated
10/06/1999	Cargo door hinge half rivet loose
10/06/1999	Top fuselage skin leaking FS 183.250
10/06/1999	Right dorsal angle cracked
10/05/1999	Right side lower vertical fin angle cracked

Table 5. Minor Repairs and Alterations (Continued)

Date	Description
10/05/1999	Four rivets loose on lower fuselage skin at forward spar
10/05/1999	Left dorsal angle cracked
10/04/1999	Right wing spar fasteners replaced (Kit 129-4015-1)
10/04/1999	Right ventral fin inboard angle cracked
10/04/1999	Left gear bay forward stiffener cracked
10/04/1999	Right gear bay forward stiffener cracked
03/28/1997	Left inboard flap top skin worn
01/31/1996	Rivets loose on left and right vertical stab
01/31/1996	Right and left wheel well fender support brackets cracked
09/19/1996	Right inboard flap damaged
09/19/1996	Left and right outboard flaps have worn ribs
11/07/1996	Right outboard flap bracket cracked
02/12/1998	Right aileron damaged by BaGougeage cart
11/13/1994	Left flap cove missing rivets

RBL = Right body line LBL = Left body line VHF = Very high frequency
LWS = Left wing station RWS = Right wing station

2.1.4 Special Airworthiness Information Bulletin.

Table 6 lists the Special Airworthiness Information Bulletin (SAIB) that was retrieved from the FAA database. An SAIB is an information tool that alerts, educates, and makes recommendations to the aviation community. An SAIB contains nonregulatory information and guidance that does not meet the criteria for an AD.

Table 6. Special Airworthiness Information Bulletin

SAIB Number	SAIB Date	Description
CE-00-15	1/21/2000	Advisement of SB Compliance—CVR Amplifier

A search of the NTSB database of accidents did not indicate that any accidents or incidents were ever recorded for serial number UE-0066. A review of Type Certificate Data Sheet A20SO and the Supplemental Type Certificates indicates the airplane was in compliance with requirements for airworthiness at the time of inspection.

2.1.5 Safety Communiqué.

A Safety Communiqué (SC) is a courtesy publication issued by Raytheon technical support to its customers for the sole purpose of identifying potential airworthiness hazards discovered in the field and providing instructions to correct identified condition. Table 7 lists two recent SCs for the Beechcraft 1900D.

Table 7. Safety Communiqués

SC	SC Date	Description
SC 071	6/2004	Biocorrosion WS 124
SC 275	9/2006	Wing rear spar lower cap inspection WS 117

WS = Wing station

2.2 SERVICE DIFFICULTY REPORTS DATABASE REVIEW.

The database review on the fleet of Beechcraft 1900D airplane SDRs involved over 3083 reports from 1993 to 2003. Table 8 lists some of the SDRs obtained from the FAA database by the Air Transport Association of America (ATA) and Joint Aircraft System/Component (JASC) code, which is used to categorize the reports. It is important to note that the SDR database is make and model-specific, not serial number-specific. Table 9 lists the SDR categories of interest to this research program and the number of occurrences per category. The breakdown of SDRs by ATA/JASC code is shown graphically in figure 2, which shows that 16% are related to the landing gear systems and an additional 23% are related to the turboprop engines. SDRs are not always generated for each issue that arises; therefore, common problems may exist that are not appropriately represented by the SDR database.

Table 8. Service Difficulty Reports

JASC	Description of Discrepancy
3211	Right and left main landing gear sockets loose P/N 5081032019
5100	Frame at FS 456 cracked at stringer #10 intersection
5100	Stringer 10 cracked at FS 451
5311	Horizontal stabilizer forward spar forward web cracked four places from hole
5312	Forward pressure bulkhead cracked FS 84, on right lower web below stiffener P/N 114-410026-6
5312	Bulkhead cracked at FS 84, three places from rivet hole P/N 114-410026-113
5313	Skin under stringer 10R cracked at FS 303
5313	Clip cracked at stringer 13, FS 399 P/N 101-420087-5
5313	Internal skin to stringer corrosion, 16R, FS 220 to FS 236 P/N 131686
5314	Right forward outboard wheel well keel casting cracked P/N 114-980024-12
5320	Right clip cracked FS 288 P/N 114-430002-140

Table 8. Service Difficulty Reports (Continued)

JASC	Description of Discrepancy
5320	Right heavy angle cracked FS 300 P/N 114-430002-180
5320	Left doubler disbonded FS 290 P/N 114-430106-53
5320	Right bonded doubler disbonded FS 438 P/N 129-430060-23
5320	Vertical stabilizer to fuselage L bracket cracked FS 70.107
5510	Right and left outboard elevator hinge assemblies corroded P/N 101-620011-1
5510	Water drain hole in bulkhead in wrong location P/N 101-600015-9
5511	Forward spar web of horizontal stabilizer cracked at grommet hole P/N 10162000061
5511	Horizontal stabilizer spar cracked around deice hose P/N 101-620000-61
5511	Six leading-edge ribs and four center ribs of horizontal stabilizer cracked P/N 101-620017-1
5511	Horizontal stabilizer main spar center web cracked P/N 101-620000-61
5511	Horizontal stabilizer forward spar forward web cracked four places at hole
5511	Horizontal stabilizer main spar web cracked four places at deice line hole
5530	Vertical stabilizer forward spar has loose rivets P/N CR3245
5530	Rudder torque shaft support bracket cracked P/N 101-524013-3
5530	Vertical stabilizer forward spar upper attach bolt four each loose P/N EWB22514
5530	Vertical stabilizer to fuselage L bracket cracked
5531	Vertical stabilizer forward top rib cracked at stress relief holes P/N 101-640000-17
5531	Vertical stabilizer rib flanges at CSS 39.289 and SS 54.026 cracked
5531	Vertical stabilizer rib flanges at CSS 24.397, SS 39.289, SS 54.026 cracked P/N 114-640000-59, 114-640000-61, 114-640000-69
5531	Vertical stabilizer ribs at CSS 69.184 cracked at stringer 101-640000-46 P/N 114-640000-57
5533	Left and right ventral fin attach angles cracked FS 557.50 P/N 129-440061-3
5700	Accumulation of water under panel 612 BB
5711	Left and right wing lower spar cap corroded at WS 124.5 P/N 118-100021-9
5711	Right forward wing spar chaffed by electric line in wheel well
5711	Right lower spar cap horizontal flange cracked at BL 117.0 P/N 118-120029-1
5712	Left wing center section mid-rib cracked at WS 83 P/N 114-120033-27
5712	Left wing center section mid-rib cracked at WS 69 P/N 114-120032-3
5712	Left inboard keel web cracked
5720	Loose rivets in right wing top spar outboard of nacelle P/N MS20426AD
5730	Right wing root exterior skin inboard forward of spar cracked

WS = Wing station
CSS = Canted stabilizer station
SS = Stabilizer station

Table 9. Number of SDR Occurrences by Category

ATA/JASC Code	Number of Reports
11xx-Placards and Markings	5
14xx-Hardware	33
21xx-Air Conditioning	139
22xx-Auto Flight	19
23xx-Communications	25
24xx-Electrical Power	97
25xx-Equipment/Furnishings	28
26xx-Fire Protection	98
27xx-Flight Controls	166
28xx-Fuel	53
29xx-Hydraulic Power	41
30xx-Ice and Rain Protection	48
31xx-Instruments	28
32xx-Landing Gear	488
33xx-Lights	24
34xx-Navigation	258
35xx-Oxygen	11
36xx-Pneumatic	48
51xx-Standard Practices/Structures	2
52xx-Doors	197
53xx-Fuselage	64
54xx-Nacelles/Pylons	9
55xx-Stabilizers	148
56xx-Windows	67
57xx-Wings	222
61xx-Propellers/Propulsors	311
71xx-Powerplant	43
72xx-Turbine/Turboprop Engine	151
73xx-Engine and Fuel Control	77
74xx-Ignition	7
75xx-Air	31
76xx-Engine Controls	18
77xx-Engine Indicating	86
78xx-Engine Exhaust	2
79xx-Engine Oil	38
80xx-Starting	1
Total	3083

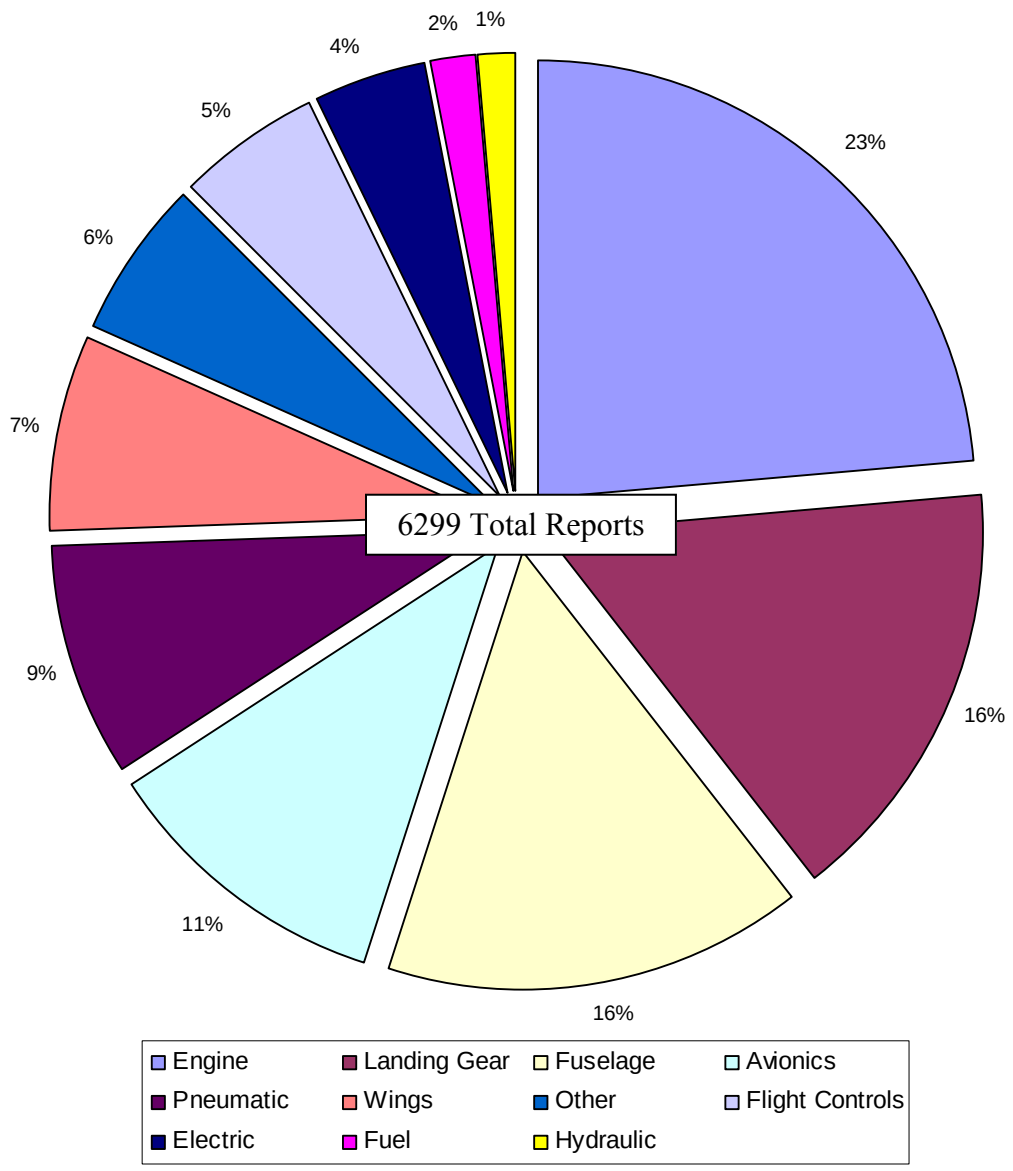


Figure 2. The SDR Occurrences by Category

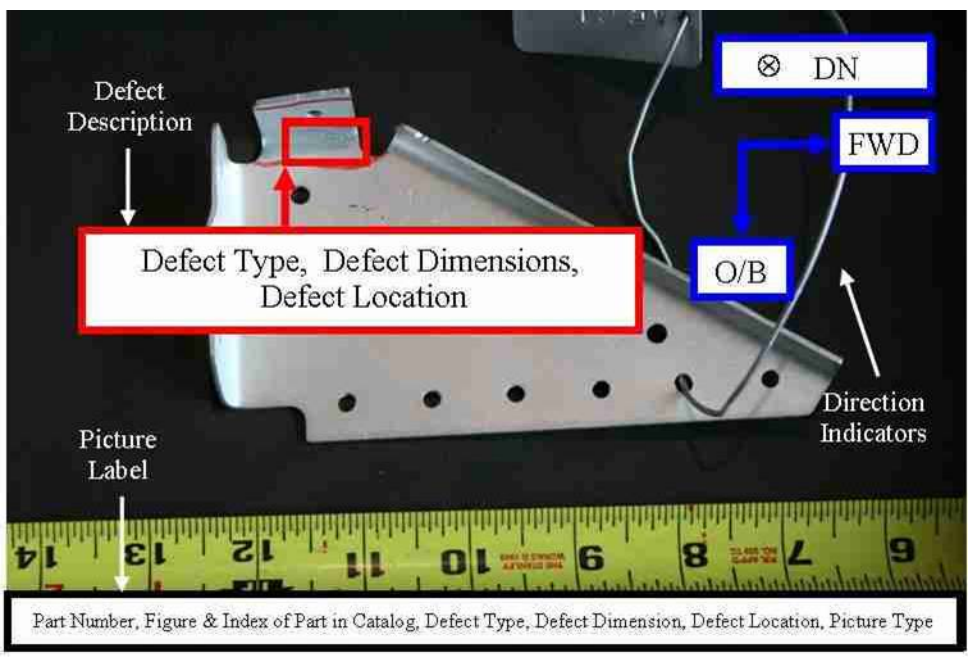
2.2.1 Airframe Structural Routine Visual Inspections.

The Beechcraft 1900D airframe visual inspections listed in the Beechcraft 1900D SIM were divided into three main groups: the wing, the fuselage, and empennage. All routine visual inspections were performed by licensed airframe mechanics under the supervision of a licensed airframe powerplant mechanic with inspection authorization. Two hundred twenty-one separate visual inspections were performed on the Beechcraft 1900D. The intent of these inspections were to find all possible visual defects normally discovered during routine inspections, then document each defect severity and location. The inspection concentration was structural only; no system components or wiring inspections were performed for this particular project. Due to the airplane having a pressurized fuselage, the team looked very closely at every accessible

structural component for cracks, corrosion, or defects that may have possibly affected airworthiness. This inspection methodology led to a large number of documented flaws. One hundred fourteen inspection areas are listed in the wing section of the Beechcraft 1900D SIM, 65 in the fuselage, and 42 in the empennage group. Of these areas, only 49 of the 194 findings were determined to be noteworthy, while the remaining 145 findings were deemed minor by airframe mechanic inspectors. Flaws such as minor cracks, scratches, dents, paint chips, and slight corrosion are to be expected with aged airplanes and pose no immediate threat to the safety of the airplane. In addition to dents and areas of missing paint, slight to moderate corrosion was noted on a majority of the screws on the airplane. All defects were recorded by location relative to the airplane coordinate system, by right wing station (RWS), left wing station (LWS), FS, water line (WL), right body line (RBL) or left body line (LBL), as established in the Beechcraft 1900D Maintenance Manual.

2.2.2 Picture and Table Orientation.

During the inspection Phase, all relevant defects were captured through a picture-taking process. This process was accomplished by taking overview and close-up macroshots using high-resolution cameras. Each defect identified as relevant was captured through this picture-taking process, the captured pictures were then oriented for report purposes, as shown in figure 3. Also, for identification and location, relevant defects are annotated in the tables throughout this report as shown in table 10.



DN = Down
O/B = Outboard
FWD = Forward

Figure 3. Example of Picture Orientation

Table 10. Example of Parts Defect Table

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	HSS		
Type of Defect	Length of Defect	Width of Defect	Depth of Defect	Fuselage Station	Horizontal Stabilizer Station	Additional Information for Defect	Figure Number of Global Picture
							Figure Number of Overview Picture
							Figure Number of Macro Picture
							Figure Number of Micro Picture

2.2.3 Visual Inspection Findings.

The visual inspection findings for the wing, fuselage, and empennage are listed in table 11. The general condition of these airplanes sections was evaluated through routine visual inspections using the Beechcraft 1900D SIM for guidance. The intent of these inspections was to find all possible visual defects as called out in the Beechcraft 1900D Maintenance Manual and the Beechcraft 1900D SIM. An independent inspector followed up each initial inspection performed.

Table 11. Inspection Findings

Airplane Section	Number of Inspections	Number of Findings	Noteworthy Findings
Wing	114	143	14
Fuselage	65	27	19
Empennage	42	24	16

2.2.4 Visual Fuselage Inspection Results.

Sixty-five visual inspections were accomplished on the fuselage. Twenty-seven discrepancies were discovered with 19 being classified as noteworthy. Noteworthy findings are defined as defects or discrepancies that would require further maintenance action. Overall findings of the fuselage inspection are shown in table 12, with examples shown in figures 4 through 56. Note: All global pictures were taken from the Beechcraft 1900D Illustrated Parts Manual.

Table 12. Fuselage Predisassembly Visual Findings

Defect				Defect Location			Defect Description	Defect Figure
Type	L (inches)	W (inches)	D (inches)	FS	WL	BL		
Crack	0.75			40	90	1R	Thru Rivet Hole Avionics Bay FWD Bulkhead	Figure 4 Global Figure 5 Overview Figure 6 Macroscopic
Crack	2.00			57	77	5L	Left Support Lower Nose Gear Wheel Well	Figure 7 Global Figure 8 Overview Figure 9 Macroscopic
Crack	0.10			61	108	19R	Most Fwd Hinge—Avionics Bay	Figure 10 Global Figure 11 Overview Figure 12 Macroscopic
Crack	0.65			68	84.5	21R	Lower Left Edge—Below Avionics Bay	Figure 13 Global Figure 14 Overview Figure 15 Macroscopic
Crack	0.65			68	86	22R	Upper Left Edge—Below Avionics Bay	Figure 13 Global Figure 14 Overview Figure 15 Macroscopic
Crack	0.25			102	113	27R	Torn Screw Hole Aft Access Panel Rt Side	Figure 16 Global Figure 17 Overview Figure 18 Macroscopic
Corr	1.00	0.75		157	75	5.5R	Antenna Mounting Surface	Figure 19 Global Figure 20 Overview Figure 21 Macroscopic
Corr	0.65	0.65		157	7	2R	Antenna Mounting Surface	Figure 19 Global Figure 20 Overview Figure 22 Macroscopic
Corr	0.75	0.75	0.15	162	75	5.5R	Around Antenna	Figure 19 Global Figure 20 Overview Figure 23 Macroscopic
Corr	5.25	1.70		188	75	10.5L	Antenna Mounting Surface	Figure 24 Global Figure 25 Overview Figure 26 Macroscopic
Corr	4.50	1.50		235.5	76	18L	Antenna Mounting Surface	Figure 27 Global Figure 28 Overview Figure 29 Macroscopic
Break	1.25		Thru	245.25	79.5	1R	SIM “B” Inspection	Figure 30 Global Figure 31 Overview Figure 32 Macroscopic

Table 12. Fuselage Predisassembly Visual Findings (Continued)

Defect				Defect Location			Defect Description	Defect Figure
Type	L (inches)	W (inches)	D (inches)	FS	WL	BL		
Crack	0.26 0.19 0.59		Through crack	265	135	28.5R	Gusset	Figure 33 Global Figure 34 Overview Figure 35 Macroscopic
Crack	0.26 0.32 0.56		Through crack	290	135	28.5R	Gusset	Figure 33 Global Figure 36 Overview Figure 37 Macroscopic
Gouge	0.45	0.30	0.015	278	120	30R	SIM "B" Inspection	Figure 38 Global Figure 39 Overview Figure 40 Macroscopic
Corr	1.25	0.20		295	160	2.75R	N/A	Figure 41 Global Figure 42 Overview Figure 43 Macroscopic
Gouge	0.55	0.30	0.02	340	120	30R	N/A	Figure 38 Global Figure 44 Overview Figure 45 Macroscopic
Gouge	0.25	0.25	0.015	340	120	30L	N/A	Figure 38 Global Figure 46 Overview Figure 47 Macroscopic
Corr	10.00	2.80		396	75	2R	Antenna Mounting Surface	Figure 48 Global Figure 49 Overview Figure 50 Macroscopic
Corr	3.50	3.50		446	75	2R	Antenna Mounting Surface	Figure 51 Global Figure 52 Overview Figure 53 Macroscopic
Corr	3.50	3.50		475.5	75	2R	Antenna Mounting Surface	Figure 54 Global Figure 55 Overview Figure 56 Macroscopic

Corr = Corrosion

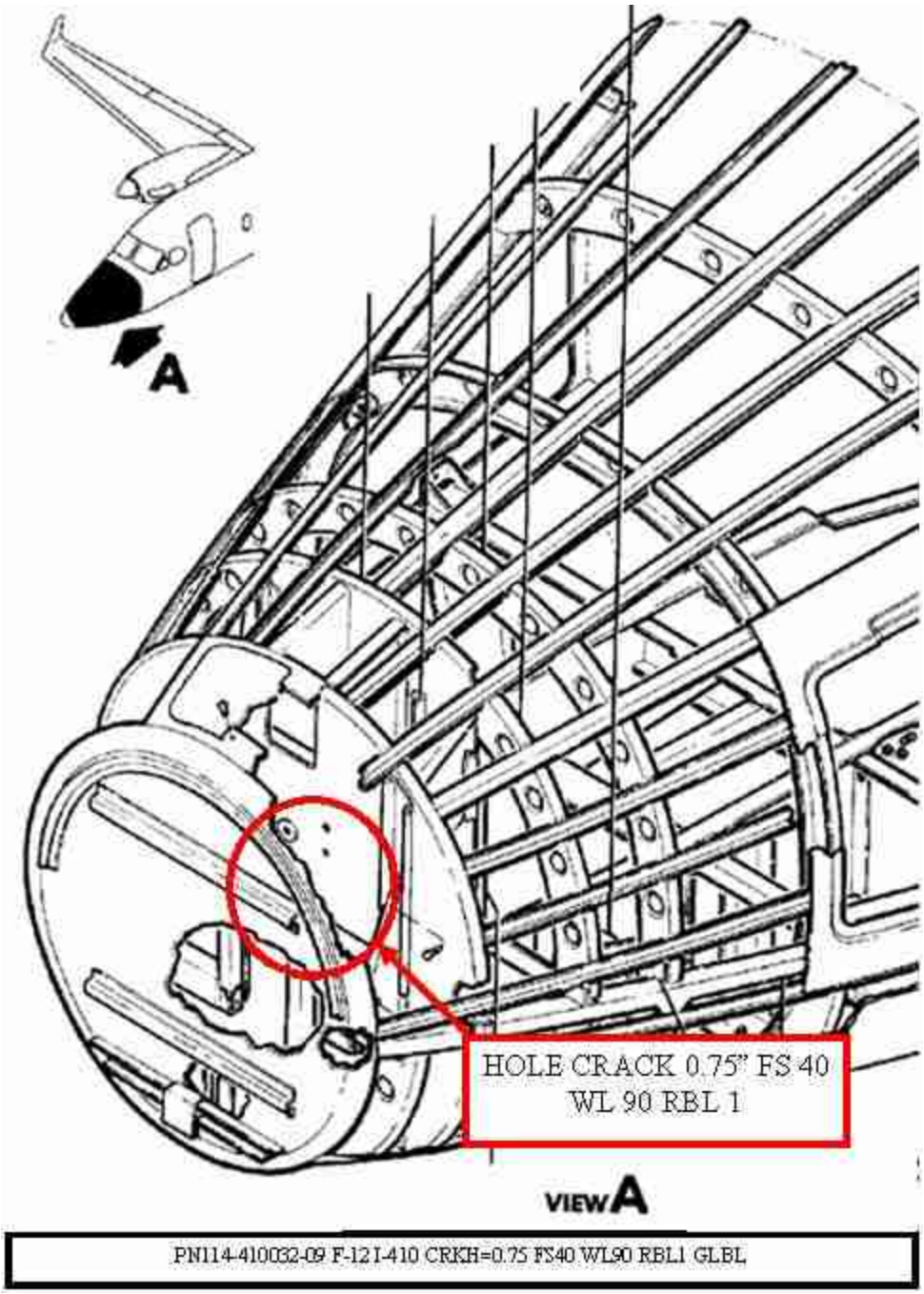


Figure 4. Hole Crack on Avionics Bulkhead—Global View

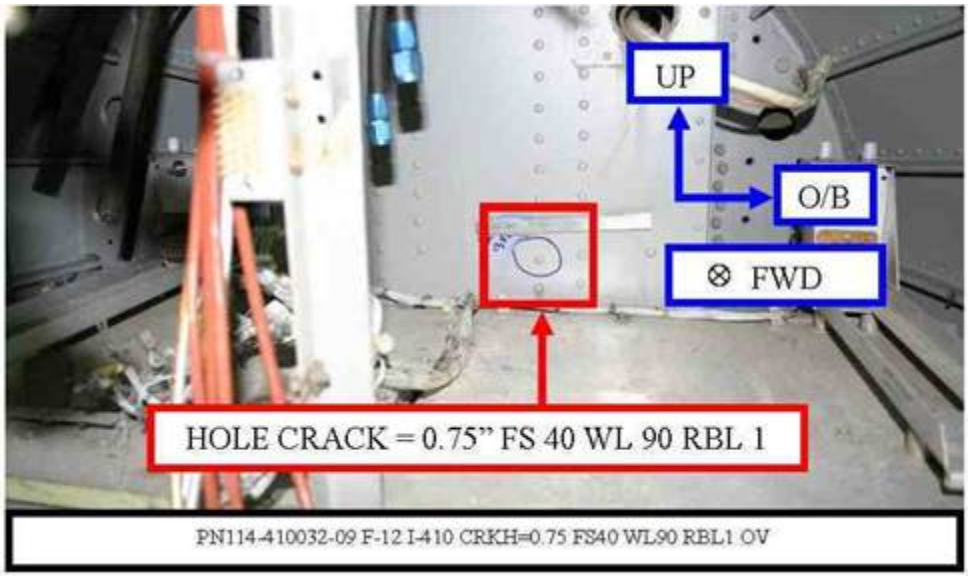


Figure 5. Hole Crack on Avionics Bulkhead—Overview

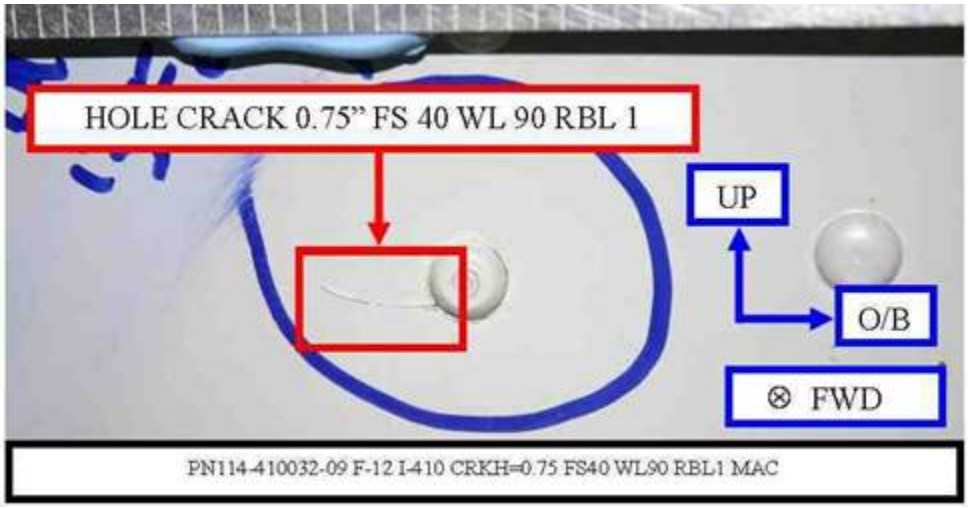


Figure 6. Hole Crack on Avionics Bulkhead—Macroscopic View

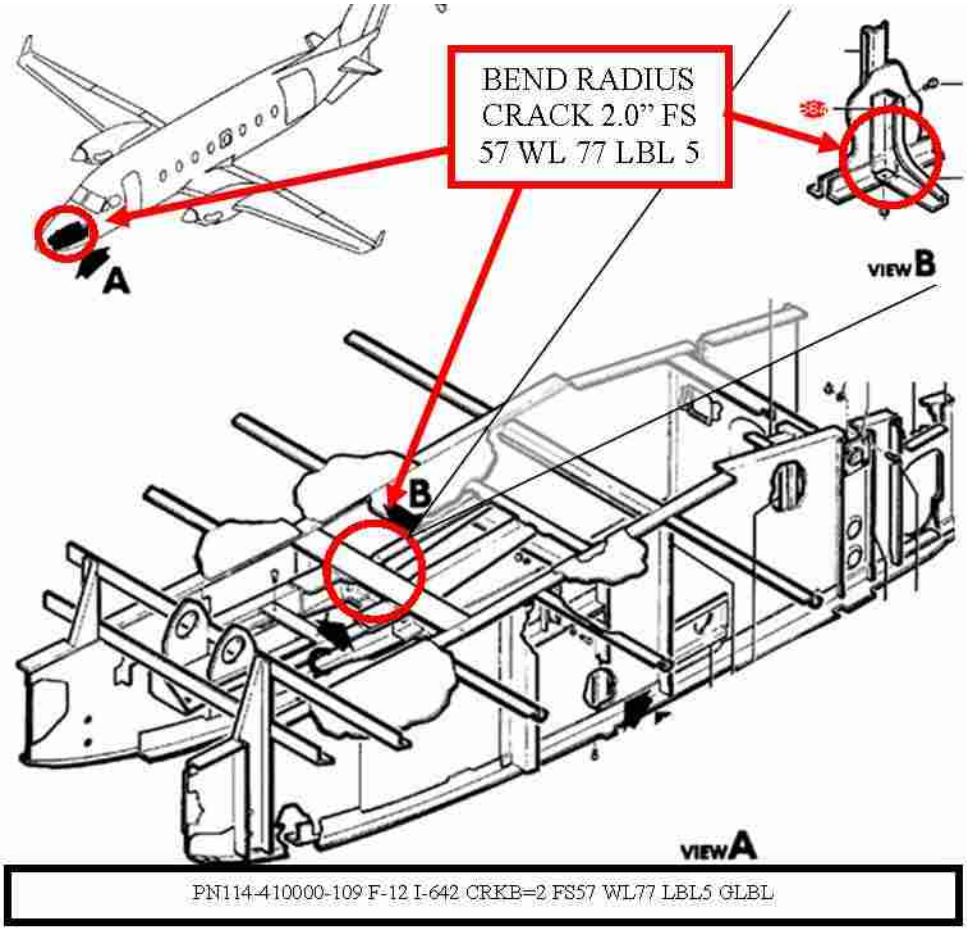


Figure 7. Bend Radius Crack on Stiffener—Global View

Figure 8. Bend Radius Crack on Stiffener—Overview

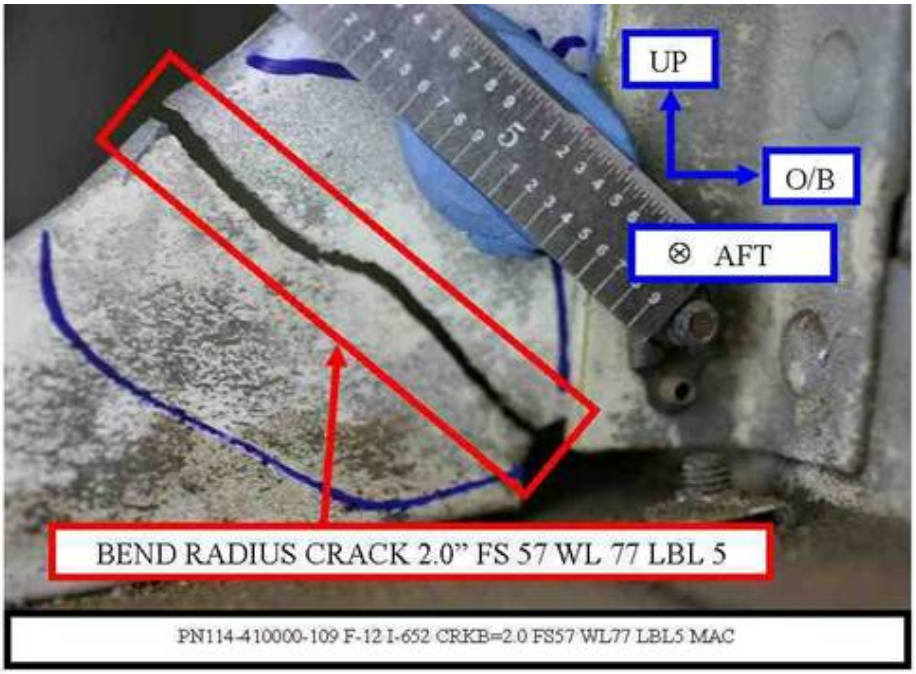


Figure 9. Bend Radius Crack on Stiffener—Macroscopic View

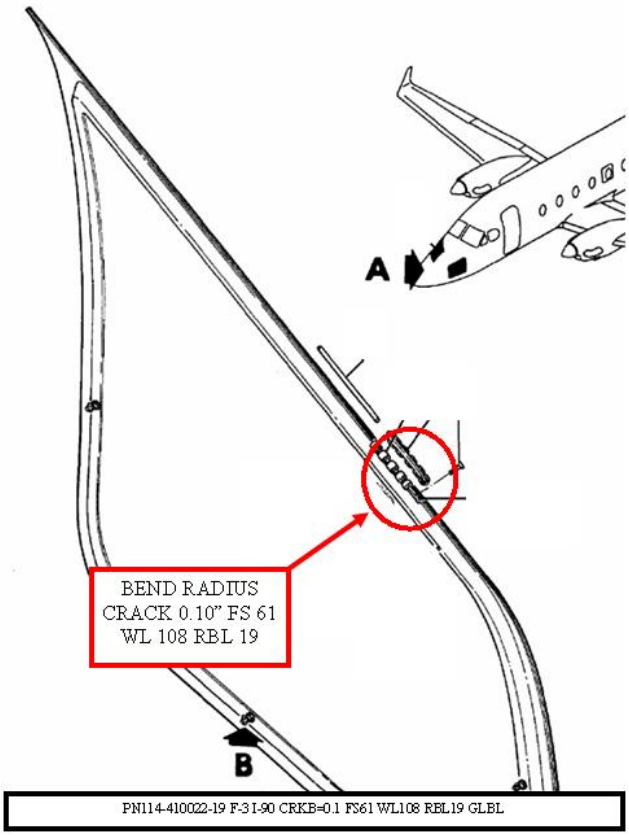
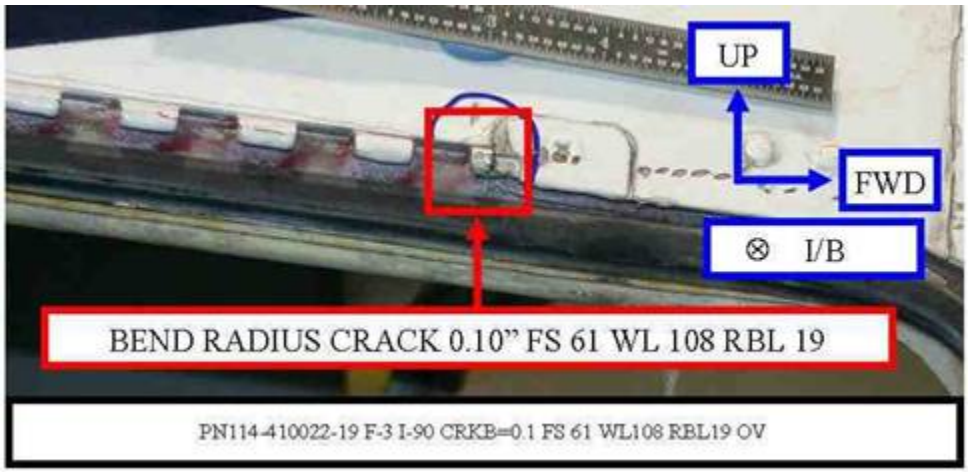


Figure 10. Bend Radius Crack on Avionics Bay Hinge—Global View



I/B = Inboard

Figure 11. Bend Radius Crack on Avionics Bay Hinge—Overview

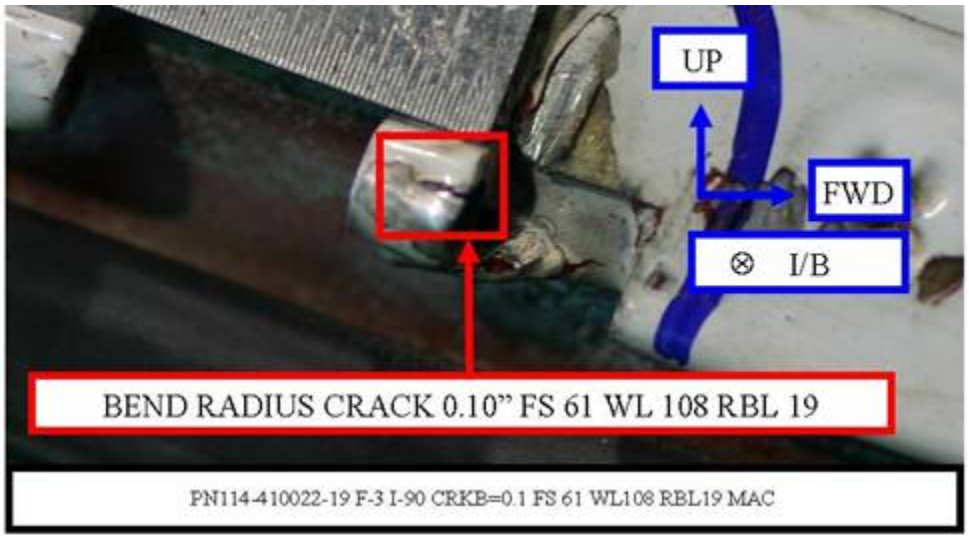


Figure 12. Bend Radius Crack on Avionics Bay Hinge—Macroscopic View

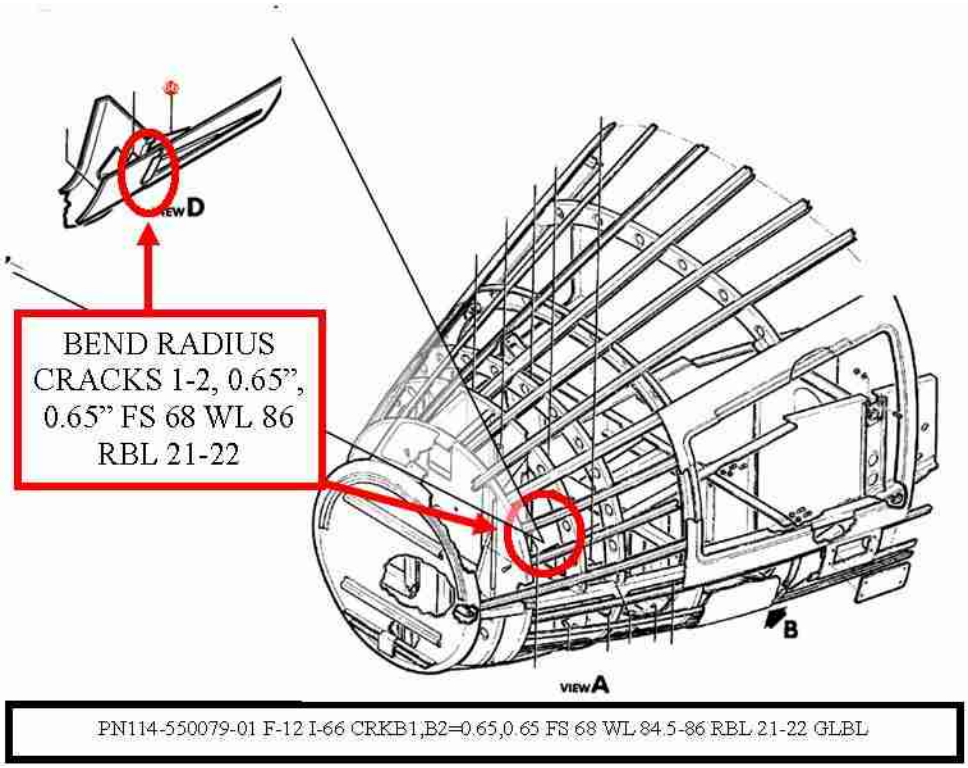


Figure 13. Bend Radii Cracks on Inlet—Global View

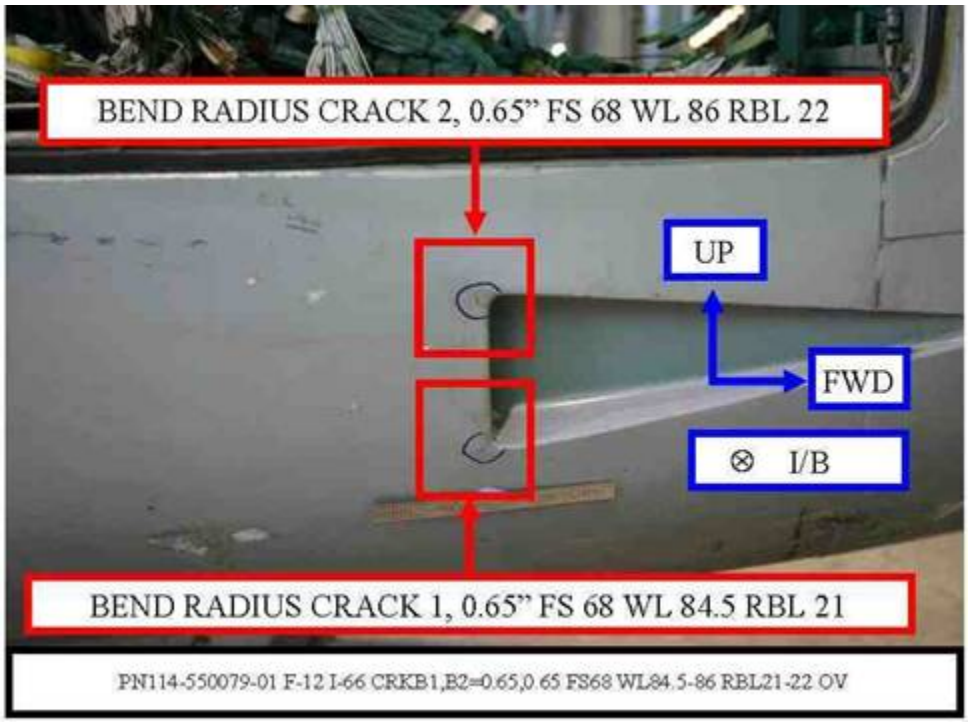


Figure 14. Bend Radii Cracks on Inlet—Overview

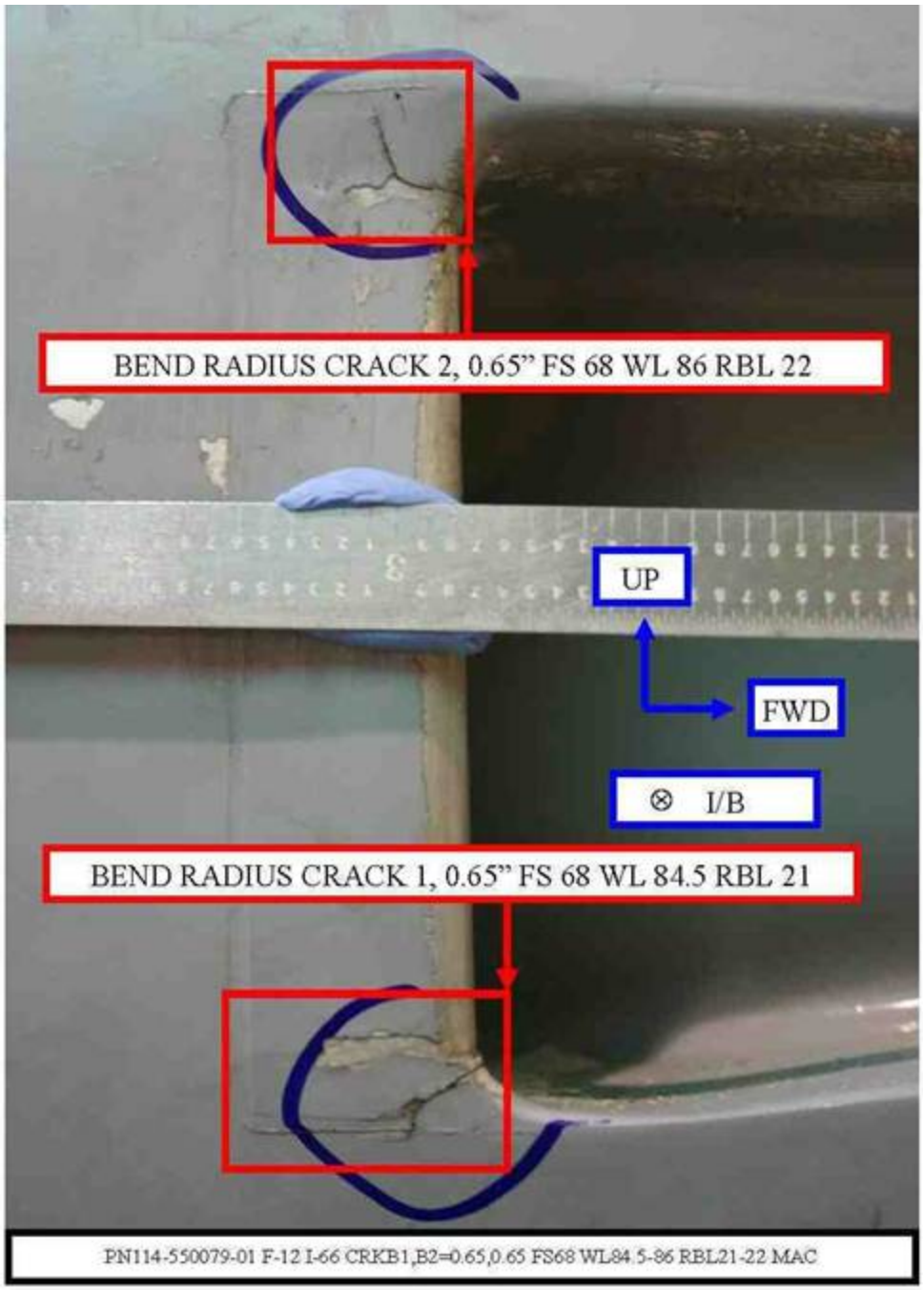


Figure 15. Bend Radii Cracks on Inlet—Macroscopic View

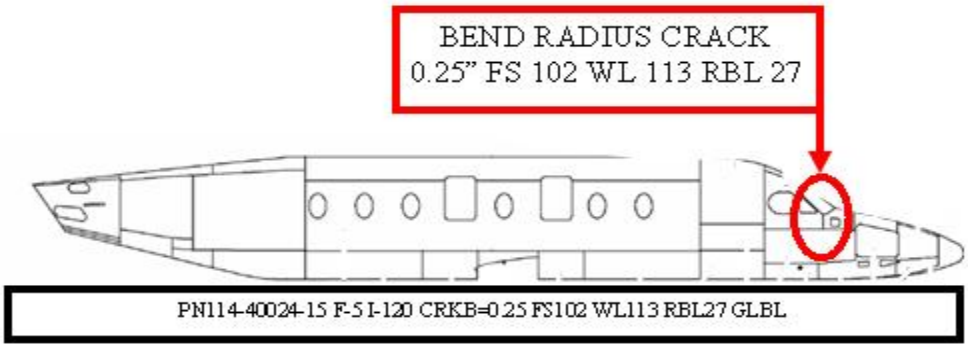


Figure 16. Bend Radius Crack on Cover Plate—Global View

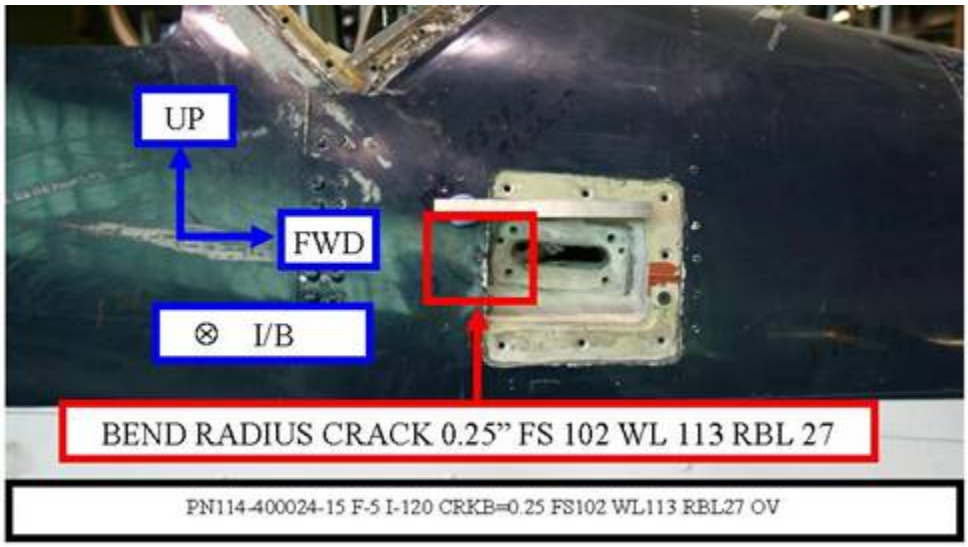


Figure 17. Bend Radius Crack on Cover Plate—Overview

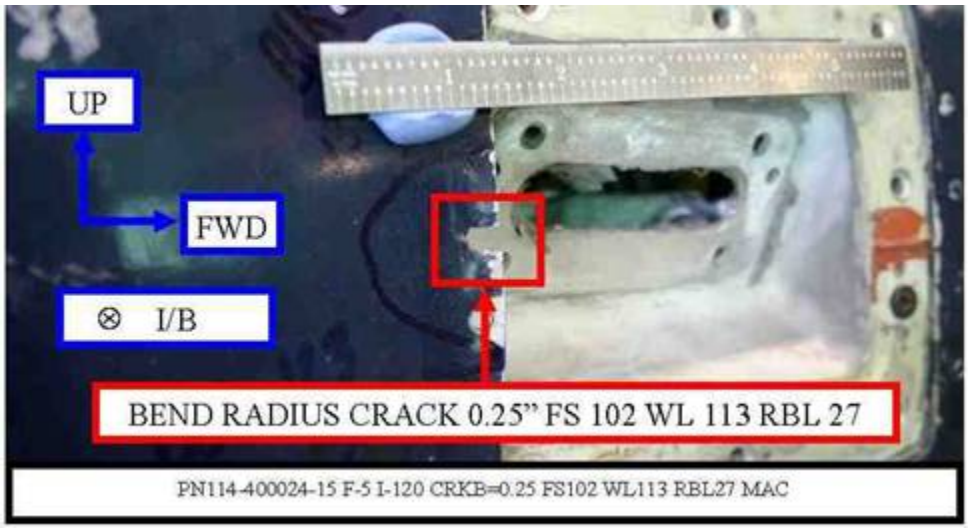


Figure 18. Bend Radius Crack on Cover Plate—Macroscopic View

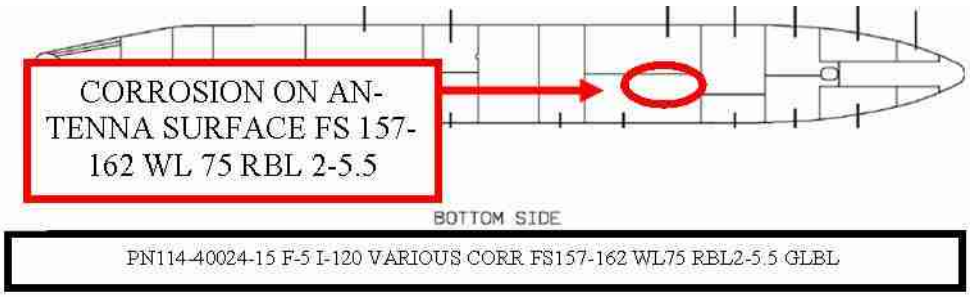


Figure 19. Corrosion on Antenna Surface FS 157-FS 162, WL 75, RBL 2-5.5—Global View

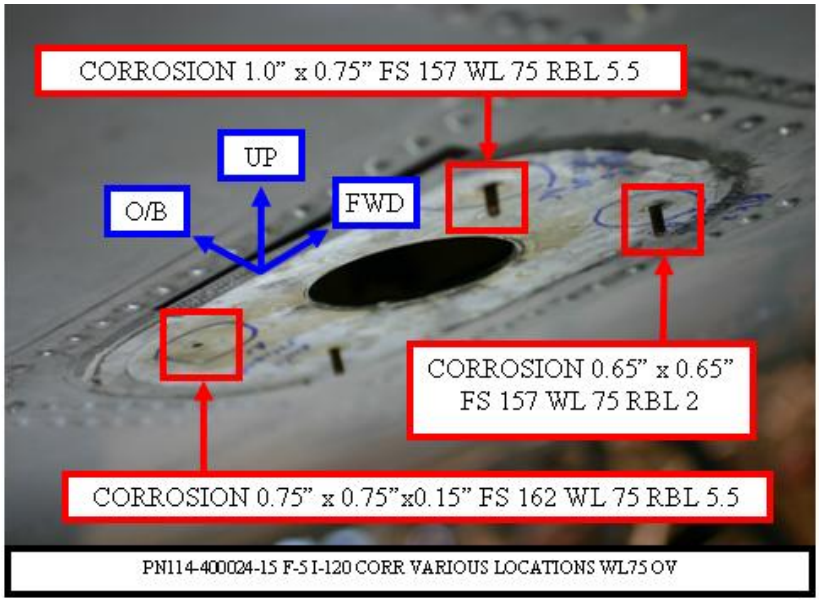


Figure 20. Corrosion on Antenna Surface FS 162, WL 75, RBL 5.5—Overview

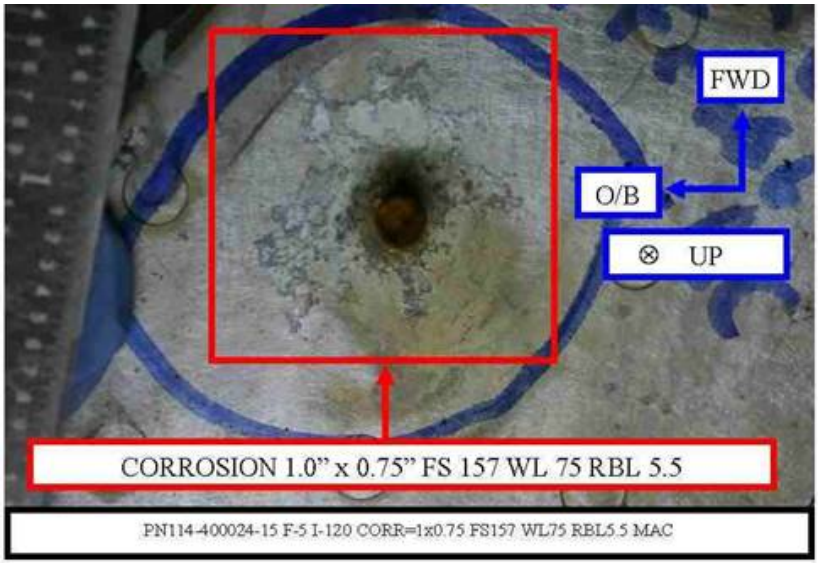


Figure 21. Corrosion on Antenna Surface—Macroscopic View

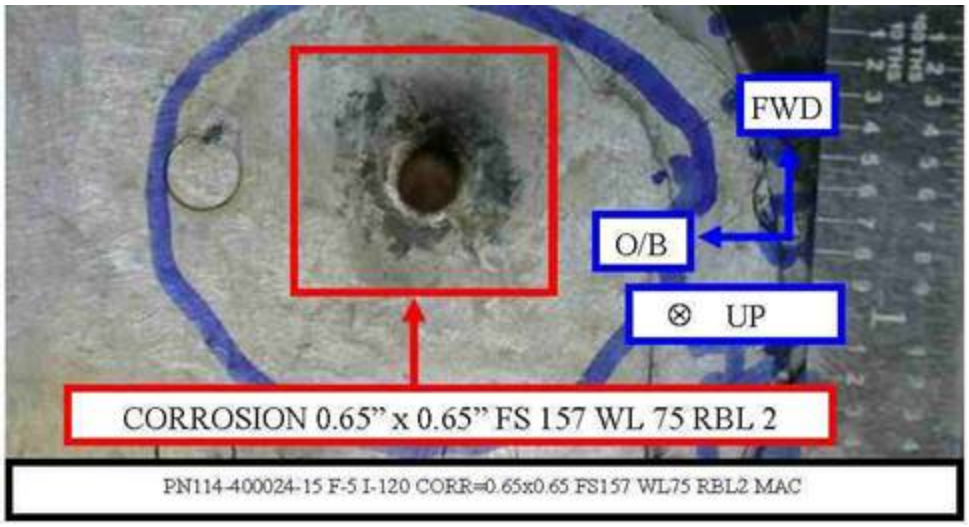


Figure 22. Corrosion on Antenna Surface—Macroscopic View

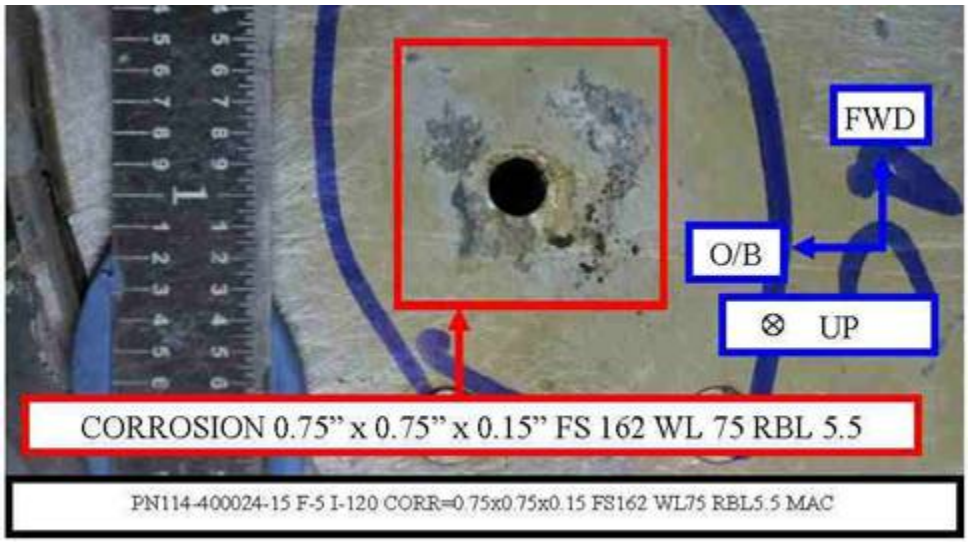


Figure 23. Corrosion on Antenna Surface—Macroscopic View

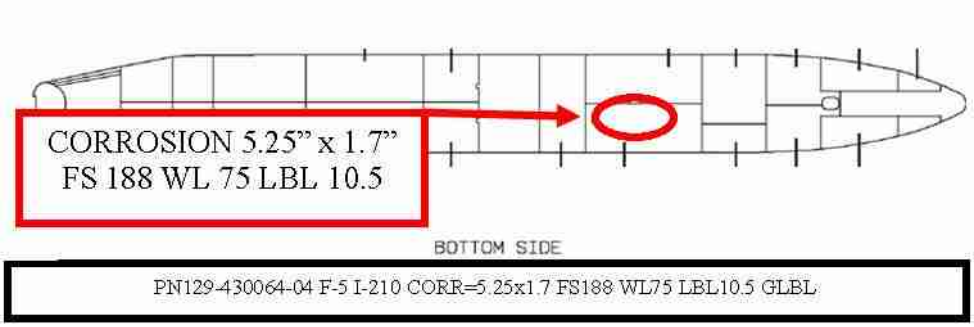


Figure 24. Corrosion on Antenna Surface FS 188, WL 75, LBL 10.5—Global View

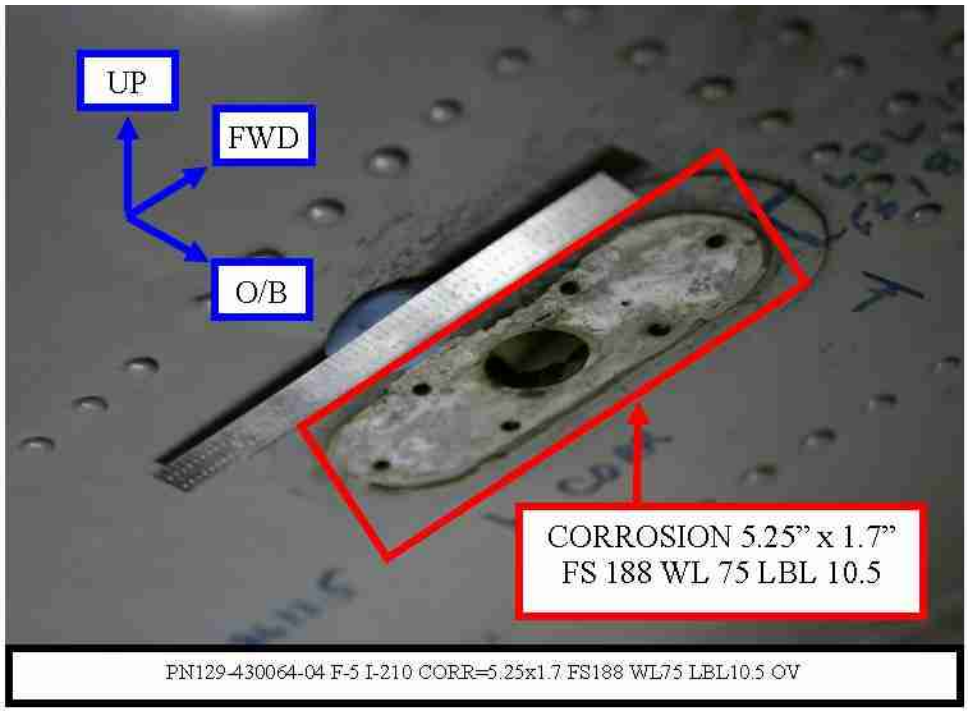


Figure 25. Corrosion on Antenna Surface FS 188, WL 75, LBL 10.5—Overview

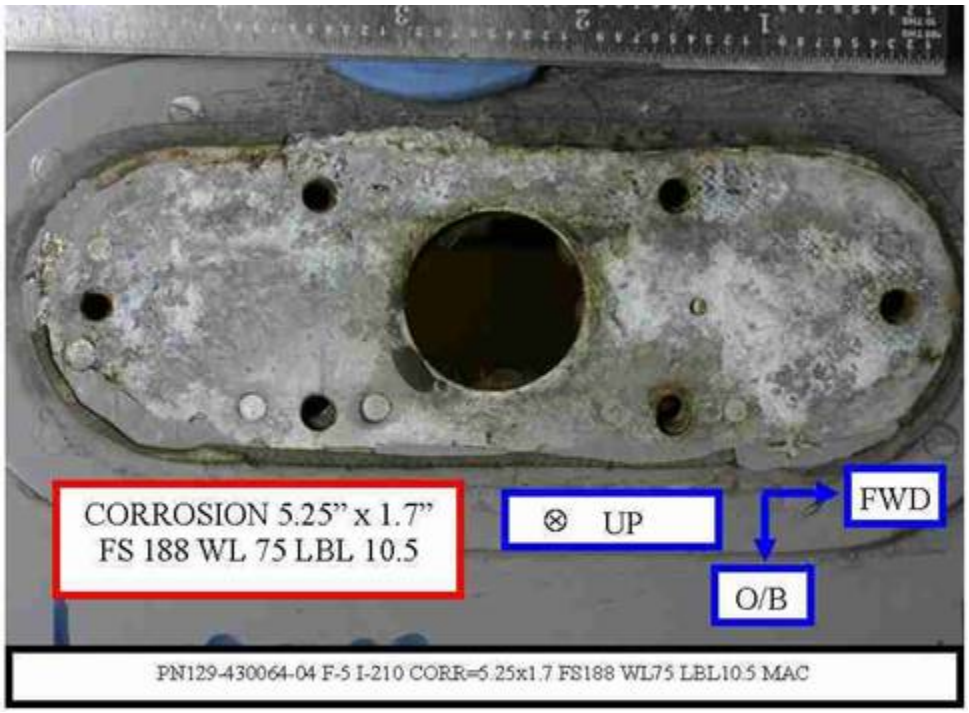


Figure 26. Corrosion on Antenna Surface—Macroscopic View

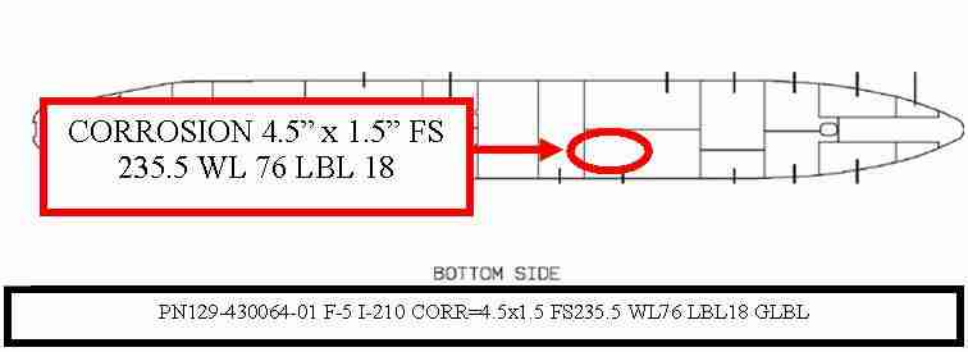


Figure 27. Corrosion on Antenna Surface FS 235.5, WL 76, LBL 18—Global View

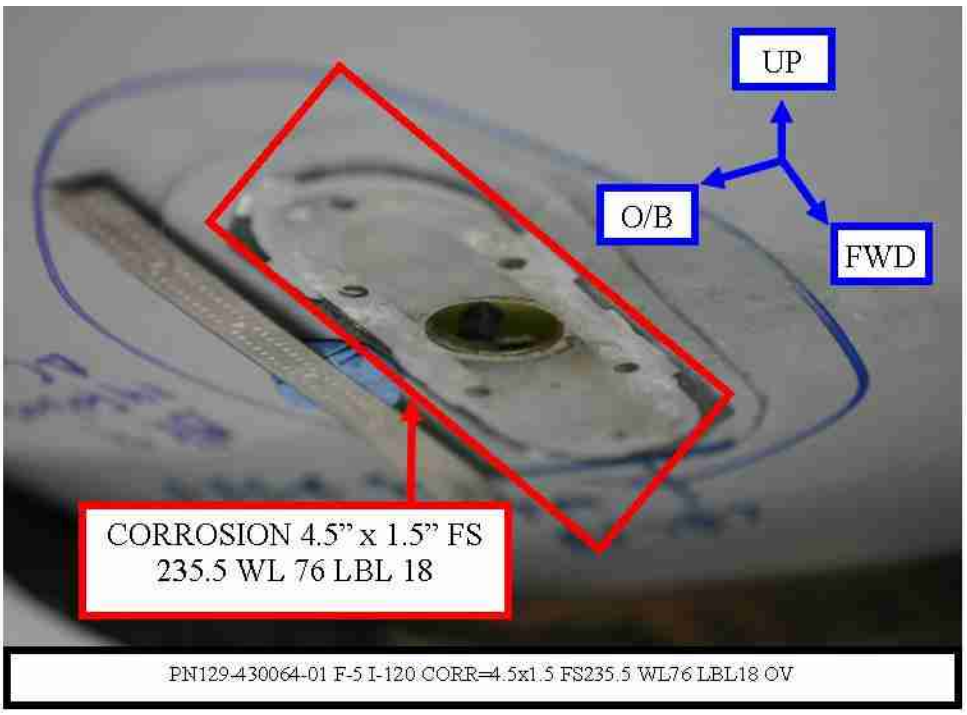


Figure 28. Corrosion on Antenna Surface FS 235.5, WL 75, LBL 18—Overview

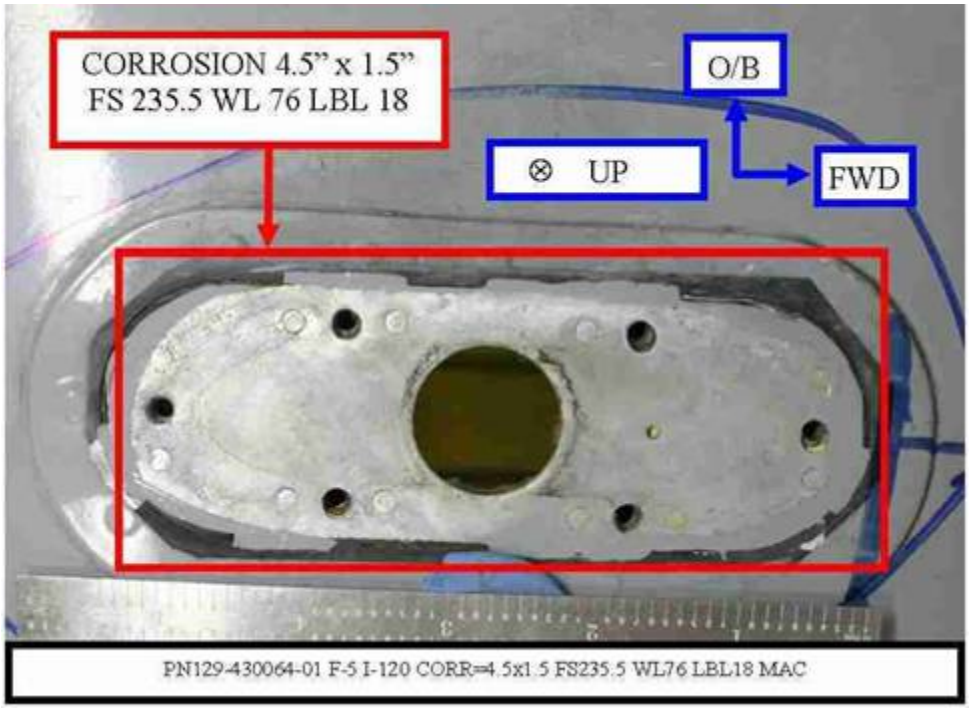


Figure 29. Corrosion on Antenna Surface—Macroscopic View

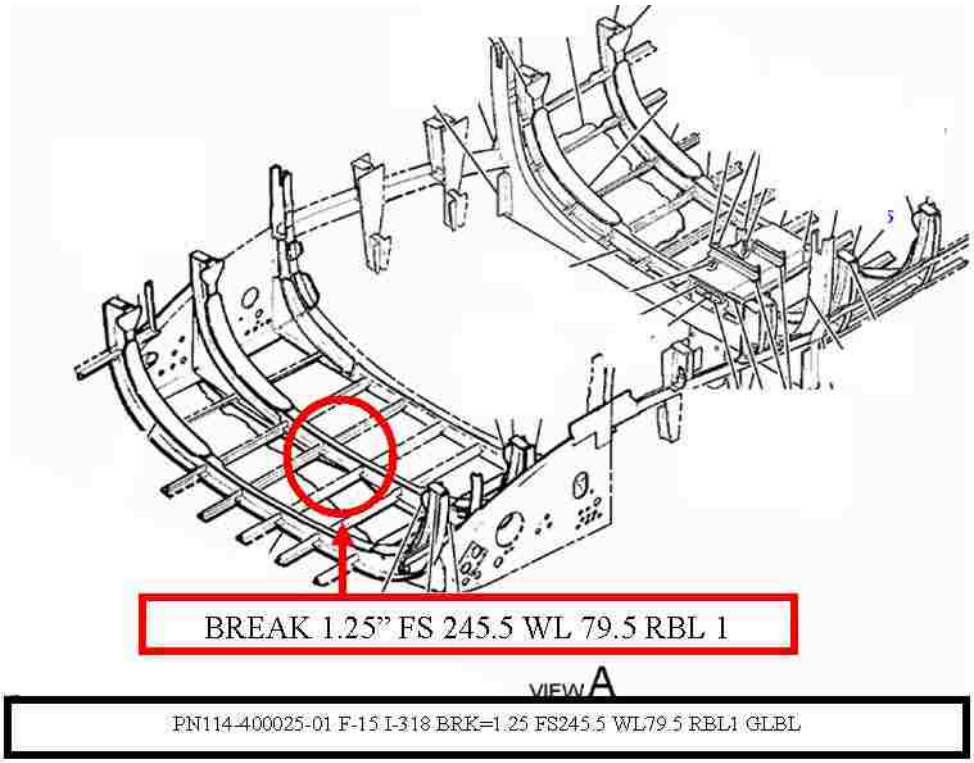


Figure 30. Break on FS 245.5—Global View

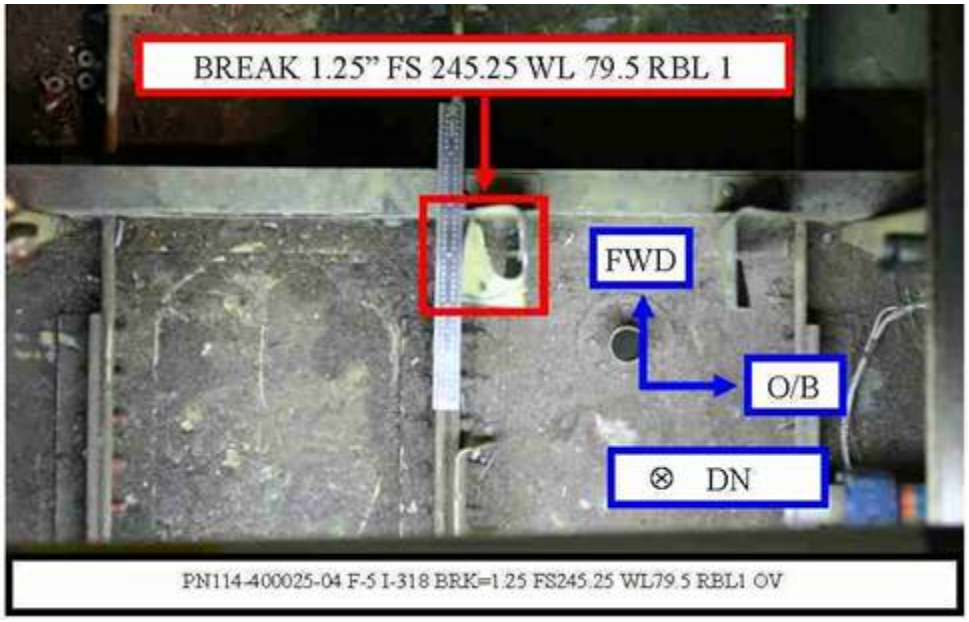


Figure 31. Break on FS 245.25—Overview

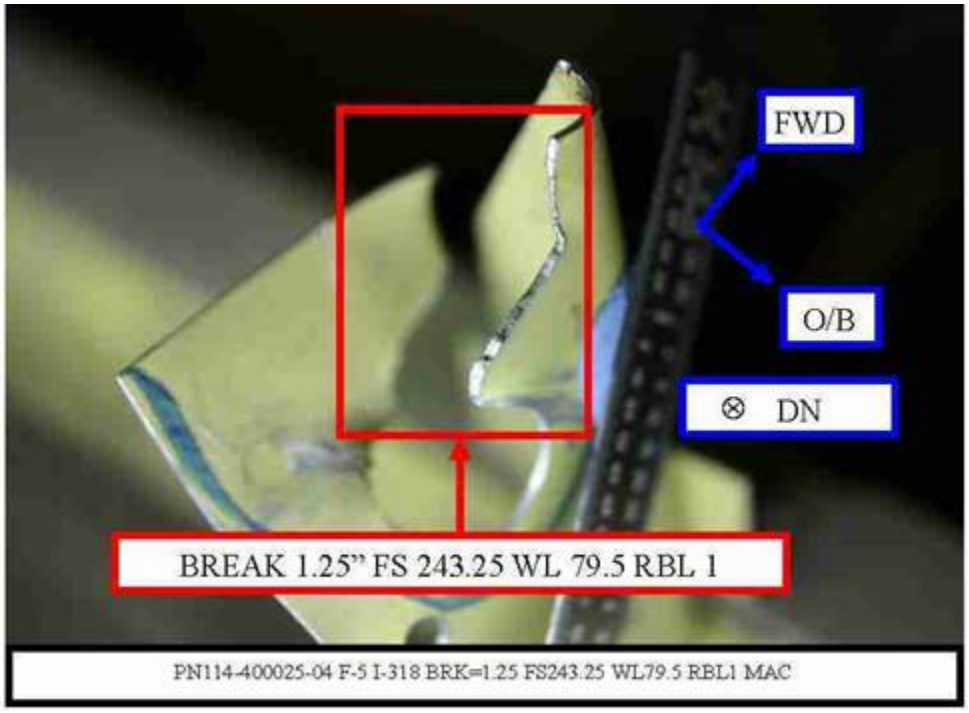


Figure 32. Break on FS 243.25—Macroscopic View

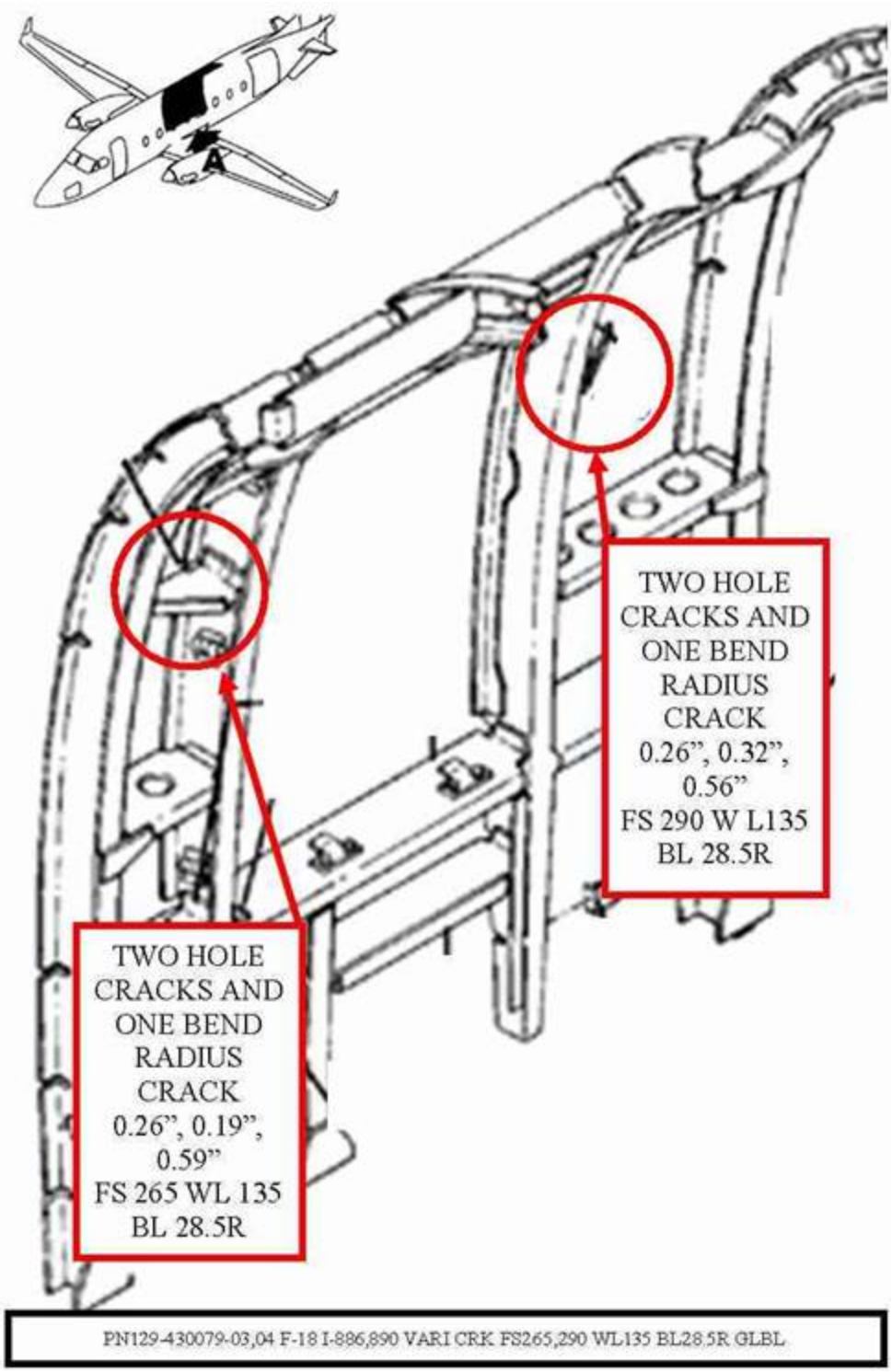


Figure 33. Multiple Cracks on Escape Hatch Gussets—Global View

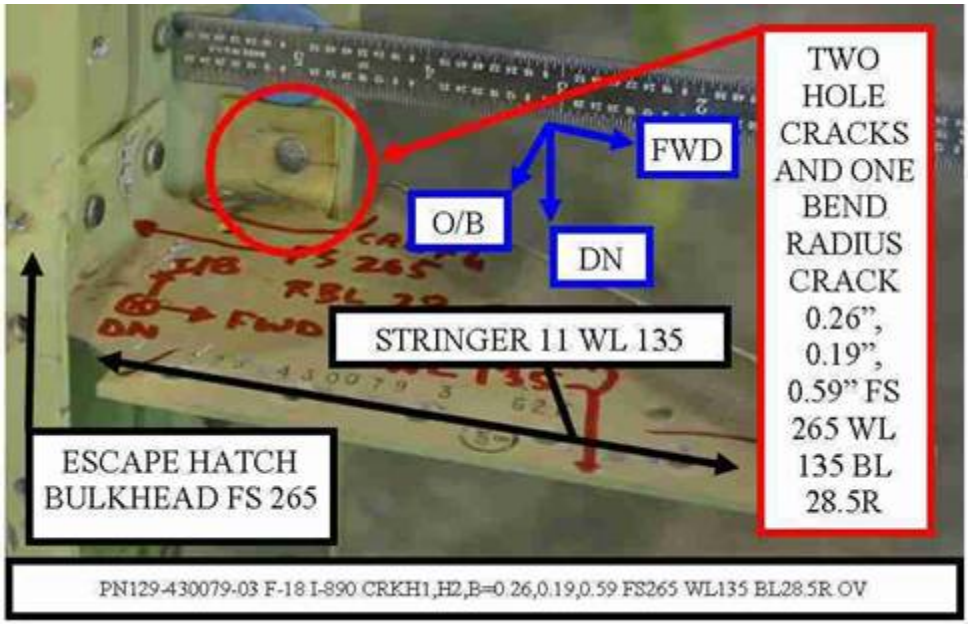


Figure 34. Multiple Cracks on Escape Hatch Gusset—Overview (FS 265)

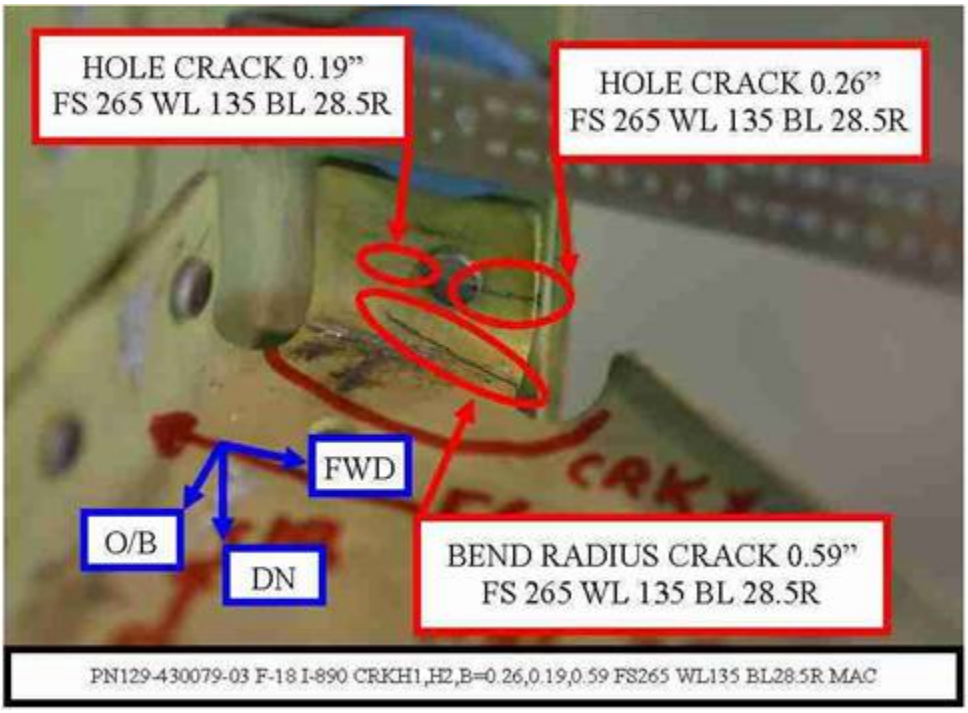


Figure 35. Multiple Cracks on Escape Hatch Gusset—Macroscopic View (FS 265)

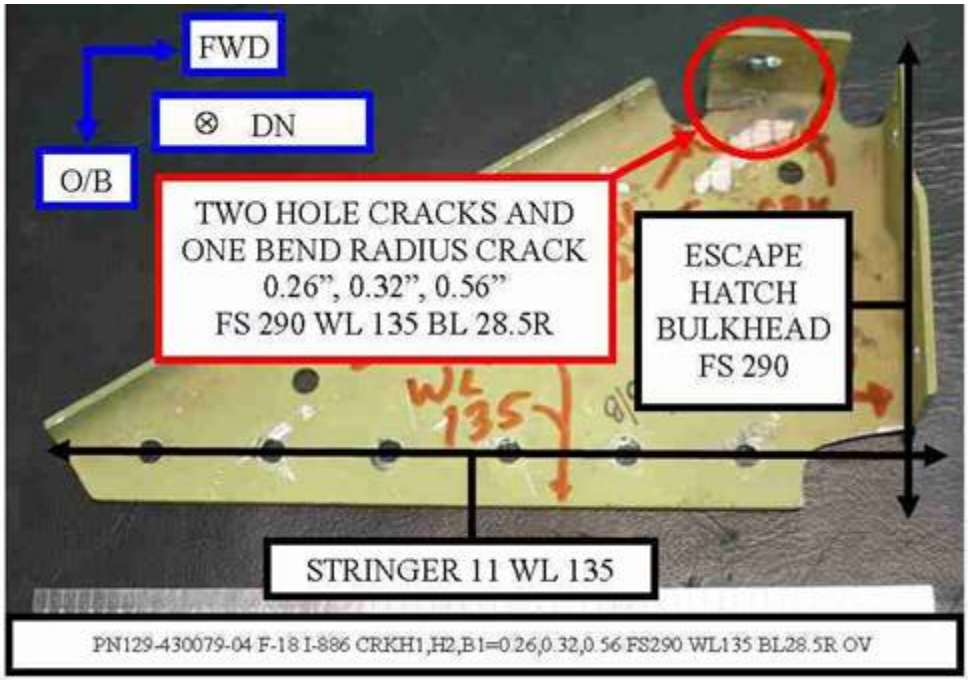


Figure 36. Multiple Cracks on Escape Hatch Gusset—Overview (FS 290)

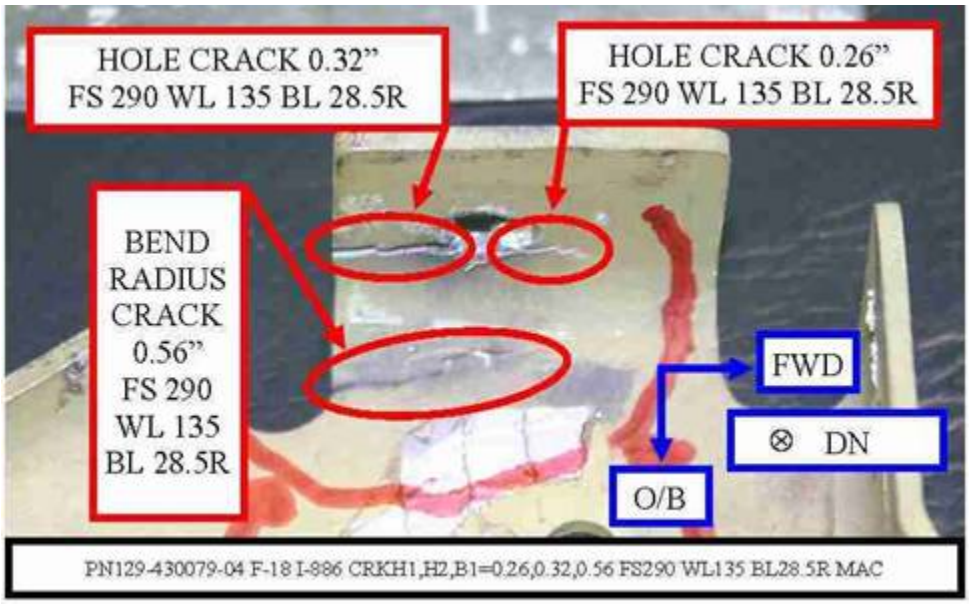


Figure 37. Multiple Cracks on Escape Hatch Gusset—Macroscopic View (FS 290)

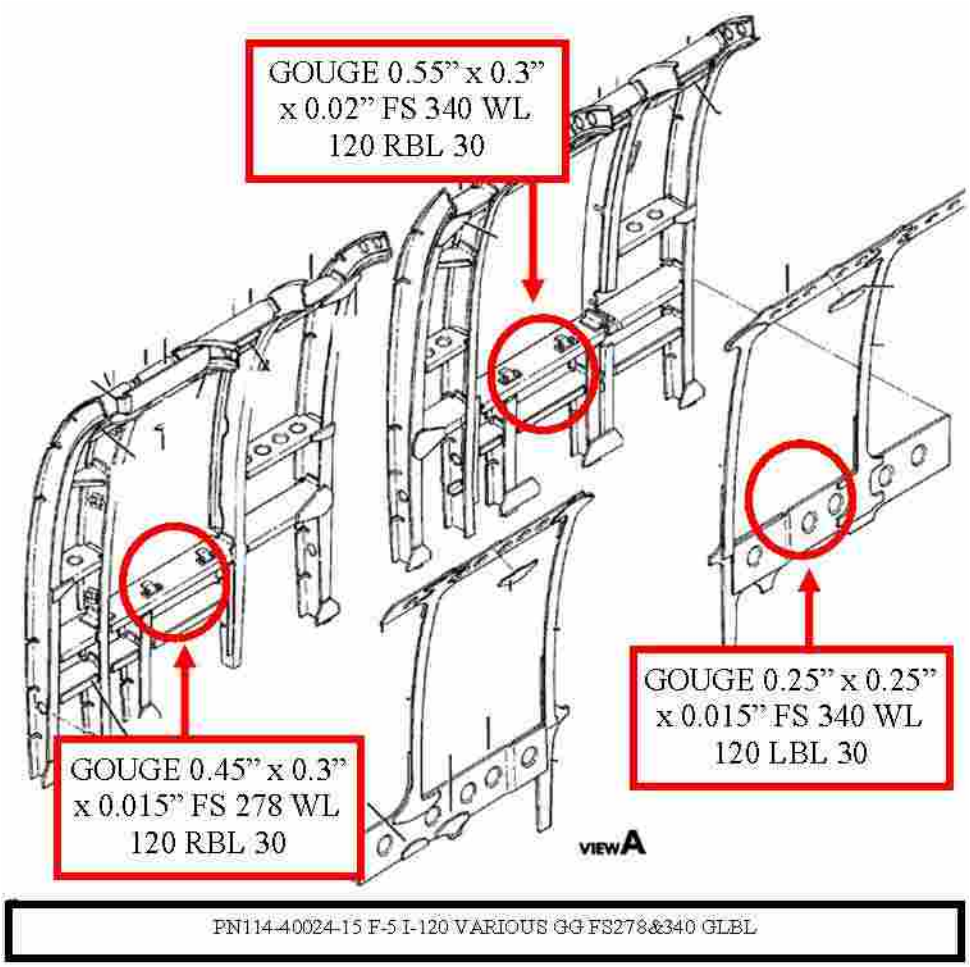


Figure 38. Various Gouges on Escape Hatch Frames—Global View

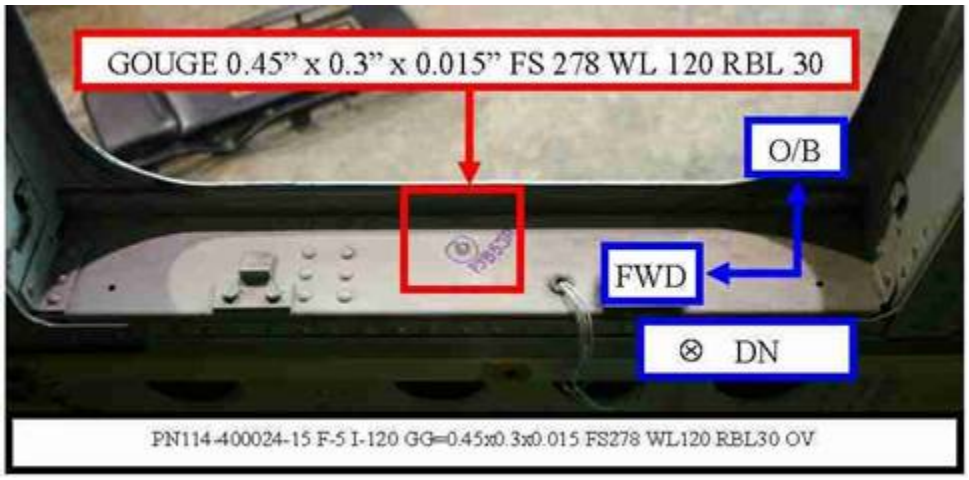


Figure 39. Gouge on Right Escape Hatch Frame—Overview (FS 278)

Figure 40. Gouge on Right Escape Hatch Frame—Macroscopic View (FS 278)

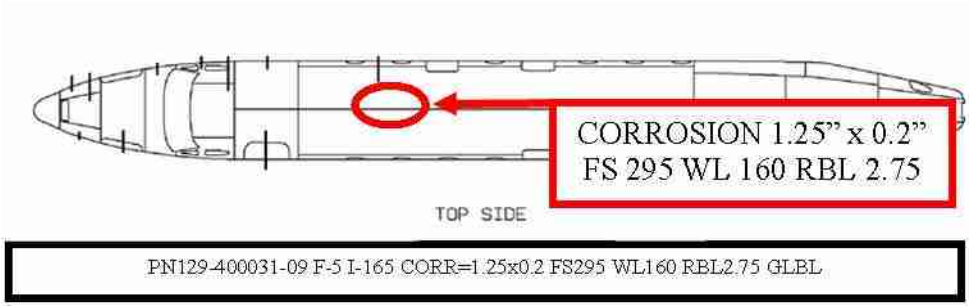


Figure 41. Corrosion on Skin—Global View

Figure 42. Corrosion on Skin—Overview

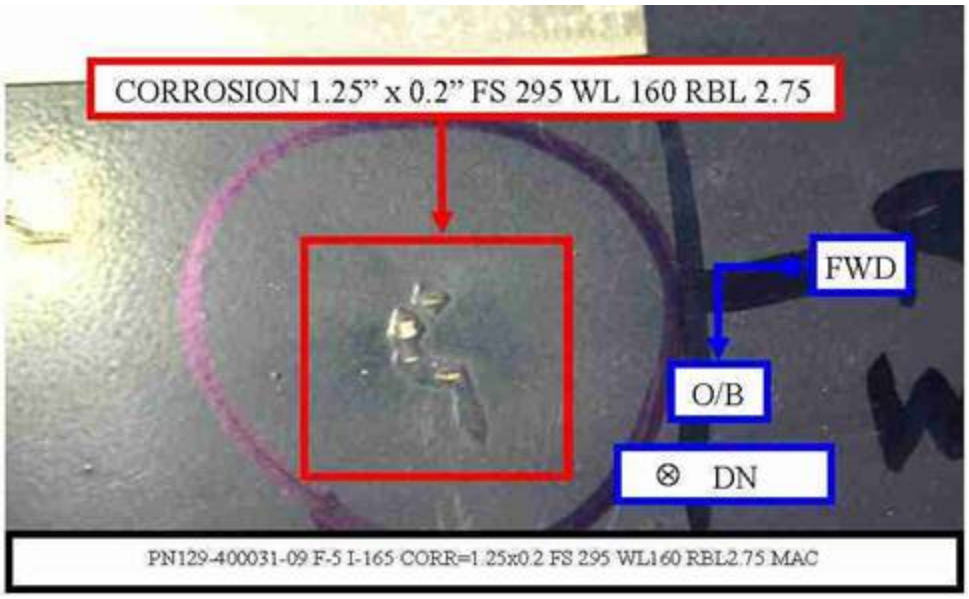


Figure 43. Corrosion on Skin—Macroscopic View

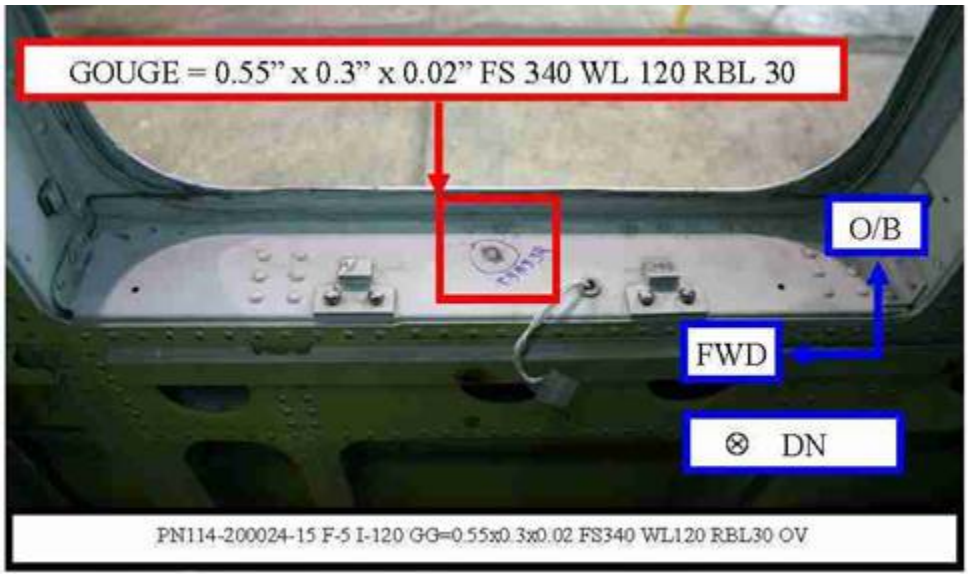


Figure 44. Gouge on Right Escape Hatch Frame—Overview (FS 340)

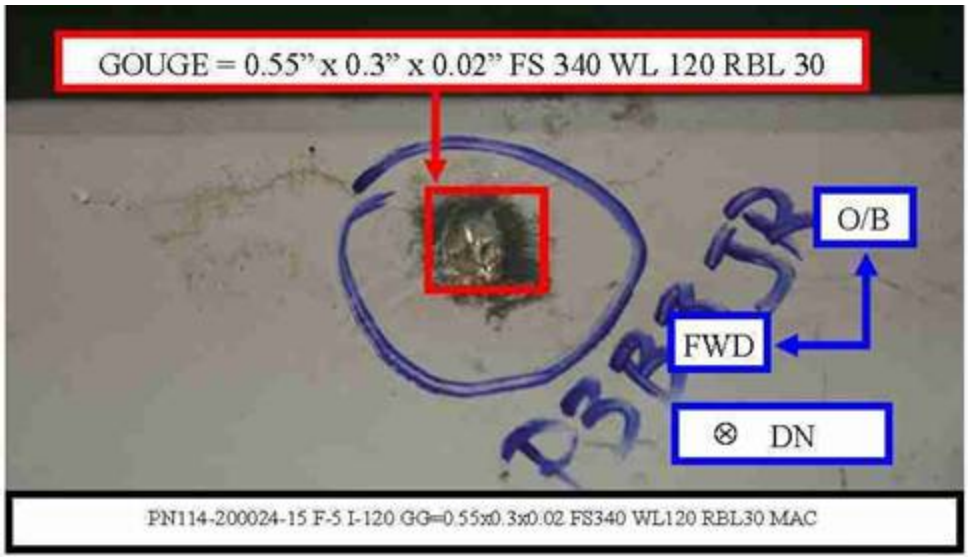


Figure 45. Gouge on Right Escape Hatch Frame—Macroscopic View

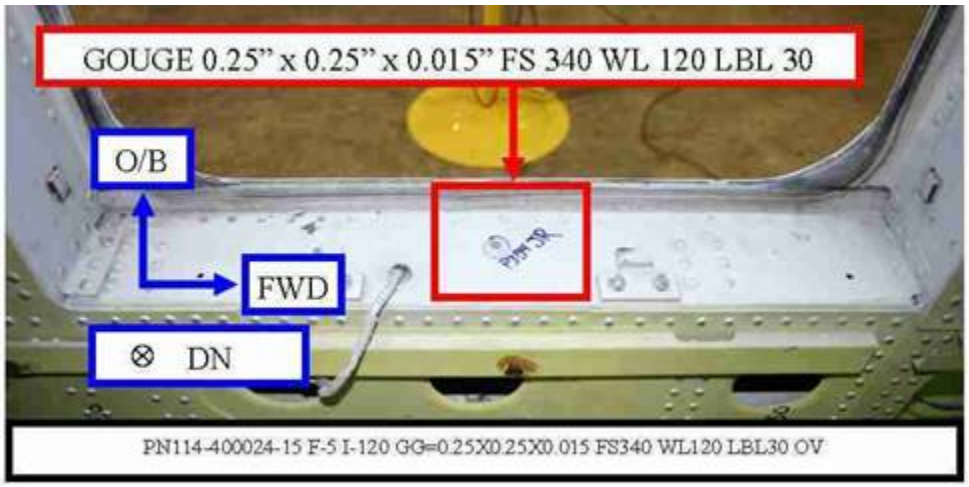


Figure 46. Gouge on Left Escape Hatch Frame—Overview

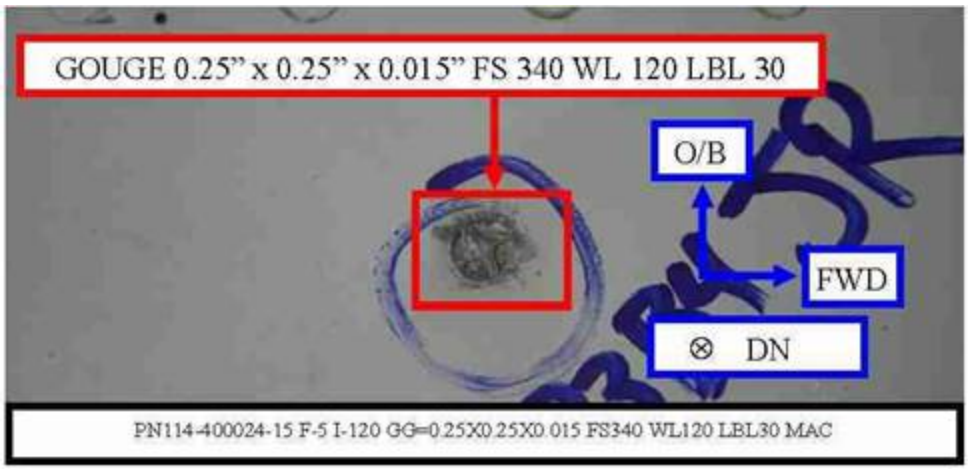


Figure 47. Gouge on Left Escape Hatch Frame—Macroscopic View

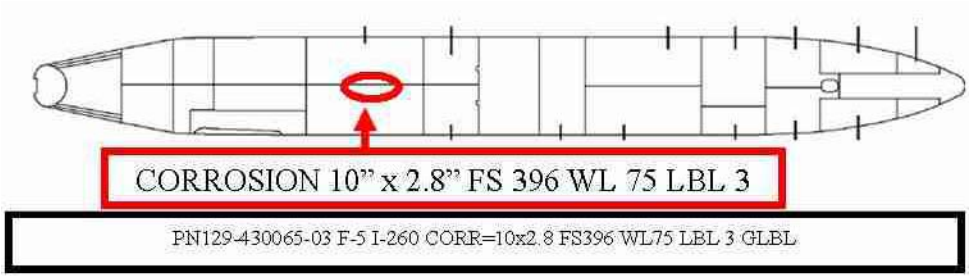


Figure 48. Corrosion on Antenna Surface—Global View (FS 396)

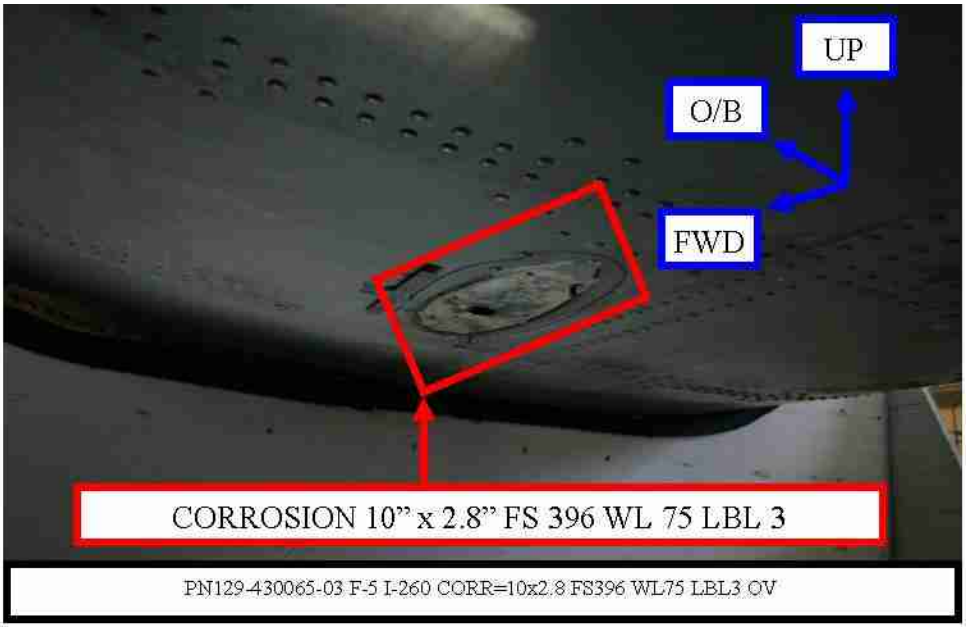


Figure 49. Corrosion on Antenna Surface—Overview (FS 396)

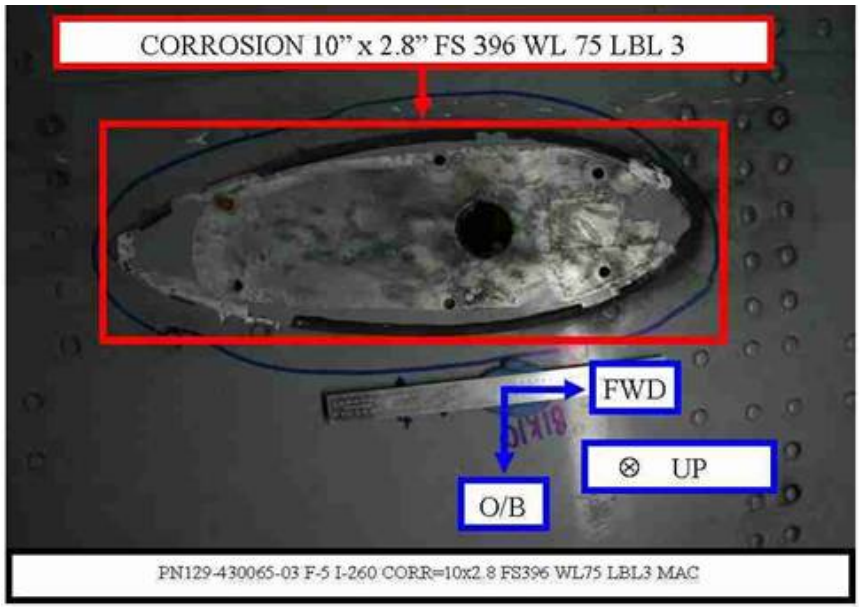


Figure 50. Corrosion on Antenna Surface—Macroscopic View (FS 396)

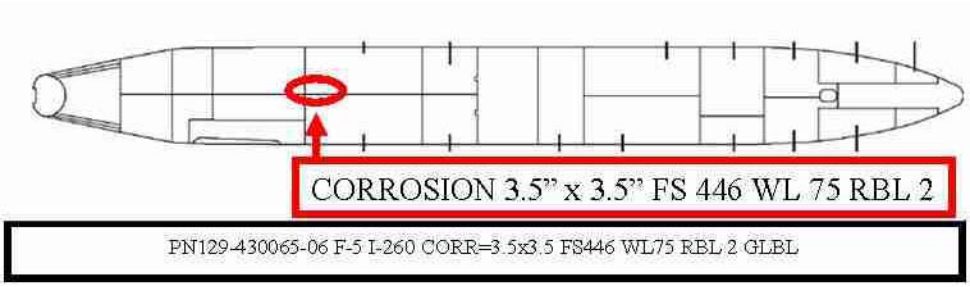


Figure 51. Corrosion on Antenna Surface—Global View (FS 446)

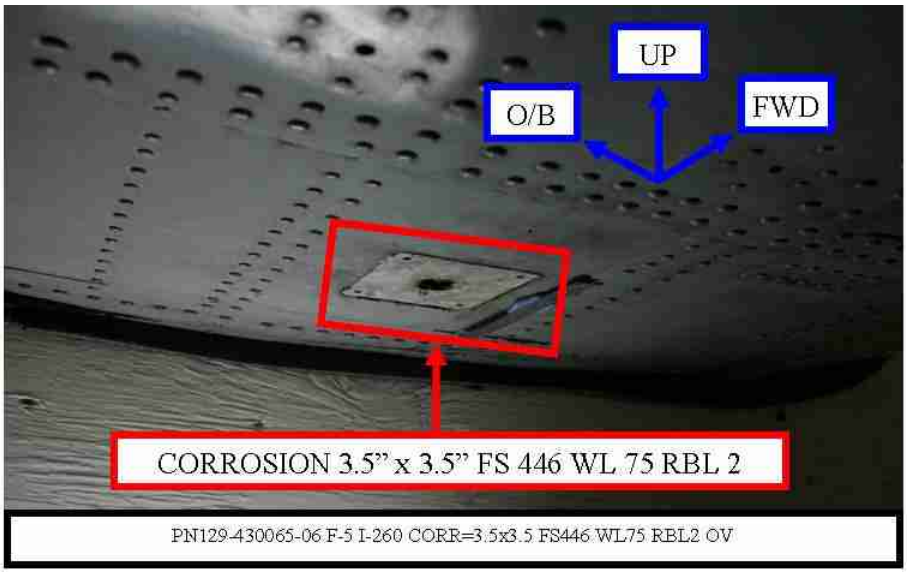


Figure 52. Corrosion on Antenna Surface—Overview (FS 446)

Figure 53. Corrosion on Antenna Surface—Macroscopic View (FS 446)

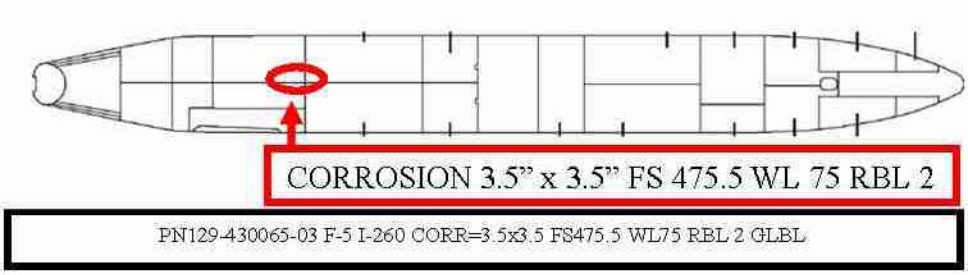


Figure 54. Corrosion on Antenna Surface—Global View (FS 475)

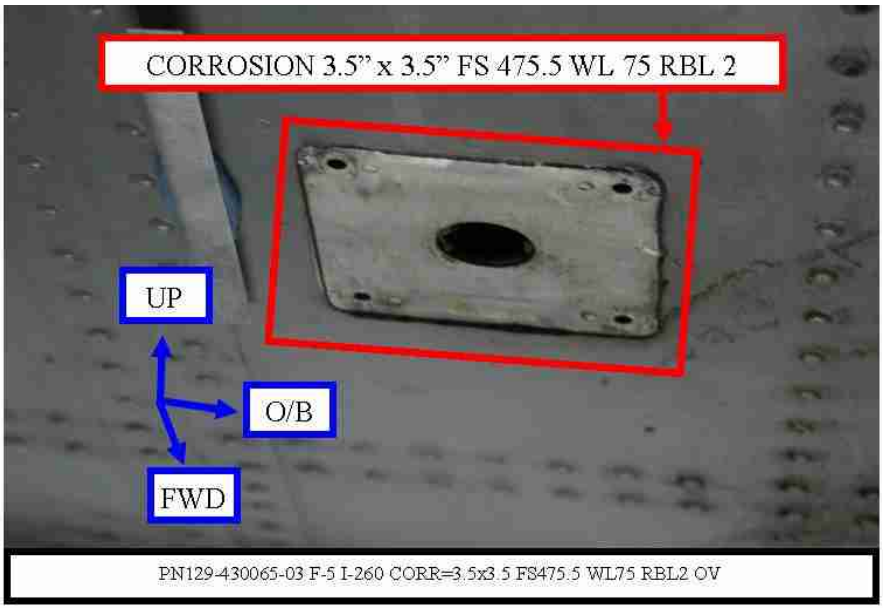


Figure 55. Corrosion on Antenna Surface—Overview (FS 475)

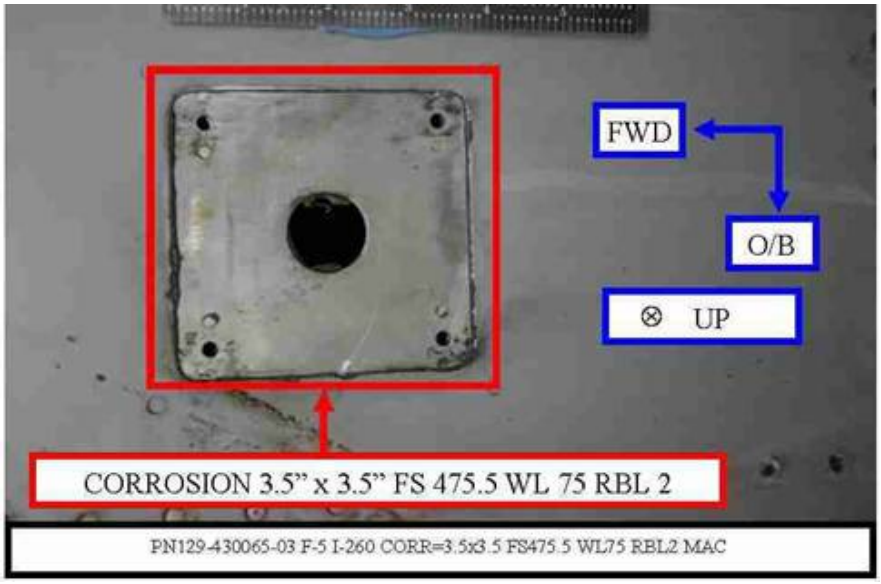


Figure 56. Corrosion on Antenna Surface—Macroscopic View (FS 475)

2.2.5 Visual Wing Inspection Results.

The general condition of the left, right, and center wing was evaluated through routine visual inspections using the Beechcraft 1900D SIM for guidance. Two licensed airframe inspectors performed 114 SIM inspections. The intent of these inspections was to find all possible visual defects normally discovered during routine inspections, then document the severity and location of each defect.

An independent inspector followed up each inspection performed. These inspections revealed 143 findings of which 14 were categorized as noteworthy (see table 13). A licensed airframe mechanic with inspection authorization to determine which findings were deemed noteworthy reviewed the results. Noteworthy findings are defined as defects or discrepancies that would require further maintenance action.

Table 13. Wings Predisassembly Visual Findings

Defect				Defect Location	Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	WS		
Crack	0.19			96	On Left Upper Nacelle Skin	Figure 57 Global Figure 58 Overview Figure 59 Macroscopic
Corr	6.00	2.00		118	Paint Bubbled Over Rivets	Figure 60 Global Figure 61 Overview Figure 62 Macroscopic
Corr	19.00	0.10		118	Corroded Along Skin Seam	Figure 63 Global Figure 64 Overview Figure 65 Macroscopic

Table 13. Wings Predisassembly Visual Findings (Continued)

Defect				Defect Location	Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	WS		
Corr	0.25	0.25		123.5	Corroded Rivet Head	Figure 66 Global Figure 67 Overview Figure 68 Macroscopic
Corr	0.4	0.4		124	Paint Bubbled Over Rivets	Figure 69 Global Figure 70 Overview Figure 71 Macroscopic
Corr	0.50	0.35		126	Paint Bubbled Over Rivets	Figure 72 Global Figure 73 Overview Figure 74 Macroscopic
Corr	0.20	0.20		131	Paint Bubbled Over Rivets	Figure 75 Global Figure 76 Overview Figure 77 Macroscopic
Corr	8.00	0.15		140	Corroded Along Skin Seam	Figure 78 Global Figure 79 Overview Figure 80 Macroscopic
Corr	31.5	0.60		158	Corroded Along Skin Seam	Figure 81 Global Figure 82 Overview Figure 83 Macroscopic
Wear	0.60	0.10	0.002	160	Multiple Wear Marks	Figure 84 Global Figure 85 Overview Figure 86 Macroscopic
Corr	16.50	0.30		191	Corroded Along Skin Seam	Figure 87 Global Figure 88 Overview Figure 89 Macroscopic
Gouge	1.50	1.50	0.004	208	Gouge	Figure 90 Global Figure 91Overview Figure 92 Macroscopic
Gouge	2.00	0.125	0.002	278	Gouge	Figure 93 Global Figure 94 Overview Figure 95 Macroscopic
Crack	0.60			326.93	On Right Outboard Wing Rib	Figure 96 Global Figure 97 Overview Figure 98 Macroscopic

WS = Wing station

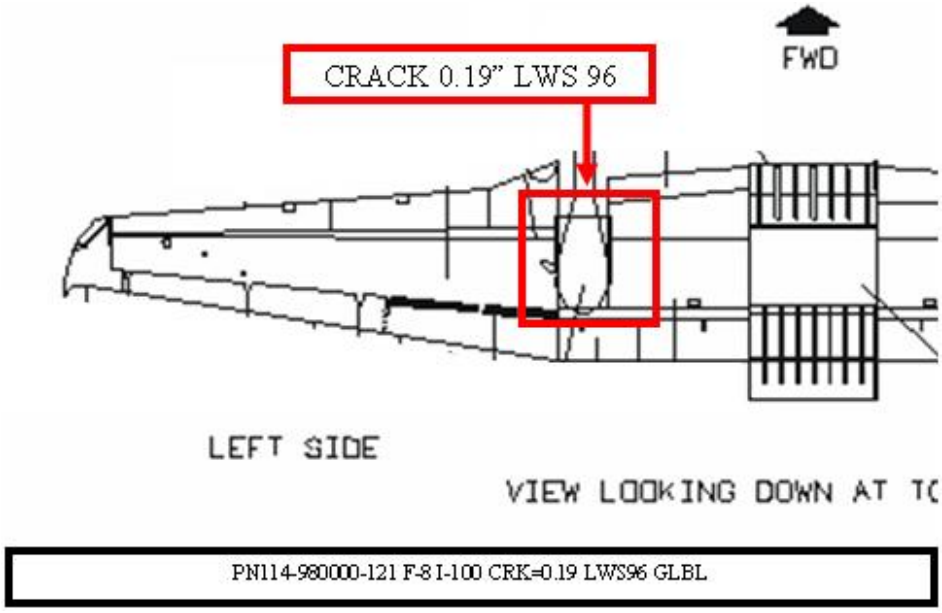


Figure 57. Crack on Left Upper Nacelle Skin—Global View

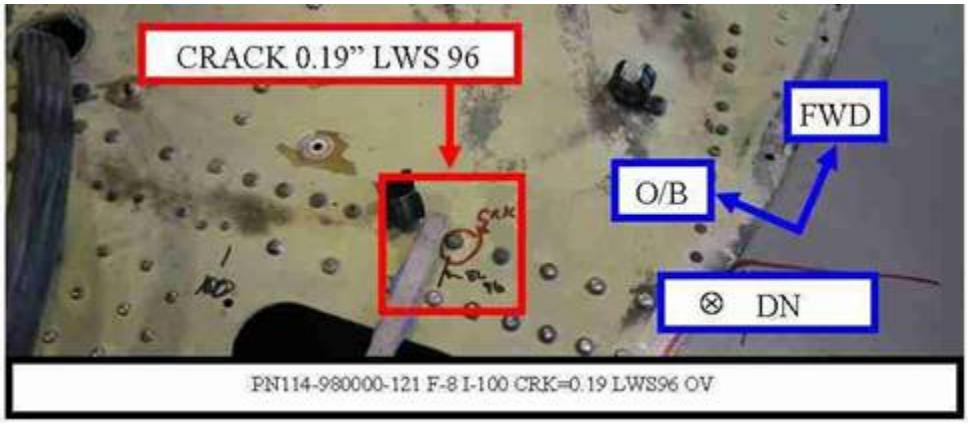


Figure 58. Crack on Left Upper Nacelle Skin—Overview

Figure 59. Crack on Left Upper Nacelle Skin—Macroscopic View

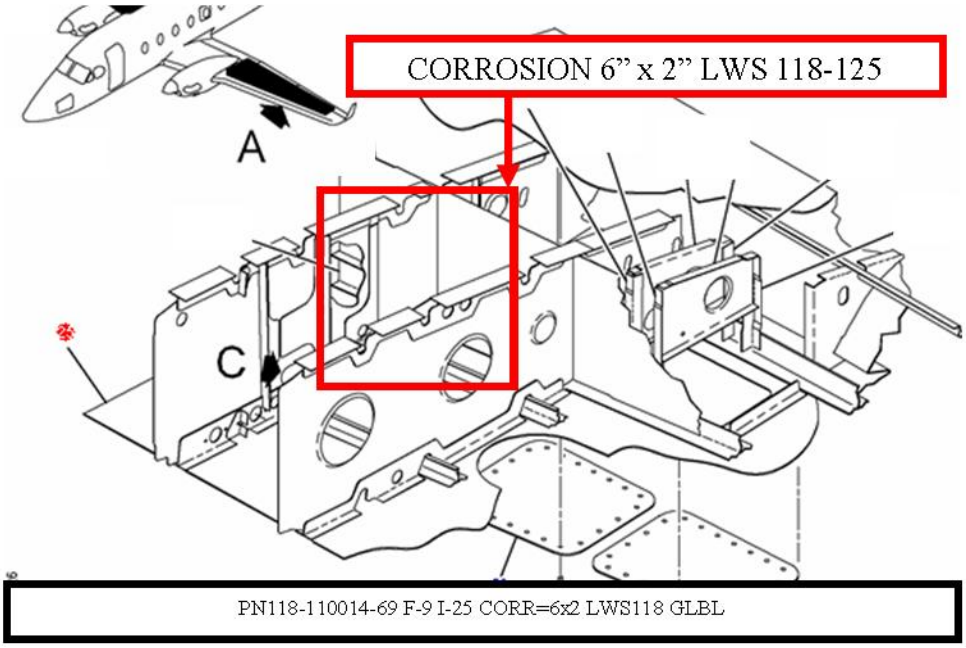


Figure 60. Corrosion on Left Lower Wing Skin—Global View (LWS 118-125)

Figure 61. Corrosion on Left Lower Wing Skin—Overview (LWS 118-125)

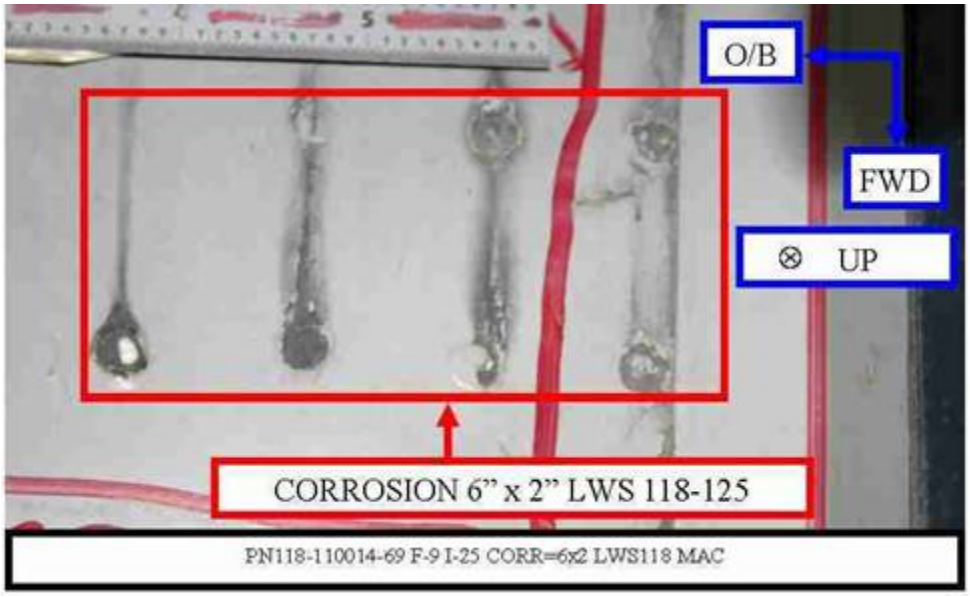


Figure 62. Corrosion on Left Lower Wing Skin—Macroscopic View (LWS118-125)

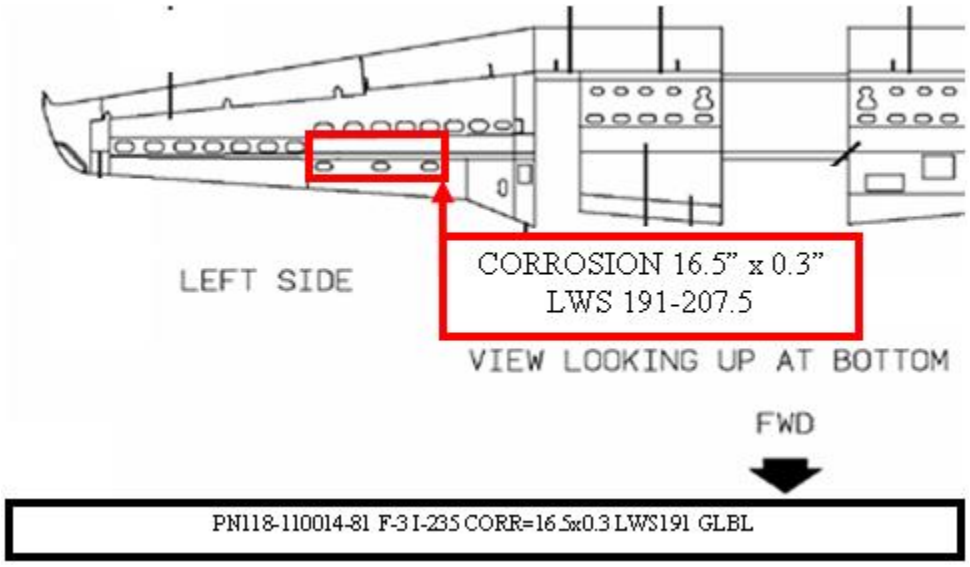


Figure 63. Corrosion on Left Lower Wing Skin Seam—Global View (LWS 191-207.5)

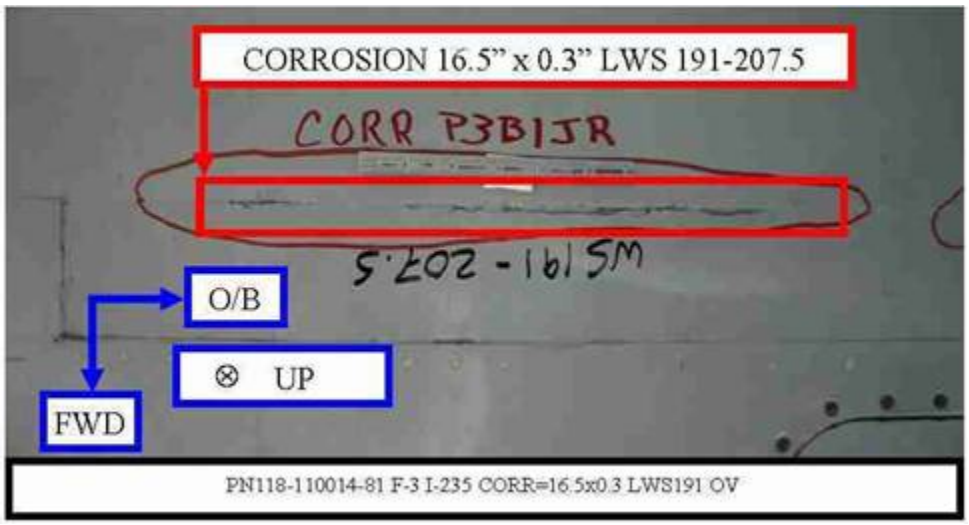


Figure 64. Corrosion on Left Lower Wing Skin Seam—Overview (LWS 191-207.5)

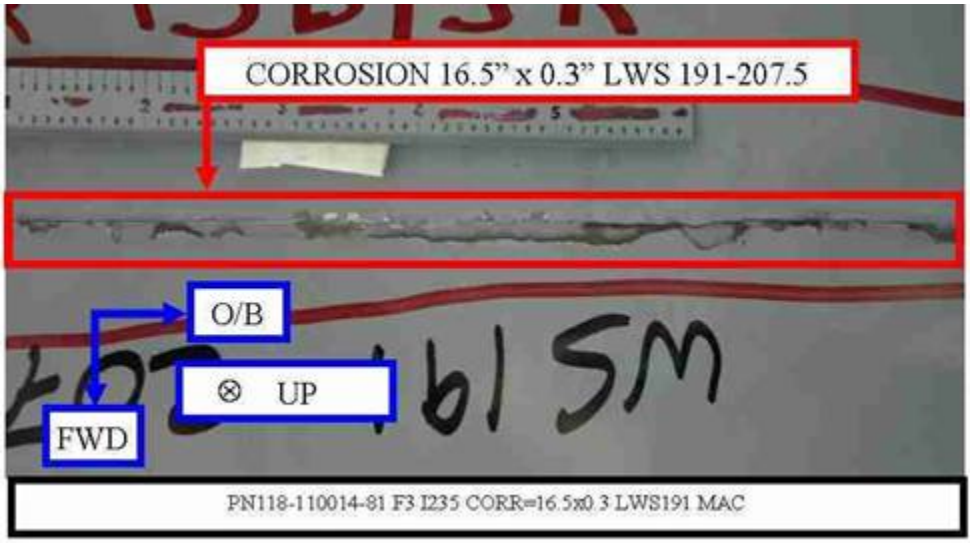


Figure 65. Corrosion on Left Lower Wing Skin Seam—Macroscopic View (LWS 191-207.5)

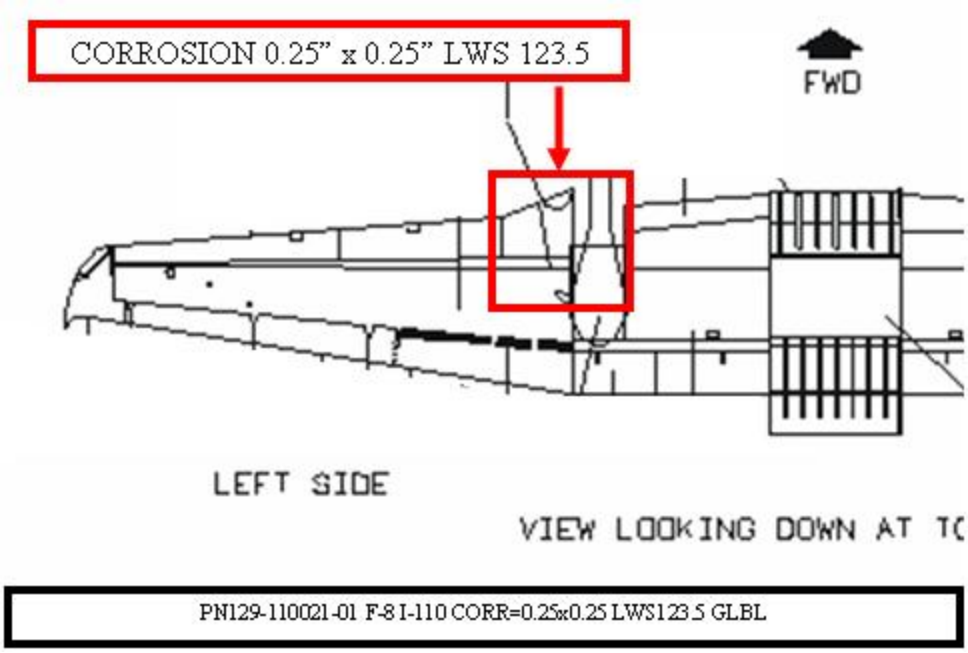


Figure 66. Corrosion on Left Wing Upper Skin Fastener—Global View

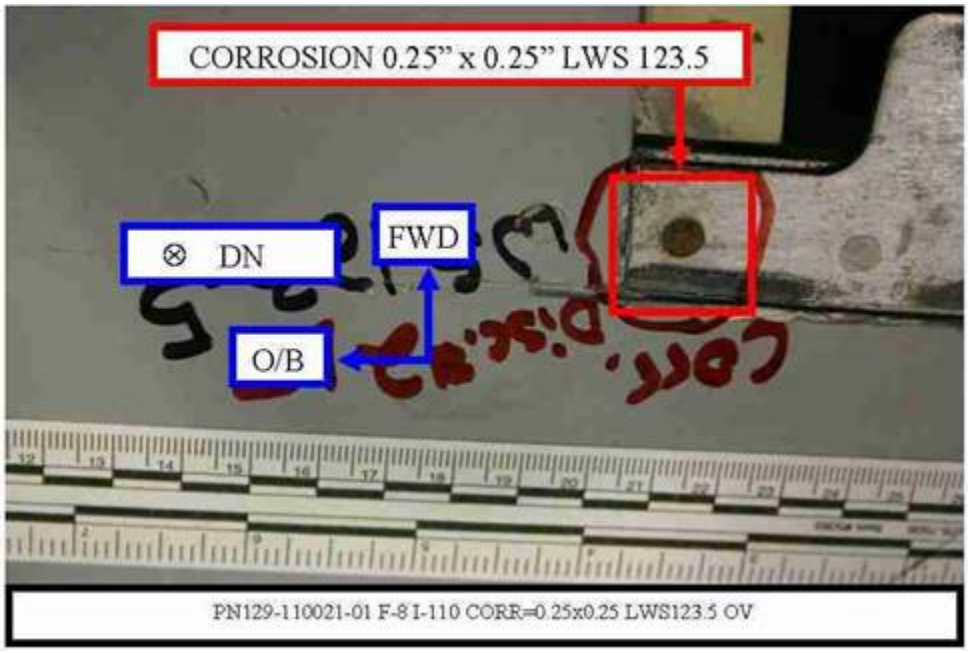


Figure 67. Corrosion on Left Wing Upper Skin Fastener—Overview

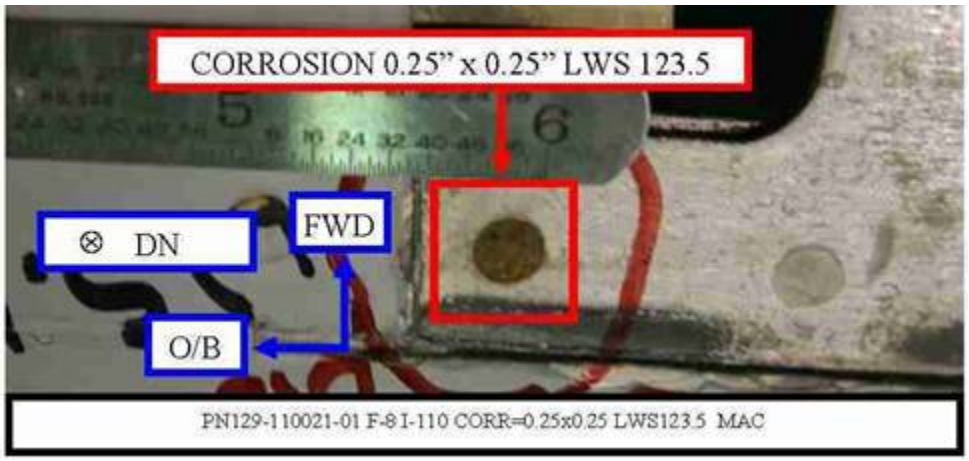


Figure 68. Corrosion on Left Wing Upper Skin Fastener—Macroscopic View

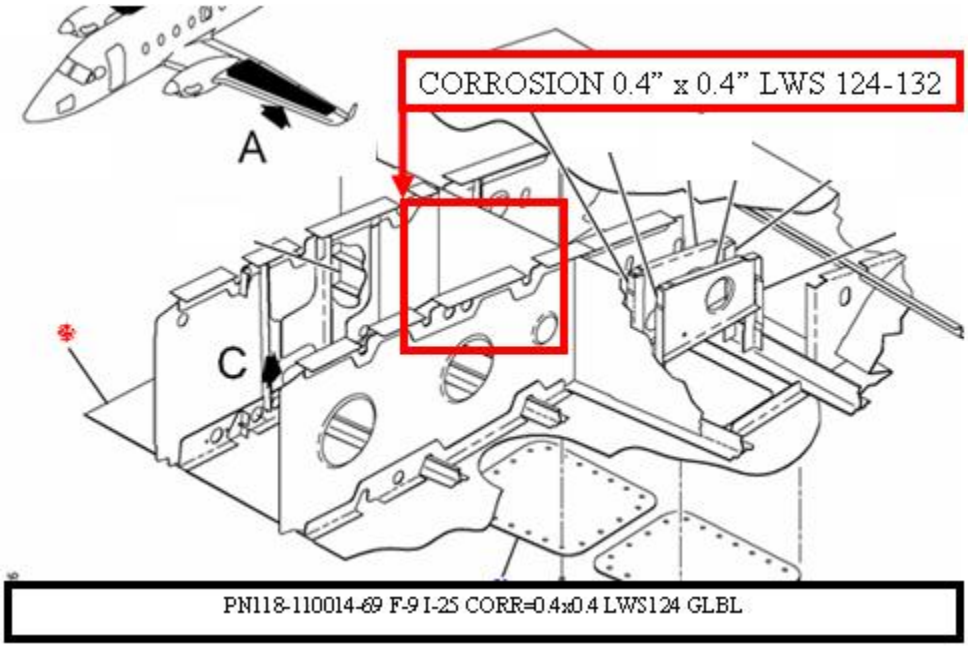


Figure 69. Corrosion on Left Lower Wing Skin—Global View (LWS 124-132)

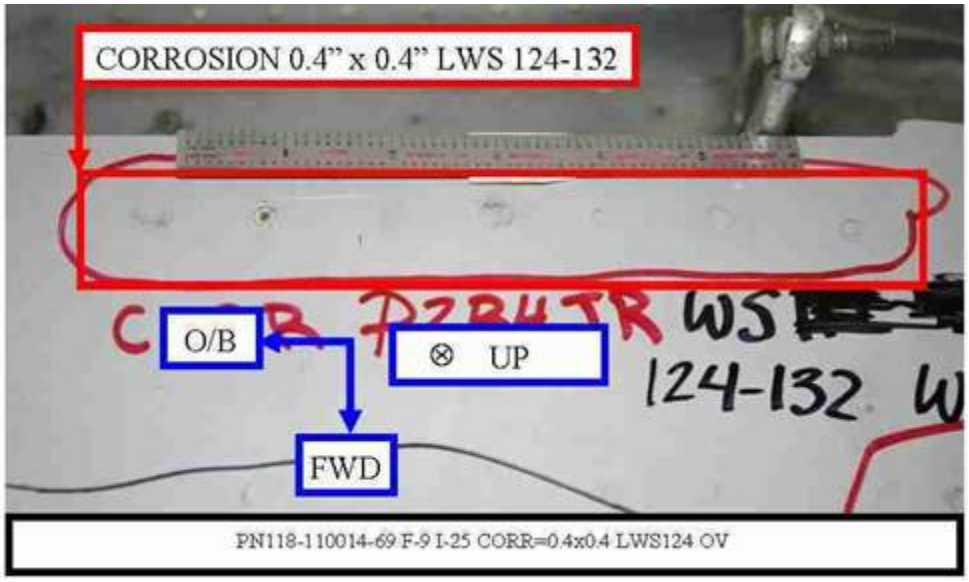


Figure 70. Corrosion on Left Lower Wing Skin—Overview (LWS 124-132)

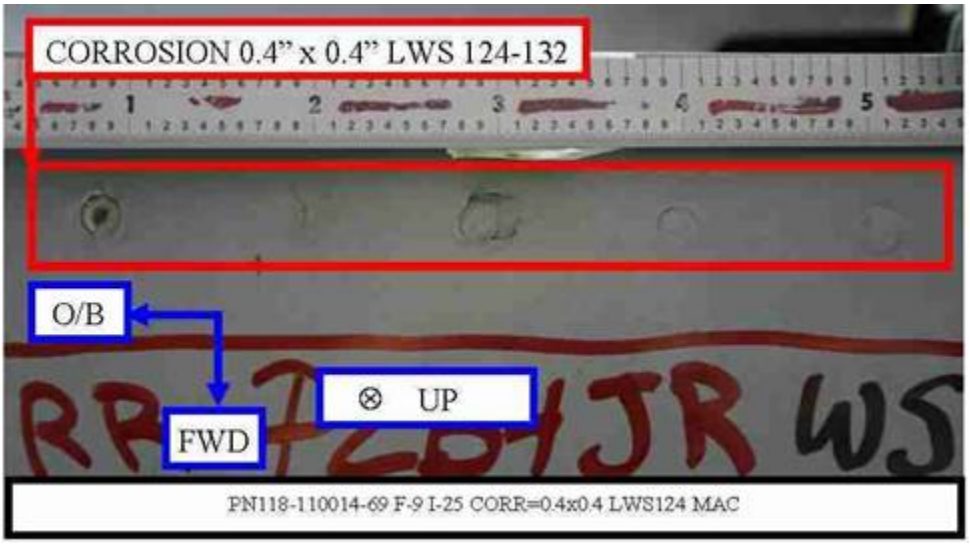


Figure 71. Corrosion on Left Lower Wing Skin—Macroscopic View (LWS 124-132)

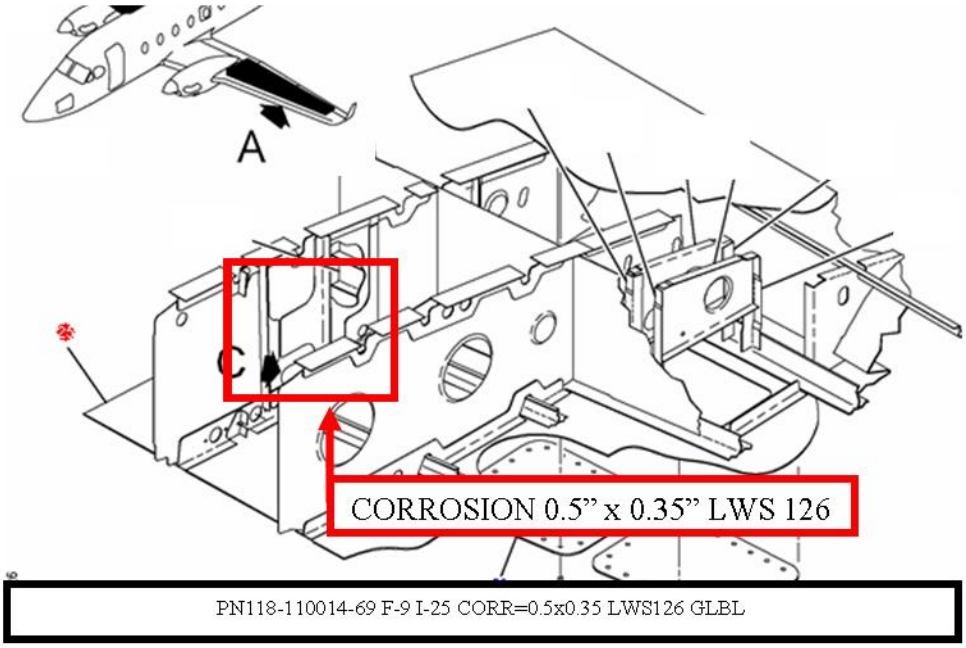


Figure 72. Corrosion on Left Lower Wing Skin—Global View (LWS 126)

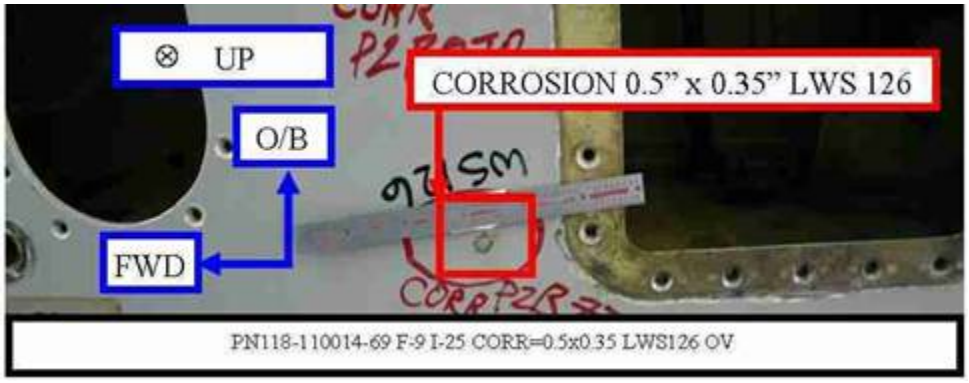


Figure 73. Corrosion on Left Lower Wing Skin—Overview (LWS 126)

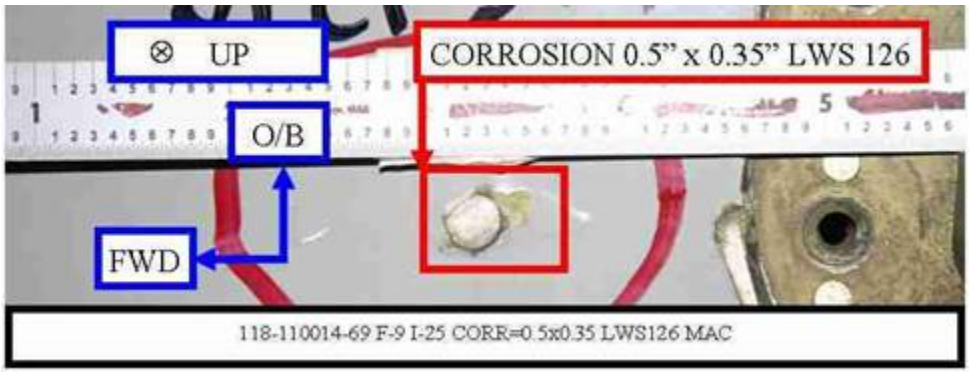


Figure 74. Corrosion on Left Lower Wing Skin—Macroscopic View (LWS 126)

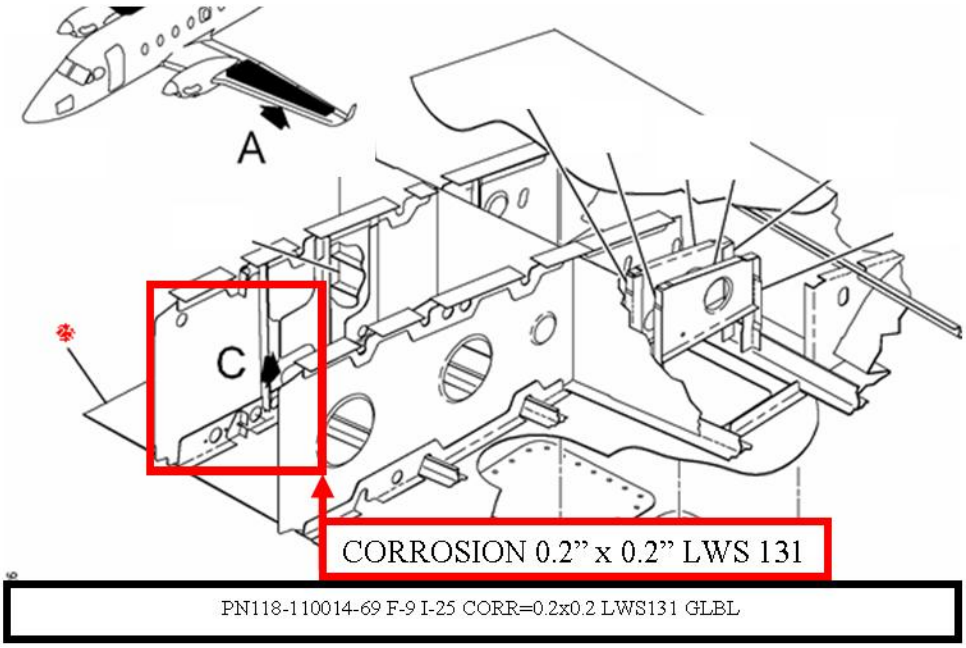


Figure 75. Corrosion on Left Lower Wing Skin—Global View (LWS 131)

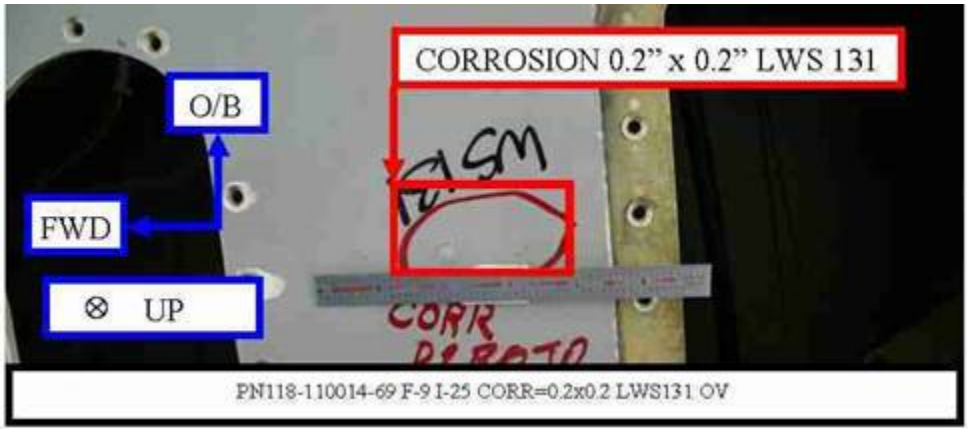


Figure 76. Corrosion on Left Lower Wing Skin—Overview (LWS 131)

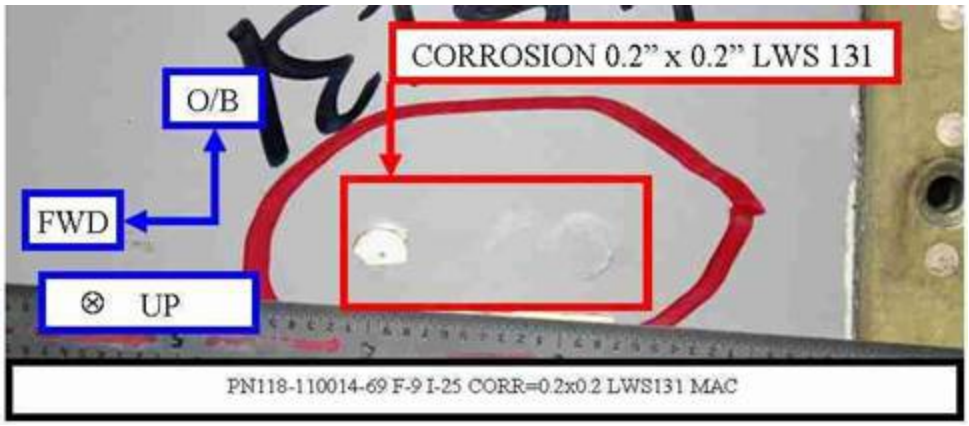


Figure 77. Corrosion on Left Lower Wing Skin—Macroscopic View (LWS 131)

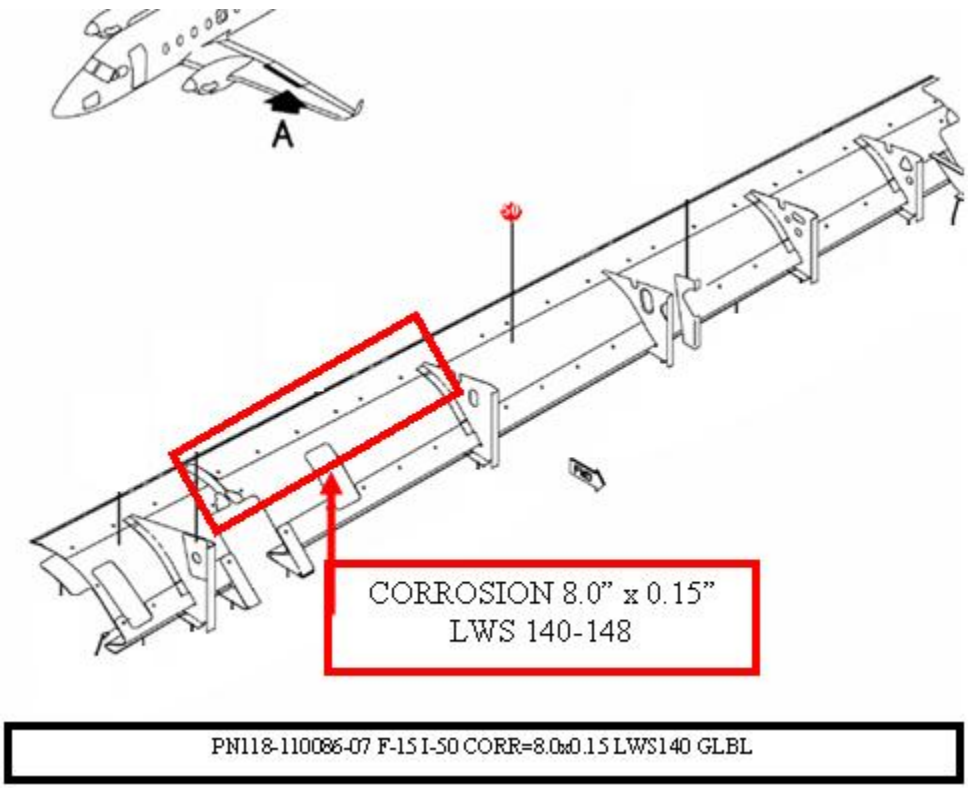


Figure 78. Corrosion on Left Outboard Flap Cover—Global View

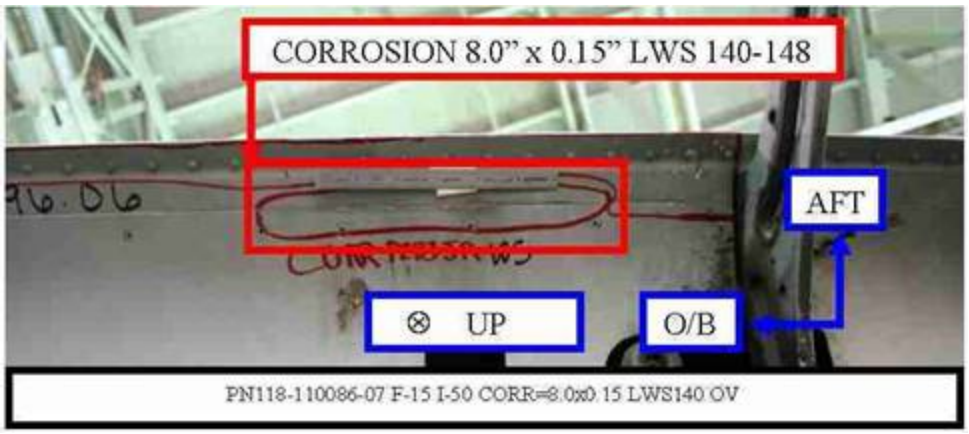


Figure 79. Corrosion on Left Outboard Flap Cover—Overview

Figure 80. Corrosion on Left Outboard Flap Cover—Macroscopic View

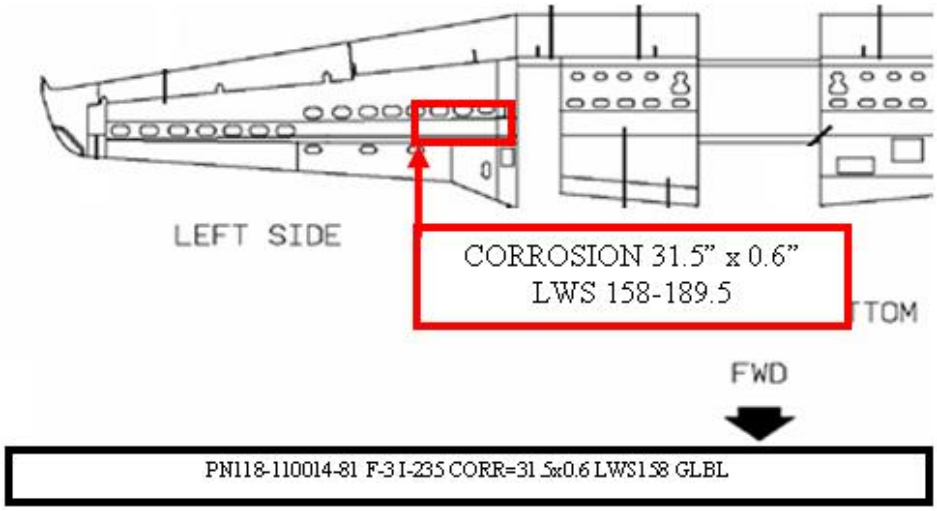


Figure 81. Corrosion on Left Lower Wing Skin Seam—Global View (LWS 158-189.5)

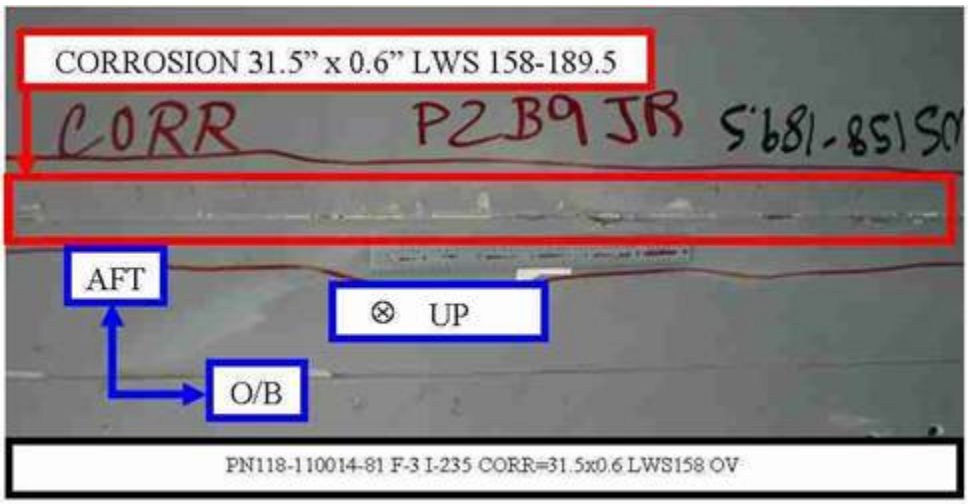


Figure 82. Corrosion on Left Lower Wing Skin Seam—Overview (LWS 158-189.5)

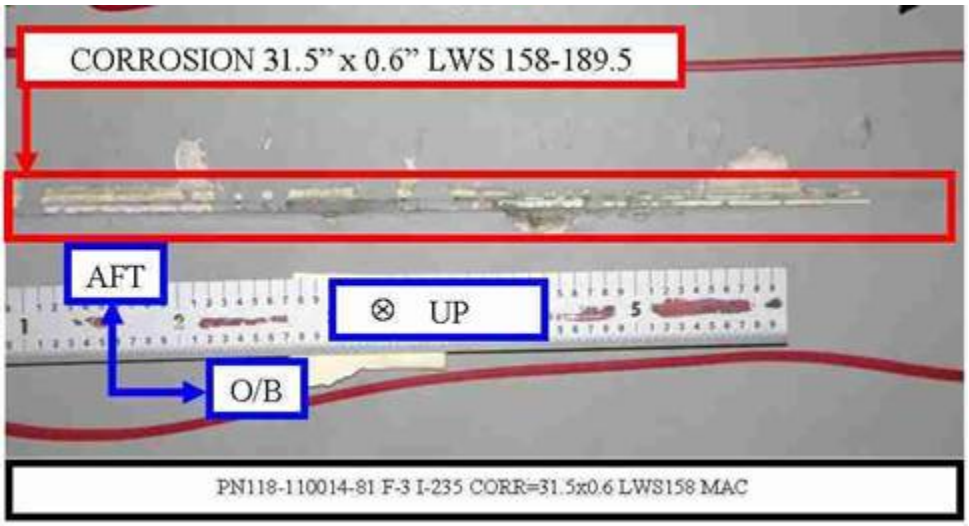


Figure 83. Corrosion on Left Lower Wing Skin Seam—Macroscopic View (LWS 158-189.5)

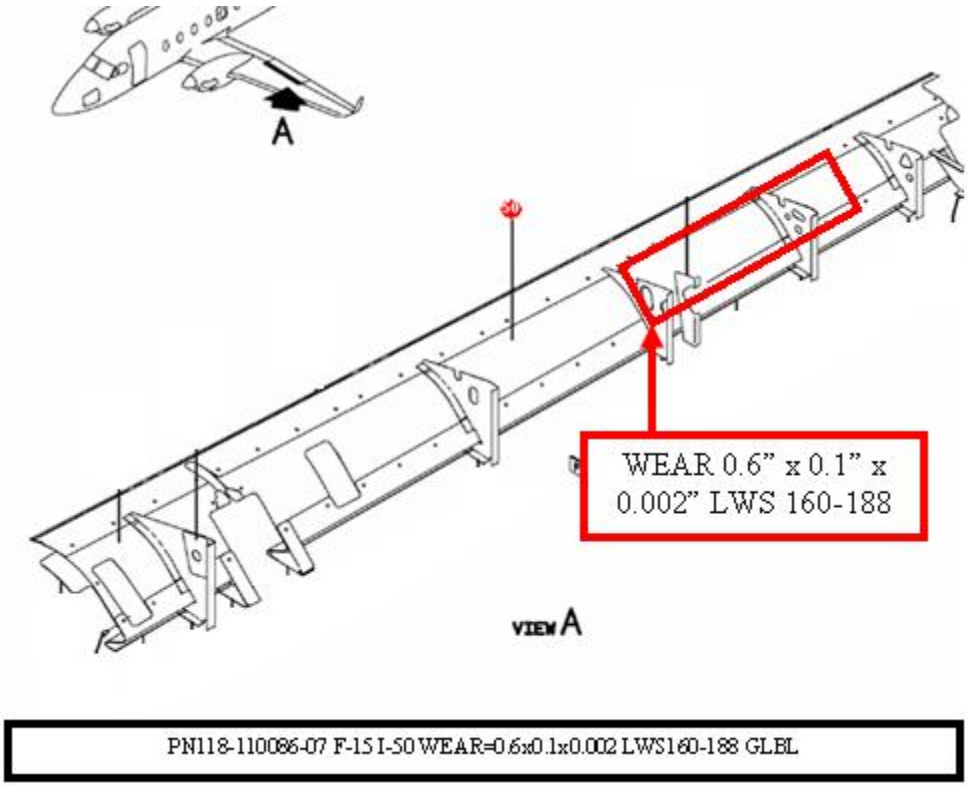


Figure 84. Multiple Wear on Left Outboard Flap Cover—Global View

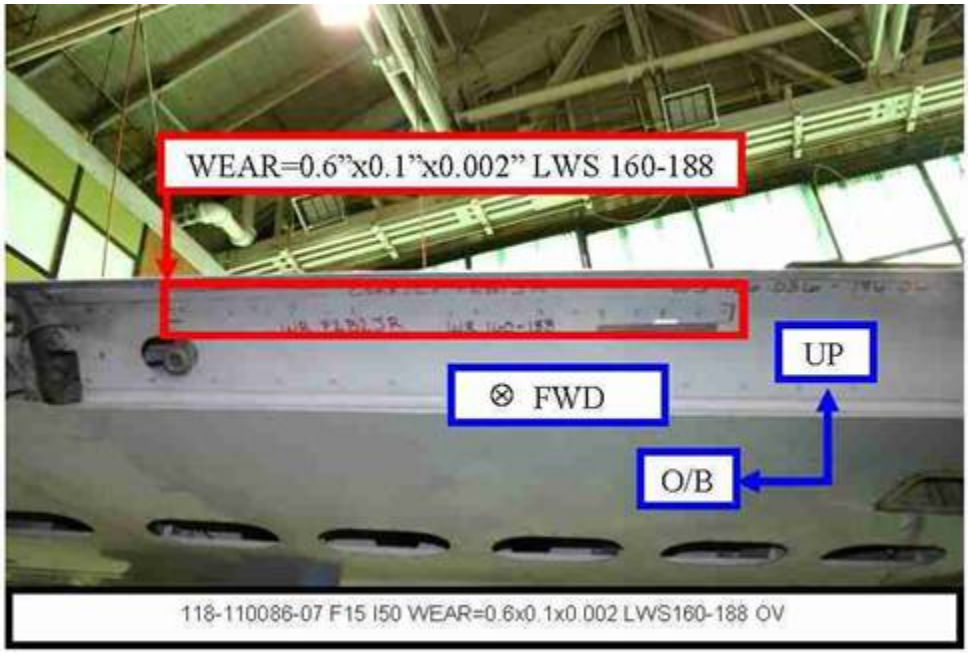


Figure 85. Multiple Wear on Left Outboard Flap Cover—Overview

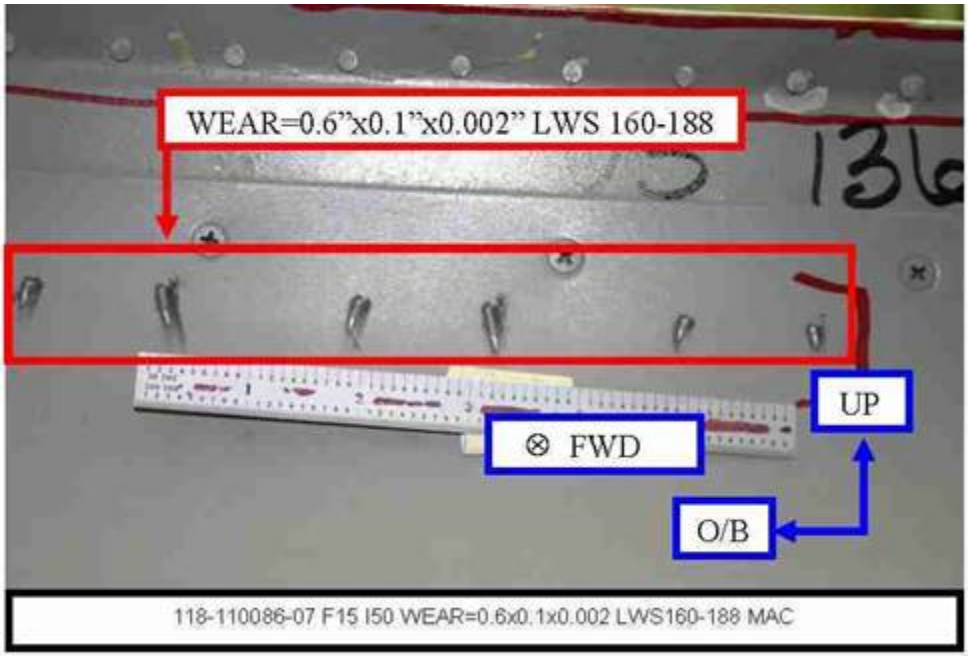


Figure 86. Multiple Wear on Left Outboard Flap Cover—Macroscopic View

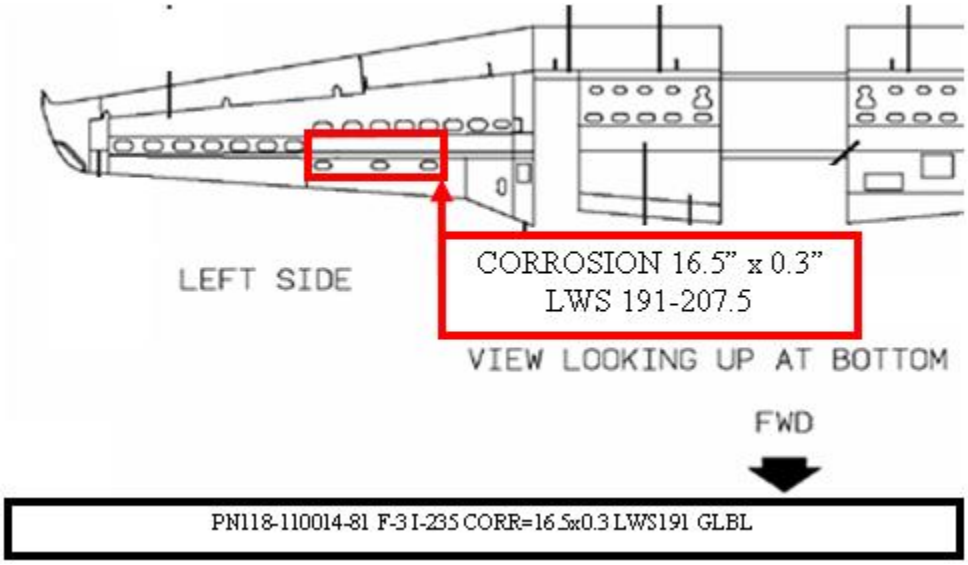


Figure 87. Corrosion on Left Lower Wing Skin Seam—Global View (LWS 191-207.5)

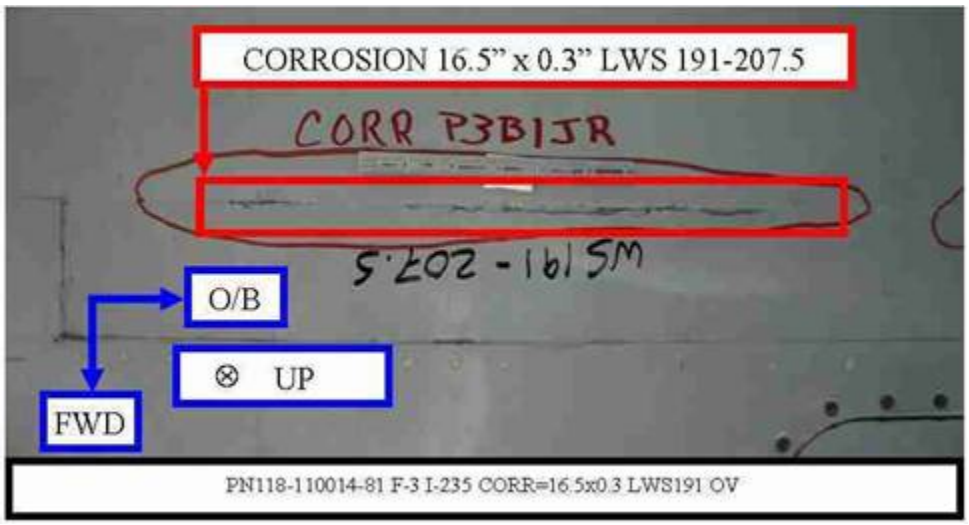


Figure 88. Corrosion on Left Lower Wing Skin Seam—Overview (LWS 191-207.5)

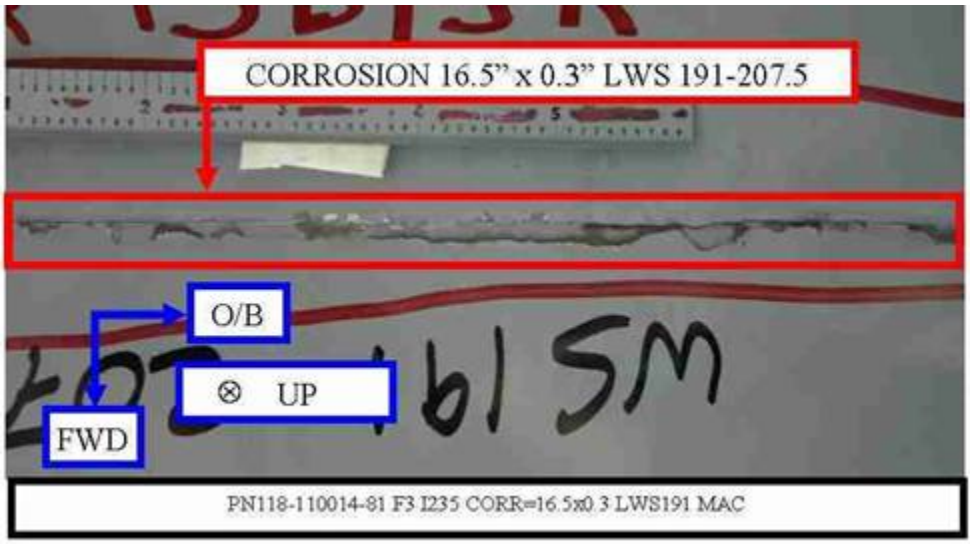


Figure 89. Corrosion on Left Lower Wing Skin Seam—Macroscopic View (LWS 191-207.5)

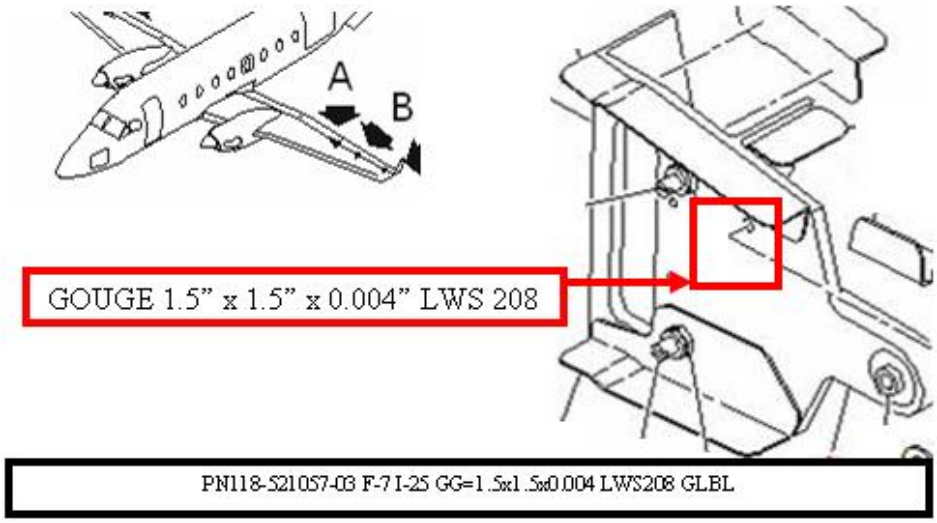


Figure 90. Gouge on Left Inboard Aileron Hinge—Global View

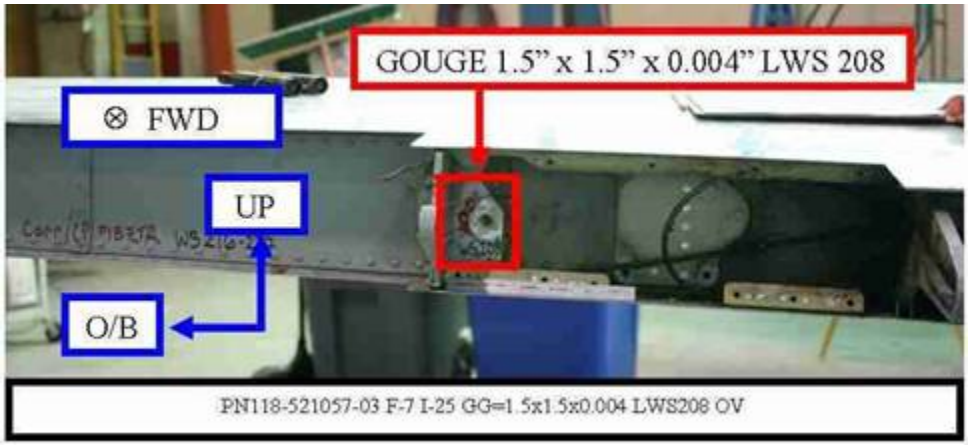


Figure 91. Gouge on Left Inboard Aileron Hinge—Overview

Figure 92. Gouge on Left Inboard Aileron Hinge—Macroscopic View

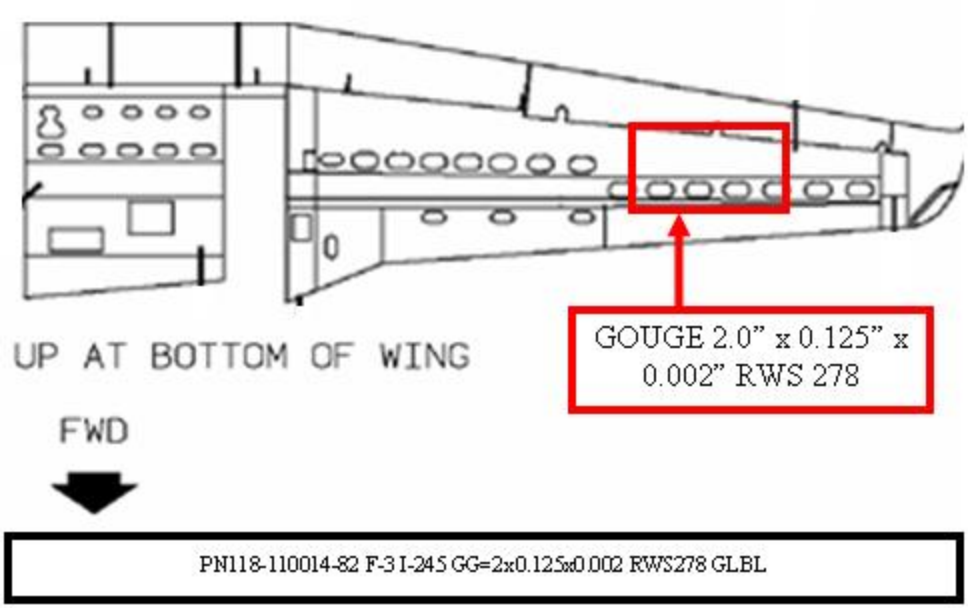


Figure 93. Gouge on Right Lower Outboard Wing Skin—Global View

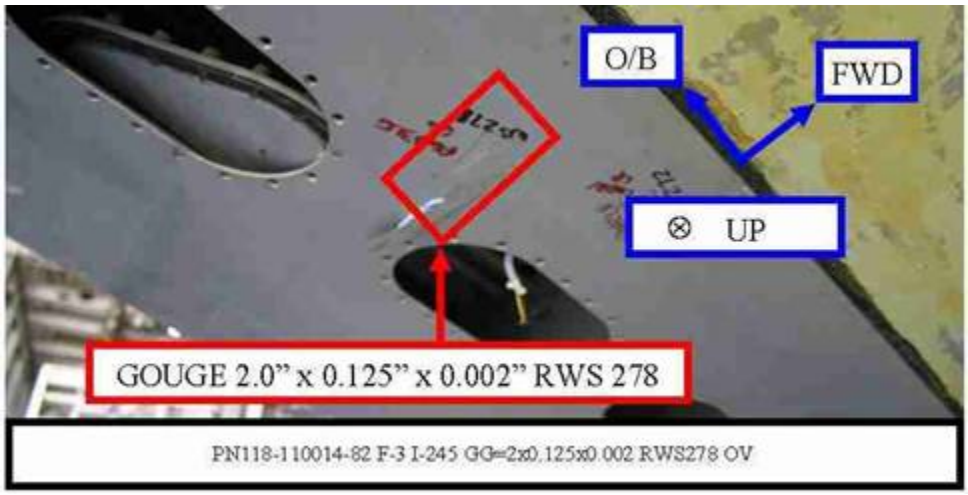


Figure 94. Gouge on Right Lower Outboard Wing Skin—Overview

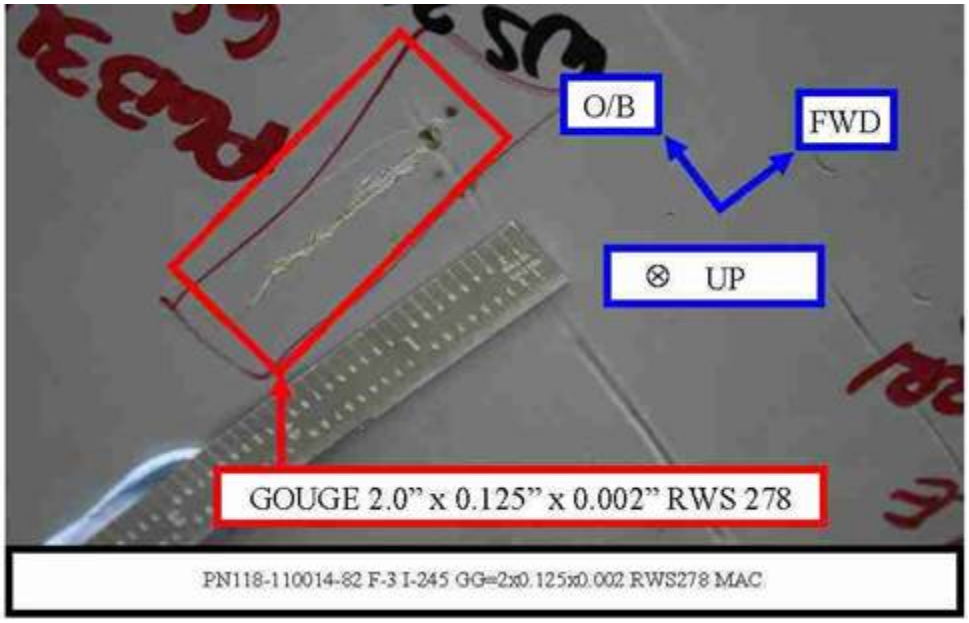


Figure 95. Gouge on Right Lower Outboard Wing Skin—Macroscopic View

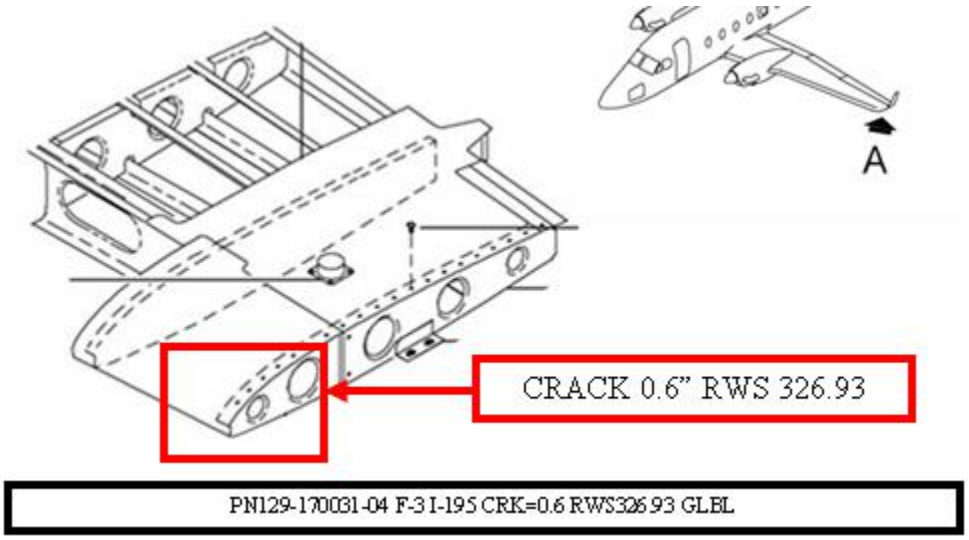


Figure 96. Crack on Right Outboard Wing Rib—Global View

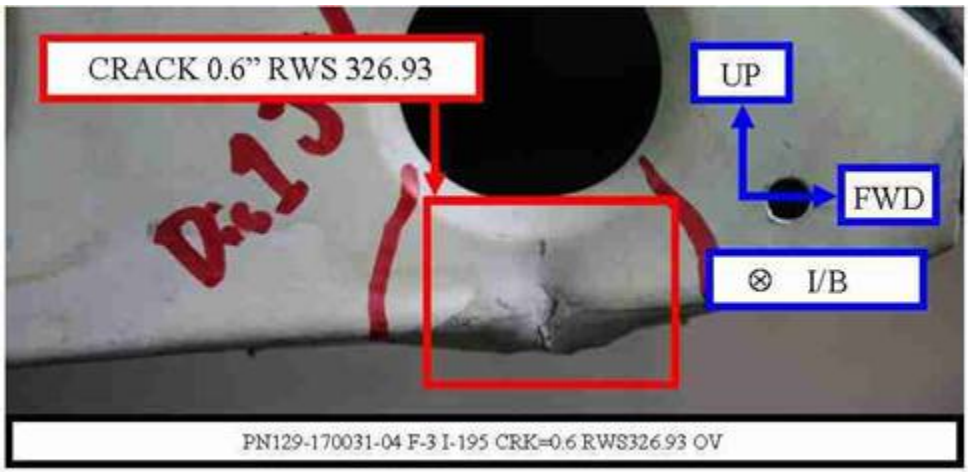


Figure 97. Crack on Right Outboard Wing Rib—Overview

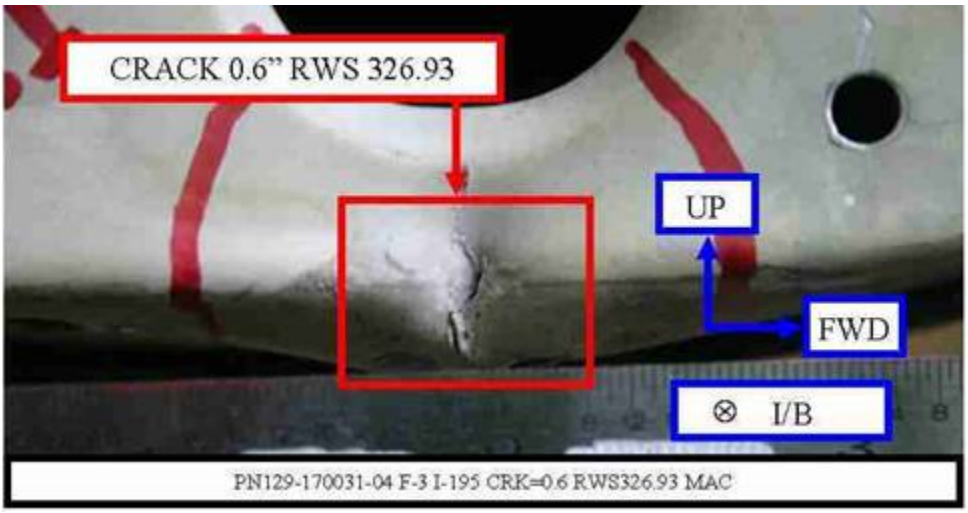


Figure 98. Crack on Right Outboard Wing Rib—Macroscopic View

2.2.6 Visual Horizontal and Vertical Stabilizer Inspection Results.

The general condition of the horizontal and vertical stabilizer were both evaluated through routine visual inspections using the Beechcraft 1900D SIM and Beechcraft 1900D Maintenance Manual for guidance. Two licensed inspectors performed 42 inspections. The intent of these inspections was to find all possible visual defects normally discovered during routine inspections, then document each defect severity and location. An independent inspector followed up each inspection performed. A total of 24 findings were documented and of these 16 were determined as noteworthy (see table 14 and figures 99 through 115 for tail horizontal stabilizer findings and table 15 and figures 116 through 145 for tail vertical stabilizer findings). A licensed airframe mechanic with inspection authorization to determine which findings were deemed noteworthy also reviewed these results. Noteworthy findings are defined as defects or discrepancies that would require further maintenance action.

Table 14. Tail Horizontal Stabilizer Predisassembly Visual Findings

Defect				Defect Location		Defect Description	Defect Figure
Type	L (inches)	W (inches)	D (inches)	FS	HSS		
Wear	22.0	1.50		642	7.5L	Wear on Left Horizontal Stabilizer	Figure 99 Global Figure 100 Overview Figure 101 Macroscopic
Wear	0.7	0.6	0.002	644.5	7.5L	Wear Under Fastener	Figure 102 Global Figure 103 Overview Figure 104 Macroscopic
Gouge	1.2	0.05	0.005	662.0	8.5R	During Disassembly	Figure 105 Global Figure 106 Overview Figure 107 Macroscopic
Corr	7.0	2.50		669.5	92.45R	Right Leading Edge	Figure 108 Global Figure 109 Overview Figure 110 Macroscopic
Corr	0.6	0.60		670.	82R	Galvanic Corrosion	Figure 111 Global Figure 112 Overview Figure 113 Macroscopic
Crack	0.3	0.10	Through crack	679.3	110R	#40 Drill Start—Mouth of Crack Outboard on Wing Tip Common to Static Wick	Figure 114 Global Figure 115 Macroscopic

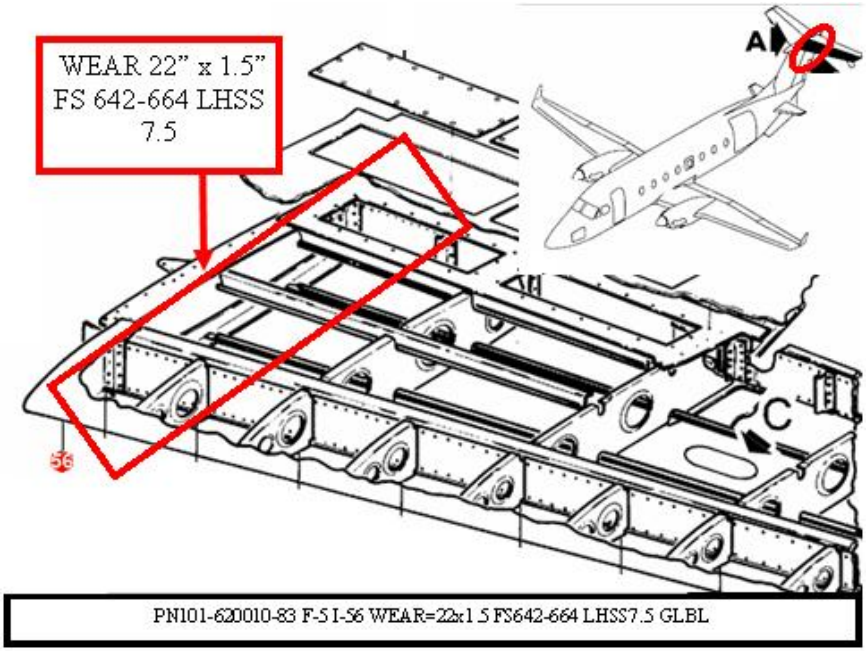


Figure 99. Wear on Left Horizontal Stabilizer—Global View (FS 642-664)

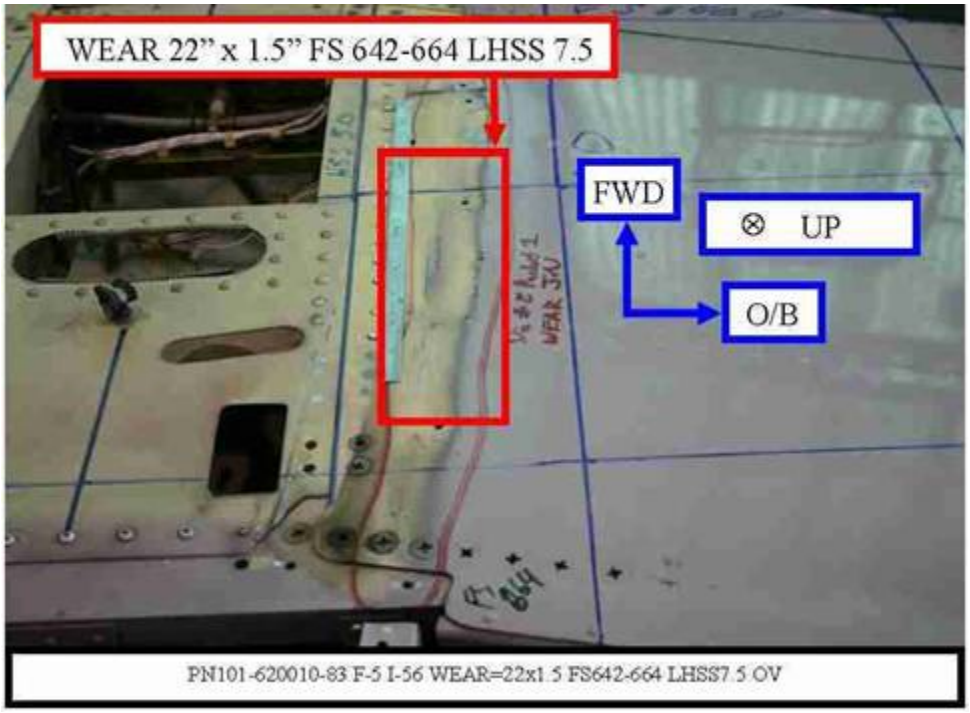


Figure 100. Wear on Left Horizontal Stabilizer—Overview (FS 642-664)

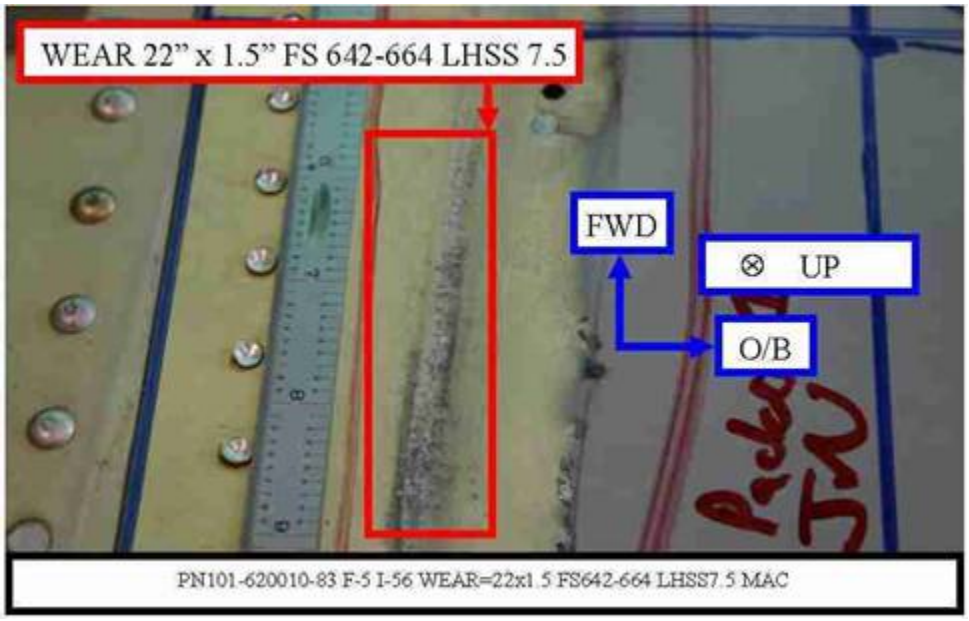


Figure 101. Wear on Left Horizontal Stabilizer—Macroscopic View (FS 642-664)

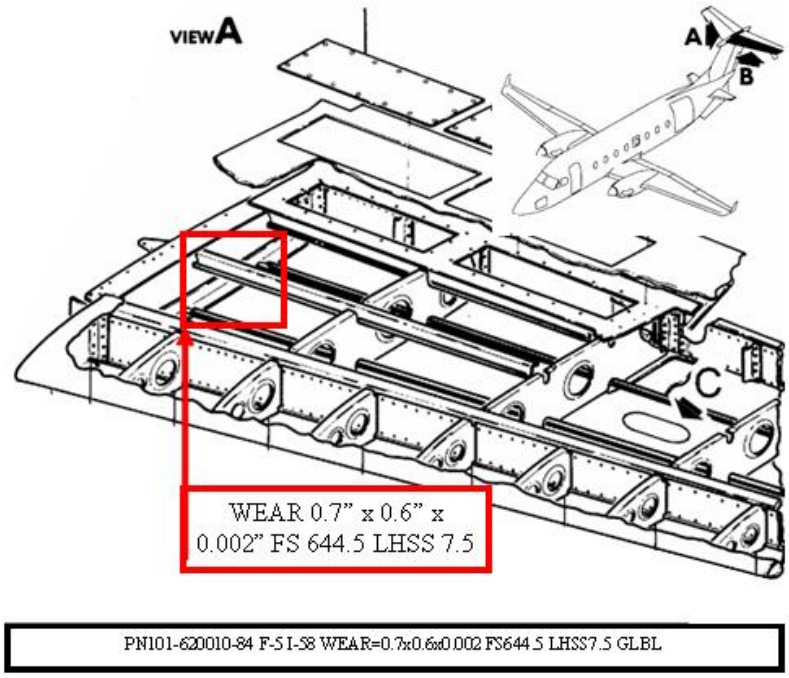


Figure 102. Wear on Left Horizontal Stabilizer—Global View (FS 644.5)

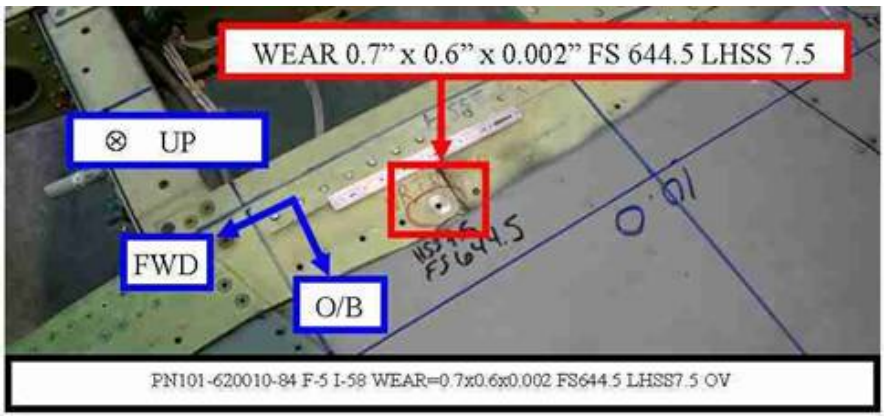


Figure 103. Wear on Left Horizontal Stabilizer—Overview (FS 644.5)

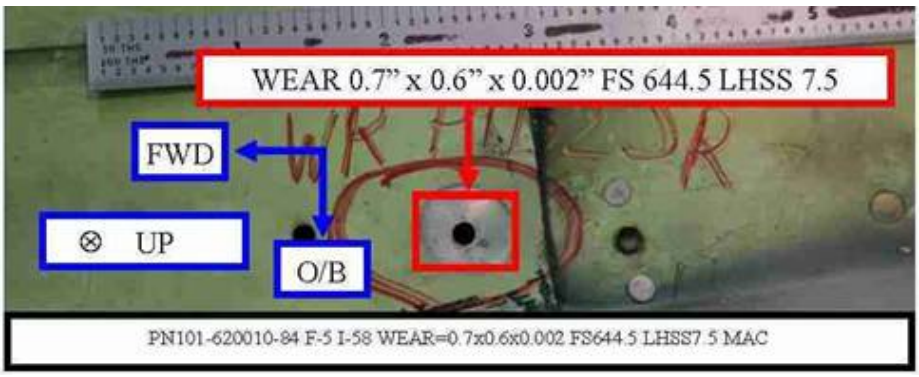


Figure 104. Wear on Left Horizontal Stabilizer—Macroscopic View (FS 644.5)

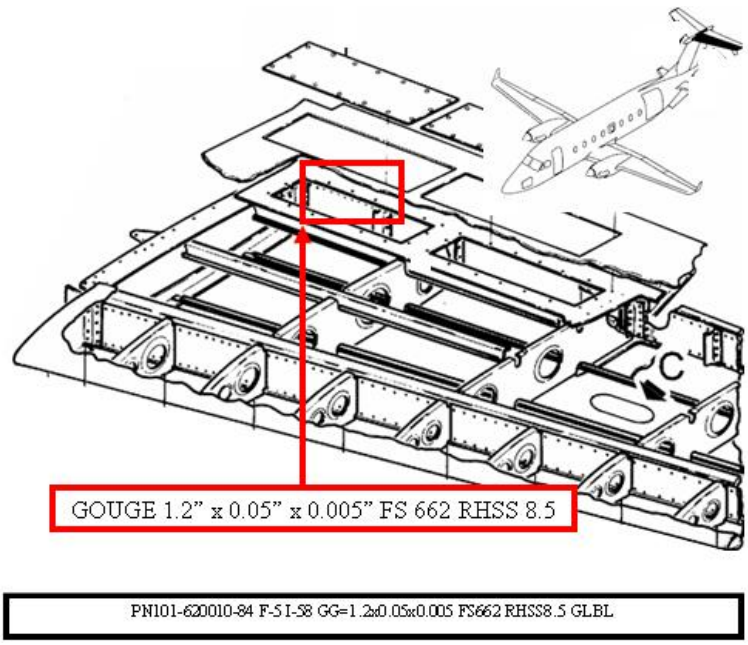


Figure 105. Gouge on Right Horizontal Stabilizer—Global View

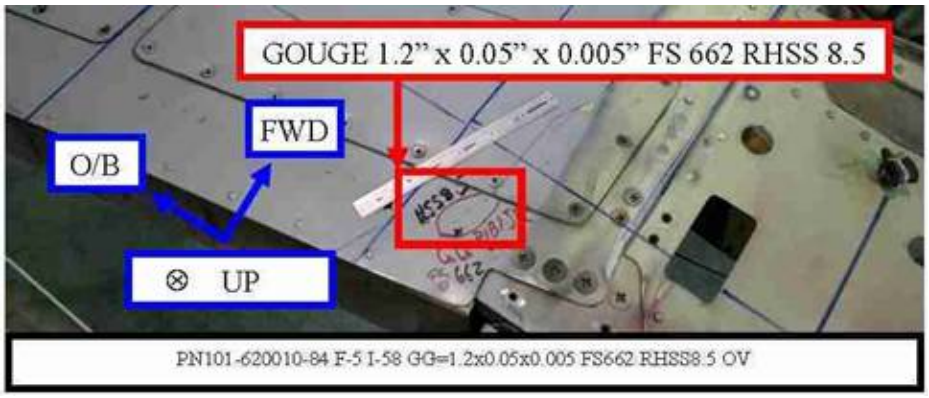


Figure 106. Gouge on Right Horizontal Stabilizer—Overview

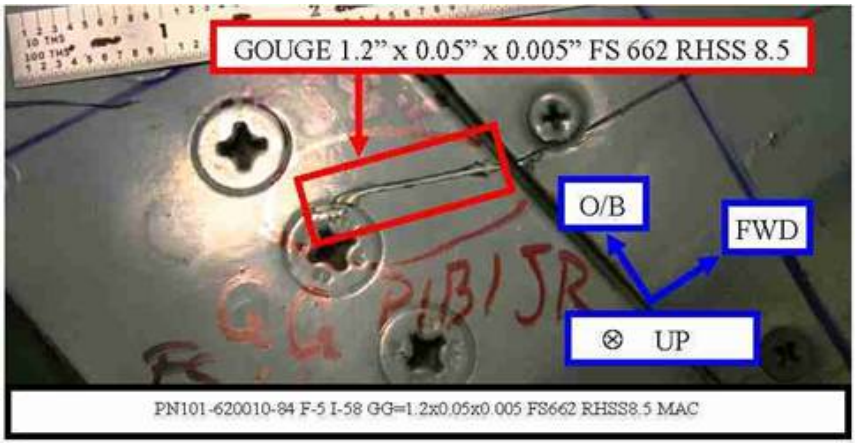


Figure 107. Gouge on Right Horizontal Stabilizer—Macroscopic View

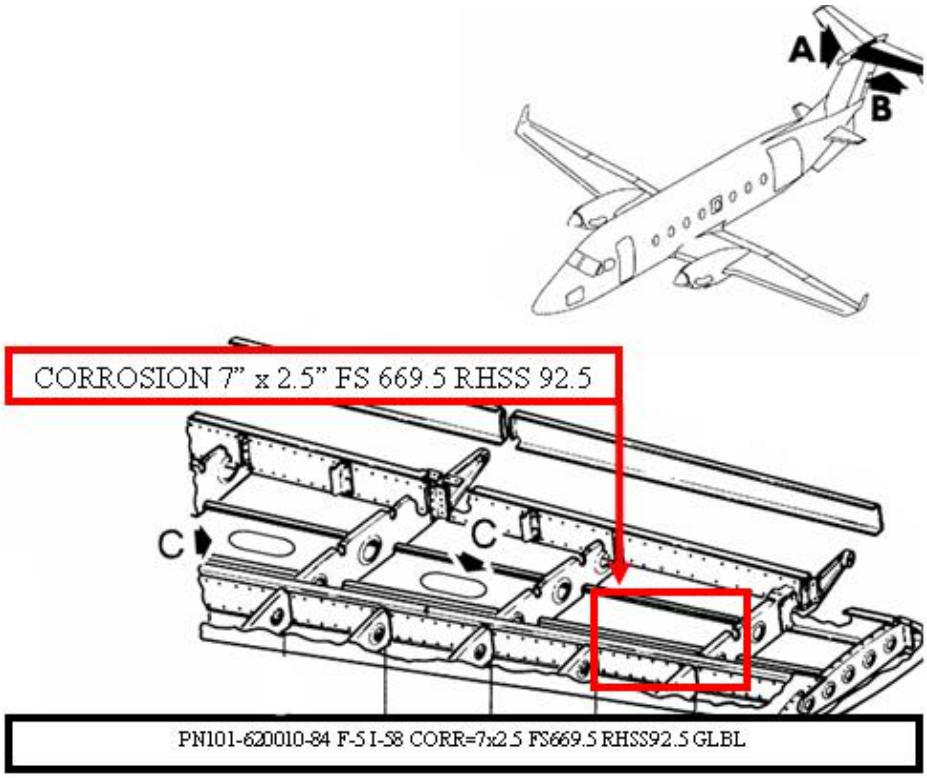


Figure 108. Corrosion on Right Leading Edge—Global View

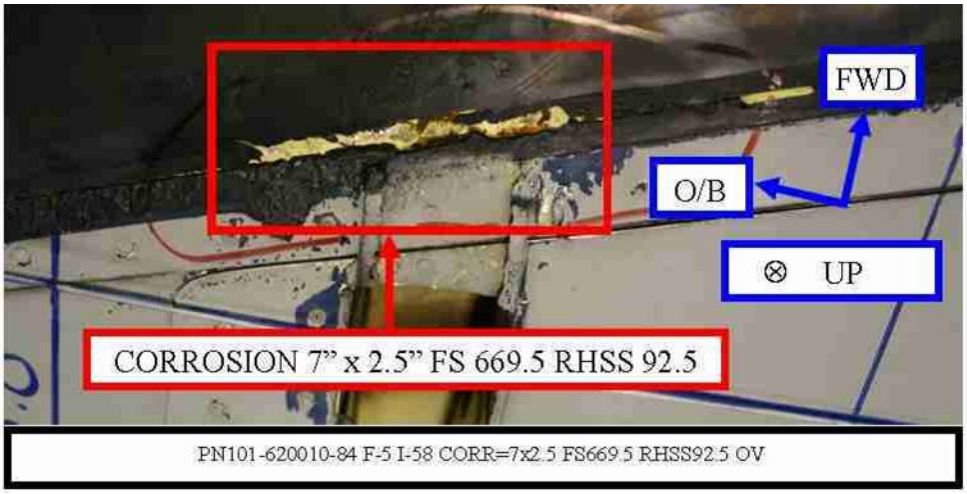


Figure 109. Corrosion on Right Leading Edge—Overview

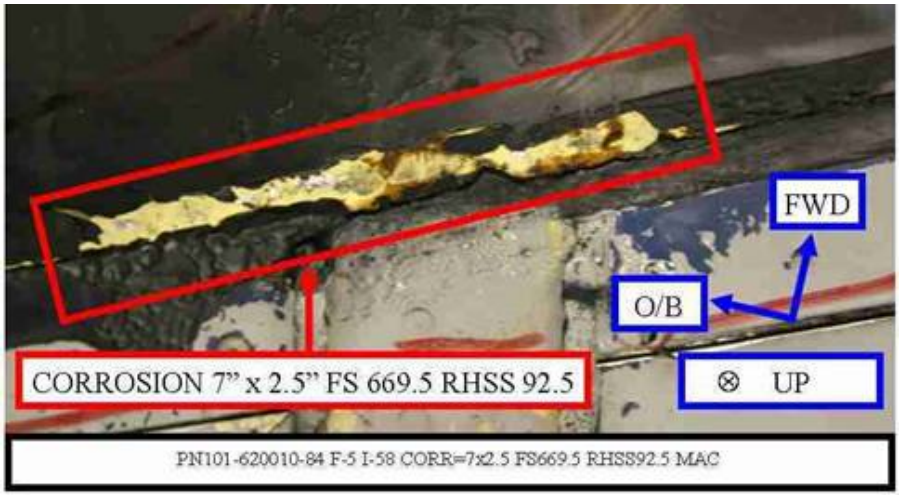


Figure 110. Corrosion on Right Leading Edge—Macroscopic View

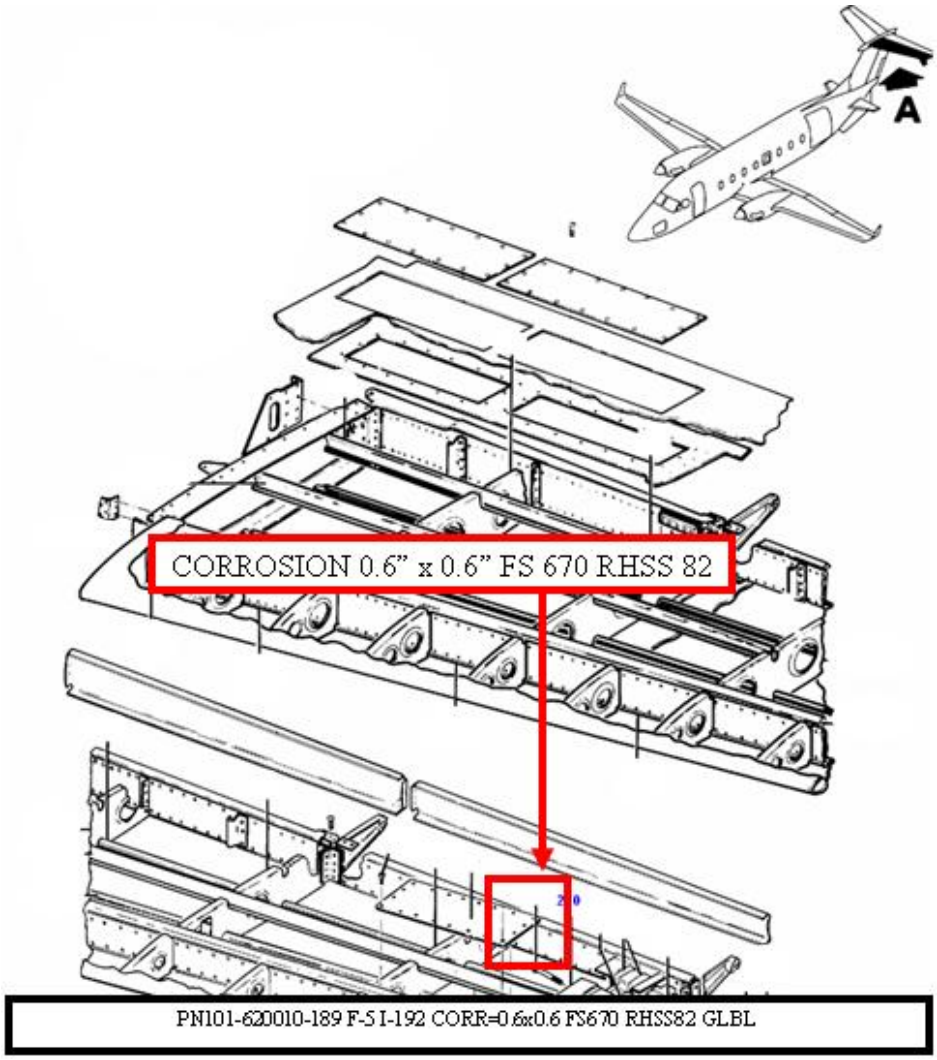


Figure 111. Corrosion on Right Horizontal Stabilizer—Global View

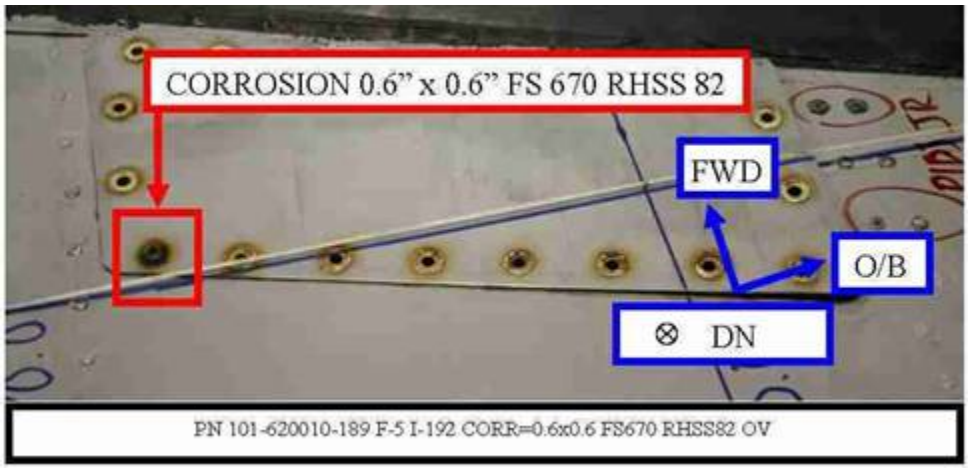


Figure 112. Corrosion on Right Horizontal Stabilizer—Overview

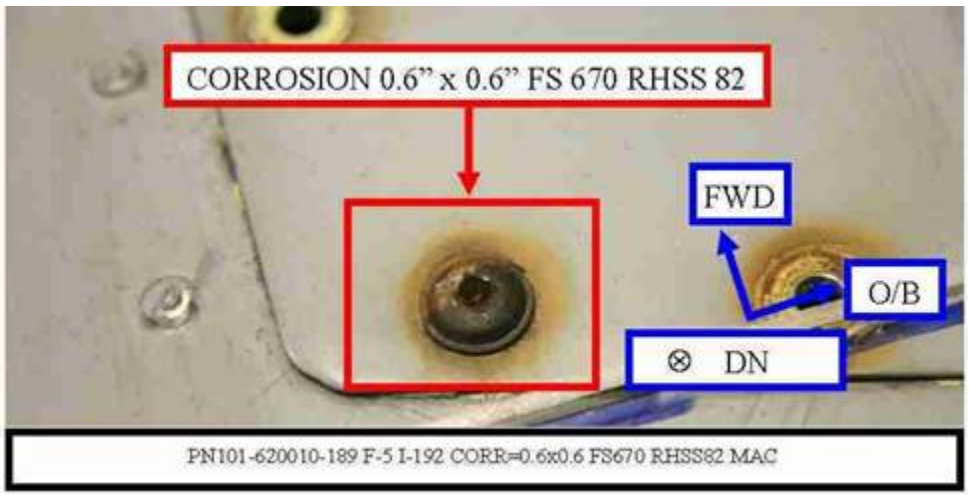


Figure 113. Corrosion on Right Horizontal Stabilizer—Macroscopic View

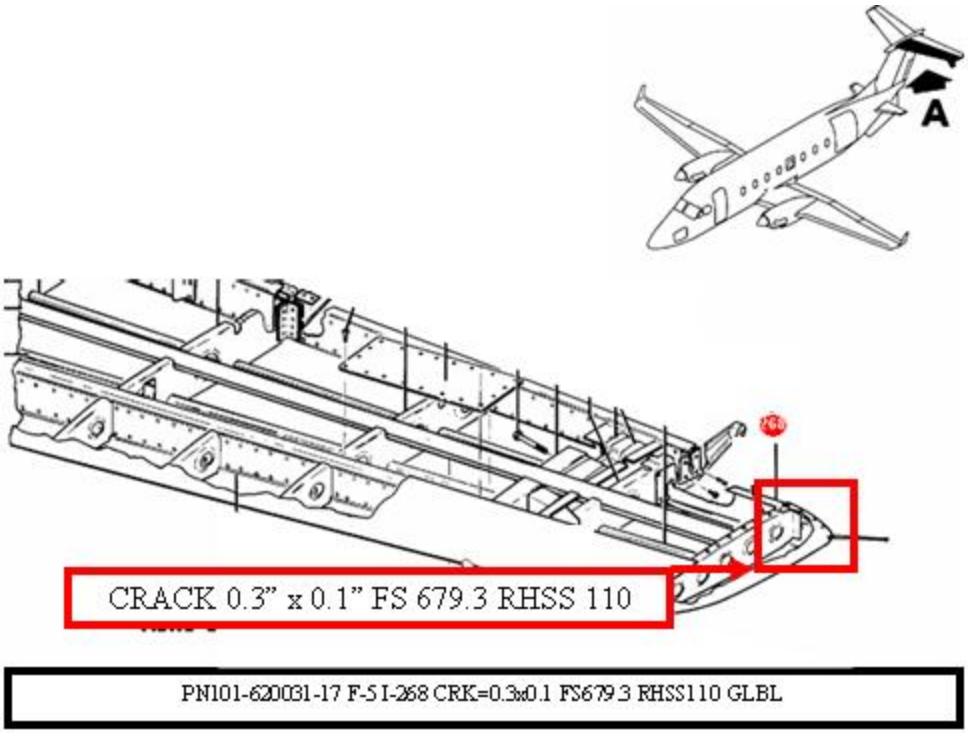


Figure 114. Crack on Right Horizontal Stabilizer—Global View

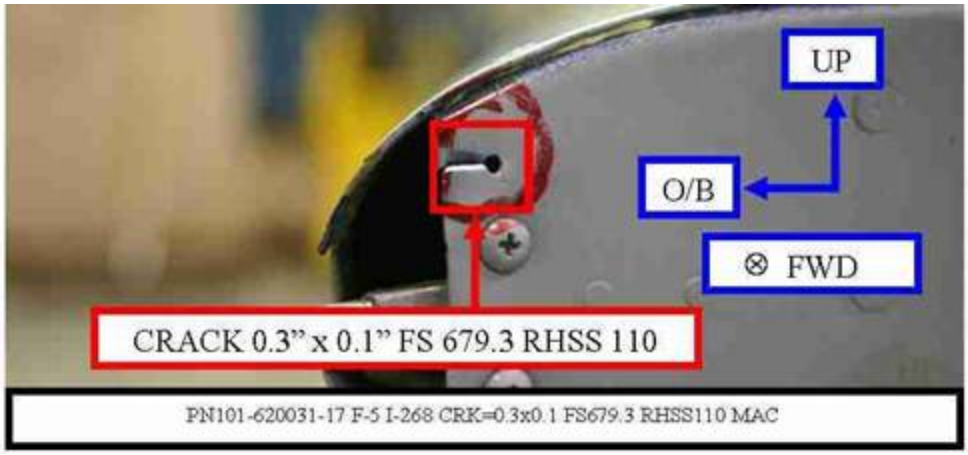


Figure 115. Crack on Right Horizontal Stabilizer—Macroscopic View

Table 15. Tail Vertical Stabilizer Predisassembly Visual Findings

Defect				Defect Location		Defect Description	Defect Figure
Type	L (inches)	W (inches)	D (inches)	FS	VSS		
Gouge	0.2	0.15		575	10R	Three Rivets Gouged	Figure 116 Global Figure 117 Overview Figure 118 Macroscopic
Gouge	0.2	0.05		579	82R	Located Inboard Lower Green Primer Section	Figure 125 Global Figure 126 Overview Figure 127 Macroscopic
Corr	8.5	4.00		612	12R	Scattered Over Area	Figure 119 Global Figure 120 Overview Figure 121 Macroscopic
Wear	1.3	1.10		613	88.4L	Wear Located at Contour Center Rotation	Figure 134 Global Figure 135 Overview Figure 136 Macroscopic
Corr	3.0	2.00		614	43L	Light Scattered	Figure 122 Global Figure 123 Overview Figure 124 Macroscopic
Crack	0.4			623.5	86.5R	Previously Repaired	Figure 128 Global Figure 129 Overview Figure 130 Macroscopic
Wear	4.0	1.30		633.5	87L	Chipped Paint Due to Wear	Figure 131 Global Figure 132 Overview Figure 133 Macroscopic
Corr	2.3	1.53		654	92R	Common to Stiffener Upper aft Location	Figure 140 Global Figure 141 Overview Figure 142 Macroscopic
Gouge	3.4	0.20		656.5	90.5R	Common to Nutplate Location Upper aft Attachment to Fz Location	Figure 137 Global Figure 138 Overview Figure 139 Macroscopic
Crack	0.5			657.5	94L	On Flange	Figure 143 Global Figure 144 Overview Figure 145 Macroscopic

VSS = Vertical stabilizer station

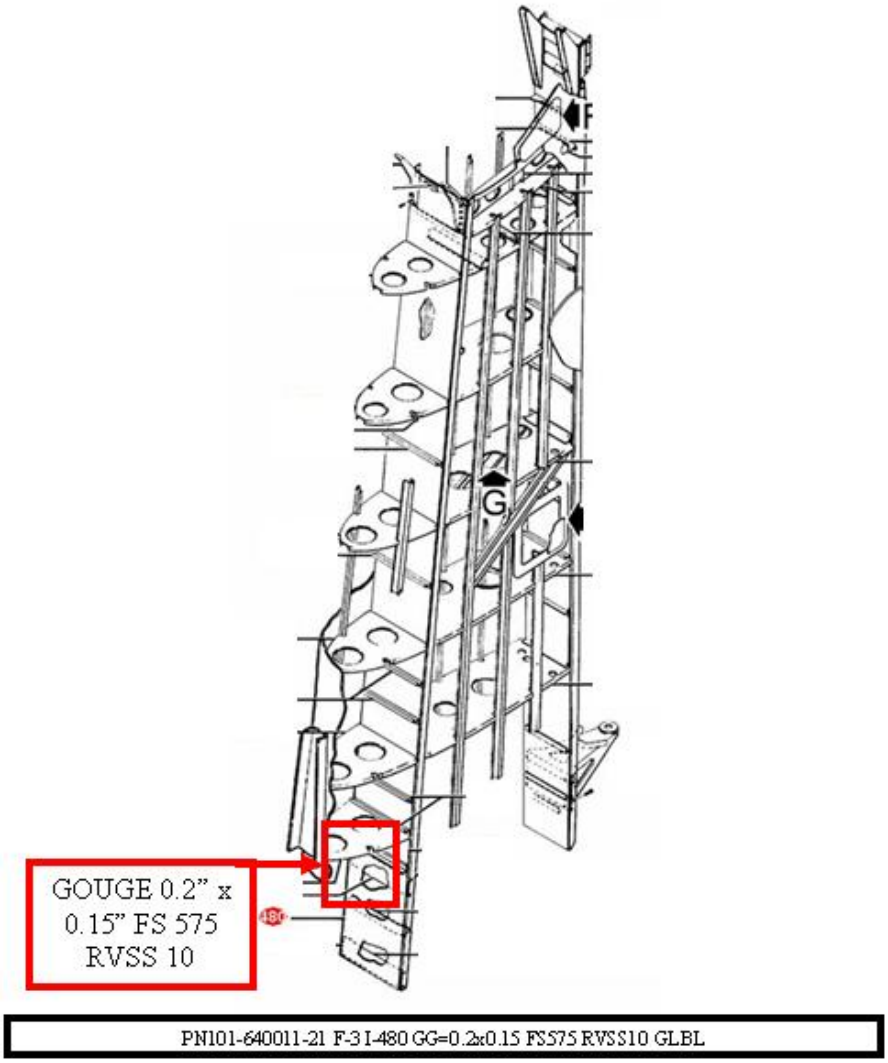


Figure 116. Gouge on Right Vertical Stabilizer—Global View (FS 575)

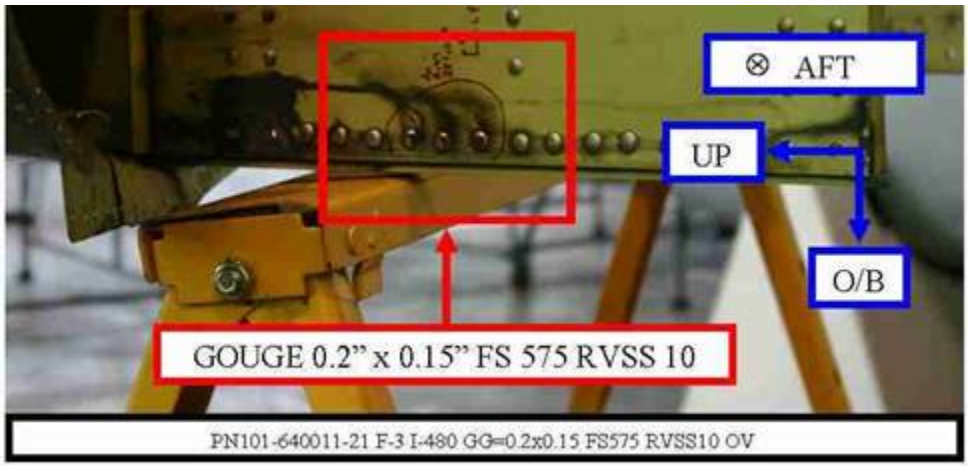


Figure 117. Gouge on Right Vertical Stabilizer—Overview (FS 575)

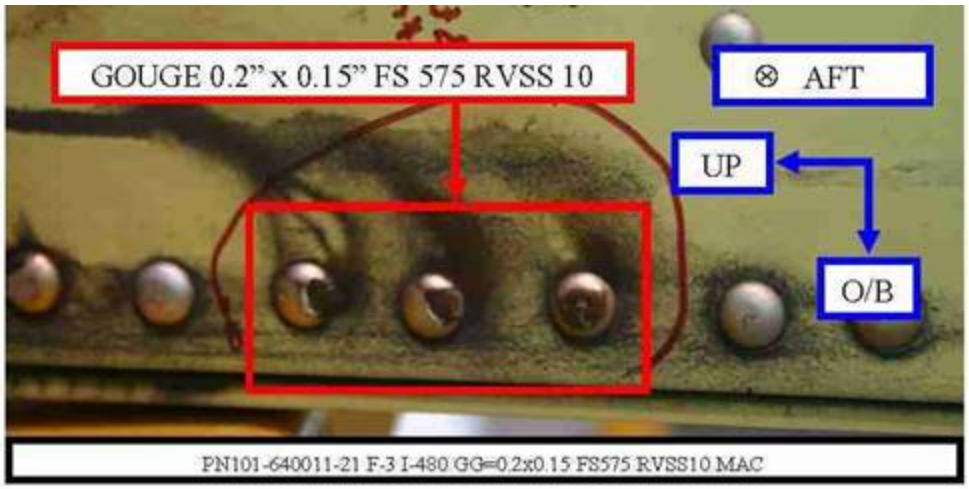


Figure 118. Gouge on Right Vertical Stabilizer—Macroscopic View (FS 575)

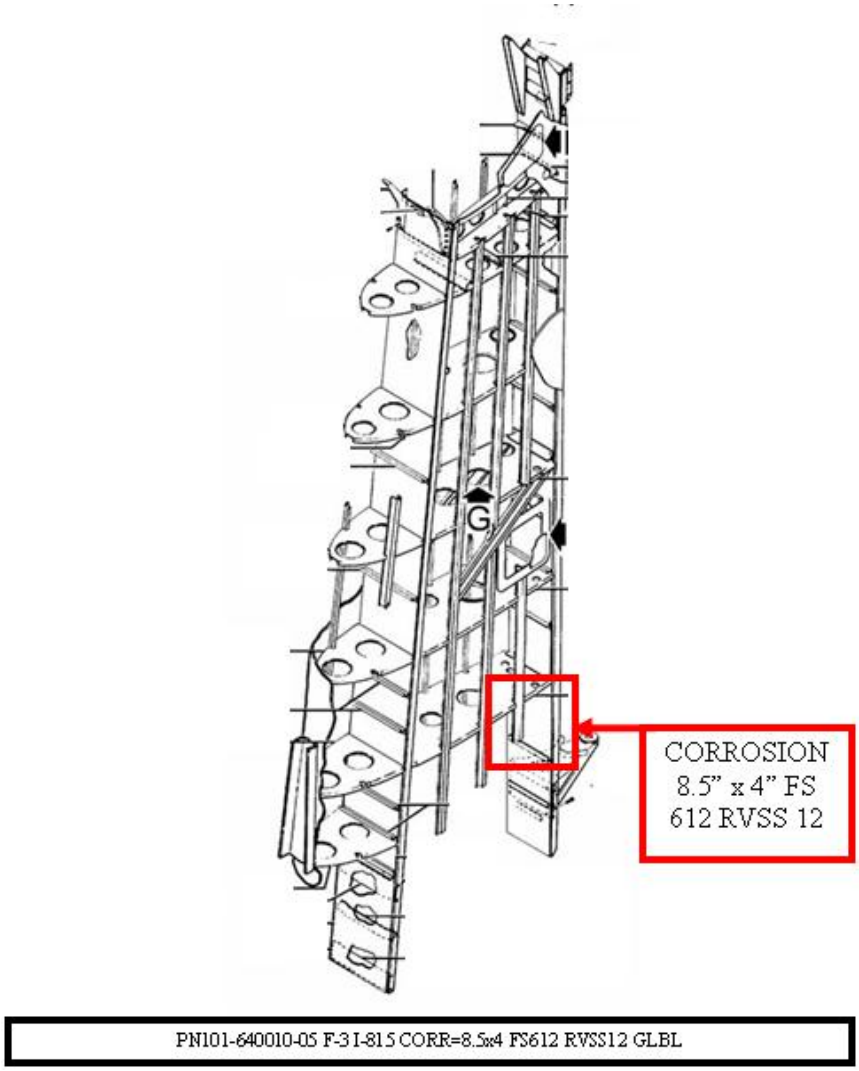


Figure 119. Corrosion on Right Vertical Stabilizer—Global View (FS 612)

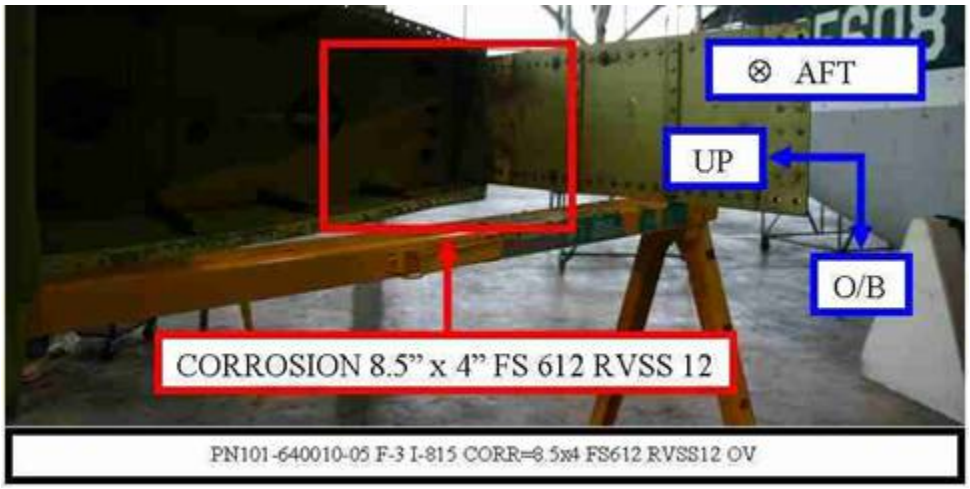


Figure 120. Corrosion on Right Vertical Stabilizer—Overview (FS 612)

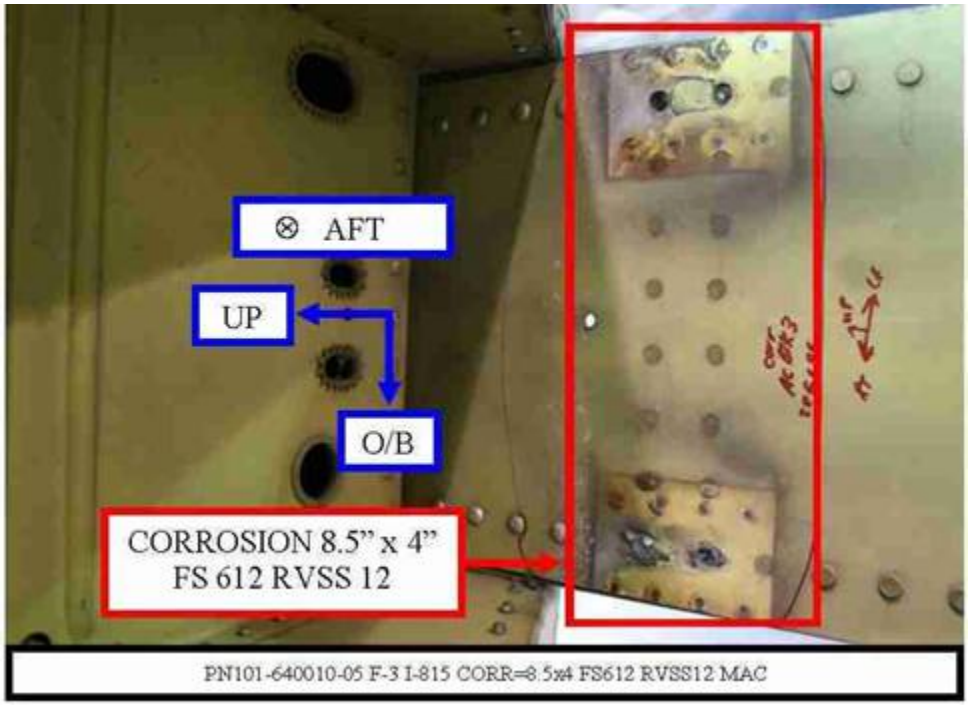


Figure 121. Corrosion on Right Vertical Stabilizer—Macroscopic View (FS 612)

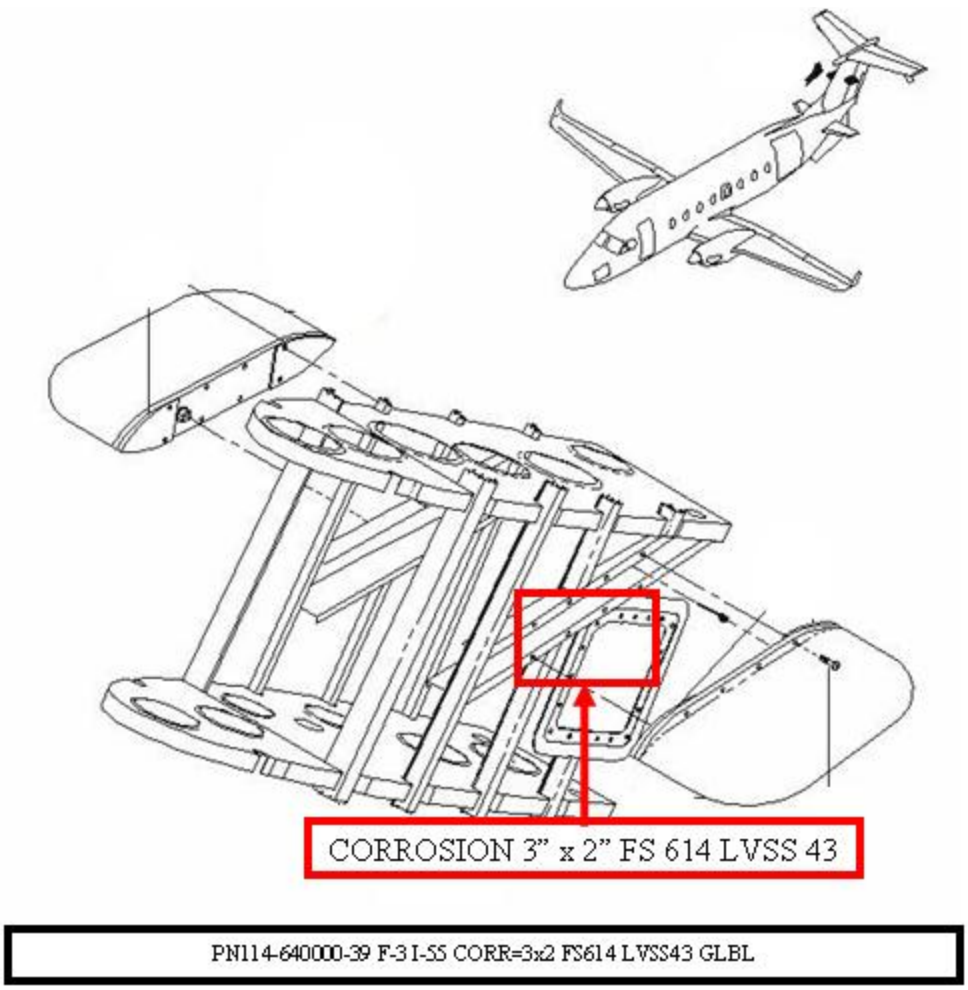


Figure 122. Corrosion on Left Vertical Stabilizer—Global View

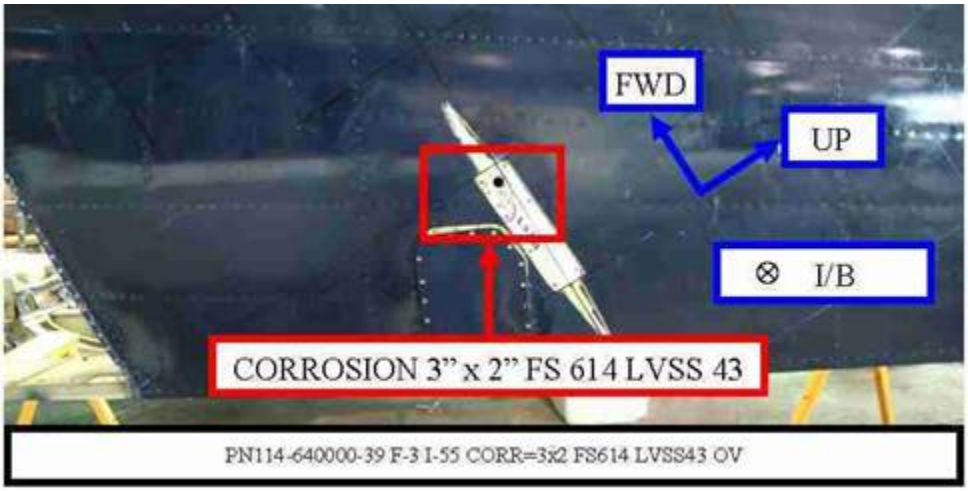


Figure 123. Corrosion on Left Vertical Stabilizer—Overview

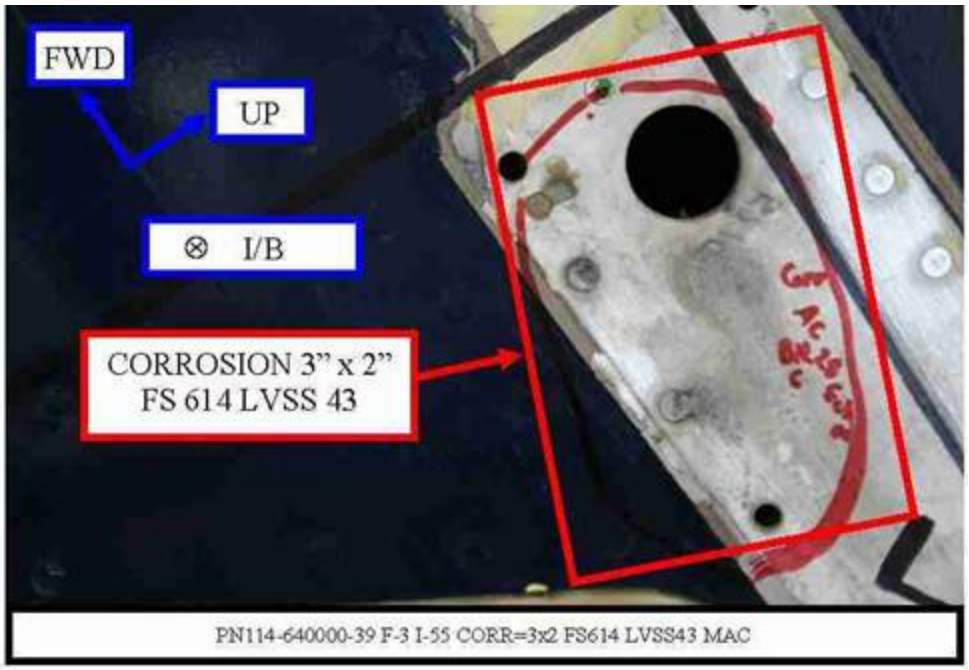


Figure 124. Corrosion on Left Vertical Stabilizer—Macroscopic View

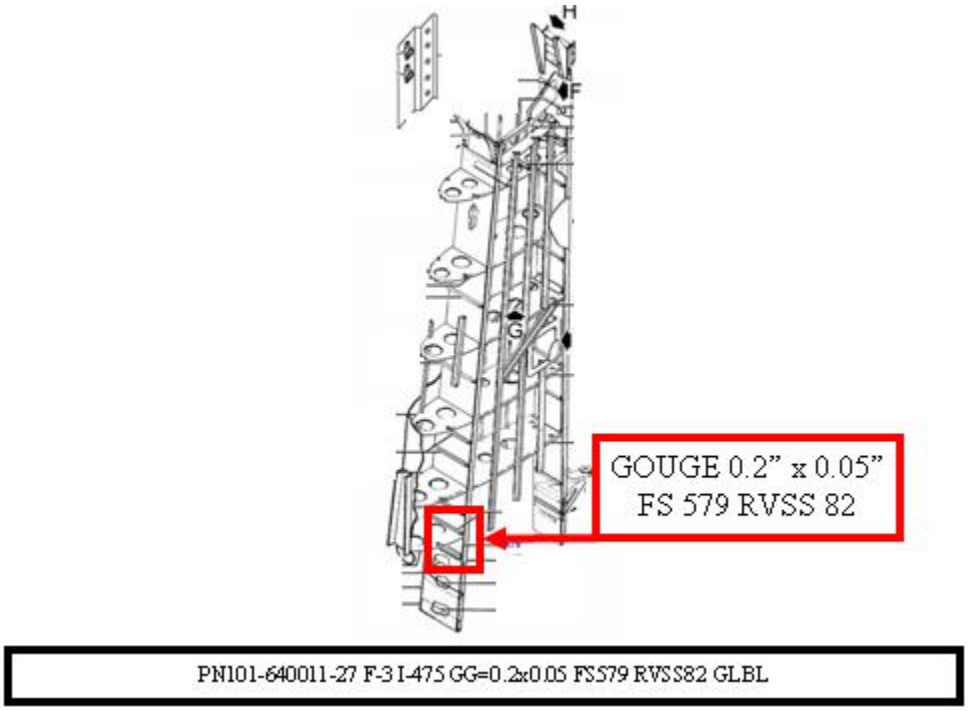


Figure 125. Gouge on Right Vertical Stabilizer—Global View (FS 579)

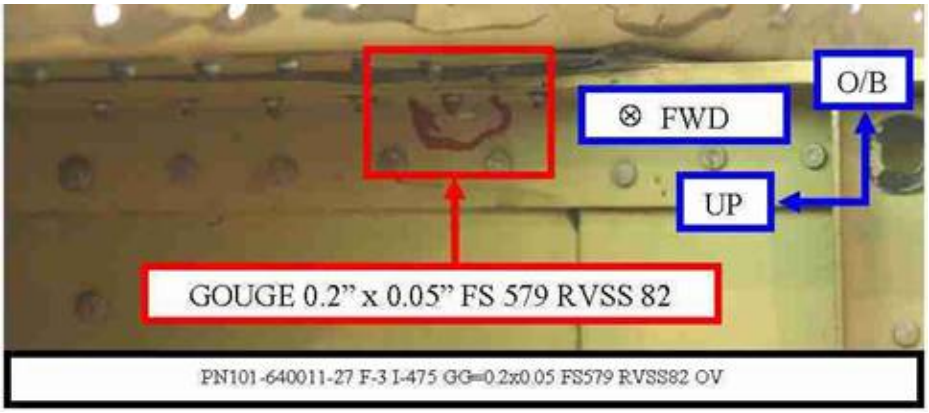


Figure 126. Gouge on Right Vertical Stabilizer—Overview (FS 579)

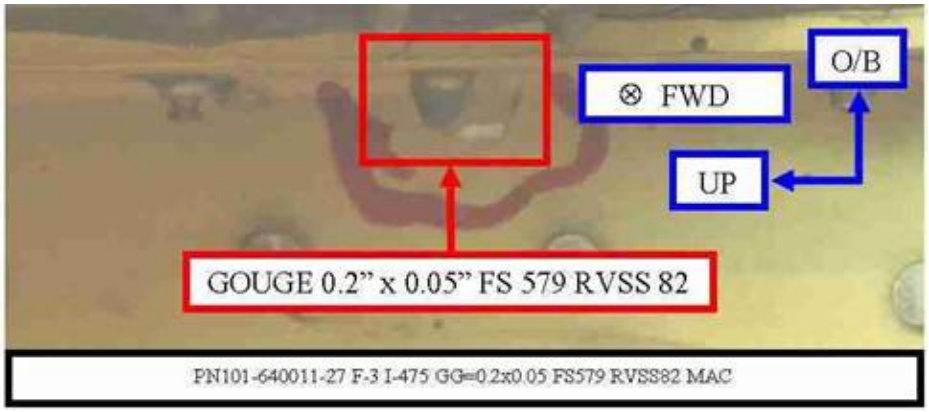


Figure 127. Gouge on Right Vertical Stabilizer—Macroscopic View (FS 579)

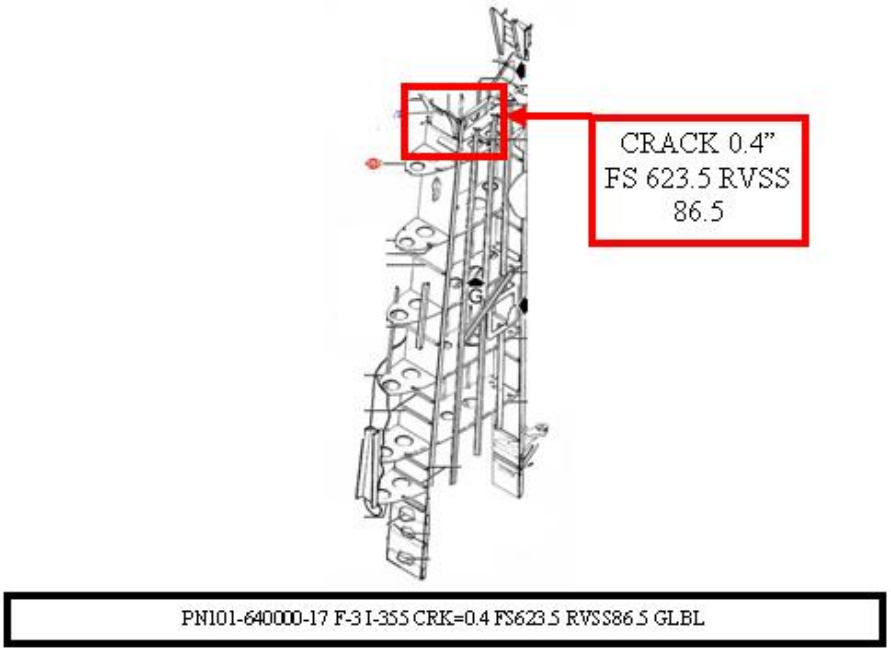


Figure 128. Crack on Right Vertical Stabilizer—Global View

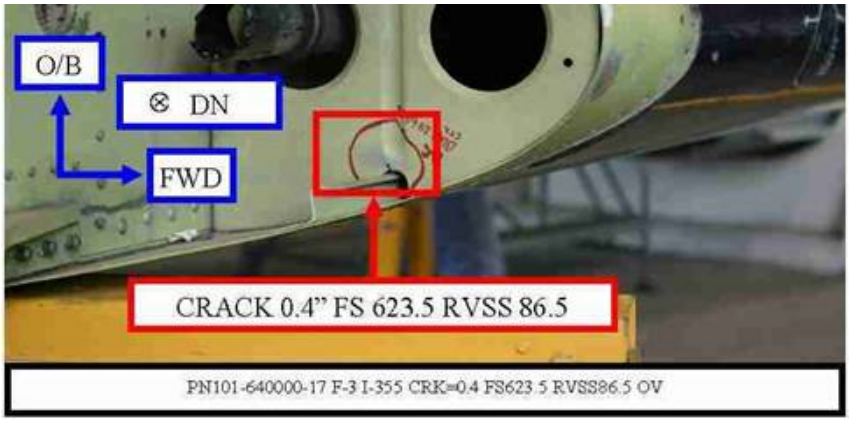


Figure 129. Crack on Right Vertical Stabilizer—Overview

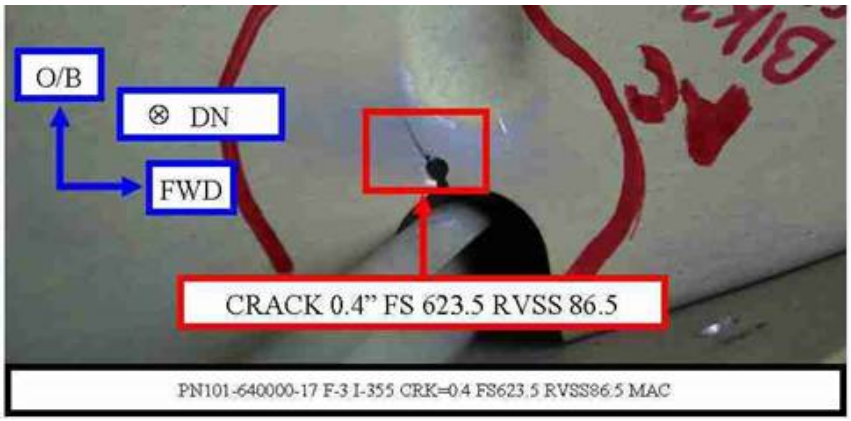


Figure 130. Crack on Right Vertical Stabilizer—Macroscopic View

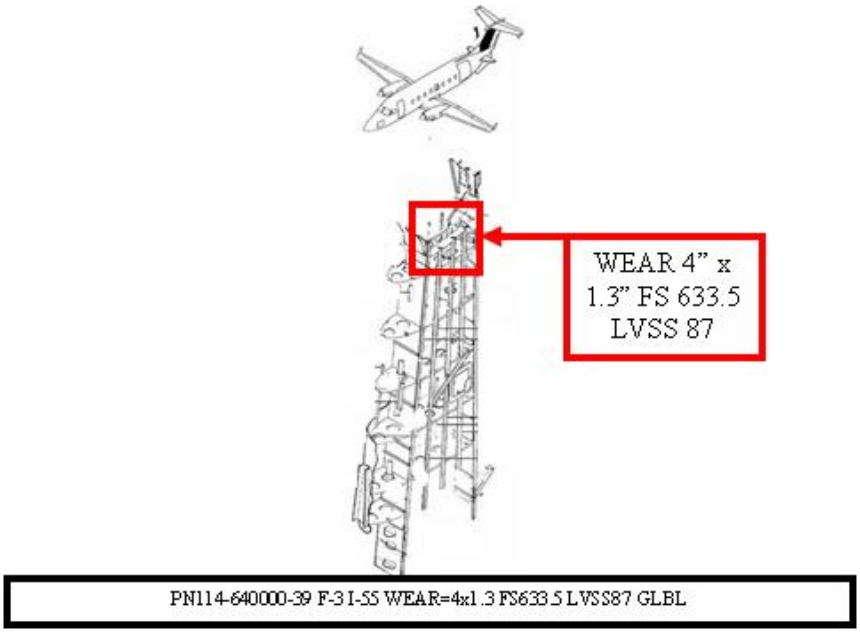


Figure 131. Wear on Left Vertical Stabilizer—Global View (FS 633.5)

Figure 132. Wear on Left Vertical Stabilizer—Overview (FS 633.5)

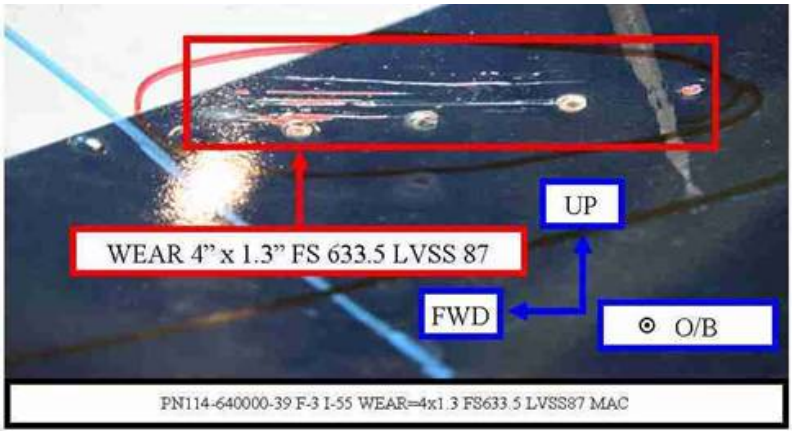


Figure 133. Wear on Left Vertical Stabilizer—Macroscopic View (FS 633.5)

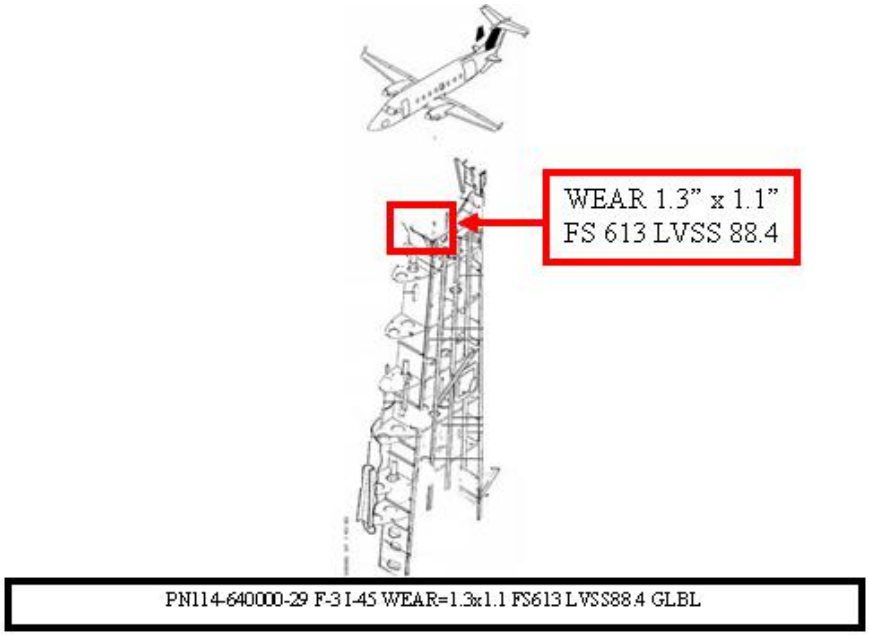


Figure 134. Wear on Left Vertical Stabilizer—Global View (FS 613)

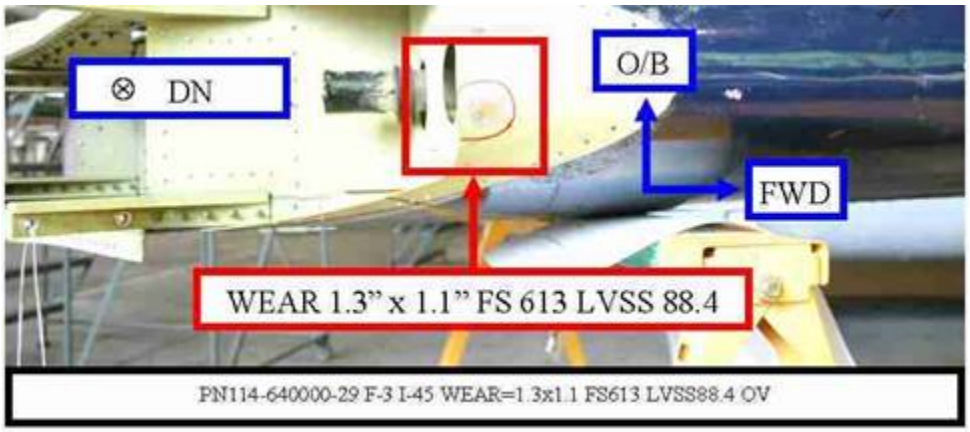


Figure 135. Wear on Left Vertical Stabilizer—Overview (FS 613)

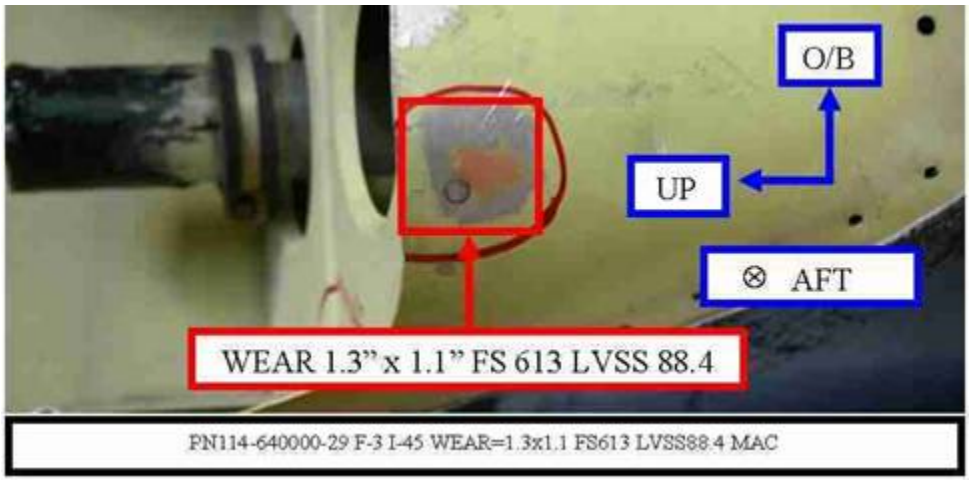


Figure 136. Wear on Left Vertical Stabilizer—Macroscopic View (FS 613)

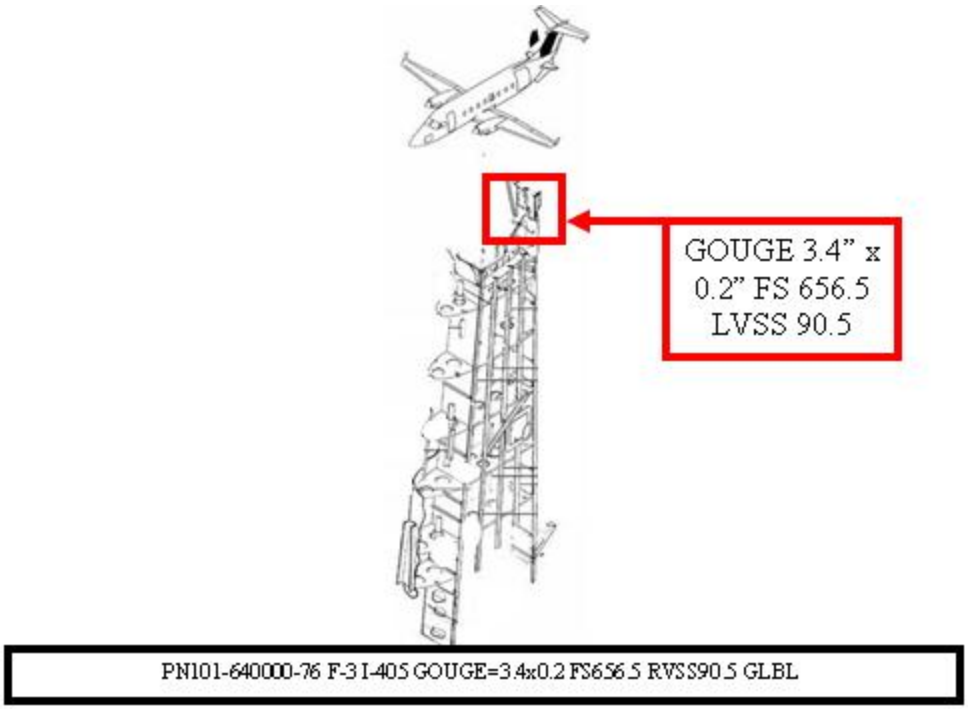


Figure 137. Gouge on Right Vertical Stabilizer—Global View (FS 656.5)

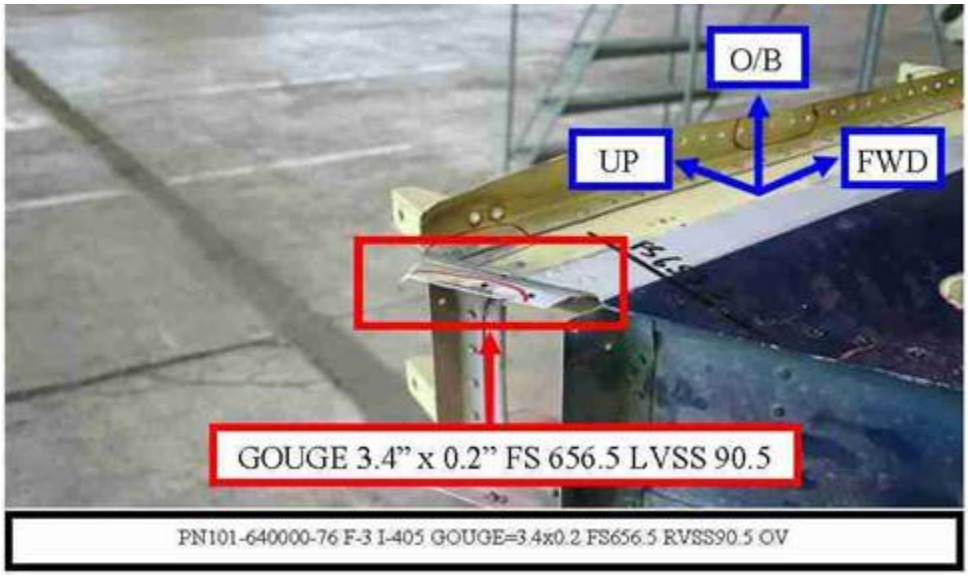


Figure 138. Gouge on Right Vertical Stabilizer—Overview (FS 656.5)

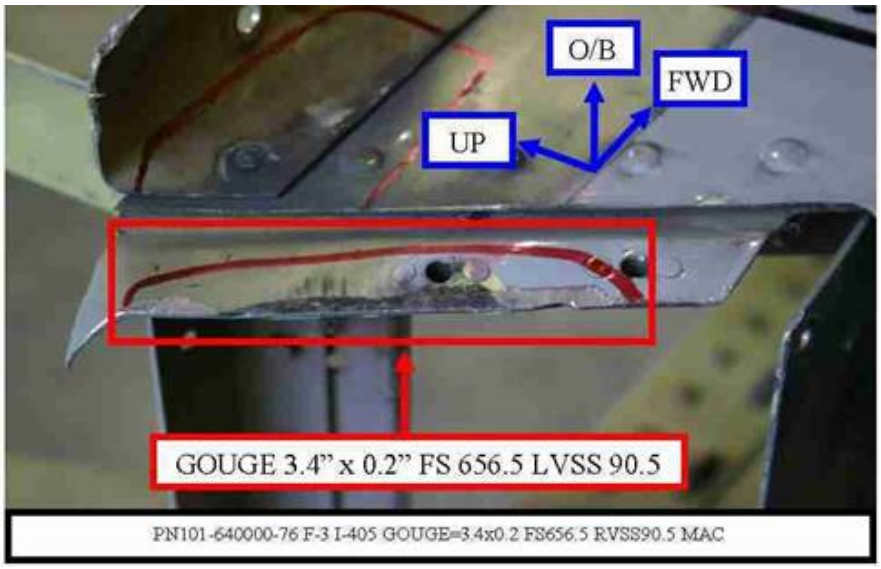


Figure 139. Gouge on Right Vertical Stabilizer—Macroscopic View (FS 656.5)

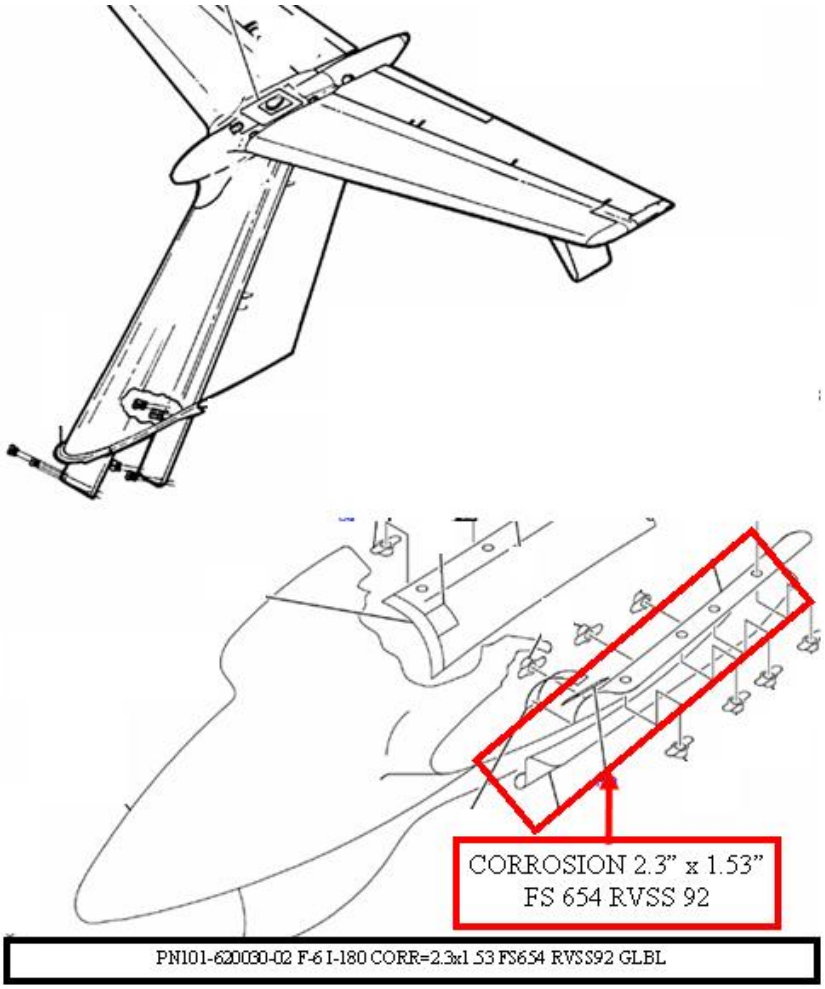


Figure 140. Corrosion on Right Vertical Stabilizer—Global View (FS 654)

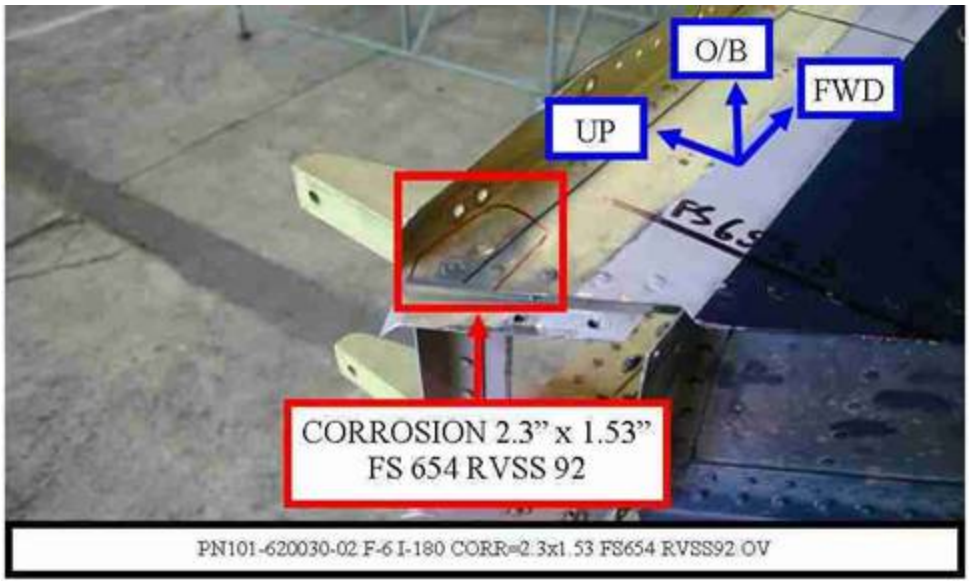


Figure 141. Corrosion on Right Vertical Stabilizer—Overview (FS 654)

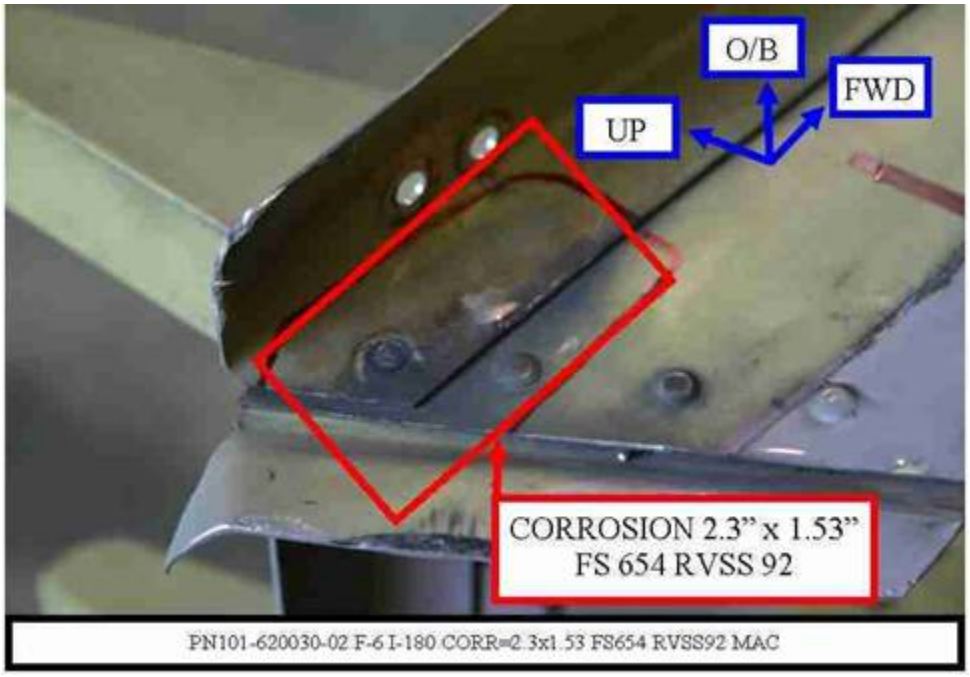


Figure 142. Corrosion on Right Vertical Stabilizer—Macroscopic View (FS 654)

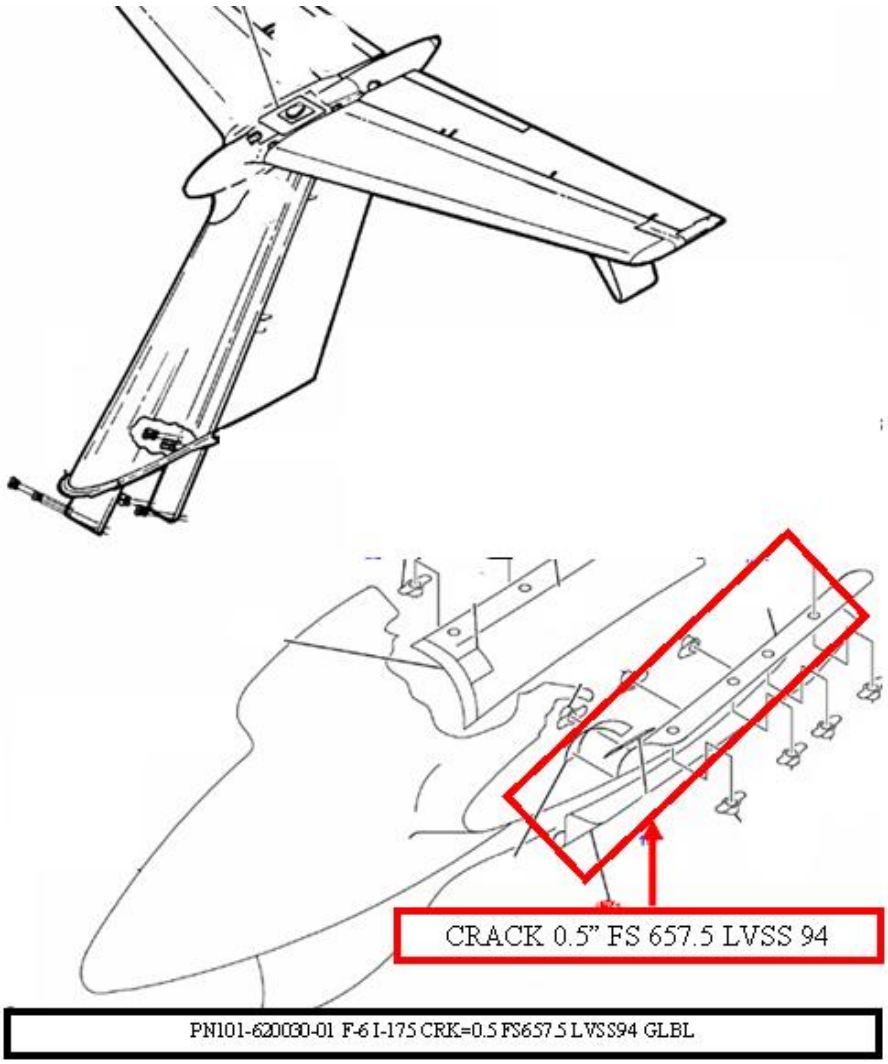


Figure 143. Crack on Left Vertical Stabilizer—Global View

Figure 144. Crack on Left Vertical Stabilizer—Overview

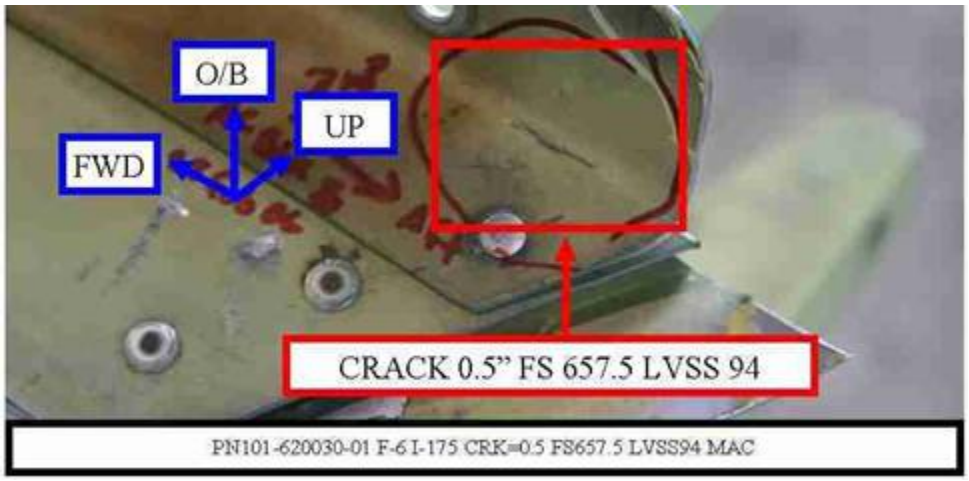


Figure 145. Crack on Left Vertical Stabilizer—Macroscopic View

2.3 BEECHCRAFT 1900D STRUCTURAL INSPECTION MANUAL.

As small airplanes approach and surpass their design life objectives, in-service failures due to corrosion and fatigue become more probable. To address this issue for the Beechcraft 1900D, serial number UE-0066, the NIAR team followed an established structural inspection program based on engineering tests, analysis, and airplane maintenance history, referred to as the Beechcraft 1900D SIM, which was designed specifically for the Beechcraft 1900D. The SIM targets specific areas using NDI methods when the airplane reaches a specific number of flight hours and cycles.

2.3.1 Deployment of SIM.

The SIM is typically performed at designated flight hours or cycles for the duration of the airplane. The SIM for the Beechcraft 1900D consisted of nine checks (A through I). The NDI methods used for these SIMs included visual (VT) inspections, liquid penetrant (PT) inspections, magnetic particle (MT) inspections, and eddy-current surface scan (ETSS) inspections. The NDI methods used for serial number UE-0066 included VT and ETSS inspections due to no engine structures. The SIM provides an owner/operator manual with information on when and where to inspect a high-time or high-cycle Beechcraft 1900D and provides inspection procedures developed for specific structural locations found in the SIMs of this airplane.

All checks, A through I, required a general inspection. A general inspection consists strictly of a VT inspection. The general inspection includes the following: working rivets, damaged/worn areas, loose paint, skin cracks, and skin corrosion. A-Check through C-Check are mainly fuselage inspections and are listed in table 16. D-Check through G-Check are mainly wing inspections as listed in table 17. The engine structures are inspected during the H-Check, as shown in table 18. I-Check deals only with the vertical stabilizer, as shown in table 19.

Table 16. The SIM Inspection Intervals Common to Fuselage

Inspection	Start		Repeat	
A-Check	12,000 Hours	16,000 Cycles	3000 Hours	4000 Cycles
B-Check	15,000 Hours	20,000 Cycles	3000 Hours	4000 Cycles
C-Check	18,000 Hours	24,000 Cycles	3000 Hours	4000 Cycles

Table 17. The SIM Inspection Intervals Common to Wing

Inspection	Start	Repeat
D-Check	17,500 Hours	17,500 Hours
E-Check	20,500 Hours	3,000 Hours
F-Check	24,000 Hours	None
G-Check	30,000 Hours	6,000 Hours

Table 18. The SIM Inspection Interval Common to Engine Structures

Inspection	Start	Repeat
H-Check	N/A	N/A

Table 19. The SIM Inspection Interval Common to Vertical Stabilizer

Inspection	Start	Repeat
I-Check	10 years from date of manufacture	1200 hours or every 2 years, whichever occurs first

The A-Check consists of 36 specific VTs plus the general inspection. It is worthwhile to note that there were no escape hatch doors, no cargo door, and no crew entry door with serial number UE-0066. Every A-Check is scheduled to begin at 12,000 hours or 16,000 cycles. It is repeated every 3000 hours or 4000 cycles.

The B-Check consists of 19 specific VTs and one ETSS inspection plus the A-Check and the general inspection. Every B-Check is scheduled to begin at 15,000 hours or 20,000 cycles. It is repeated every 3000 hours or 4000 cycles. A portion of the table from the Raytheon Electronic Publication System (REPS) Beechcraft 1900D SIM B-Check requires NDI, as shown in table 20.

Table 20. The SIM B-Check NDI

Location on Structure	Refer to Figure
At fuselage stations 150 through 183, at stringer 8R, inspect the skin for cracks and corrosion in the area just above the skin splice (refer to C of figure 2). Perform the EDDY-CURRENT TEST PROCEDURE FOR FUSELAGE found in the STANDARD PRACTICES section of this manual.	Figure 2 is taken from the REPS Beechcraft SIM B-Check table.

The B-Check calls for ETSS on a 3-foot section of a double row of rivets (84 fasteners total for serial number UE-0066) from FS 150 through FS 183. Figures 146 through 149 show the areas to be inspected with ETSS.

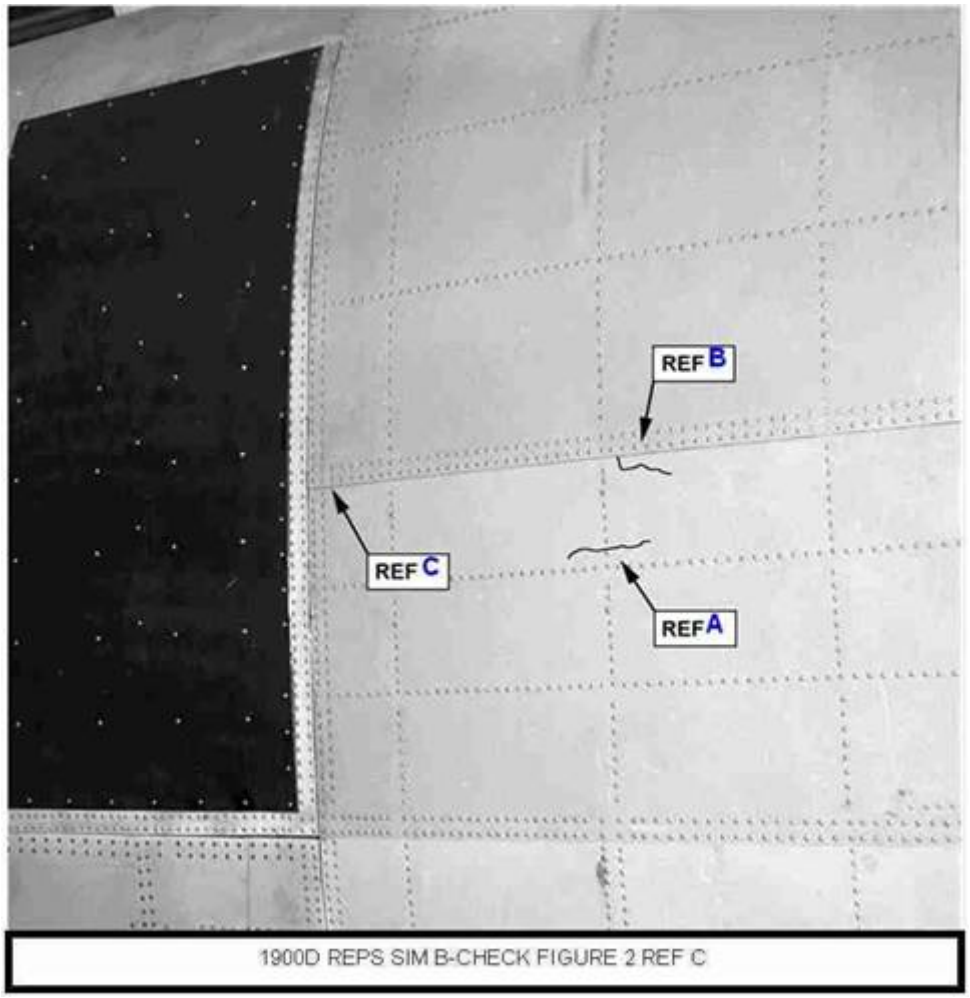


Figure 146. Sample Picture Taken From the REPS SIM B-Check of Area to be Inspected by ETSS

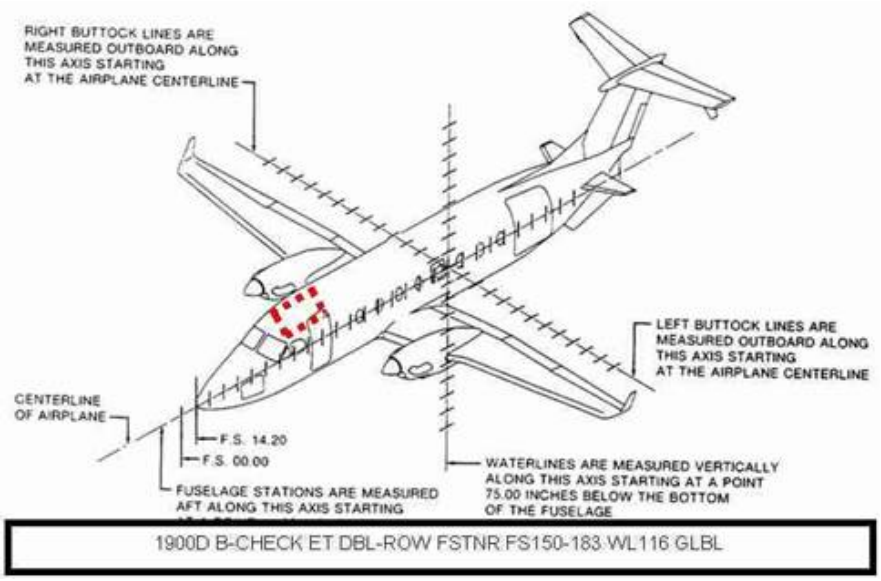


Figure 147. Oblique Global View of the Beechcraft 1900D of REPS SIM B-Check of Area to be Inspected by ETSS

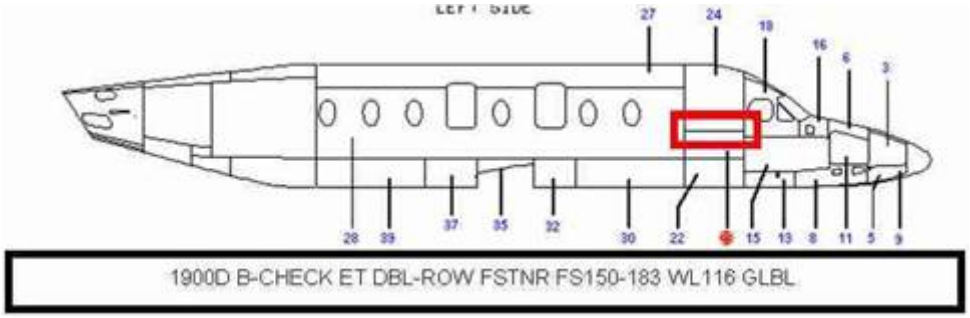


Figure 148. Profile View of the Beechcraft 1900D of REPS SIM B-Check of Area to be Inspected by ETSS

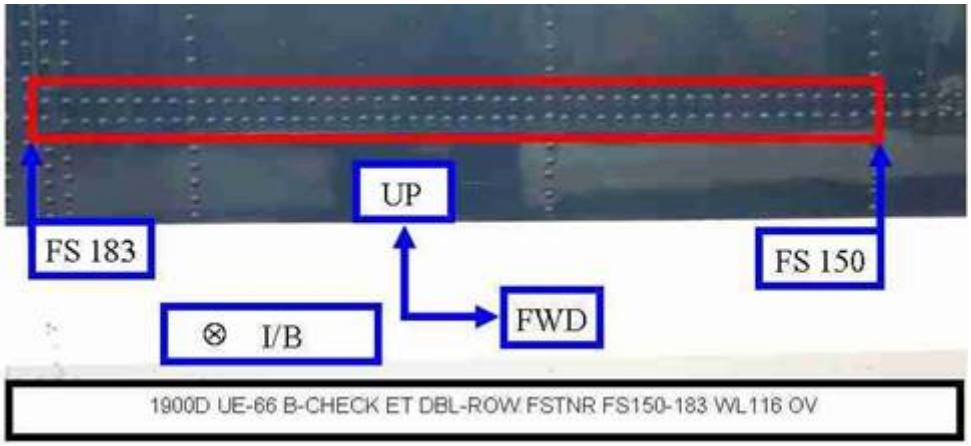


Figure 149. Overview of the Beechcraft 1900D of REPS SIM B-Check of Area to be Inspected by ETSS

The C-Check consists of 11 specific VTs plus the A-Check, B-Check, and the general inspection. The C-Check is scheduled to begin at 18,000 hours or 24,000 cycles. It is repeated every 3000 hours or 4000 cycles.

The D-Check and E-Check consists of 144 specific VTs and 144 ETSSs and the general inspection. For serial number UE-0066, 142 fasteners were inspected by ETSS. The D-Check is scheduled to begin at 17,500 hours. It is repeated every 17,500 hours. The E-Check begins at 20,500 hours and repeats 3,000 hours.

The F-Check and G-Check consists of 13 specific VTs, 8 specific ETSSs, and the general inspection. The F-Check is scheduled to begin at 24,000 hours and is not repeated. The G-Check is scheduled to begin at 30,000 hours and repeats every 6,000 hours.

2.3.2 Results of SIM.

The NDI methods used for the Beechcraft 1900D SIMs included VT, PT, MT, and ETSS inspections. The NDI methods used for serial number UE-0066 only included VT and ETSS inspections due to no engine structures.

These inspections were performed on specified areas of the wings, fuselage, horizontal stabilizer, and vertical stabilizer. Two qualified NIAR level II inspectors (one with an airframe rating and one airframe and powerplant mechanic (visuals only)) performed all of the SIMs, as shown in tables 21-24.

Table 21. The SIM Fuselage Inspections

Inspection Type	Method of Inspection
A, B, and C	VT
B	ETSS

Table 22. The SIM Wing Inspections

Inspection Type	Method of Inspection
D, E, F, and G	VT
D, E, F, and G	ETSS

Table 23. The SIM Engine Structures Inspections*

Inspection Type	Method of Inspection
H	VT
H	PT
H	MT

*Engine structure was not available for serial number UE-0066.

Table 24. The SIM Empennage Inspections

Inspection Type	Method of Inspection
I	VT

2.3.2.1 Visual Inspection SIM.

VTs constitute an important part of practical quality control and quality assurance. This inspection method is the most extensively used NDI method. It is easy to apply, very quick, and often requires no special equipment other than good eyesight, bright light source and no colorblindness, and relatively inexpensive tools when necessary. A ten-power, hand-held magnifying glass under a minimum 100 foot-candle light is often used to detect smaller flaws. Since paint is rarely removed from the inspection area, the inspector must decide whether a crack is in the paint only, or if it extends into the underlying structure. All SIMs received a VT prior to additional NDIs. These inspections revealed no additional defects aside from the defects found in the routine VTs.

2.3.2.2 Liquid Penetrant SIM Results.

PT inspection is another inexpensive and reliable NDI method for detecting discontinuities open to the surface of a material under evaluation. It can be used on metals and other nonporous materials not harmed by the penetrant. The PT inspection procedures from the REPS Beechcraft 1900D SIM was used as a reference guide during this evaluation. PT inspections tend to take longer than visual or eddy-current inspections, since surfaces must be stripped of paint before this inspection can be conducted. A penetrating liquid is placed on the surface of the part, and this liquid penetrates into the cavity formed by a discontinuity, such as a crack, in the material. The surface liquid is then removed gently to avoid disturbing the penetrant that settled in the discontinuity. The liquid left in the cavity is brought back to the surface with the application of a developer. A black light is used to view the flaw if a fluorescent penetrant is used. Fluorescent penetrant is limited to surface flaws and requires about 20 minutes of inspection preparation. This method was performed only during the H-Check, if a VT failed. Type 1, level 3 penetrant materials were selected for this application with a minimum dwell time of 10 minutes. PT inspection was not conducted on the Beechcraft 1900D serial number UE-0066 due to no engine structures.

Figure 150 shows the PT inspection process.

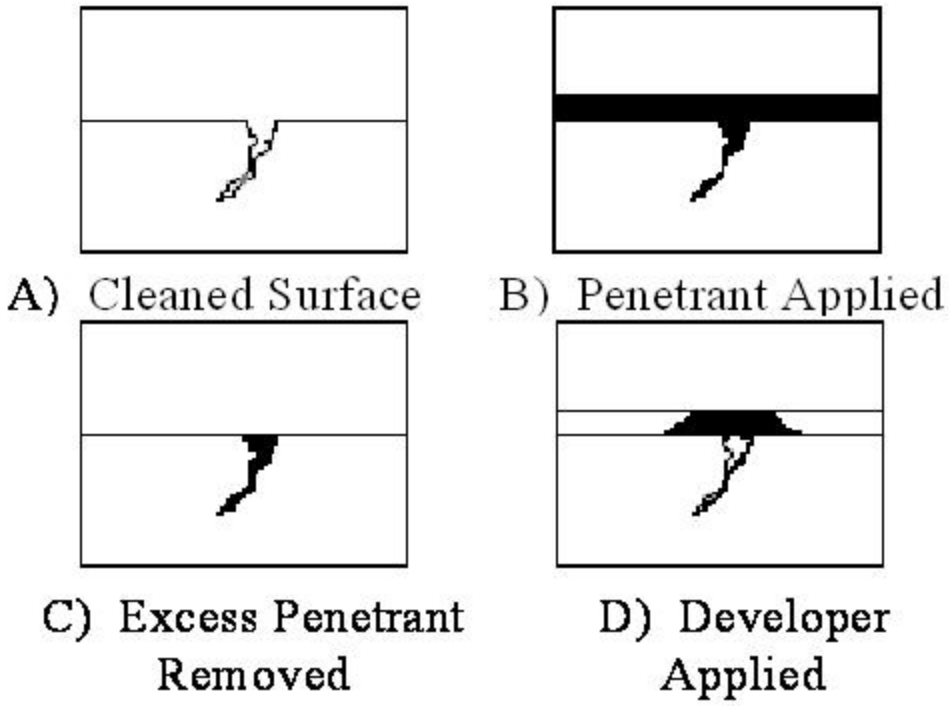


Figure 150. Penetrant Inspection Process

2.3.2.3 Magnetic Particle SIM Results.

MT inspection is used to reveal surface and near subsurface discontinuities in magnetic materials. This inspection can only be used on materials that can be magnetized (ferrous). American Society for Testing Materials (ASTM) E-1444-01 practices were used during this evaluation. On some material, MT was used instead of liquid penetrant because it is faster and requires less surface preparation; however, liquid penetrant can be used on most inspections that require MT inspection, if time is not a constraint. MT inspections consist of three basic steps: (1) magnetize the part; (2) spray magnetic particles, such as iron filings, onto the part; and (3) interpret indications by a qualified inspector. Fluorescent MT is most commonly used for airplane inspections. Figure 151 shows a typical indication of a surface crack. MT is easy to use, requires minimal training, and results can be achieved quickly. MT inspections were performed on the landing gear strut housing attachment points and on all welds on the engine structure. Longitudinal and circular magnetism were selected for this application to cover all possible defect orientations. See the Beechcraft 1900D SIM for detailed MT procedures. With respect to the Beechcraft 1900D serial number UE-0066, MT inspection was not conducted due to no engine structure.

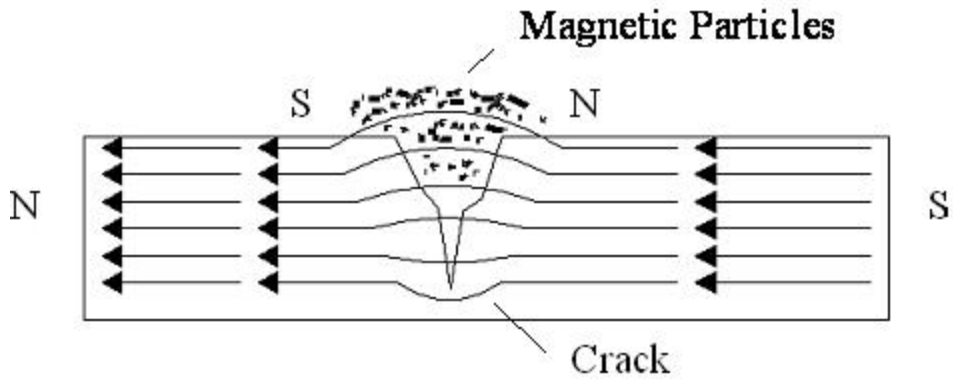


Figure 151. Surface Crack Indications

2.3.2.4 Eddy-Current SIM Results.

Eddy-current inspection is used to detect discontinuities in parts that are conductors of electricity. In general, the eddy-current method of NDI is used to inspect relatively small areas; however, the probe design and test parameters must be established with a good understanding of the flaw to be detected. Since eddy currents tend to concentrate at the surface of a material, they can only be used to detect surface and near-surface defects. Optimum sensitivity to cracks or other flaws generally occur in specific frequency ranges for each combination of metal, flaw size, and flaw depth. A primary magnetic field created by alternating current will cause the current to flow in a circular direction, known as eddy currents. For the current to flow, the test part must be made of conductive materials. A secondary magnetic field forms in the part and opposes changes to the primary magnetic field. Changes in material properties alter the eddy currents, which in turn changes the opposing secondary magnetic field. This change alters the electrical characteristics of the primary magnetic field, which can be detected by the eddy-current instrument. Eddy-current inspections were performed on the lower wing main and aft spars, and an overlap seam on the fuselage. Due to the material thickness of the SIMs and the anticipated flaws to be detected for the necessary materials, a frequency of 200 kHz was selected for ETSS. The basic setup for an eddy-current probe and test material is shown in figure 152.

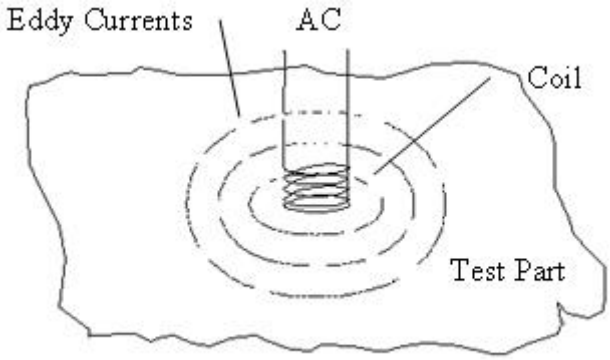


Figure 152. Eddy Current From Probe Into Test Material

A very small minority of the SIM inspections were performed using the ETSS method. Table 25 shows the results from the ETSS supplemental inspections.

Table 25. The ETSS SIM Results

Name of Inspection	Results Reported
B-Check (fuselage)	No Defects
D-, E-, F-, G-Checks (lower wing main and rear spar caps)	No Defects

3. TEARDOWN EXAMINATION PHASE.

Following the completion of the inspection phase, the teardown examination phase was performed to find defects not found by typical maintenance or supplemental inspections. Every defect found in the inspection phase and the teardown examination phase was completely characterized during the microscopic examination portion of this project. The airplane was initially disassembled into nine separate major airplane sections: forward fuselage, mid fuselage, aft fuselage, and tail, see figure 153, followed by the left wing, right wing, and center wing, see figure 154, horizontal stabilizer, and vertical stabilizer. A structural assessment of primary airplane structure using alternative NDI techniques was performed to examine the wing spars and the horizontal and vertical stabilizer spars prior to disassembly in an effort to identify additional defects. Following the assessment using alternative NDI techniques, the major airplane sections were disassembled to remove the critical structural details and suspect locations identified during inspections. These details were then examined microscopically to find and characterize all defects in the structure.

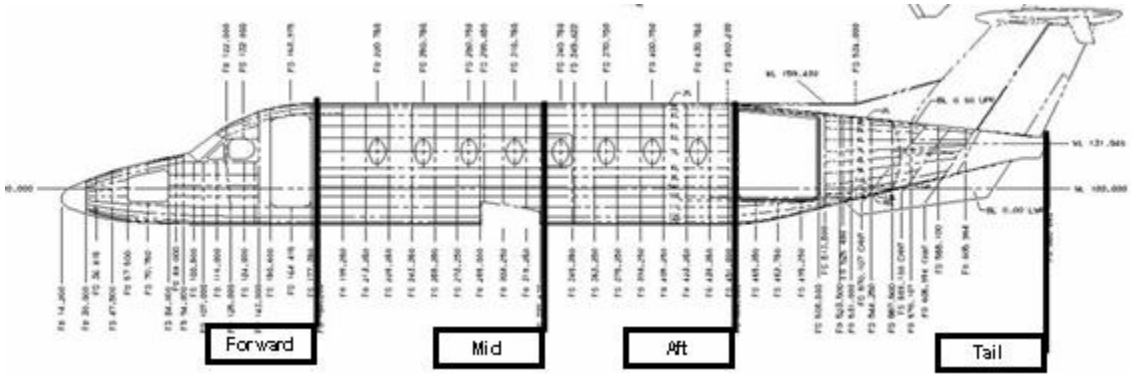


Figure 153. Beechcraft 1900D Fuselage Disassembled

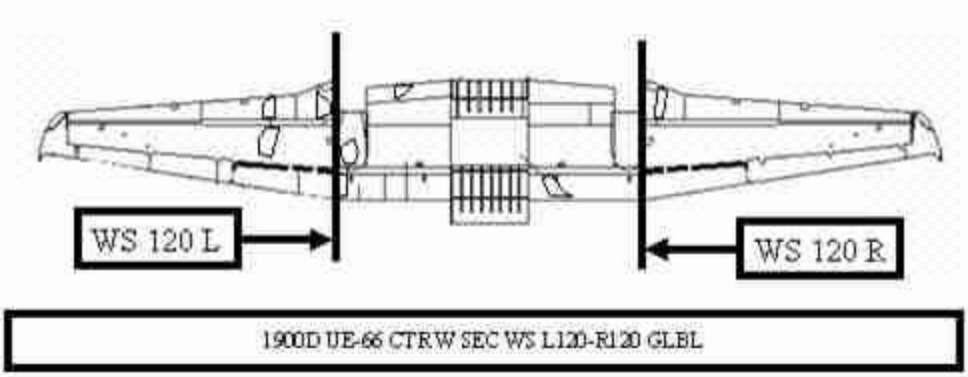


Figure 154. Beechcraft 1900D Wing Disassembled

3.1 DISSASSEMBLY OF AIRPLANE INTO MAJOR SECTIONS.

To facilitate the alternative NDI and detailed disassembly, the airplane was disassembled, per the Beechcraft 1900D Maintenance Manual and the Beechcraft 1900D SIM, into its major airframe sections: wings, horizontal stabilizer, vertical stabilizer, forward fuselage, aft fuselage, and cabin. Prior to any disassembly of the airplane sections, the engines and landing gears were previously removed and were not investigated as part of this program. All systems' components (including wiring) were previously removed and were not included in this project. Disassembly was conducted using techniques to minimize damage to existing structures and the underlying structure of the airplane.

3.2 STRUCTURAL ASSESSMENT USING ALTERNATIVE NDI TECHNIQUES.

During this research program, alternative NDI techniques were implemented to assess the primary airplane structure beyond the inspections from the SIM prior to teardown. The wing, horizontal stabilizer, and vertical stabilizer spars were inspected using two eddy-current-based inspection techniques capable of detecting surface and subsurface cracks and areas of corrosion. The sliding probe shown in figures 155 and 156 is capable of detecting cracks in up to three layers of metal, while the MOI, shown in figures 157 and 158, can detect cracks and corrosion in multiple layers.

The primary purpose of these inspections was to locate additional defects in the airframe using alternative NDI techniques prior to disassembly. These techniques are not called out in the Beechcraft 1900D SIM, and they are not typically used for inspection on small airplanes. Therefore, no procedures were established or validated for using these techniques on the Beechcraft 1900D. Inspectors attempted to identify target areas for further microscopic examination using existing structure. No effort was made to evaluate the capabilities of the alternative NDI techniques, and conclusions about the capabilities of the sliding probe should not be made from the results presented in this report.

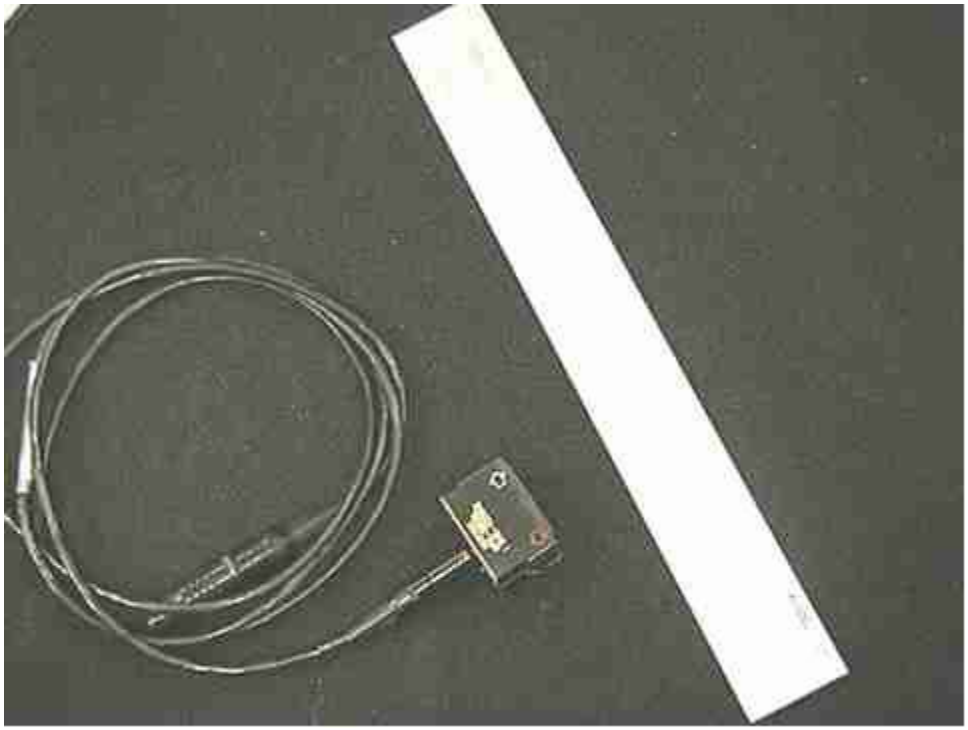


Figure 155. Sliding Probe and Standard

Figure 156. Demonstration of the 1- to 100-kHz Sliding Probe

Figure 157. The MOI Probe and Standard

Figure 158. Demonstration of MOI Probe

Instrument settings, which are determined by a number of factors including material composition, number and thickness of material layers, and desired signal penetration depth, are all important factors when performing eddy-current-based inspections. Table 26 shows the machine settings used during these inspections. The results of these inspections are presented in tabular and pictorial format in the subsequent sections for the fuselage wing, horizontal stabilizer, and vertical stabilizer.

Table 26. The NDI Machine Settings

Method	Frequency	Mode
Sliding Probe	1-100 kHz	Single Frequency
MOI Probe	1.5-100 kHz	Single Frequency

During the sliding probe and MOI inspections, the airplane structure limited the use of the sliding probe on the spars to be inspected. The sliding probe can only detect cracks parallel to and up to 30 degrees off axis from its scan direction, see figure 159. For the wing spars, the only permissible scan direction due to edge-effect considerations was parallel to the load path. Since typical fatigue cracks grow perpendicular to the load path, they could not be detected by this inspection procedure. Nevertheless, the inspection was performed and no defects were noted.

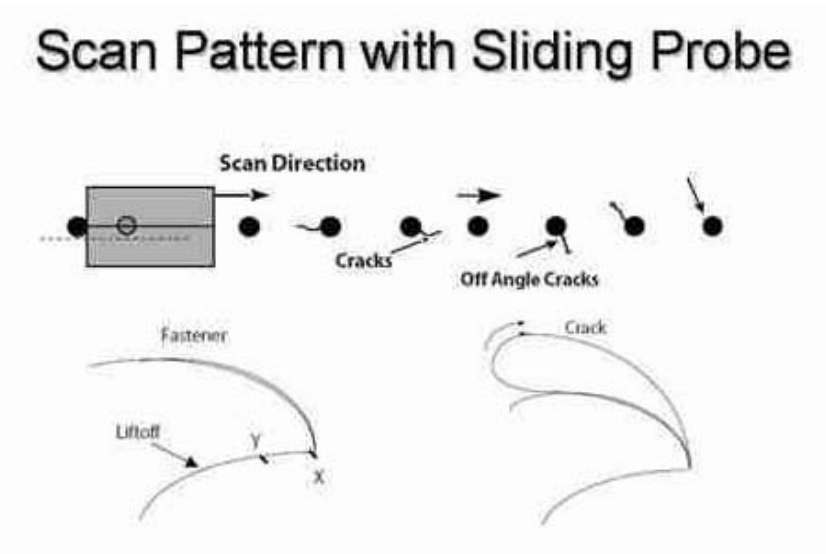


Figure 159. Sliding Probe Scan Pattern Demonstration Picture

3.2.1 Fuselage Results.

All lap joint, bonded surface, and window structures on the fuselage from forward to tail were inspected for surface and subsurface cracks and areas of corrosion using the sliding probe, MOI, and tap testing. No indications were noted during the inspections of these areas; however, indications using tap testing displayed possible disbonding at FS 321, see figure 160. Upon further inspections following disassembly, this area revealed false indications due to excessive bonding of the skin to frame, see figure 161.

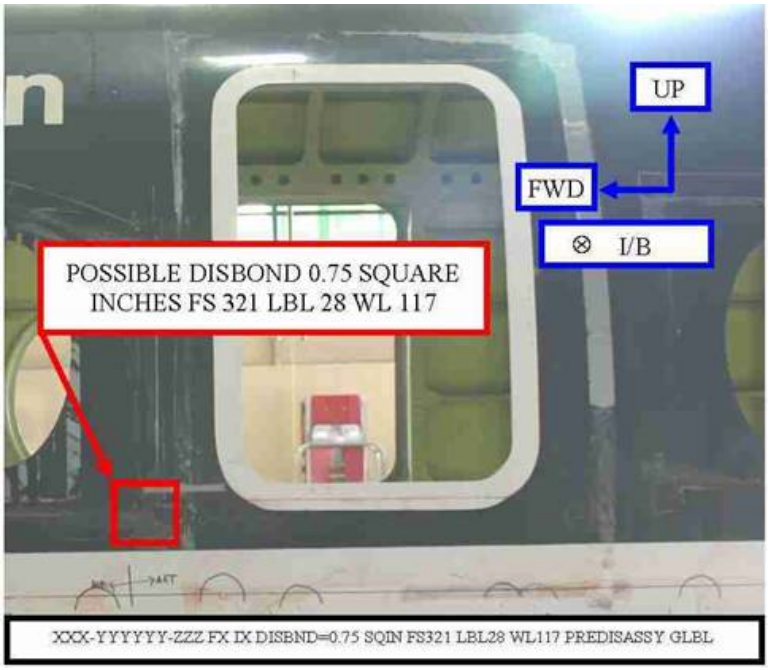


Figure 160. Mid Fuselage Disbonding

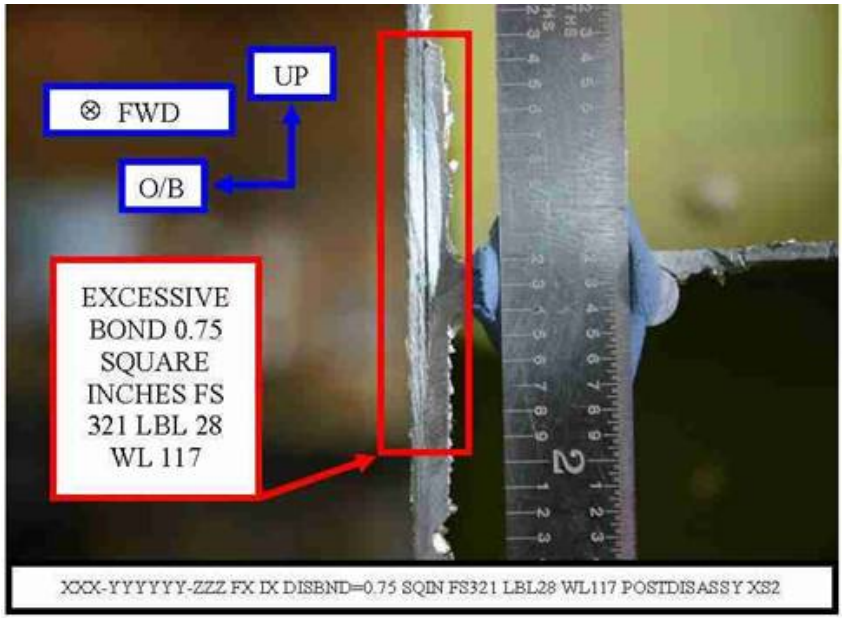


Figure 161. Mid Fuselage Excessive Bonding

3.2.2 Wing Results.

The upper and lower surfaces of the front, main, and rear spars of the left and right wing were inspected for surface and subsurface cracks and areas of corrosion using the sliding probe and MOI. No indications were noted during these inspections on either section of the entire wing surface.

3.2.3 Horizontal and Vertical Stabilizer Results.

The front and rear spars of the horizontal stabilizer were inspected for cracks and corrosion using MOI, and the vertical stabilizer was inspected for cracks using the sliding probe. All indications were noted and further investigated for validity during the postdisassembly inspection and microscopic examination phase of this project. Table 27 shows the indications reported during these inspections and includes information on the inspection method, type of indication, and the airplane location where the indications were found. Figures 162 and 163 show the locations of indications on the upper and lower surfaces of the horizontal and vertical stabilizers, respectively. The final results for these indications are listed in sections 3.4.11 through 3.4.13.

Table 27. The NDI Indications on Horizontal and Vertical Stabilizers

NDI Method	Indication	Location
Sliding Probe	Crack	Vertical Stabilizer Left Side Spar VSS 48.375 FS 604.25
Sliding Probe	Crack	Vertical Stabilizer Right Side Spar VSS 79.75 FS 625.125
MOI Probe	Corrosion	Horizontal Stabilizer Left Side Lwr Fwd Spar HSS 19.5 FS 642.5

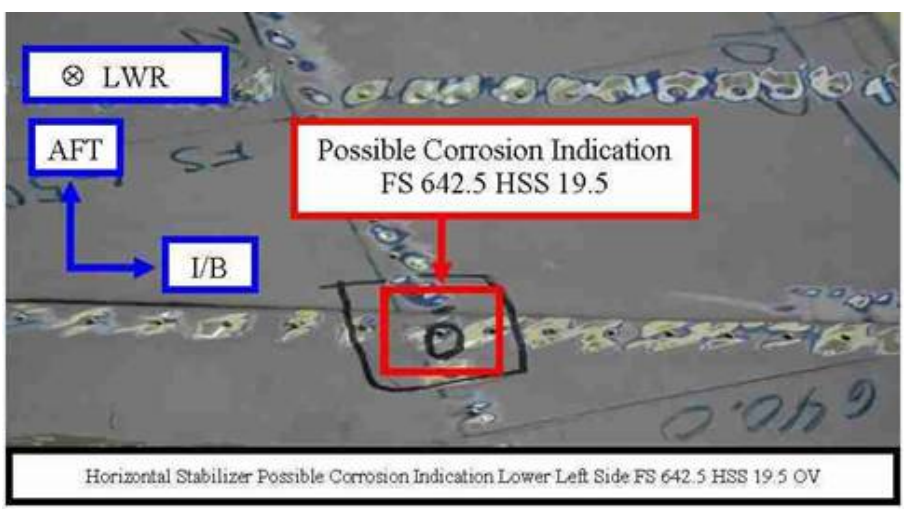


Figure 162. Horizontal Stabilizer Corrosion Indication

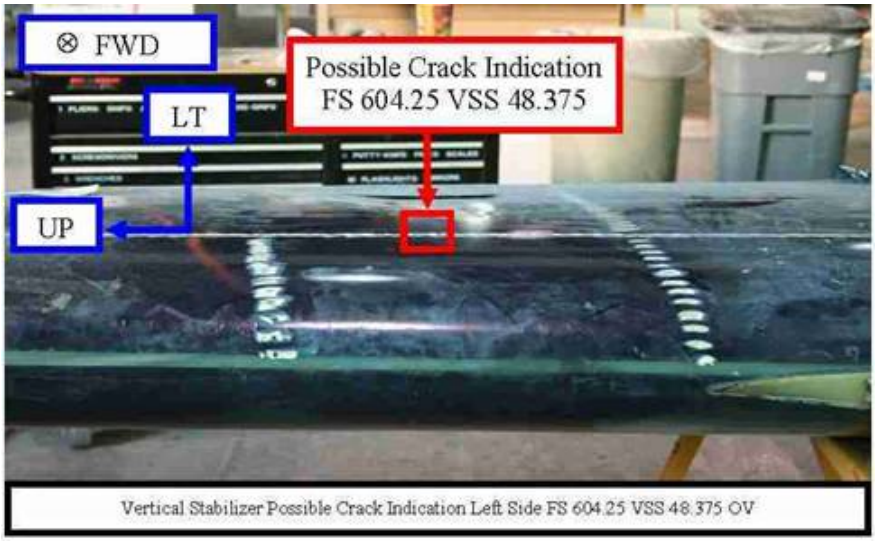


Figure 163. Vertical Stabilizer Crack Indication

3.3 TEARDOWN EXAMINATION.

Following the completion of the assessment of primary airplane structure using alternative NDI techniques, the teardown examination of the airplane began. Teardown examination involves the detailed disassembly of four major airplane sections to remove primary structure and areas with damage found during the inspections. These areas are (1) paint removal and etching of the structure to aid in damage identification and characterization, (2) postdisassembly inspection to identify damage requiring characterization, (3) microscopic examination to identify and characterize all damage, and (4) fractographic analysis to determine failure modes of selected cracks.

3.3.1 Detailed Disassembly Procedure.

At the conclusion of the structural assessment using alternative NDI techniques, each section of the airplane was completely disassembled to allow full access to the primary structure and defects identified during the previous inspections. During the detailed disassembly of the major airplane sections, all primary structures are removed from the airplane using disassembly methods that minimize the potential for damage to the surround structure, systems' components, and wiring. All parts, when removed from the airplane, are subjected to a visual inspection to identify damage such as cracks, corrosion, and wear. The parts are then machine tagged with a 3″ x 5″ metal tag (see figure 164) to aid with identification; the information is then logged into an electronic parts log database for demographic purposes. All part tags include part number, part name, and airplane location. These parts are then assessed to determine if they will be subjected to a full microscopic examination. Areas examined should meet one or more of the following criteria:

- Critical areas prescribed in the Beechcraft 1900D SIM.

- Critical areas determined to be areas that cannot be inspected during the structural inspection.
- Areas assessed using alternative NDI techniques.
- Areas with visible damage found during the inspection phase or during the postdisassembly visual inspection.
- Any other areas of interest determined by the industry engineers or NIAR personnel.

Figure 164. Tag Machine

3.3.2 Paint Removal and Etching.

To aid with damage detection on parts selected for a full microscopic examination, paint is removed using a media blasting machine with Type V size 20/30 plastic media, as shown in figure 165. The parts are then etched using a sodium hydroxide base. Paint removal and etching are not performed on cracks identified as critical during the inspection phase or during the postdisassembly visual inspection because media blasting and etching can possibly damage the fracture face, removing evidence of crack failure mode. In this case, cracks are extracted from the part and set aside for microscopic examination and fractographic analysis, while the remainder of the part is subjected to the normal process.

Figure 165. Media Blasting of Selected Parts

3.3.3 Postdisassembly Inspections.

Following the detailed disassembly and paint removal and etching process of the Beechcraft 1900D, comprehensive inspections were performed on all primary structure and all parts found to have defects during disassembly, using fluorescent liquid penetrant (as shown in figure 166) and magnetic particle inspection. These inspections were performed to aid in the identification of all crack and corrosion defects present in the structure. The liquid penetrant inspections were performed according to ASTM E-1417 (99) using Type 1, Method A with Level 3 sensitivity. Magnetic particle inspections were performed according to ASTM E-1444-01 using longitudinal and circular magnetism. All defects recorded during these inspections were further examined and characterized during the microscopic examinations.

Figure 166. Liquid Penetrant Process

3.3.4 Microscopic Examination.

Following the postdisassembly inspections, all defects were characterized during the microscopic examination with the aid of two 7-45 power optical microscopes, as shown in figure 167. The lengths of all cracks were noted as well as the surface area and depth of each area of corrosion. The severities of the corrosion were classified by the percentage of the thickness loss as follows:

- Light—0-2% thickness loss
- Light to moderate—2-5% thickness loss
- Moderate—5-7% thickness loss
- Moderate to severe—7-10% thickness loss
- Severe—>10% thickness loss

Figure 167. Microscopic Examination Process

Corrosion effects were classified by percentage of thickness loss, as it seemed most representative of the actual damage done by corrosion. Typically, corrosion is classified by pit depth; however, for the purposes of this study, pit depth would not be representative of the severity of damage caused. The different classification levels used in this program are unique to this research and are not representative of other studies. NIAR recommends that these classification levels be used for future studies. It is important to note that corrosion is not assumed as uniform throughout the entire area, but that it represents the maximum depth of corrosion in that area.

3.3.5 Fractographic Analysis.

Upon completion of the microscopic process, and if necessary, fractographic analysis is used to determine failure mode, such as fatigue and stress corrosion and cracking, for selected cracks.

3.3.6 Documentation of Defects.

Upon completion of the postdisassembly inspection and microscopic examination, all relevant defects were captured through a picture-taking process. This process is accomplished by taking overview and up-close macroshots using high-resolution cameras. Each defect identified as relevant is captured through this picture-taking process. The captured pictures are then oriented for report purposes, as shown in figure 168. Also for identification and location, relevant defects are annotated in the tables throughout this report, as shown in the sample table 28.

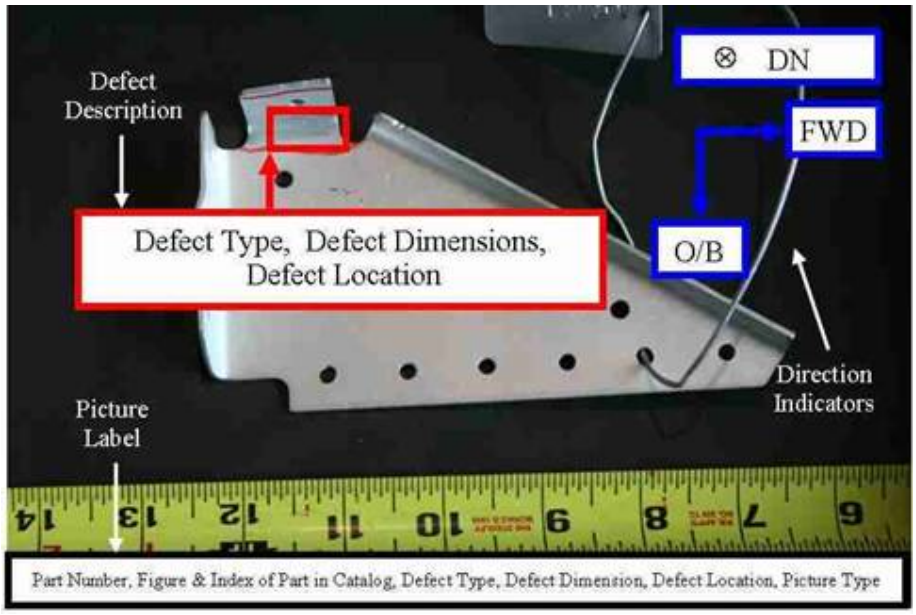


Figure 168. Picture Orientation Example

Table 28. Example of Parts Defect Table

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	HSS		
Type of Defect	Length of Defect	Width of Defect	Depth of Defect	Fuselage Station	Horizontal Stabilizer Station	Additional Information for Defect	Figure Number of Global Picture
							Figure Number of Overview Picture
							Figure Number of Macroscopic Picture
							Figure Number of Microscopic Picture

3.4 TEARDOWN EXAMINATION RESULTS.

Documentation of each inspected airplane section includes a summary table showing defect type, location, description, and report figure number of the relevant defect found. The table is followed by applicable global illustration, picture overview, macroscopic, and/or microscopic view of each defect identified. Each report section also shows an overview picture of areas of concentration in each airplane section.

During the teardown examinations, light and light to moderate corrosion was found to be widespread over the airplane. This is typical of an airplane of this age and operational environment history. Since the less severe corrosion was so widespread, example pictures of light and light to moderate corrosion are provided sparingly throughout this document, as opposed to providing a picture of each occurrence. Figure 169 represents examples of light corrosion found throughout the entire examination.

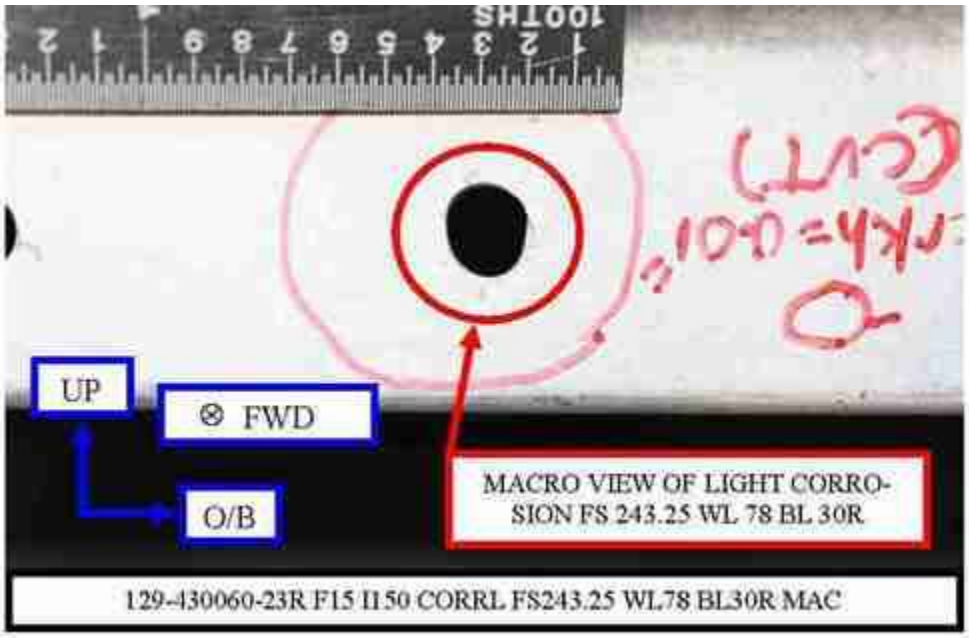


Figure 169. Example of Light Corrosion

3.4.1 Forward Fuselage Examination Overview.

During the teardown examination of the forward fuselage (displayed in figure 170), areas of concentration included, but are not limited to, the frames, escape hatch, and windows. One hundred sixty-three parts were examined during detailed disassembly and postdisassembly process in an effort to locate and characterize all areas of damage on the Beechcraft 1900D, see figure 171. Sixteen defects were discovered and characterized, ranging from relevant to minor. Three cracks were classified as relevant; also, one other area considered noteworthy was light to moderate corrosion on the right seat track rails (see table 29). Twelve instances of light to moderate corrosion were found in numerous areas and classified as minor. Microscopic examinations performed included 13,881 holes of the 163 parts identified.

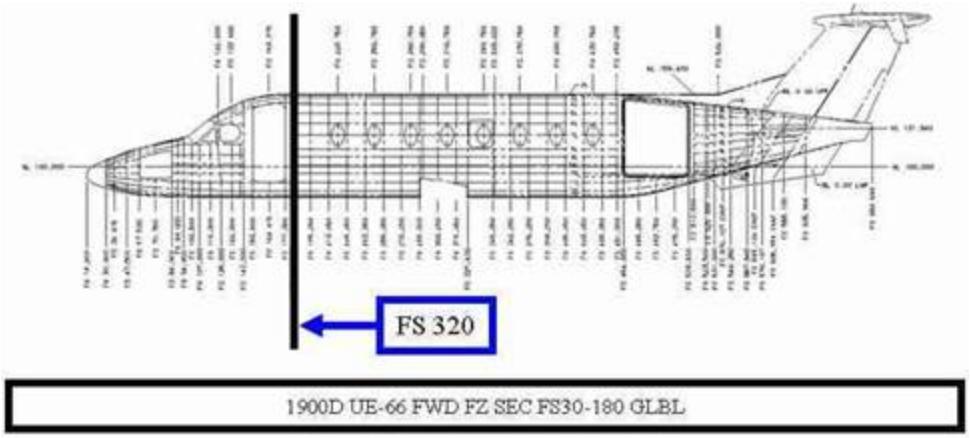


Figure 170. Forward Fuselage Section

Figure 171. Forward Fuselage Detailed Disassembly

Table 29. Forward Fuselage Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Corr	6.75	0.113	0.005	143	100	Light Moderate Corrosion on Right Seat Rail	Figure 172 Global Figure 173 Overview Figure 174 Macroscopic Figure 175 Microscopic
Crack	1.32		Thru	150	120	Entry Door Angle Cracked	Figure 176 Global Figure 177 Overview Figure 178 Macroscopic
Crack	0.4231		Thru	183	85	Inner Door Skin Cracked	Figure 179 Global Figure 180 Overview Figure 181 Macroscopic Figure 182 Microscopic
Crack	0.11			183	160	Intercostal Cracked	Figure 183 Global Figure 184 Overview Figure 185 Macroscopic Figure 186 Microscopic

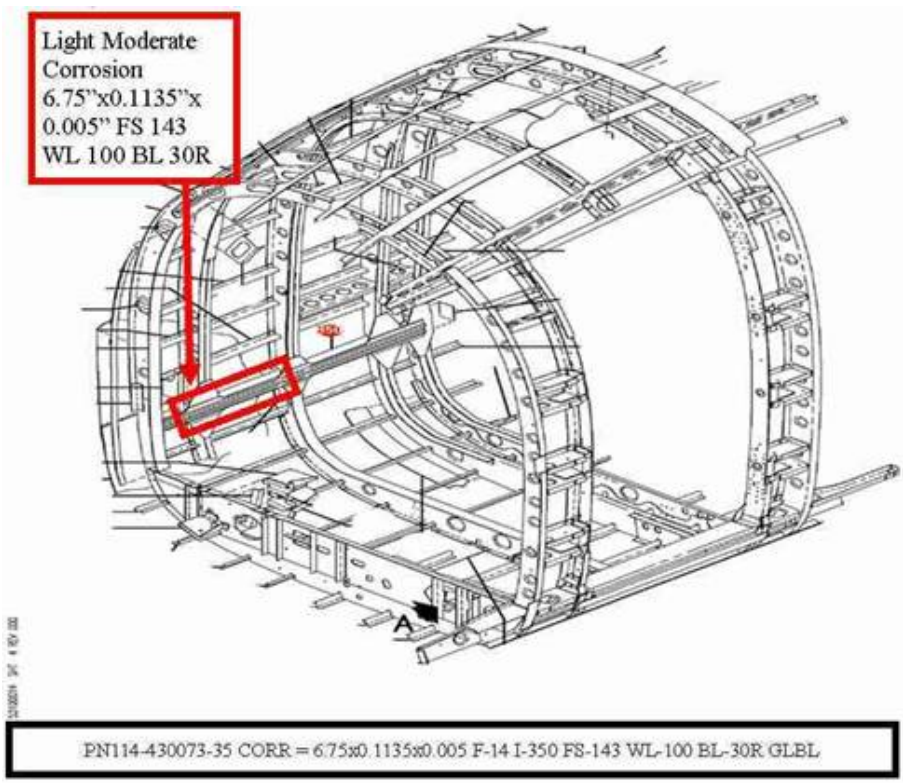


Figure 172. Right Seat Rail, Light to Moderate Corrosion—Global View

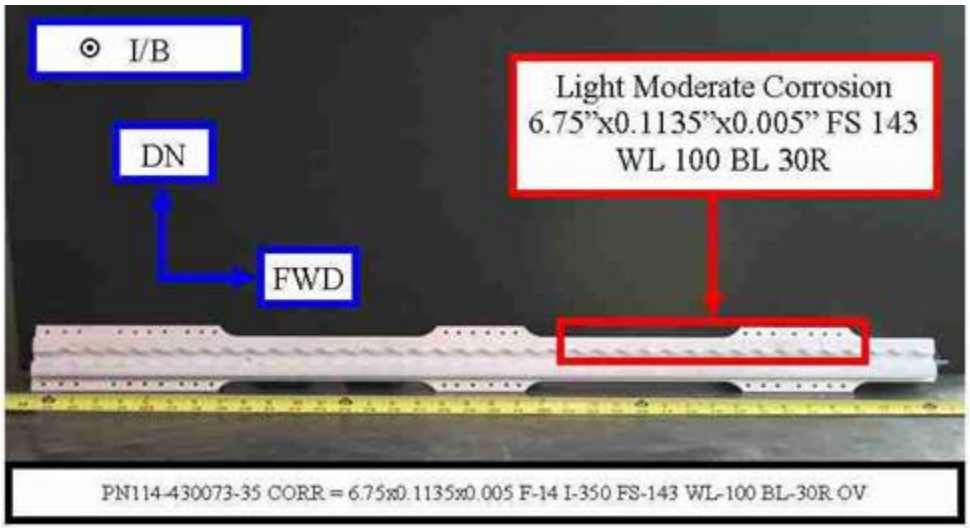


Figure 173. Right Seat Rail, Light to Moderate Corrosion—Overview

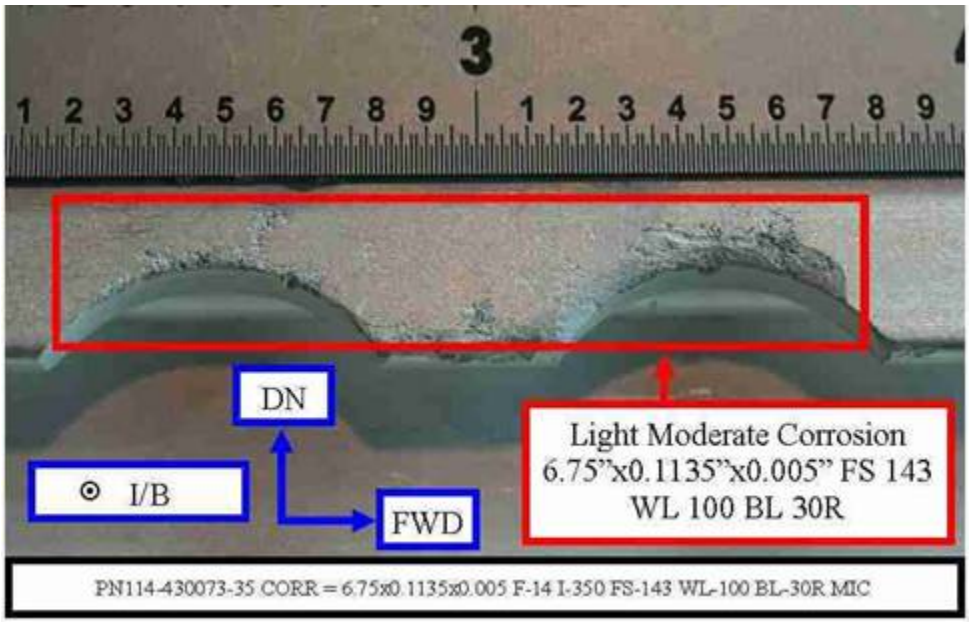


Figure 174. Right Seat Rail, Light to Moderate Corrosion—Macroscopic View

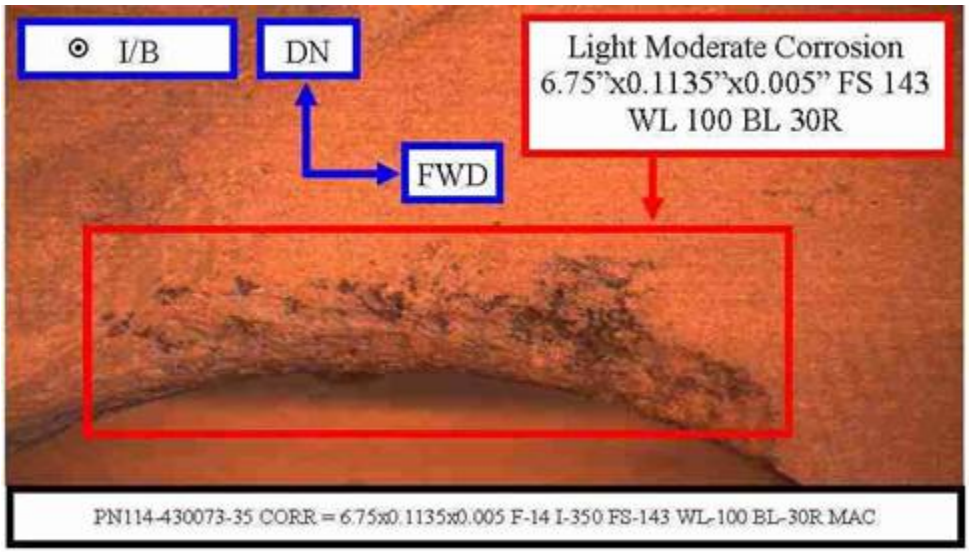


Figure 175. Right Seat Rail, Light to Moderate Corrosion—Microscopic View

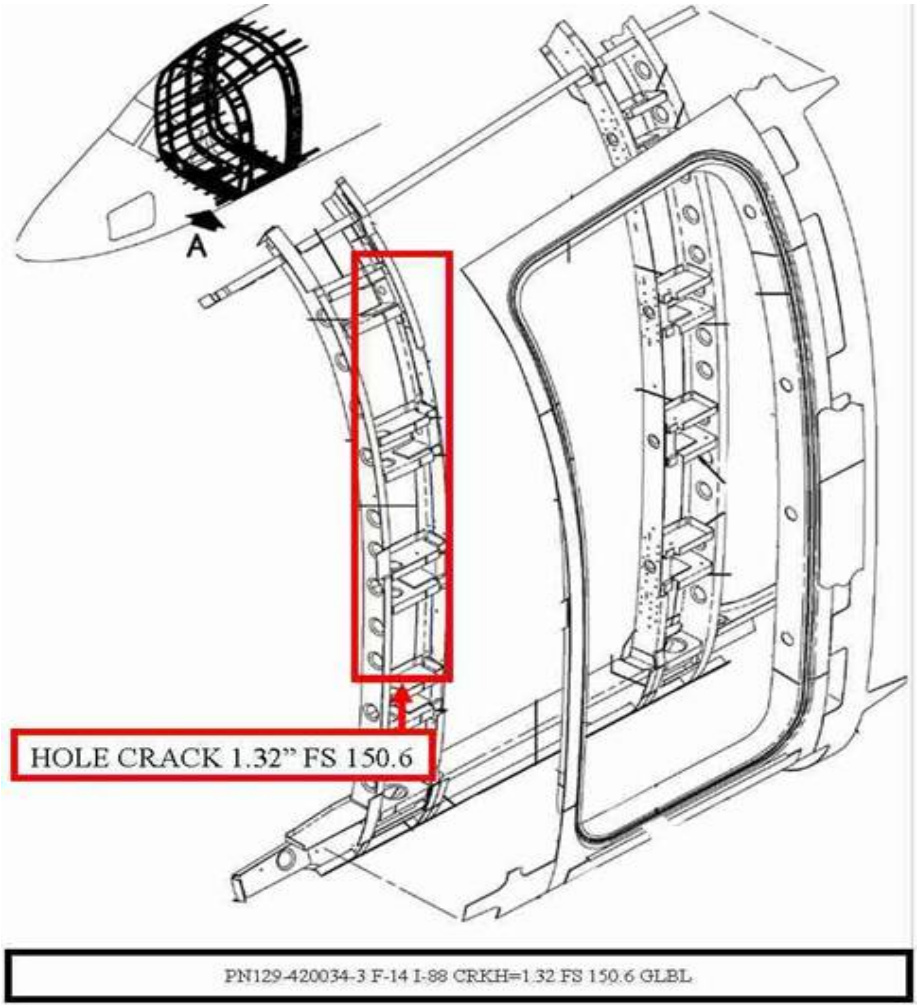


Figure 176. Entry Door Angle Crack—Global View

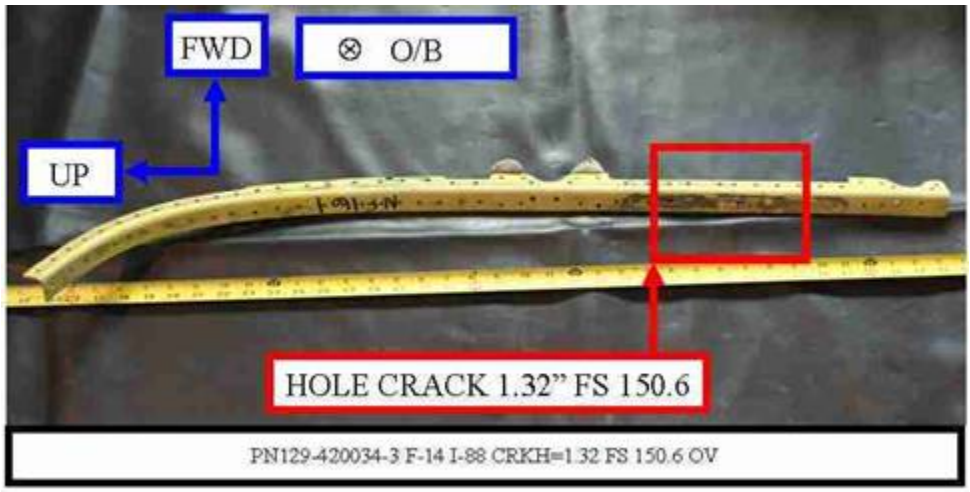


Figure 177. Entry Door Angle Crack—Overview

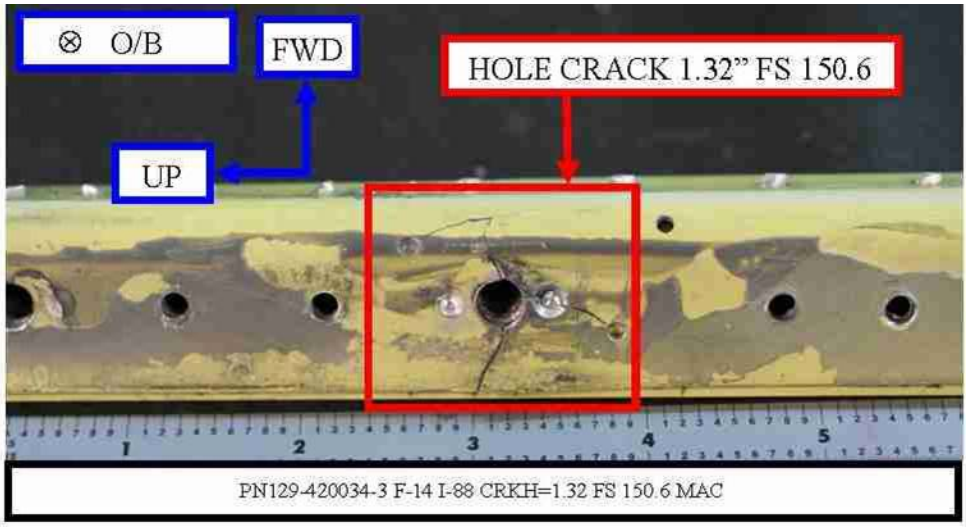


Figure 178. Entry Door Angle Crack—Macroscopic View

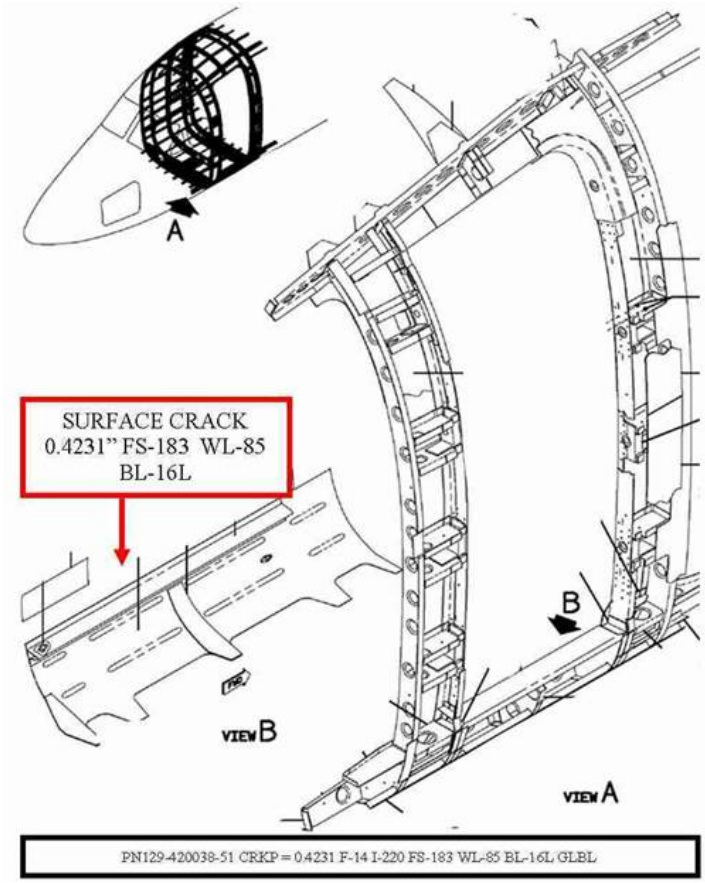


Figure 179. Inner Skin Surface Crack—Global View

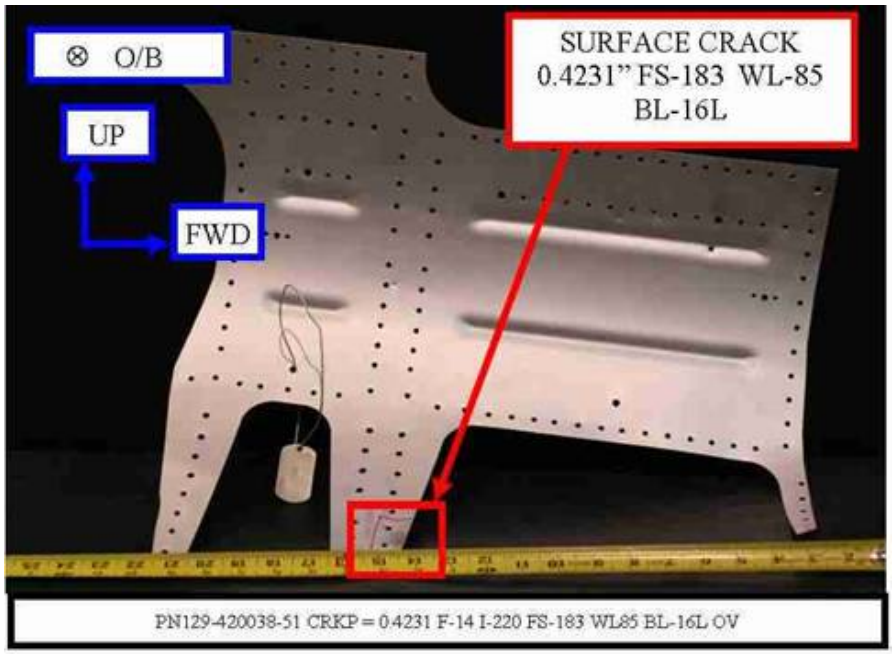


Figure 180. Inner Skin Surface Crack—Overview

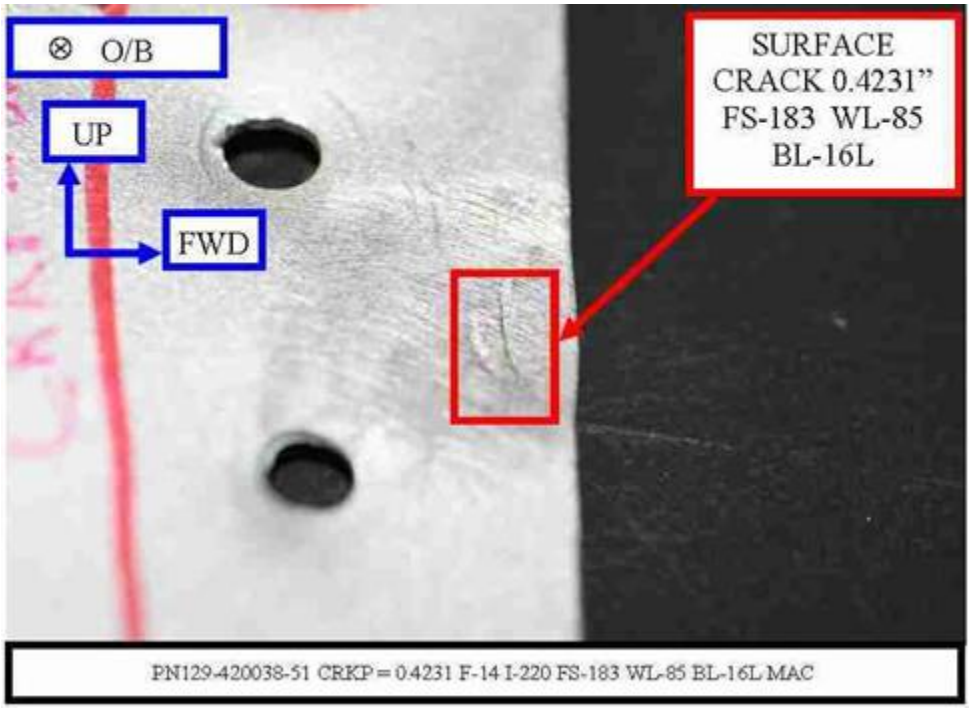


Figure 181. Inner Skin Surface Crack—Macroscopic View

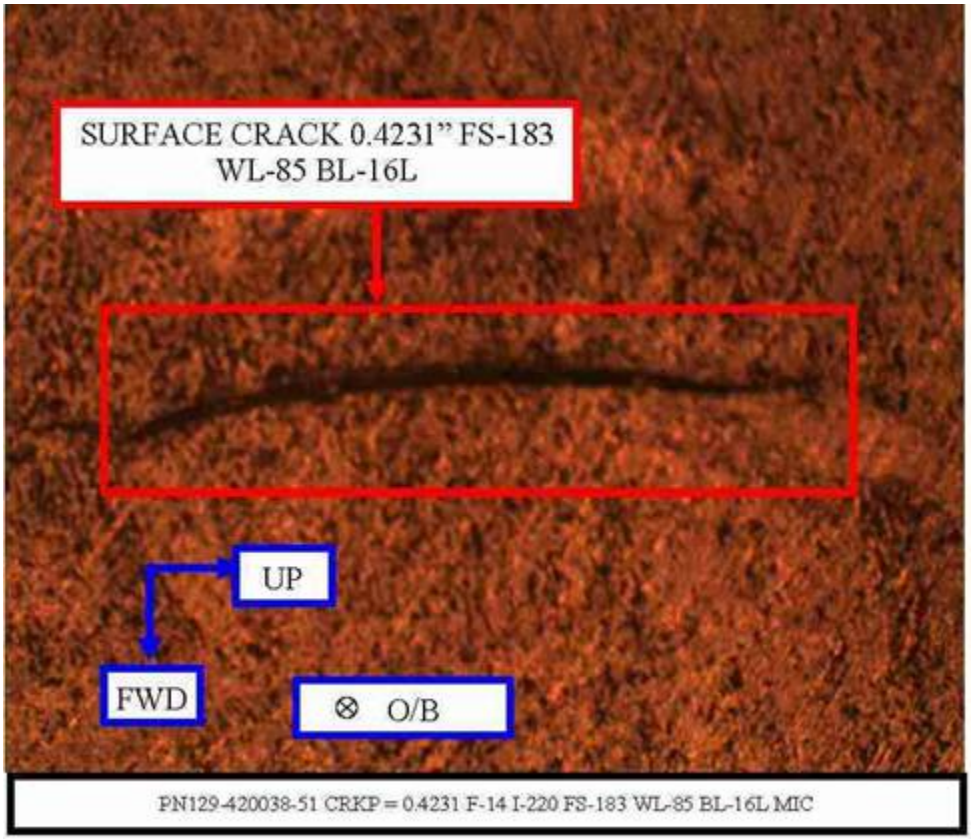


Figure 182. Inner Skin Surface Crack—Microscopic View

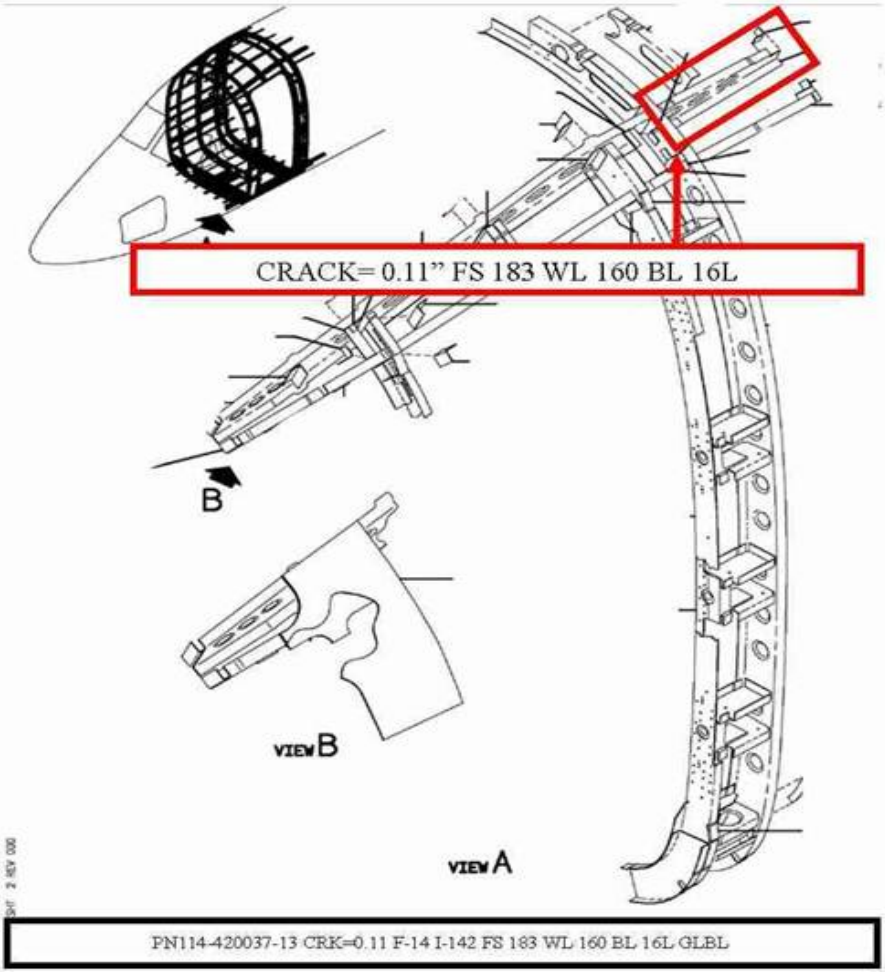


Figure 183. Cracked Intercostal—Global View

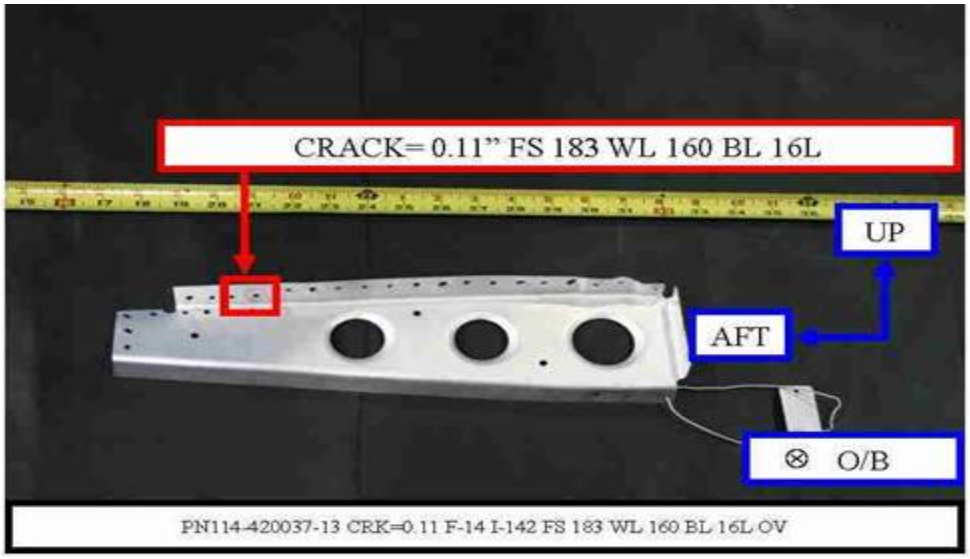


Figure 184. Cracked Intercostal—Overview

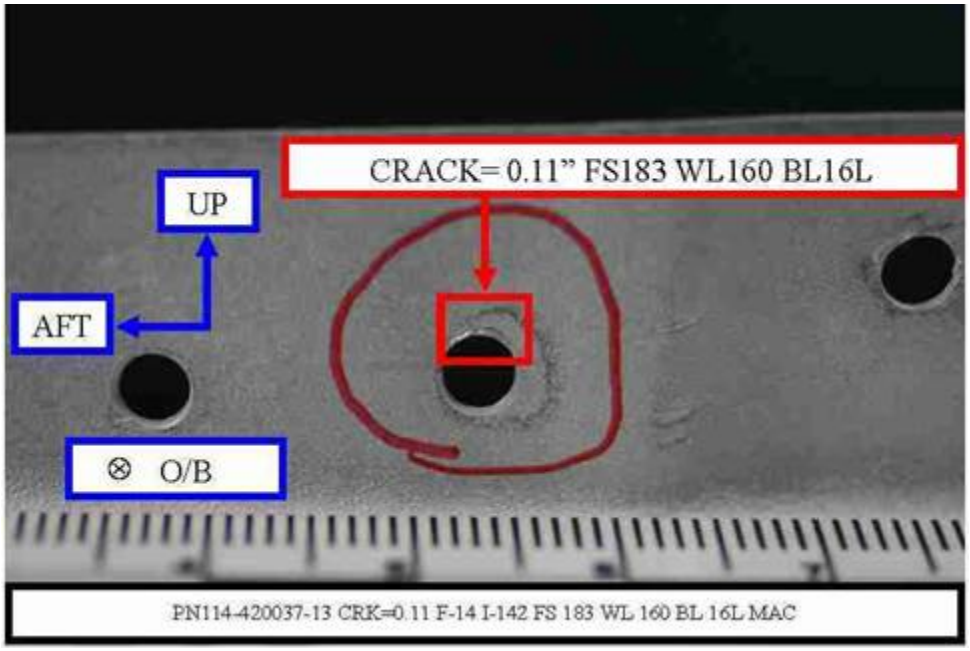


Figure 185. Cracked Intercostal—Macroscopic View

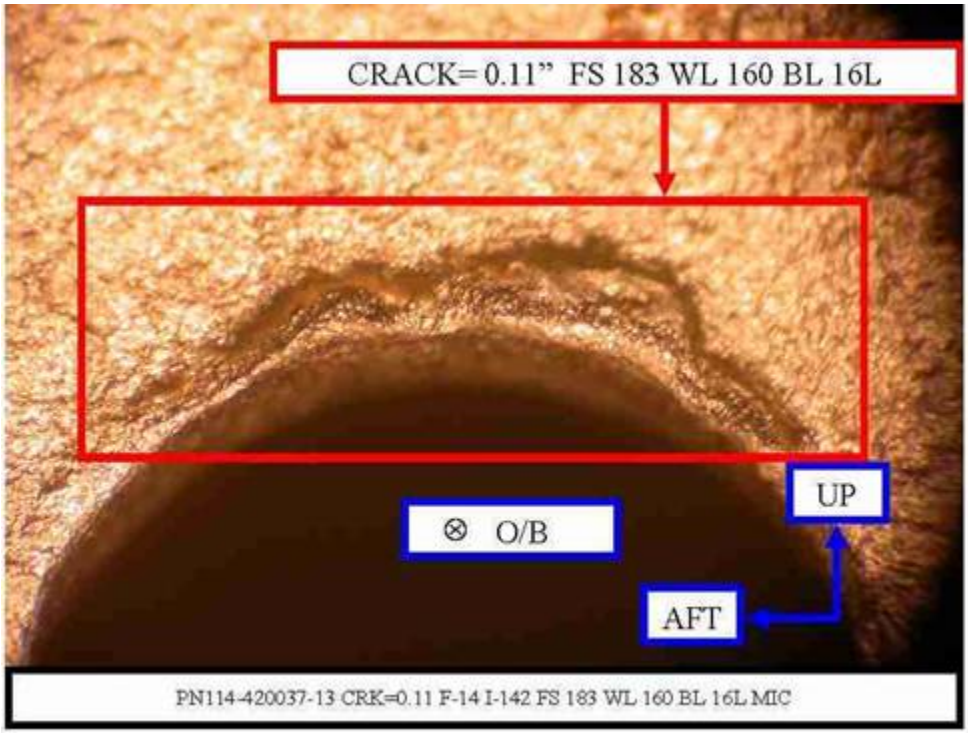


Figure 186. Cracked Intercostal—Microscopic View

3.4.2 Mid Fuselage Examination Overview.

During the teardown examination of the mid fuselage (see figure 187), the area of concentration included, but was not limited to, the frames, escape hatch, and windows. Two hundred eighty-eight parts were examined during the detailed disassembly and postdisassembly process in an effort to locate and characterize all areas of damage on the Beechcraft 1900D. Thirty-two defects were discovered and characterized as relevant findings during the disassembly and postdisassembly process of the mid fuselage. There were 7 cracks classified as relevant, 22 areas of light to moderate corrosion were found, with 3 additional areas of corrosion classified as severe (see table 30). Microscopic examinations were performed on 14,129 holes of the 288 parts identified.

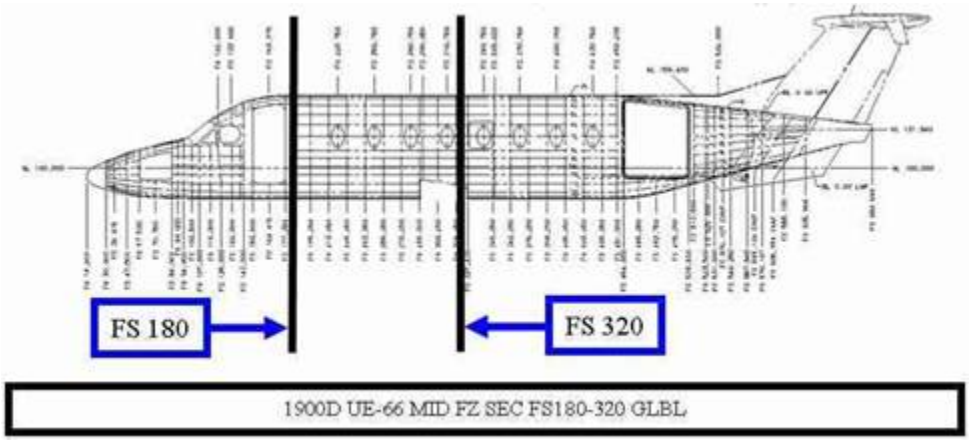


Figure 187. Mid Fuselage Section

Categorizing relevant findings were subjected to the technical expertise and historical data provided by Raytheon structure engineers and technical support based upon prior history of defects discovered in the field relating to this particular airframe. Prior to examining the frames, all skins were removed, as shown in figure 188, and each frame was disassembled for total accessibility, an illustration of this is shown in figure 189.

Of the 288 parts examined during the disassembly phase of the mid fuselage teardown examination, 7 defects pertaining to the frames were considered relevant, such as cracks, corrosion, and wear, and they are listed in table 30. Two particular areas of concentration that required special attention were the escape hatch and windows.

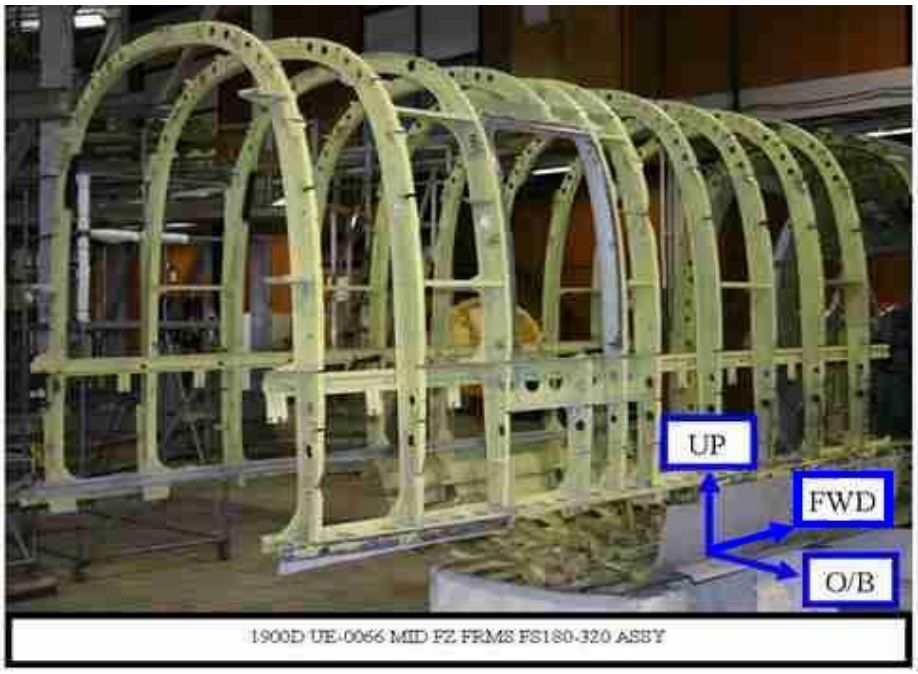


Figure 188. Mid Fuselage Frames Overview Assembled

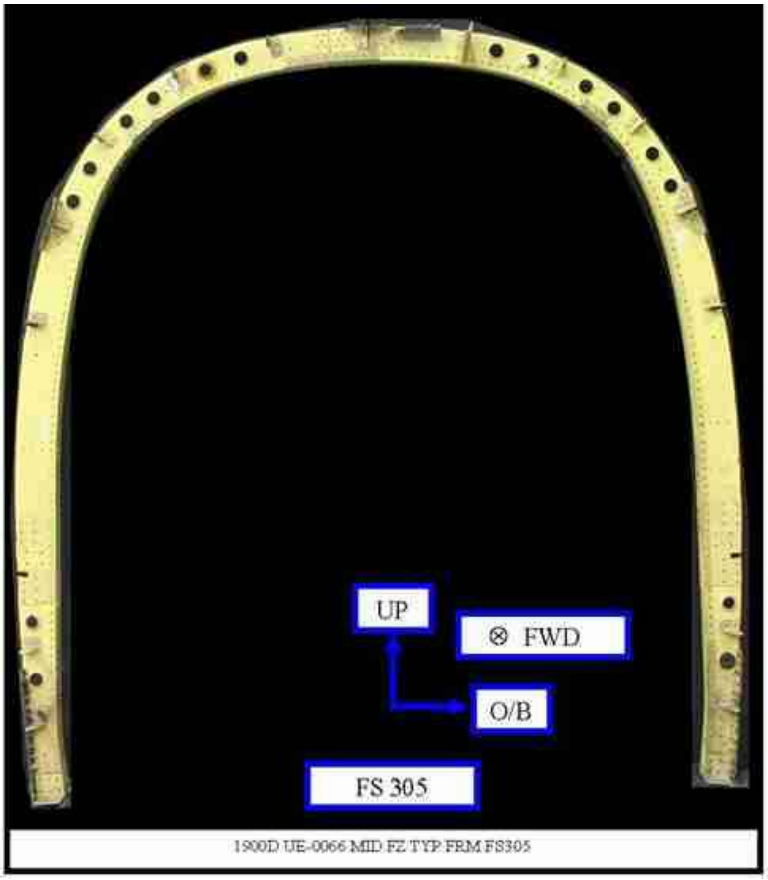


Figure 189. Frame Overview Disassembled

Table 30. Mid Fuselage Frames Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Corr	1.250	0.85	0.022	213.3	78	Severe Corrosion on Frame Assembly	Figure 190 Global Figure 191 Overview Figure 192 Macroscopic Figure 193 Microscopic
Crack	0.030			213	93	Crack on Frame Clip	Figure 194 Global Figure 195 Overview Figure 196 Macroscopic Figure 197 Microscopic
Crack	0.010			243.2	78	Crack on Frame Assembly	Figure 198 Global Figure 199 Overview Figure 200 Macroscopic Figure 201 Microscopic
Corr	6.750	1.5	0.015	243.3	78	Severe Corrosion on Frame Assembly	Figure 202 Global Figure 203 Overview Figure 204 Macroscopic
Crack	0.750 0.125			246	93	Crack on Seat Track Support Assembly	Figure 205 Global Figure 206 Overview Figure 207 Macroscopic Figure 208 Microscopic
Corr	0.200	0.8	0.025	288	93	Severe Corrosion on Frame Doubler	Figure 209 Global Figure 210 Overview Figure 211 Macroscopic Figure 212 Microscopic

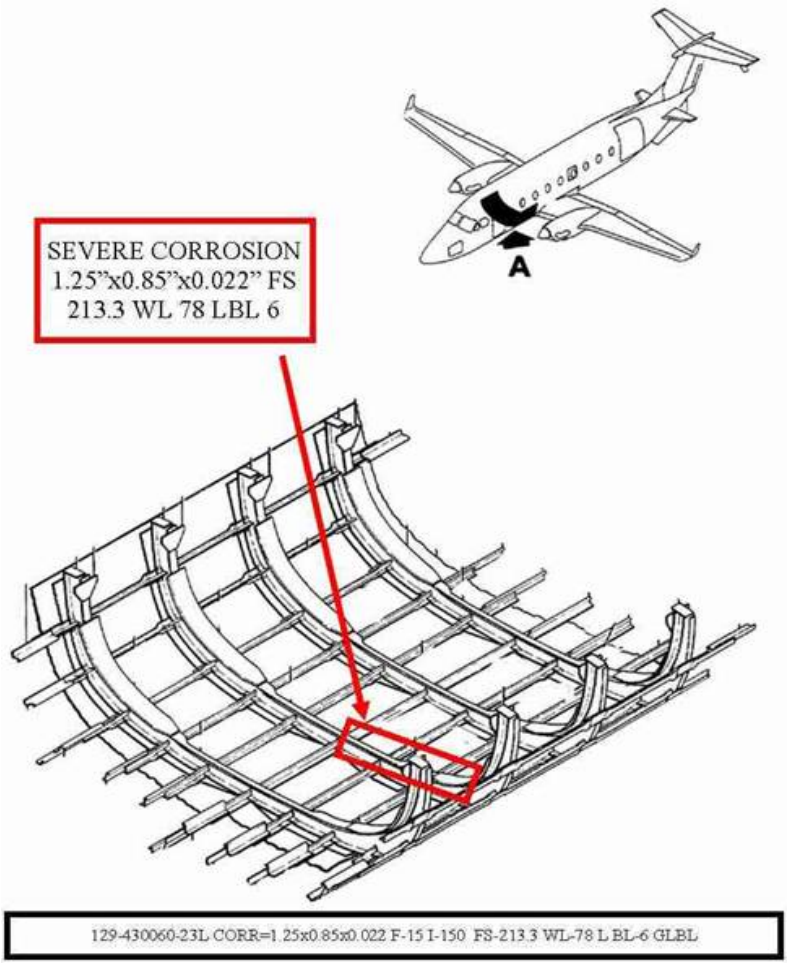


Figure 190. Severe Corrosion Frame Assembly—Global View (FS 213.3)

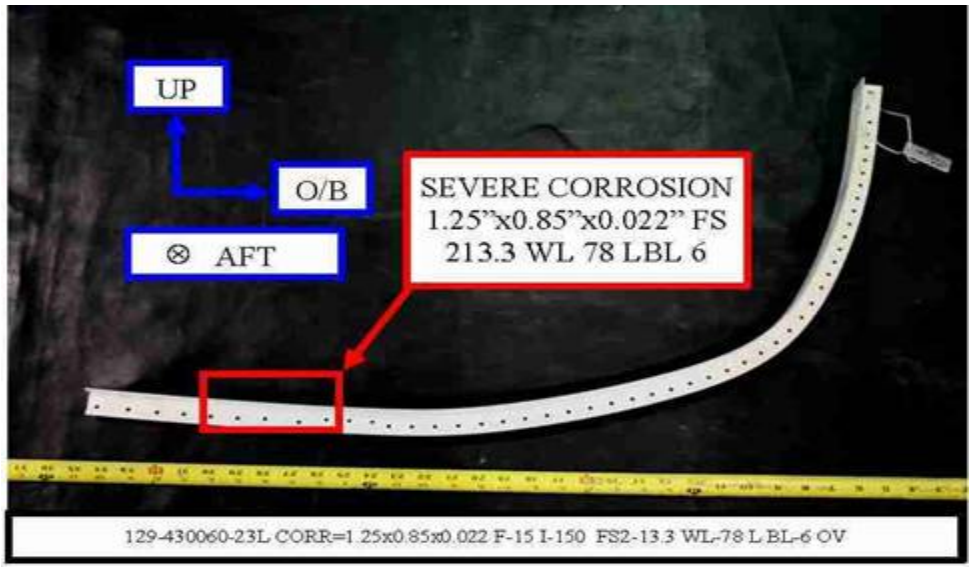


Figure 191. Severe Corrosion Frame Assembly—Overview (FS 213.3)

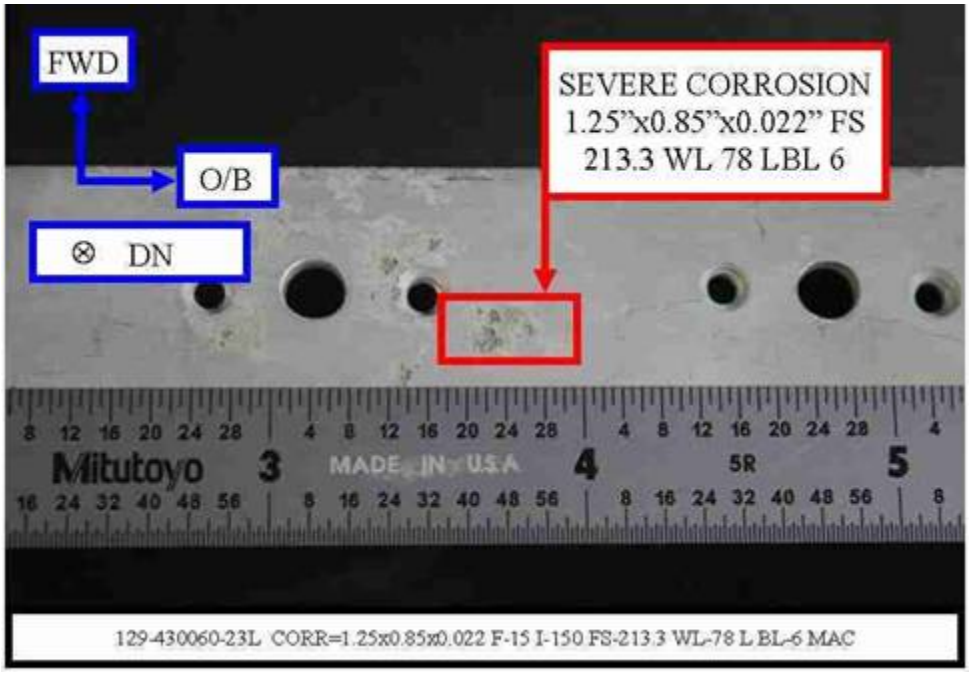


Figure 192. Severe Corrosion Frame Assembly—Macroscopic View (FS 213.3)

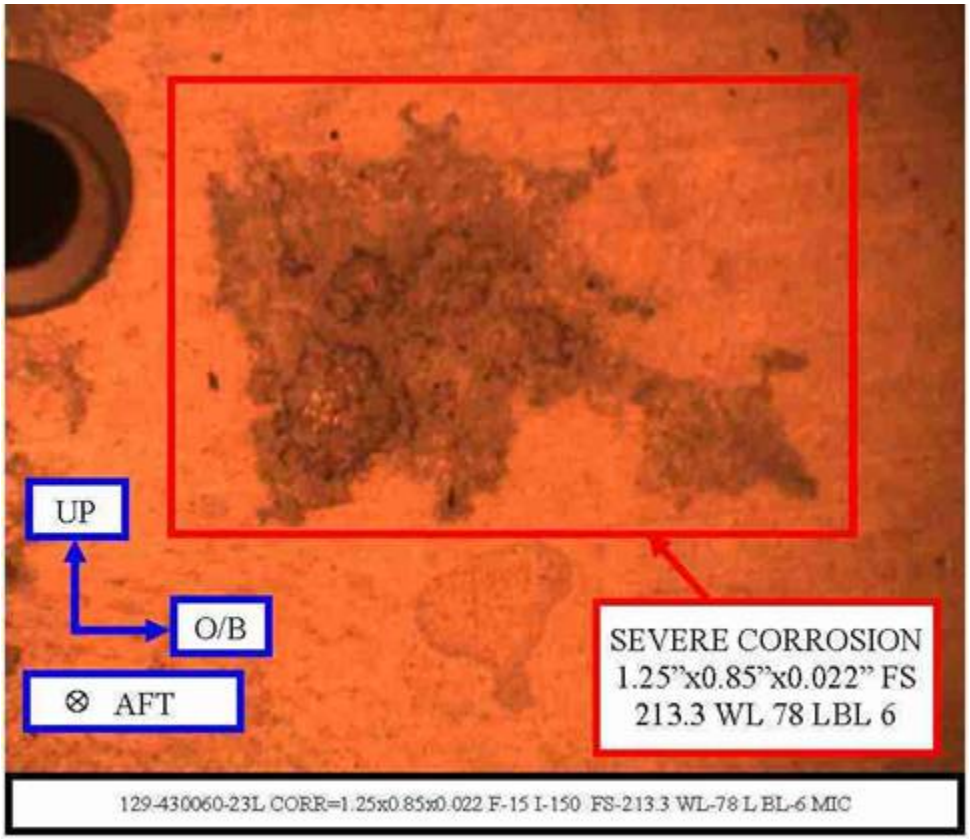


Figure 193. Severe Corrosion Frame Assembly—Microscopic View (FS 213.3)

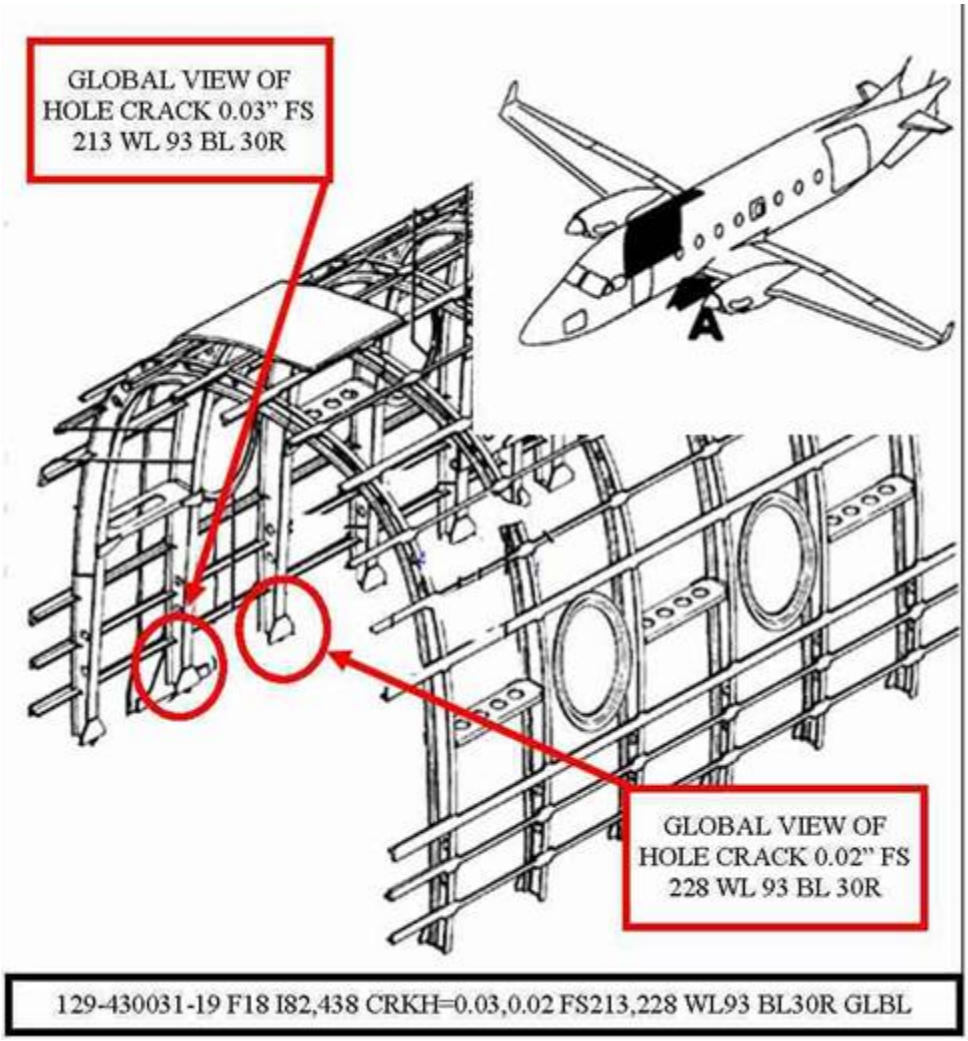


Figure 194. Crack on Frame Clip—Global View

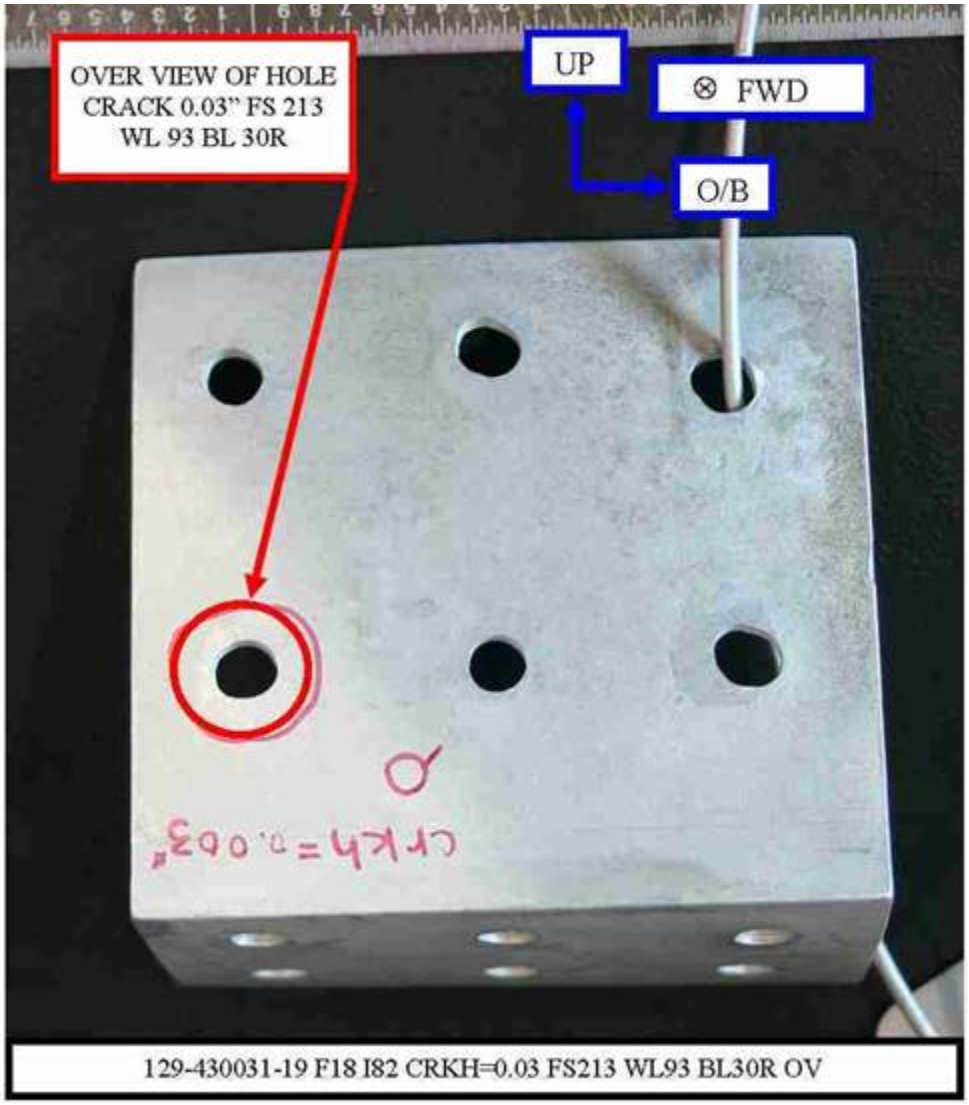


Figure 195. Crack on Frame Clip—Overview

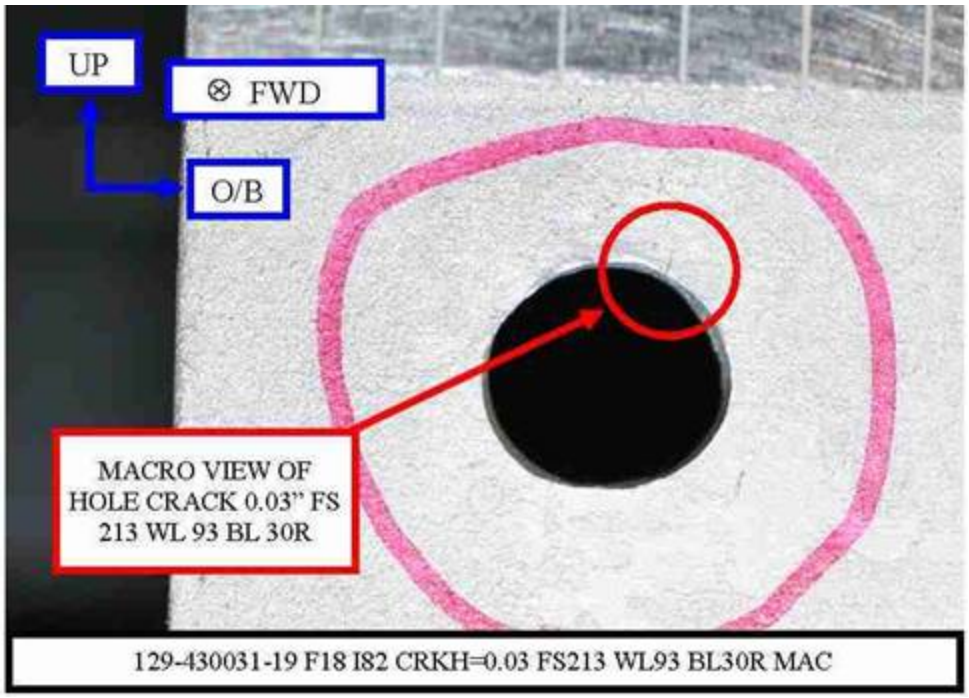


Figure 196. Crack on Frame Clip—Macroscopic View

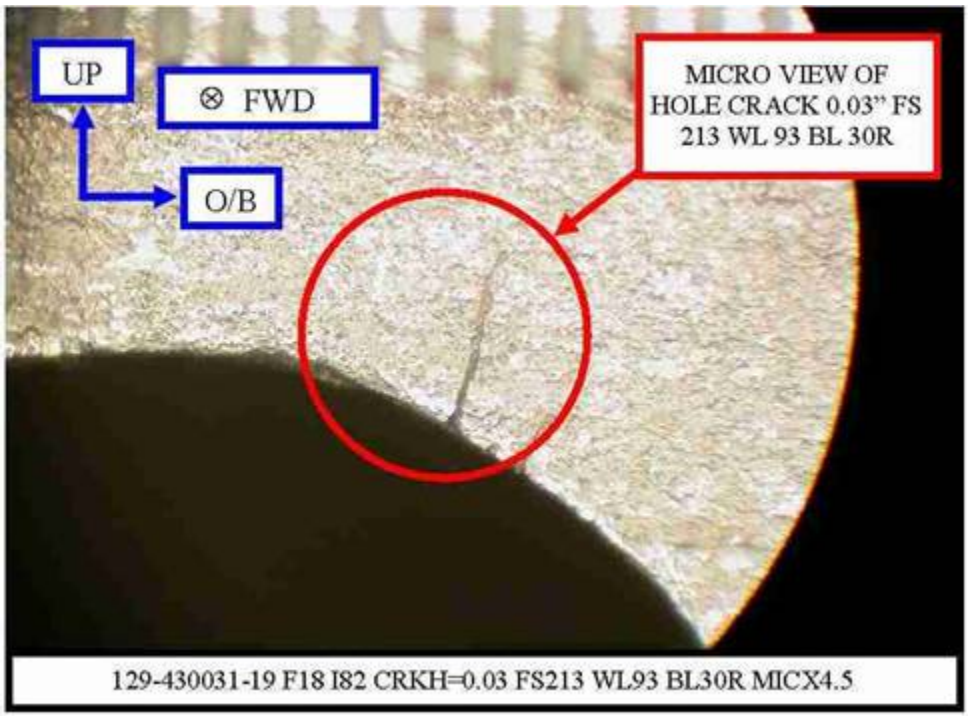


Figure 197. Crack on Frame Clip—Microscopic View

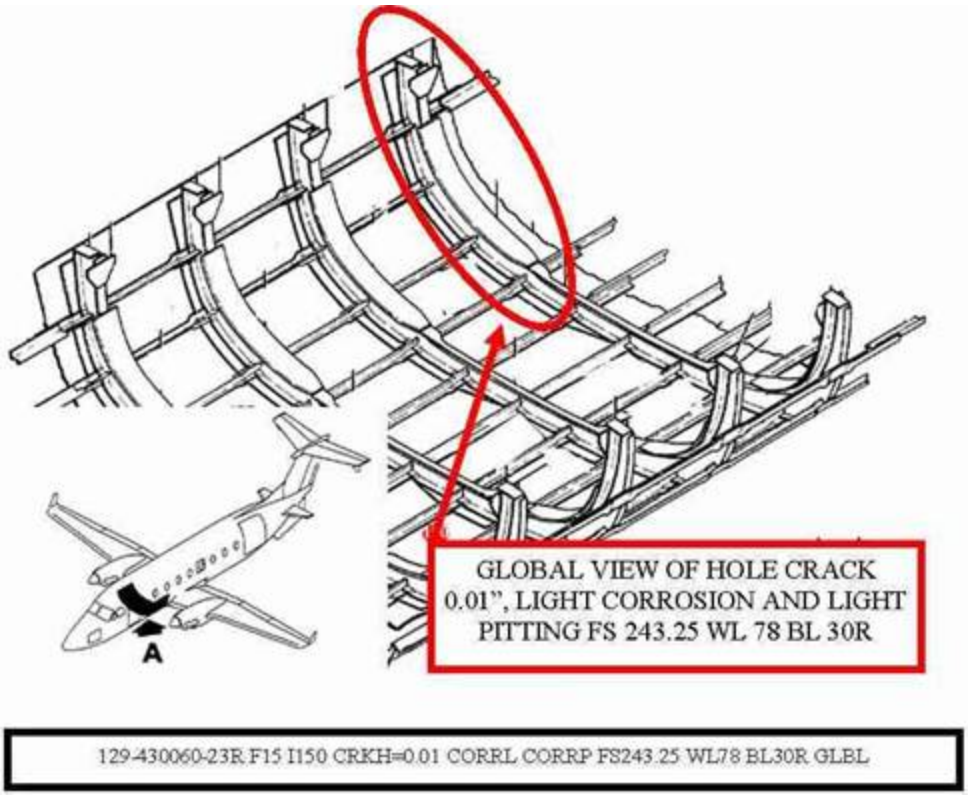


Figure 198. Hole Crack on Frame Assembly—Global View

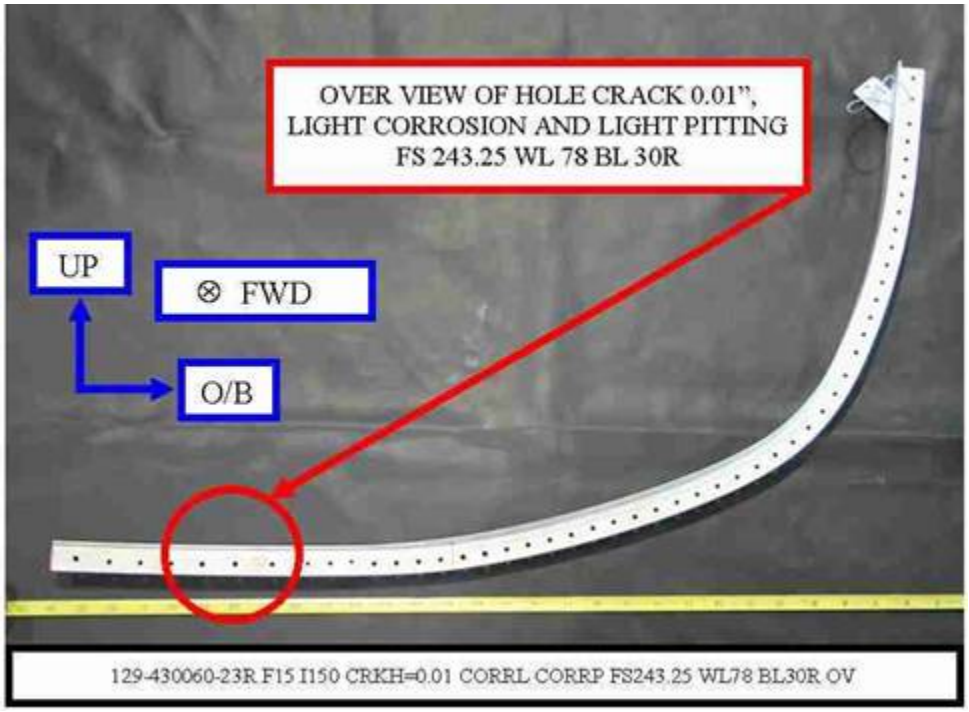


Figure 199. Hole Crack on Frame Assembly—Overview

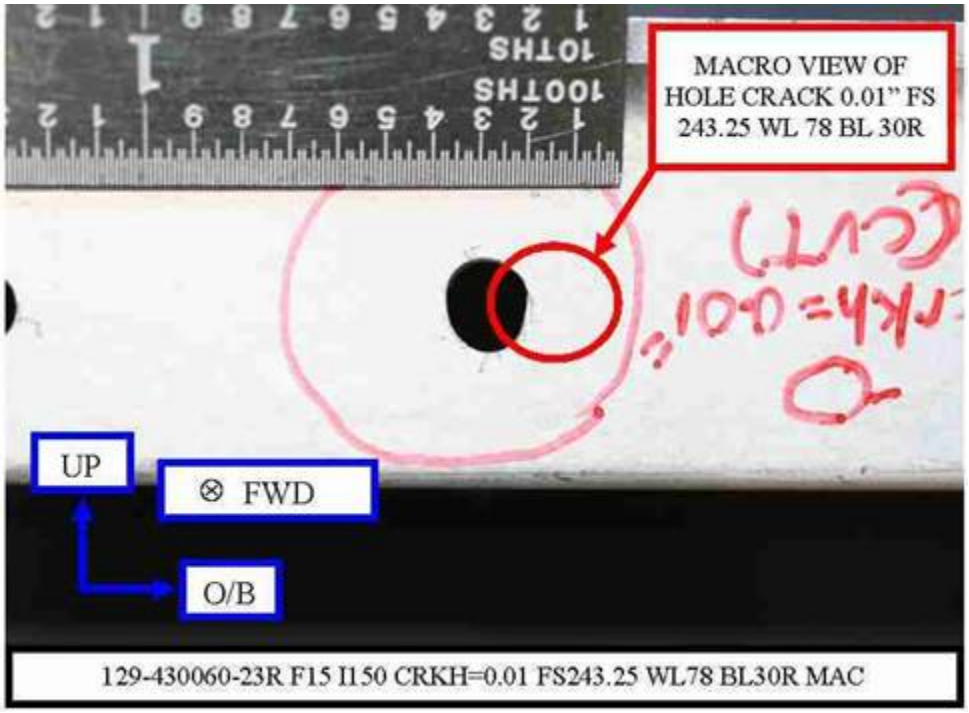


Figure 200. Hole Crack on Frame Assembly—Macroscopic View

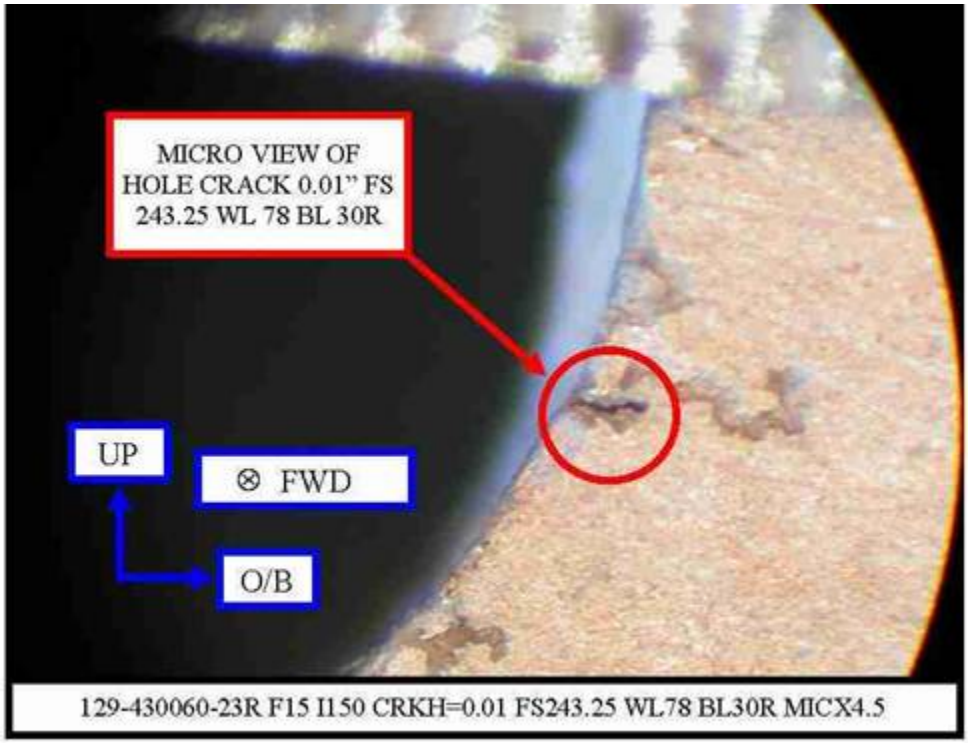


Figure 201. Hole Crack on Frame Assembly—Microscopic View

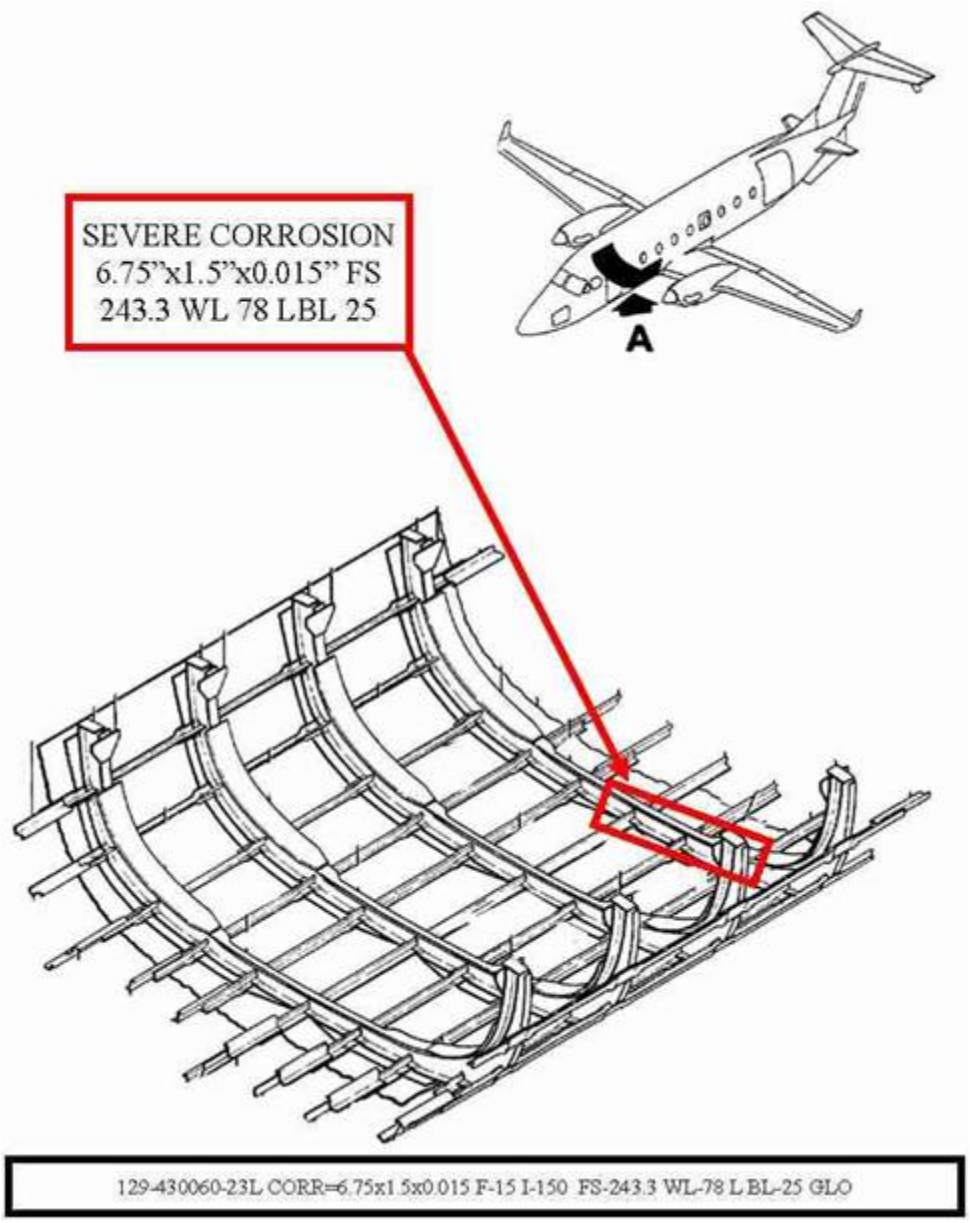


Figure 202. Severe Corrosion on Frame Assembly—Global View (FS 243.3)

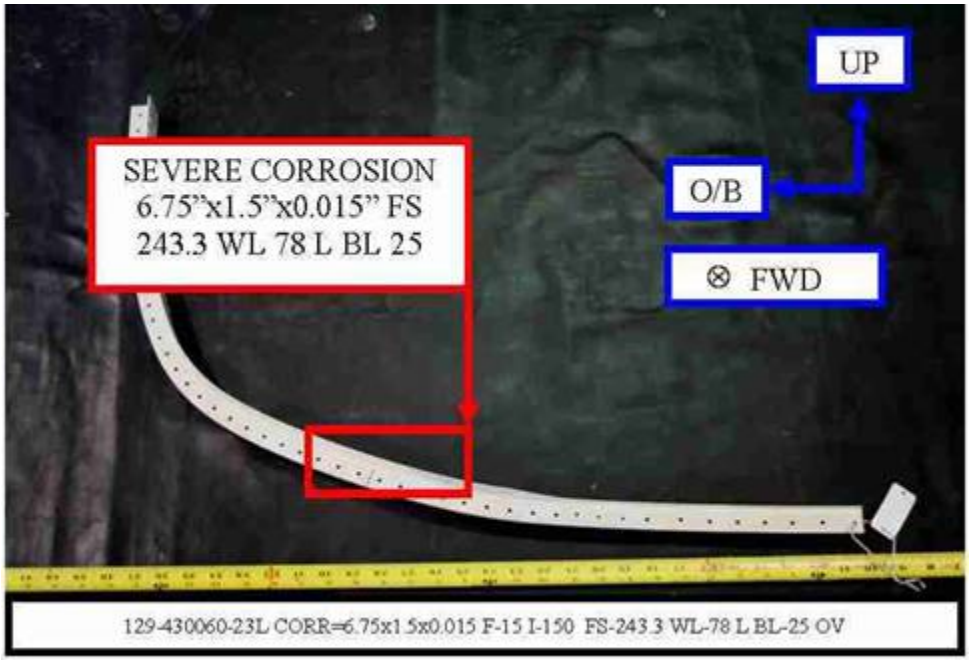


Figure 203. Severe Corrosion on Frame Assembly—Overview (FS 243.3)

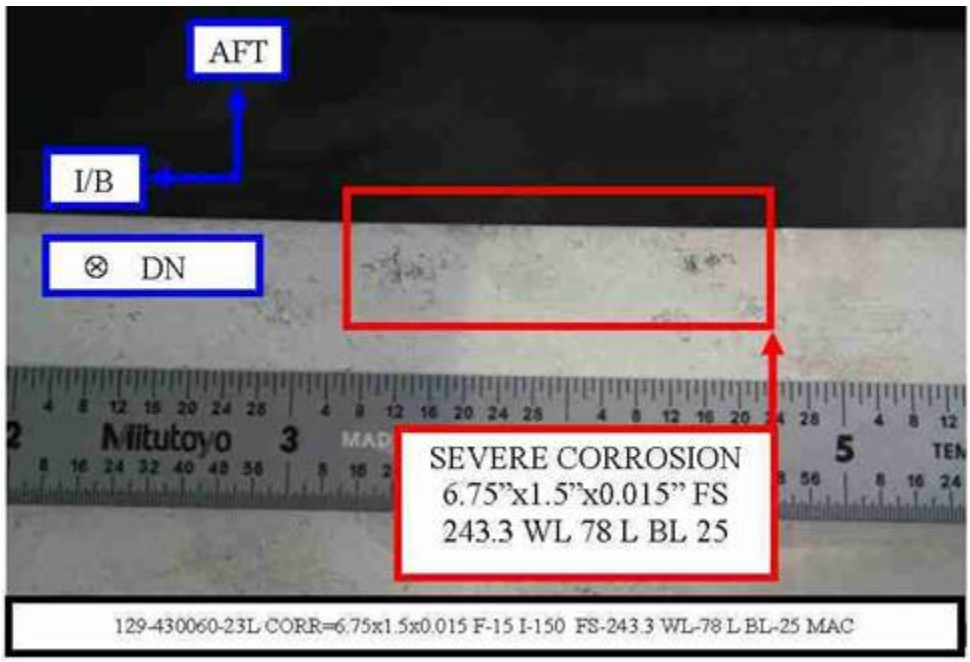


Figure 204. Severe Corrosion on Frame Assembly—Macroscopic View (FS 243.3)

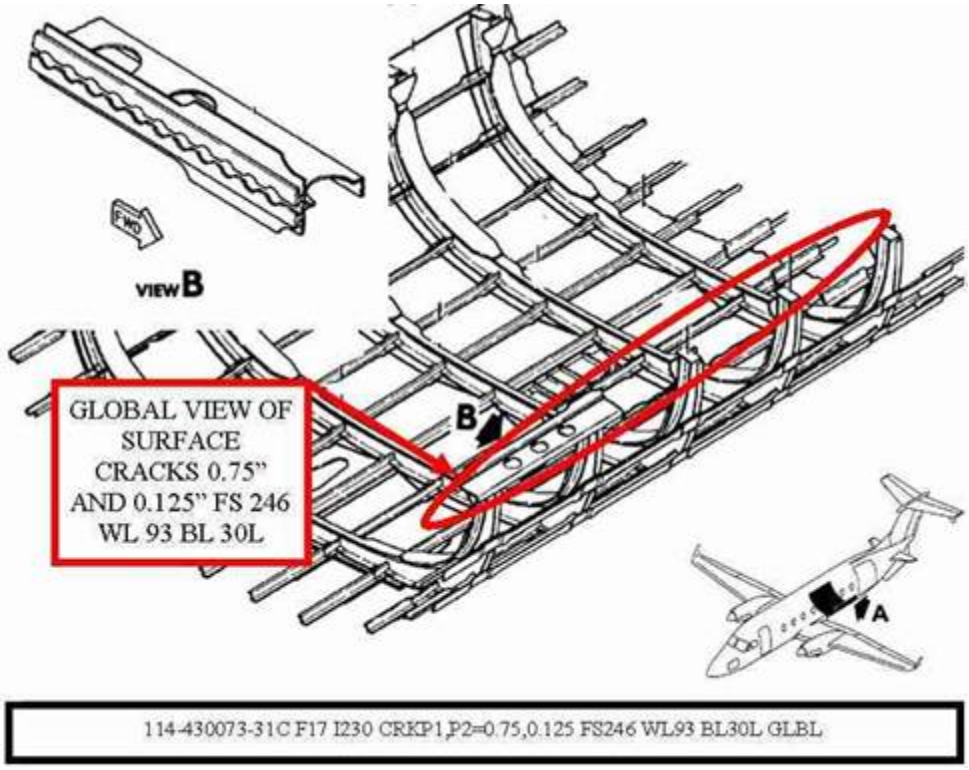


Figure 205. Cracks on Seat Track Support Assembly—Global View

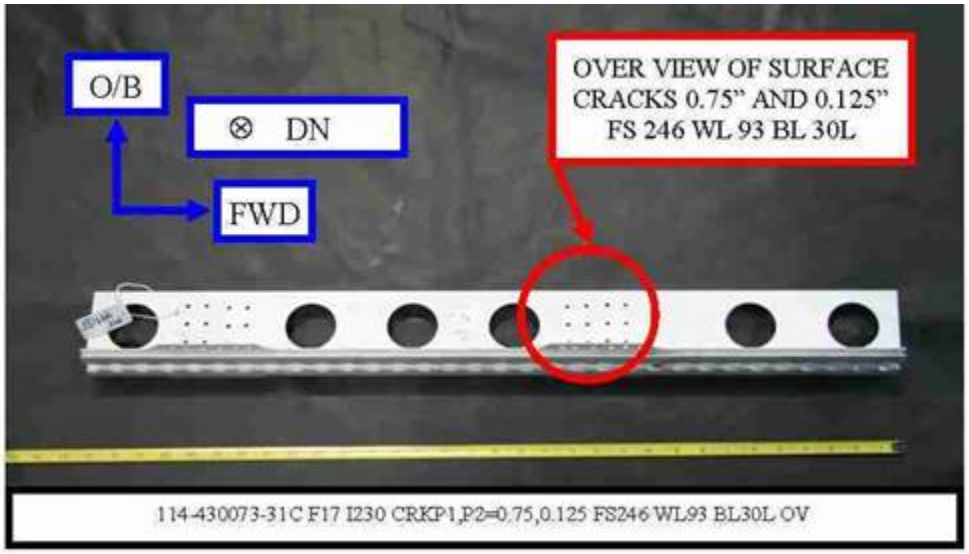


Figure 206. Cracks on Seat Track Support Assembly—Overview

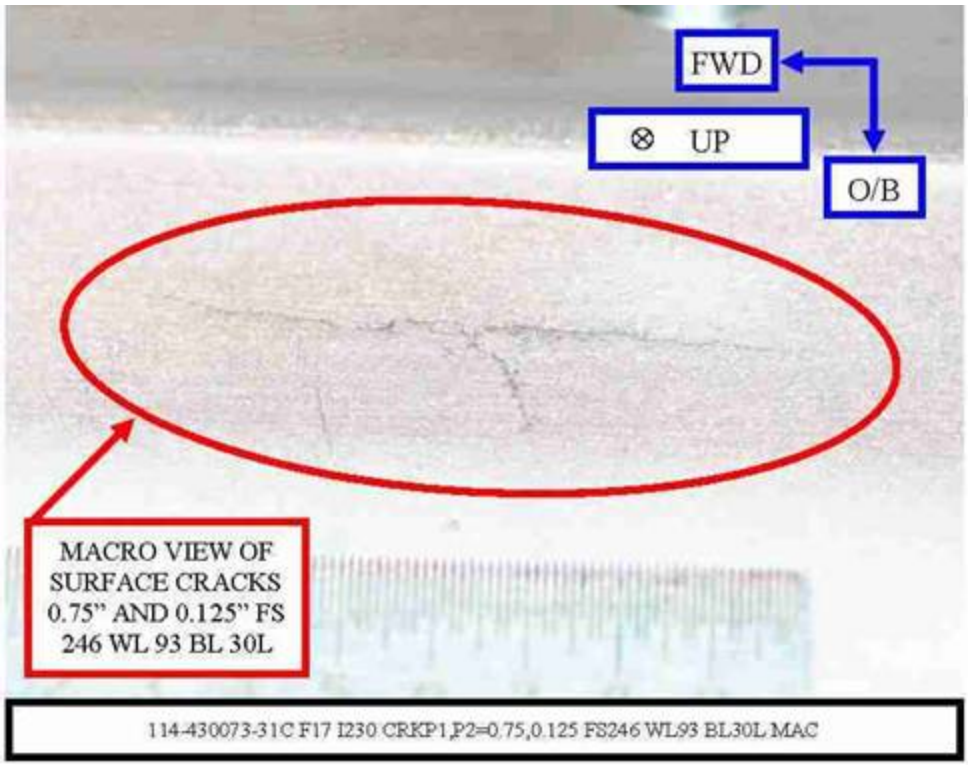


Figure 207. Cracks on Seat Track Support Assembly—Macroscopic View

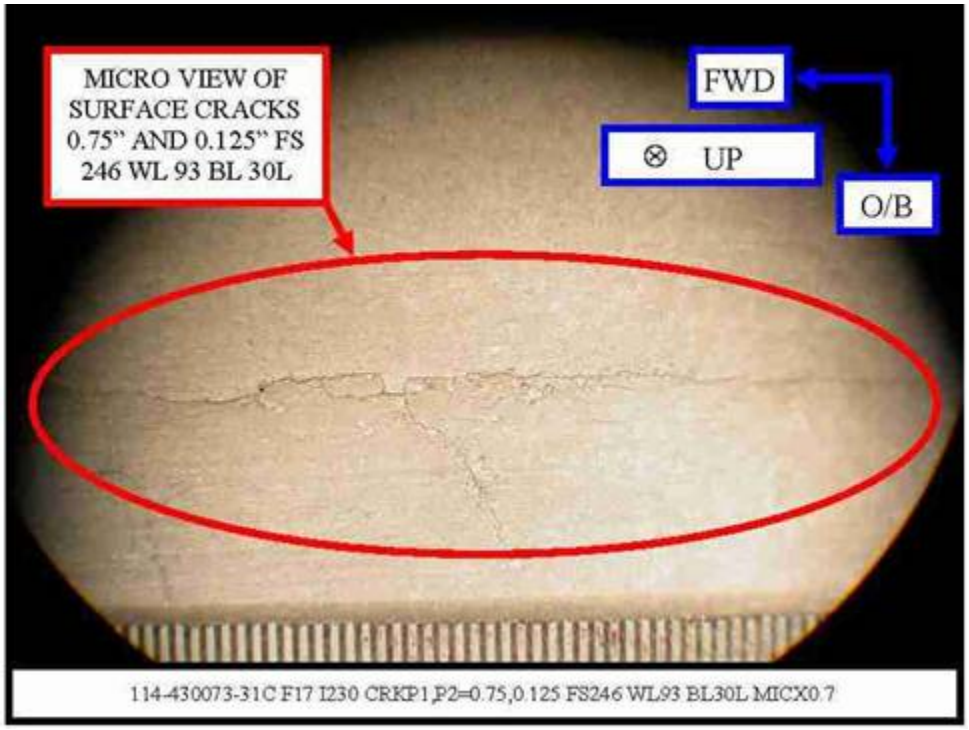


Figure 208. Cracks on Seat Track Support Assembly—Microscopic View

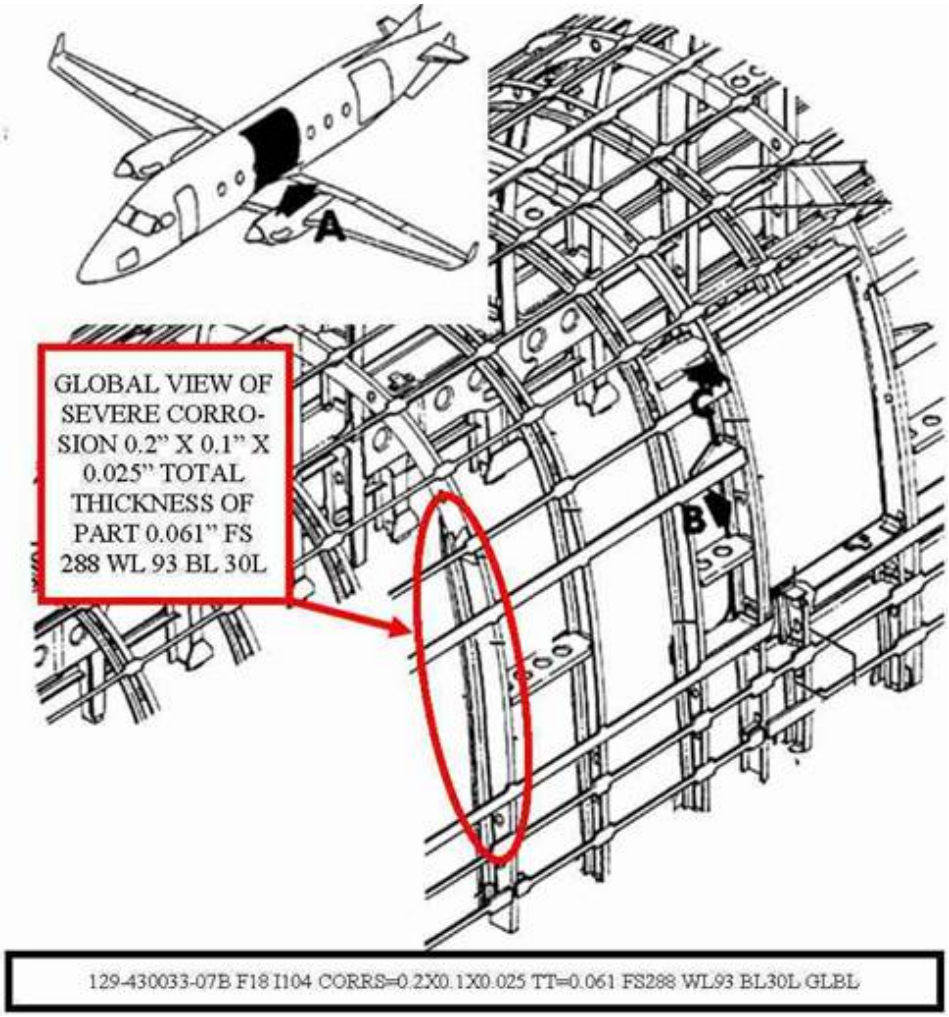


Figure 209. Severe Corrosion on Frame Doubler—Global View

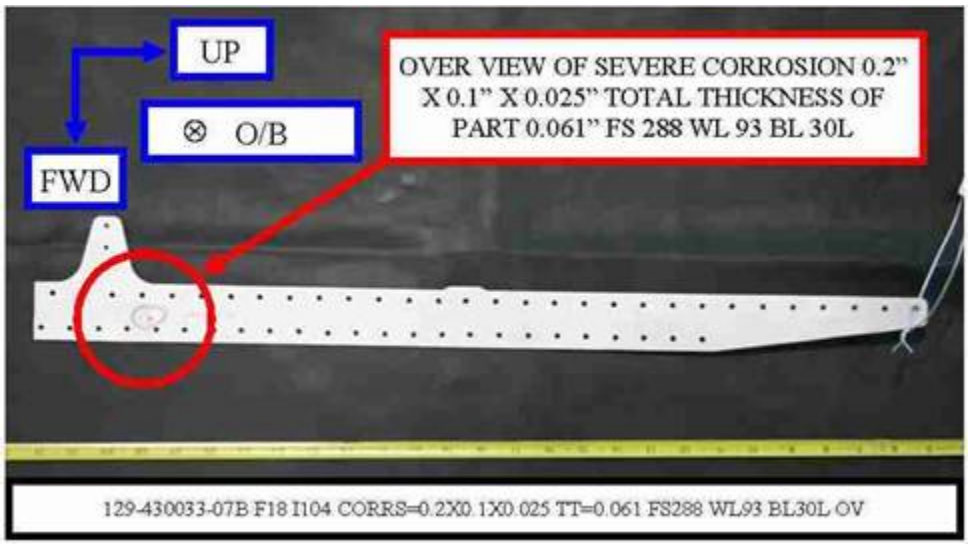


Figure 210. Severe Corrosion on Frame Doubler—Overview

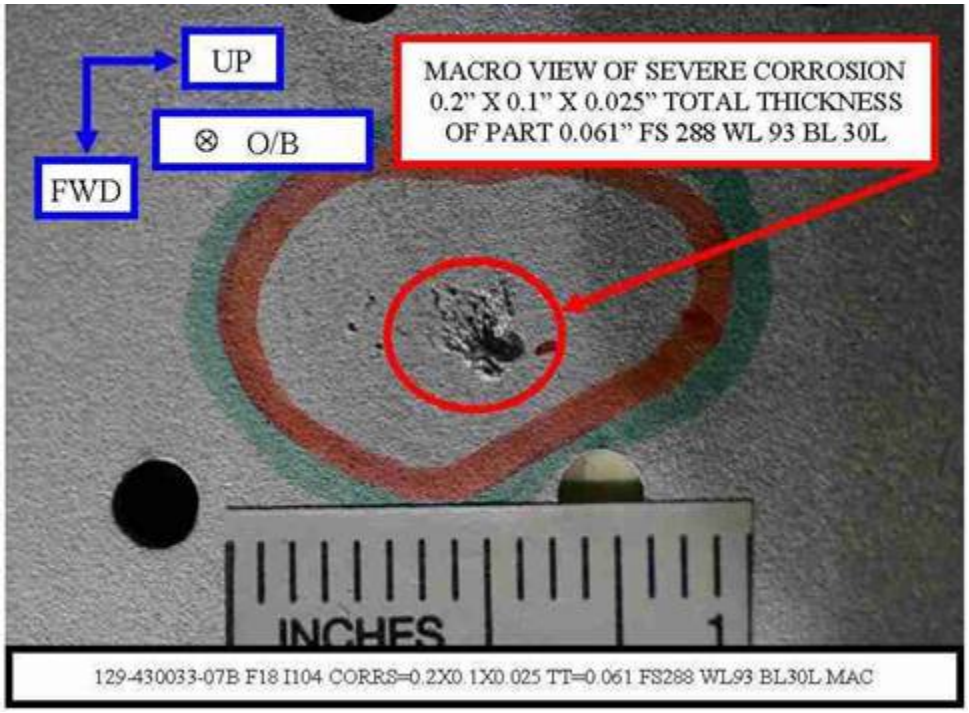


Figure 211. Severe Corrosion on Frame Doubler—Macroscopic View

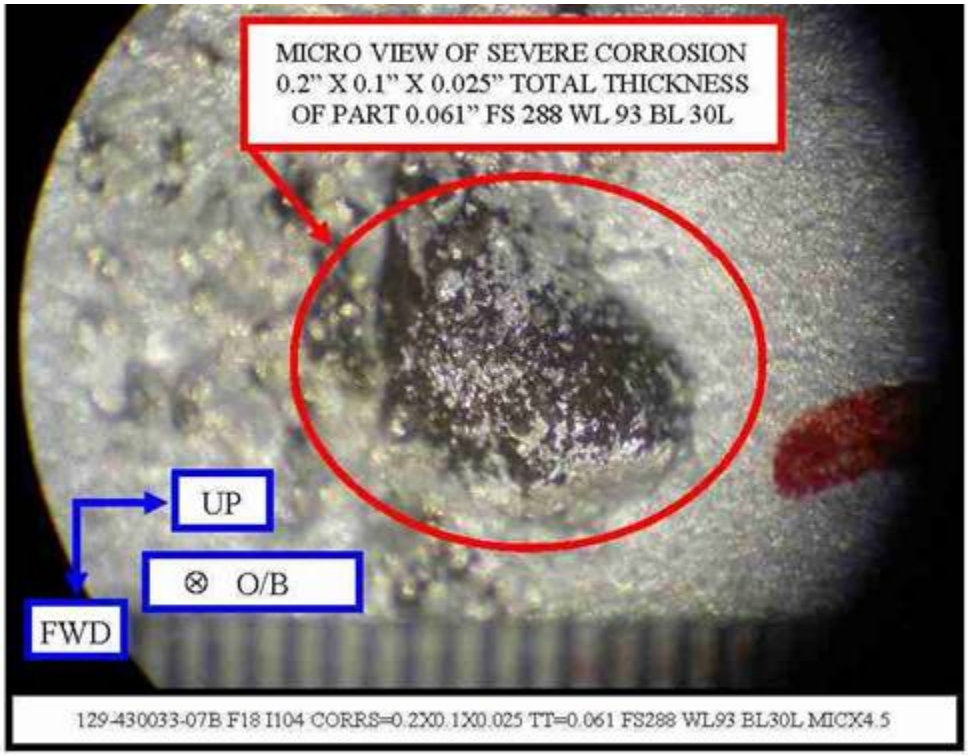


Figure 212. Severe Corrosion on Frame Doubler—Microscopic View

3.4.2.1 Mid Fuselage Escape Hatch.

The mid fuselage escape hatch (see figure 213) was inspected by NDI technicians for crack and corrosion indications using current MOI techniques. Figure 214 shows the areas inspected, such as double rivet rows skin, gussets stringer, and the surrounding area. These areas were identified as areas of high emphasis by Raytheon technical support and engineering. Seven relevant crack defects listed in table 31 were found as a result of this inspection.

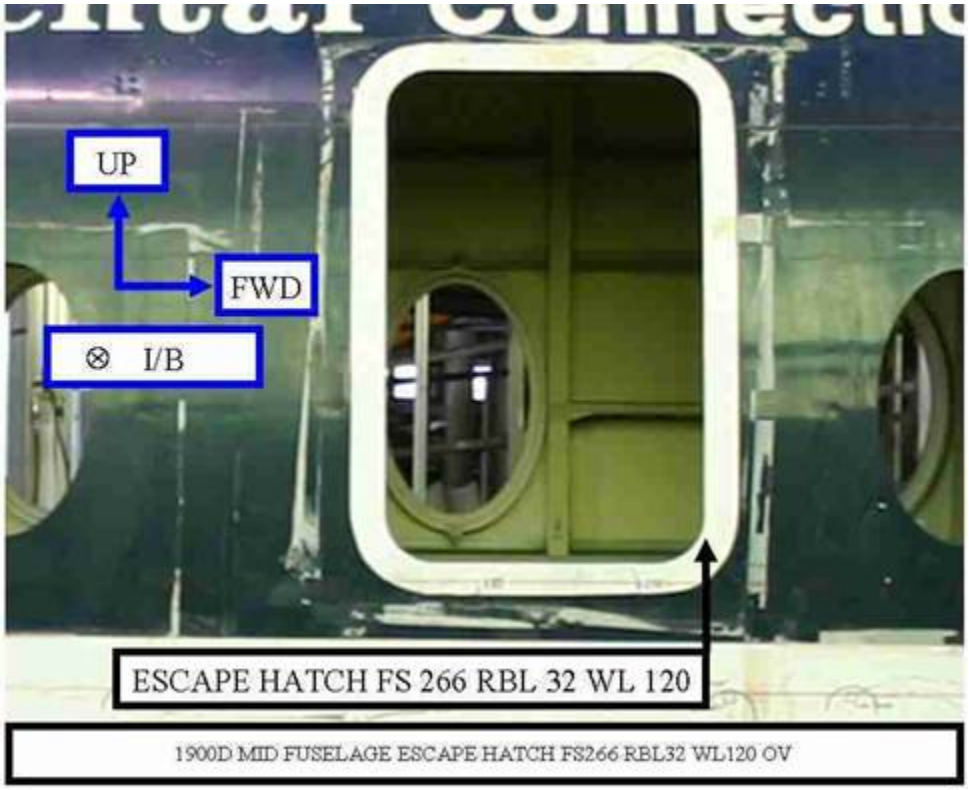


Figure 213. Mid Fuselage Escape Hatch

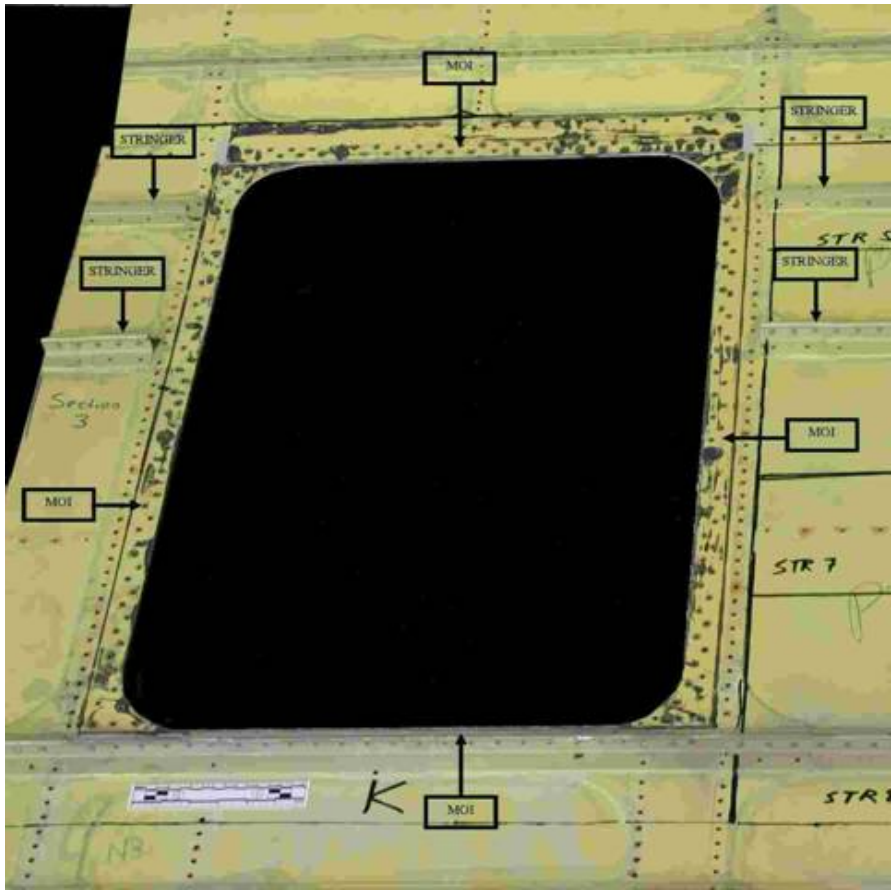


Figure 214. Escape Hatch Disassembled

Table 31. Mid Fuselage Escape Hatch Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Crack	0.26 0.19 0.59		Through crack	265	135	Crack Gussets, Left Side	Figure 215 Global Figure 216 Overview Figure 217 Macroscopic
Crack	0.26 0.32 0.56		Through crack	290	135	Crack Gussets, Right Side	Figure 215 Global Figure 218 Overview Figure 219 Macroscopic
Crack	0.03			296	160	Fuselage Skin Crack	Figure 220 Global Figure 221 Overview Figure 222 Macroscopic

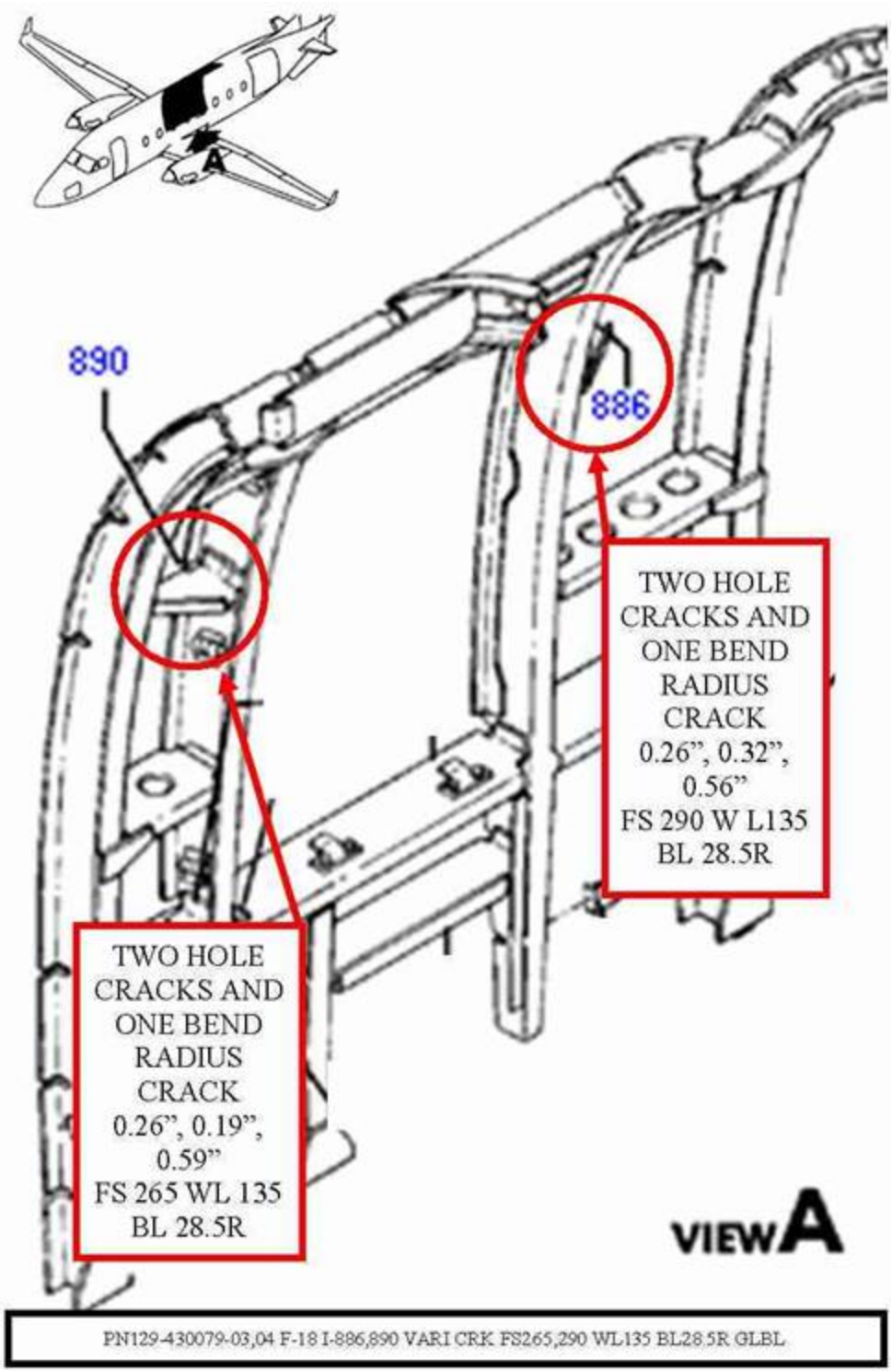


Figure 215. Cracks on Gusset—Global View

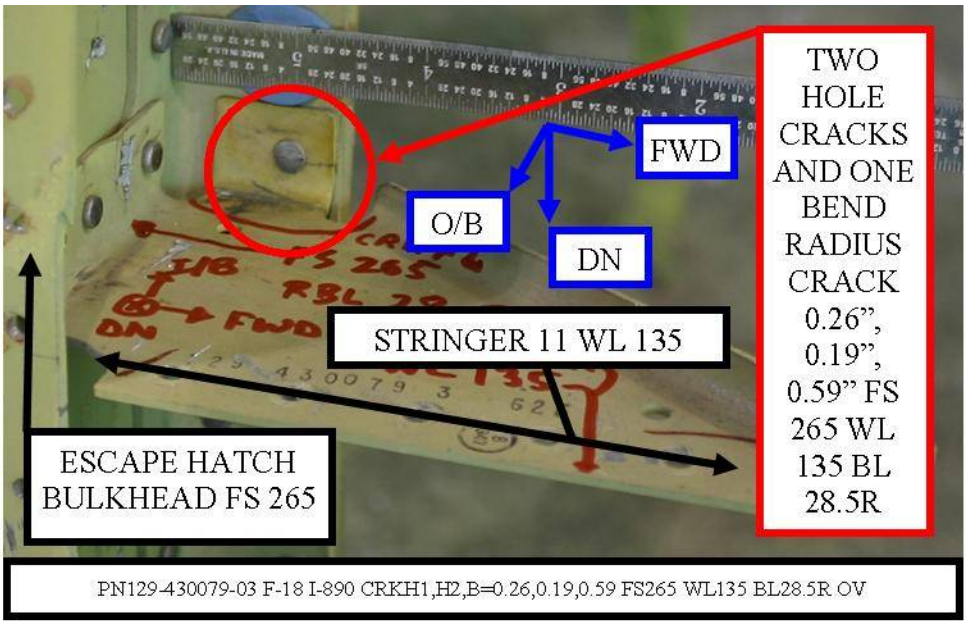


Figure 216. Multiple Cracks on Left Gusset—Overview

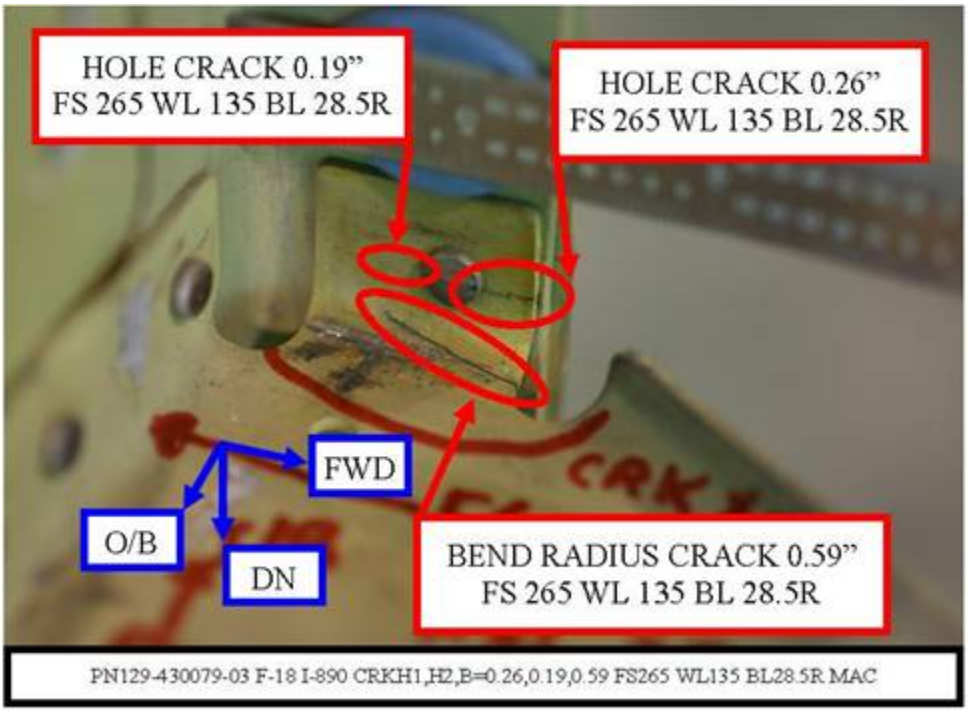


Figure 217. Multiple Cracks on Left Gusset—Macroscopic View

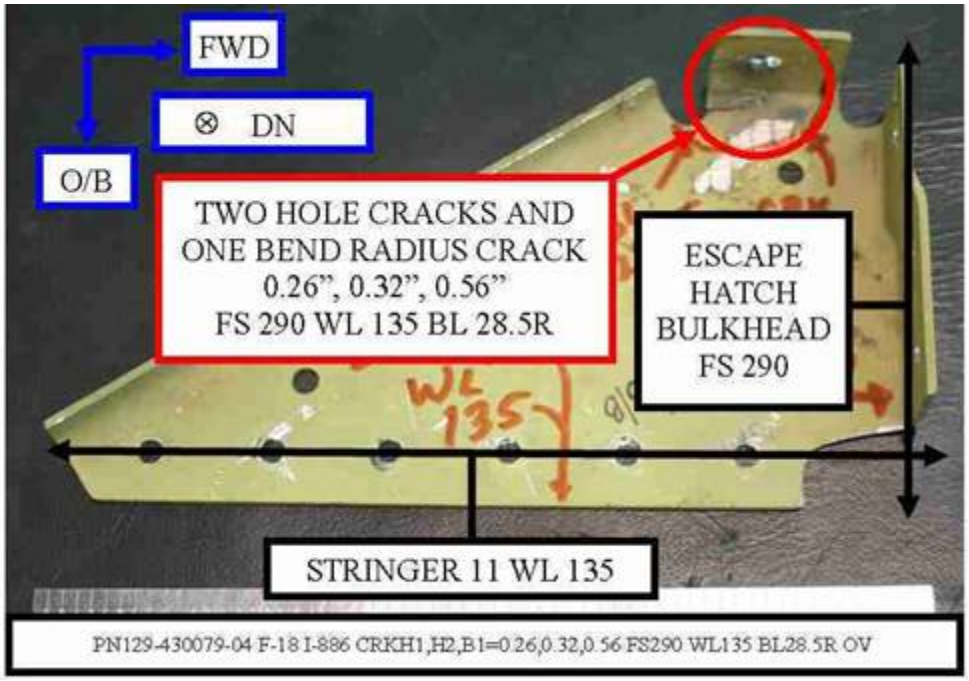


Figure 218. Multiple Cracks on Right Gusset—Overview

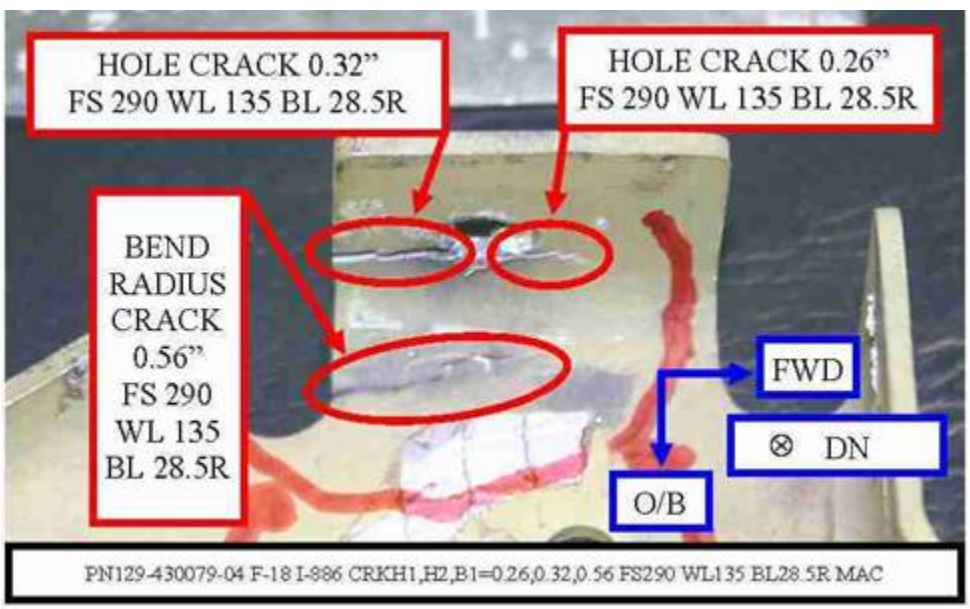


Figure 219. Multiple Cracks on Right Gusset—Macroscopic View

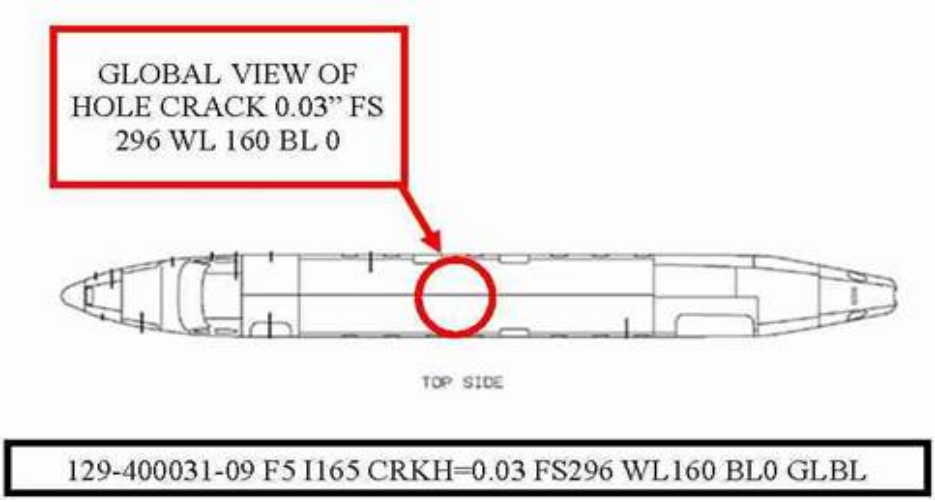


Figure 220. Crack on Fuselage Skin—Global View

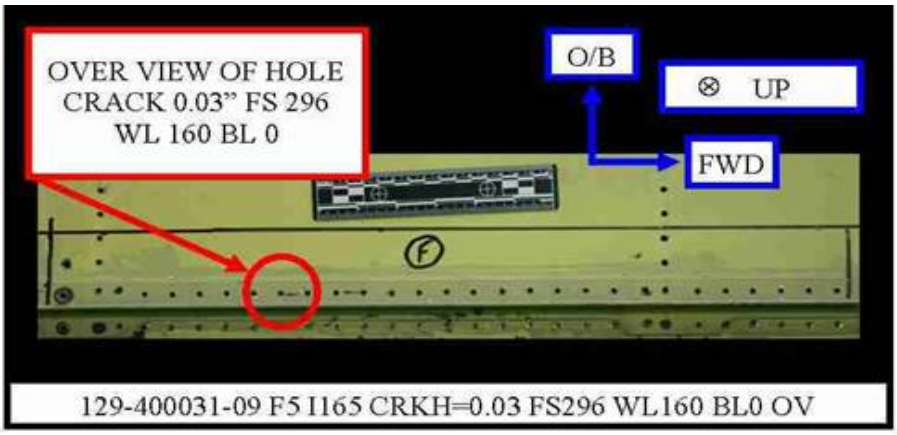


Figure 221. Crack on Fuselage Skin—Overview

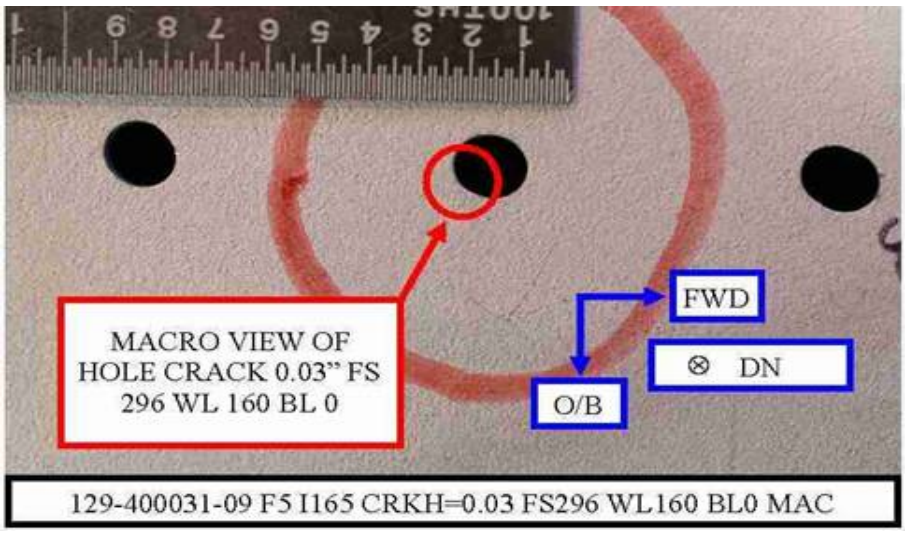


Figure 222. Crack on Fuselage Skin—Macroscopic View

3.4.2.2 Mid Fuselage Windows.

The mid fuselage windows (see figure 223) were also inspected by NDI and airframe inspectors for crack and corrosion indications using current MOI and general inspection techniques. Figure 224 shows the areas inspected, such as the inner ring and stringers. These areas were identified as areas of high emphasis by Raytheon technical support and engineering. No relevant defects were found as a result of this inspection method.

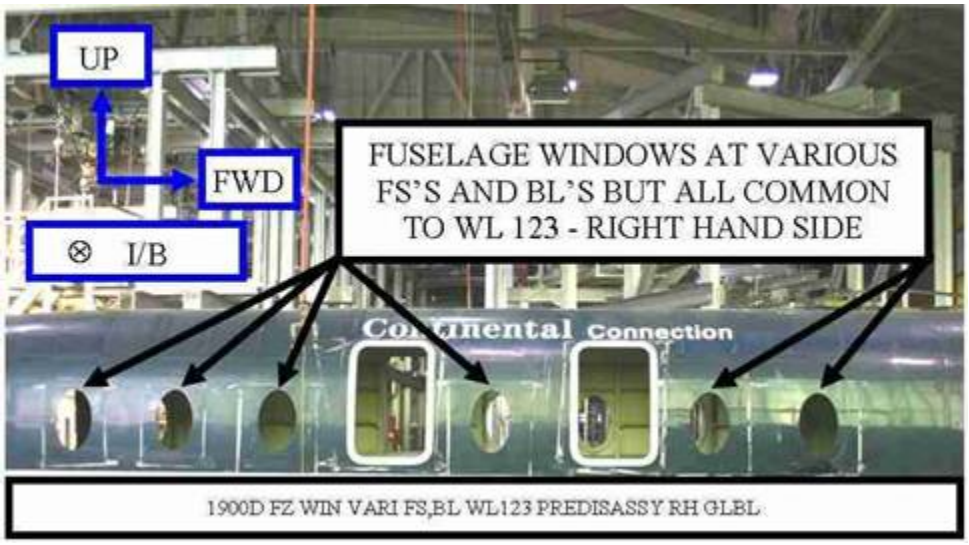


Figure 223. Mid Fuselage Windows

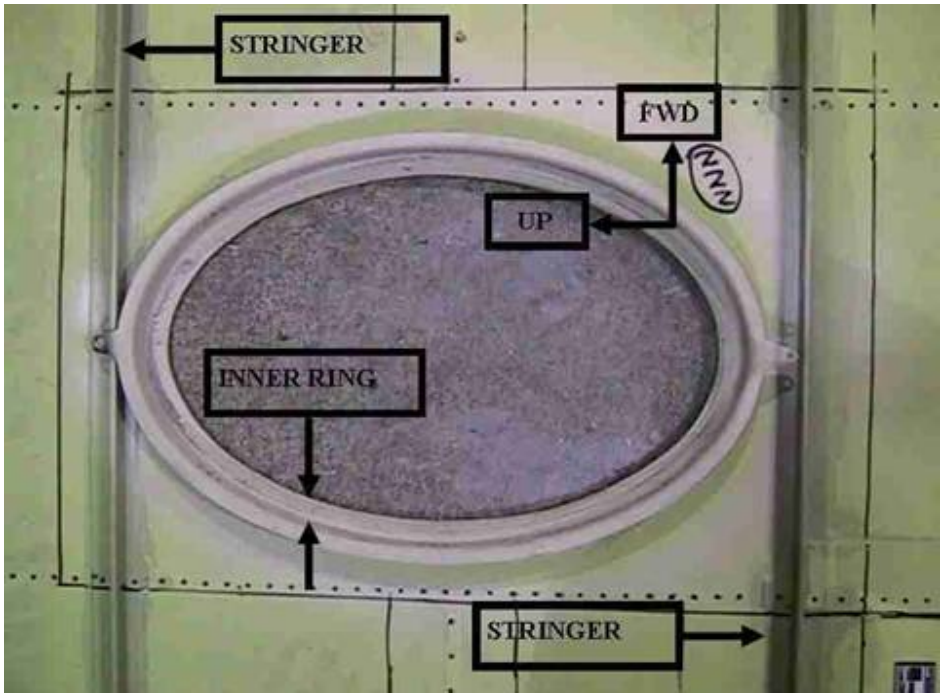


Figure 224. Mid Fuselage Window Disassembled

3.4.3 Aft Fuselage Examination Overview.

During the teardown examination of the aft fuselage (see figure 225), the areas of concentration included, but was not limited to, the frames, escape hatch, and windows. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, 268 parts were examined during the detailed disassembly and postdisassembly process. During the microscopic examination, 13,086 holes were inspected. Nineteen defects were discovered and characterized as relevant or noteworthy findings. In the escape hatch shown in figure 226, five cracks and one gouge, listed in table 32, were classified as relevant. Also, 15 areas of light to moderate corrosion were found and characterized as noteworthy, with no areas of corrosion classified as severe.

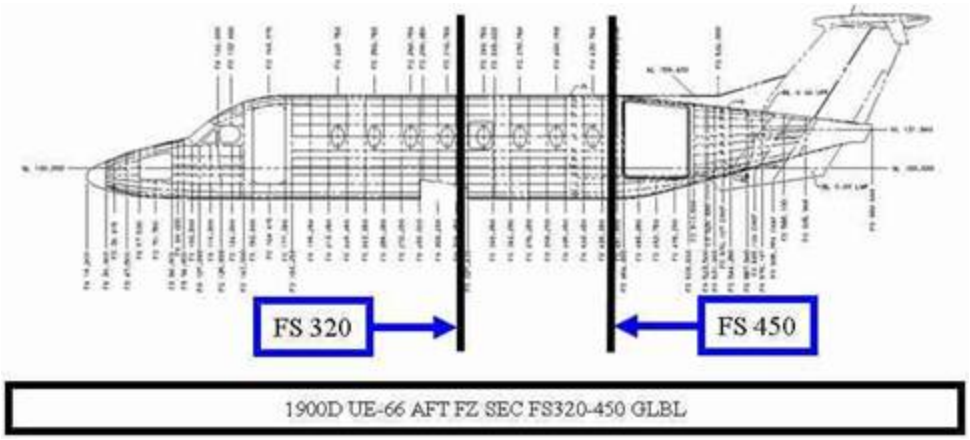


Figure 225. Aft Fuselage Section

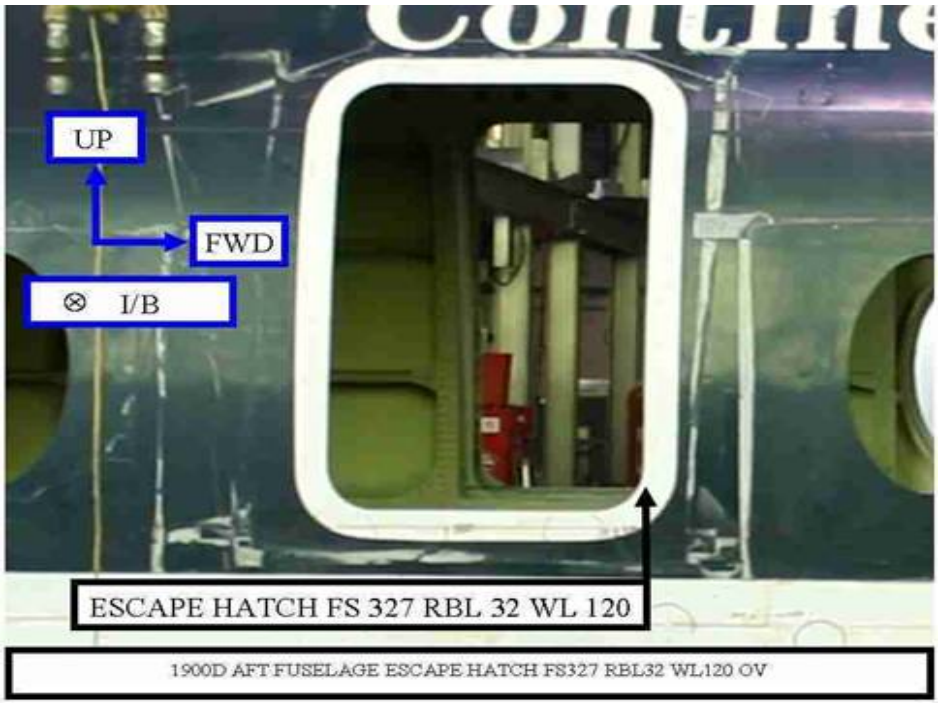


Figure 226. Aft Fuselage Escape Hatch

Table 32. Aft Fuselage Escape Hatch Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Crack	0.1590 0.1591 0.1244			328	135	Cracked Gusset	Figure 227 Global Figure 228 Overview Figure 229 Macroscopic Figure 230 Microscopic
Gouge	0.5500	0.30	0.020	340	120	Gouge on Escape Hatch Frame	Figure 231 Overview Figure 232 Macroscopic
Crack	0.3412			350	135	Bend Radius Crack Gussets	Figure 233 Global Figure 234 Overview Figure 235 Macroscopic Figure 236 Microscopic
Crack	0.0918			350	135	Bend Radius Crack Gussets	Figure 233 Global Figure 234 Overview Figure 235 Macroscopic Figure 236 Microscopic

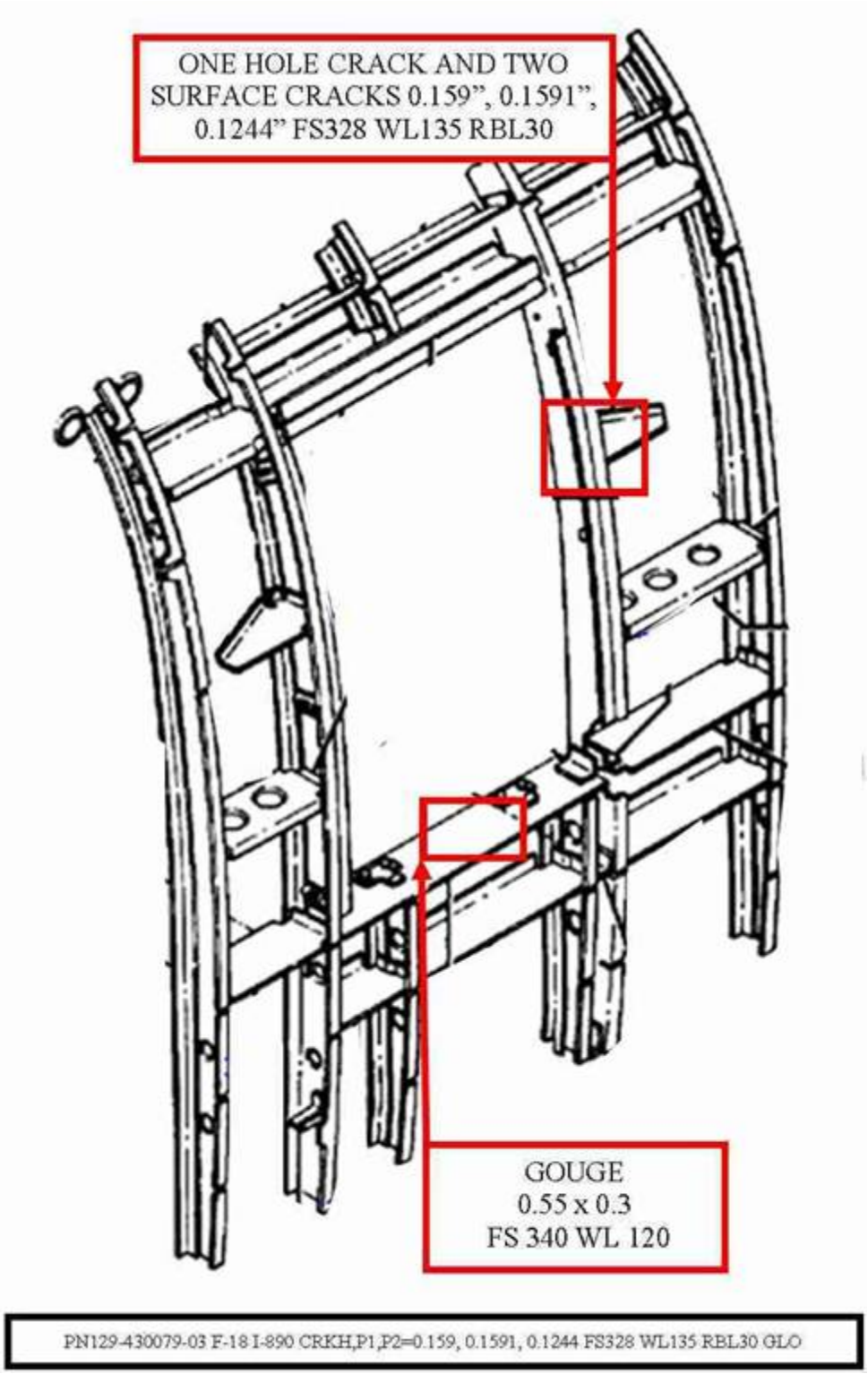


Figure 227. Multiple Defects on Aft Fuselage Escape Hatch—Global View

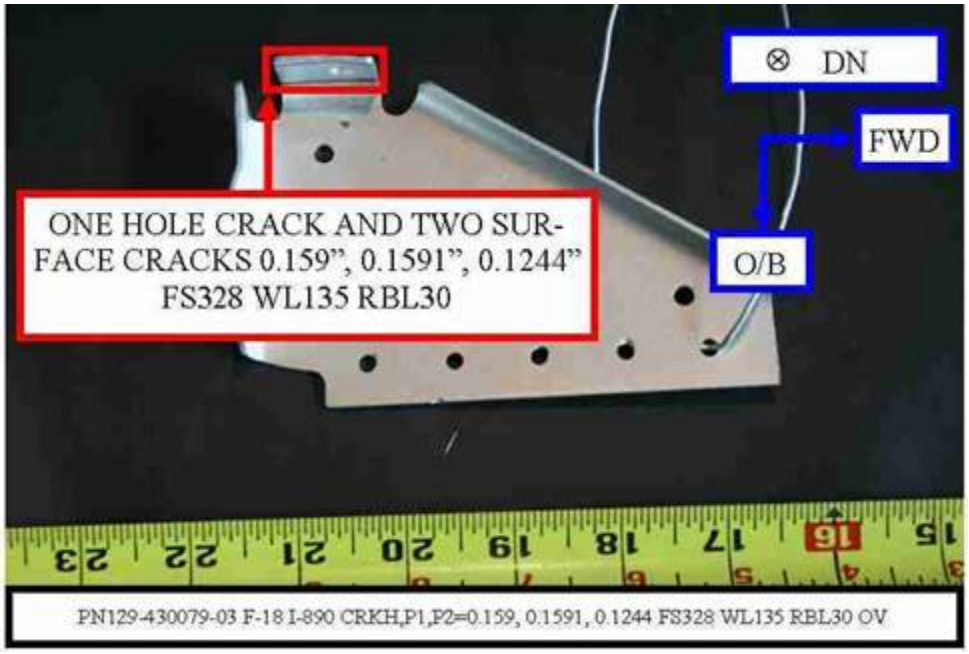


Figure 228. Multiple Cracks on Gusset—Overview

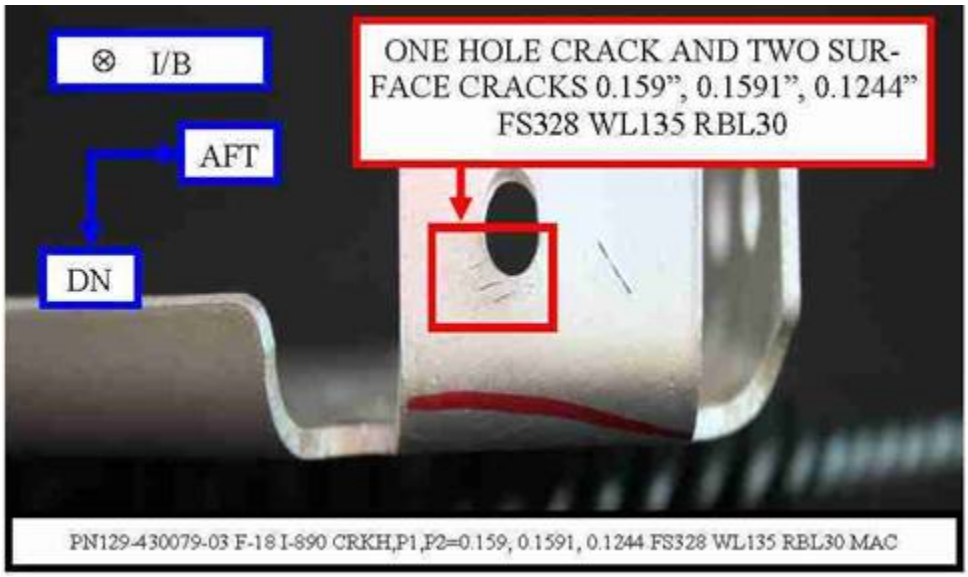


Figure 229. Multiple Cracks on Gusset—Macroscopic View

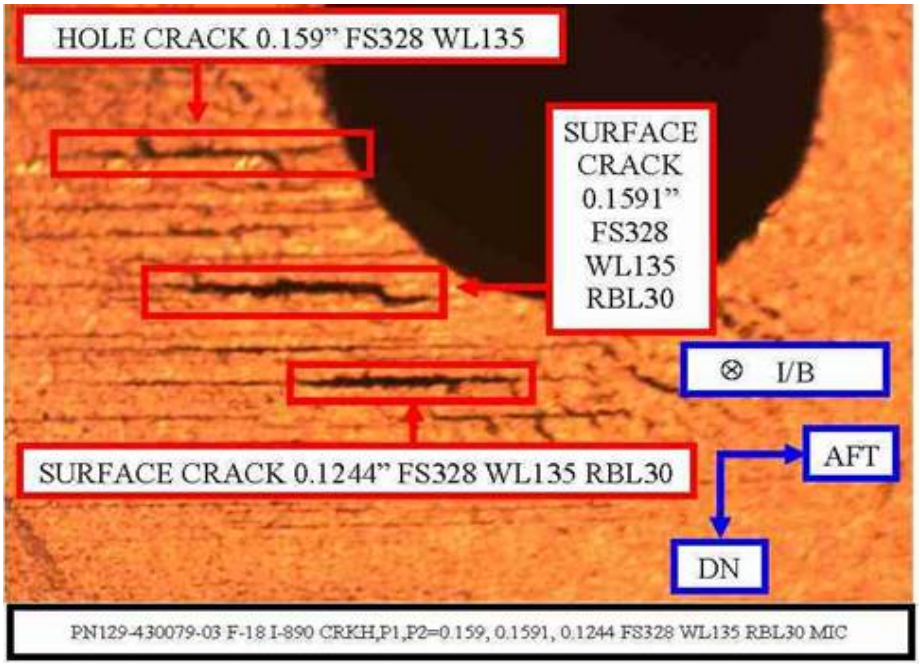


Figure 230. Multiple Cracks on Gusset—Microscopic View

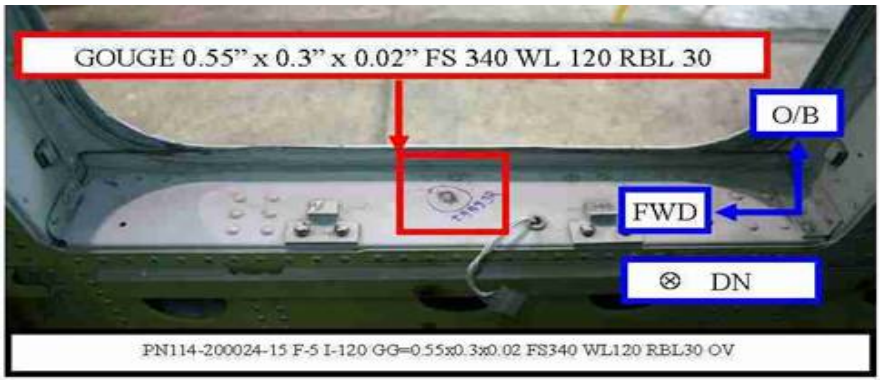


Figure 231. Gouge on Escape Hatch Frame—Overview

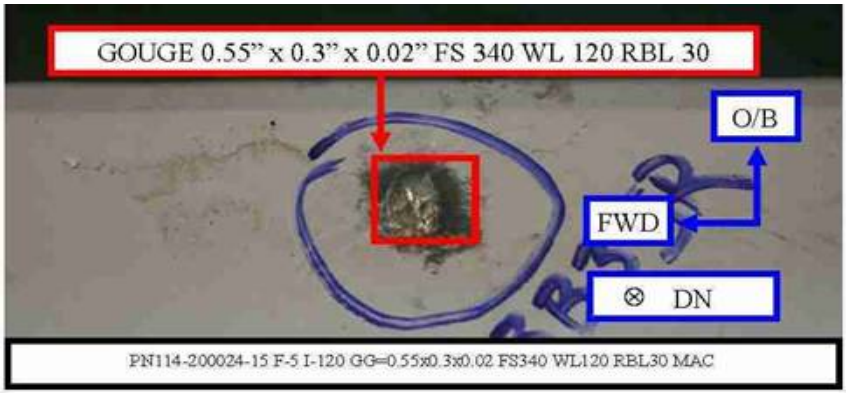


Figure 232. Gouge on Escape Hatch Frame—Macroscopic View

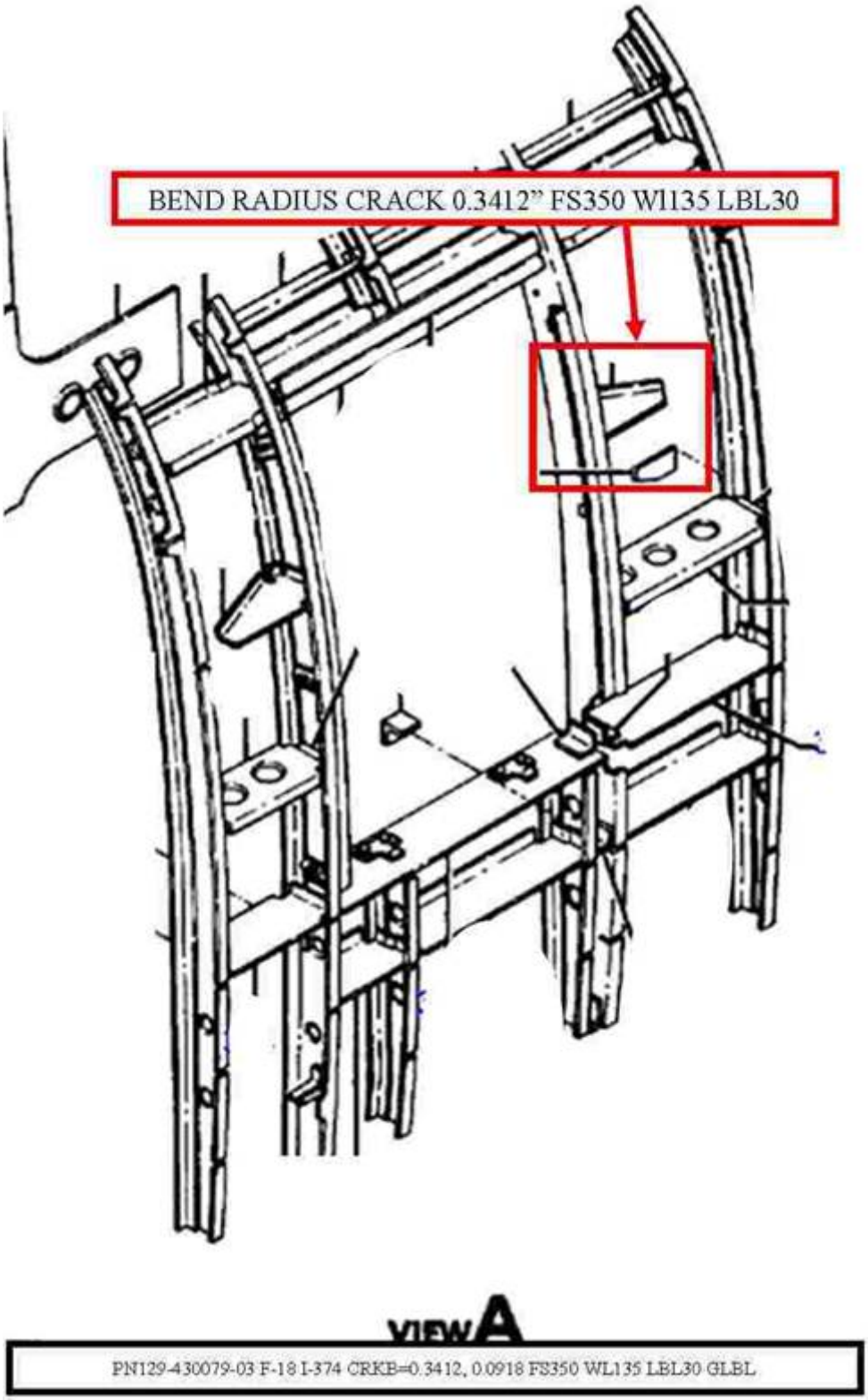


Figure 233. Cracks on Escape Hatch Gusset—Global View

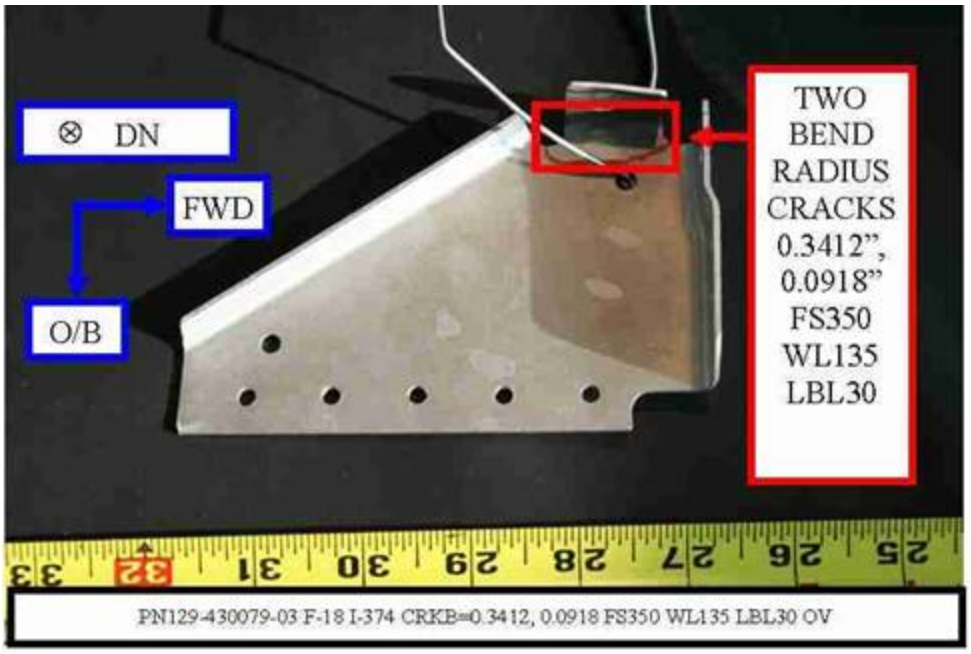


Figure 234. Cracks on Escape Hatch Gusset—Overview

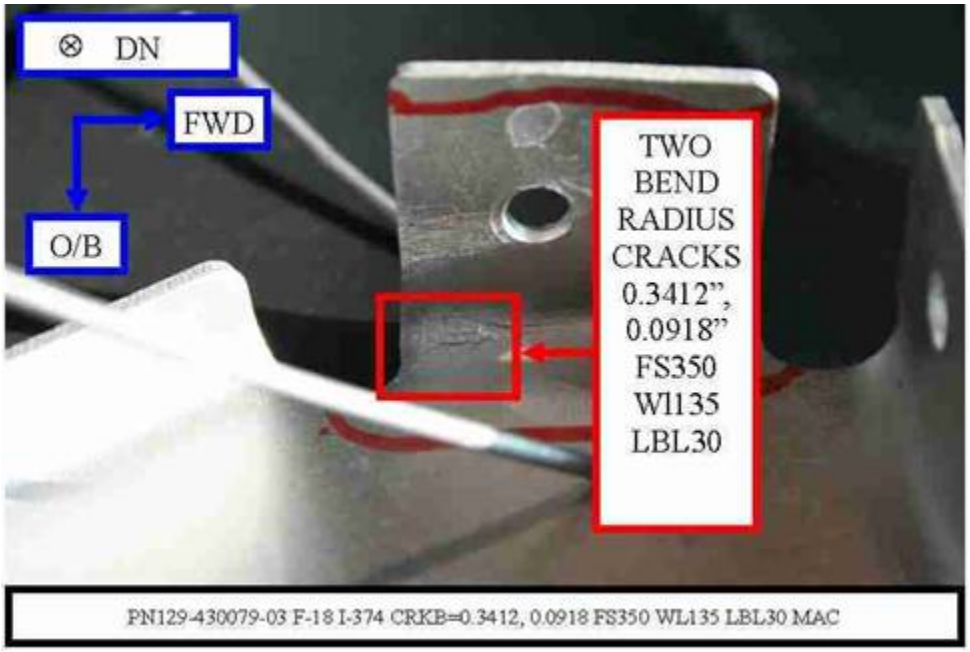


Figure 235. Cracks on Escape Hatch Gusset—Macroscopic View

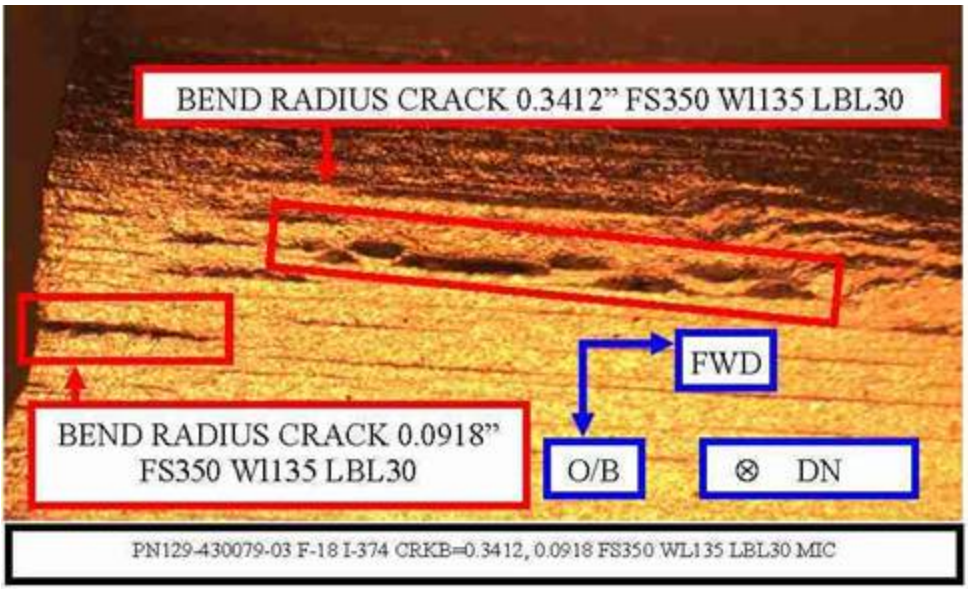


Figure 236. Cracks on Escape Hatch Gusset—Microscopic View

3.4.4 Tail Fuselage Examination Overview.

During the teardown examination of the tail fuselage (see figure 237), the areas of concentration included, but was not limited to, the frames, cargo door, and bulkheads. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, 363 parts were examined during detailed and postdisassembly inspection. Of the 363 parts disassembled, 27,226 holes were examined for defects during the microscopic examination phase. Fifty-three defects were discovered and characterized as relevant or noteworthy findings. Twenty cracks were classified as relevant. Thirty-three small areas of light to moderate corrosion were found with no areas of corrosion classified as severe. Nine areas of minor wear were also noted. Two particular areas of concentration that required special attention were the frames and bulkheads.

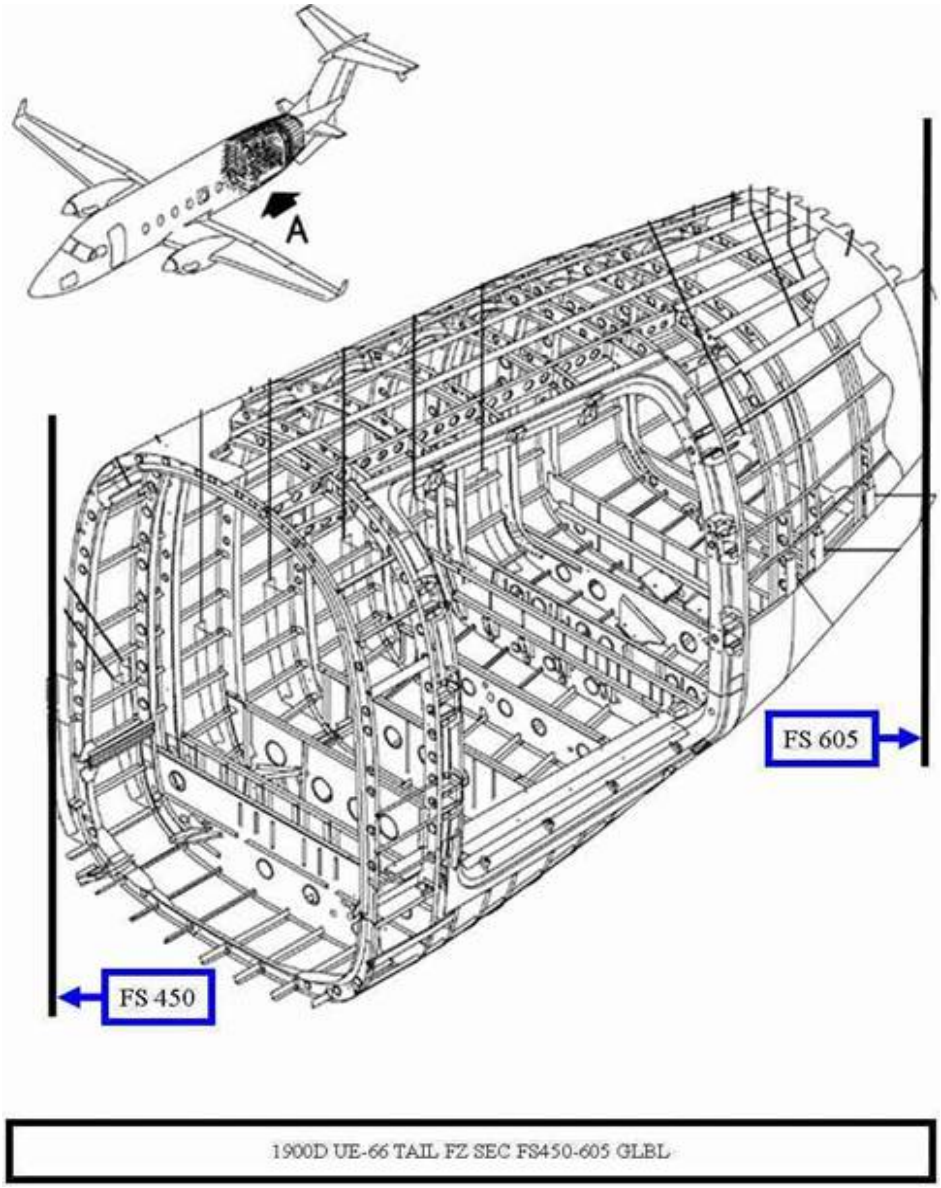


Figure 237. Tail Fuselage Section

3.4.4.1 Tail Fuselage Frames.

Fifteen cracks located on the tail fuselage were classified as relevant and are listed in table 33. No severe corrosion or major damage was found in this section.

Table 33. Aft Fuselage Frames Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Crack	0.3757			438	75	Frame	Figure 238 Global Figure 239 Overview Figure 240 Macroscopic Figure 241 Microscopic
Crack	0.1649			438	75	Frame	Figure 242 Global Figure 243 Overview Figure 244 Macroscopic Figure 245 Microscopic
Crack	0.2254 0.0476 0.0617			451	78	Frame	Figure 246 Global Figure 247 Overview Figure 248 Macroscopic Figure 249 Microscopic
Crack	0.3380 0.1146			453	158	Upper Cargo Door Hinge	Figure 250 Global Figure 251 Overview Figure 252 Macroscopic
Crack	0.2615 0.1968 0.2147			456	75	Web Frame	Figure 253 Global Figure 254 Overview Figure 255 Macroscopic Figure 256 Microscopic
Crack	1.0625 0.4062		Through crack	456	93	Lower Angle	Figure 257 Global Figure 258 Overview Figure 259 Macroscopic
Crack	0.787 0.2621 0.0571			509	75	Left Upper Frame Assembly	Figure 260 Global Figure 261 Overview Figure 262 Macroscopic Figure 263 Microscopic

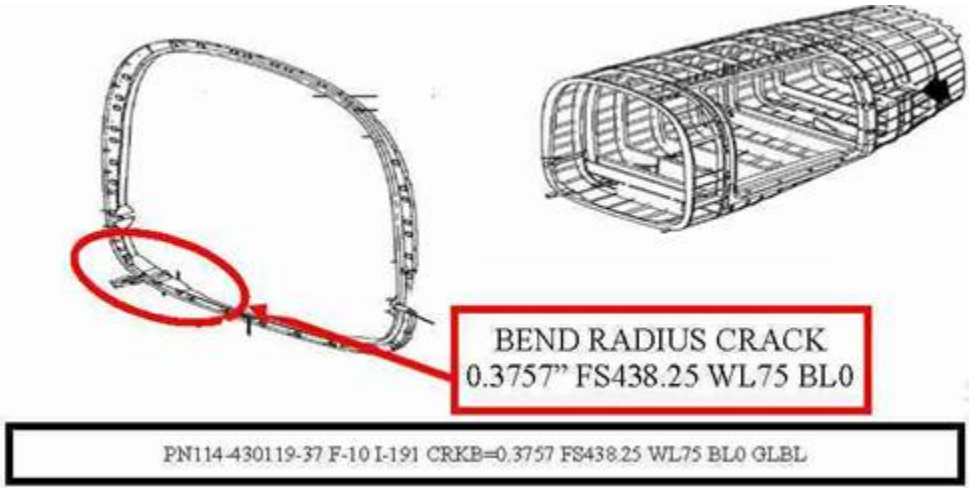


Figure 238. Crack on Tail Frame Assembly—Global View (0.3757″)

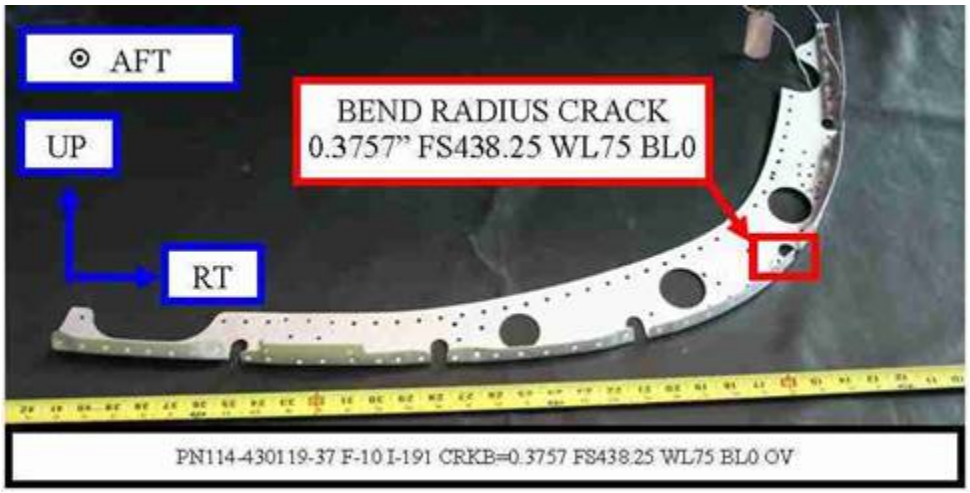


Figure 239. Crack on Tail Frame Assembly—Overview (0.3757″)

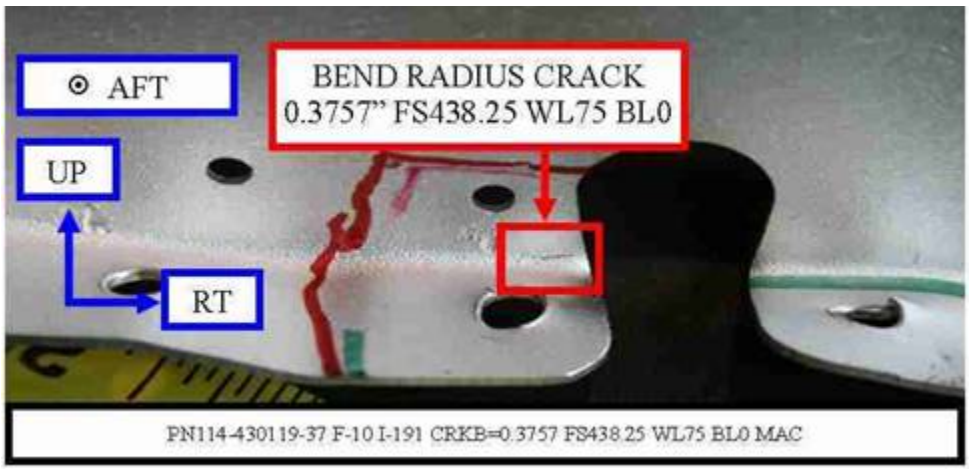


Figure 240. Crack on Tail Frame Assembly—Macroscopic View (0.3757″)

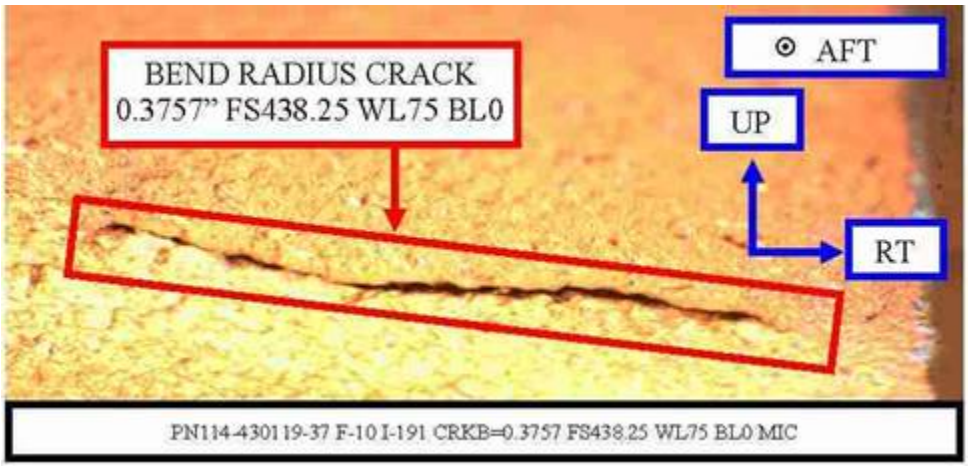


Figure 241. Crack on Tail Frame Assembly—Microscopicl View (0.3757″)

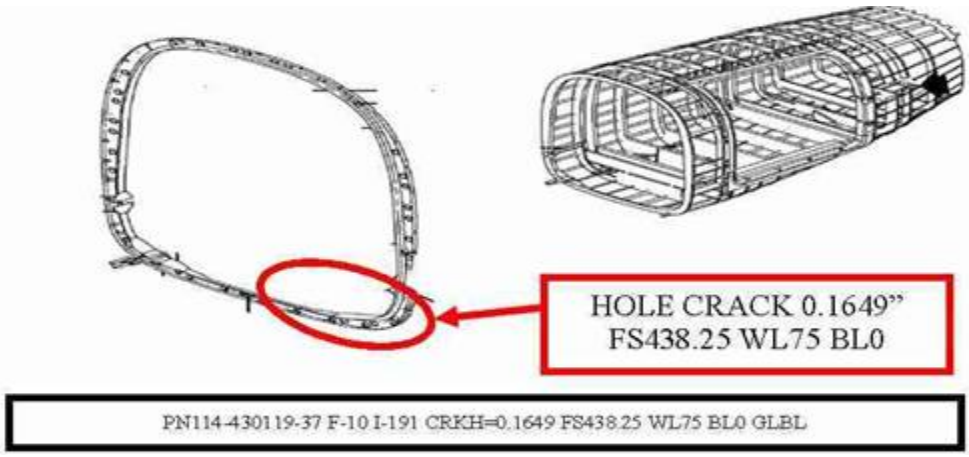


Figure 242. Crack on Tail Frame Assembly—Global View (0.1649″)

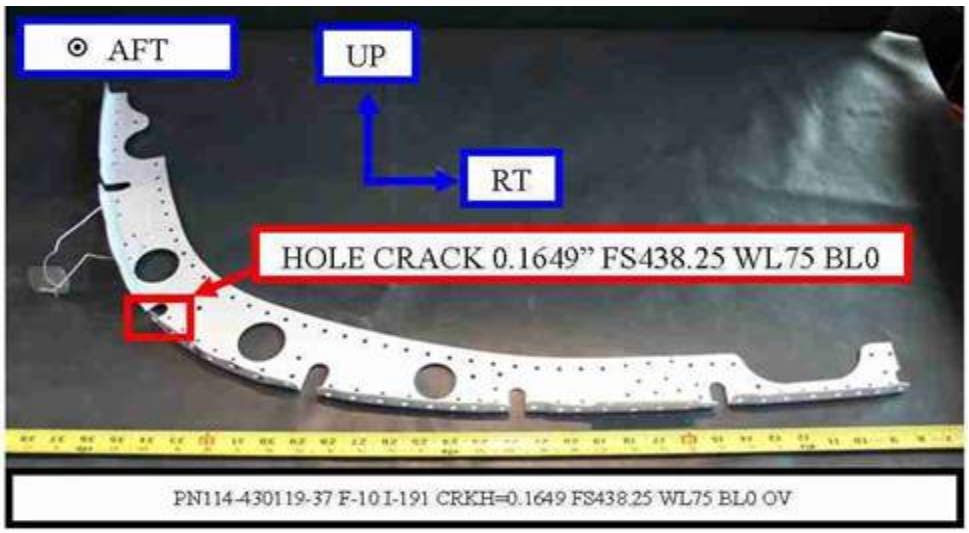


Figure 243. Crack on Tail Frame Assembly—Overview (0.1649″)

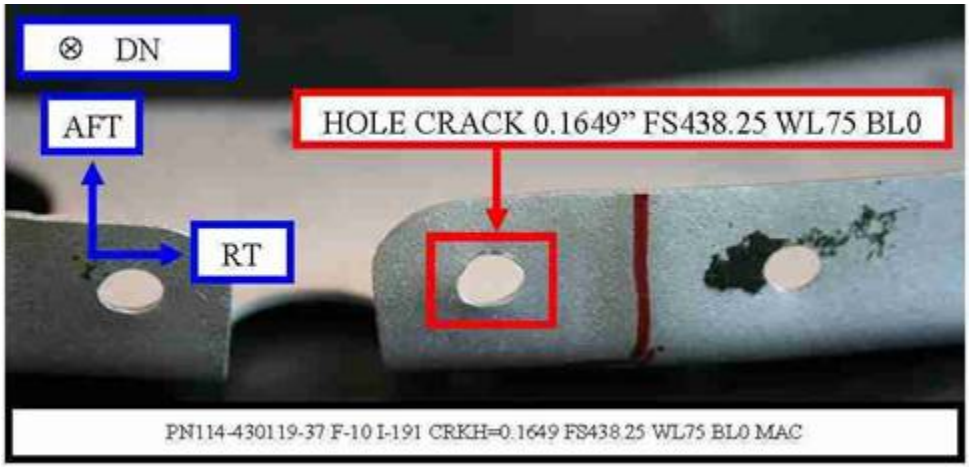


Figure 244. Crack on Tail Frame Assembly—Macroscopic View (0.1649″)

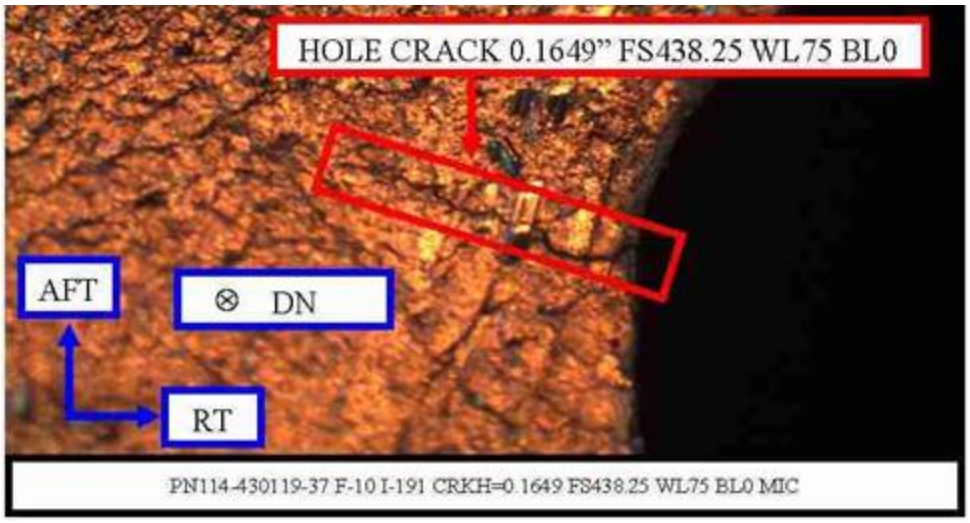


Figure 245. Crack on Tail Frame Assembly—Microscopic View (0.1649″)

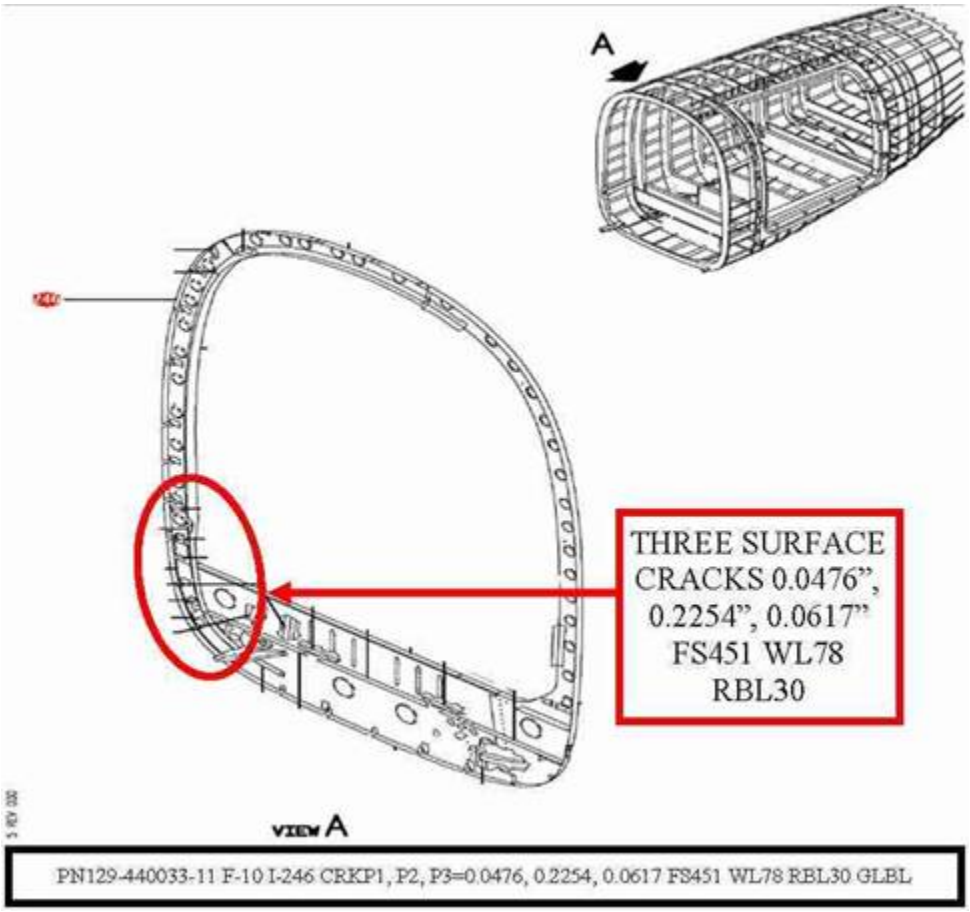


Figure 246. Multiple Cracks on Tail Frame Assembly—Global View

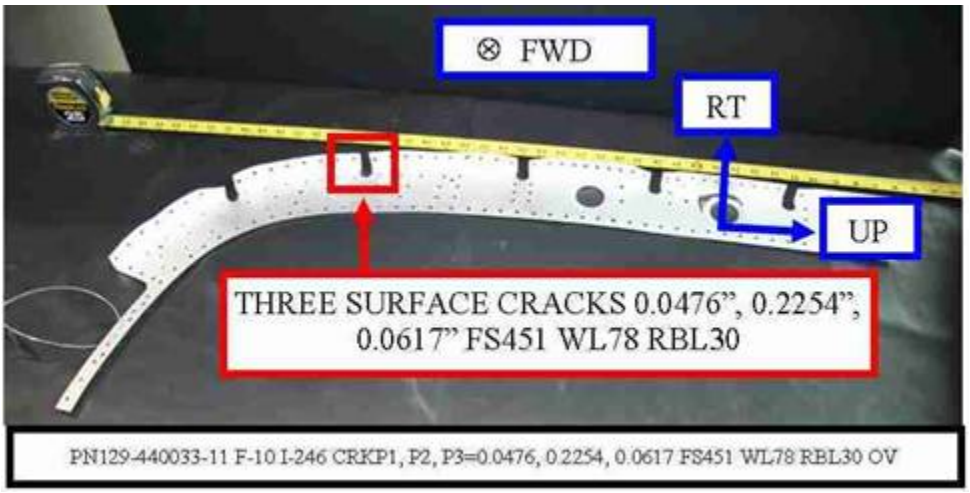


Figure 247. Multiple Cracks on Tail Frame Assembly—Overview

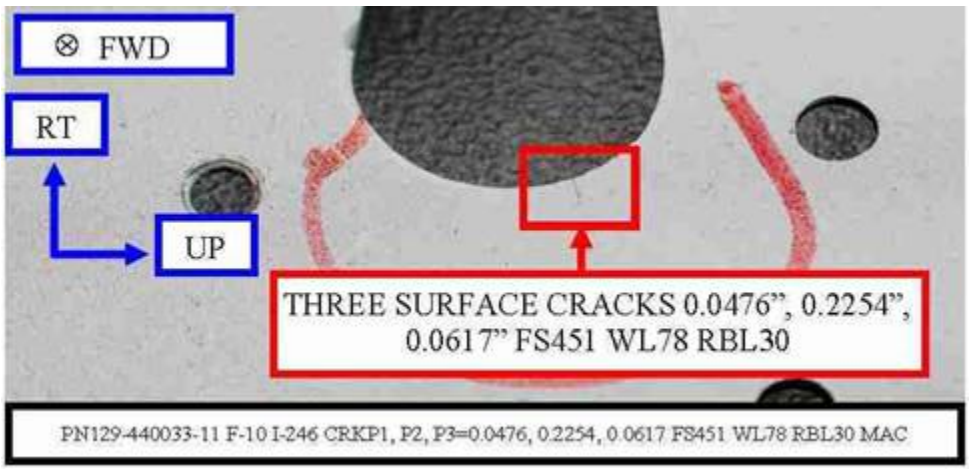


Figure 248. Multiple Cracks on Tail Frame Assembly—Macroscopic View

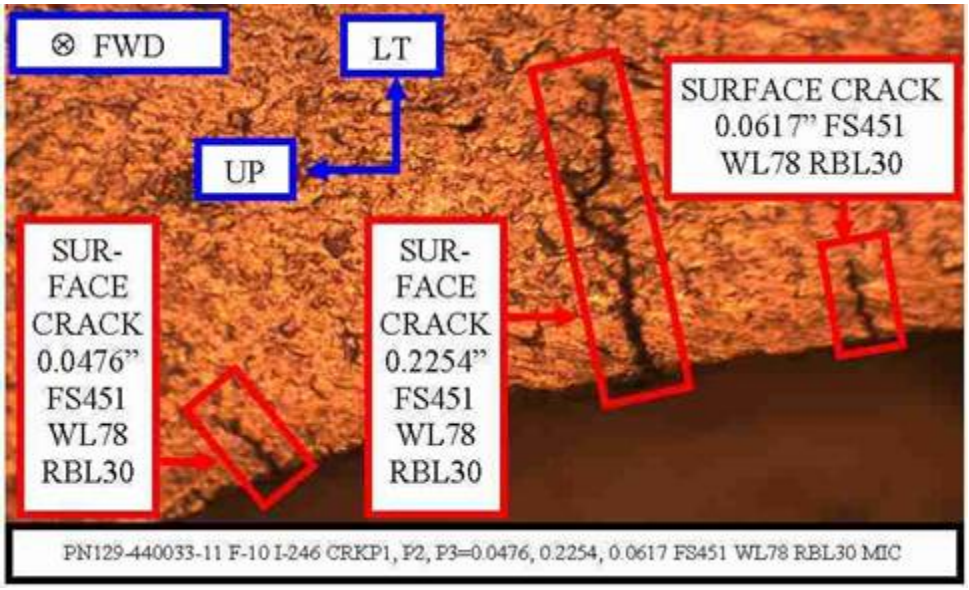


Figure 249. Multiple Cracks on Tail Frame Assembly—Microscopic View

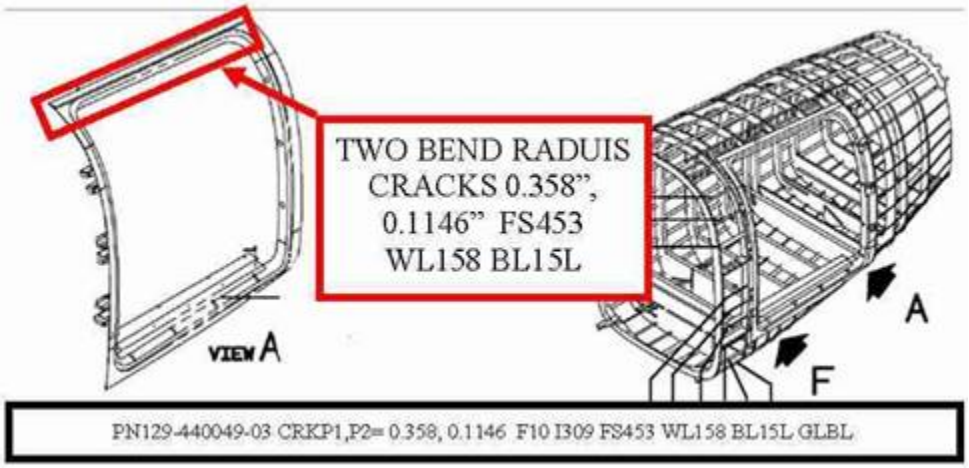


Figure 250. Multiple Cracks on Cargo Door Hinges—Global View

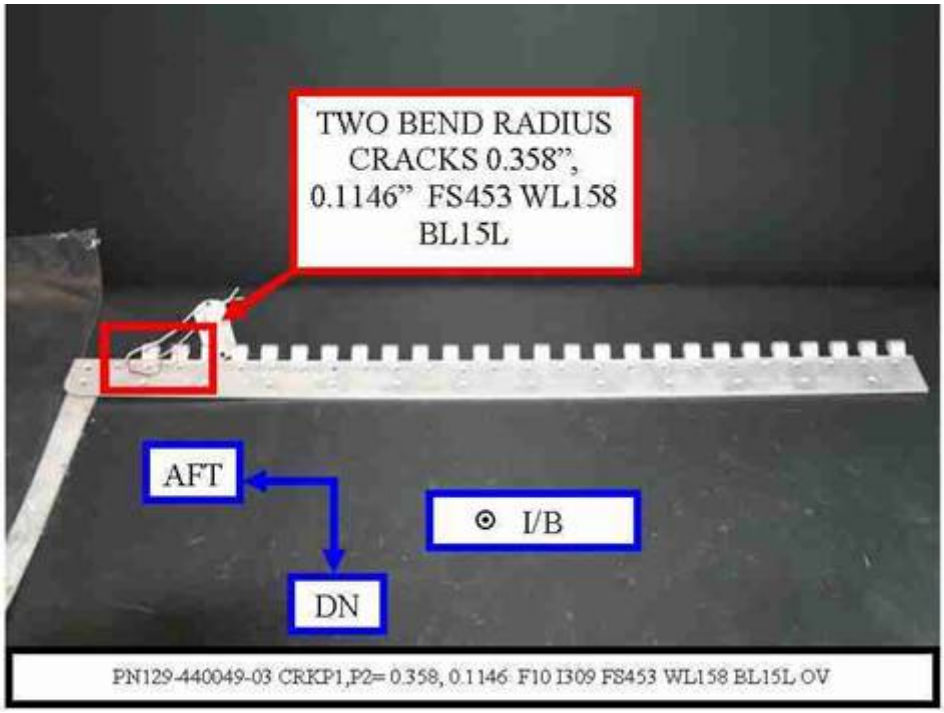


Figure 251. Multiple Cracks on Cargo Door Hinges—Overview

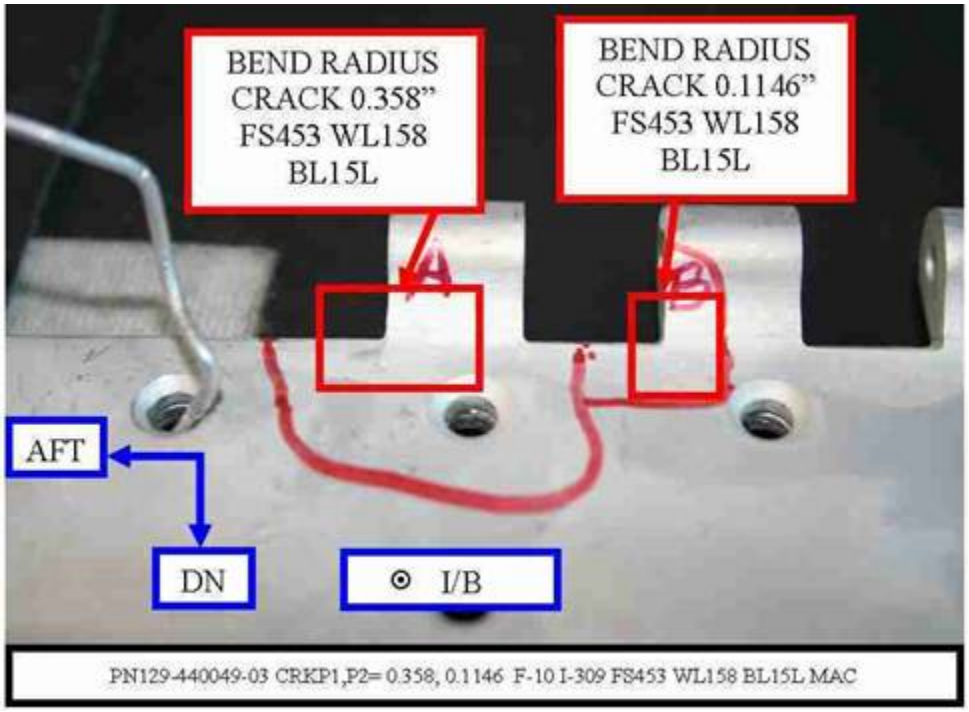


Figure 252. Multiple Cracks on Cargo Door Hinges—Macroscopic View

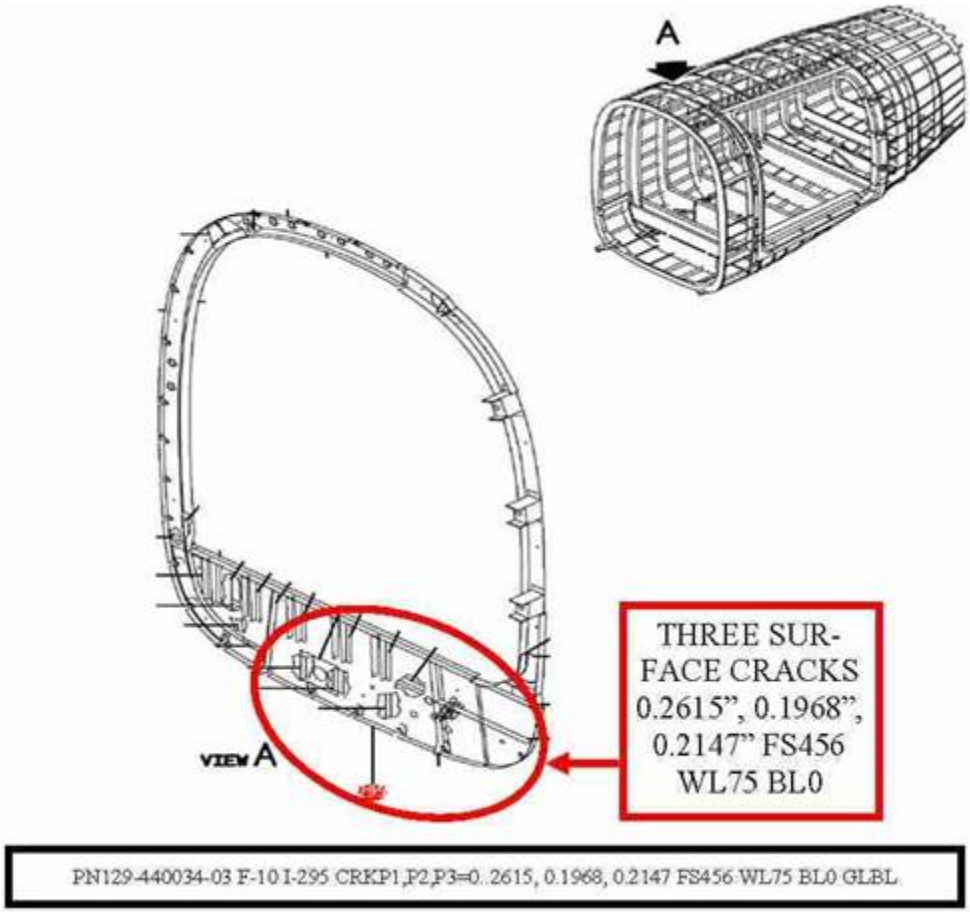


Figure 253. Multiple Cracks on Web Frame—Global View

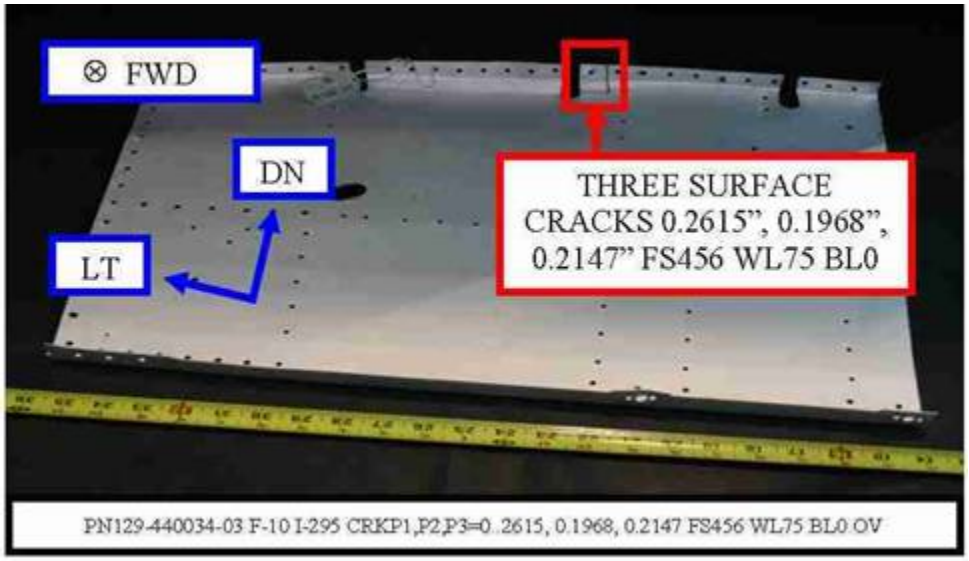


Figure 254. Multiple Cracks on Web Frame—Overview

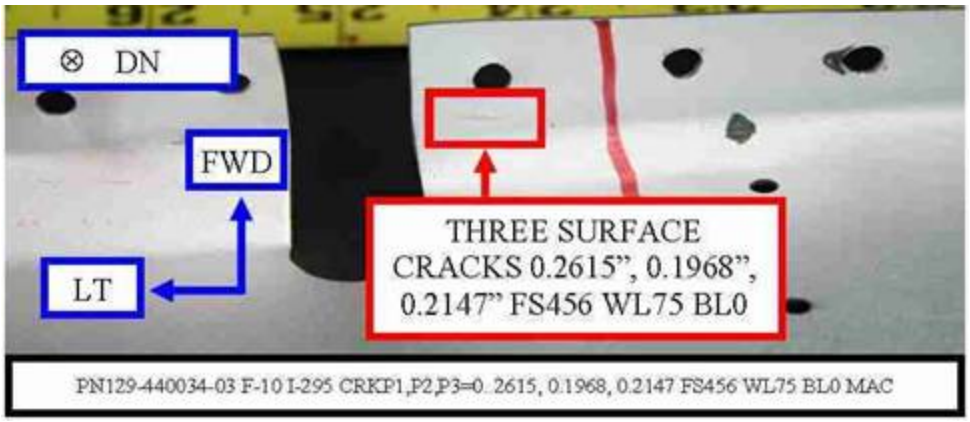


Figure 255. Multiple Cracks on Web Frame—Macroscopic View

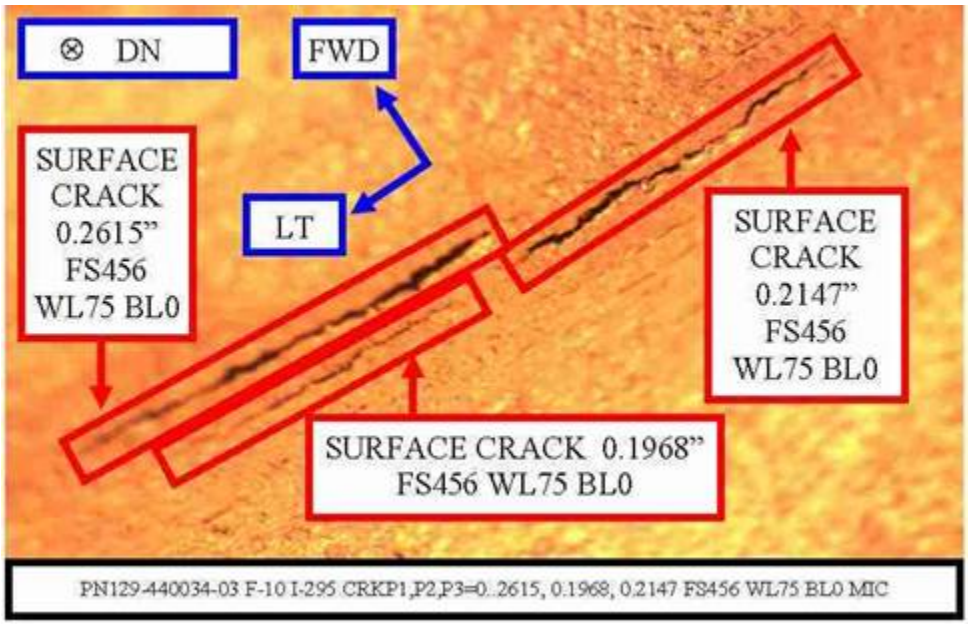


Figure 256. Multiple Cracks on Web Frame—Microscopic View

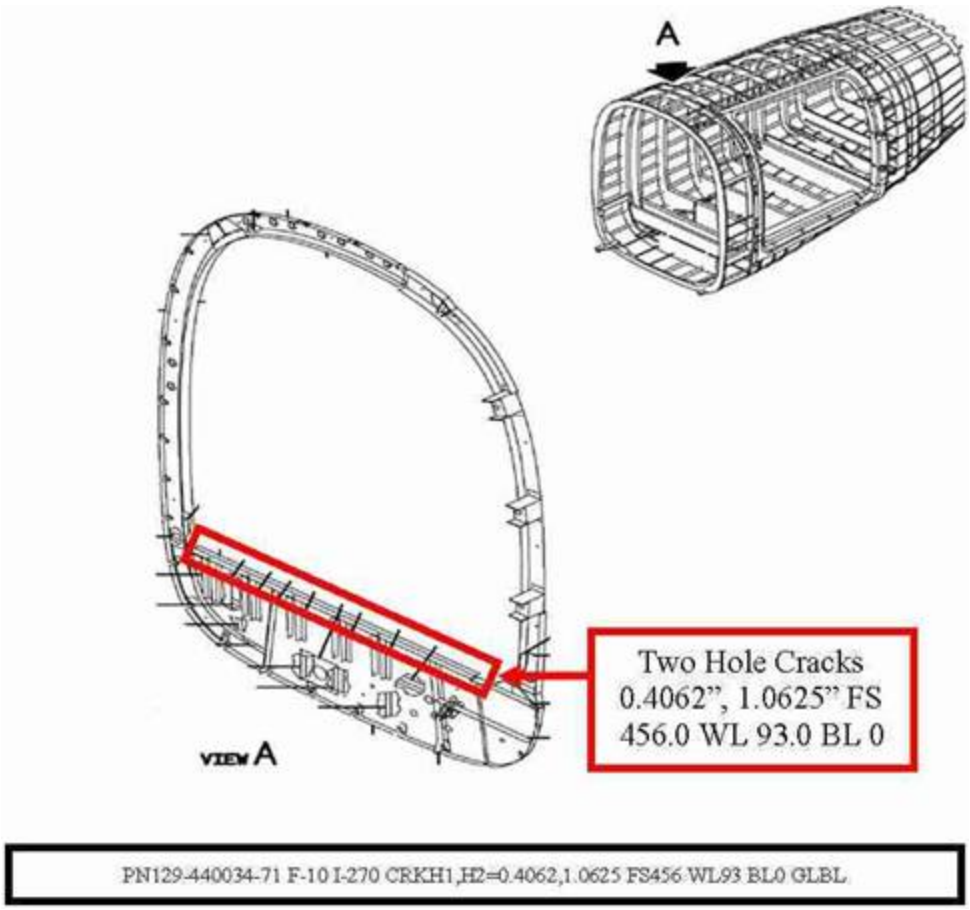


Figure 257. Multiple Cracks on Frame Lower Angle—Global View

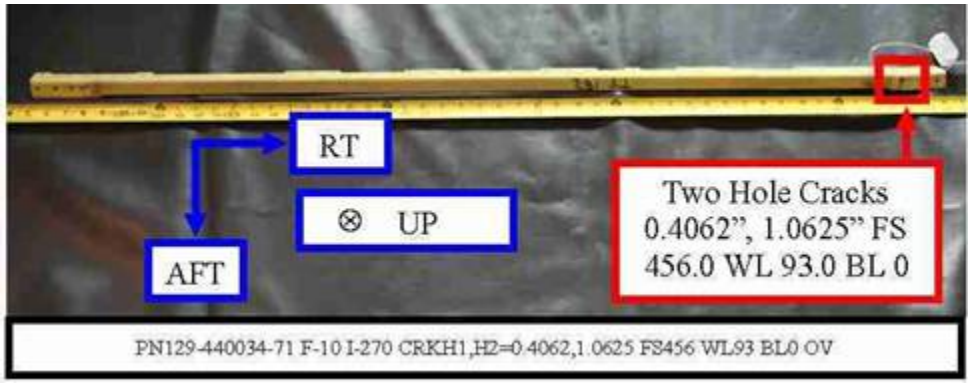


Figure 258. Multiple Cracks on Frame Lower Angle—Overview

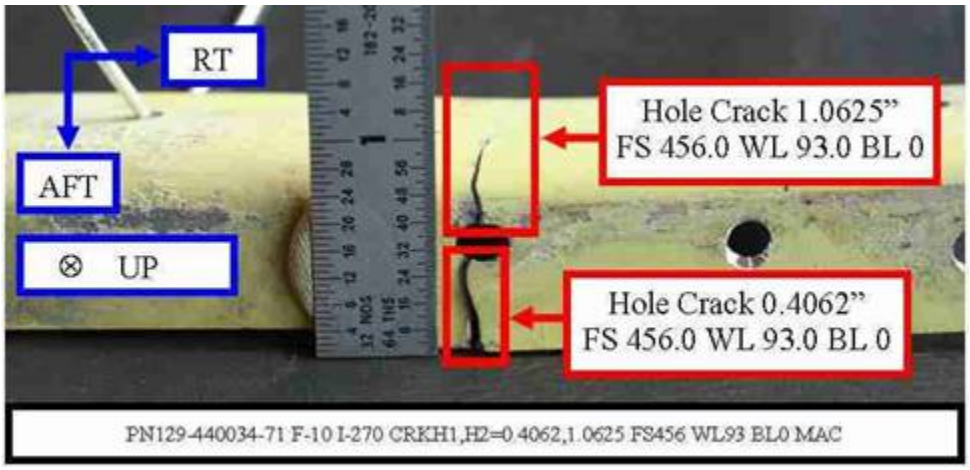


Figure 259. Multiple Cracks on Frame Lower Angle—Macroscopic View

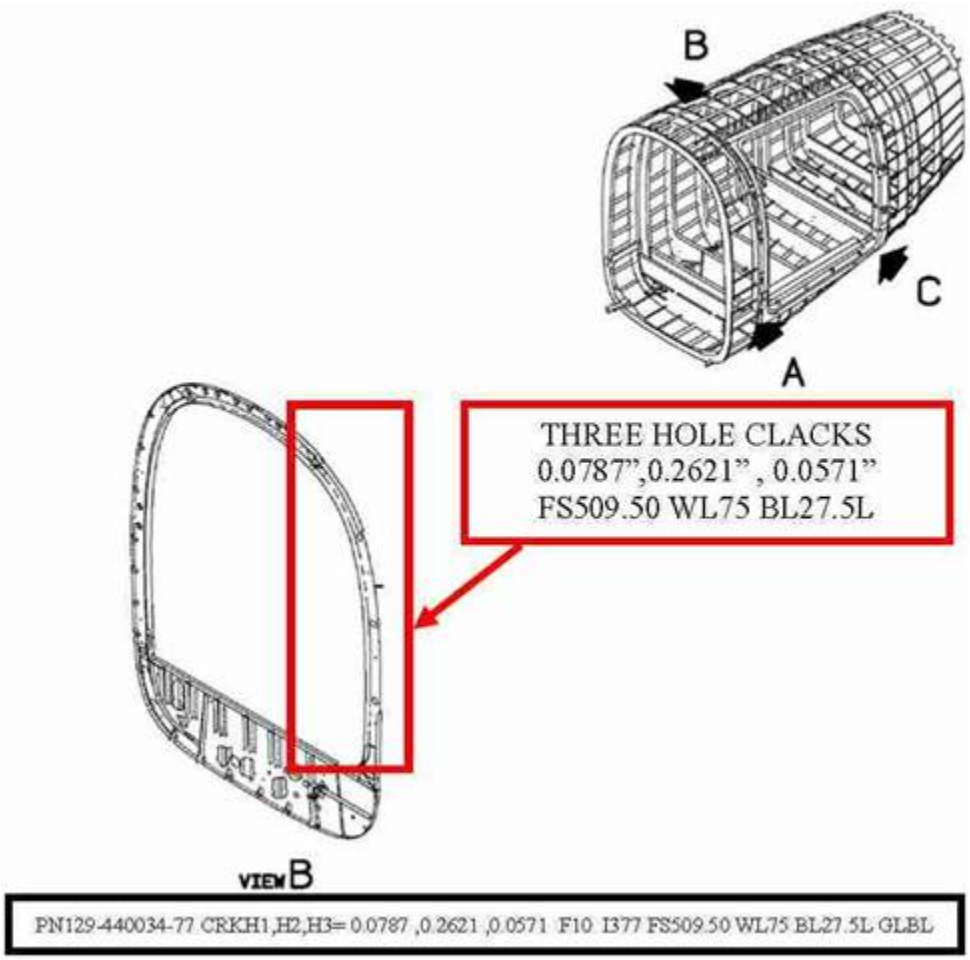


Figure 260. Multiple Cracks on Upper Frame—Global View

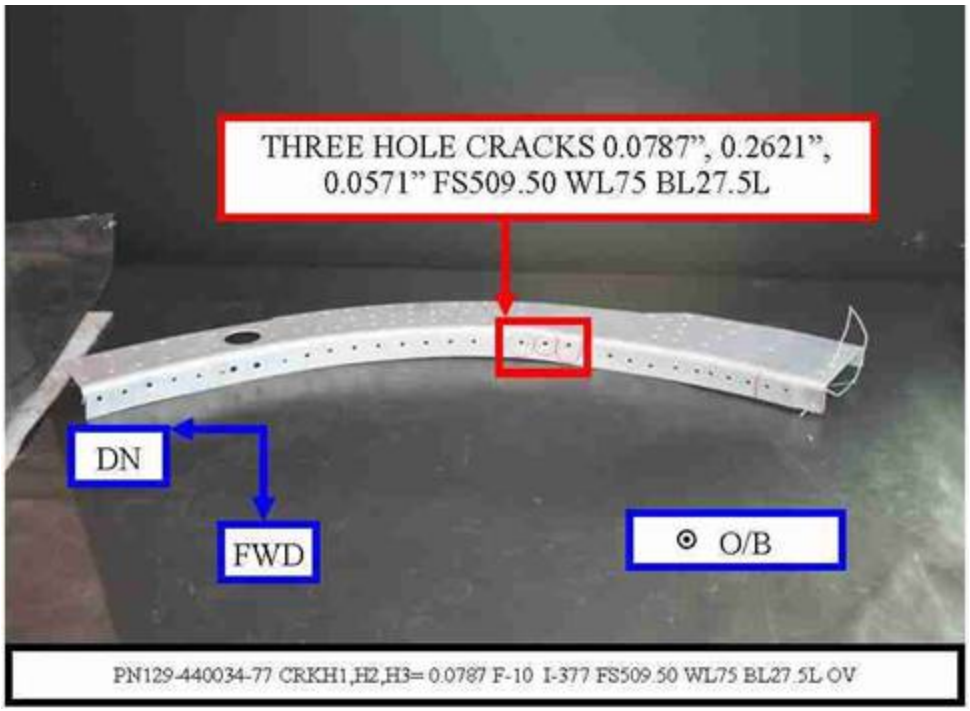


Figure 261. Multiple Cracks on Upper Frame—Overview

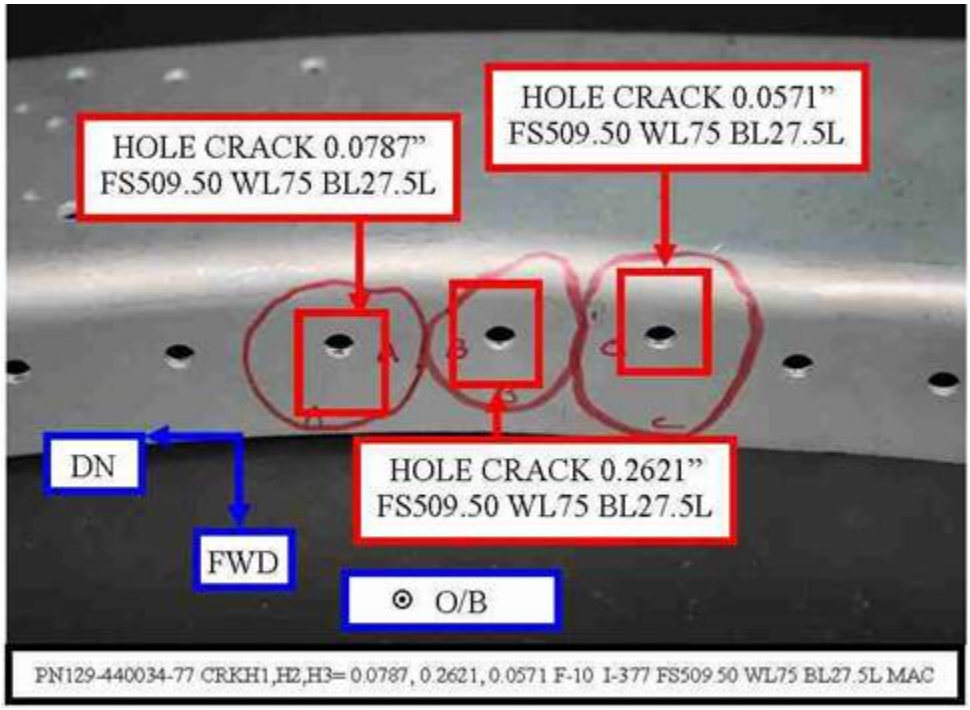


Figure 262. Multiple Cracks on Upper Frame—Macroscopic View

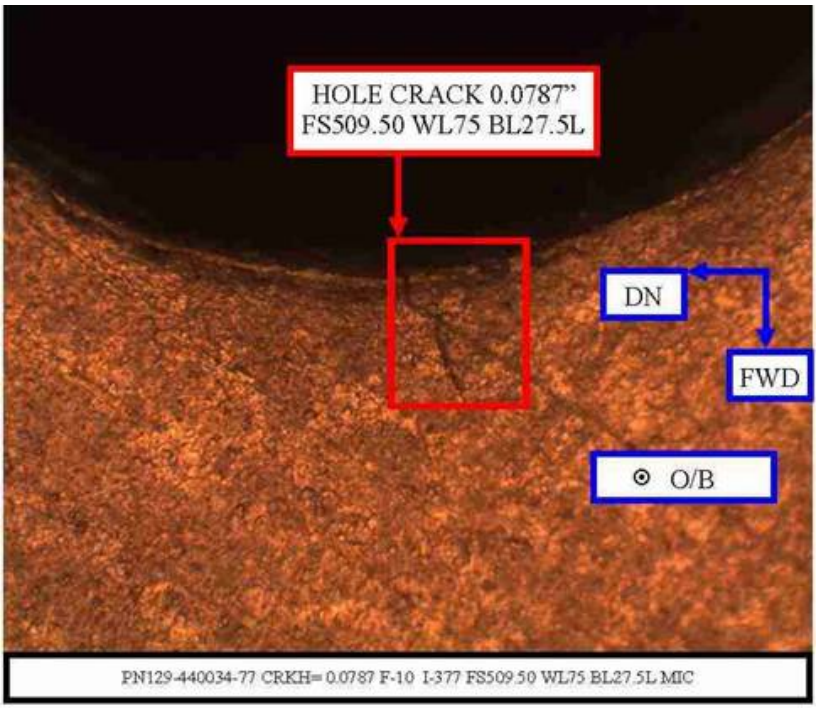


Figure 263. Multiple Cracks on Upper Frame—Microscopic View

3.4.4.2 Tail Fuselage Bulkheads.

Five cracks on the tail fuselage bulkhead were classified as relevant and are listed in table 34. Thirty-three additional small areas of light to moderate corrosion were found with no areas classified as severe. Nine areas of minor wear were also noted. Figures 276 through 281 show cracks located on the lower bulkhead frame at FS 588.10.

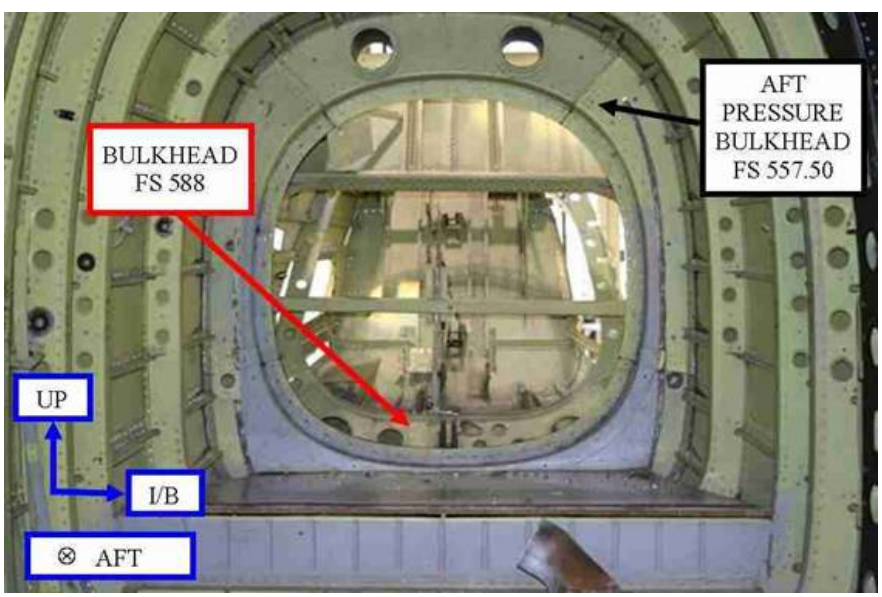


Figure 264. Tail Fuselage Bulkhead

Table 34. Tail Fuselage Bulkhead Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	FS	WL		
Crack	0.0545			588	100	Right Side Bulkhead Hole Crack	Figure 265 Global Figure 266 Overview Figure 267 Macroscopic Figure 268 Microscopic
Crack	0.1487			588	100	Right Side Bulkhead Bend Crack	Figure 269 Overview Figure 270 Macroscopic Figure 271 Microscopic
Crack	0.6616		Through crack	588	100	Surface Crack Lower Bulkhead Frame	Figure 272 Global Figure 273 Overview Figure 274 Macroscopic Figure 275 Microscopic
Crack	0.1719		Through crack	588	100	Surface Crack Bulkhead Frame	Figure 276 Global Figure 277 Overview Figure 278 Macroscopic Figure 279 Microscopic
Crack	0.1563		Through crack	588	100	Surface Crack Bulkhead Frame	Figure 276 Global Figure 277 Overview Figure 280 Macroscopic Figure 281 Microscopic

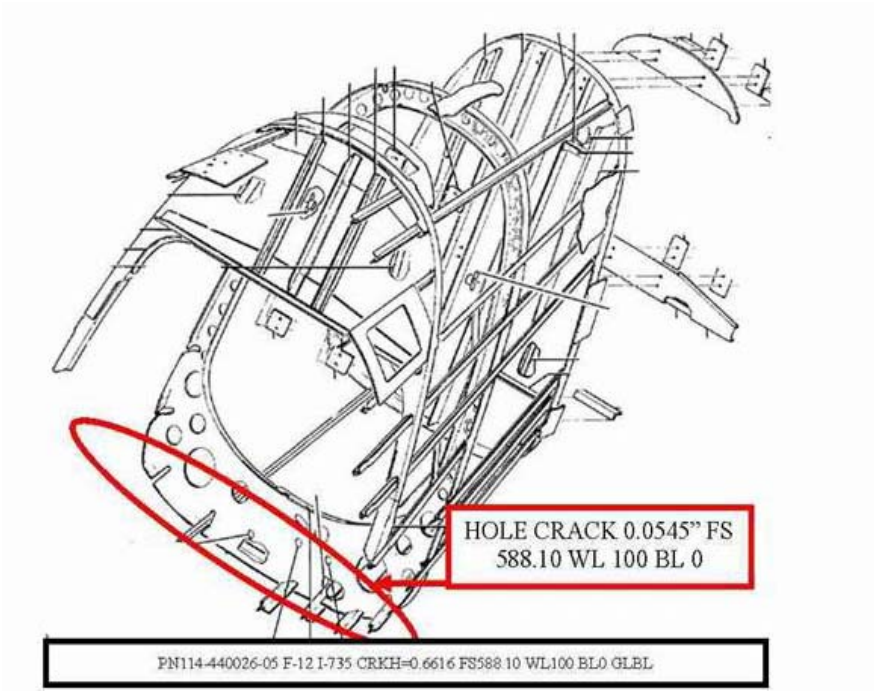


Figure 265. Crack on Right Side of Bulkhead Frame—Global View

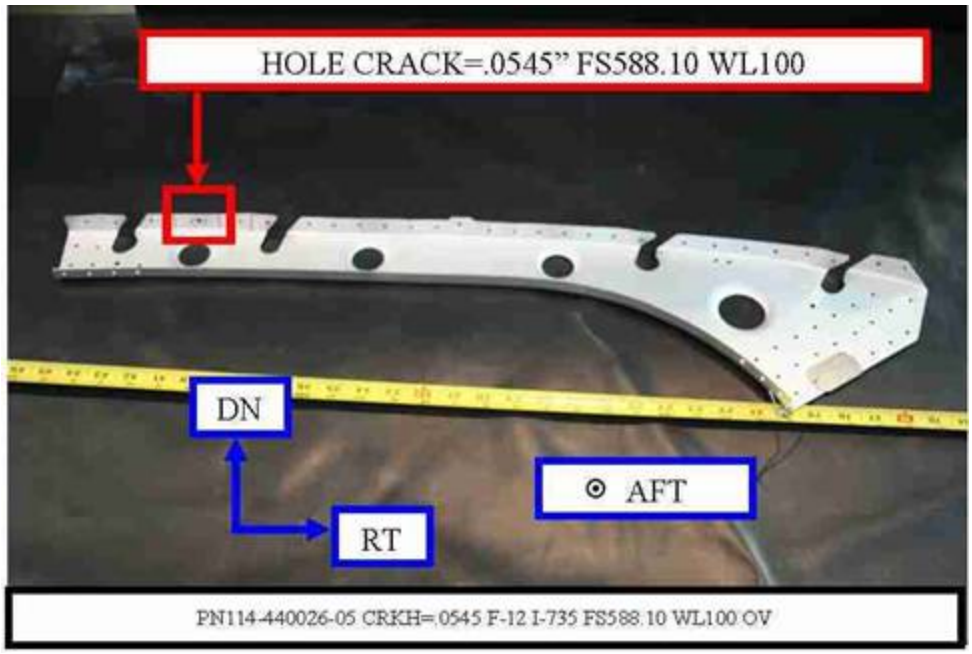


Figure 266. Crack on Right Side of Bulkhead Frame—Overview

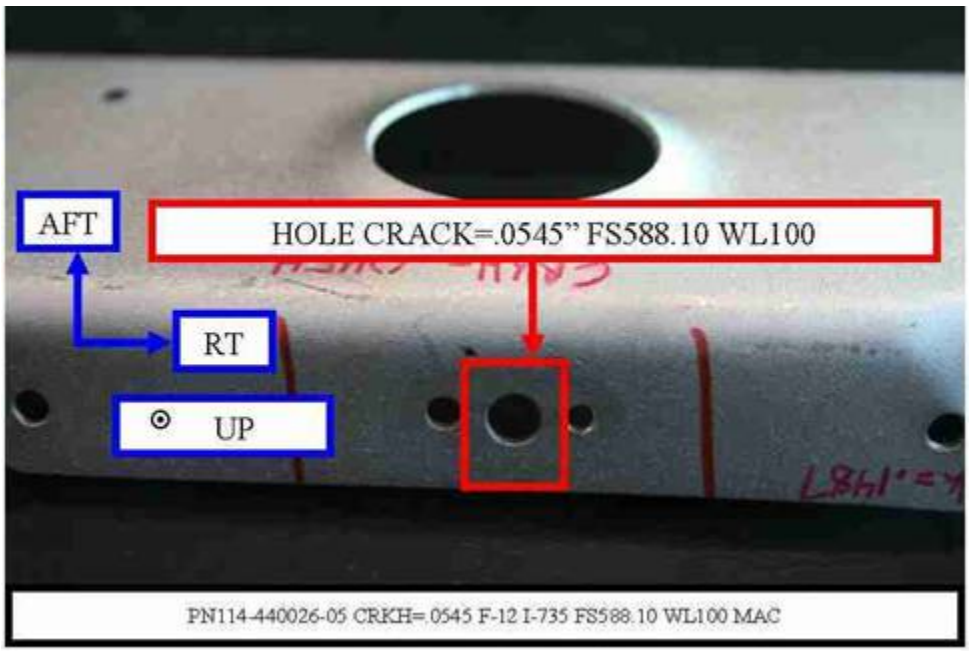


Figure 267. Crack on Right Side of Bulkhead Frame—Macroscopic View

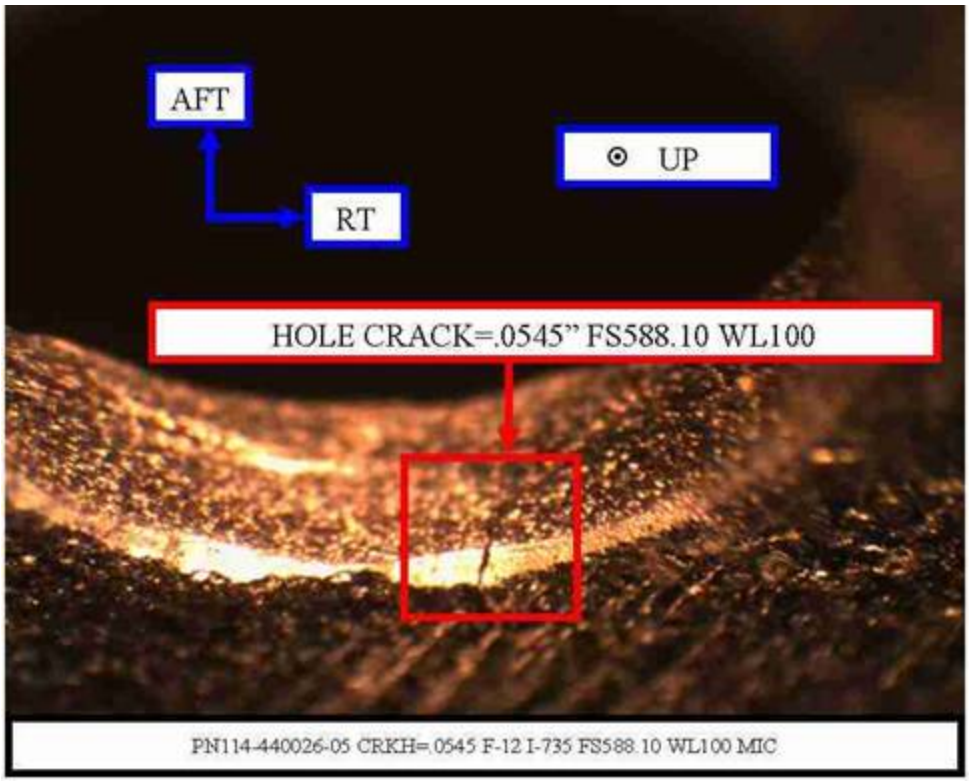


Figure 268. Crack on Right Side of Bulkhead Frame—Microscopic View

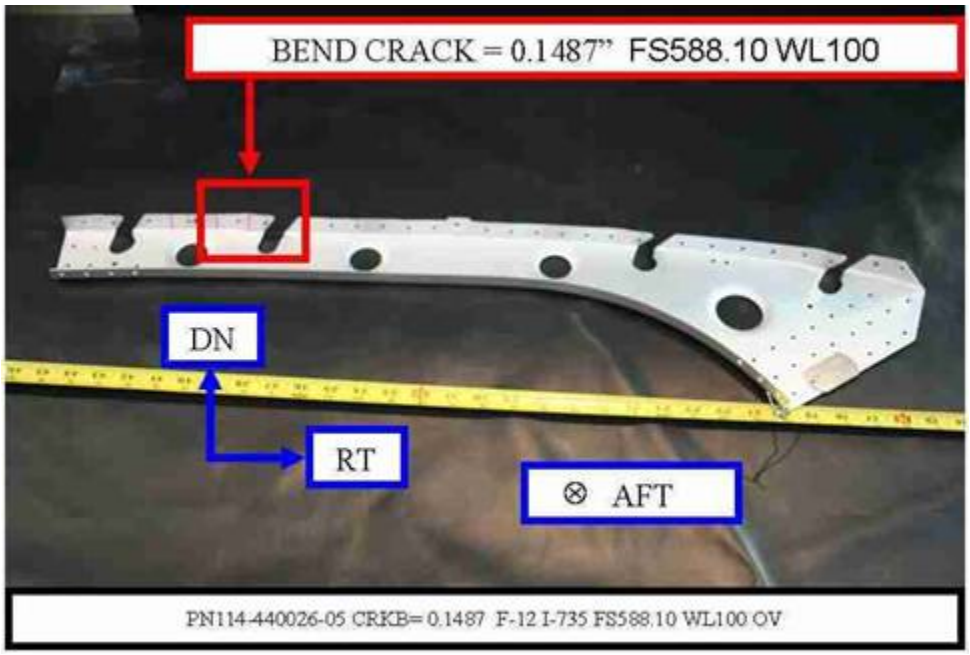


Figure 269. Bend Crack on Right Side of Bulkhead Frame—Overview

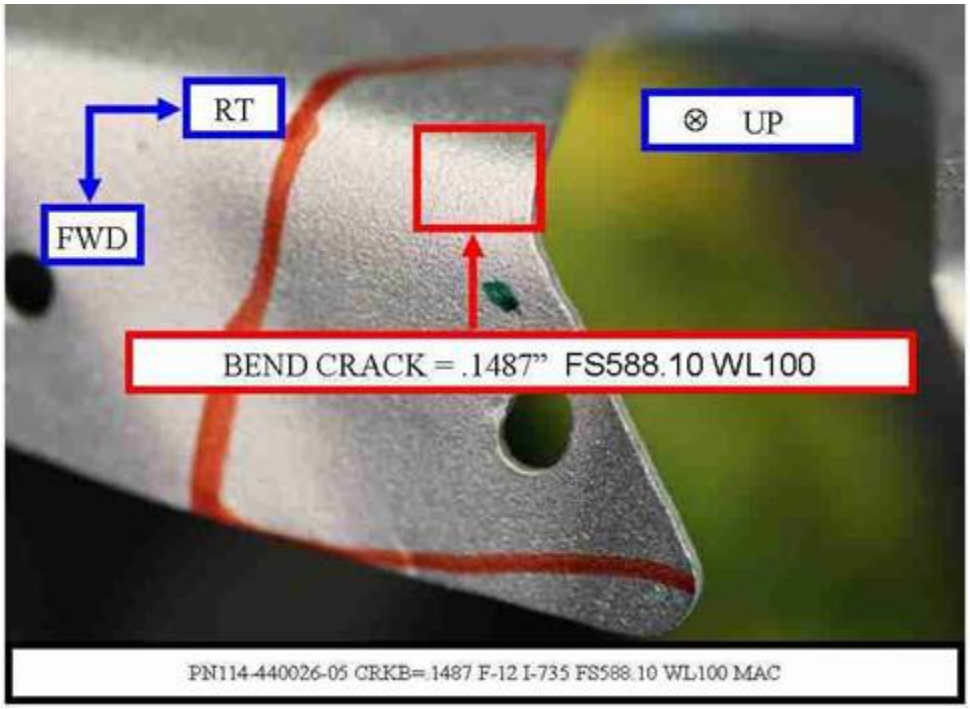


Figure 270. Bend Crack on Right Side of Bulkhead Frame—Macroscopic View

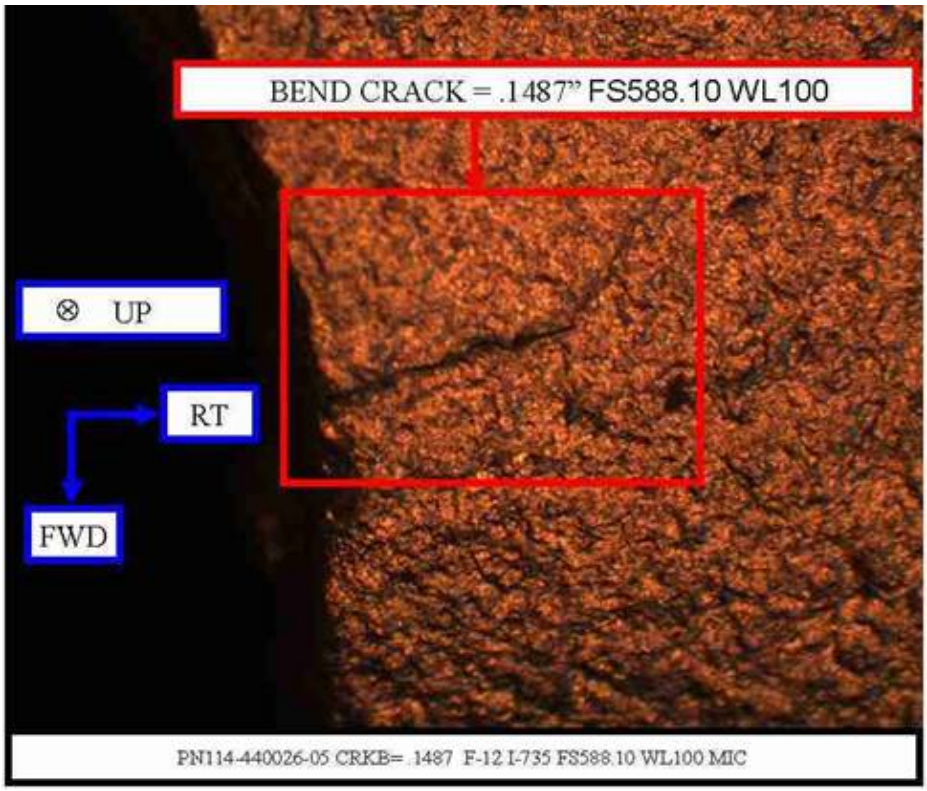


Figure 271. Bend Crack on Right Side of Bulkhead Frame—Microscopic View

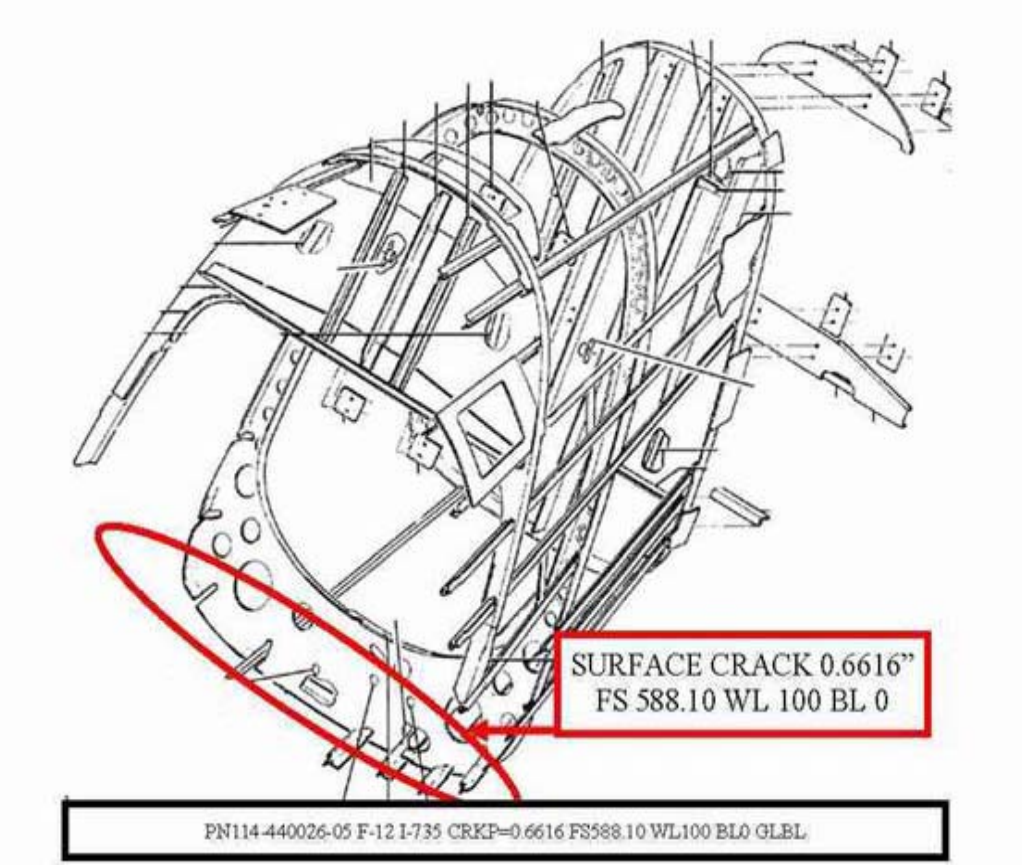


Figure 272. Surface Crack on Lower Bulkhead Frame—Global View

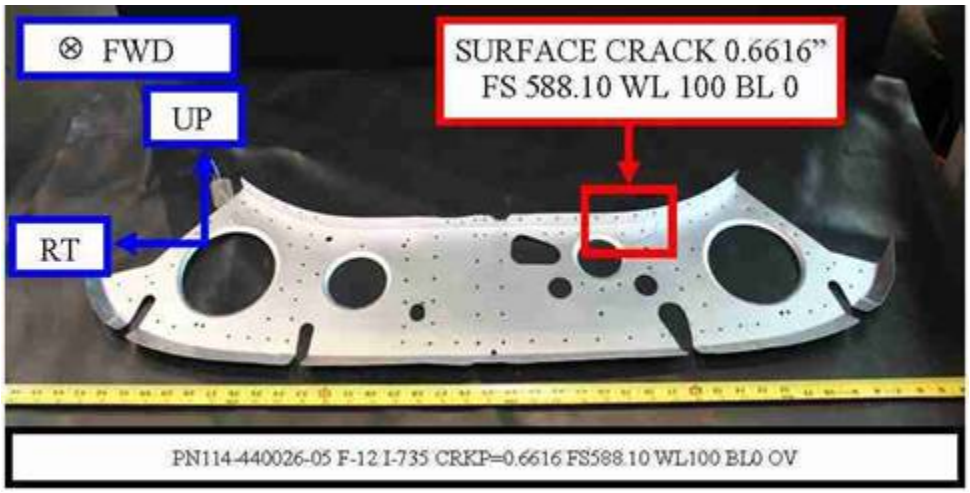


Figure 273. Surface Crack on Lower Bulkhead Frame—Overview

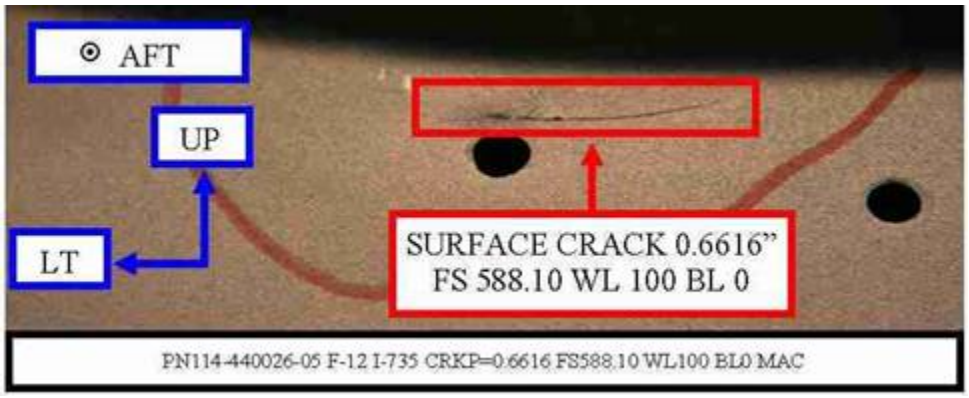


Figure 274. Surface Crack on Lower Bulkhead Frame—Macroscopic View (0.6616″)

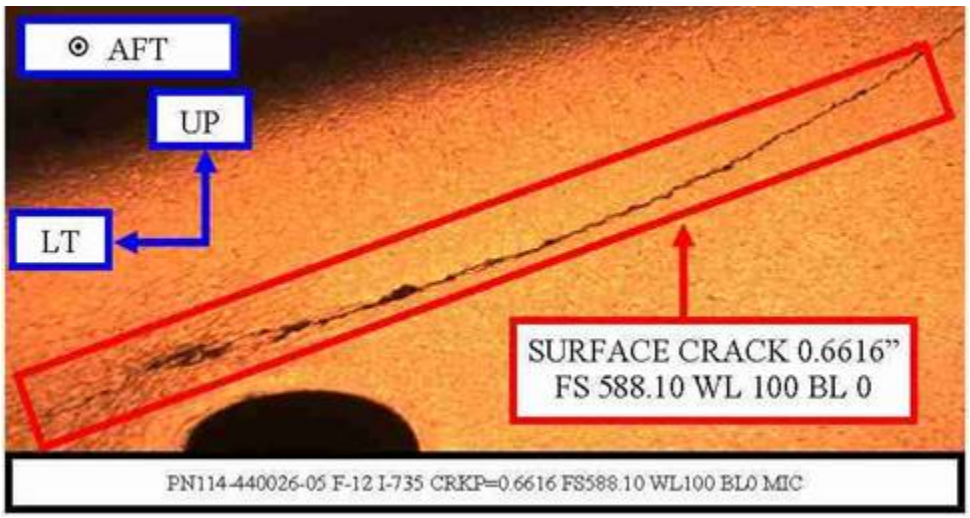


Figure 275. Surface Crack on Lower Bulkhead Frame—Microscopic View (0.6616″)

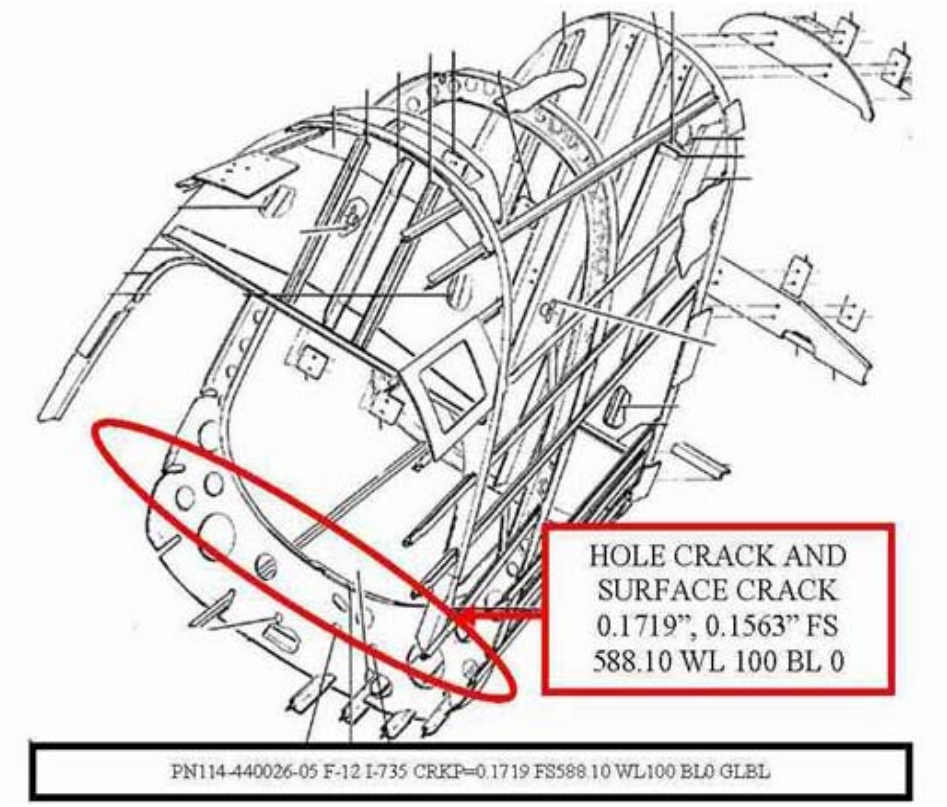


Figure 276. Multiple Cracks on Lower Bulkhead Frame—Global View

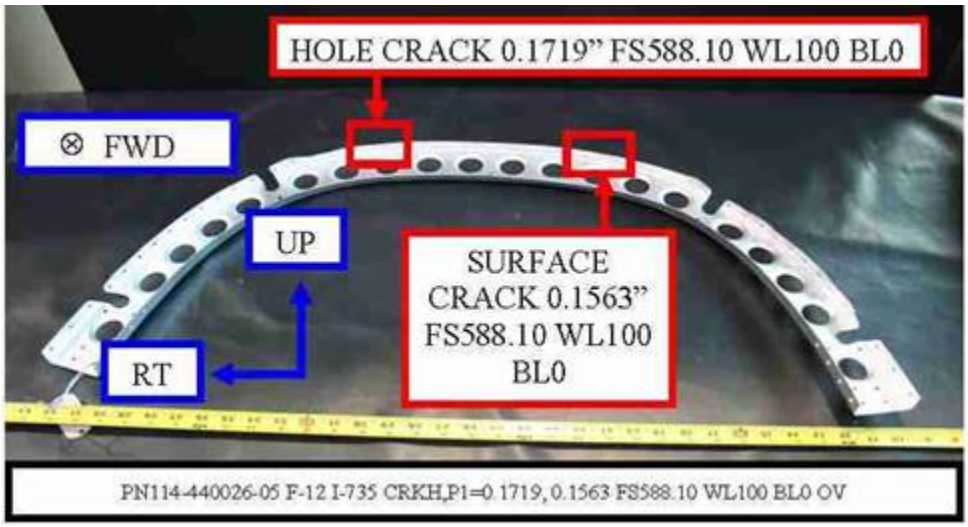


Figure 277. Multiple Cracks on Lower Bulkhead Frame—Overview

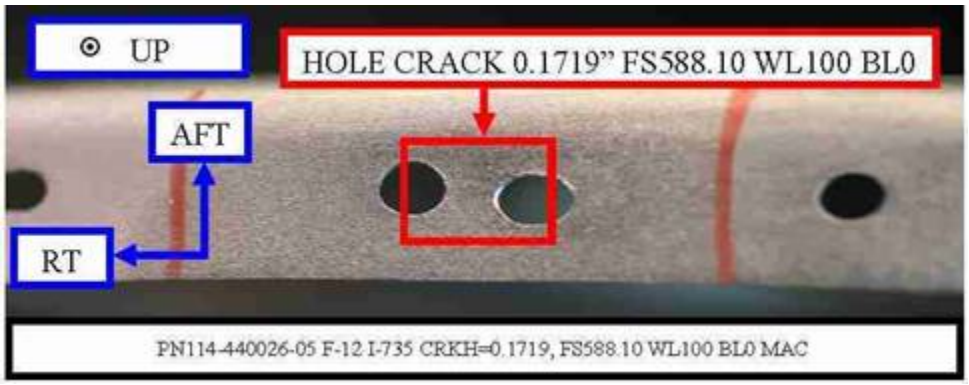


Figure 278. Hole Crack on Lower Bulkhead Frame—Macroscopic View

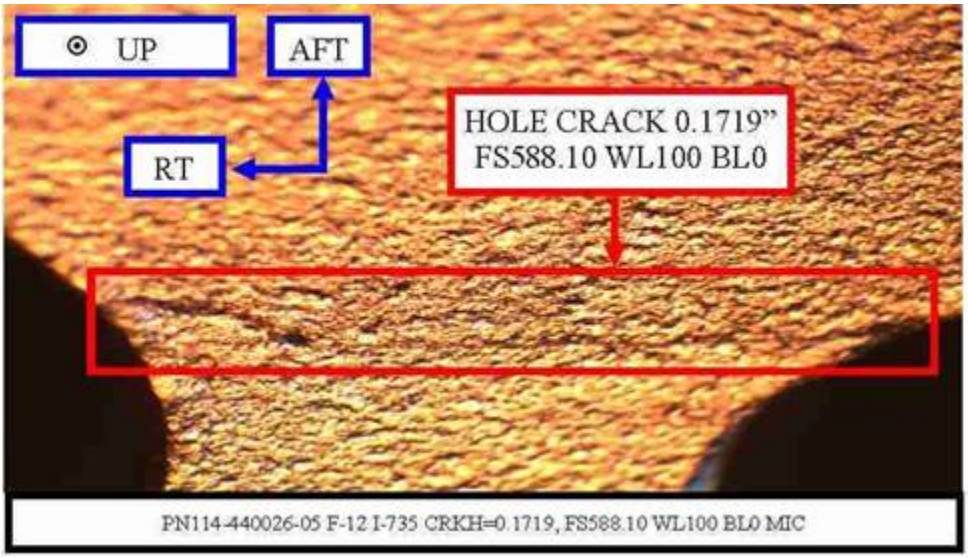


Figure 279. Hole Crack on Lower Bulkhead Frame—Microscopic View

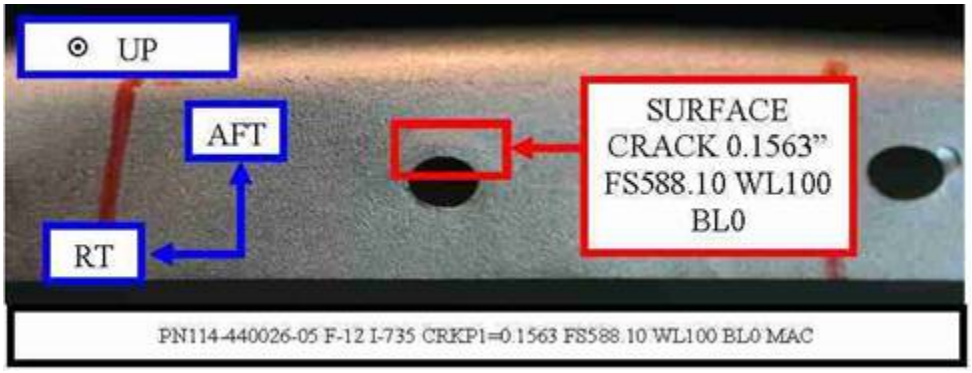


Figure 280. Surface Crack on Lower Bulkhead Frame—Macroscopic View (0.1563″)

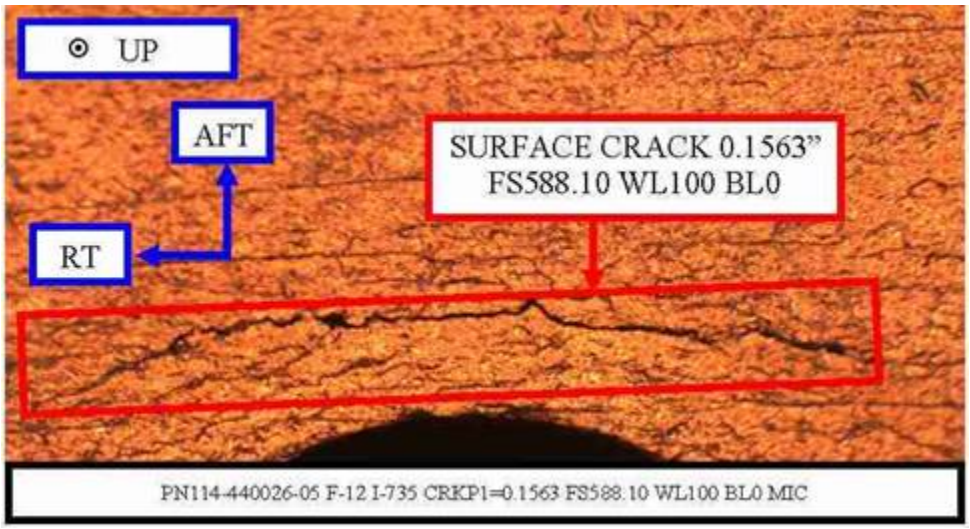


Figure 281. Surface Crack on Lower Bulkhead Frame—Microscopic View (0.1563″)

3.4.5 Fuselage Teardown Examination Summary.

The teardown examination for the Beechcraft 1900D fuselage was accomplished in four sections: forward, mid, aft, and tail. Table 35 shows the number of inspected parts, relevant defects, and microscopic holes examined on the four fuselage sections.

Table 35. Beechcraft 1900D Fuselage Examination Summary

Airplane Section	Number of Parts Inspected	Number of Defects Found	Microscopic Examination Holes Inspected
Forward Fuselage	163	16	13,881
Mid Fuselage	288	27	14,129
Aft Fuselage	268	19	13,086
Tail Fuselage	363	53	27,226
Total	1082	115	68,322

3.4.6 Left Wing Examination Overview.

During the teardown examination of the left wing (see figure 282), the areas of concentration included, but was not limited to, the forward and rear spars, wing ribs, landing gear attachments, fuel cells, and wing skins. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, a total of 42 parts were visually examined during the detailed disassembly. During the postdisassembly examination, 13 areas of light scattered corrosion were found on the wing spars; however, no relevant discrepancies were discovered. An example of light corrosion is shown in figure 169. Microscopic examination included 3960 holes inspected with no relevant defects found.

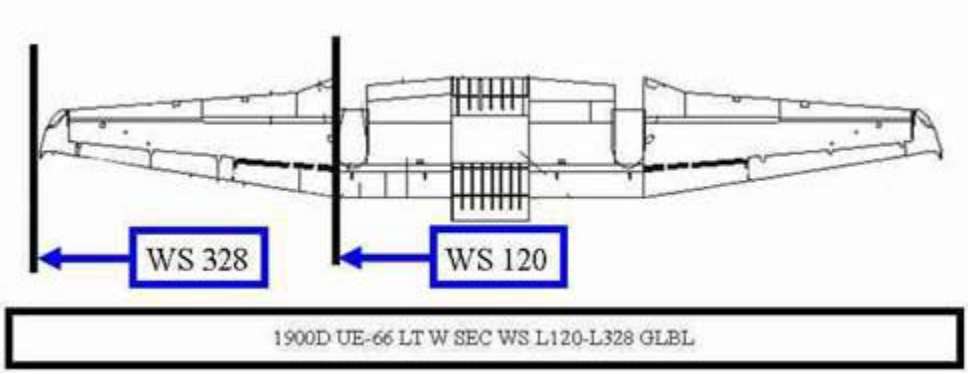


Figure 282. Left Wing Stations—Global View

3.4.7 Right Wing Examination Overview.

During the teardown examination of the right wing (shown in figure 283), the areas of concentration included, but was not limited to, the forward and rear spars, wing ribs, landing gear attachments, fuel cells, and wing skins. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, a total of 41 parts were visually examined during the detailed disassembly During the postdisassembly examination, 16 areas of light scattered corrosion was found predominately on the spars; however, no relevant discrepancies were discovered. (An example of light corrosion is shown in figure 169.) Microscopic examination included 3972 holes inspected with no relevant defects found.

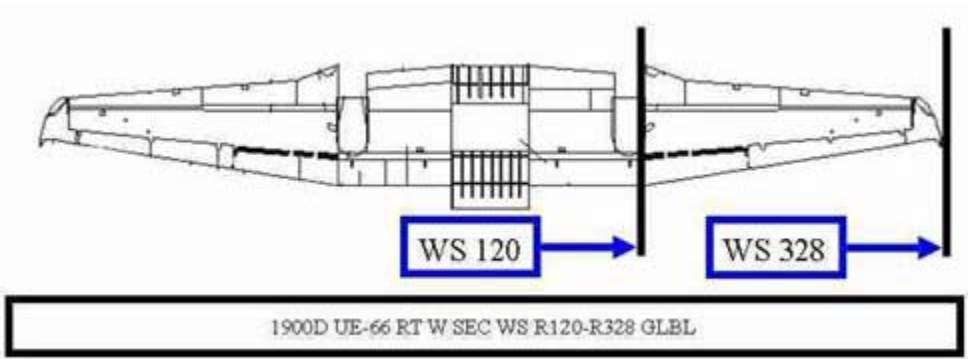


Figure 283. Right Wing Stations—Global View

3.4.8 Center Wing Examination Overview.

During the teardown examination of the center wing (see figure 284), the areas of concentration included, but were not limited to, the forward and rear spars, ribs, nacelles, keels, stringers, and wing skins. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, a total of 76 individual parts were visually examined during the detailed disassembly. During the postdisassembly examination, severe to moderate corrosion was found on numerous parts, with three areas considered as relevant. All other corrosion was classified as light corrosion. There were five other areas with cracks, which were classified as noteworthy and are listed in table 36. (An example of light corrosion is shown in figure 169.) Microscopic examination included 7718 holes inspected with no relevant defects found.

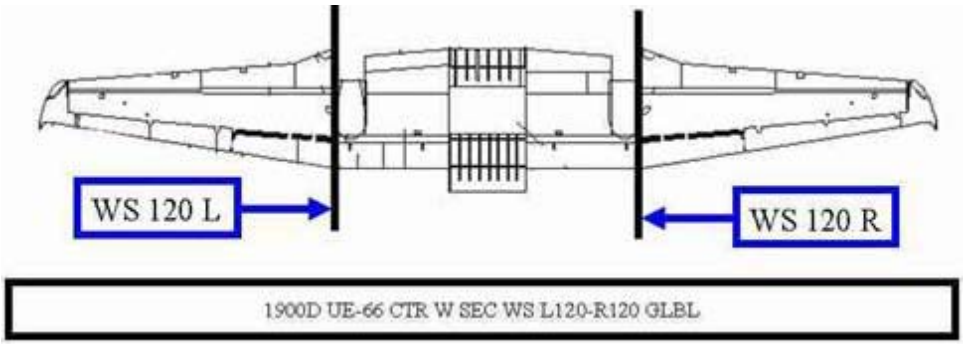


Figure 284. Center Wing Stations—Global View

3.4.8.1 Center Wing Forward and Rear Spars.

The center wing spars were a point of emphasis as deemed by Raytheon engineers. Five cracks and two areas of severe corrosion were found and classified as relevant. These defects are listed in table 36.

Table 36. Center Wing Forward and Rear Spars Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	WS	WSL		
Crack	0.0099				36	Hole Crack Left Upper Forward Spar Cap	Figure 285 Global Figure 286 Overview Figure 287 Macroscopic Figure 288 Microscopic
Corr	0.3502	0.3159	0.0205		37.5	Severe Corrosion Left Upper Rear Spar Cap	Figure 289 Global Figure 290 Overview Figure 291 Macroscopic Figure 292 Microscopic
Corr	0.4412	0.2867	0.0180		37.5	Moderate-Severe Corrosion Right Upper Rear Spar Cap	Figure 293 Global Figure 294 Overview Figure 295 Macroscopic Figure 296 Microscopic
Crack	0.3166 0.0658			72	100	Right Lower Forward Cap	Figure 297 Global Figure 298 Overview Figure 299 Macroscopic Figure 300 Microscopic
Corr	0.2702	0.1367	0.0230	100	130	Severe Corrosion on Left Lower Forward Spar Cap	Figure 301 Global Figure 302 Overview Figure 303 Macroscopic Figure 304 Microscopic
Crack	0.2301 0.0308			100.5	130	Hole Cracks on Right Lower Rear Cap	Figure 305 Global Figure 306 Overview Figure 307 Macroscopic Figure 308 Microscopic

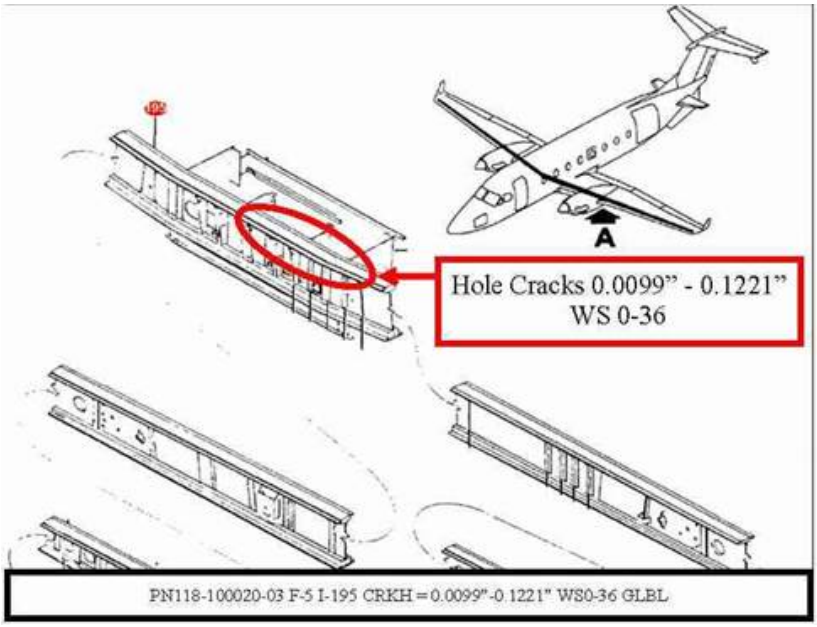


Figure 285. Crack Left Upper Forward Spar Cap—Global View

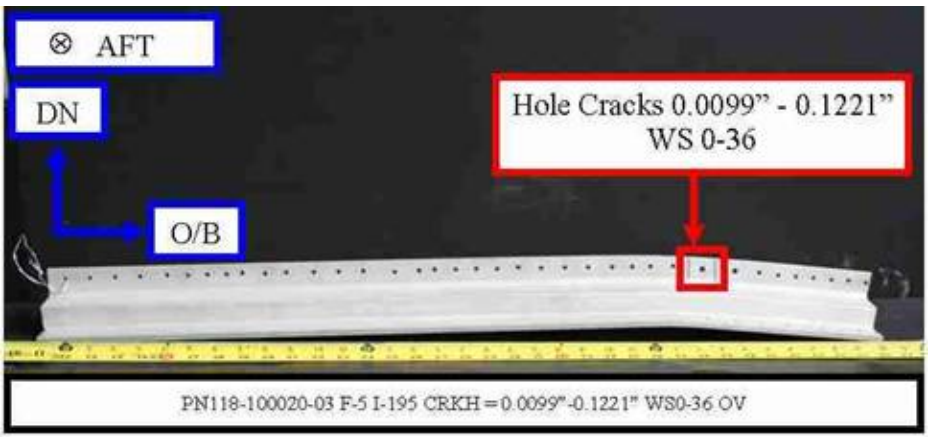


Figure 286. Crack Left Upper Forward Spar Cap—Overview

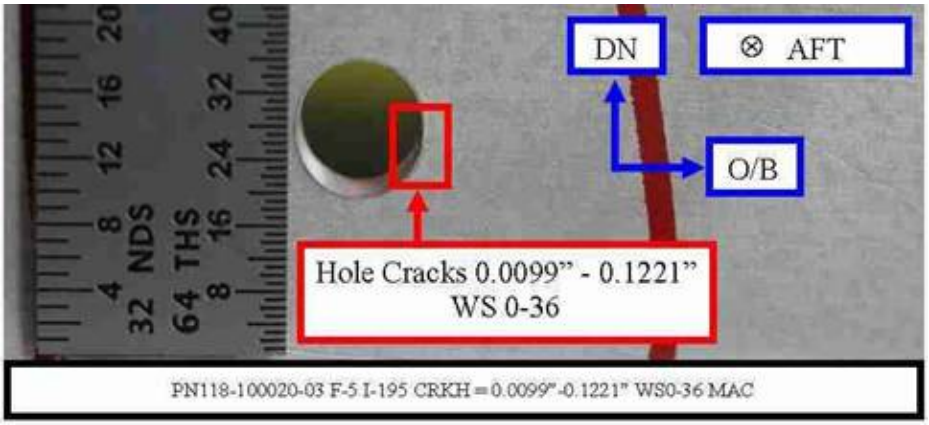


Figure 287. Crack Left Upper Forward Spar Cap—Macroscopic View

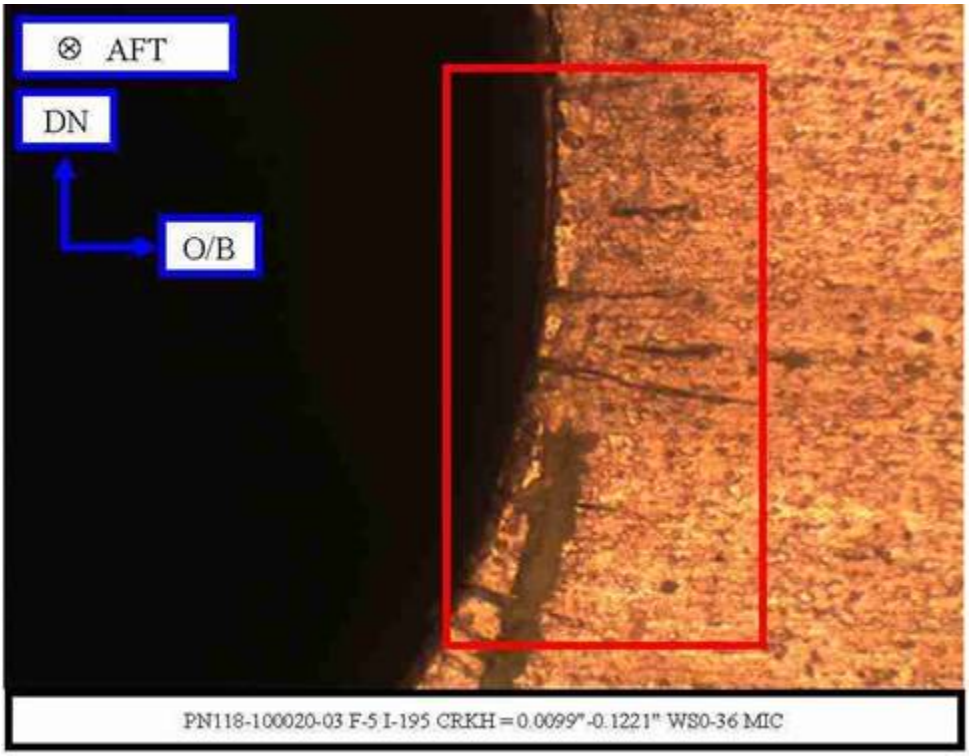


Figure 288. Crack Left Upper Forward Spar Cap—Microscopic View

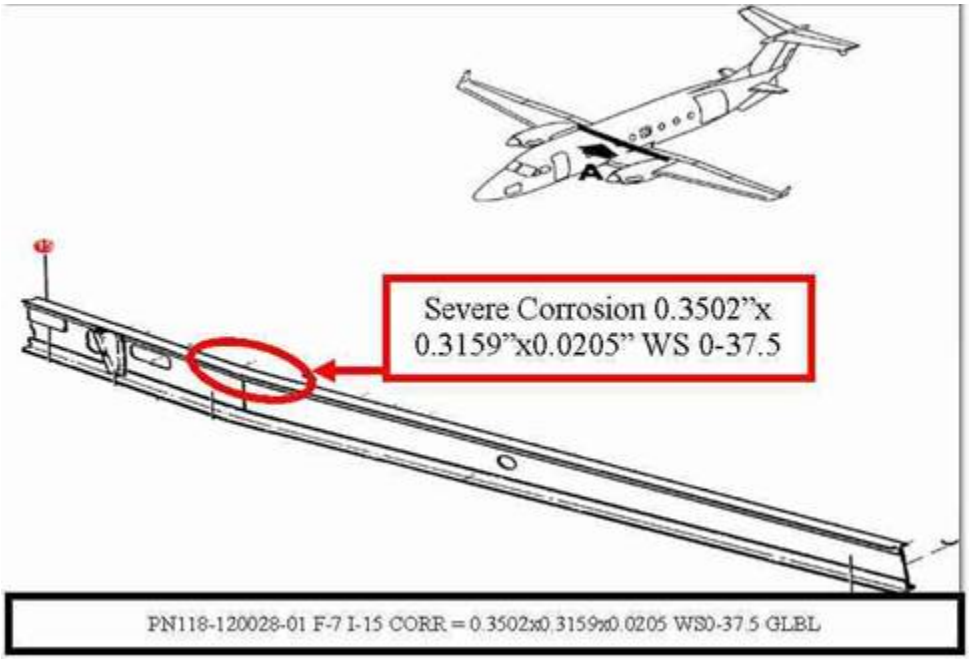


Figure 289. Severe Corrosion on Left Upper Rear Spar Cap—Global View

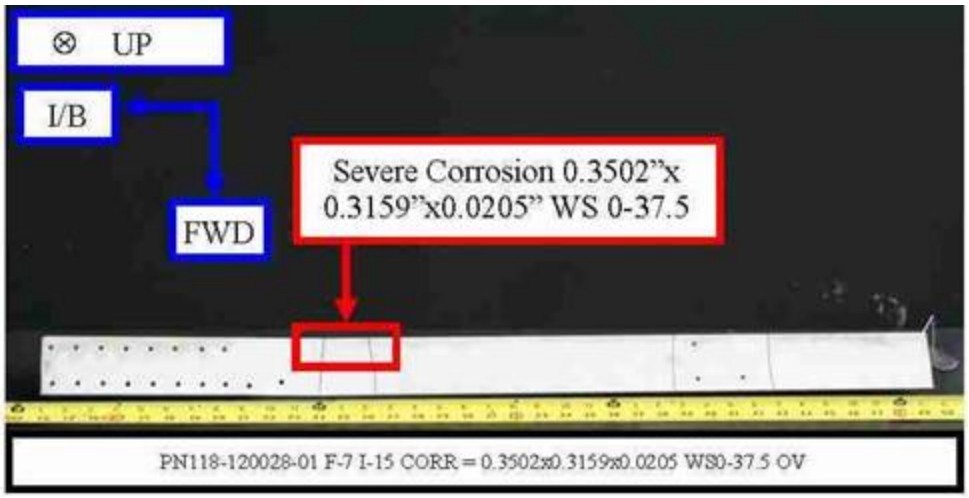


Figure 290. Severe Corrosion on Left Upper Rear Spar Cap—Overview

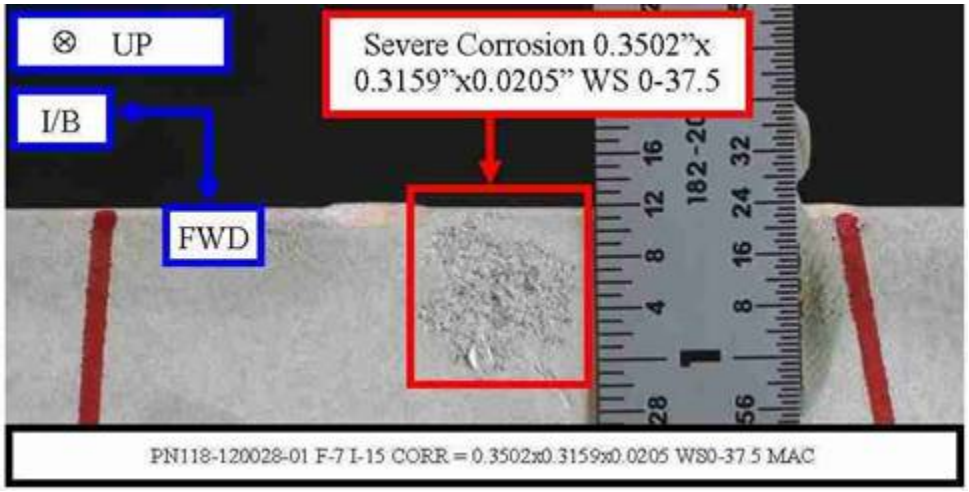


Figure 291. Severe Corrosion on Left Upper Rear Spar Cap—Macroscopic View

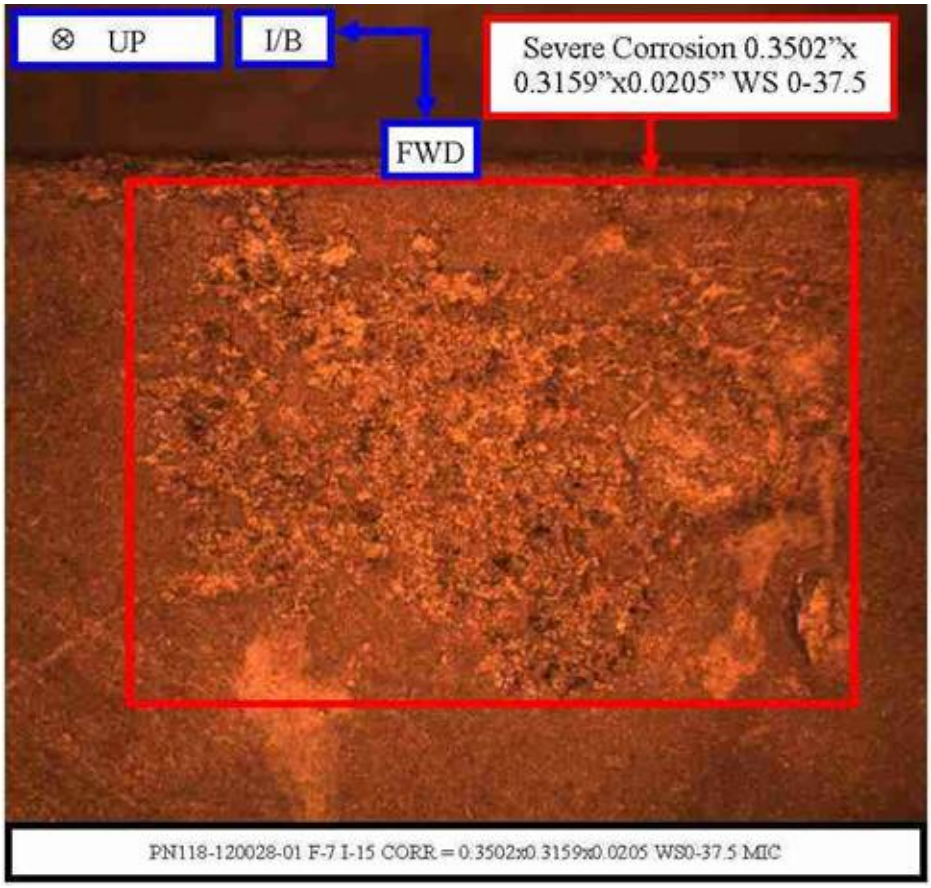


Figure 292. Severe Corrosion on Left Upper Rear Spar Cap—Microscopic View

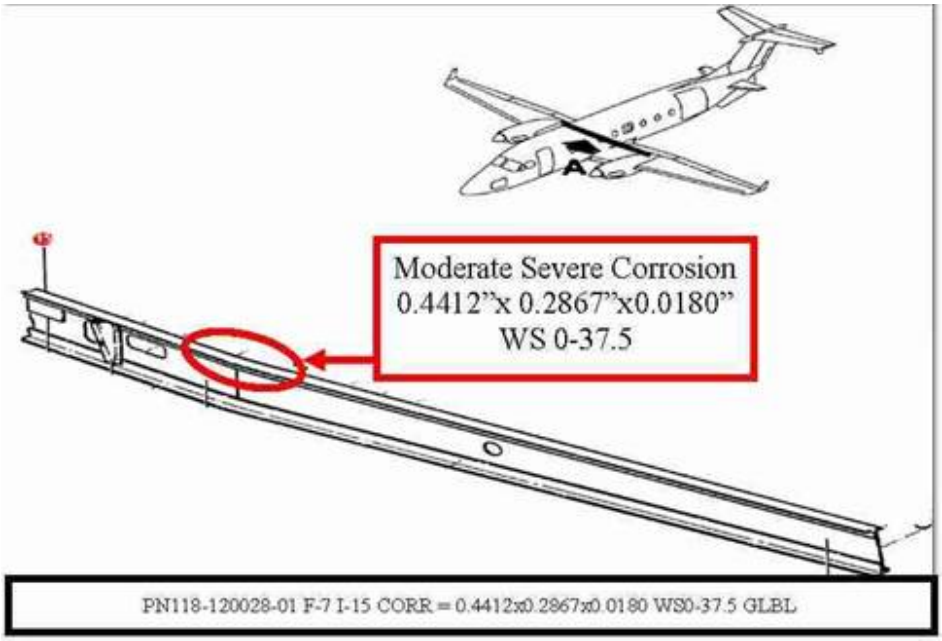


Figure 293. Moderate to Severe Corrosion on Right Upper Rear Spar Cap—Global View

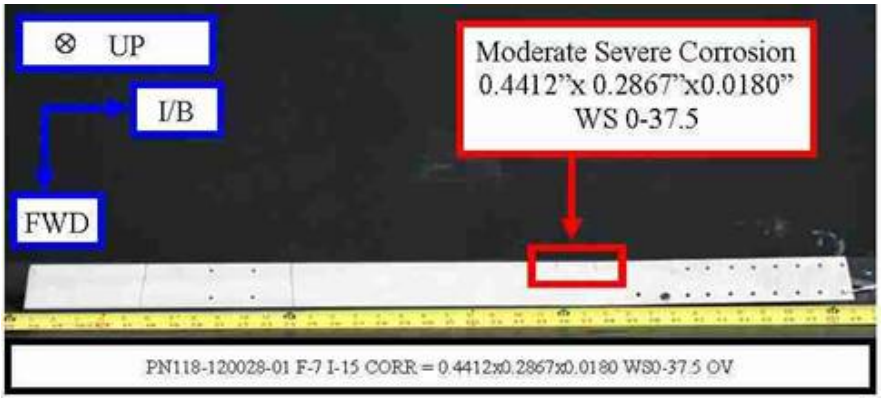


Figure 294. Moderate to Severe Corrosion on Right Upper Rear Spar Cap—Overview

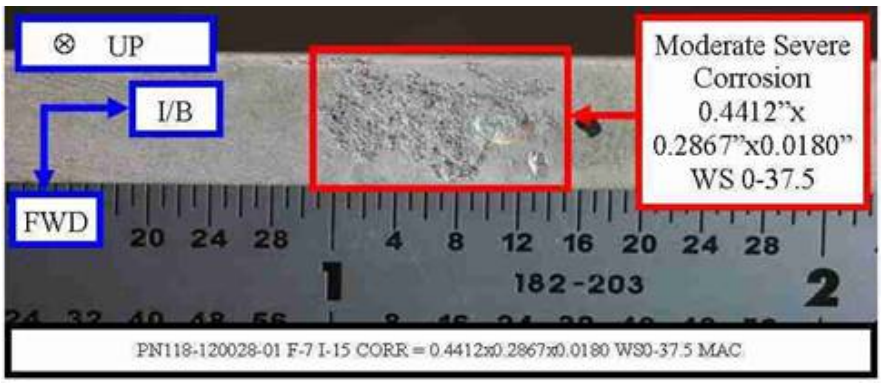


Figure 295. Moderate to Severe Corrosion on Right Upper Rear Spar Cap—Macroscopic View

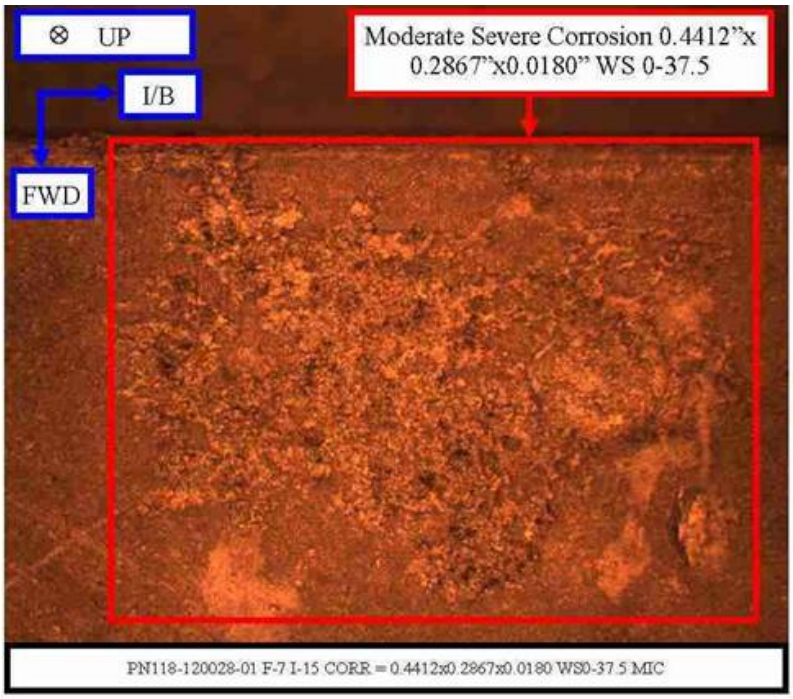


Figure 296. Moderate to Severe Corrosion on Right Upper Rear Spar Cap—Microscopic View

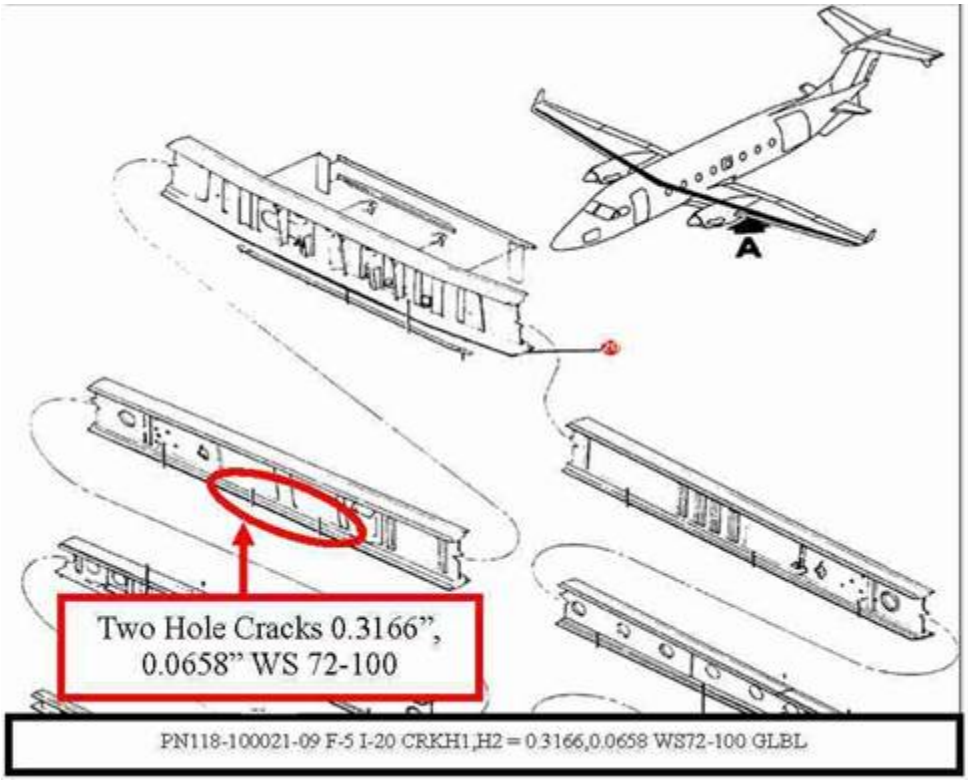


Figure 297. Cracks on Right Lower Forward Cap—Global View (0.3166″)

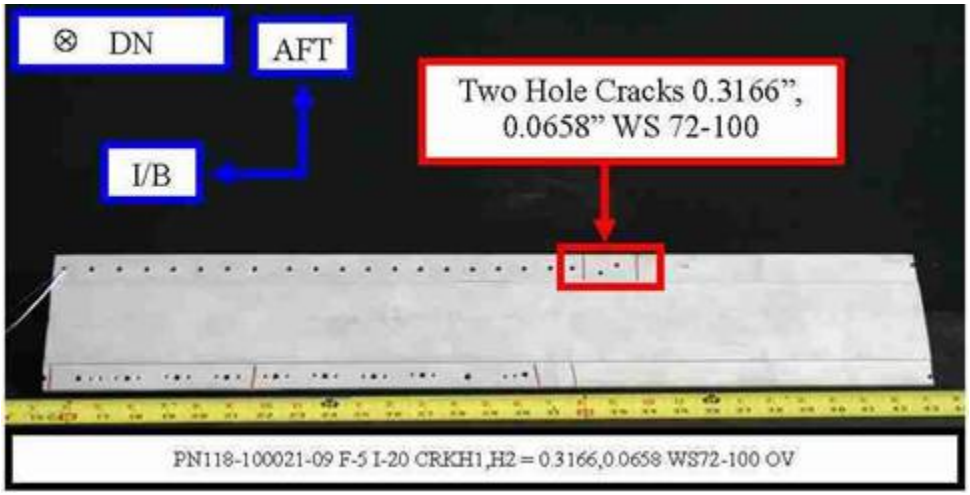


Figure 298. Cracks on Right Lower Forward Cap—Overview (0.3166″)

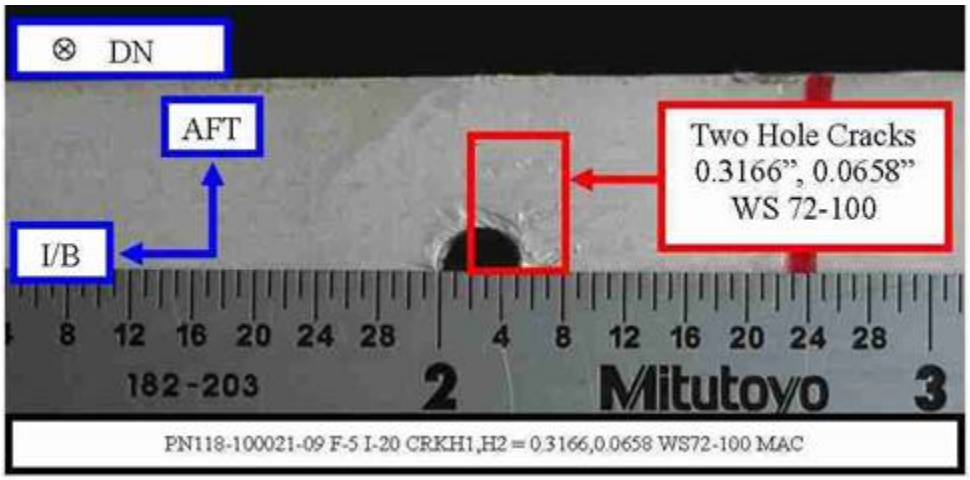


Figure 299. Cracks on Right Lower Forward Cap—Macroscopic View (0.3166″)

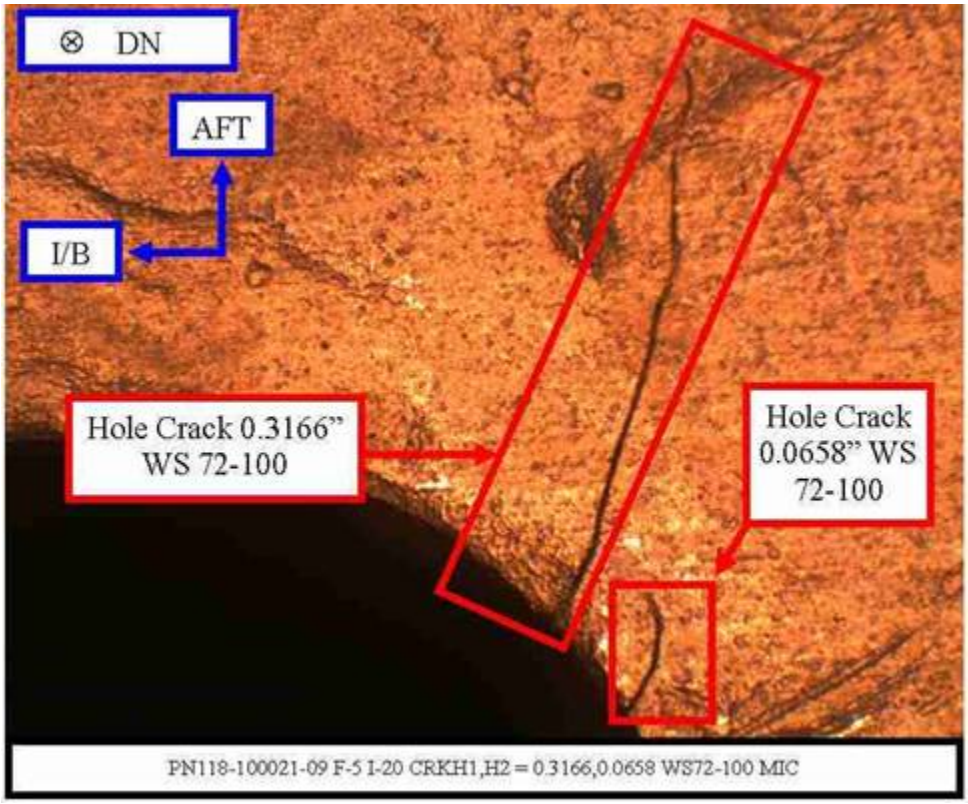


Figure 300. Cracks on Right Lower Forward Cap—Microscopic View (0.3166″)

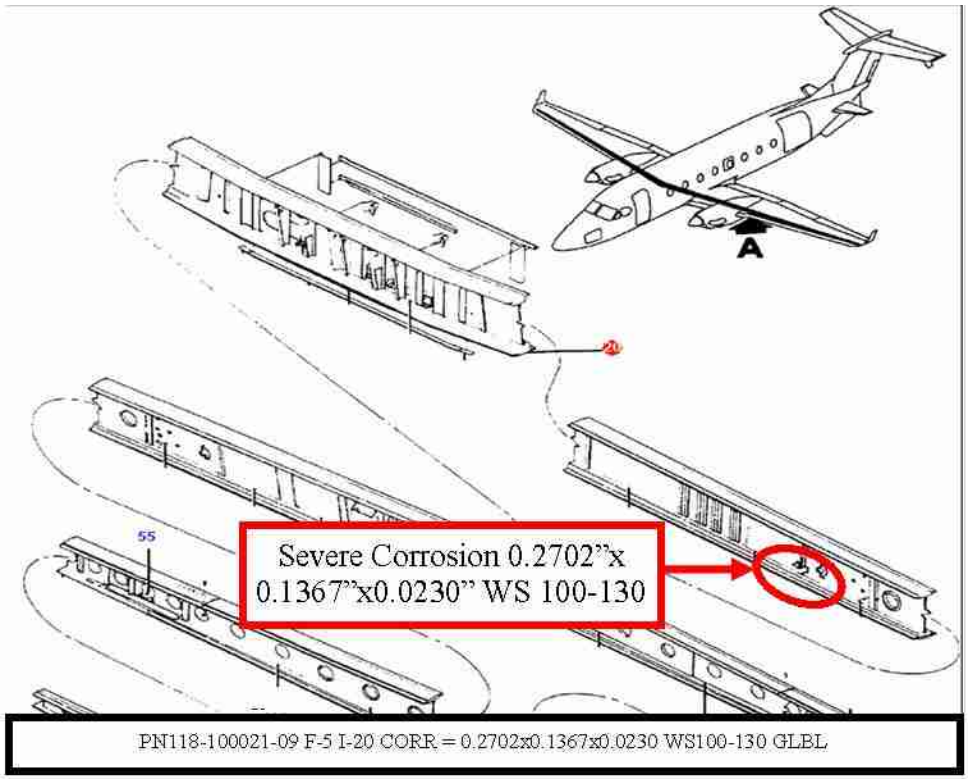


Figure 301. Corrosion on Left Lower Forward Spar Cap—Global View

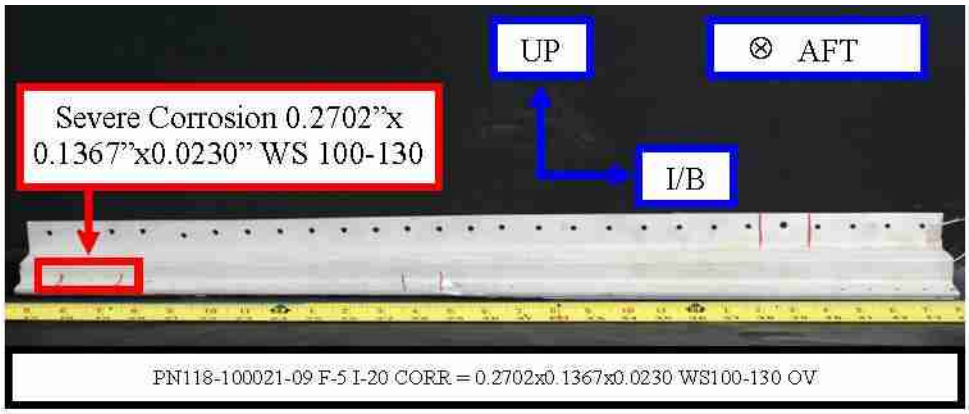


Figure 302. Corrosion on Left Lower Forward Spar Cap—Overview

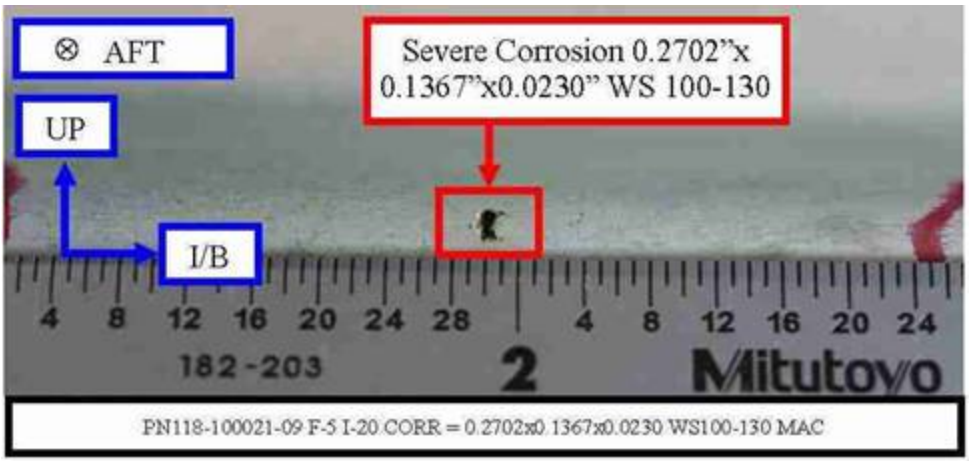


Figure 303. Corrosion on Left Lower Forward Spar Cap—Macroscopic View

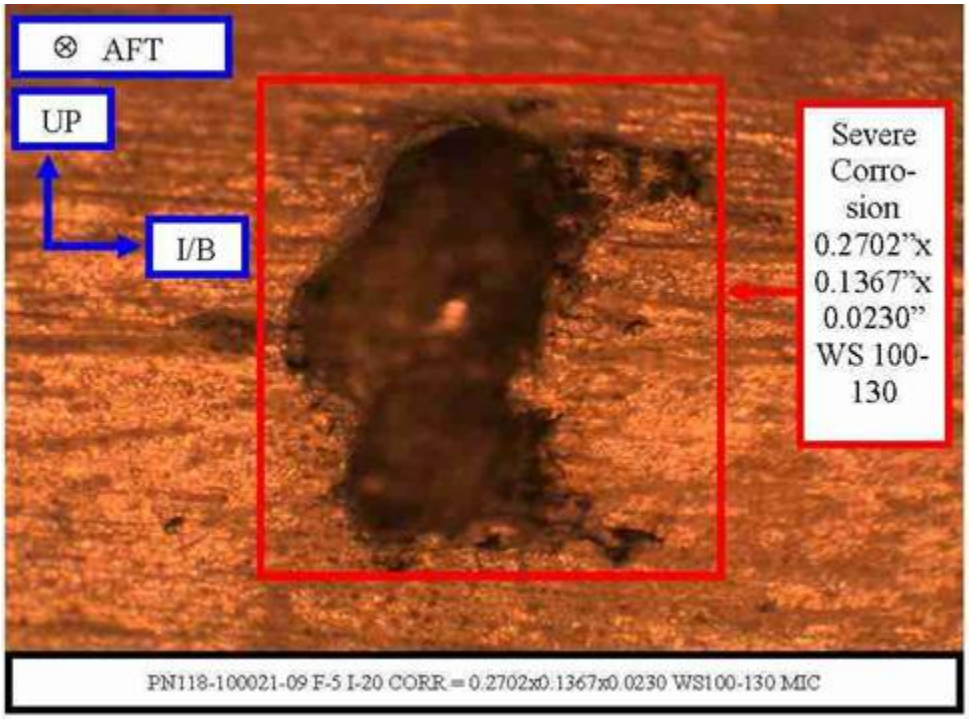


Figure 304. Corrosion on Left Lower Forward Spar Cap—Microscopic View

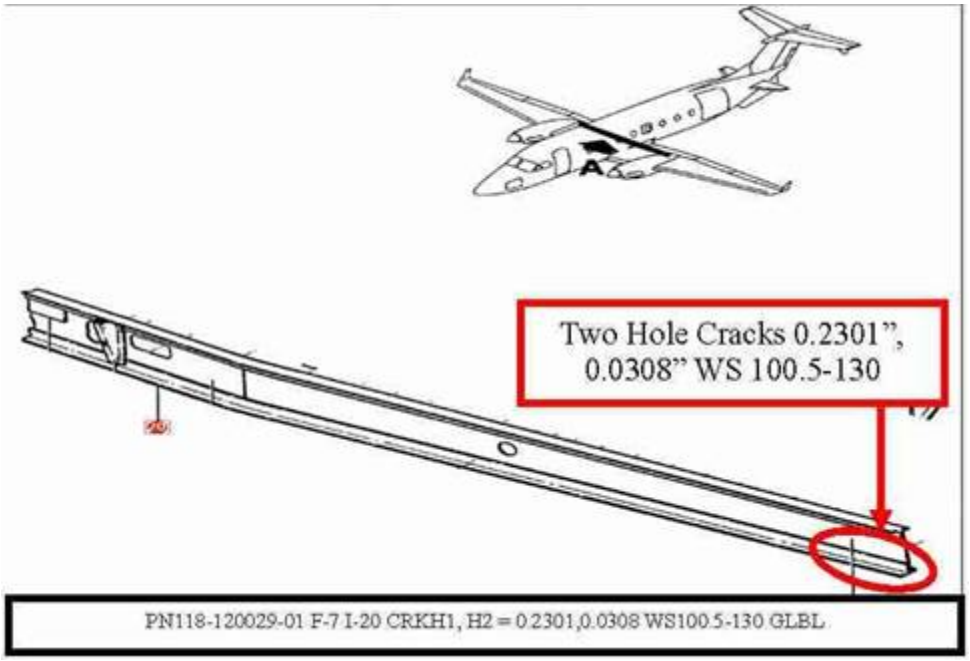


Figure 305. Cracks on Right Lower Forward Cap—Global View (0.2301″)

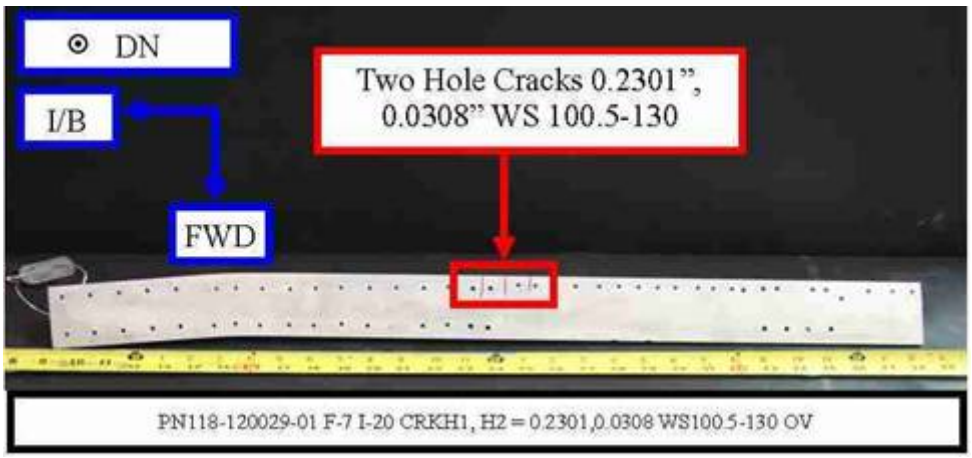


Figure 306. Cracks on Right Lower Forward Cap—Overview (0.2301″)

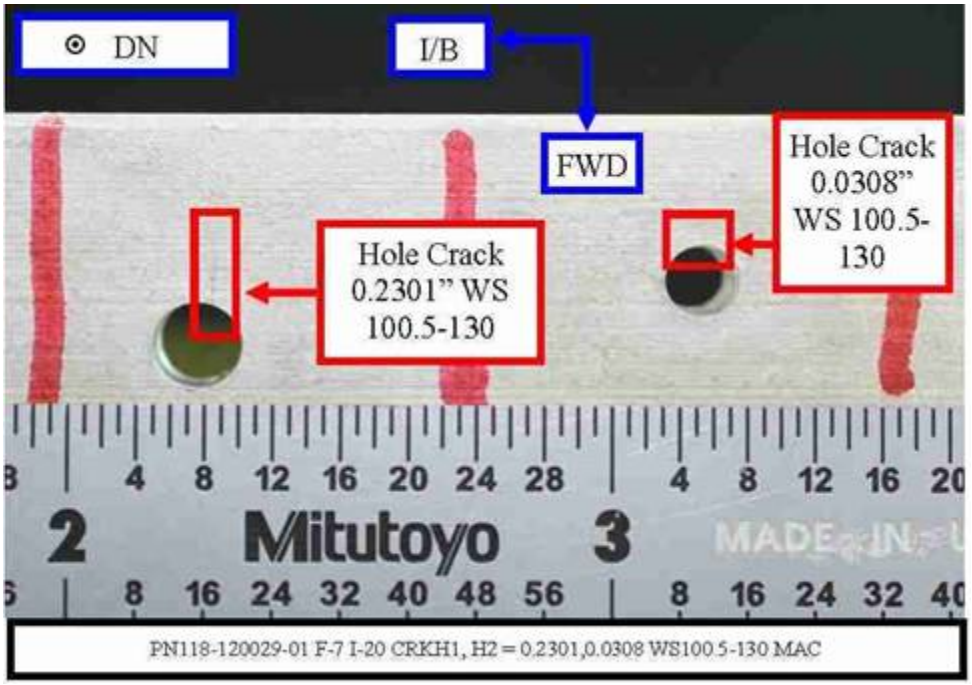


Figure 307. Cracks on Right Lower Forward Cap—Macroscopic View (0.2301″)

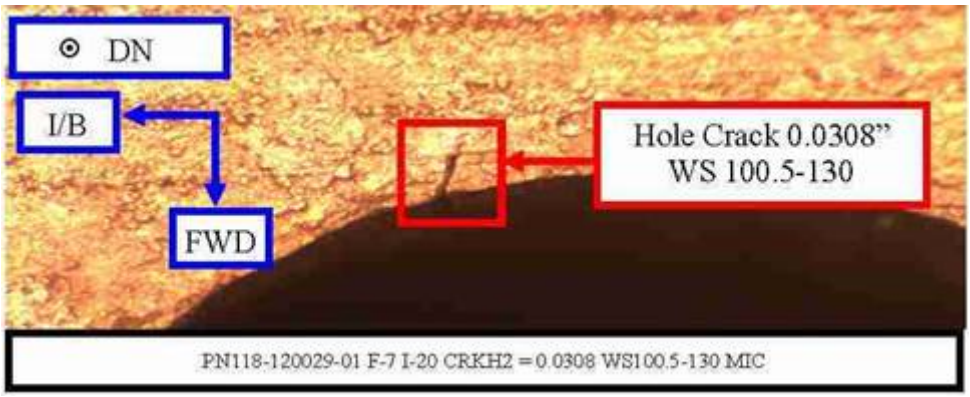


Figure 308. Cracks on Right Lower Forward Cap—Microscopic View (0.2301″)

3.4.8.2 Center Wing Keel Web.

The center wing keel web area had numerous areas of corrosion. These areas were classified, ranging from severe to moderate severe and are listed in table 37.

Table 37. Center Wing Keel Web Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	WS	WSL		
Corr	5.2500	1.0000	0.0085	92.75		Moderate to Severe Corrosion Left Inboard Web Keel	Figure 309 Global Figure 310 Overview Figure 311 Macroscopic Figure 312 Microscopic
Corr				92.75		Corrosion Inboard Web Keel Rod Hole	Figure 313 Global Figure 314 Overview Figure 315 Macroscopic
Corr	0.0055	1.8750	1.0	115.5		Moderate Corrosion Left Outboard Web Keel	Figure 316 Global Figure 317 Overview Figure 318 Macroscopic Figure 319 Microscopic
Corr	0.0085	5.7813	1.0	115.5		Severe Corrosion Right Outboard Web Keel	Figure 320 Global Figure 321 Overview Figure 322 Macroscopic Figure 323 Microscopic
Corr	0.0070	2.3125	1.0	115.5		Moderate Corrosion Left Outboard Web Keel	Figure 324 Global Figure 325 Overview Figure 326 Macroscopic Figure 327 Microscopic

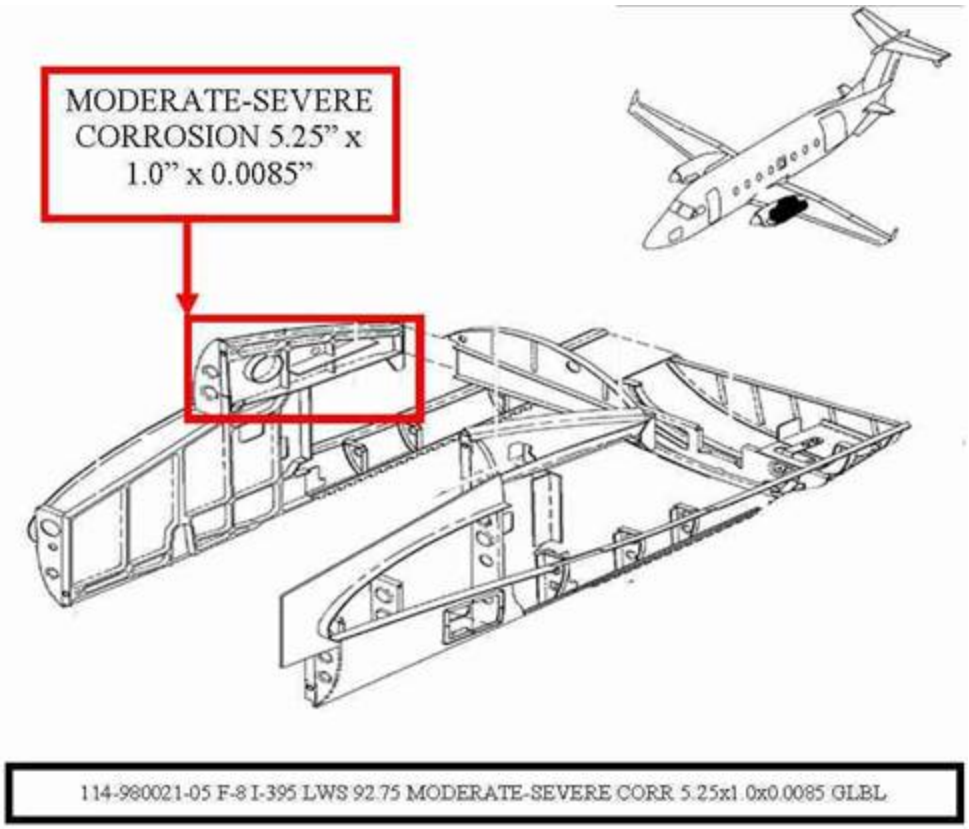


Figure 309. Moderate to Severe Corrosion on Left Inboard Web Keel—Global View

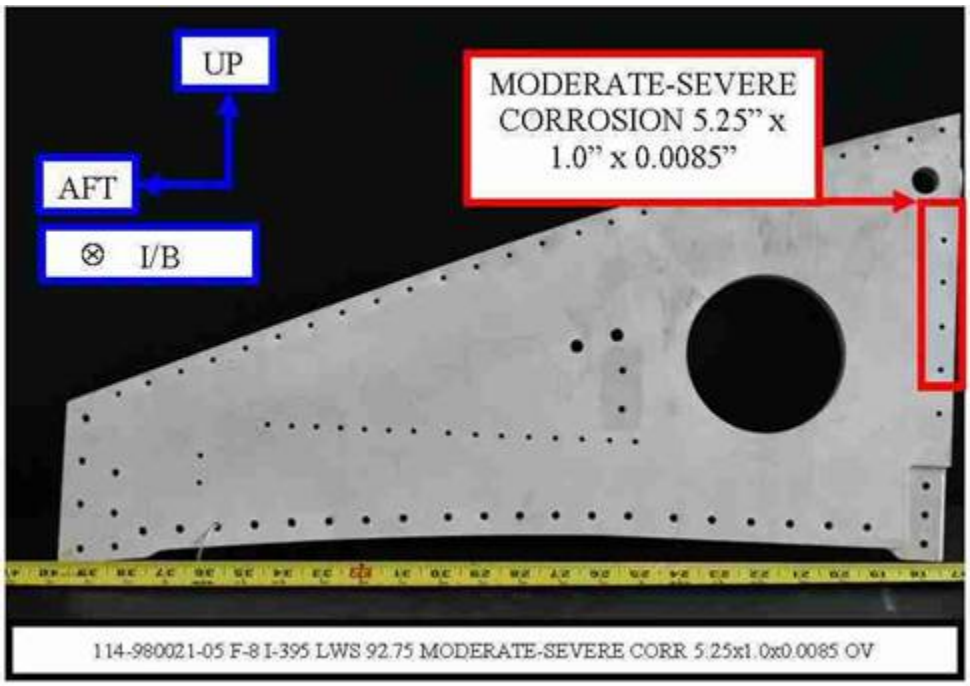


Figure 310. Moderate to Severe Corrosion on Left Inboard Web Keel—Overview

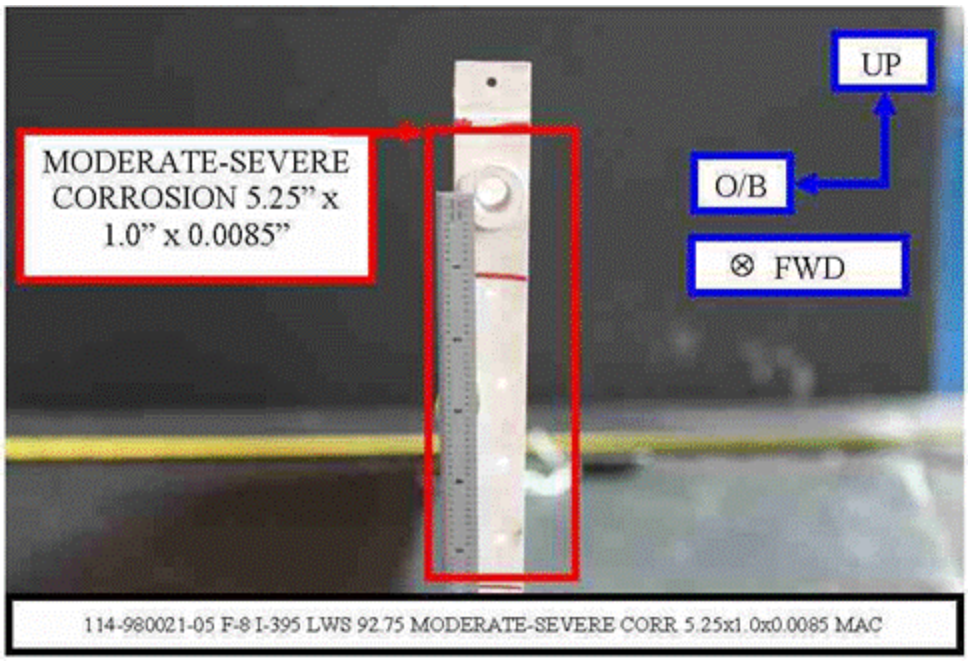


Figure 311. Moderate to Severe Corrosion on Left Inboard Web Keel—Macroscopic View

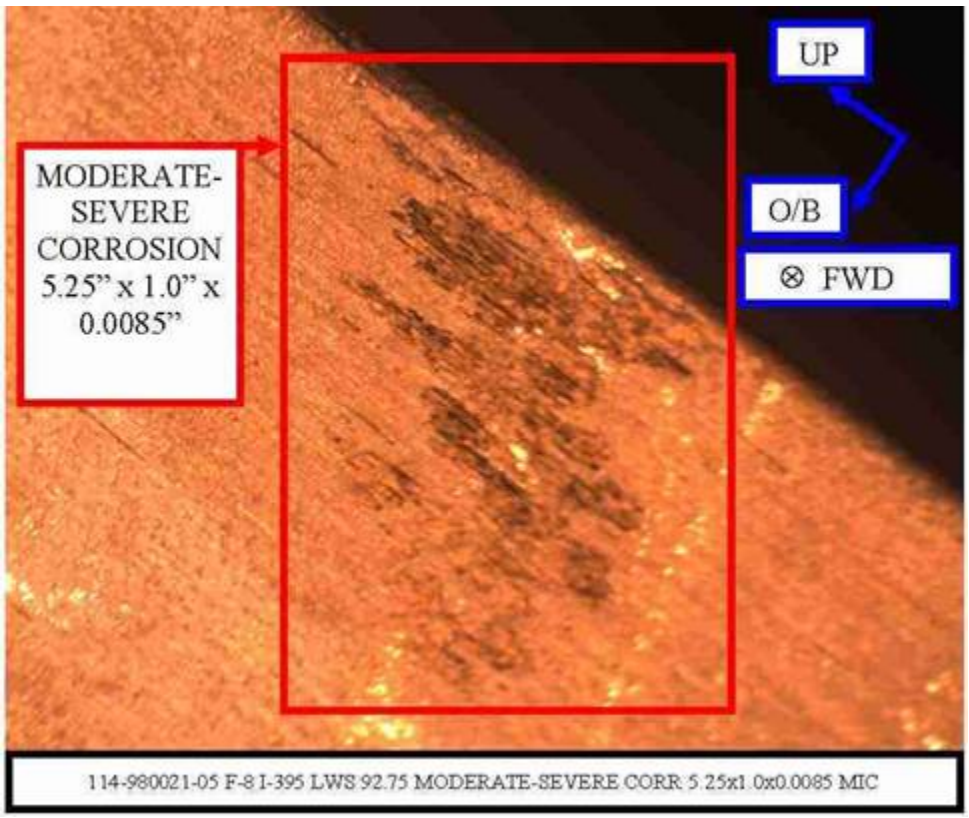


Figure 312. Moderate to Severe Corrosion on Left Inboard Web Keel—Microscopic View

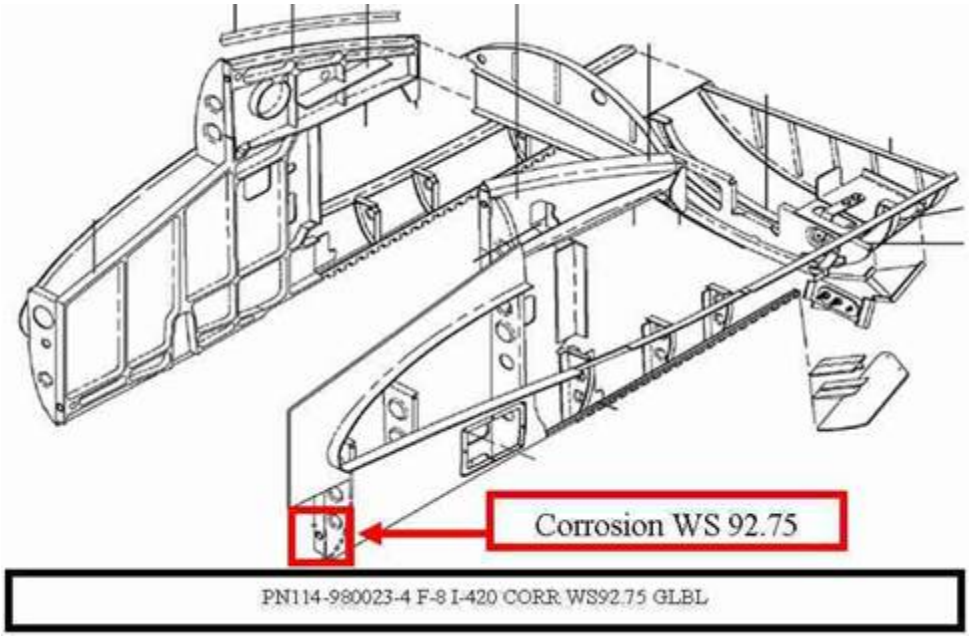


Figure 313. Corrosion on Inboard Web Keel Rod Hole—Global View

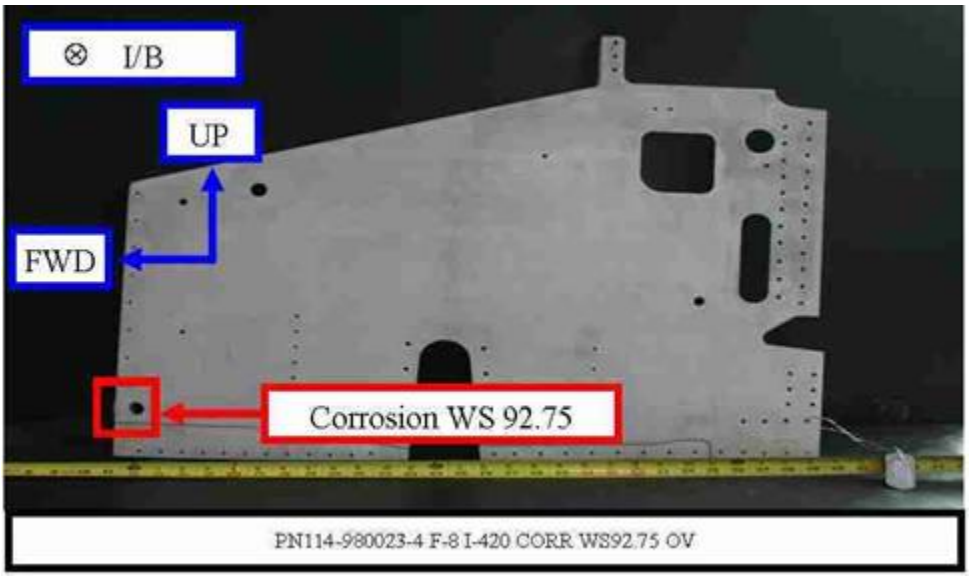


Figure 314. Corrosion on Inboard Web Keel Rod Hole—Overview

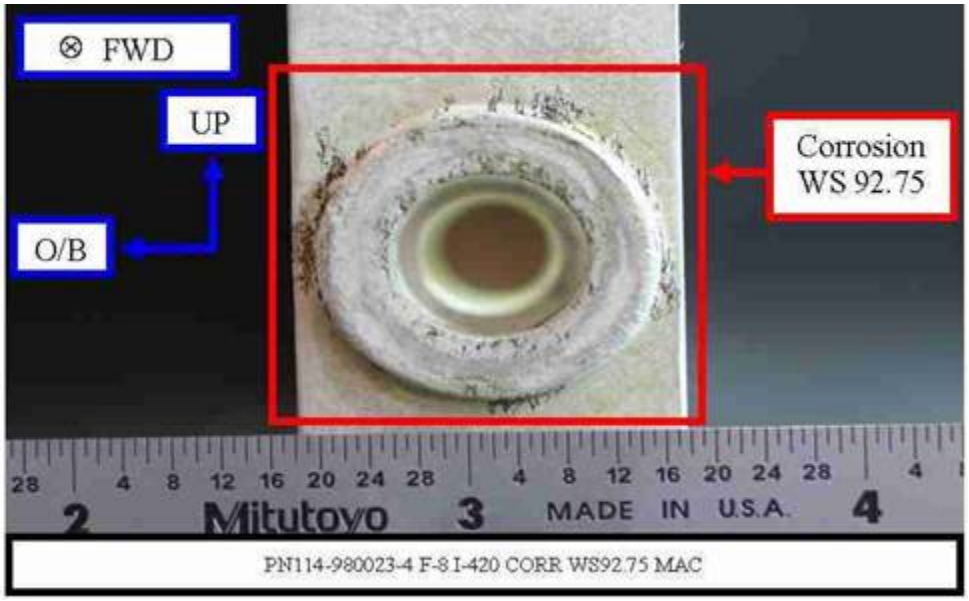


Figure 315. Corrosion on Inboard Web Keel Rod Hole—Macroscopic View

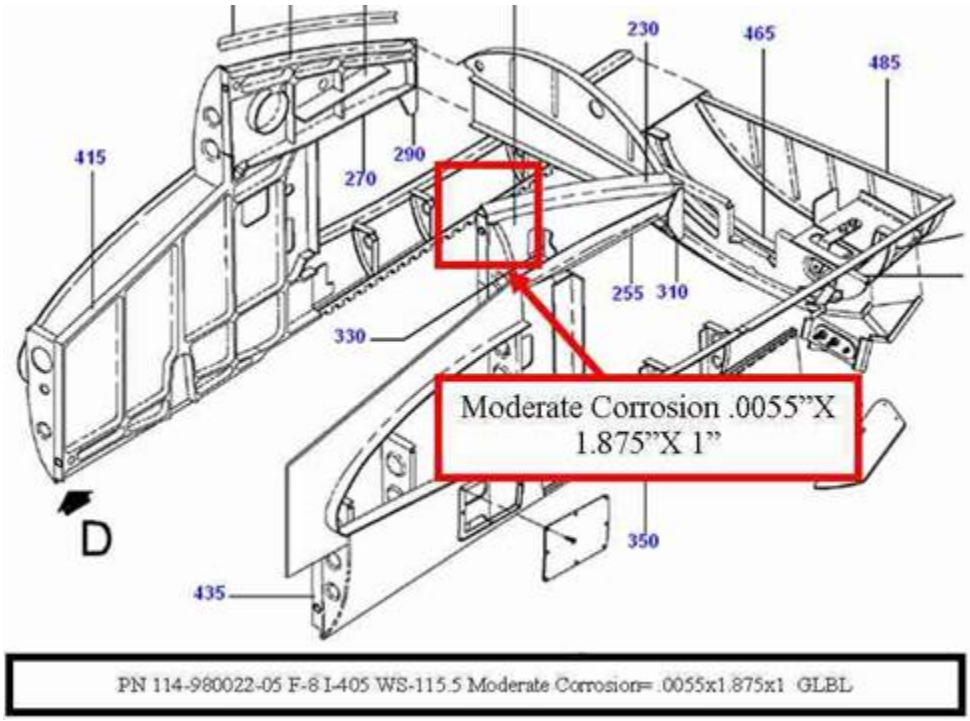


Figure 316. Moderate Corrosion on Left Outboard Web Keel—Global View

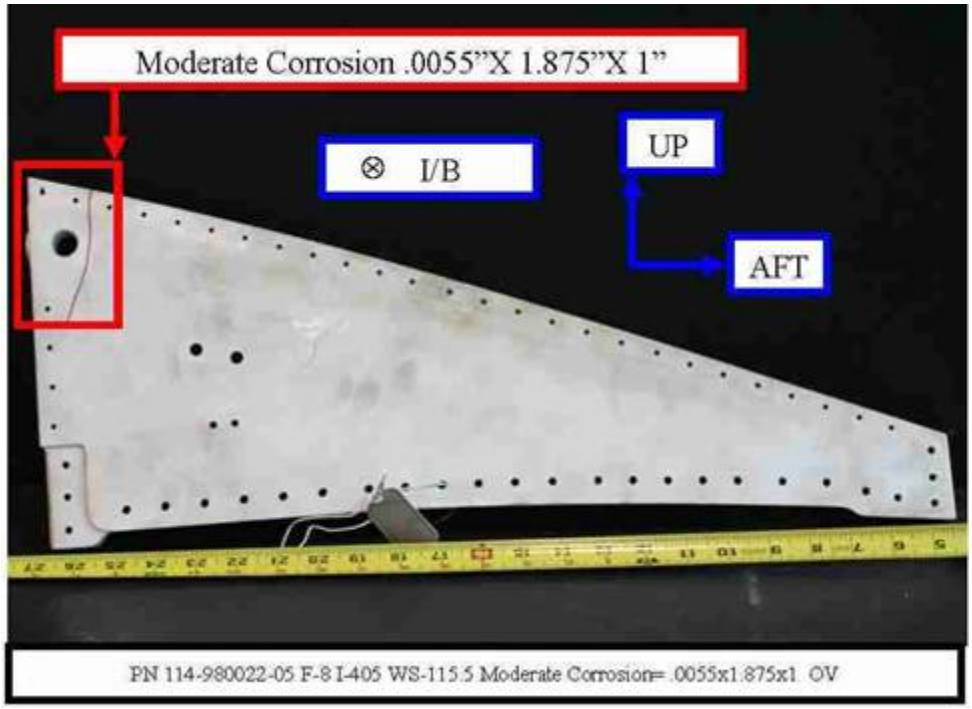


Figure 317. Moderate Corrosion on Left Outboard Web Keel—Overview

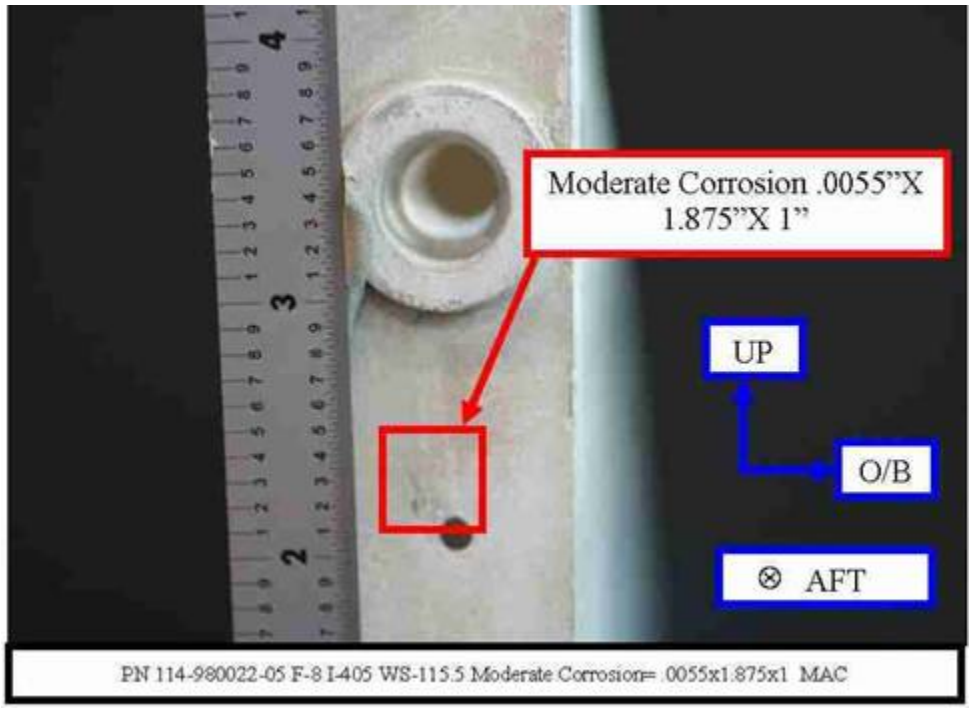


Figure 318. Moderate Corrosion on Left Outboard Web Keel—Macroscopic View

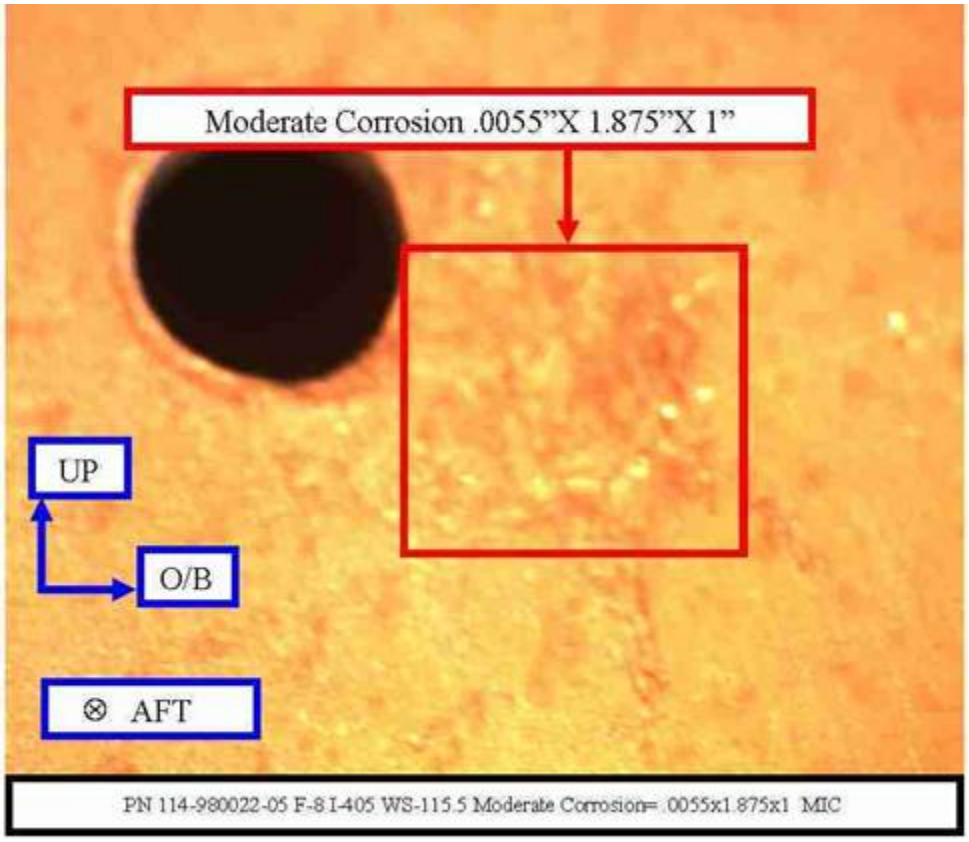


Figure 319. Moderate Corrosion on Left Outboard Web Keel—Microscopic View

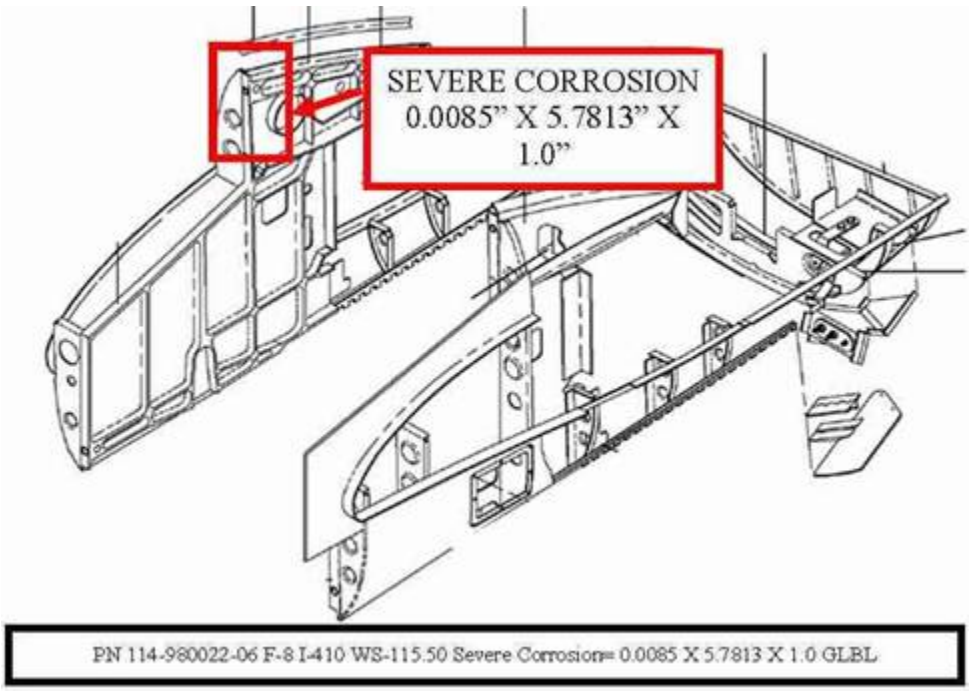


Figure 320. Severe Corrosion on Right Outboard Web Keel—Global View

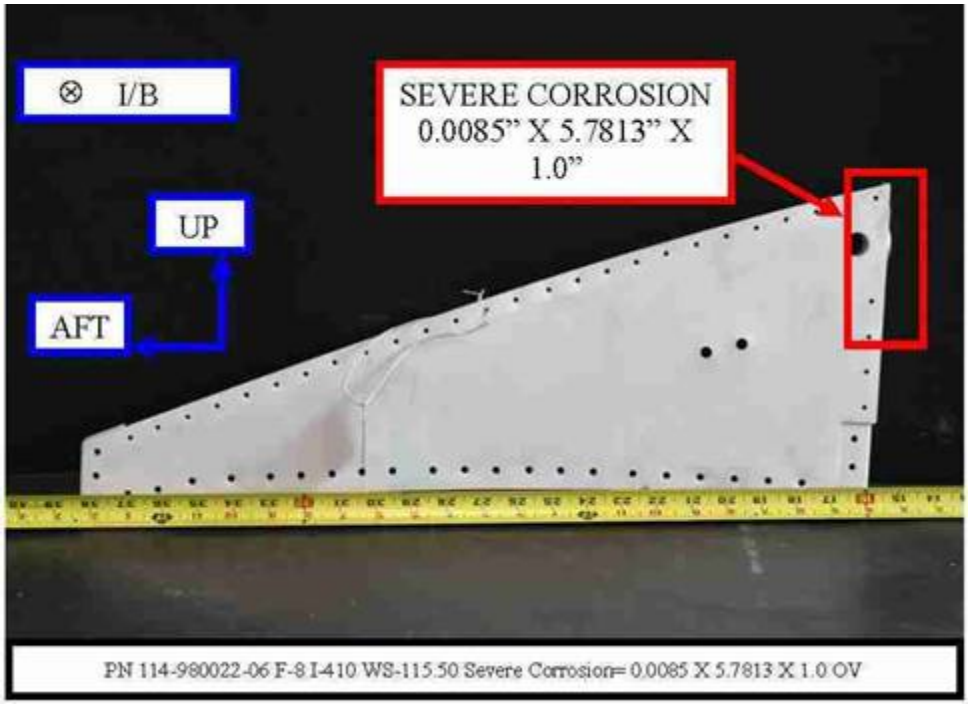


Figure 321. Severe Corrosion on Right Outboard Web Keel—Overview

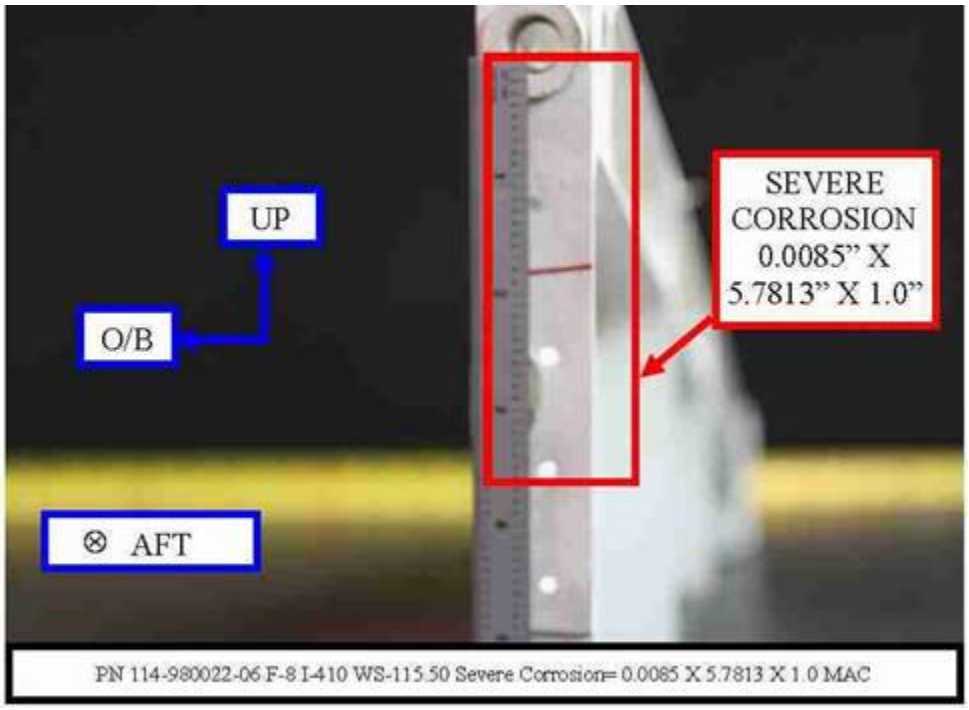


Figure 322. Severe Corrosion on Right Outboard Web Keel—Macroscopic View

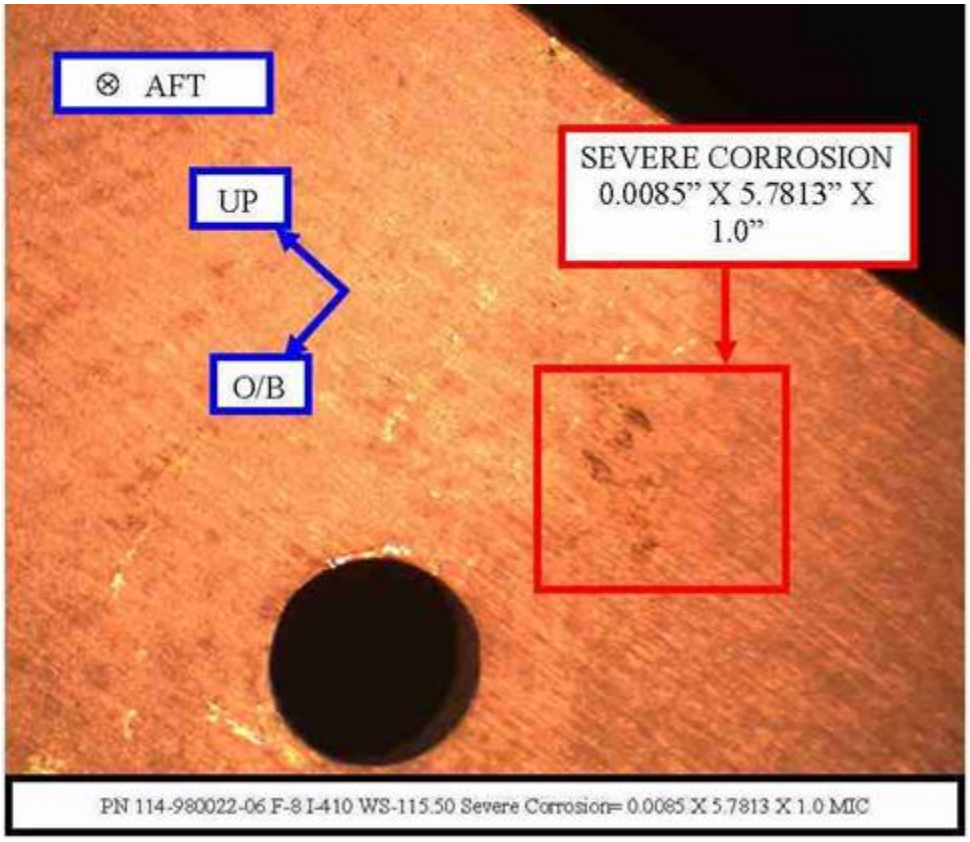


Figure 323. Severe Corrosion on Right Outboard Web Keel—Microscopic View

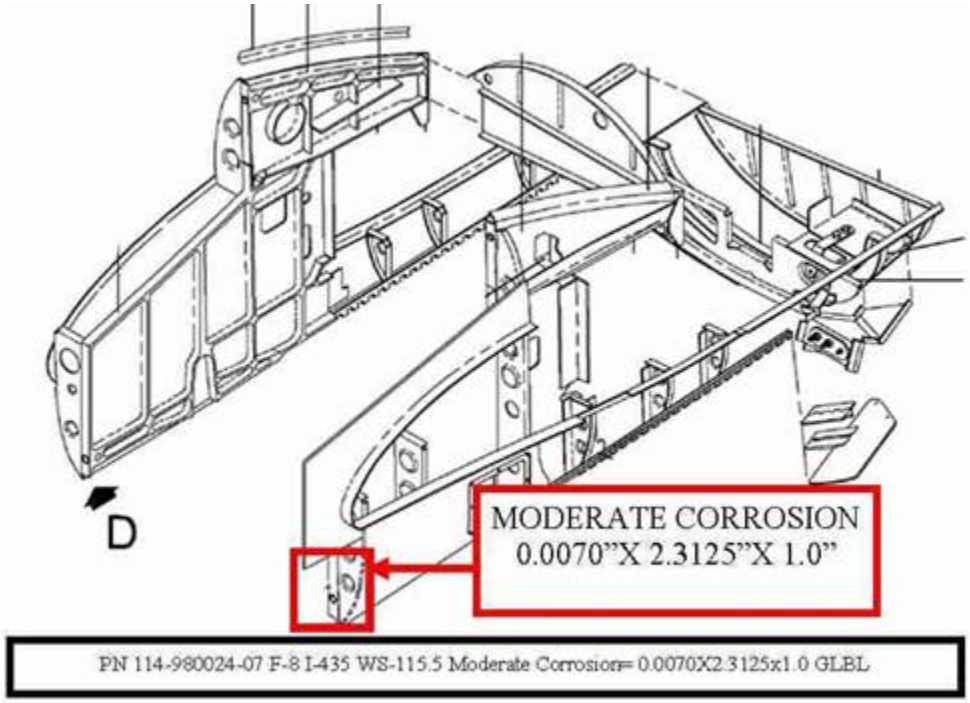


Figure 324. Moderate Corrosion on Left Outboard Web Keel—Global View (DN)

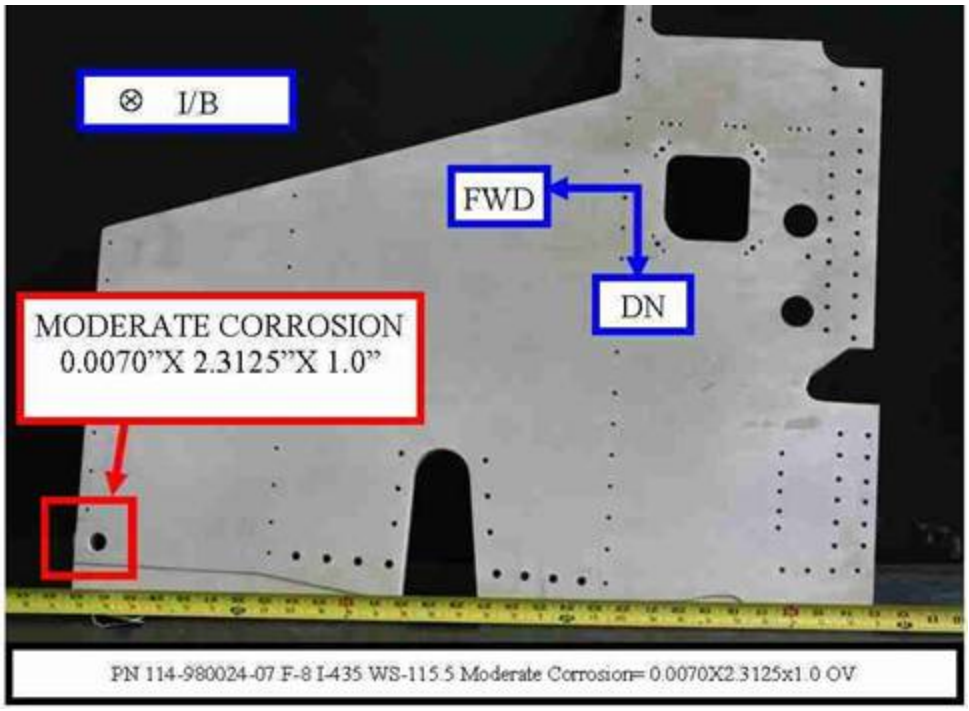


Figure 325. Moderate Corrosion on Left Outboard Web Keel—Overview (DN)

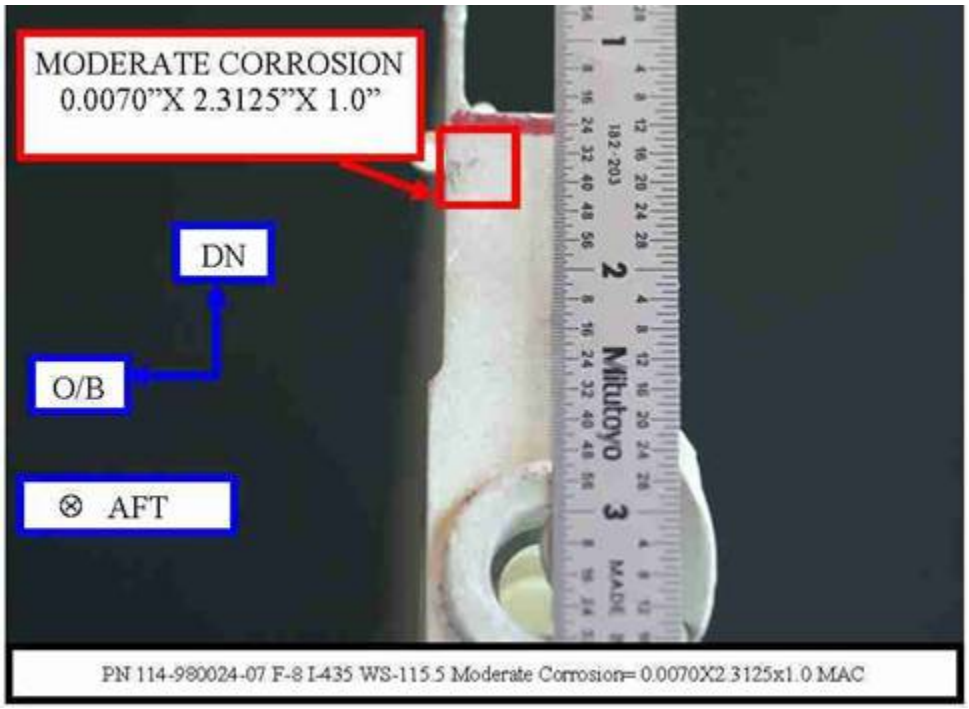


Figure 326. Moderate Corrosion on Left Outboard Web Keel—Macroscopic View (DN)

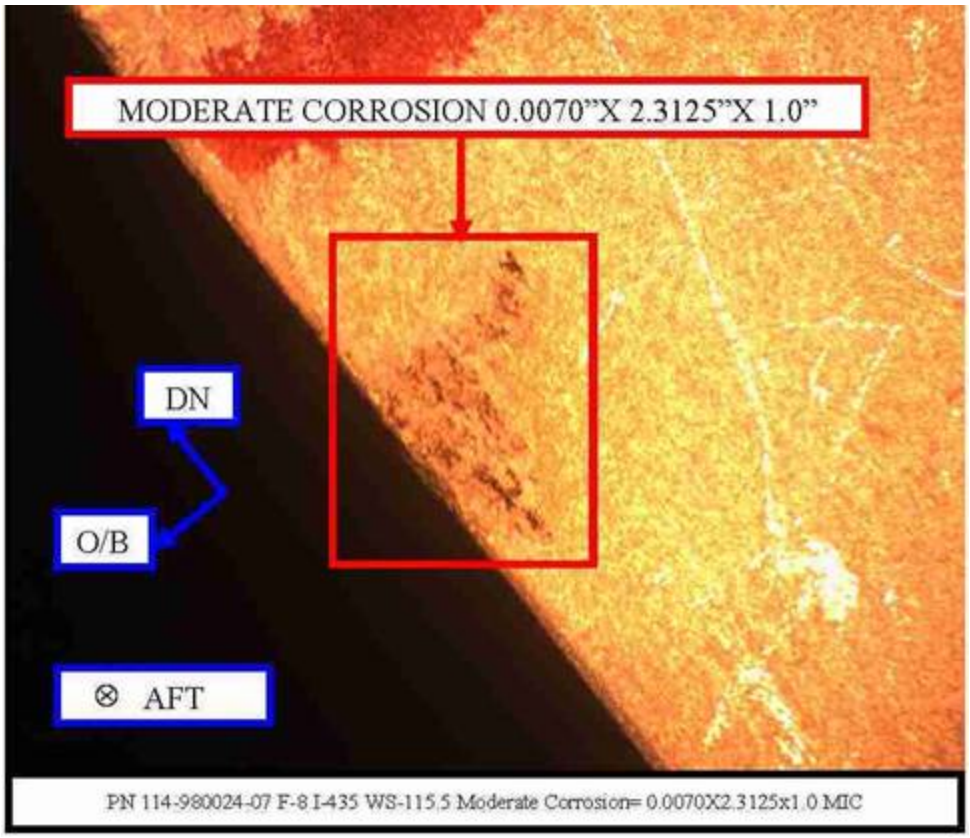


Figure 327. Moderate Corrosion on Left Outboard Web Keel—Microscopic View (DN)

3.4.8.3 Center Wing Miscellaneous.

All other areas, such as angles and tee assemblies for the center wing, were classified as miscellaneous. There were seven relevant cracks found, with two cracks on the right and left angles classified as significant. Raytheon engineers and technical support are aware of the defects, further analysis is ongoing. The areas mentioned are listed in table 38.

Table 38. Center Wing Miscellaneous Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	WS	WL		
Crack	1.6800		Through crack	30.0	87.0	Bend Radius Crack Right Center Wing Angle	Figure 328 Global Figure 329 Overview Figure 330 Macroscopic
Crack	1.6300		Through crack	30.0	87.0	Bend Radius Crack Left Center Wing Angle	Figure 328 Global Figure 331 Overview Figure 332 Macroscopic
Crack	3.9438		Through crack	92.75		Surface Crack Right Inboard Tee Assembly	Figure 333 Global Figure 334 Overview Figure 335 Macroscopic Figure 336 Microscopic
Crack	3.7000 3.8500		Through crack	92.75		Two Surface Cracks Left Inboard Tee Assembly	Figure 337 Global Figure 338 Overview Figure 341 Macroscopic Figure 342 Microscopic
Crack	2.8500		Through crack	92.75		Two Surface Cracks Left Inboard Tee Assembly	Figure 337 Global Figure 338 Overview Figure 339 Macroscopic Figure 340 Microscopic
Crack	3.5000		Through crack	115.5		Surface Crack Left Outboard Tee Assembly	Figure 343 Global Figure 344 Overview Figure 345 Macroscopic Figure 346 Microscopic

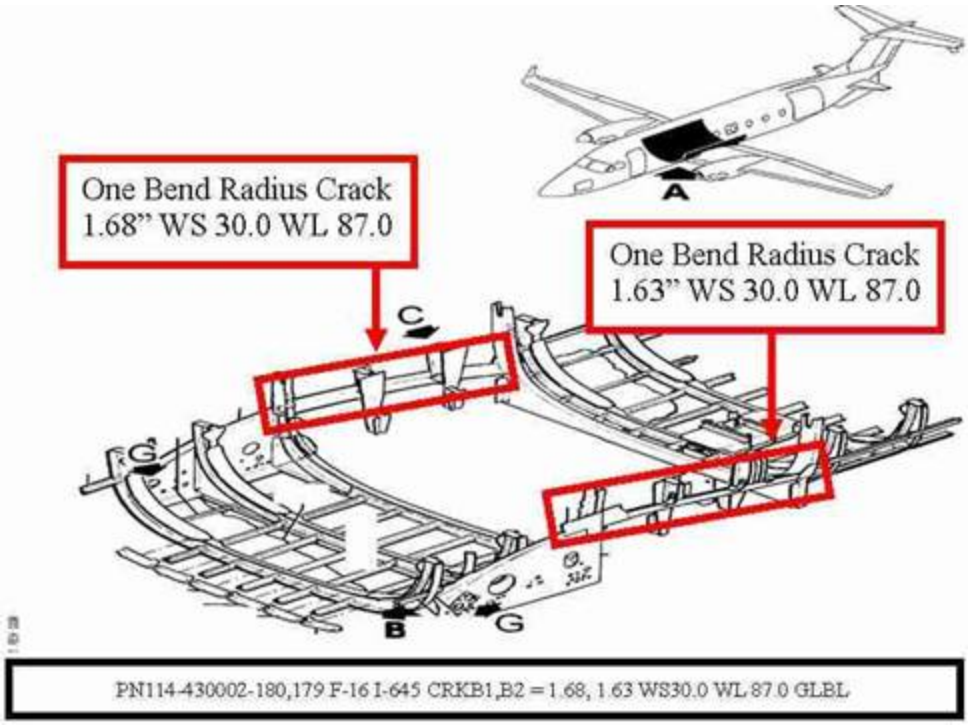


Figure 328. Crack on Right Center Wing Angle—Global View

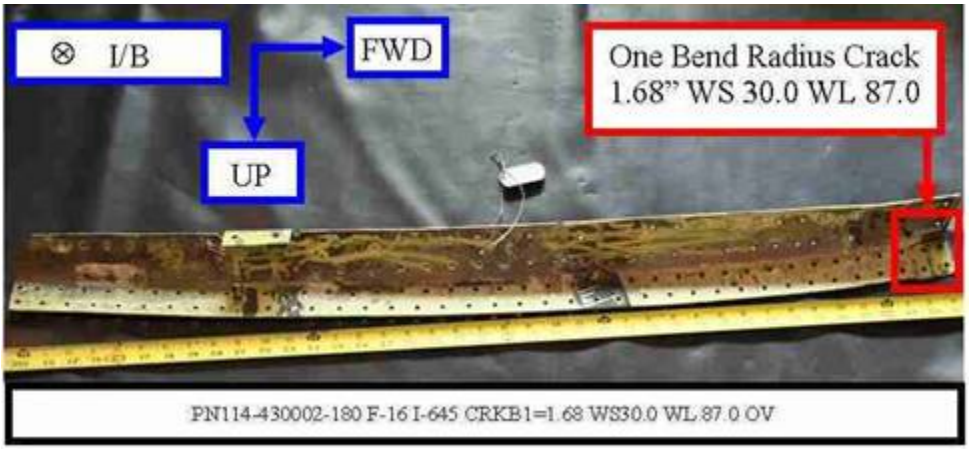


Figure 329. Crack on Right Center Wing Angle—Overview

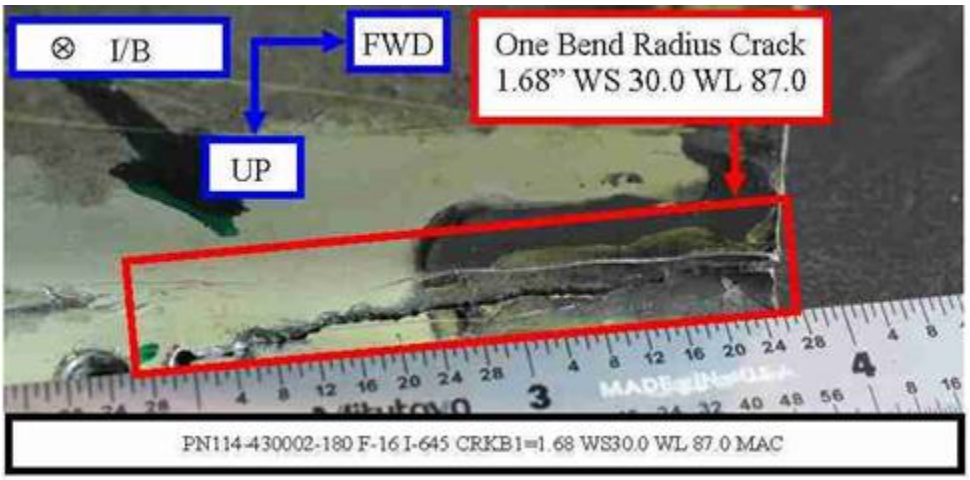


Figure 330. Crack on Right Center Wing Angle—Macroscopic View

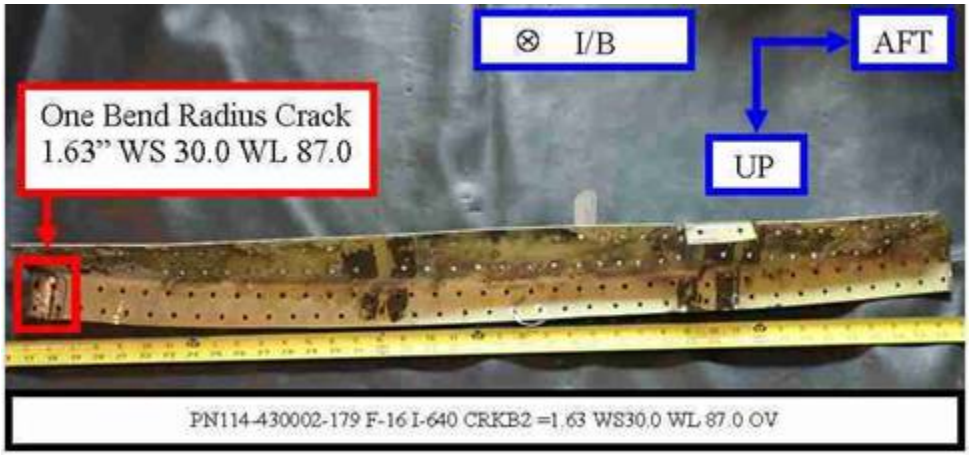


Figure 331. Crack on Left Center Wing Angle—Overview

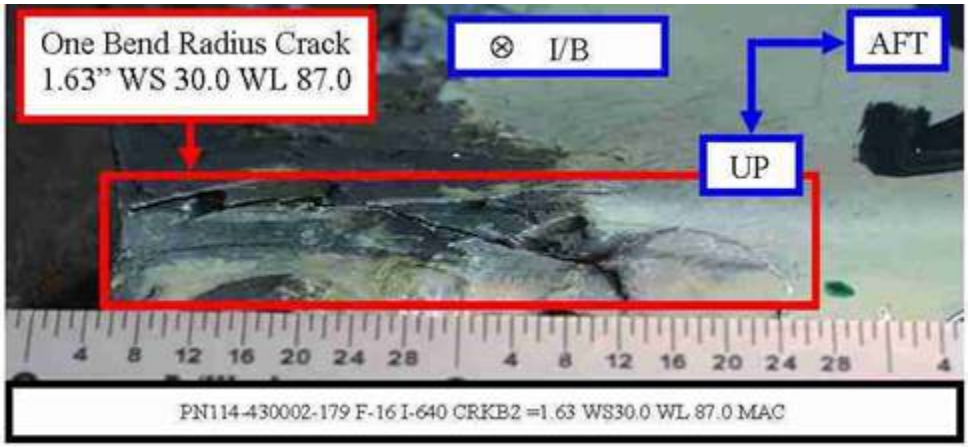


Figure 332. Crack on Left Center Wing Angle—Macroscopic View

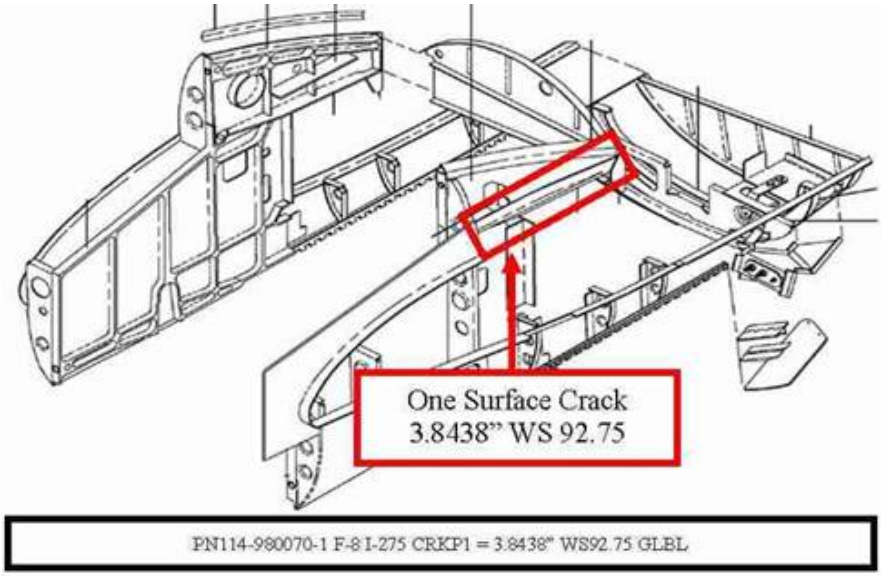


Figure 333. Crack on Right Inboard Tee Assembly—Global View

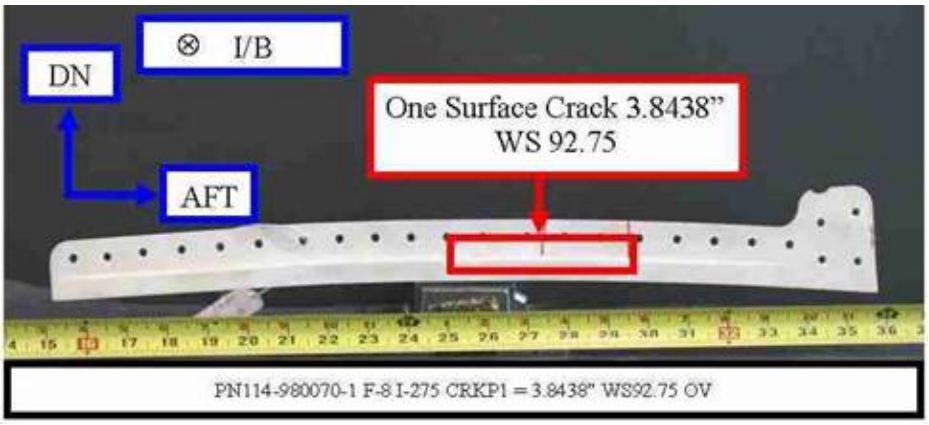


Figure 334. Crack on Right Inboard Tee Assembly—Overview

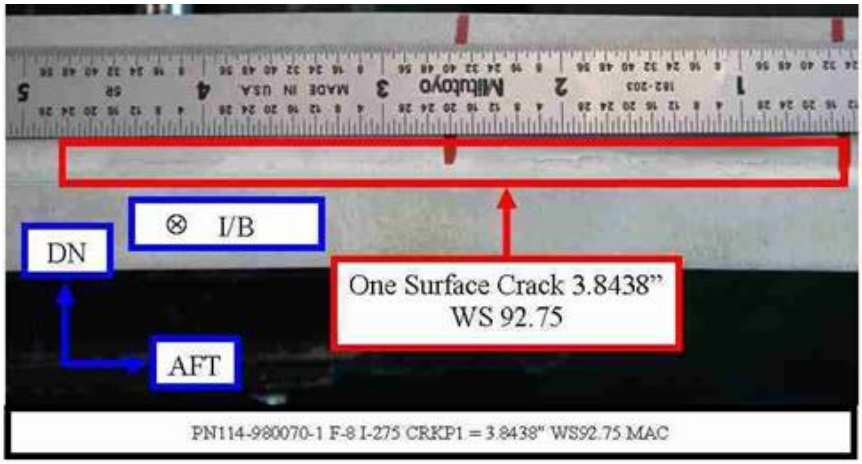


Figure 335. Crack on Right Inboard Tee Assembly—Macroscopic View

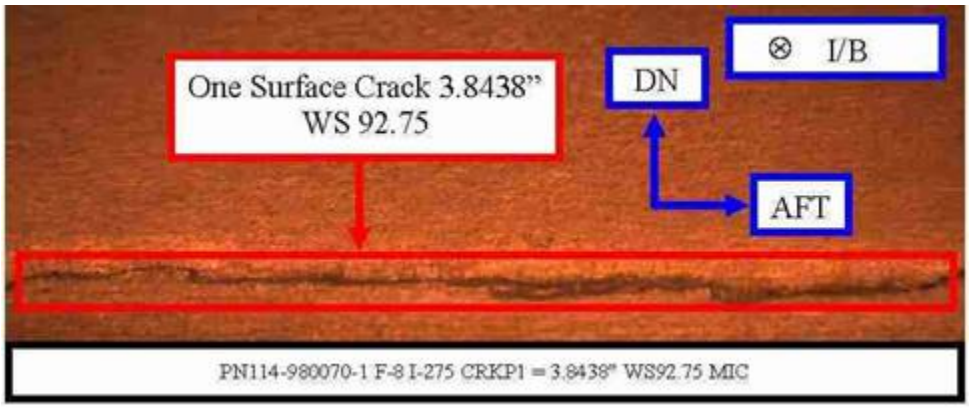


Figure 336. Crack on Right Inboard Tee Assembly—Microscopic View

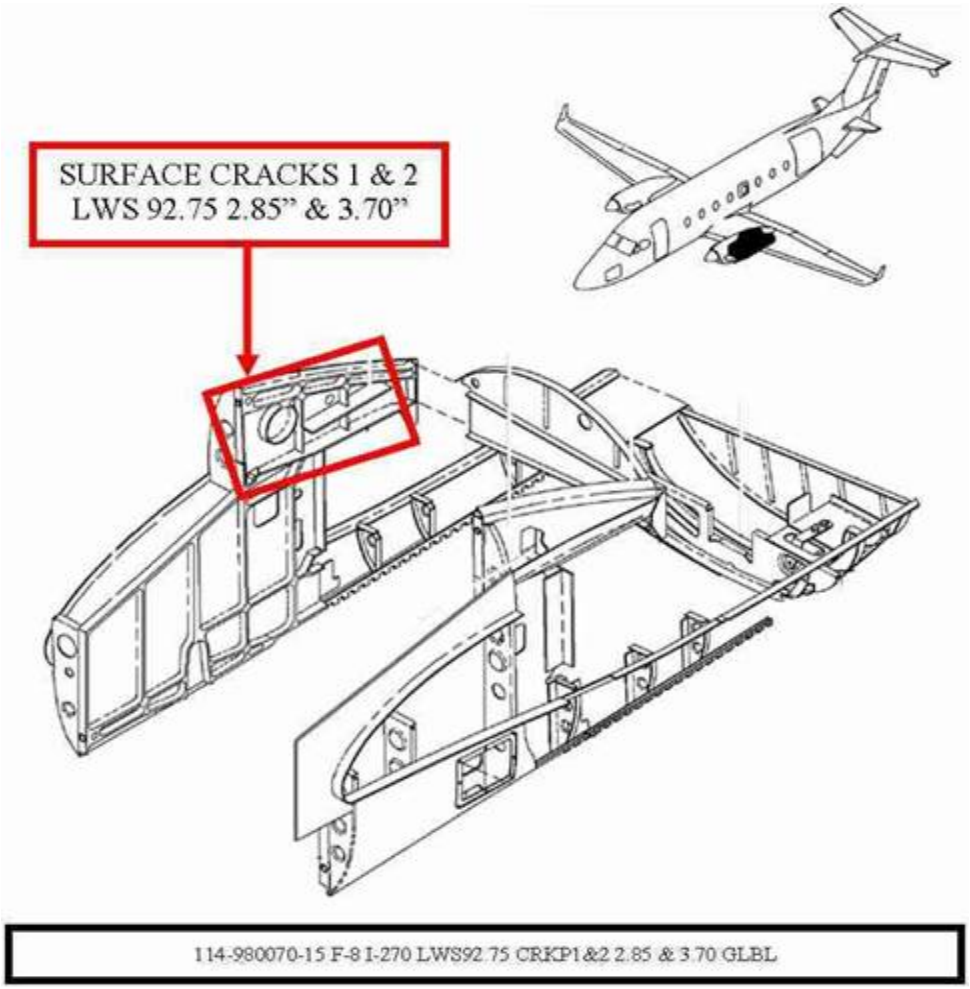


Figure 337. Multiple Cracks on Left Inboard Tee Assembly—Global View

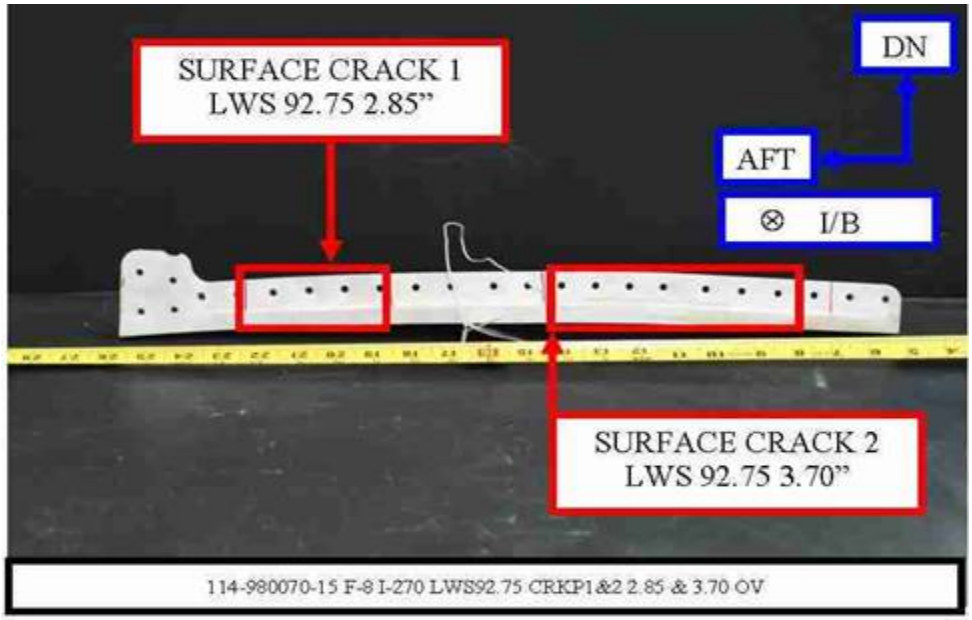


Figure 338. Multiple Cracks on Left Inboard Tee Assembly—Overview

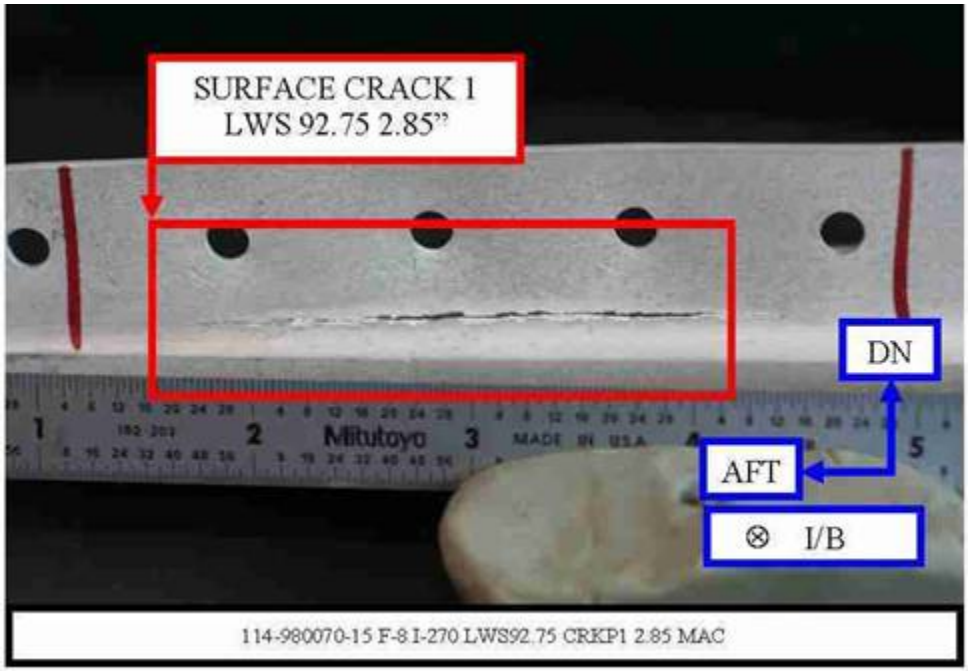


Figure 339. Crack on Left Inboard Tee Assembly—Macroscopic View

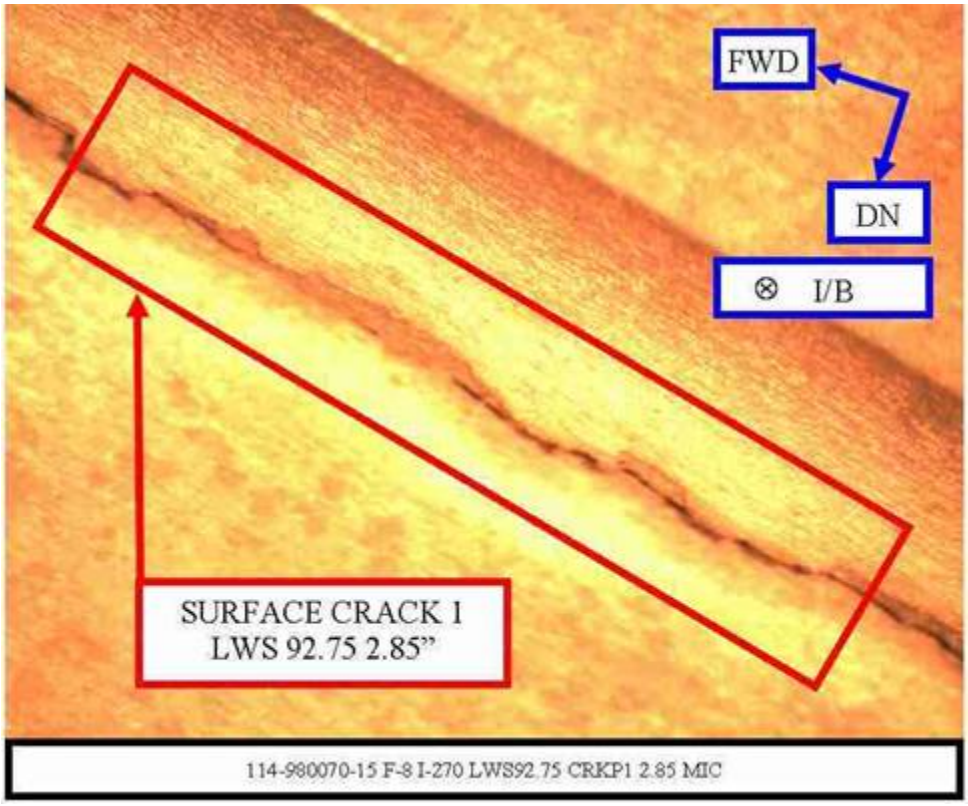


Figure 340. Crack on Left Inboard Tee Assembly—Close-Up Microscopic View

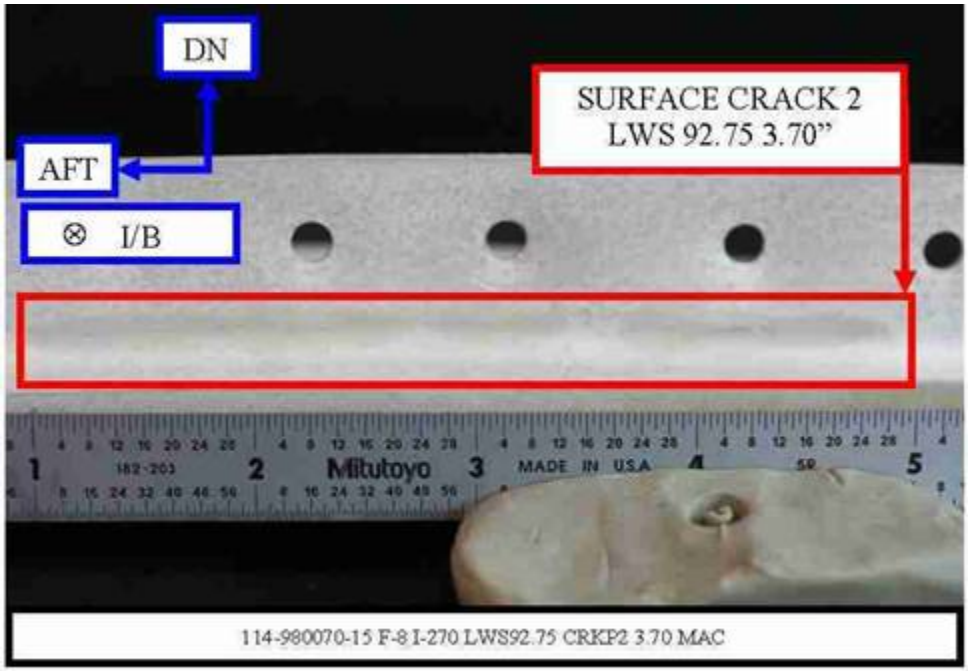


Figure 341. Crack on Left Inboard Tee Assembly—Macroscopic View

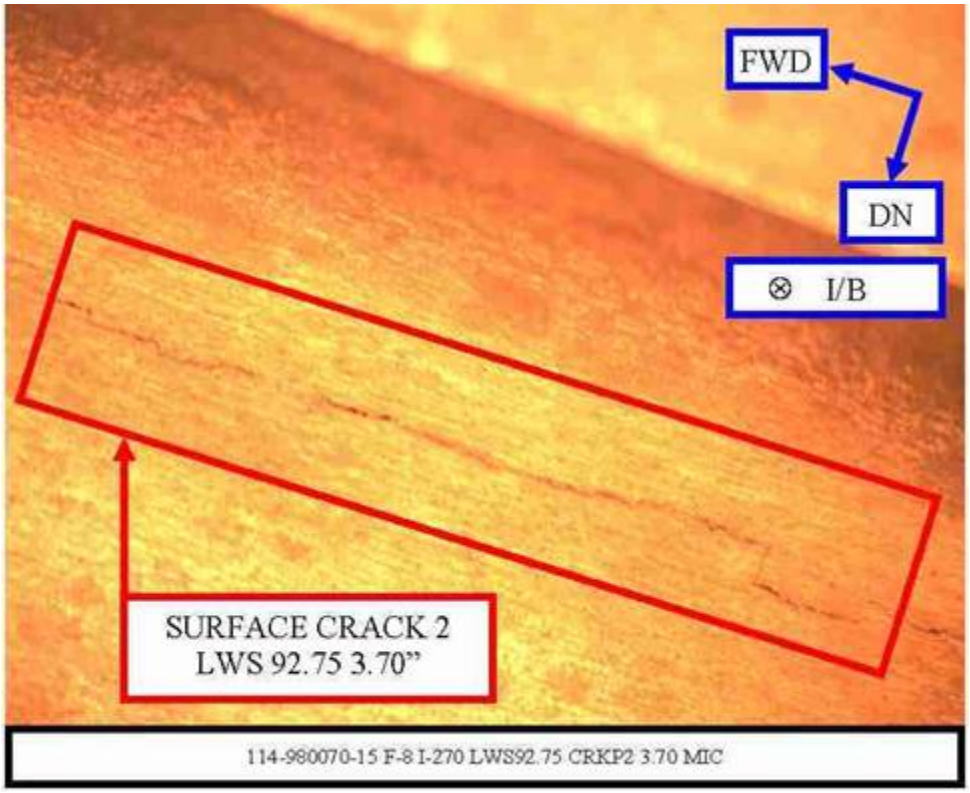


Figure 342. Crack on Left Inboard Tee Assembly—Close-Up Macroscopic View

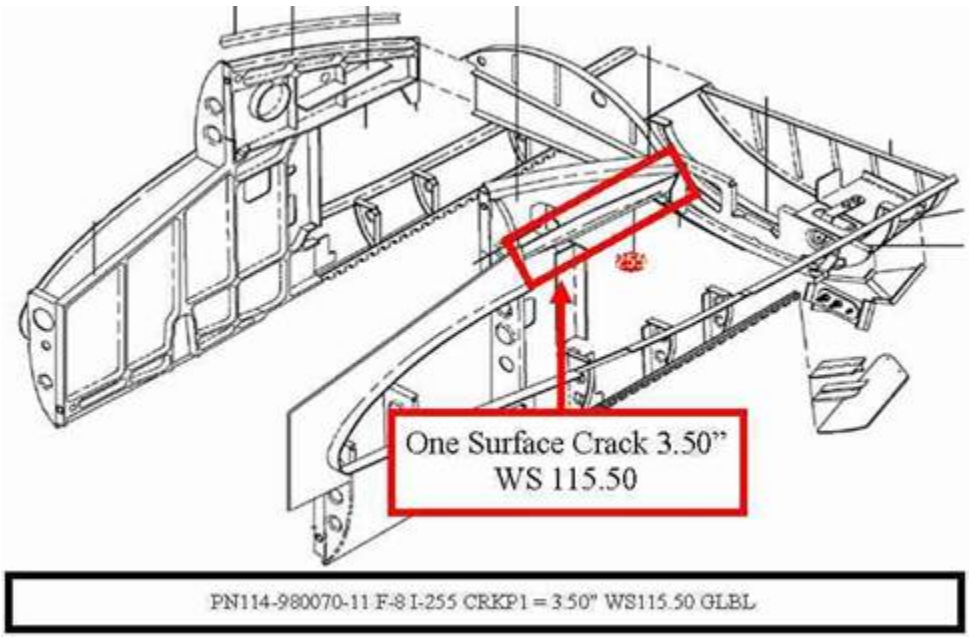


Figure 343. Crack on Left Outboard Tee Assembly—Global View

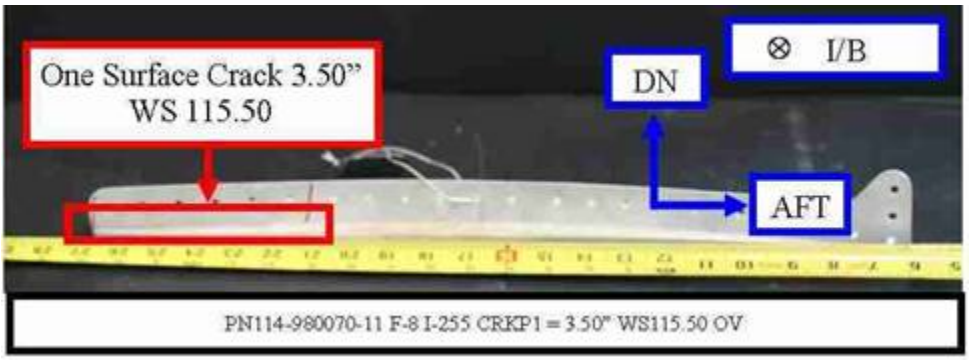


Figure 344. Crack on Left Outboard Tee Assembly—Overview

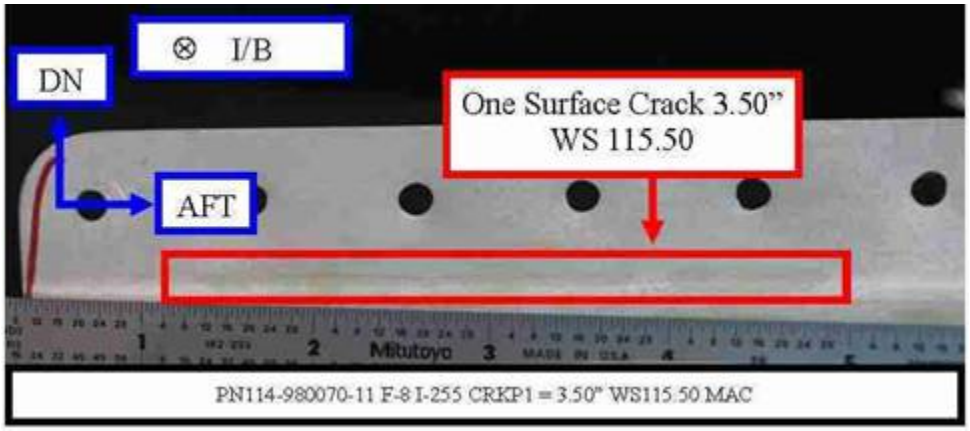


Figure 345. Crack on Left Outboard Tee Assembly—Macroscopic View

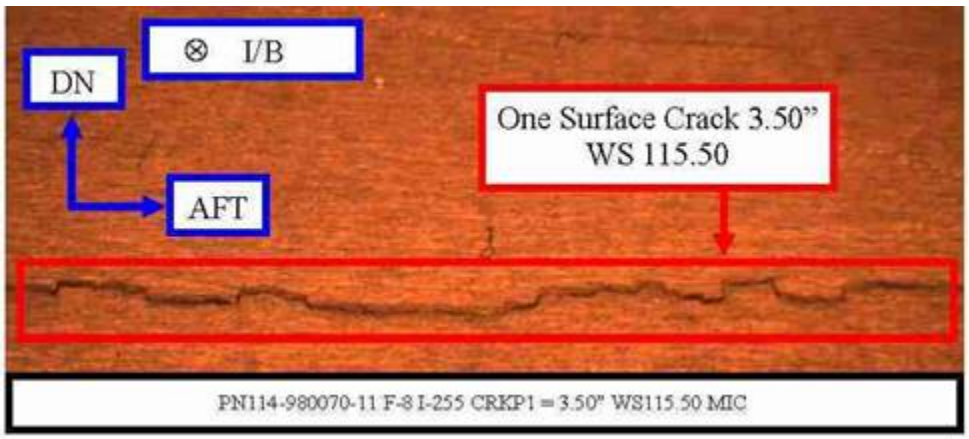


Figure 346. Crack on Left Outboard Tee Assembly—Microscopic View

3.4.9 Safety Communiqués SC 071 and SC 275.

Special attention was focused at wing station (WS) 124 for SC 071 and WS 117.5 for SC 275. SC 071 was inspected for possible evidence of biocorrosion, this condition had previously been discovered on more than 40 Beechcraft 1900D airplane at WS 124 near the fuel sump pump

drain hole and the surrounding area. SC 275 dealt with the wing spar lower cap cracking condition. The cracking had occurred in the lower flange area fasteners and through the spar web extending from the lower edge to the lightning hole. These conditions are located at WS 117.5.

WS 124 and WS 117.5 were visually inspected to include surrounding areas, and a thorough NDI was performed on the wing spar lower cap for cracking. This inspection resulted in no defects found on either left or right sides of serial number UE-0066. Figures 347 and 348 show the areas inspected during the teardown examination.

Figure 347. Left Wing Spar Lower Cap—SC 275—Overview

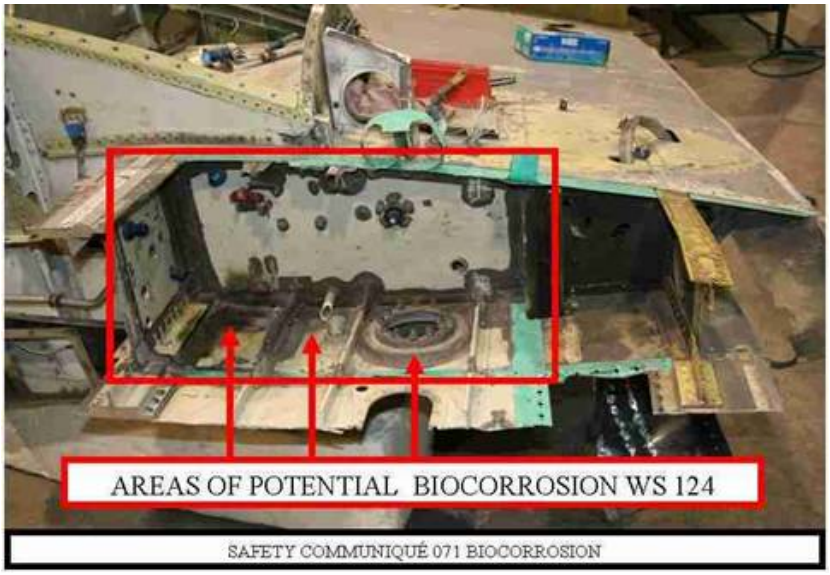


Figure 348. Center Wing Fuel Cell—SC 071—Overview

3.4.10 Wing Teardown Examination Summary.

The teardown examination for the Beechcraft 1900D wing was accomplished in three sections: left, right, and center. Table 39 shows the number of inspected parts, relevant defects, and microscopic holes examined on all wing sections.

Table 39. Wing Teardown Summary

Airplane Section	Number of Parts Inspected	Number of Defects Found	Microscopic Examination Holes Inspected
Left Wing	42	13	3,960
Right Wing	41	16	3,972
Center Wing	76	19	7,718
Total	159	48	15,650

3.4.11 Horizontal Examination Overview.

During the teardown examination of the horizontal stabilizer, the areas of concentration included, but was not limited to, the access bay panels, forward and rear spars, ribs, and skin. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, 62 individual parts were visually examined during detailed and postdisassembly inspection. During postdisassembly examination, five cracks on three different parts were found. Corrosion classified as light corrosion was found in small quantities and was not considered reportable. (Example of light corrosion is shown in figure 169.) During the microscopic examination, 2946 holes were inspected with five relevant crack defects found (see table 40). Verification of corrosion indication found at horizontal stabilizer station (HSS) 19.5 during the alternative NDI resulted in a false positive, as referenced in table 27.

Table 40. Horizontal Stabilizer Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	HSS	HSS		
Crack	0.2960			5		Bend Radius Crack on Tee	Figure 349 Global Figure 350 Overview Figure 351 Macroscopic Figure 352 Microscopic
Crack	0.0773 0.0780 0.1560			5		Three Bend Radius Cracks on Tee	Figure 353 Global Figure 354 Overview Figure 355 Macroscopic Figure 356 Microscopic
Crack	0.0780		Through crack	5	41	Crack on Right Aft Stringer	Figure 357 Global Figure 358 Overview Figure 359 Macroscopic Figure 360 Microscopic

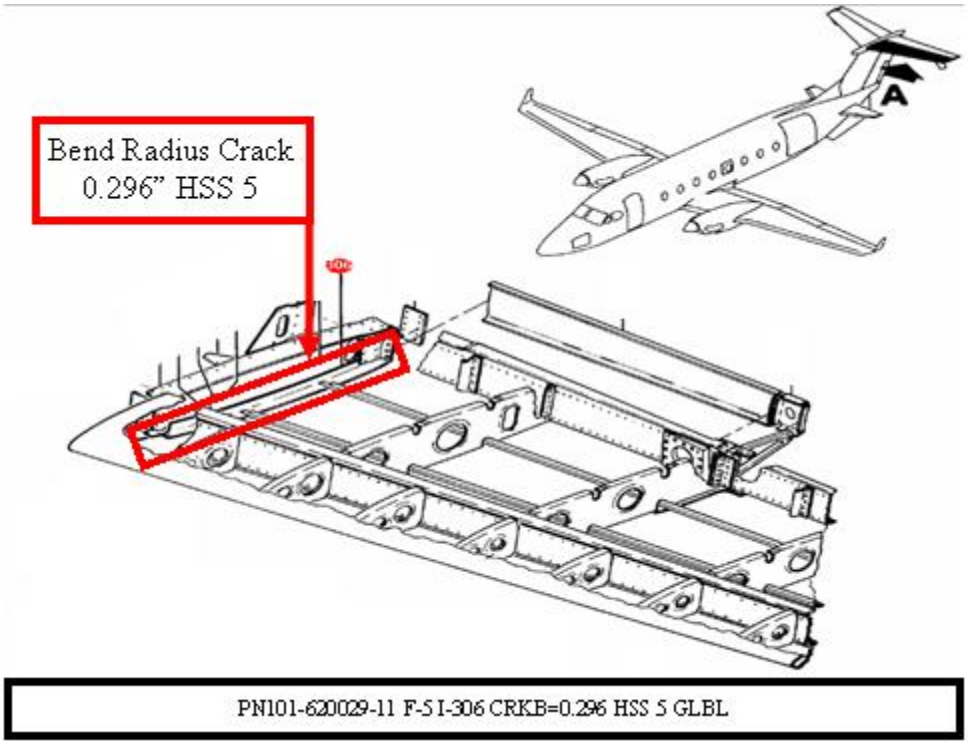


Figure 349. Crack on Tee Assembly—Global View

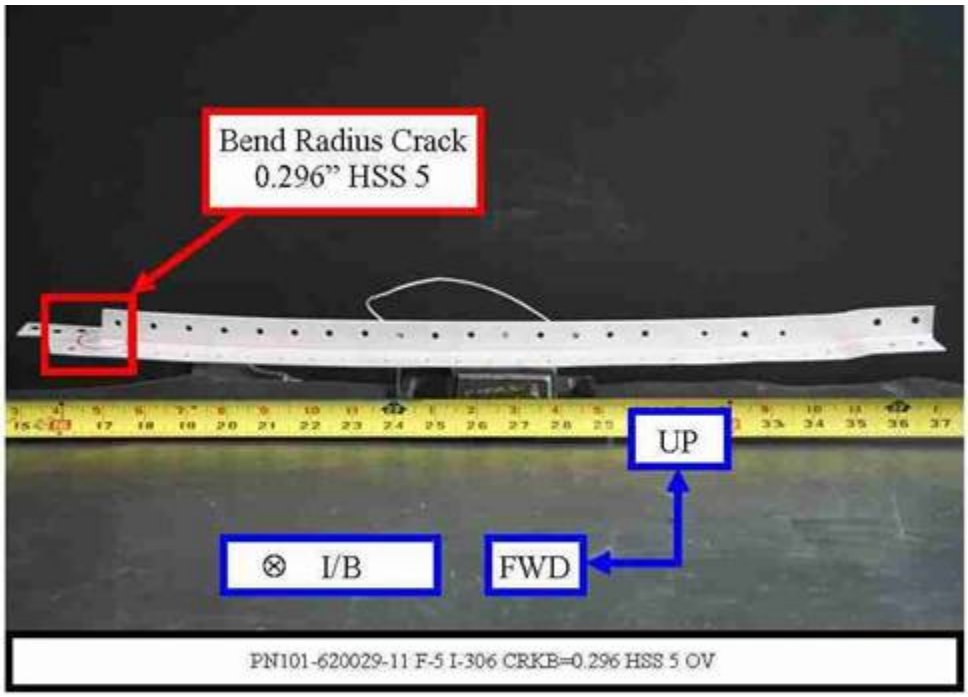


Figure 350. Crack on Tee Assembly—Overview

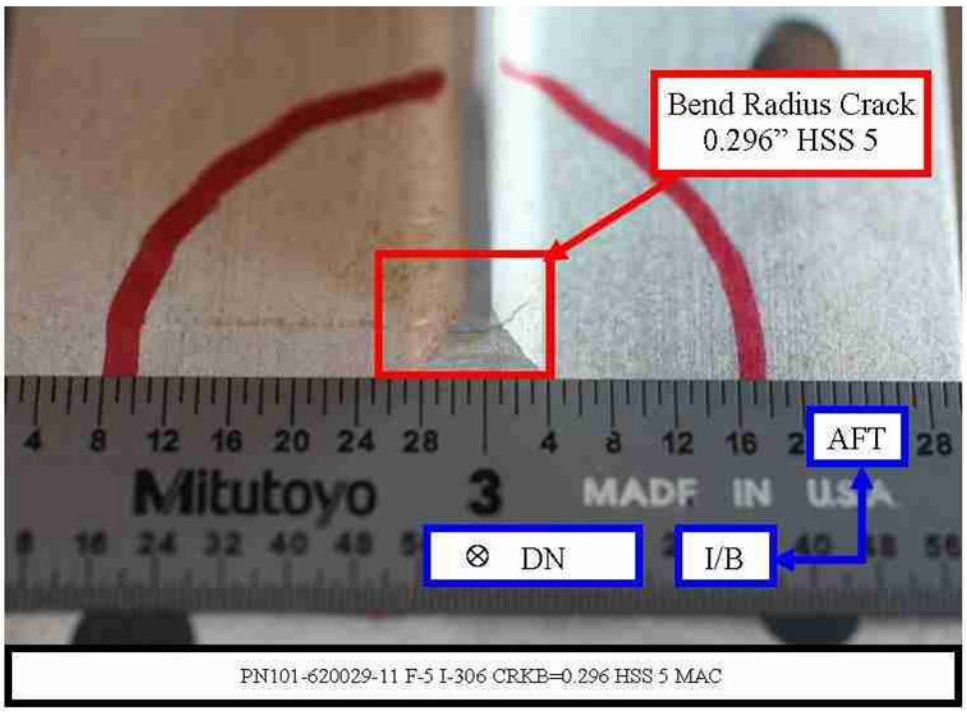


Figure 351. Crack on Tee Assembly—Macroscopic View

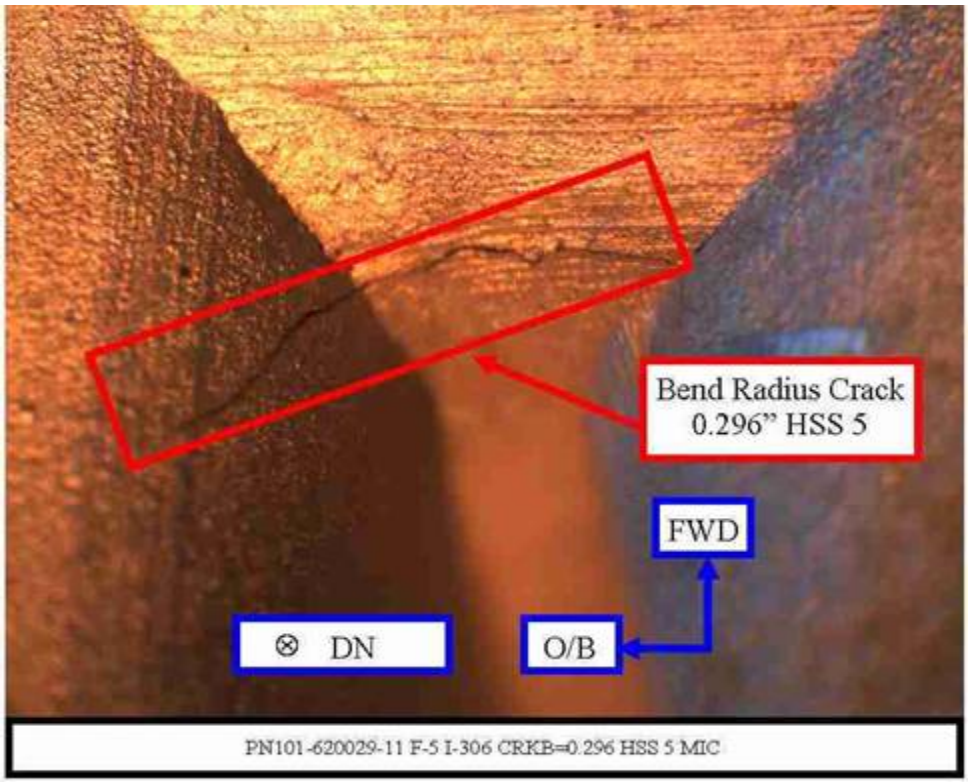


Figure 352. Crack on Tee Assembly—Microscopic View

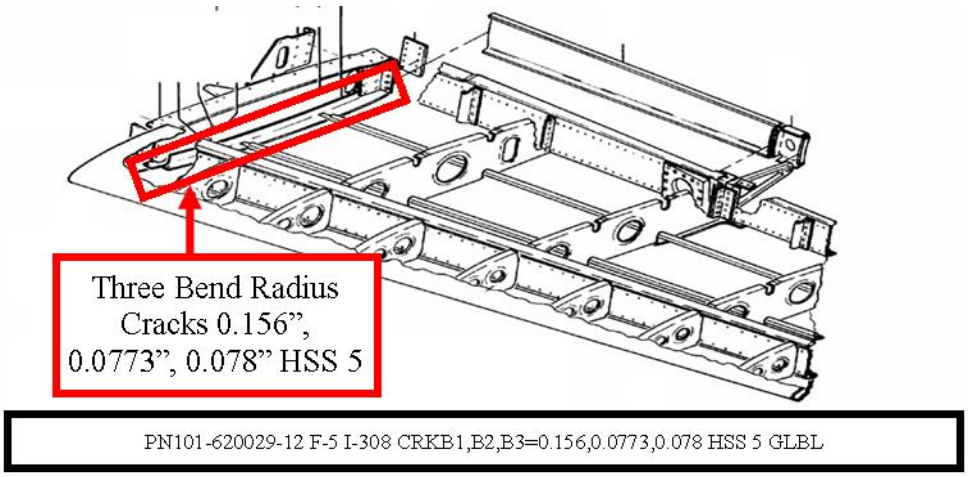


Figure 353. Multiple Cracks on Tee Assembly—Global View

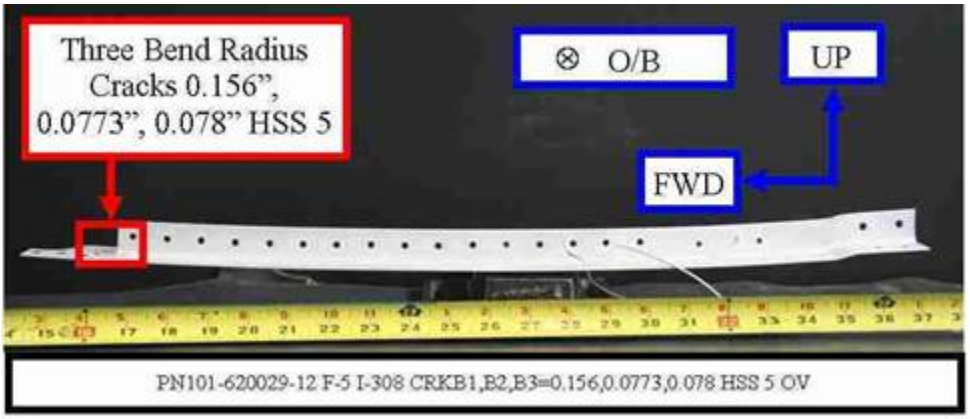


Figure 354. Multiple Cracks on Tee Assembly—Overview

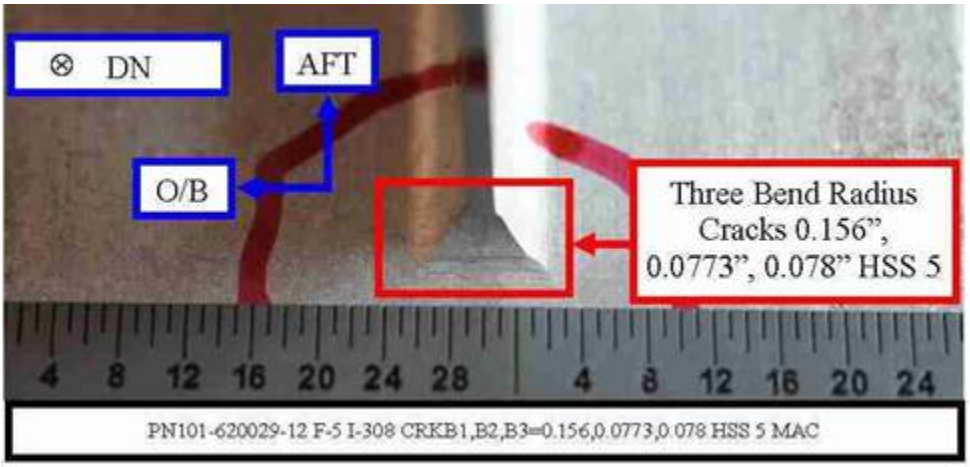


Figure 355. Multiple Cracks on Tee Assembly—Macroscopic View

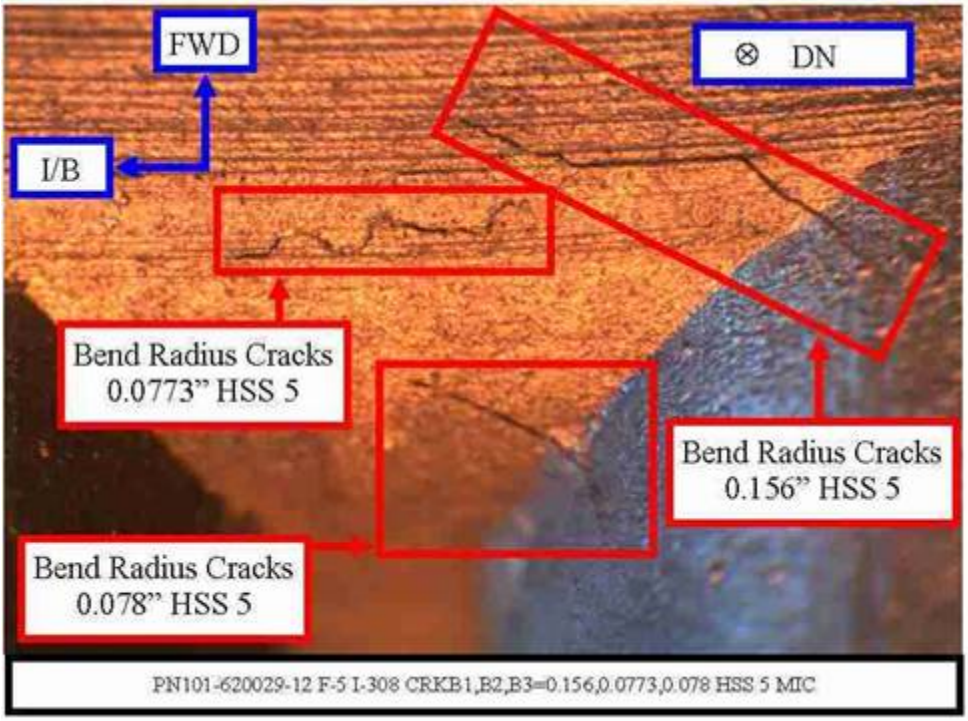


Figure 356. Multiple Cracks on Tee Assembly—Microscopic View

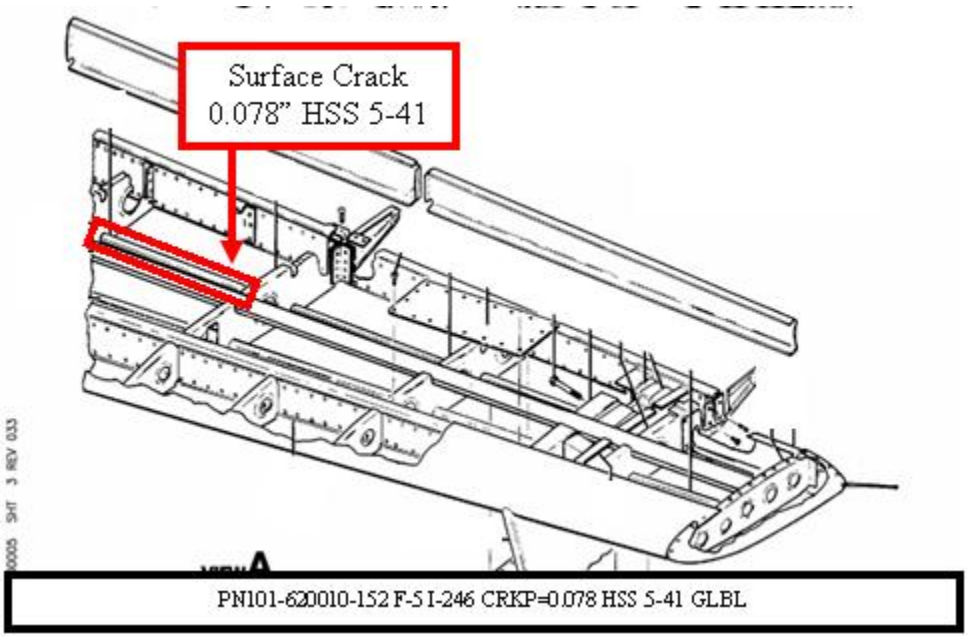


Figure 357. Crack on Right Aft Stringer—Global View

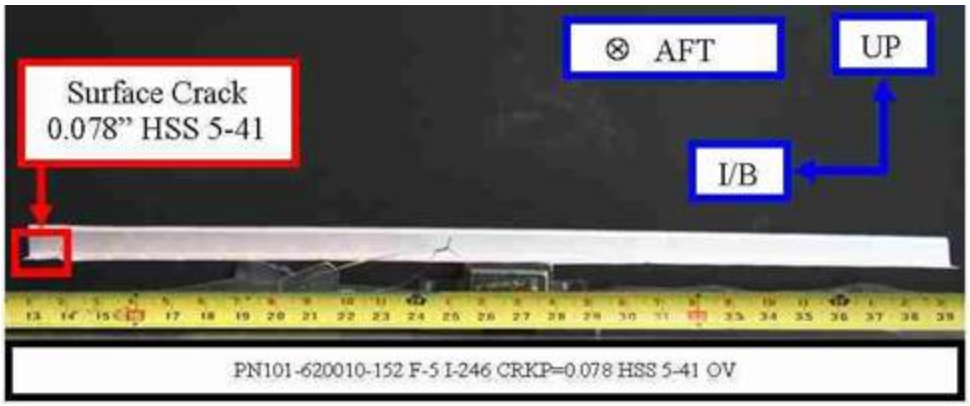


Figure 358. Crack on Right Aft Stringer—Overview

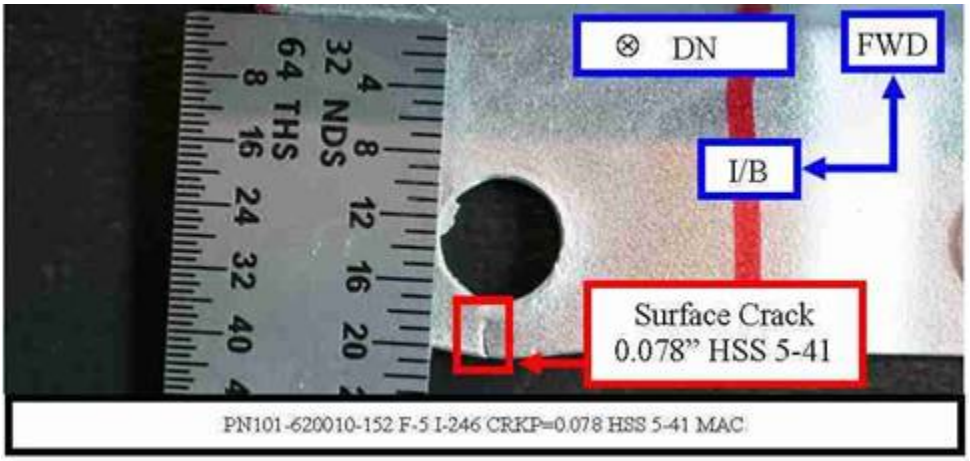


Figure 359. Crack on Right Aft Stringer—Macroscopic View

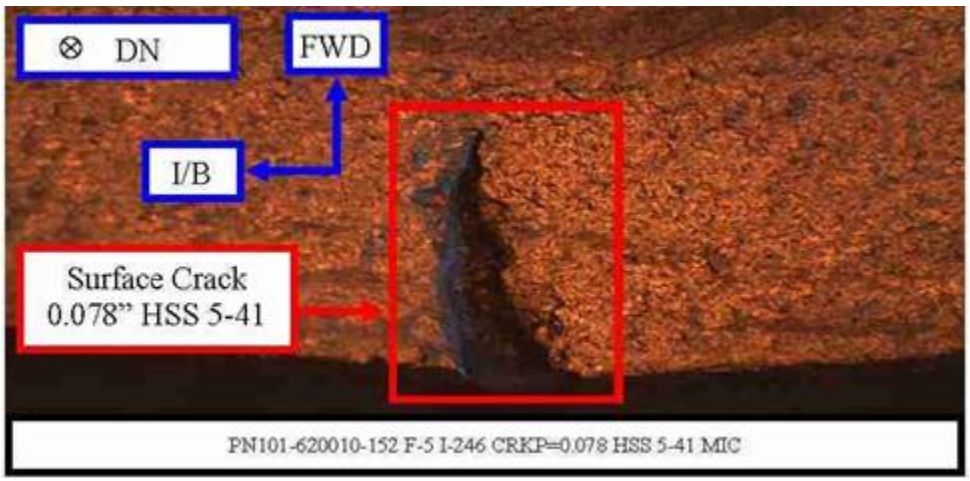


Figure 360. Crack on Right Aft Stringer—Microscopic View

3.4.12 Vertical Examination Overview.

During the teardown examination of the vertical stabilizer, the areas of concentration included, but were not limited to, the access bay panels, ribs, stringers, and skin. In an effort to locate and characterize all areas of damage on the Beechcraft 1900D, a total of 39 individual parts were visually examined during detailed disassembly. During postdisassembly examination, three cracks and one area of wear was found and classified as relevant (see table 41). During the microscopic examination, 2241 holes were inspected with no relevant defects found. Verification of crack indications found at vertical stabilizer (VS) 79.75 and 48.375 during the alternative NDI resulted in a false positive, as referenced in table 27.

Table 41. Vertical Stabilizer Defects

Defect				Defect Location		Defect Description	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	VS	VS		
Wear	0.6875	0.75		11.5	25	Excessive Wear Lower Forward Web	Figure 361 Global Figure 362 Overview Figure 363 Macroscopic Figure 364 Microscopic
Crack	0.2809 0.2463			39		Two Cracks Near Hole On Rib	Figure 365 Global Figure 366 Overview Figure 367 Macroscopic Figure 368 Microscopic
Crack	0.3750		Through crack	54		Edge Crack On Outboard Rib	Figure 369 Global Figure 370 Overview Figure 371 Macroscopic Figure 372 Microscopic

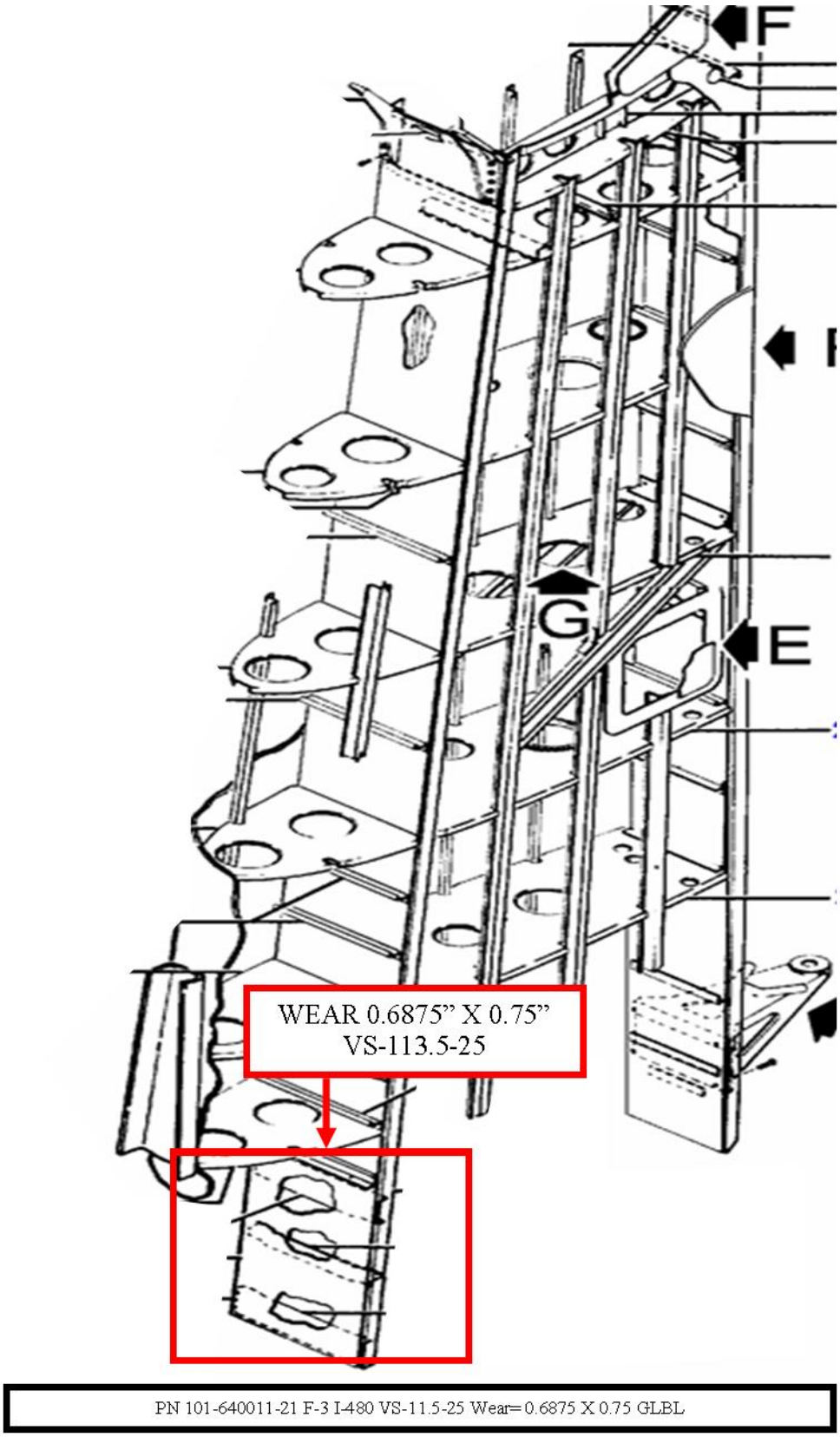


Figure 361. Wear on Lower Forward Web—Global View

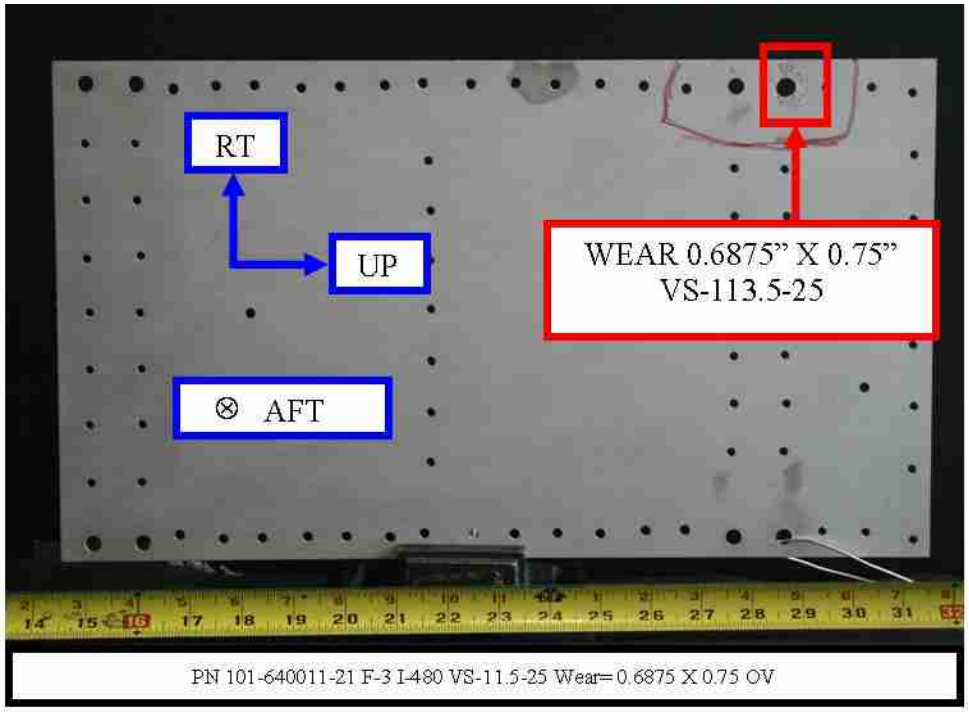


Figure 362. Wear on Lower Forward Web—Overview

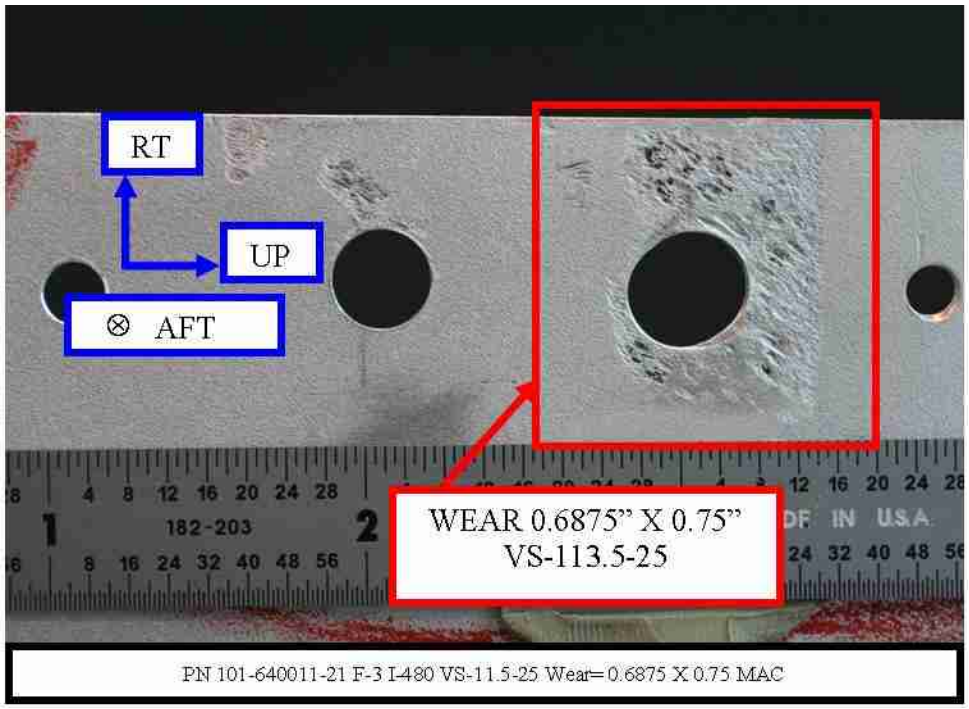


Figure 363. Wear on Lower Forward Web—Macroscopic View

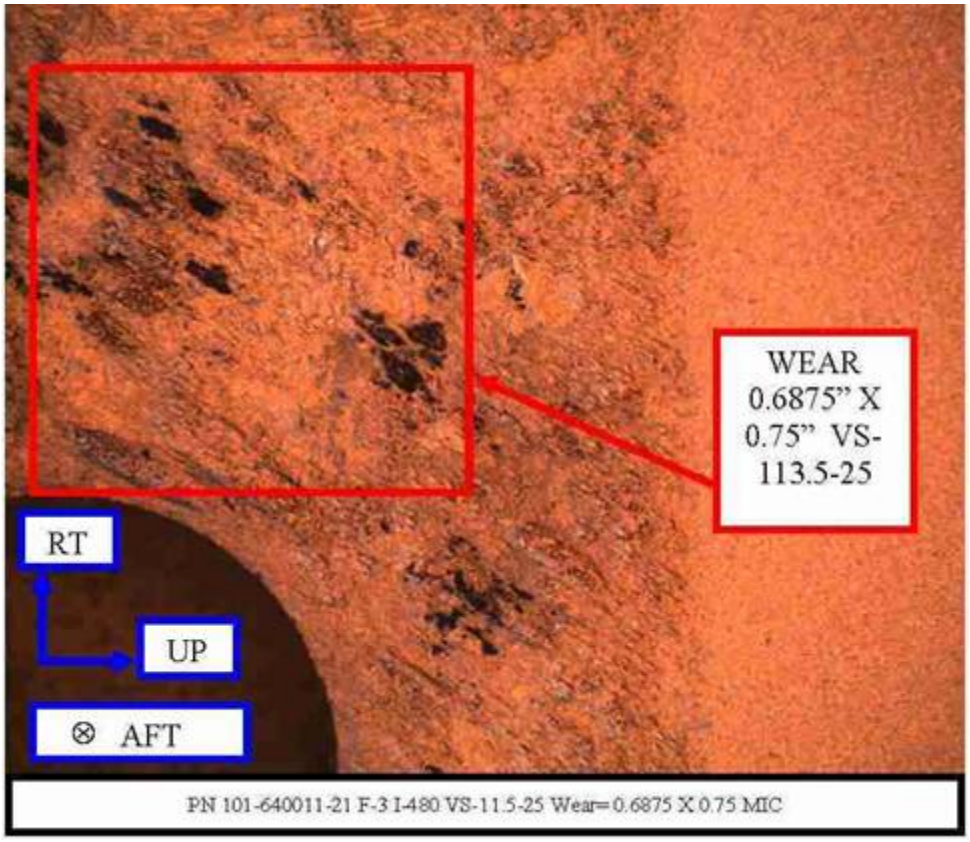


Figure 364. Wear on Lower Forward Web—Microscopic View

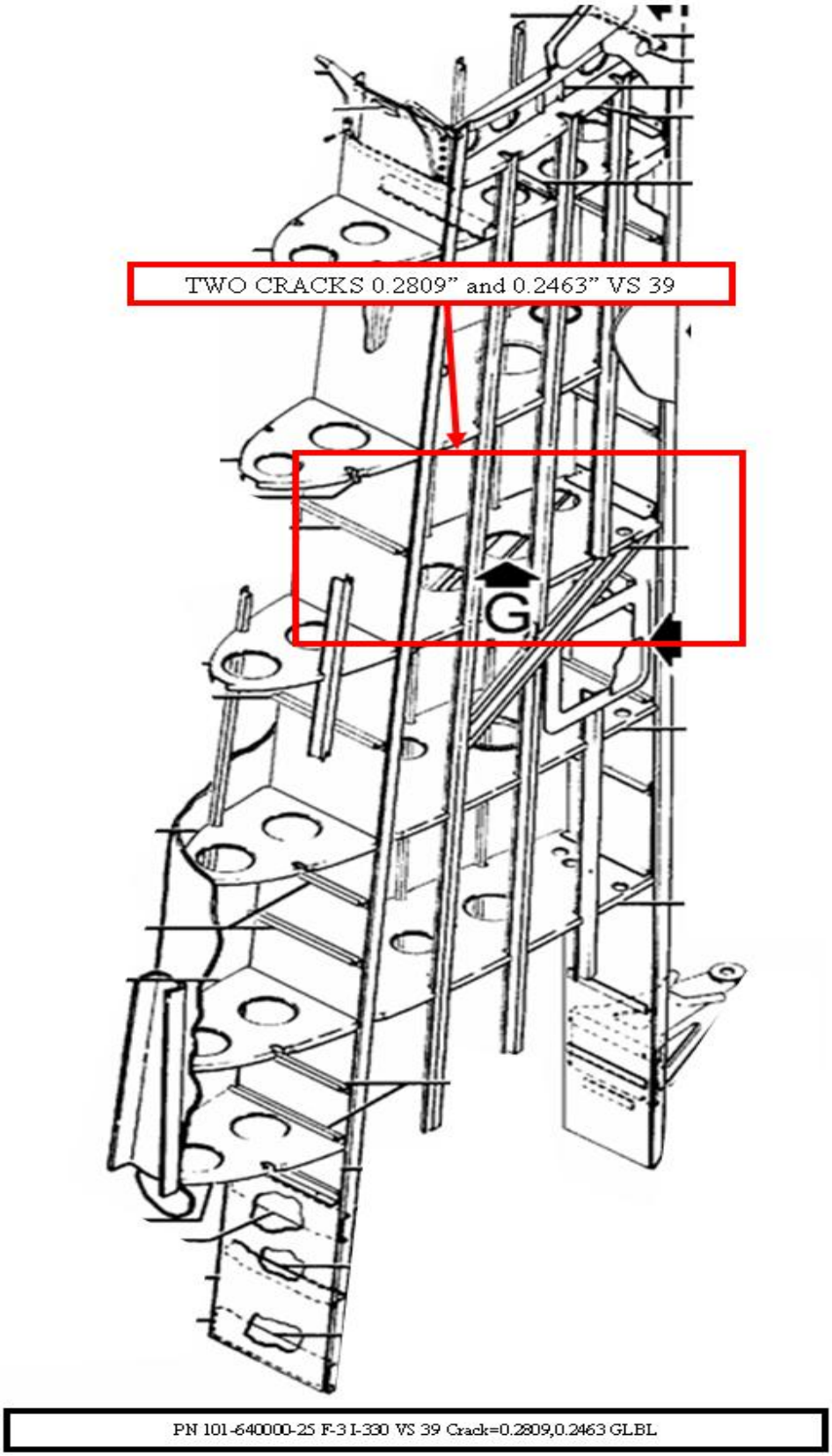


Figure 365. Multiple Cracks on Rib—Global View

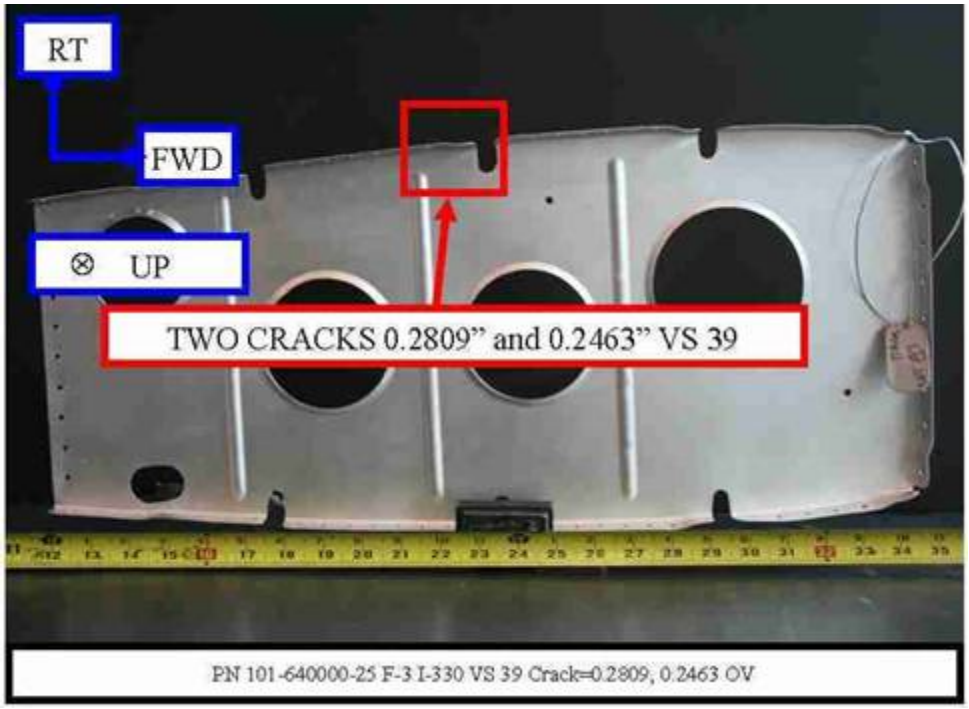


Figure 366. Multiple Cracks on Rib—Overview

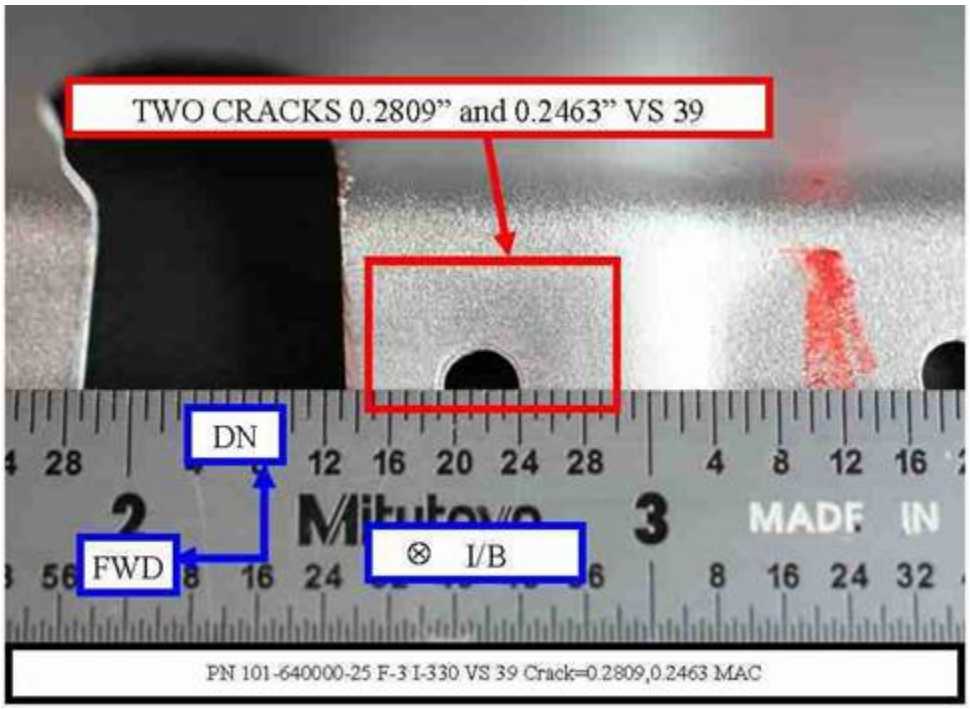


Figure 367. Multiple Cracks on Rib—Macroscopic View

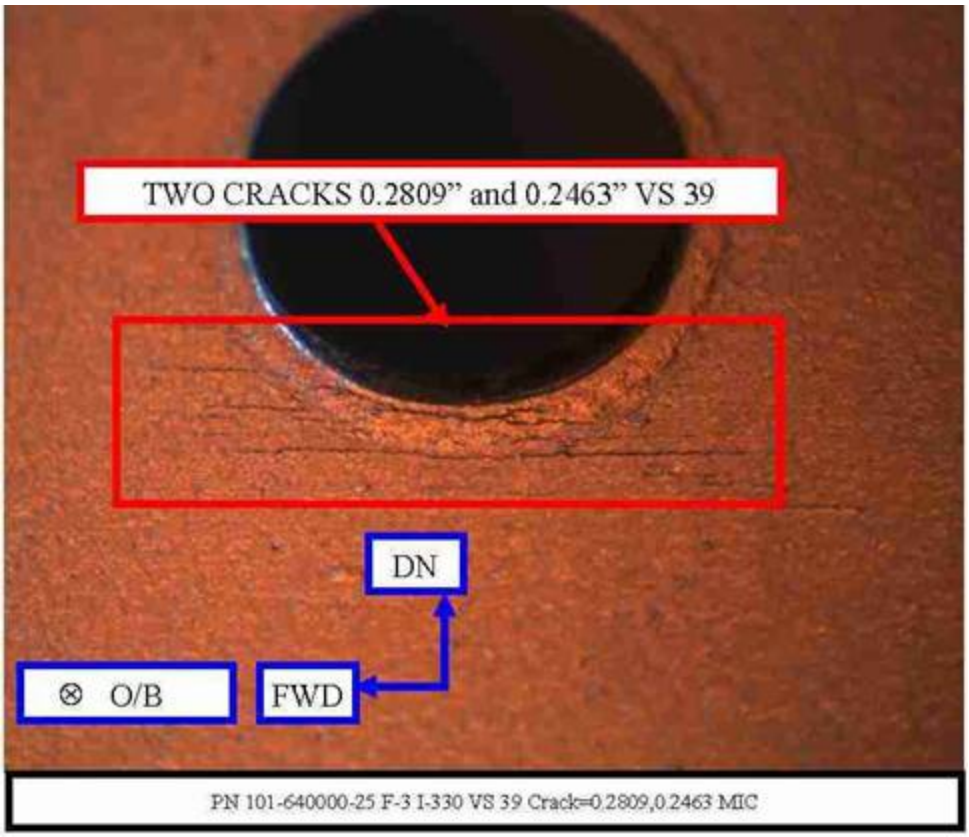


Figure 368. Multiple Cracks on Rib—Microscopic View

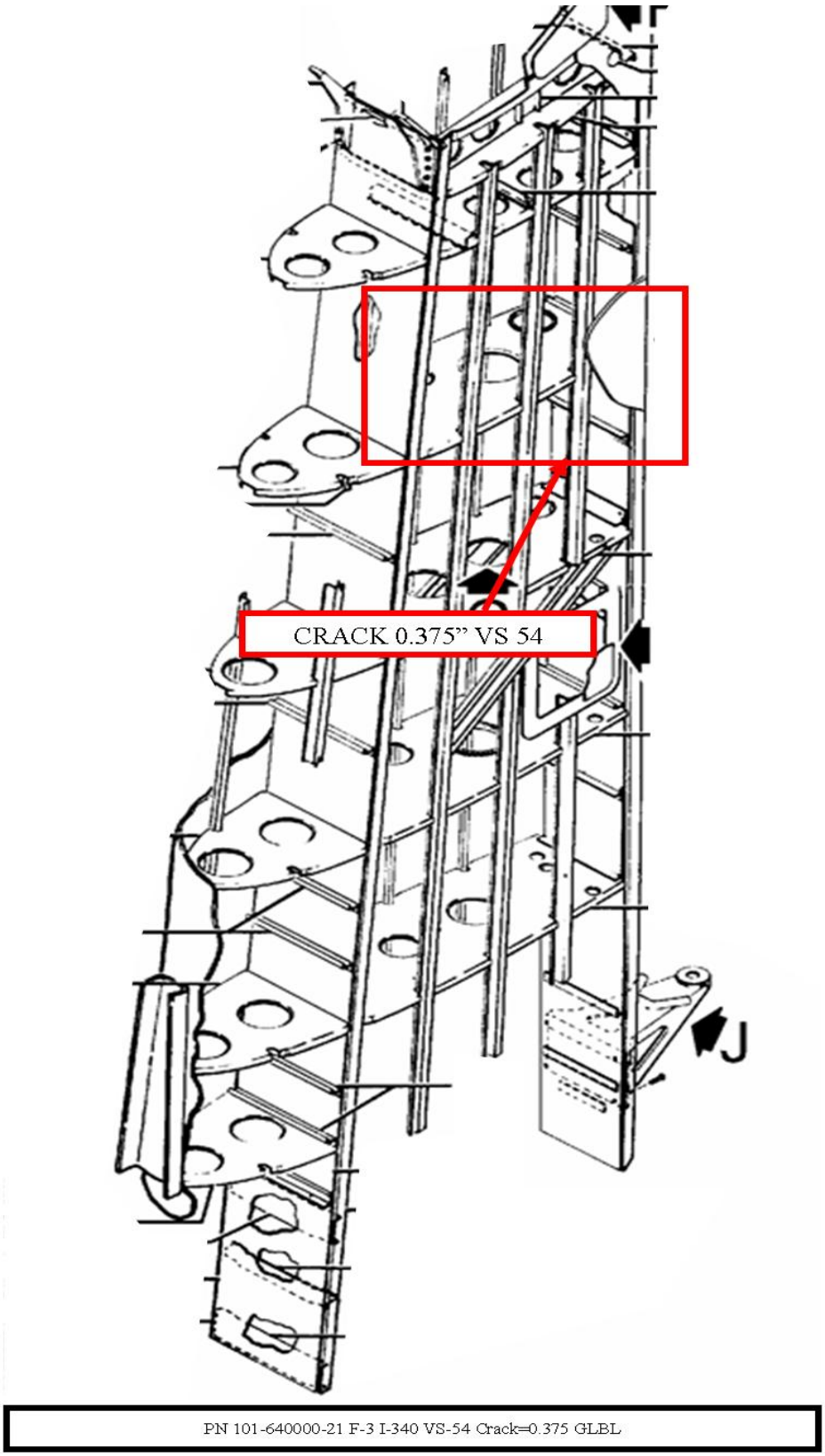


Figure 369. Crack on Outboard Rib—Global View

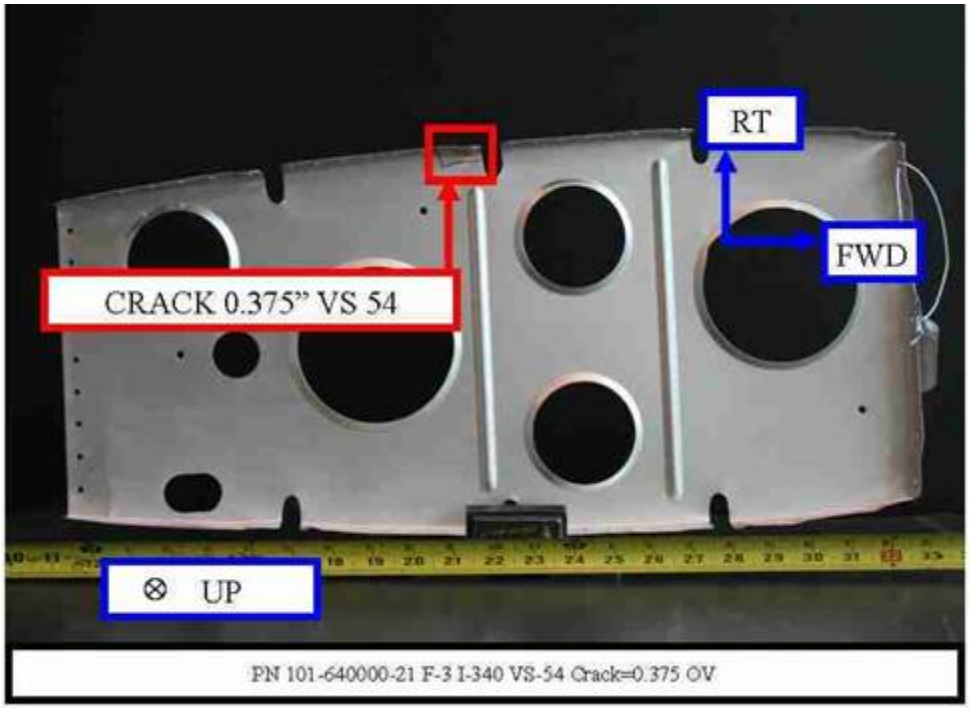


Figure 370. Crack on Outboard Rib—Overview

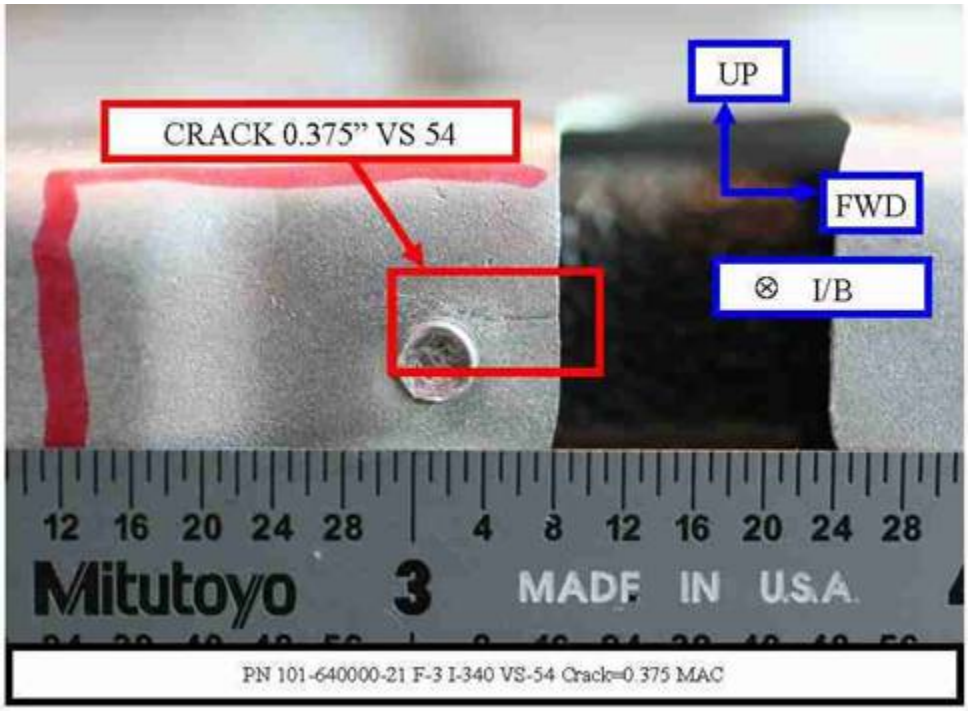


Figure 371. Crack on Outboard Rib—Macroscopic View

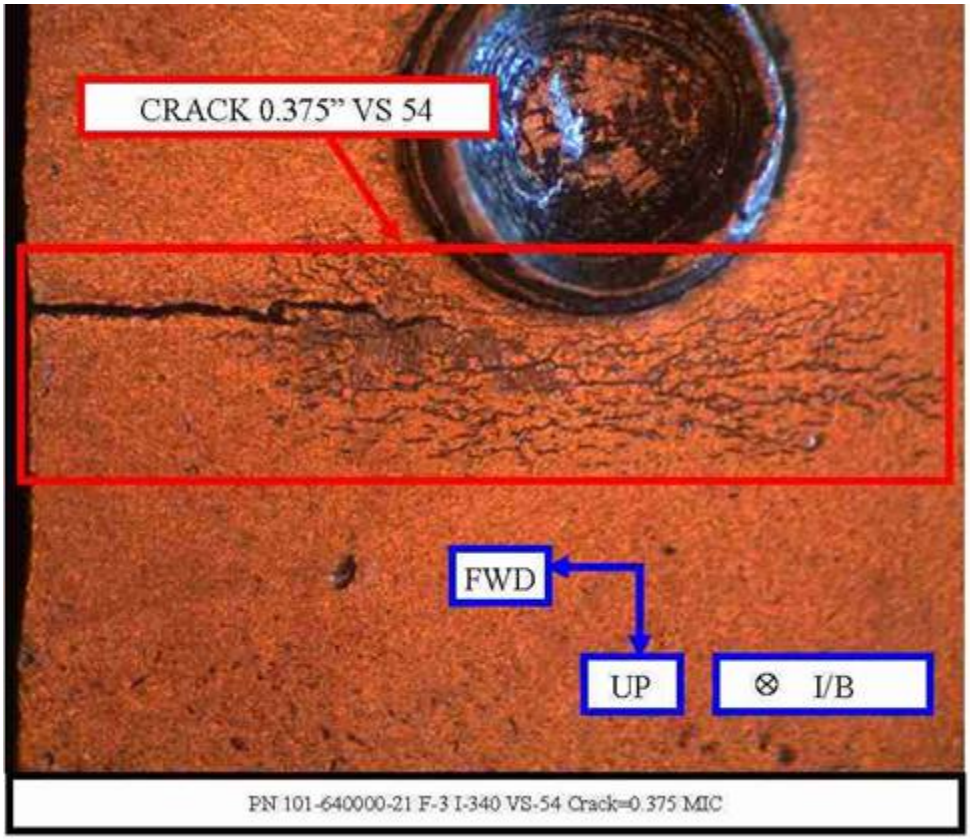


Figure 372. Crack on Outboard Rib—Microscopic View

3.4.13 Horizontal and Vertical Stabilizer Examination Summary.

The tear down examination for the Beechcraft 1900D fuselage was accomplished in two sections: horizontal and vertical. Table 42 shows the number of inspected parts, relevant defects, and microscopic holes examined on the two fuselage sections.

Table 42. Beechcraft 1900D Stabilizer Defect Summary

Airplane Section	Number of Parts Inspected	Number of Defects Found	Microscopic Examination Holes Inspected
Horizontal Stabilizer	62	5	2946
Vertical Stabilizer	39	3	2241
Totals	101	8	5187

3.5 FRACTOGRAPHIC ANALYSIS.

Several parts with cracks were selected for fractographic analysis, including an examination using a scanning electronic microscope (SEM) when necessary. A metallurgist analyzed each part to identify and evaluate primary and secondary crack origins, identify fatigue cracks, and determine crack growth directions. Each selected part was broken open at the defect location to

examine the fracture face for smearing, growth direction, and fatigue origins, which determine crack striations and whether or not multiple origins exist. Table 43, along with brief summaries and figures, shows a complete synopsis of the fractographic analysis, including the SEM examinations performed on the Beechcraft 1900D.

Table 43. Fractographic Analysis and SEM

Defect				Defect Location		Exam Type	Defect Figure Number
Type	L (inches)	W (inches)	D (inches)	S	S		
Crack	1.32		Through crack	FS 150		Fractographic Analysis and SEM	Figure 373 Overview Figure 374 Macroscopic Figure 375 Microscopic Figure 376 SEM
Crack	0.19 0.26 0.59		Through crack	FS 265	WL 135	Fractographic Analysis and SEM	Figure 377 Overview Figure 378 Macroscopic Figure 379 Macroscopic Figure 380 SEM
Crack	0.26 0.32 0.56		Through crack	FS 290	WL 135	Fractographic Analysis	Figure 381 Overview Figure 382 Macroscopic Figure 383 Microscopic Figure 384 SEM Figure 385 Macroscopic Figure 386 Microscopic
Crack	1.0625 0.4062		Through crack	FS 456	WL 93	Fractographic Analysis	Figure 387 Overview Figure 388 Macroscopic Figure 389 Microscopic Figure 390 Macroscopic Figure 391 Microscopic
Crack	1.63		Through crack	WS 30	WL 87	Fractographic Analysis and SEM	Figure 392 Overview Figure 393 Macroscopic Figure 394 Microscopic Figure 395 Microscopic Figure 396 SEM

3.5.1 Forward Fuselage Lower Door Angle.

The fatigue cracking on the forward fuselage lower door angle, shown in figures 373 to 376, shows the crack growing completely through the thickness as a stable fatigue crack. Outside the identified region, the growth is more unstable, and some crack features are smeared. The combination of origins, shown in figure 375, indicates the chord may have had some installation-related loading that tended to twist past the part. SEM pictures in figure 376 show the crack direction.

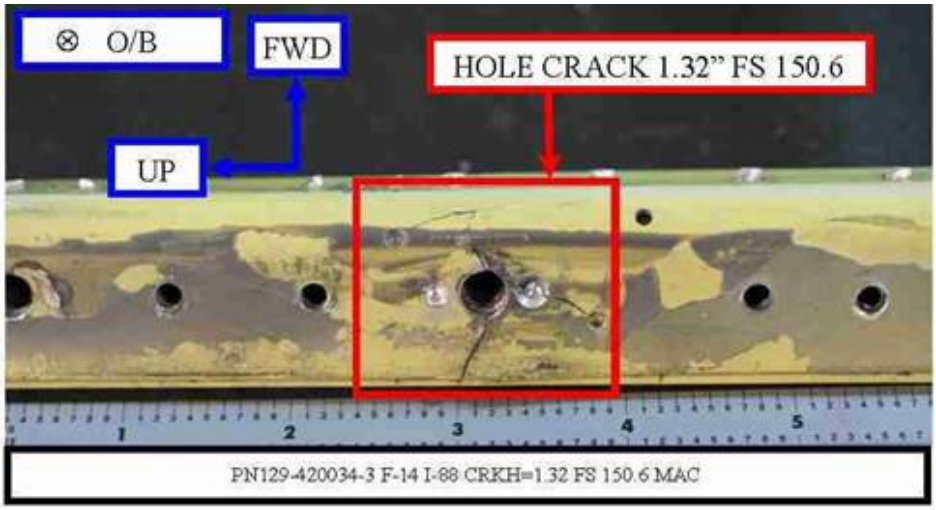


Figure 373. Forward Fuselage Lower Door Angle—Overview

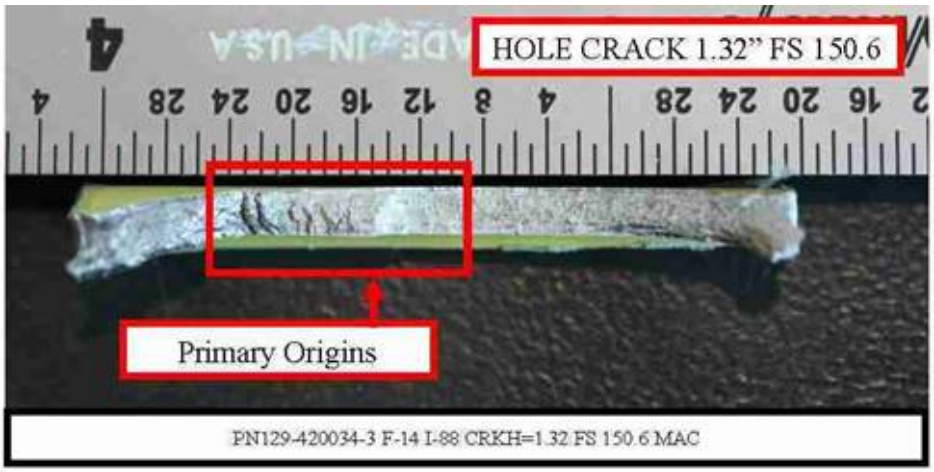


Figure 374. Door Angle Crack Fracture—Macroscopic View

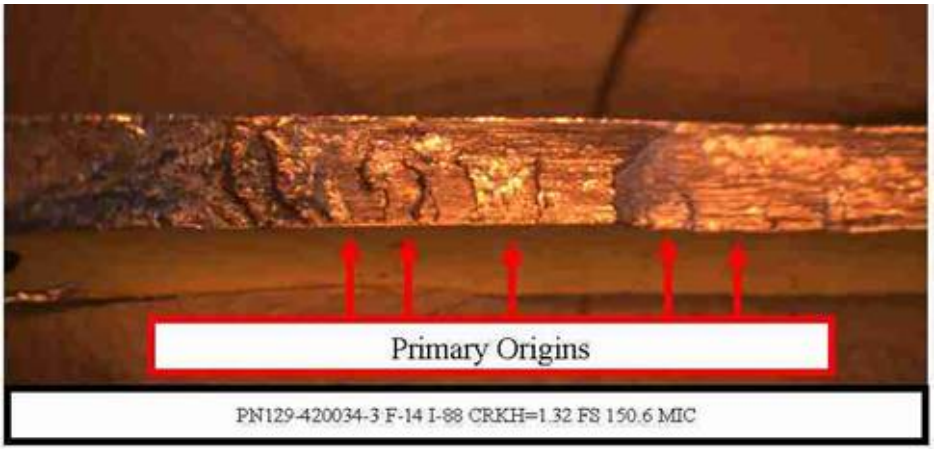


Figure 375. Fracture Face Primary Origin—Microscopic View

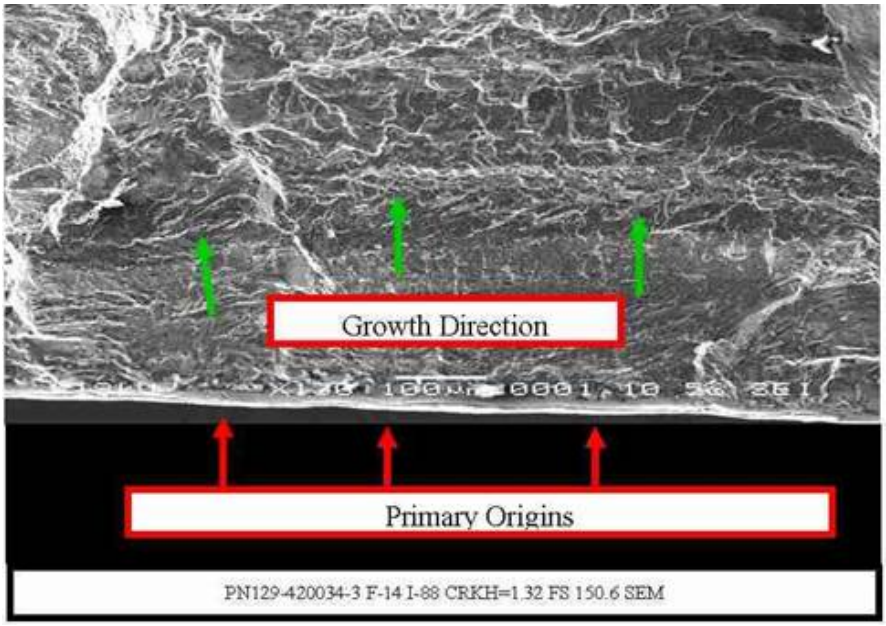


Figure 376. Growth Direction—SEM

3.5.2 Mid Fuselage FS 265 Escape Hatch Gusset.

Fractographic analysis of the crack on the mid fuselage escape hatch gusset at FS 265, shown in figure 377, revealed that the majority of the crack face had smearing, thus prohibiting a valid assessment of the entire area. Figure 378 shows the fracture face, and figure 379 indicates where primary and secondary origins occurred. Figure 380 taken with the SEM displays crack direction. Expanded overview pictures of this particular part are also shown in the mid fuselage examination, see section 3.4.2.

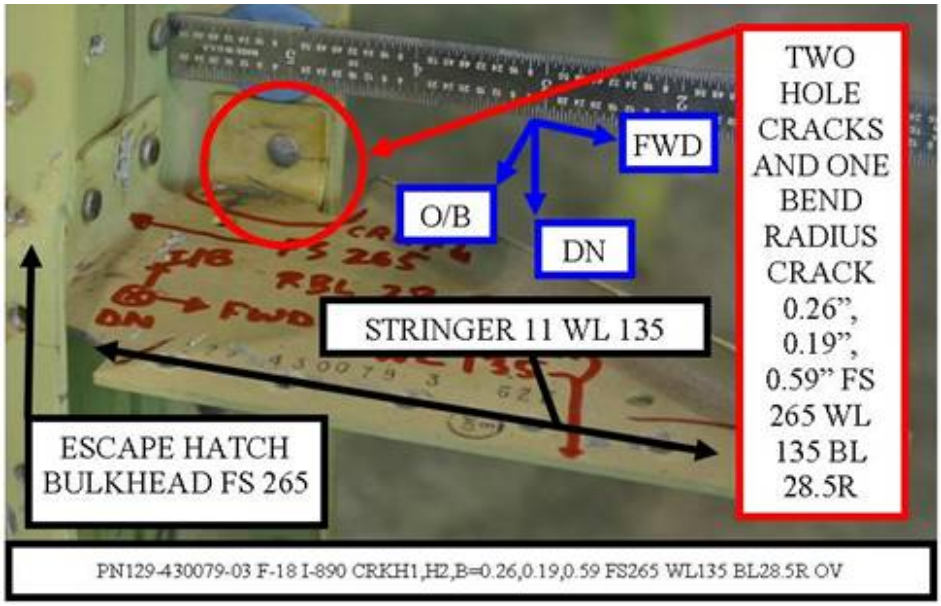


Figure 377. Mid Fuselage Escape Hatch Gusset—Overview (FS 265)

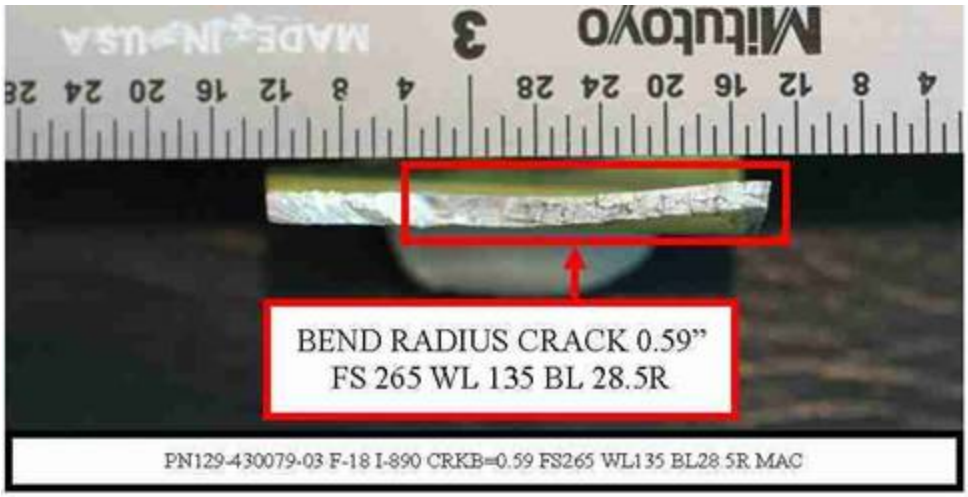


Figure 378. Mid Fuselage Gusset Crack Fracture—Macroscopic View

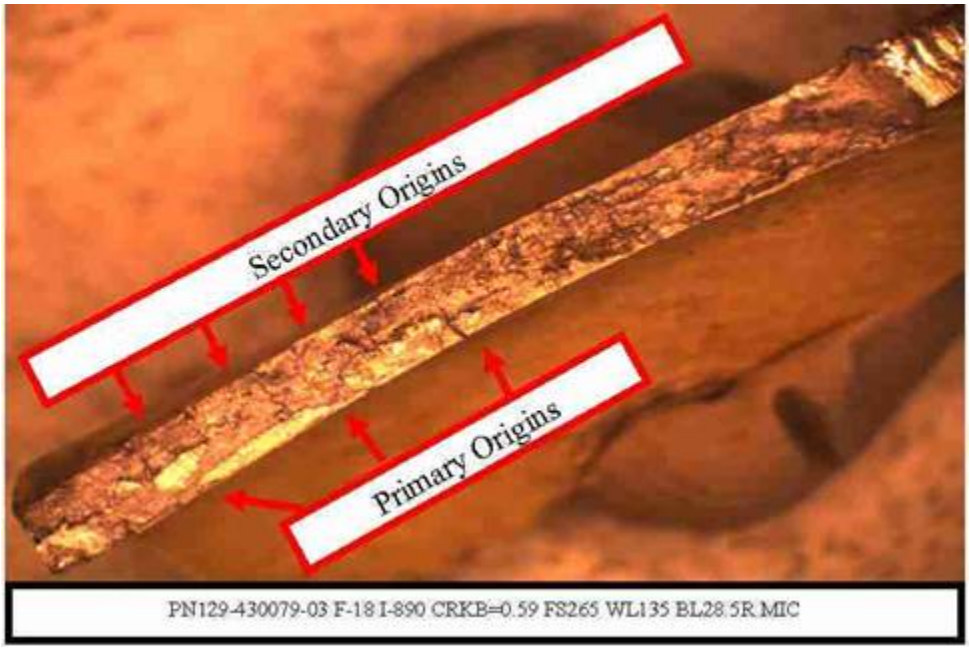


Figure 379. Gusset Fracture Face Primary and Secondary Origins—Microscopic View (FS 265)

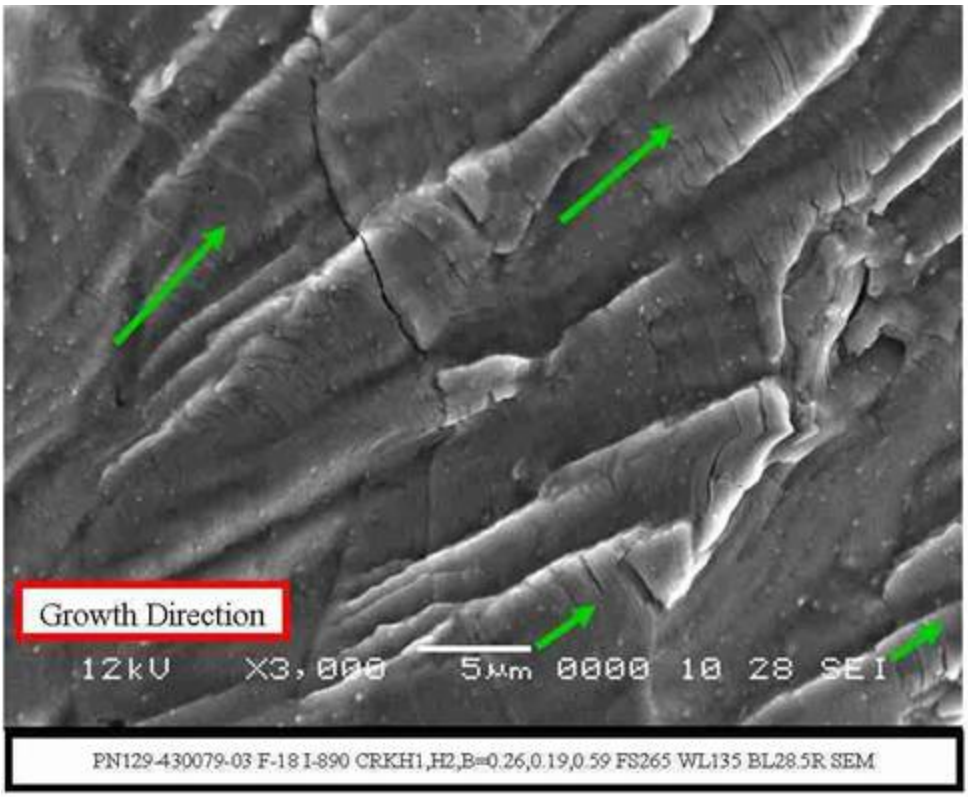


Figure 380. Gusset Crack Growth Direction—SEM (FS 265)

3.5.3 Mid Fuselage Escape Hatch Gusset.

Fractographic analysis of the mid fuselage escape hatch gusset (see figure 381) revealed smearing across the fracture facing of the crack (see figure 382). Figure 383 shows primary and secondary origin locations discovered by the metallurgist. Multiple primary origins are also displayed in the same figure. Figure 384 shows crack growth direction pictures taken during the SEM examination.

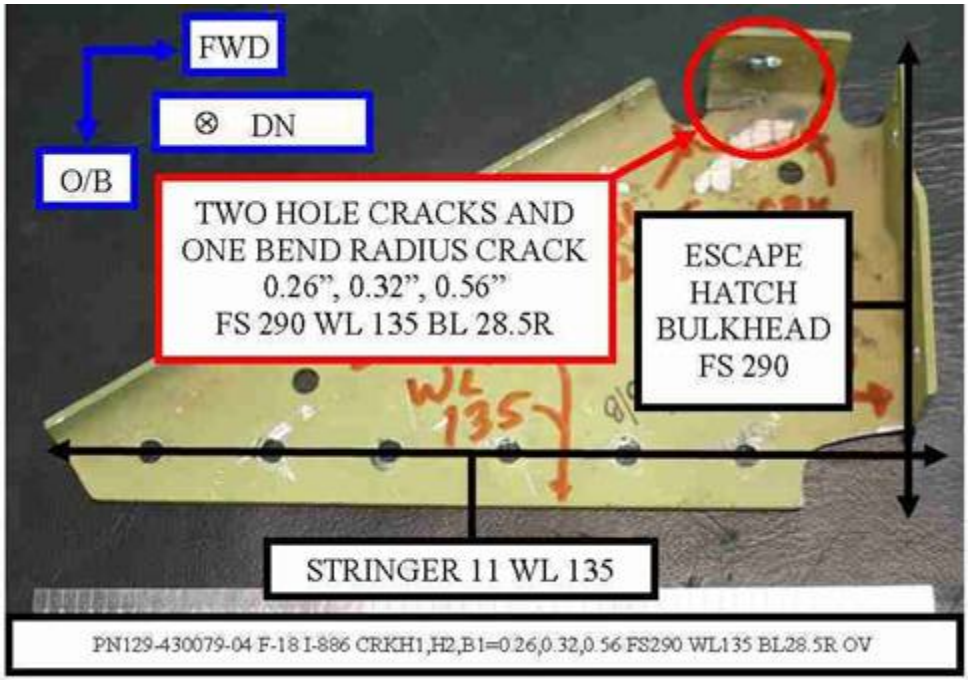


Figure 381. Mid Fuselage Escape Hatch Gusset—Overview (FS 290)

Figure 382. Gusset Crack Fracture Face—Macroscopic View

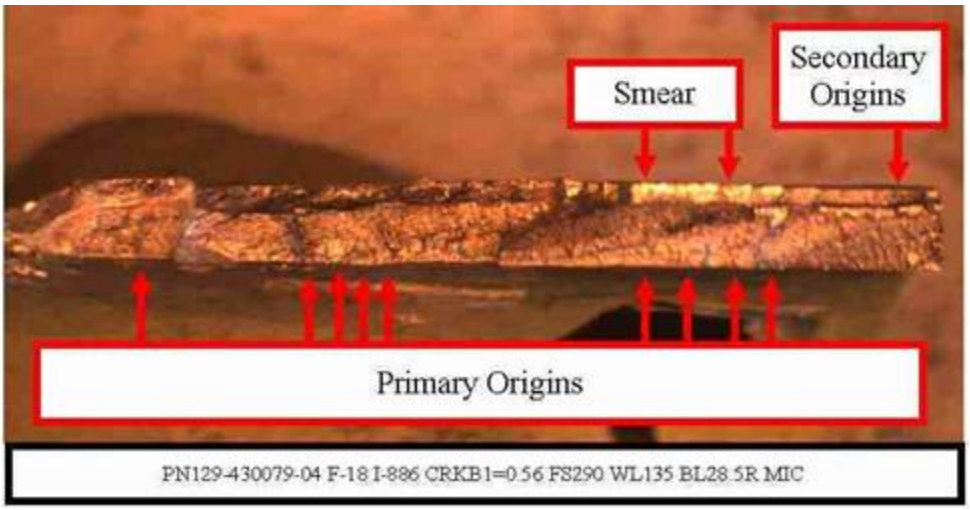


Figure 383. Gusset Fracture Face Primary and Secondary Origins—Microscopic View (FS 290)

Figure 384. Gusset Crack Growth Direction—SEM (FS 290)

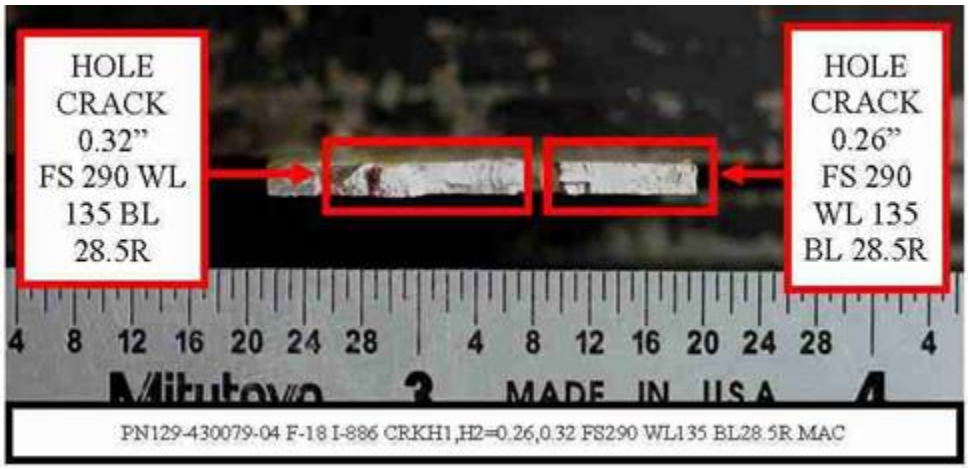


Figure 385. Mid Fuselage Gusset Multiple Cracks—Macroscopic View

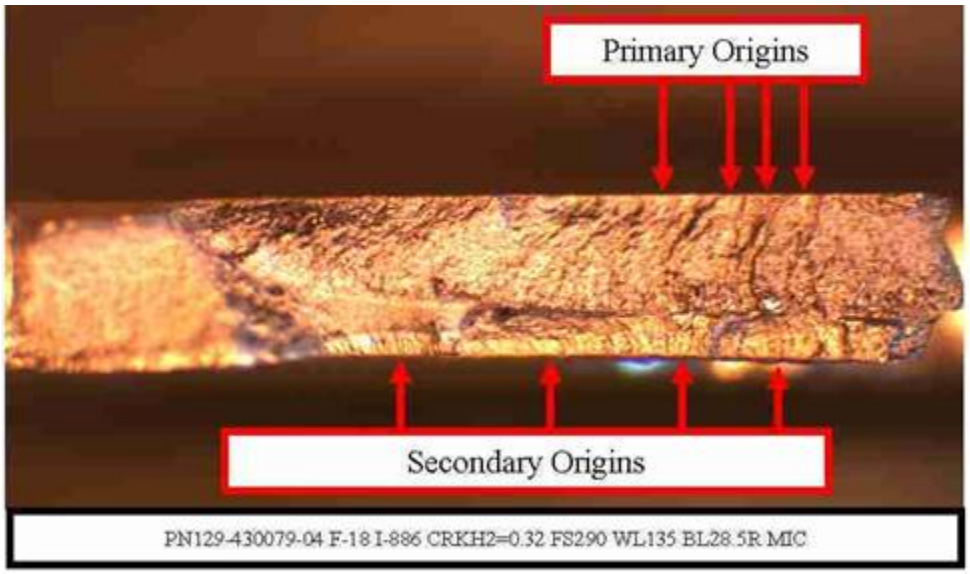


Figure 386. Mid Fuselage Gusset Primary and Secondary Origins—Microscopic View

3.5.4 Tail Fuselage Lower Support Angle.

The tail fuselage lower support angle, shown in figure 387, revealed multiple origins on the surface. However, much of the surface was smeared, prohibiting pertinent details from being captured. Figure 388 shows the fracture face, while figures 389 through 391 display primary origins and smearing. Secondary origins could not be determined by the metallurgist due to surface smearing; therefore, no SEM examinations were performed.

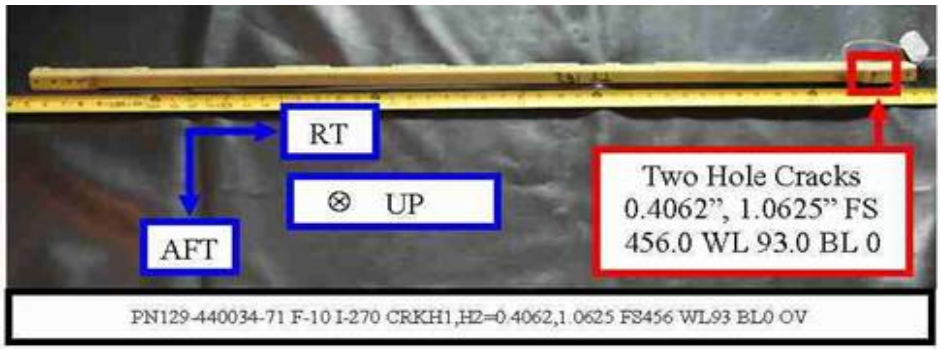


Figure 387. Tail Fuselage Lower Support Angle—Overview

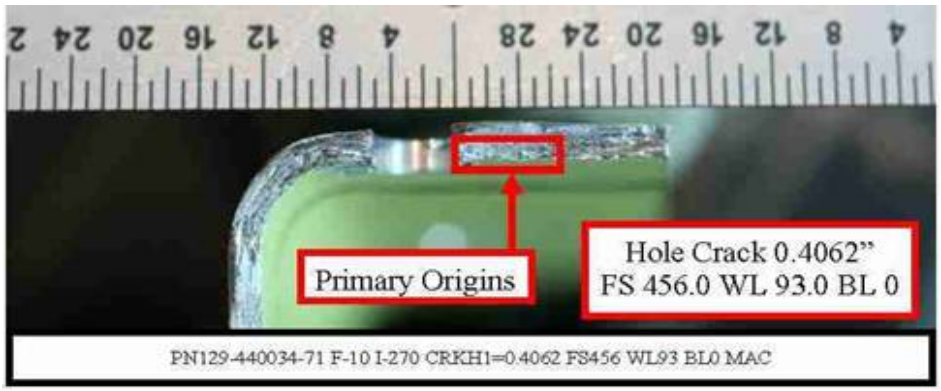


Figure 388. Tail Fuselage Support Angle Crack Fracture Face—Macroscopic View

Figure 389. Support Angle Crack Fracture Face Primary Origins—Microscopic View

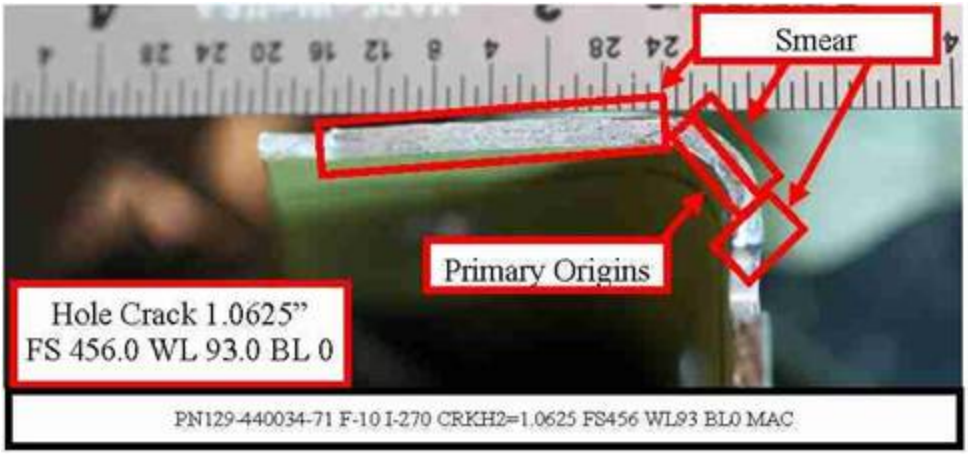


Figure 390. Crack Fracture Face Primary Origins and Smearing—Macroscopic View

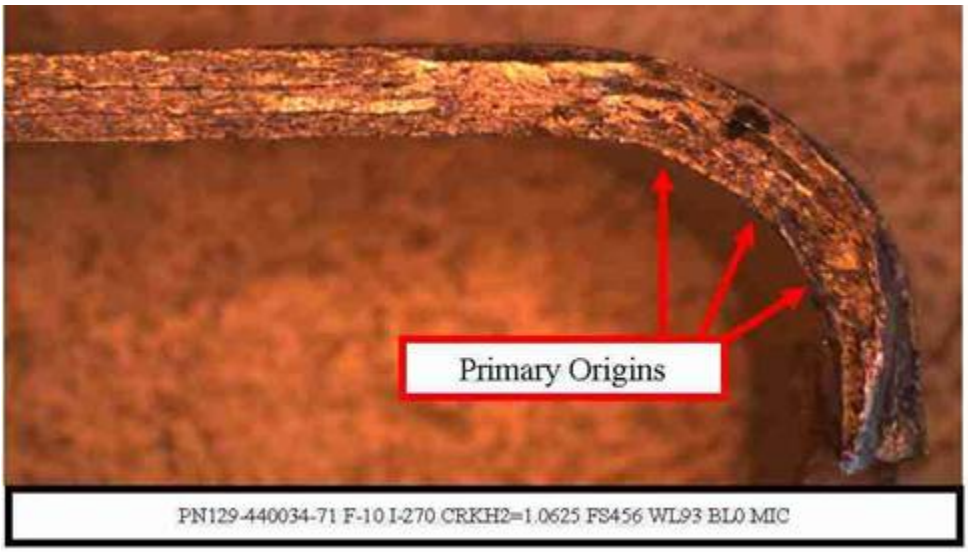


Figure 391. Crack Fracture Face Primary Origins—Microscopic View

3.5.5 Center Wing Left Angle.

It was determined that the center wing left angle crack, shown in figure 392, was caused by fatigue. Approximately 50 percent of the crack surface is smeared, as shown in figure 393, and sealant covers most of the surface, which made identifying the origins very difficult. Indications (see figure 394) show that primary origins are located on the inside of the bend radius near the part's edge. Secondary (see figure 395) origins are located on the inside of the bend radius toward the end of the crack. Figure 396 shows crack growth direction during the SEM examination.

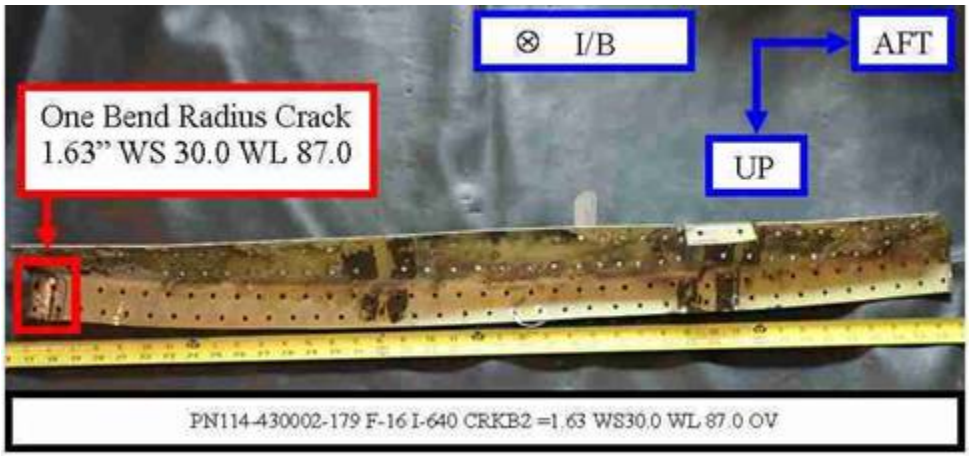


Figure 392. Center Wing Left Angle—Overview

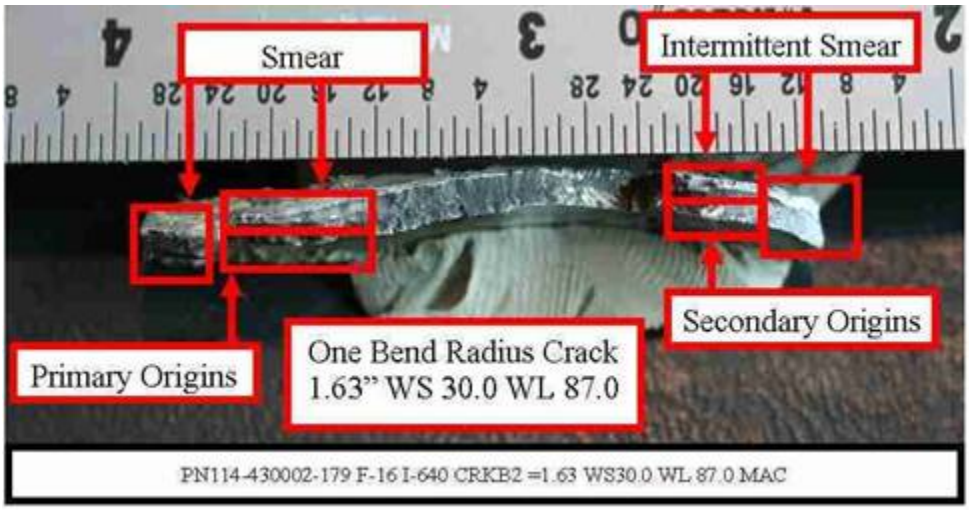


Figure 393. Center Wing Angle Crack Fracture Face—Microscopic View

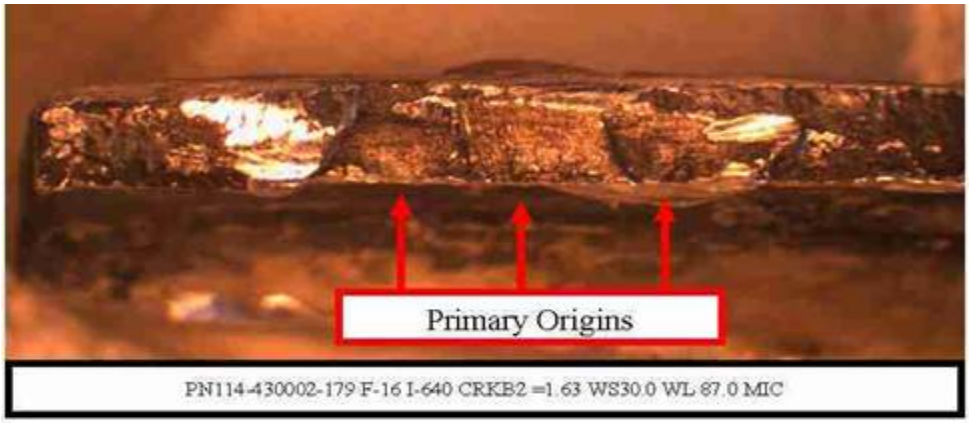


Figure 394. Center Wing Angle Crack Fracture Face Primary Origins—Microscopic View

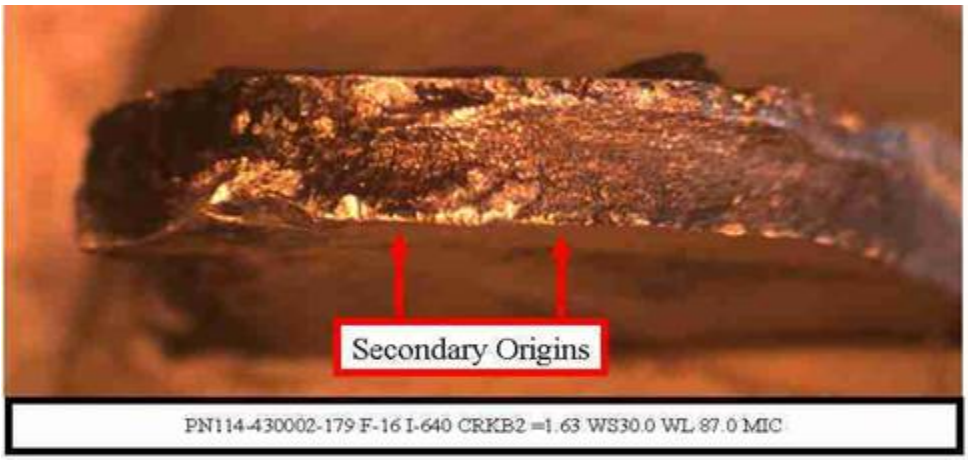


Figure 395. Center Wing Crack Fracture Face Secondary Origins—Microscopic View

Figure 396. Center Wing Crack Direction—SEM

3.5.6 Circuit Breaker Testing.

Circuit breakers are specifically designed to protect airplane wiring. A circuit breaker will trip off when the current going through it exceeds its rating, providing primary electrical protection. The functionality of each Beechcraft 1900D circuit breaker was tested during the teardown evaluation. The circuit breakers were removed from the airplane and tested in the laboratory to verify current trip time specifications. Figure 397 shows the circuit breaker panel with the circuit breakers installed. Figure 398 shows the circuit breaker panel and the removed circuit breakers that were tested.

Figure 397. Circuit Breaker Panel and Circuit Breakers

Figure 398. Circuit Breaker Panel With Removed Circuit Breakers

3.5.7 Circuit Breaker Testing Procedure.

The following test procedure was used to check the circuit breakers' functionality and compliance to manufacturer's specifications. Testing was also conducted to examine the effects of periodically manually cycling the circuit breakers.

- The circuit breakers were removed from the panel prior to testing.
- The current rating and physical condition of each circuit breaker was noted.
- Conductivity was measured and recorded before applying current to each breaker.
- During each test, the circuit breakers were tested at two current levels, 200% and 500% overload:
  - In the 200% overload test, 200% of the rated current was applied to the breaker, and the time required for it to trip was recorded.
  - In the 500% overload test, 500% of the rated current was applied to the breaker, and the time required for it to trip was recorded.
- Initially, four tests were performed. If the circuit breaker was within specifications and stable, no further testing was done. If the circuit breaker was functional, but outside specifications or unstable, six additional tests were performed.
- For tests 1 through 4, each circuit breaker was reset after each test.
- For tests 5 through 10, the circuit breakers that were unstable or outside specifications were manually cycled five times before each test.
- If a circuit breaker failed to trip during a test, it was manually cycled before the next test.
- Each circuit breaker was given at least half an hour to cool off between tests.

The data was tabulated and compared with the circuit breaker specifications.

3.5.8 Circuit Breaker Findings.

Table 44 shows the relevant information of the circuit breakers subjected to testing. The information includes the manufacturer's part number, the current rating of the circuit breaker, the condition of the breaker, and what system the circuit breaker was used for. One hundred three circuit breakers were installed on the panel, which had 130 places for circuit breakers. Due to the high current rating of three of the circuit breakers (numbers 27, 43, and 59), they were not tested at 200% overload. Nine other circuit breakers (numbers 27, 32, 43, 48, 59, 87, 105, 110, and 121) were not tested at 500% overload because the equipment available could not supply the required current. Because the airplane was stored outside for several years with the circuit

breaker panel open to the elements, all of the circuit breakers had corrosion to some extent. Normally, the circuit breakers are not open to the elements while in the airplane, thus allowing the circuit breakers to trip without having to overcome the friction caused by the corrosion. Because of this corrosion, many of the circuit breakers failed to trip within the specifications given by the manufacturer.

Table 44. Circuit Breakers Tested

Number	Name	Part Number	Rating	Condition
1	Landing Gear Warn Horn Silence	7277-2-5	5A	Corroded
2	Annunciator Power	4200-002-705	7.5A	Corroded
3	Stall Warning	7277-2-5	5A	Corroded
4	Left Bleed Air Warning	4200-002-5	5A	Corroded
5	Left Start Control	7200-002-705	7.5A	Corroded
6	Left Igniter Power	4200-002-5	5A	Corroded
7	Left Fire Detection	4200-002-5	5A	Corroded
8	Left Oil Temperature	4200-002-5	5A	Corroded
9	Left Oil Pressure	4200-002-5	5A	Corroded
10	Left Fuel Flow Indicator	4200-002-5	5A	Corroded
11	Left Torque Meter	MS26574-1 1/2	1.5A	Corroded
12	Not Indicated	4200-002-5	5A	Corroded
13	Not Indicated	4200-002-2	2A	Corroded
14	---	---	---	---
15	Avionics Master Control	4200-002-5	5A	Corroded
16	Landing Gear Position Indicator	4200-002-5	5A	Corroded
17	Annunciator Indicator	4200-002-705	7.5A	Corroded
18	Aural Warning	4200-002-5	5A	Corroded
19	Right Bleed	4200-002-5	5A	Corroded
20	Right Start Control	7277-2-7 1/2	7.5A	Corroded
21	Right Ignitor Power	4200-002-5	5A	Corroded
22	Right Fire Detection	4200-002-5	5A	Corroded
23	Right Oil Temperature	4200-002-5	5A	Corroded
24	Right Oil Pressure	4200-002-5	5A	Corroded
25	Right Fuel Flow Indicator	4200-002-5	5A	Corroded
26	Right Torque Meter ac	MS26574-1 1/2	1.5A	Corroded
27	Avionics No. 1	MS25244-25	25A	Corroded
28	Not Indicated	4200-002-705	7.5A	Corroded
29	Not Indicated	2/3/7277	3A	Corroded
30	Pilot Speaker	7277-2-2	2A	Corroded
31	Copilot Speaker	7277-2-2	2A	Corroded
32	Rotating Beacon	4200-002-10	10A	Corroded
33	---	---	---	---

Table 44. Circuit Breakers Tested (Continued)

Number	Name	Part Number	Rating	Condition
34	---	---	---	---
35	---	---	---	---
36	---	---	---	---
37	---	---	---	---
38	Autofeather	4200-002-5	5A	Corroded
39	---	---	---	Corroded
40	Flap Control and Indicator	4200-002-5	5A	Corroded
41	---	---	---	Corroded
42		7277-2-3	3A	Corroded
43	Avionics No. 2	MS25244-25	25A	Corroded
44	---	---	---	---
45	Not Indicated	4200-002-2	2A	Corroded
46	Not Indicated	4200-002-705	7.5A	Corroded
47	Pilot Phone	4200-002-2	2A	Corroded
48	Not Indicated	7277-2-10	10A	Corroded
49	---	---	---	---
50	---	---	---	---
51	---	---	---	---
52	---	---	---	---
53	Prop Ground Sol	---	---	---
54	Prop Synchrophaser	4200-002-5	5A	Corroded
55	---	---	---	---
56	Not Indicated	4200-002-1	1A	Corroded
57	Yaw Servo	4200-002-5	5A	Corroded
58	Yaw Control	7277-2-3	3A	Corroded
59	Avionics No. 3	MS25244-25	25A	Corroded
60	Not Indicated	4200-002-2	2A	Corroded
61	---	---	---	---
62	---	---	---	---
63	P.A. and Copilot Phone	7277-2-2	2A	Corroded
64	Not Indicated	4200-002-1	1A	Corroded
65	Instrument Indirect Lights	4200-002-5	5A	Corroded
66	Avionics Annunciator	4200-002-5	5A	Corroded
67	Navigation Lights	4200-002-5	5A	Corroded
68	Wing Ice Light	4200-002-5	5A	Corroded
69	Auto Prop Deice	4200-002-5	5A	Corroded

Table 44. Circuit Breakers Tested (Continued)

Number	Name	Part Number	Rating	Condition
70	Manual Prop Deice	4200-002-5	5A	Corroded
71	Surface Deice	4200-002-5	5A	Corroded
72	Pilot Slip and Turn Indicator	---	---	---
73	Encoding Altimeter	4200-002-1	1A	Corroded
74	Not Indicated	4200-002-5	5A	Corroded
75	ac	4200-002-5	5A	Corroded
76	Not Indicated	4200-002-705	7.5A	Corroded
77	Not Indicated	4200-002-1	1A	Corroded
78	Not Indicated	4200-002-2	2A	Corroded
79	Not Indicated	4200-002-2	2A	Corroded
80	Not Indicated	4200-002-2	2A	Corroded
81	Not Indicated	7277-2-3	3A	Corroded
82	Left Bleed Air	4200-002-705	7.5A	Corroded
83	Cabin Temp Control	4200-002-5	5A	Corroded
84	Cabin Pressure Control	7277-2-5	5A	Corroded
85	---	---	---	---
86	---	---	---	---
87	Windshield Wiper Power	4200-002-10	10A	Corroded
88	---	---	---	---
89	Copilot Slip and Turn	---	---	---
90	Overspeed Sensor	4200-002-5	5A	Corroded
91	Not Indicated	4200-002-5	5A	Corroded
92	Not Indicated	4200-002-5	5A	Corroded
93	Not Indicated	4200-002-705	7.5A	Corroded
94	Not Indicated	4200-002-1	1A	Corroded
95	Not Indicated	4200-002-2	2A	Corroded
96	---	---	---	---
97	Not Indicated	4200-002-2	2A	Corroded
98	Not Indicated	7277-2-3	3A	Corroded
99	Right Bleed Air Control	7277-2-7 1/2	7.5A	Corroded
100	---	---	---	---
101	No. 1 Inv. Power Select	4200-002-5	5A	Corroded
102	---	---	---	---
103	Windshield Control	MS26574-1/2	0.5A	Corroded
104	Windshield Power	MS26574-1/2	0.5A	Corroded
105	Not Indicated	4200-002-15	15A	Corroded

Table 44. Circuit Breakers Tested (Continued)

Number	Name	Part Number	Rating	Condition
106	Not Indicated	4200-002-2	2A	Corroded
107	Not Indicated	4200-002-2	2A	Corroded
108	Not Indicated	4200-002-2	2A	Corroded
109	Not Indicated	4200-002-5	5A	Corroded
110	Not Indicated	7277-2-10	10A	Corroded
111	Not Indicated	4200-002-5	5A	Corroded
112	Not Indicated	4200-002-1	1A	Corroded
113	Not Indicated	4200-002-2	2A	Corroded
114	Not Indicated	4200-002-1	1A	Corroded
115	Not Indicated	4200-002-1	1A	Corroded
116	---	---	---	---
117	No. 2 Inv. Power Select	7277-2-5	5A	Corroded
118	Furnishings Bus Control	---	---	---
119	Not Indicated	7277-2-2	2A	Corroded
120	Not Indicated	7277-2-2	2A	Corroded
121	Not Indicated	4200-002-15	15A	Corroded
122	Not Indicated	7277-2-1	1A	Corroded
123	Not Indicated	4200-002-1	1A	Corroded
124	Not Indicated	7277-2-5	5A	Corroded
125	Not Indicated	7277-2-2	2A	Corroded
126	Not Indicated	4200-002-1	1A	Corroded
127	Not Indicated	7277-2-1	1A	Corroded
128	Not Indicated	4200-002-2	2A	Corroded
129	Not Indicated	4200-002-1	1A	Corroded
130	Not Indicated	4200-002-1	1A	Corroded

ac = Alternate current
Sol = Solenoid

Tables 45 and 46 show the results for the 200% and 500% overload tests, respectively. The trip time in seconds is listed in these tables for the ten tests performed and are compared with the maximum trip time specified on the manufacturer's datasheet, which are 10 seconds for 200% overload and 2 seconds for 500% overload, respectively. Not applicable (N/A) listed in the tables for tests 5 to 10 means that these breakers were not tested further due to the fact that the circuit breaker met the manufacturer's specifications for the 200% and 500% overload tests by test 4 and were stable, or that the required current could not be supplied to the circuit breaker. An open circuit (OC) listing instead of a value in the tables indicates that the corresponding circuit breaker had an open circuit during the respective test. The three dashes indicated that the circuit breaker was not installed at that position.

Table 45. Experimental Results 200% Overload

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
1	5A	11	8	9	6	N/A	N/A	N/A	N/A	N/A	N/A
2	7.5A	>30	>30	>30	>30	11	8	8	6	9	>30
3	5A	>30	>30	>30	>30	>30	OC	OC	OC	>30	26
4	5A	16	12	15	12	14	11	15	16	14	16
5	7.5A	8	7	6	5	N/A	N/A	N/A	N/A	N/A	N/A
6	5A	9	9	8	6	N/A	N/A	N/A	N/A	N/A	N/A
7	5A	>30	>30	>30	>30	OC	OC	>30	OC	OC	OC
8	5A	11	12	10	10	N/A	N/A	N/A	N/A	N/A	N/A
9	5A	12	11	13	11	11	8	10	>30	8	8
10	5A	10	9	12	10	N/A	N/A	N/A	N/A	N/A	N/A
11	1.5A	22	10	11	12	11	9	11	10	10	13
12	5A	13	16	11	16	12	19	13	16	17	9
13	2A	7	3	5	7	N/A	N/A	N/A	N/A	N/A	N/A
14	---	---	---	---	---	---	---	---	---	---	---
15	5A	>30	>30	>30	>30	>30	7	4	3	5	3
16	5A	13	9	9	10	N/A	N/A	N/A	N/A	N/A	N/A
17	7.5A	16	6	5	6	N/A	N/A	N/A	N/A	N/A	N/A
18	5A	17	9	10	13	OC	OC	OC	OC	OC	OC
19	5A	14	10	11	9	N/A	N/A	N/A	N/A	N/A	N/A
20	7.5A	9	7	7	6	N/A	N/A	N/A	N/A	N/A	N/A
21	5A	>30	6	5	6	N/A	N/A	N/A	N/A	N/A	N/A
22	5A	17	>30	21	9	N/A	N/A	N/A	N/A	N/A	N/A
23	5A	11	9	10	10	N/A	N/A	N/A	N/A	N/A	N/A
24	5A	12	8	9	9	N/A	N/A	N/A	N/A	N/A	N/A
25	5A	10	8	9	8	N/A	N/A	N/A	N/A	N/A	N/A
26	1.5A	>30	27	10	15	14	12	11	16	14	19
27	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	7.5A	6	5	5	5	N/A	N/A	N/A	N/A	N/A	N/A
29	3A	14	14	15	9	N/A	N/A	N/A	N/A	N/A	N/A
30	2A	17	26	18	20	15	15	16	14	13	13

Table 45. Experimental Results 200% Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
31	2A	12	11	13	10	N/A	N/A	N/A	N/A	N/A	N/A
32	10A	>30	>30	>30	>30	>30	>30	OC	OC	OC	12
33	---	---	---	---	---	---	---	---	---	---	---
34	---	---	---	---	---	---	---	---	---	---	---
35	---	---	---	---	---	---	---	---	---	---	---
36	---	---	---	---	---	---	---	---	---	---	---
37	---	---	---	---	---	---	---	---	---	---	---
38	5A	>30	10	10	8	N/A	N/A	N/A	N/A	N/A	N/A
39	---	---	---	---	---	---	---	---	---	---	---
40	5A	9	8	10	9	N/A	N/A	N/A	N/A	N/A	N/A
41	---	---	---	---	---	---	---	---	---	---	---
42	3A	12	10	10	6	N/A	N/A	N/A	N/A	N/A	N/A
43	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
44	---	---	---	---	---	---	---	---	---	---	---
45	2A	>30	>30	>30	>30	>30	>30	>30	OC	OC	OC
46	7.5A	>30	>30	>30	>30	OC	>30	>30	OC	OC	OC
47	2A	>30	>30	>30	>30	>30	OC	OC	OC	OC	OC
48	10A	8	4	4	3	N/A	N/A	N/A	N/A	N/A	N/A
49	---	---	---	---	---	---	---	---	---	---	---
50	---	---	---	---	---	---	---	---	---	---	---
51	---	---	---	---	---	---	---	---	---	---	---
52	---	---	---	---	---	---	---	---	---	---	---
53	---	---	---	---	---	---	---	---	---	---	---
54	5A	>30	>30	>30	>30	10	10	9	9	10	10
55	---	---	---	---	---	---	---	---	---	---	---
56	1A	13	8	12	5	N/A	N/A	N/A	N/A	N/A	N/A
57	5A	10	11	10	9	N/A	N/A	N/A	N/A	N/A	N/A
58	3A	13	6	8	6	N/A	N/A	N/A	N/A	N/A	N/A
59	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	2A	>30	>30	>30	>30	21	>30	9	9	10	5
61	---	---	---	---	---	---	---	---	---	---	---
62	---	---	---	---	---	---	---	---	---	---	---
63	2A	27	16	17	11	12	12	13	12	16	15
64	1A	>30	>30	>30	>30	OC	OC	OC	OC	OC	OC
65	5A	>30	>30	>30	>30	>30	>30	>30	>30	12	9

Table 45. Experimental Results 200% Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
66	5A	>30	>30	>30	>30	12	10	11	10	10	13
67	5A	9	12	11	9	N/A	N/A	N/A	N/A	N/A	N/A
68	5A	>30	>30	>30	>30	>30	>30	OC	>30	>30	OC
69	5A	>30	>30	>30	>30	OC	OC	OC	OC	OC	OC
70	5A	10	9	10	9	N/A	N/A	N/A	N/A	N/A	N/A
71	5A	14	12	11	14	9	11	12	12	12	12
72	---	---	---	---	---	---	---	---	---	---	---
73	1A	8	6	9	4	N/A	N/A	N/A	N/A	N/A	N/A
74	5A	6	8	8	8	N/A	N/A	N/A	N/A	N/A	N/A
75	5A	9	7	7	7	N/A	N/A	N/A	N/A	N/A	N/A
76	7.5A	11	>30	8	10	N/A	N/A	N/A	N/A	N/A	N/A
77	1A	>30	>30	>30	>30	>30	OC	OC	OC	OC	OC
78	2A	>30	>30	>30	>30	>30	>30	>30	12	8	7
79	2A	>30	>30	>30	>30	9	8	8	7	9	9
80	2A	>30	>30	9	9	N/A	N/A	N/A	N/A	N/A	N/A
81	3A	14	9	12	7	N/A	N/A	N/A	N/A	N/A	N/A
82	7.5A	13	13	16	9	N/A	N/A	N/A	N/A	N/A	N/A
83	5A	>30	>30	>30	>30	10	8	8	10	6	5
84	5A	12	14	8	9	N/A	N/A	N/A	N/A	N/A	N/A
85	---	---	---	---	---	---	---	---	---	---	---
86	---	---	---	---	---	---	---	---	---	---	---
87	10A	15	10	11	11	11	13	12	11	11	10
88	---	---	---	---	---	---	---	---	---	---	---
89	---	---	---	---	---	---	---	---	---	---	---
90	5A	12	12	11	10	N/A	N/A	N/A	N/A	N/A	N/A
91	5A	7	6	6	5	N/A	N/A	N/A	N/A	N/A	N/A
92	5A	8	7	7	6	N/A	N/A	N/A	N/A	N/A	N/A
93	7.5A	>30	>30	>30	>30	7	9	7	5	6	4
94	1A	28	18	11	9	N/A	N/A	N/A	N/A	N/A	N/A
95	2A	13	8	10	8	N/A	N/A	N/A	N/A	N/A	N/A
96	---	---	---	---	---	---	---	---	---	---	---
97	2A	10	OC	OC	OC	7	6	>30	OC	OC	OC
98	3A	8	6	7	7	N/A	N/A	N/A	N/A	N/A	N/A
99	7.5A	11	8	7	7	N/A	N/A	N/A	N/A	N/A	N/A
100	---	---	---	---	---	---	---	---	---	---	---

Table 45. Experimental Results 200% Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
101	5A	>30	4	9	10	N/A	N/A	N/A	N/A	N/A	N/A
102	---	---	---	---	---	---	---	---	---	---	---
103	0.5A	>30	>30	>30	>30	>30	>30	>30	12	13	15
104	0.5A	30	18	7	10	N/A	N/A	N/A	N/A	N/A	N/A
105	15A	13	12	12	12	11	10	9	11	11	9
106	2A	>30	>30	13	9	N/A	N/A	N/A	N/A	N/A	N/A
107	2A	7	>30	OC	OC	5	6	5	2	6	4
108	2A	7	9	>30	6	N/A	N/A	N/A	N/A	N/A	N/A
109	5A	12	9	8	8	N/A	N/A	N/A	N/A	N/A	N/A
110	10A	8	8	9	8	N/A	N/A	N/A	N/A	N/A	N/A
111	5A	9	8	9	8	N/A	N/A	N/A	N/A	N/A	N/A
112	1A	>30	>30	>30	>30	>30	>30	OC	OC	>30	OC
113	2A	>30	>30	>30	>30	11	10	OC	6	6	7
114	1A	19	11	7	5	N/A	N/A	N/A	N/A	N/A	N/A
115	1A	>30	>30	>30	>30	OC	OC	OC	OC	OC	OC
116	---	---	---	---	---	---	---	---	---	---	---
117	5A	>30	>30	>30	>30	>30	>30	>30	>30	>30	>30
118	---	---	---	---	---	---	---	---	---	---	---
119	2A	24	>30	>30	>30	26	19	26	23	17	24
120	2A	>30	>30	>30	>30	>30	>30	>30	>30	>30	>30
121	15A	10	8	7	7	N/A	N/A	N/A	N/A	N/A	N/A
122	1A	22	13	10	6	N/A	N/A	N/A	N/A	N/A	N/A
123	1A	14	9	7	6	N/A	N/A	N/A	N/A	N/A	N/A
124	5A	9	6	6	5	N/A	N/A	N/A	N/A	N/A	N/A
125	2A	>30	>30	>30	>30	>30	>30	>30	30	27	24
126	1A	>30	>30	>30	>30	>30	14	18	OC	OC	8
127	1A	30	17	11	9	N/A	N/A	N/A	N/A	N/A	N/A
128	2A	7	10	8	6	N/A	N/A	N/A	N/A	N/A	N/A
129	1A	13	10	6	>30	7	9	10	7	13	6
130	1A	12	9	6	5	N/A	N/A	N/A	N/A	N/A	N/A

Table 46. Experimental Results 500% Overload

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
1	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
2	7.5A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
3	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
4	5A	2	1	2	2	N/A	N/A	N/A	N/A	N/A	N/A
5	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
6	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
7	5A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
8	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
9	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
10	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
11	1.5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
12	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
13	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
14	---	---	---	---	---	---	---	---	---	---	---
15	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
16	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
17	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
18	5A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
19	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
20	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
21	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
22	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
23	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
24	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
25	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
26	1.5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
27	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 46. Experimental Results 500%Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
28	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
29	3A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
30	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
31	2A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
32	10A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
33	---	---	---	---	---	---	---	---	---	---	---
34	---	---	---	---	---	---	---	---	---	---	---
35	---	---	---	---	---	---	---	---	---	---	---
36	---	---	---	---	---	---	---	---	---	---	---
37	---	---	---	---	---	---	---	---	---	---	---
38	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
39	---	---	---	---	---	---	---	---	---	---	---
40	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
41	---	---	---	---	---	---	---	---	---	---	---
42	3A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
43	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
44	---	---	---	---	---	---	---	---	---	---	---
45	2A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
46	7.5A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
47	2A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
48	10A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
49	---	---	---	---	---	---	---	---	---	---	---
50	---	---	---	---	---	---	---	---	---	---	---
51	---	---	---	---	---	---	---	---	---	---	---
52	---	---	---	---	---	---	---	---	---	---	---
53	---	---	---	---	---	---	---	---	---	---	---
54	5A	2	2	2	1	N/A	N/A	N/A	N/A	N/A	N/A
55	---	---	---	---	---	---	---	---	---	---	---
56	1A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
57	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
58	3A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
59	25A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
61	---	---	---	---	---	---	---	---	---	---	---
62	---	---	---	---	---	---	---	---	---	---	---

Table 46. Experimental Results 500% Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
63	2A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
64	1A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
65	5A	2	2	2	1	N/A	N/A	N/A	N/A	N/A	N/A
66	5A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
67	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
68	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
69	5A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
70	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
71	5A	2	1	2	2	N/A	N/A	N/A	N/A	N/A	N/A
72	---	---	---	---	---	---	---	---	---	---	---
73	1A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
74	5A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
75	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
76	7.5A	1	2	1	1	N/A	N/A	N/A	N/A	N/A	N/A
77	1A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
78	2A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
79	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
80	2A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
81	3A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
82	7.5A	2	2	1	1	N/A	N/A	N/A	N/A	N/A	N/A
83	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
84	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
85	---	---	---	---	---	---	---	---	---	---	---
86	---	---	---	---	---	---	---	---	---	---	---
87	10A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
88	---	---	---	---	---	---	---	---	---	---	---
89	---	---	---	---	---	---	---	---	---	---	---
90	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
91	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
92	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
93	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
94	1A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
95	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
96	---	---	---	---	---	---	---	---	---	---	---
97	2A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
98	3A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A

Table 46. Experimental Results 500% Overload (Continued)

Number	Current Rating	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
99	7.5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
100	---	---	---	---	---	---	---	---	---	---	---
101	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
102	---	---	---	---	---	---	---	---	---	---	---
103	0.5A	>10	8	>10	9	8	9	9	8	>10	>10
104	0.5A	4	5	4	3	3	3	3	3	3	1
105	15A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
106	2A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
107	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
108	2A	1	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
109	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
110	10A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
111	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
112	1A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
113	2A	1	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
114	1A	2	2	2	1	N/A	N/A	N/A	N/A	N/A	N/A
115	1A	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
116	---	---	---	---	---	---	---	---	---	---	---
117	5A	2	1	2	2	N/A	N/A	N/A	N/A	N/A	N/A
118	---	---	---	---	---	---	---	---	---	---	---
119	2A	2	2	2	1	N/A	N/A	N/A	N/A	N/A	N/A
120	2A	>10	>10	>10	>10	>10	>10	>10	>10	>10	>10
121	15A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
122	1A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
123	1A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
124	5A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
125	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
126	1A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
127	1A	2	1	2	1	N/A	N/A	N/A	N/A	N/A	N/A
128	2A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
129	1A	2	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A
130	1A	1	1	1	1	N/A	N/A	N/A	N/A	N/A	N/A

As shown in table 45, the initial test (test 1) shows that 74 out of 100 (74%) functional breakers failed to trip within the specified time of 10 seconds. None of the circuit breakers had open circuit faults (a failure in a safe manner), which was also considered nonfunctional when calculating the percent of circuit breakers out of specification. As shown in table 46, the initial

test (test 1) shows that 3 out of 94 (3.2%) functional circuit breakers failed to trip within the specified time of 2 seconds for 500% overload. The same three circuit breakers failed to meet timing specifications after test 4, and at the end of test 10, only 1 out of 94 (1.1%) of the functional circuit breakers did not meet specifications. Twelve out of 94 (12.8%) had open circuit faults (test 1), which is a failure in a safe manner.

Additional tests reveal interesting characteristics of the circuit breakers. Analysis of tests 1 through 4 indicated that some of the circuit breaker performances improved as the number of the tests increased. For the 200% overload test, 33 circuit breakers (numbers 1, 8, 16, 17, 19, 21, 22, 23, 24, 29, 31, 38, 42, 56, 58, 76, 80, 81, 82, 84, 90, 94, 95, 99, 101, 104, 106, 109, 114, 122, 123, 127, and 130) went from either failing or open circuit in test 1 to passing by test 4. For the 500% overload test, none of the circuit breakers went from open circuiting in test 1 to passing by test 4. Tests 5 through 10 were performed on selected circuit breakers whose trip times were inconsistent in order to allow the circuit breaker to stabilize and to verify that the improvement in performance was a result of manual cycling. At the final test (test 10), the number of circuit breakers that failed to trip within the specified time had dropped from 73 (test 1) to 15 for 200% overload, providing a 21% reduction in failures. The number of circuit breakers with an open circuit fault was 12 (12%). For the 500% overload, the number of circuit breakers that failed dropped from three (test 1) to two (test 10), resulting in 33% reduction in failures.

As seen from the data in this report, the percent of circuits breakers on aging airplane that fail to meet specifications is moderate (11.5% for 200% overload and 2.1% for 500% overload). However, the data in this study also suggests the circuit breakers can extend their functional lifetimes if manual cycling of the circuit breakers is part of the routine maintenance. This is evident in the data by the reduction of failures as the circuit breaker is cycled.

Table 45 shows the experimental results for 200% current overload. Also shown in the table is the current rating for each of the circuit breakers and the trip times for ten tests. The numbers in red indicate a trip time that exceeds the manufacturer's specification of 10 seconds. Each of the circuit breakers was tested four times, and those that had unstable trip times or that were out of specification were tested an additional six times.

Table 46 shows experimental results for the 500% current overload. Also shown in the table is the current rating for each of the circuit breakers and the trip times for ten tests. The numbers in red indicate a trip time that exceeds the manufacturer's specification of 2 seconds. Each of the circuit breakers was tested four times, and those that had unstable trip times or that were out of specification were tested an additional six times. Due to the high current rating of nine of the circuit breakers (numbers 27, 32, 43, 48, 59, 87, 105, 110, and 121), they were not tested at 500% overload because of equipment limitations.

4. SUMMARY.

To determine if potential continuing airworthiness problems exist for the small airplane fleet as a function of the aging process, and to assess the ability of current inspection programs to detect defects that might compromise airworthiness, the FAA established a research program to conduct a destructive evaluation of four aged airplanes (two Cessna 402s, a Piper Navajo Chieftain, and a Beechcraft 1900D) used in commuter service. The intent of the program was to

provide insight into the condition of a typical aged airplane, to see if a correlation exists between its maintenance history and current condition from a safety of flight perspective and to assess maintenance and inspection program's capabilities to detect defects that might pose a threat to the airworthiness of an airplane. This document provides findings in a summary report for the teardown evaluation of a 1993 Beechcraft 1900D airplane in support of the research program. The results provide information for use in future investigations into the aged small airplane fleet and to determine if additional research is required to address specific problems observed (if any). Specific observations are made regarding findings discovered during the teardown evaluation of the Beechcraft 1900D.

The destructive evaluation of this commuter-class airplane was divided into two phases – inspection and teardown examination of the airframe. During the inspection phase, three tasks were performed: a survey of the airplane maintenance records, routine visual inspections of the airframe, and additional inspections of the airframe using other NDI techniques, as prescribed by Raytheon's service and SIMs for the Beechcraft 1900D. The maintenance records survey provided information on the airplane maintenance history for correlation of maintenance practices to airplane condition, while the inspections determined the condition of the airplane based on normal maintenance activity.

The teardown examination involved disassembly of the airframe and major airplane sections, a structural assessment using alternative NDI techniques, circuit breaker testing, microscopic examination of critical and suspect areas, and fractographic analysis of selected cracks and areas of corrosion. For the intent of this teardown evaluation, which only covered structural inspections and examinations, all airplane systems' components and wiring were previously removed prior to disassembly. The disassembly was performed in order to provide full access to all critical structural areas on the airplane. The structural assessment using alternative NDI techniques was conducted on primary structure prior to disassembly. The microscopic examination of suspect and critical structural areas provided verification and detailed quantification of the extent of damage found during the structural inspections, structural assessment using alternative NDI, and disassembly of the entire airframe. Fractographic analysis is used to determine the failure mode of selected cracks as well as to provide a more detailed characterization of cracks and areas of corrosion.

4.1 SUMMARY OF INSPECTION PHASE.

In the inspection phase, the survey of the airplane maintenance records provided information on the airplane maintenance history for correlation of maintenance practices to airplane condition. The visual inspection of the airframe along with the structural inspections determined the condition of the airplane based on normal maintenance activity. The airplane selected for destructive evaluation was a 1993 Beechcraft Model 1900D (tail number N856CA). This airplane was registered under one tail number, and it was operated by the same owner. Primarily used for commercial flights on the East Coast, the airplane accumulated 15,203.9 hours. A number of SBs, ADs, and major repairs were completed on the Beechcraft 1900D airplane. Several of these documents were reviewed in detail concerning their impact on the airworthiness of the airplane, which included an engine truss inspection, a wing spar inspection, and the inspection of WS 124 for biocorrosion.

Most of the flaws found during the visual airframe and structural inspections on the Beechcraft 1900D were deemed minor, meaning that no further maintenance action was required. Only four findings were deemed noteworthy by certified airframe inspectors. These findings included multiple cracks on the escape hatch gussets, corrosion on lower antenna surfaces, and numerous minor damage and wear. Structural inspection manual requirements consist of visual, eddy-current, liquid penetrant, and magnetic particle testing. Only visual and eddy-current tests were performed on the wings, empennage, and fuselage of the Beechcraft 1900D airplane. Damage and wear were identified in several areas, including the forward fuselage nose compartment, horizontal stabilizer skins and spars, wing spar caps, and various area of wing and fuselage skin.

4.1.1 Maintenance Records Review.

A survey of the airplane maintenance records took place in an attempt to correlate airplane condition with airplane usage and maintenance history. Maintenance logbooks, SBs, ADs, and FAA 337s forms for major repairs and modifications were reviewed in this survey. The survey of the airplane records for the Beechcraft 1900D serial number UE-0066 was completed using data obtained from the following resources:

- Airframe Log Books
- AAIP
- FAA Registry Databases
- NTSB Databases
- Beechcraft 1900D Maintenance Manual and SIMs

4.1.2 Airframe Structural Routine Visual Inspections.

The Beechcraft 1900D airframe visual inspections, listed in the Beechcraft 1900D SIM, were divided into three main groups: the wing, the fuselage and the empennage. All routine visual inspections were performed by licensed airframe mechanics under the supervision of a licensed airframe powerplant mechanic with inspection authorization. Two hundred twenty-one separate visual inspections were performed on the Beechcraft 1900D. The intent of these inspections was to find all possible visual defects normally discovered during routine inspections, then document each defect's severity and location. The inspection concentration was structural only; no system components or wiring inspections were performed for this particular project. Due to the airplane having a pressurized fuselage, the team looked very closely at every accessible structural component for cracks, corrosion, or defects that may have possibly affected airworthiness. This inspection methodology led to a fairly large number of documented flaws. Table 47 summarizes the number of inspections and inspection findings on the airframe. There are 114 inspection areas listed in the wing section of the SIM, 65 in the fuselage, and 42 in the empennage group. Of the inspection findings in these areas, only 49 of 194 findings were determined to be noteworthy, while the remaining 145 findings were deemed minor by airframe mechanic inspectors. With aged airplane, flaws such as minor cracks, scratches, dents, paint chips, and slight corrosion are to be expected and pose no immediate threat to the safety of the airplane. In addition to dents and areas of missing paint, slight to moderate corrosion was noted on a majority of the screws on the airplane. All defects were recorded by location relative to the airplane coordinate system, by RWS, LWS FS, WL, RBL or LBL, as established in the Beechcraft 1900D Maintenance Manual.

Table 47. Inspection Findings

Airplane Section	Number of Inspections	Number of Findings	Noteworthy Findings
Wing	114	143	14
Fuselage	65	27	19
Empennage	42	24	16

4.2 SUMMARY OF TEARDOWN EXAMINATION PHASE.

During the teardown examination phase, all airplane structural components were individually removed during disassembly, which then provided full access to all critical structural areas on the airplane. Inspection of the airplane structural components assisted in determining if any aging effects were related to the airplane structure. The microscopic examination of suspect and critical structural areas provided verification and detailed quantification of the extent of damage found during the visual structural inspections and disassembly of the entire airframe. Fractographic analyses were performed on selected structural defects to include the center wing support angles and the escape hatch gussets.

During this research program, alternative NDI techniques were implemented to assess the primary airplane structure beyond the structural inspections prior to teardown. The wing, horizontal stabilizer, and vertical stabilizer spars were inspected using two eddy-current-based inspection techniques capable of detecting surface and subsurface cracks and areas of corrosion. The sliding probe is capable of detecting cracks in up to three layers of metal, while the MOI can detect cracks and corrosion in multiple layers. The sliding probe, tap tests, and MOI were used on the fuselage. The primary purpose of these inspections was to locate additional defects in the airframe using alternative NDI techniques prior to disassembly. These techniques are not called out in the Beechcraft 1900D SIMs, and they are not typically used for inspection on small airplanes. Therefore, no procedures had been established or validated for using these techniques on the Beechcraft 1900D. Although a few indications were identified in the airframe using these alternative NDI techniques, the teardown examination confirmed that no additional defects were found.

4.3 STRUCTURAL TEARDOWN EXAMINATION RESULTS.

Of the 1432 parts inspected during the teardown examination, 172 relevant defects were identified and characterized and are listed in table 48.

Table 48. Teardown Examination Summary

Airplane Section	Total Number of Parts Inspected	Cracks	Corrosion	Other Damage	Total Number of Defects
Left Wing	42	0	13	0	13
Center Wing	76	4	15	0	19
Right Wing	41	0	16	0	16
Fuselage	1082	28	76	11	115
Horizontal Stabilizer	62	5	0	0	5
Vertical Stabilizer	39	3	0	1	4
Total	1432	40	120	12	172

During the teardown examination of the fuselage, 1082 parts were inspected and 115 relevant defects were identified and characterized. There were 28 cracks recorded on the fuselage, along with 76 areas of corrosion, and 11 instances of other damage such as wear. Multiple cracks were characterized on numerous escape hatch gussets ranging from 0.26 to 0.032 inch in length. Additional cracks were characterized on seat track frames, fuselage frames, and bulkhead frames. Multiple areas of corrosion were found on the forward fuselage seat tracks, severe corrosion was found on the mid fuselage frame assembly, and light to moderate corrosion was found on multiple lower antenna mounts.

Of the 83 parts inspected during the teardown examination of the left and right wings, 29 relevant defects were noted and characterized. Twenty-nine areas of light to moderate corrosion were found for both wings combined, but no relevant cracks or noteworthy damage was found on either the left or right wings during the examination. Both the left and right wings showed multiple areas of light to moderate corrosion on the front spar lower caps. Small quantities of light corrosion were frequently observed throughout numerous areas of both the left and right wings.

Of the 76 parts inspected during the teardown examination of the center wing, 19 relevant defects were noted and characterized. These defects included 4 cracks and 15 areas of corrosion, with no areas of noteworthy damage recorded on the center wing. Two significant open bend radius cracks were found on both left and right angles, measuring 1.68 and 1.63 inches, respectively. During postdisassembly examination, severe to moderate corrosion was found on numerous parts, with three areas considered as relevant; all other corrosion areas were classified as light corrosion.

During the teardown examination of the horizontal and vertical stabilizers, 101 parts were inspected, and 8 relevant defects were identified and characterized. Five cracks were recorded on the horizontal stabilizer tee assembly, along with multiple areas of light corrosion on the both spar assemblies. Multiple areas of light corrosion were recorded throughout the vertical stabilizer, and three cracks were reported, two located on ribs and another located on the outboard edge of a rib hole. One area of wear was found on the lower forward web section, classified as relevant.

APPENDIX A—AIRWORTHINESS DIRECTIVES

Below are detailed descriptions of the Airworthiness Directives (AD) noted in table 2.

AD 94-20-05: This action requires inspecting the hot battery bus fuse assembly for proper wiring, correcting the wiring if incorrect, and modifying the wiring to add a redundant power source for the hot battery bus. This action results from a report of the hot battery bus bar wrongly installed on the lower (load) side of the hot battery fuse assembly on one of the affected airplanes. Correct installation is the upper (power) side of the circuit. The actions specified by this AD is intended to protect from overloads to either circuit connected to the hot battery bus from overloads, which, if not protected, could result in loss of certain emergency equipment.

AD 95-02-17: This AD requires inspecting (one time) the elevator trim tab control cables at the top of the vertical stabilizer to ensure that cables (at the left, right, and crossover pulleys) are correctly routed around the pulleys, within the cable guide pins, and are not contacting any structure; and replacing any cable that is incorrectly routed or chafed. The actions specified by this AD are intended to prevent in-flight separation of the elevator trim tab control cable caused by misrouting, which could result in loss of control of the airplane.

AD 95-14-02: This action requires an additional modification to the plumbing of the instrument air system of the Models 1900 and 1900C airplanes, and adds the Model 1900D airplanes to the applicability. Eight reports of moisture freezing in this system on airplanes with the modification required by AD 91-24-15 incorporated prompted this action. In addition, recent testing on the Model 1900D indicates that the design of the instrument air system on these airplanes are also conducive to moisture freeze-ups. The actions specified by this AD are intended to prevent ice formation in the plumbing of the instrument air system, which, if not detected and corrected, could result in aerodynamic problems and subsequent loss of control of the airplane.

AD 95-26-14: This action will require inspecting the cabin partition to ensure that a right-hand forward partition bracket exists on certain airplanes, installing this bracket if it does not exist, and improving the right-hand forward partition installation on all affected airplanes. The actions specified by this AD are intended to prevent cabin partition failure because of a structural deficiency in the bracket or if the bracket is not installed, which, if not detected and corrected, could cause passenger injury if the partition could not withstand the load incurred with the baGougeage compartment loaded to its 250-pound limit.

AD 96-09-13: This action requires revising the Airplane Flight Manual (AFM) to provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions, and to limit or prohibit the use of various flight control devices. This amendment is prompted by results of a review of the requirements for certification of the airplane in icing conditions, new information on the icing environment, and icing data provided currently to the flight crews. The actions specified by this AD are intended to minimize the potential hazards associated with operating the airplane in freezing rain or freezing drizzle conditions by providing more clearly defined procedures and limitations associated with such conditions.

AD 96-15-01: This AD requires immediately pulling and banding the circuit breakers leading to the windshield heat control on both the pilot and co-pilot sides, inserting a copy of the priority letter AD into the Limitations section of the Airplane Flight Manual (AFM), and fabricating and installing a placard instructing the pilot to avoid flight into known icing conditions. Reports of smoke and fire in the cockpit on two Beechcraft Model 1900D airplanes caused by a high resistance short circuit condition in the heated windshield wiring prompted the action. The actions specified by this AD are intended to prevent smoke and fire around the forward edge of the glare shield in the cockpit, which could result in loss of control of the airplane.

AD 96-22-12: This action requires inspecting (one time) the fuel filter assemblies to detect any bypass valve that is glued shut. If a bypass valve is glued shut, the AD requires replacing the associated fuel filter assembly. Three in-flight occurrences in which the low fuel pressure light illuminated prompted this action. In each of the instances, a bypass valve on the affected airplane engine was glued shut with anaerobic thread lock adhesive and when the fuel filter became cloGougeed, proper fuel flow to the engine was not obtained. The actions specified by this AD are intended to prevent lack of fuel to the engine and eventually engine shutdown caused by a cloGougeed fuel filter and a contaminated fuel filter bypass valve.

AD 97-03-01: This action requires replacing the right-hand exhaust stack for both the left and right engines. This action results from reports of wing skin damage (with associated fuel seepage) and cabin window damage caused by the heat of the right-hand exhaust stacks on the affected airplanes. The actions specified by this AD are intended to prevent wing skin de-bonding or warping of the cabin windows because of the heat generated by the engines' right-hand exhaust stacks.

AD 97-10-14: This action requires inspecting the stabilon attachment angles for the correct thickness, repetitively inspecting for cracks, and replacing the attachment angles that are the incorrect thickness with ones of the correct thickness. Reports of the affected airplanes having the incorrect size stabilon attachment angles prompted this action. The actions specified by this AD are intended to prevent separation of the stabilon from the airplane, which could cause loss of airplane stability during flight.

AD 97-15-13 R2: This amendment revises AD 97-15-13 R1, which currently requires installing lubrication fittings in the air stair door handle and latch housing mechanisms on certain Beechcraft Models 1900, 1900C, and 1900D airplanes. Since the issuance of AD 97-15-13 R1, Raytheon has revised the applicable service information to correct the reference to the number of parts each owner/operator of the affected airplanes should order and to change an incorrect reference to a maintenance manual. This AD retains the actions of AD 97-15-13 R1, and incorporates the revised service bulletin into the AD. The actions specified by this AD are intended to continue to prevent moisture from accumulating and freezing in the airstair door handle and latch housing, which could result in the door freezing shut and passengers not being able to evacuate the airplane in an emergency situation.

AD 97-25-03: This AD requires amending the Limitations Section of the airplane flight manual (AFM) to prohibit lifting or positioning the power levers below the flight idle stop while the airplane is in flight. This AD results form numerous incidents and five documented accidents

involving airplanes equipped with turboprop engines where the propeller beta was improperly utilized during flight. The actions specified by this AD are intended to prevent nose down pitch and a descent rate leading to airplane damage and injury to personnel caused by the power levers being positioned below the flight idle stop or the power levers being lifted while the airplane is in flight.

AD 97-26-15: This AD requires lubricating the main landing gear actuator rod ends and eventually replacing these rod ends with Teflon-lined rod ends. The AD results from reports of in-flight separations of the rod end that attaches to actuator to the arm of the main landing gear drag braces assembly on two of the affected airplanes caused by excessive friction in the rod end bearing. The actions specified by this AD are intended to prevent actuator rod end failure caused by excessive friction in the rod end bearing, which could result in the inability to lower the main landing gear or result in landing gear collapse during landing.

AD 98-19-12: This AD requires inspecting and repairing the radio switching panel relay printed circuit board (PCB) and the nose avionics wire harnesses, and replacing the existing A017 component PCB with a new A017 component PCB that has internal over-current protection fuses. Several reported incidents of loss of use of the pilot/co-pilot intercom system, VHF communications system, and public address system while in flight prompted this action. The actions specified by this AD are intended to prevent the loss of pilot and co-pilot intercom, VHF communications, and passenger address system, which could result in loss of all communication during critical phases of flight.

AD 98-13-11: This action requires modifying the airplane by incorporating Raytheon Kit No. 129-5200-1, "Ground Fine Switch Installation Kit". This action is the result of design analysis during certification of 5.5 degree approach landings of the Model 1900D airplanes. The actions specified by this AD are intended to prevent a loose or misriGougeed ground fine switch, which could result in very hard landings causing structural damage to the airplane and possible passenger injury.

AD 98-21-20: This AD requires either modifying the existing exterior placards with door operating instructions installed in accordance with AD 97-04-02; or installing new exterior placards with operating instructions for the airstair door, cargo door, and emergency exits, as applicable. This AD results from reports of the placards (required by AD 97-04-02) covering the atmospheric vents for the cabin door differential pressure lock. The actions specified by this AD are intended to continue to assure that clear and complete operating instructions are visible for opening the airstair door, cargo door, or emergency exits, and to prevent improper operation of the cabin door differential pressure lock caused by the placards blocking the atmospheric vents.

AD 98-25-10 R1: This amendment will allow an owner/operator (pilot) to determine if the locking mechanism is engaging properly and will require replacing the buckle-half of the seat restraint system, if necessary. This amendment is prompted by a determination made by the FAA that pilots may perform the one-time check of the locking mechanism and that only affected seat restraint systems manufactured between March 1997 and November 1998 must be checked. The actions specified by this AD are intended to prevent failure of the seat restraint

system due to the buckle assembly locking mechanism not engaging properly, which could result in the seat restraint system failing to properly secure the occupant during turbulence or landing.

AD 98-26-16: This AD requires modifying the emergency exit doors and installing interior and exterior placards on each of the emergency exit doors. Difficulty in opening the emergency exit doors prompted this action. The actions specified by this AD are intended to prevent passengers and crew from not being able to open the emergency exit doors during an airplane emergency, which could result in passenger and crew injuries.

AD 99-01-03: This AD requires repetitively inspecting the outboard flap support roller bearings and flap attachment brackets for indications of contact (wear), inspecting for elongated holes in the flap attachment brackets, repairing or replacing any part showing wear, and replacing any bracket with elongated holes. AD 97-14-16 was the result of five incidents where the flap roller bearings rubbed on the flap attachment brackets and resulted in aileron interference. This AD retains the repetitive inspection requirement of AD 97-14-16, but reduces the number of ground-air-ground (GAG) cycles allowed between inspections and lowers the total number of accumulated GAG cycles allowed before mandatory accomplishment of the initial inspection. This AD also provides the option of replacing the outboard flap roller bearings with parts of improved design as terminating action for the repetitive inspection requirement. The actions specified by this AD are intended to prevent asymmetric flaps, jammed flaps, and/or possible interference between the flap and the aileron, which could inhibit aileron travel and result in possible loss of roll control of the airplane.

AD 99-04-08: This AD requires inspecting the main landing gear hydraulic actuators to determine whether a certain Frisby Aerospace actuator is installed, and reworking or replacing any of these Frisby Aerospace actuators. This AD is the result of reports of fatigue cracks in the end cap of main landing gear hydraulic actuators manufactured by Frisby Aerospace and installed on the affected airplanes. The actions specified by this AD are intended to prevent the main landing gear from failing to lock down due to the hydraulic actuator cracking and separating, which could result in loss of control of the airplane during landing, taxi, or ground operations.

AD 99-09-15: This AD requires inspecting for interference or inadequate clearance between the flight control mechanism and any component located forward of the instrument panel. If interference or inadequate clearance is found, this AD requires securing all components so that they are clear of the flight control mechanism. This AD is the result of an incident where the electrical/avionics wires made contact with and restricted the control system of the affected airplanes. The actions specified by this AD are intended to prevent any components or wiring from interfering with the flight control mechanism caused by inadequate clearance, which could result in reduced or loss of aileron and/or elevator control.

AD 99-12-07: This AD requires replacing the passenger oxygen container and mask assembly with an improved design passenger oxygen container and mask assembly. This AD is the result of an incident where a passenger had to put on the oxygen mask and the lanyard pin did not automatically pull and initiate oxygen flow during loss of airplane pressurization while in-flight. The actions specified by this AD are intended to prevent the above situation from occurring on

other airplanes, which could result in passenger injury if the lanyard pin is not manually pulled in a timely manner.

AD 99-16-12: This AD requires installing electric elevator trim servo covers. This AD is the result of reports of the affected airplanes leaving the factory without electric elevator trim servo covers installed. If the covers are not installed, moisture could freeze on parts of the electric actuator. This action specified by this AD are intended to prevent failure of the electric elevator trim and difficulty operating the manual elevator trim caused by moisture freezing on parts of the electric actuator installation, which would result in the pilot having to apply constant pressure to the control wheel during flight.

AD 2000-19-04: This AD requires installing a spiral wrap around the wing fuel quantity wiring harness and applying an adhesive sealant to the WiGougeins couplings on the internal fuel tank wiring carry-through conduit. This AD is the result of reports of chafed or shorted wing fuel quantity harness wires on the affected airplanes. These occurrences were found during regular maintenance inspections. The actions specified by this AD are intended to prevent chafing between the wing fuel quantity wiring harness and the internal wing harness supports at each wing rib location, which could cause the fuel quantity indication to become unreliable. This could leave the flight crew without an indication of the amount of fuel the airplane has during flight. The actions are also intended to prevent fuel from leaking through the wiring carry-through conduit and into the wing tip or wheel well area, which could lead to a fire or explosion.

AD 2000-20-07: This AD requires modifying the cockpit voice recorder (CVR) system. This AD is the result of instances where the recording quality of the CVR in the affected airplanes was so poor that the information was practically unrecoverable. The actions specified by this AD are intended to correct substandard quality cockpit voice recordings caused by the configurations of the present CVR system, which could affect air safety if important information that the CVR provides is not available after an accident. This information helps to determine the probable cause of an accident and aids in developing necessary corrective action or design changes to prevent future accidents.

AD 2001-11-03: This AD requires incorporating certain electrical parts to protect cooling blowers. This AD is the result of several reports of circuit breakers failing to protect cooling blowers on the affected airplanes. The actions specified by this AD are intended to protect the blower motor circuit and reduce the possibility of emission of smoke or a burning odor into the cockpit or passenger compartment as a result of a failed or seized blower motor.

AD 2001-18-07: This AD requires installing all four flap flexible shaft assemblies for the correct diagonal wrap and the correct installation. This AD also requires replacing any flap flexible shaft assembly that has an incorrect diagonal wrap or incorrect installation. This AD is the result of several occurrences of flap extension/retraction failures on the affected airplanes due to the inner flexible shaft ends separating or disengaging. The actions specified by this AD are intended to prevent these flap extension/retraction failures due to incorrectly configured flap flexible shaft assemblies. Such failures could result in an asymmetric flap condition during flight if the flap safety switch fails to function properly.

AD 2001-22-16: This AD requires repeated inspections of the engine truss assemblies for cracks, repairing or replacing any cracked engine truss assembly, and installing reinforcement doublers. This AD requires engine truss assembly replacement, periodic inspections and replacements, and the eventual incorporation of a cowling support installation kit as terminating action. The repetitive inspections of AD 95-02-18 will be retained until mandatory engine truss assembly replacement. This AD is the result of continued reports of fatigue cracks found on engine trusses on airplanes in compliance with AD 95-02-18. The actions specified by this AD are intended to detect and correct cracked engine truss assemblies, which could result in failure of the engine truss assembly and consequent loss of airplane control.

AD 2002-23-11: This AD requires checking the airplane logbook to determine if the elevator(s) has/have been removed from the airplane. If the elevator(s) has/have been removed, this AD also requires inspecting the elevator balance weight attachment screws for correct length, and, if necessary, install new bolts that are of the improved design and rebalance the elevator, depending on the results of the inspection. This AD is the result of the elevator balance weight attachment screws and balance weights being improperly installed when balancing the elevator after it had been removed for repair or repainting. The actions specified by this AD are intended to prevent the balance weight attachment screws from becoming loose. Loose screws could come into contact and interfere with the horizontal stabilizer. This interference could restrict elevator movement and result in loss of elevator pitch control.

AD 2003-03-18: This AD requires performing control column sweep and stop bolt inspection to verify full elevator travel to the primary up and down stops and that the stop bold length is not excessive. Re-rig the elevator control system if the airplane does not pass the control column sweep and stop inspections, and do a more detailed inspection at a later time if the airplane does not pass the inspection. This AD also requires reporting the results of certain inspections. This AD is the result of recent ground testing and a review of riGougeing procedures of a Beechcraft Model 1900D airplane, which reveals that the elevator control system could be misriGougeed to restrict elevator travel if current maintenance procedure are not properly followed. In these instances, it may appear to the crew that they have full elevator control movement. However, the elevator may not have full travel. Such restricted travel may remain undetected until the airplane is operated in a loading condition that requires full elevator authority to control the pitch. The actions specified by this AD are intended to detect and correct any misriGougeed elevator control system, which could lead to insufficient elevator control authority and loss of control of the airplane.

AD 2003-04-26: This AD requires inspecting the alternating current (AC) inverter and modify the AC inverter and inverter sync wire shield. This AD is the result of reports that electrical noise causes the inverter to shut down in flight with loss of AC-powered flight instruments. The actions specified by this AD are intended to prevent electrical noise causing the inverter to shut down, which could result in failure of key airplane electrical systems. Such failure could lead to loss of flight instruments during flight.

AD 2003-09-12: This AD requires accomplishing a one-time inspection for missing rivets on certain areas of the airplane and, if necessary, install rivets. This AD is the result of Raytheon identifying several instances of missing rivets on these airplanes. The actions specified by this

AD are intended to detect and correct an under strength condition in the fuselage, which could result in the failure of the fuselage. Such failure could lead to loss of control of the airplane in flight.

AD 2003-20-10: This AD requires making a correction to the elevator trim system maintenance procedures, incorporate a temporary revision to the applicable maintenance manual, and incorporate procedures that will enhance the existing elevator operational check every time maintenance is done on the elevator trim system. This AD is a result of an analysis of the maintenance procedures of the elevator trim system. The FAA is issuing this AD to detect and correct any maintenance-induced problems with the elevator trim system installation before problems occur during operation. Such a condition could lead to difficulties in controlling the airplane or a total loss of pitch control.