



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594
October 17, 2017

Group Chairman's Factual Report

STRUCTURES

CEN16FA276

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A. ACCIDENT INFORMATION

Accident #: CEN16FA276
Location: Joliet, IL.
Date: July 21, 2016
Time: 1620 eastern daylight time Zulu
Airplane: Piper PA30, N7409Y

B. STRUCTURES GROUP

Chairman: Brian K Murphy
National Transportation Safety Board (NTSB)
Office of Aviation Safety (AS-40)
Washington, DC

Member: Damian Galbraith
Piper Aircraft Inc.
Accident Investigator
Vero Beach, FL

C. SUMMARY

On July 21, 2016 about 11:14 central daylight time (CDT), a Piper PA30 airplane, N7409Y, impacted terrain during a descent near Plainfield, Illinois. The commercial pilot was fatally injured. The airplane was destroyed during the impact and subsequent fire. The airplane was registered to and operated by the pilot as 14 Code of the Federal Regulations Part 91 personal flight. Day visual meteorological conditions were reported near the accident site about the time of the accident and the flight was not operated on a flight plan. The flight originated from the Upper Cumberland Airport (SRB), near Sparta, TN and was destined for the Eagle River Union Airport, near Eagle River, Wisconsin.

This report summarizes the on-scene findings and no pictures are presented, as the group chairman was not present for that part of the investigation. The group chairman followed up with two separate examinations of the left wing and those photographs are included in the report.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft Description

N-number:	N7409Y
Airplane Serial Number:	30-470
Airplane Manufacturer:	Piper
Model:	PA30
Airplane Year:	1964
Airworthiness Certificate:	Standard
Approved Operations:	91
Aircraft Type:	Fixed Wing Multi-Engine
Engine Type:	Reciprocating
Airplane Category:	Normal
Number of Engines:	2
Type Certificate	A1BA

2.0 Fire Damage

Much of the airplane was consumed by the post-accident fire except the airframe structure that separated in flight.

3.0 Left Wing (reference Figure 1)

Approximately 83 inches of the outboard wing was separated and found approximately 0.44 nautical miles from the main wreckage. Leading edge skin separations were noted to the separated section of wing. The outboard approximate 68 inches of the left aileron remained attached to the separated section of wing with the aileron balance weight still secured to the aileron. The inboard section of the aileron was separated from the remainder of the structure and was not located within any of the recovered wreckage. No evidence of fire or fire damage was noted to the separated section of wing or aileron. The left tip tank was separated from the outboard section of the wing and was found approximately 0.41 nautical miles from the main wreckage. The tip tank was found breached from impact damage to the leading edge.

The remainder of the left wing remained attached to the fuselage; fire damage was noted to the inboard area of the left wing. The left flap was found separated from its mounts at the main wreckage site and exhibited impact and fire damage along the entire span of the flap. The left engine and nacelle structure were separated from the left wing; refer to "Left Engine" section. The left aileron bell crank assembly remained attached and the bell crank fitting was recovered at the main wreckage site. The aileron control cable attach points to the bell crank were found fragmented from the bell crank assembly. Aileron control continuity was established except where impact separations were noted. The left aileron control cables were found twisted around a push pull cable and the aft wing spar exhibited "saw" marks along the top edge of the part. Fire damage was noted in this area of the wing.

4.0 Left Wing Follow-up Examinations

The upper main spar chords fractured at about wing station 135/136 (reference Figures 2 thru 4 and 7) and lower spar chord at about station 125/126 (reference Figure 5 and 7) and both exhibited evidence of upward and aft bending. An examination of the shear lips on the horizontal legs of the spar chord at each of the fracture locations confirmed the upward bending along with the fractured ends of the horizontal legs of the spar chords deforming in an upward direction. The compression buckling (reference Figure 6), crippling, or aft bending of the horizontal legs of the upper spar chord from about station 95 to 122 and from about station 104 to 122 on the horizontal lower spar chord. The spar chords also exhibited evidence of trailing edge up twisting deformation consistent with the outboard wing rotating counter clockwise about the main the spar when looking inboard (reference Figures 2 and 5). The main spar web was missing from about station 122 to 143 in the area of the aileron bell crank assembly. The rear spar was missing (reference Figures 8 and 9) from about station 130 to 143 in the area of the rear spar aileron hinge fitting. Neither the inboard aileron nor inboard rear spar aileron hinge fitting were recovered. The bell cranks outboard support rib (reference Figures 9 and 10) fractured vertically about six inches aft the main spar attachment and the inboard support was not recovered. The bell crank, the assembly, and the remaining outboard support rib were recovered at the main wreckage site. The inboard 20 inches of the aileron spar in the area of the aileron hinge fitting attachment was not recovered and the inboard twenty inches of the aileron skin panel was recovered separate from both the main wreckage and the outboard wing section. The aileron exhibited evidence of up bending reference Figures 12 and 13). The aileron balance weight cutout exhibited evidence of impact damage from about the 5 o'clock to 12 o'clock positions (reference Figure 14). The rear upper spar chord exhibited evidence aileron cable contact from station 117 inboard to about station 85. The upper wing skin along the rear spar had evidence of a cable cut from about station 116, the aileron hinge location, inboard to about station 92 (reference Figure 15).

The outboard section of the wing is spliced to the inboard section of the wing from about station 143 to about 157 of the main spar. The outboard horizontal leg of the upper spar from about station 135 to 150 was not recovered. In this area, the spar chord is no longer an L section and only has a horizontal leg.

NTSB staff requested that Piper inspect fourteen rivet holes from the area shown in Figure 16 to determine the quality of the rivet installation in this location.

Per the 23560 drawing (reference Figure 17), the fasteners intended to be installed in the concerned holes are AN470AD4-4 rivets, which are classified as solid-shank rivets. Correct installation of these rivets in the assembly is accomplished by slightly expanding the shank while being driven (reference Figure 19).

During normal operation of the aircraft and considering the extreme conditions experienced, primer should have been present in the rivet holes had the rivets been installed correctly, the (reference Figure 20), if present, would have worn off. Since in these holes, it can be said that the rivets in these holes may not have been installed in these holes correctly. A pictorial description of these findings is shown in Figure 22.

Microscopic examination showed that the underlying aluminum grain structure could not be observed due to various build-ups that occurred on these holes over the course of time. Due to this the specimens were stripped of the primer coating and the surface was etched (etching highlights all the surface imperfections and the underlying metal structure).

Following the stripping and etching rotary drill marks were observed in holes, (# 1, # 3, # 4, # 5, # 9, # 10 and # 11) created by a drill bit rotating in the hole. The type design rivets in the holes are solid-shank rivets share the load during normal operation. During installation of these rivets and normal operation the rotary marks created by the drill bit should be disturbed. Since the above-mentioned holes showed clear indications of rotary marks from a drill bit, consistent with the rivets not participating in the load sharing.

A summary of the pre-etched and post-etched microscopy findings is as shown in Figure 21 and Table 1.

Hole #	Rivet Installed Correctly (Yes/No)	Test Proving Improper Rivet Installation (Primer in Hole/Radial Marks)	Hole Reference (Hole Under Consideration/Reference Hole)
1	No	Primer in Hole, Radial Marks	Hole Under Consideration
2	Yes	N/A	Hole Under Consideration
3	No	Radial Marks	Hole Under Consideration
4	No	Radial Marks	Hole Under Consideration
5	No	Radial Marks	Hole Under Consideration
6	Yes	N/A	Reference Hole
7	Yes	N/A	Reference Hole
8	Yes	N/A	Reference Hole
9	No	Radial Marks	Reference Hole
10	No	Primer in Hole, Radial Marks	Hole Under Consideration
11	No	Radial Marks	Hole Under Consideration
12	No	Primer in Hole	Hole Under Consideration
13	No	Primer in Hole	Hole Under Consideration
14	No	Primer in Hole	Hole Under Consideration

Table 1

The left outboard wing underwent a major repair in March of 1978. The following new Piper parts were used for the repair; ribs at stations 108 (23530-02), 108 (23530-06), 120 (20269-00), 120 (23488-02), 120 (23488-06), 135 (20318-00), 143 (20282-00), 143 (20283-00), 169 (20310-04), 197 (20257-06), 197 20275-04), 211 (20272-06), 211 (20274-06), 211 (20274-08) spar assemblies (20252-06) and (20266-02), skin assemblies (20377-56), (20377-46), (23562-10), (20377-58), (22700-12) and (22700-14), flap assembly (22699-00), bracket (20345-00), and fairing assembly (239900-00). The left aileron and tip tank were also replaced with serviceable parts. The left-hand wing center leading edge, center lower wing

skins and the left-hand aileron skin were replaced in November of 2015. Piper Aircraft has no record of these repairs.

5.0 Right Wing

The right wing was found mostly consumed by post impact fire. The right aileron was partially consumed by fire but remained attached to its mounts. The right aileron balance weight was damaged due to impact forces and separated from the aileron. The right aileron bell crank remained attached to the wing; however, the bell crank cable attach horns were fragmented. The aileron drive and balance cables remained attached to the fragmented bell crank horn attach points. Aileron control continuity was established except where impact separations were noted. The right flap was found mostly consumed by fire. The right tip tank was found breeched and separated from the wing.

6.0 Empennage

The empennage was found at the main wreckage site upside down with fire damage noted to the vertical stabilizer, rudder, the stabilator and stabilator trim tab. The rudder though fire and impact damaged, remained attached to the vertical stabilizer. The rudder cables remained attached to the rudder bell crank and to the fragmented rudder pedal assembly. Rudder control continuity was established except where rudder control cables were cut for recovery purposes.

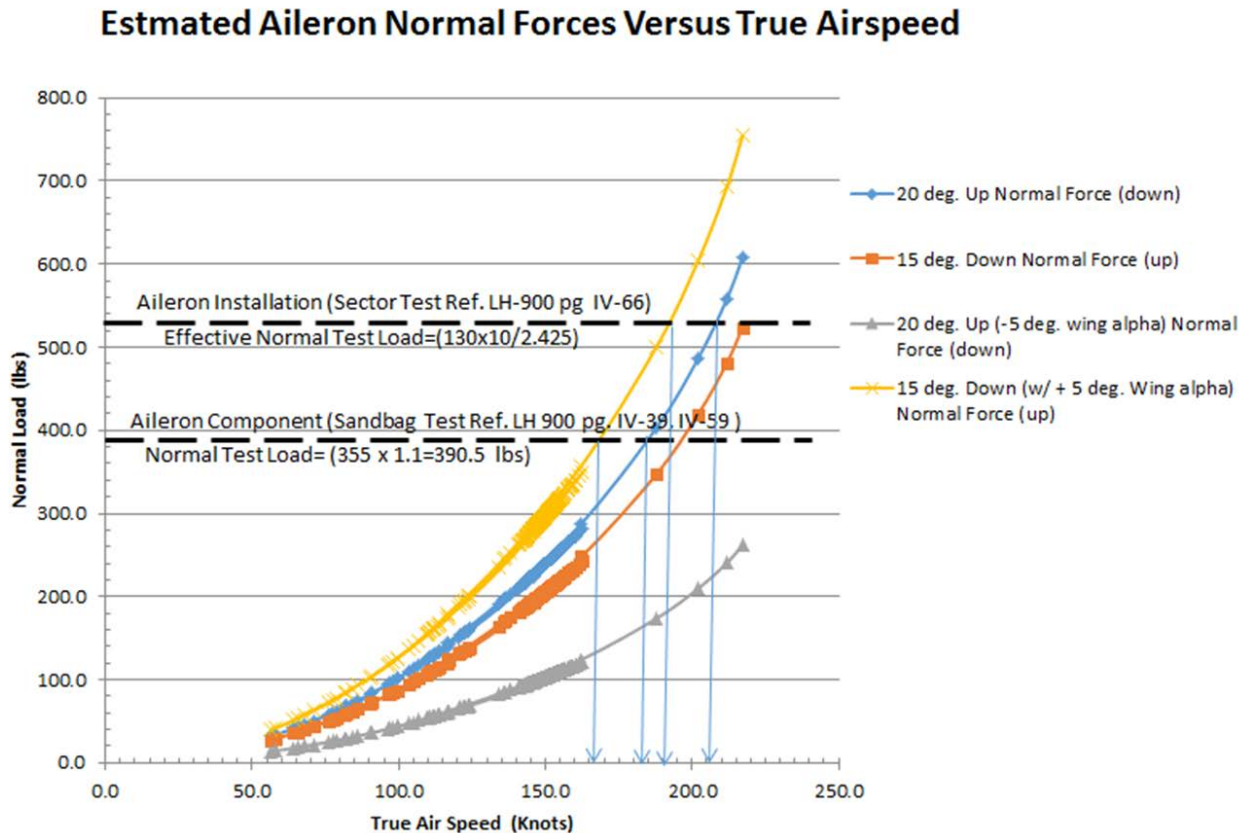
The stabilator remained attached to its mounting points on the fuselage station 258.75 frame. A section of the right stabilator aft of the main spar was separated and found approximately 30 feet to the north of the main wreckage. The separated section of the right stabilator exhibited skin separations at the main stabilator spar and fire damage to the outboard section. The right stabilator trim tab remained attached to the separated section of the stabilator. The outboard section of the attached right stabilator was found consumed by fire. The left side of the stabilator remained attached to its mounts on the fuselage station 258.75 frame and the left stabilator trim tab remained attached to the stabilator. Approximately 30 inches of the outboard section the stabilator was found folded over to the top of the stabilator. Fire damage was noted in this area of the wreckage. The stabilator trim barrel was found with impact and fire damage. The stabilator balance weight was consumed by post impact fire, however, the stabilator control cables remained attached to the stabilator balance weight tube and to the fragmented "T" bar assembly. Stabilator control continuity was established except where control cables were cut to facilitate recovery.

7.0 Fuselage

The fuselage was destroyed by impact forces and was mostly consumed by post impact fire. The instrument panel and all flight instruments including navigation equipment were destroyed upon impact and post impact fire. The "T" bar assembly was fragmented; however, the aileron and stabilator control cables were noted to have remained attached to their respective mounts to the "T" bar assembly. The rudder pedal assembly was fragmented and the rudder control cables were found attached to their respective separated mounts.

8.0 Aileron Loads and Performance Studies

Piper performed a loads analysis for the loads achieved during the descending spiral and determined that at the maximum airspeed achieved the loads on the aileron and its installation would have exceeded the loads that the aileron was tested to during the certification.



The plot demonstrates that for the accident aircraft, the aileron components per type design, at a minimum, should have been structurally capable up to full deflections (down to up) between 166 to 183 knots true, and the aileron installation per type design, should have been structurally capable for full deflection (down to up) between 190 to 206 knots true.

This analytical demonstration is considered adequate given the calculated minimum failure speeds are above the published aircraft usage limits for maximum maneuvering at 135 MPH (117.3 knots) at min. weight and 162 MPH (140.8 knots) at maximum weight as stated in the pilots operating handbook, Report 1269.

Given the plotted speeds, Piper noted:

1. Above these documented limitation speeds there could have been some permanent aileron deformation prior to aileron installation retention failure.

2. Ailerons operated above maneuvering speed limits could enable loadings that can cause aileron and/or aileron retention failure.
3. Given the magnitude of calculated loads occur at speed indicative of the tail end of the profile, the initiating event was not related to aileron failure, and aileron departure is feasible when operated at this very high speed.

Furthermore, the NTSB performance study concluded the following; “At 1108, the airplane began to climb from 8500 ft. to 10300 ft. while losing airspeed. The airspeed dropped below the reported stall speed and at 1111:23 it began to lose altitude and roll left (behavior consistent with aerodynamic stall). The airplane gained speed as it descended, exceeding both the maneuvering speed and never exceed speed, putting it at risk of structural failure. This is consistent with the wreckage pattern indicative of an in-flight breakup.”

Submitted by:
Brian K Murphy

National Resource Specialist
Aircraft Structures

9.0 Figures

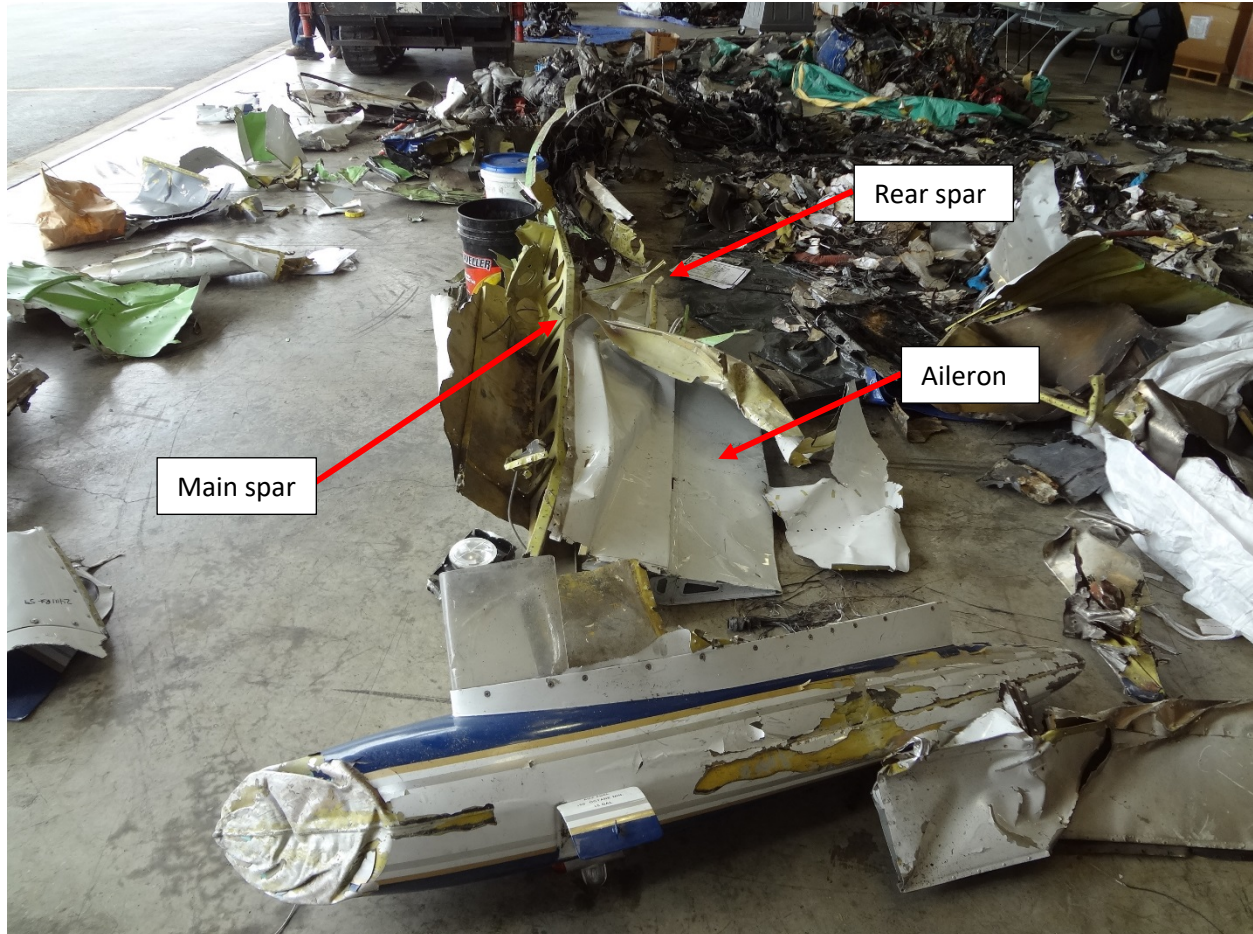


Figure 1 – Left wing looking inboard.

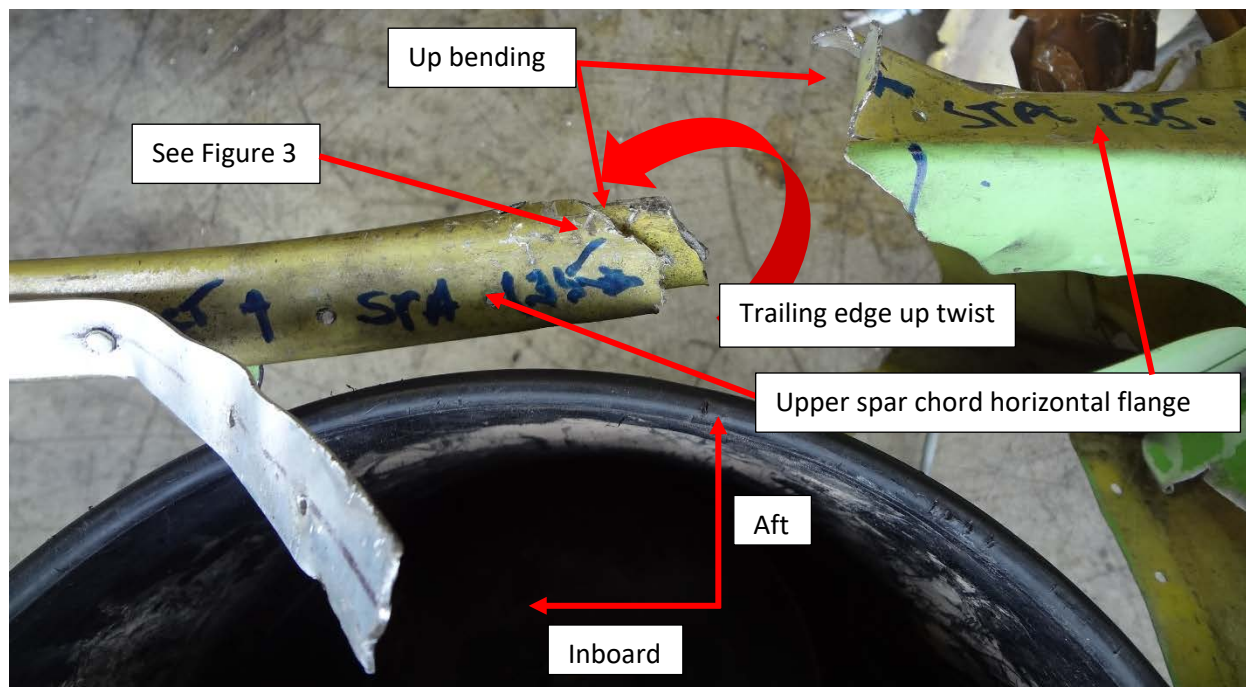


Figure 2 – Left wing main spar upper chord at about station 135.



Figure 3 – Inboard side of left wing upper spar chord fracture at station 135 exhibiting evidence of up bending.



Figure 4 – Outboard section of left wing main spar fracture at station 135.

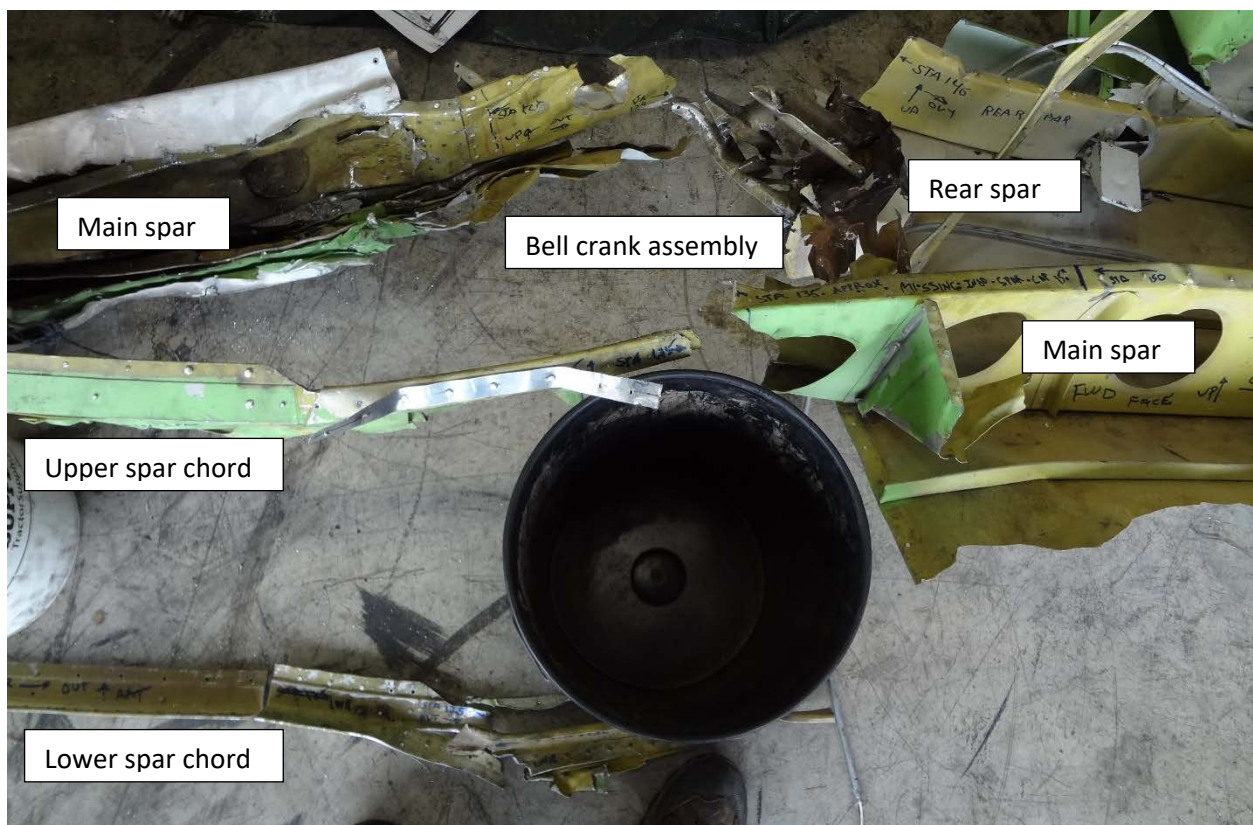


Figure 5 - Overhead view of the left-wing failure area.



Figure 6 – Left wing lower main spar chord fracture at station 125.

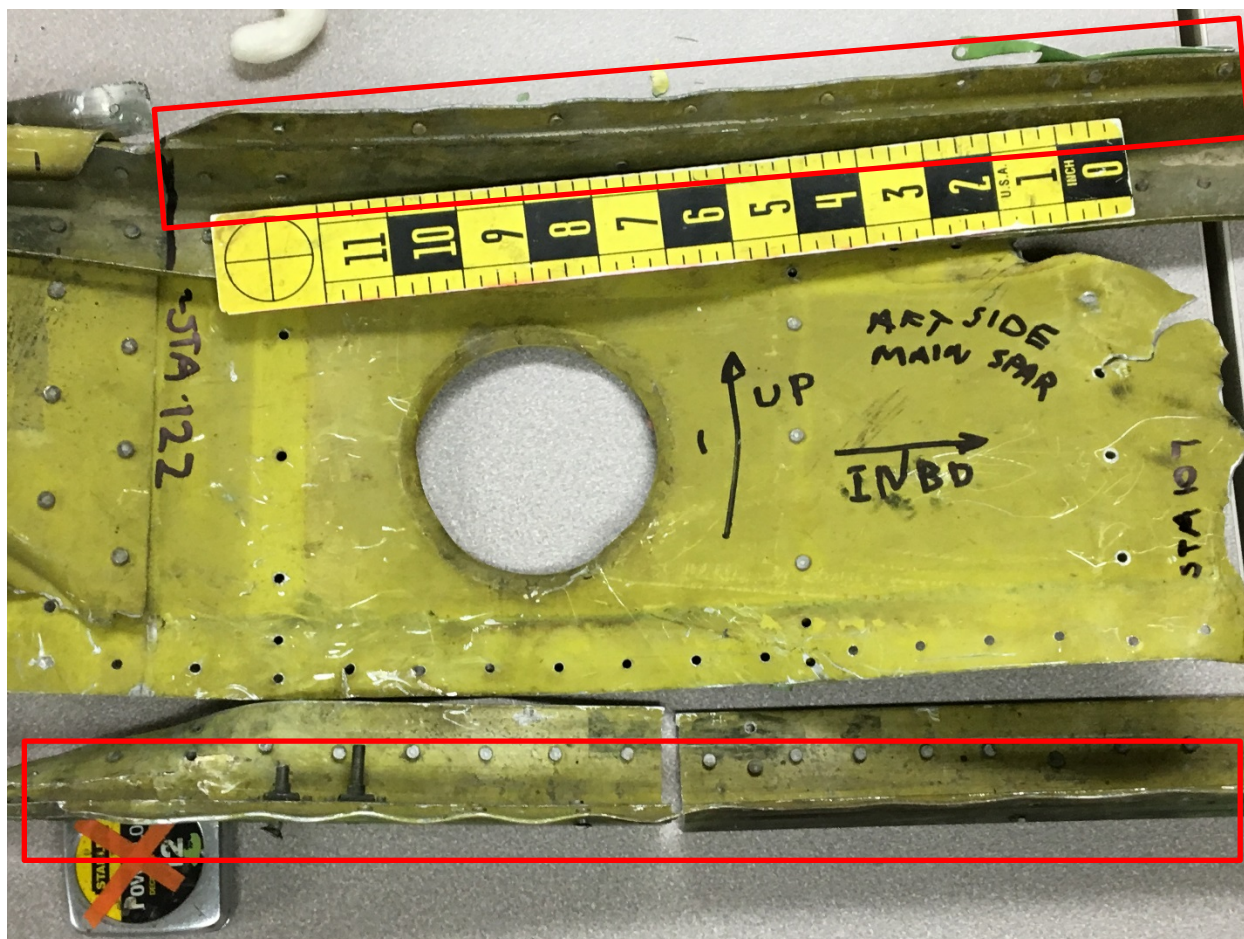


Figure 7 – Left wing upper and lower spar chord compression buckling (crippling) due to aft bending.



Figure 8 – Missing left-wing rear spar and aileron hinge fitting.



Figure 9 – Missing left-wing rear spar in the area of the inboard aileron hinge fitting.

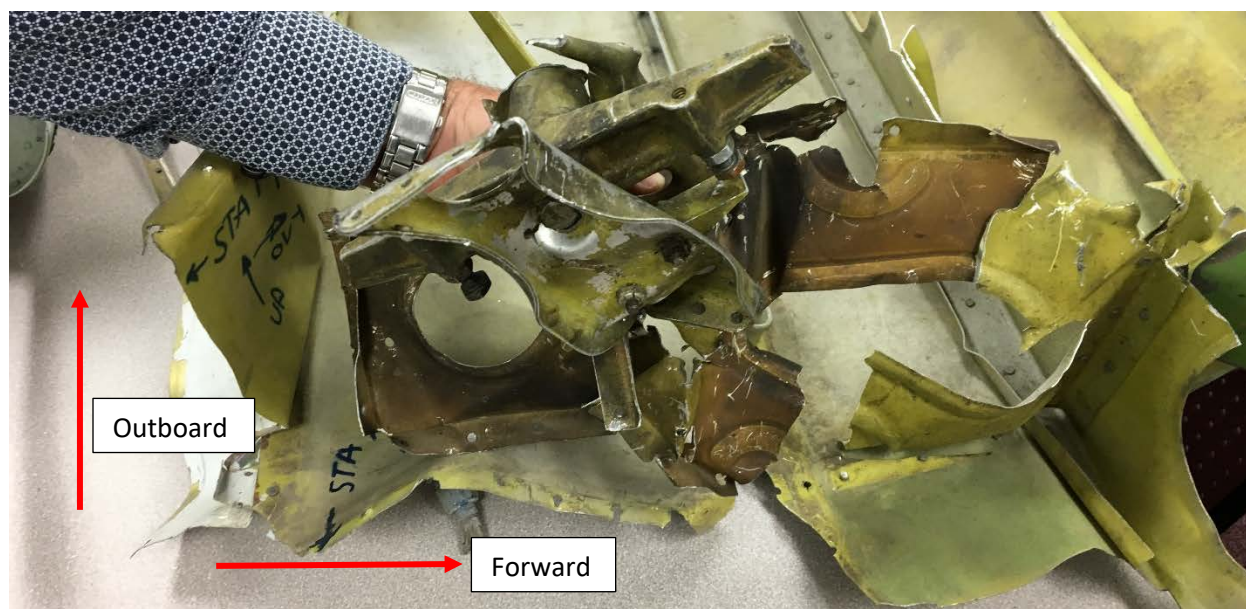


Figure 10 – Left wing bell crank assembly and outboard support rib at about station 143/146.

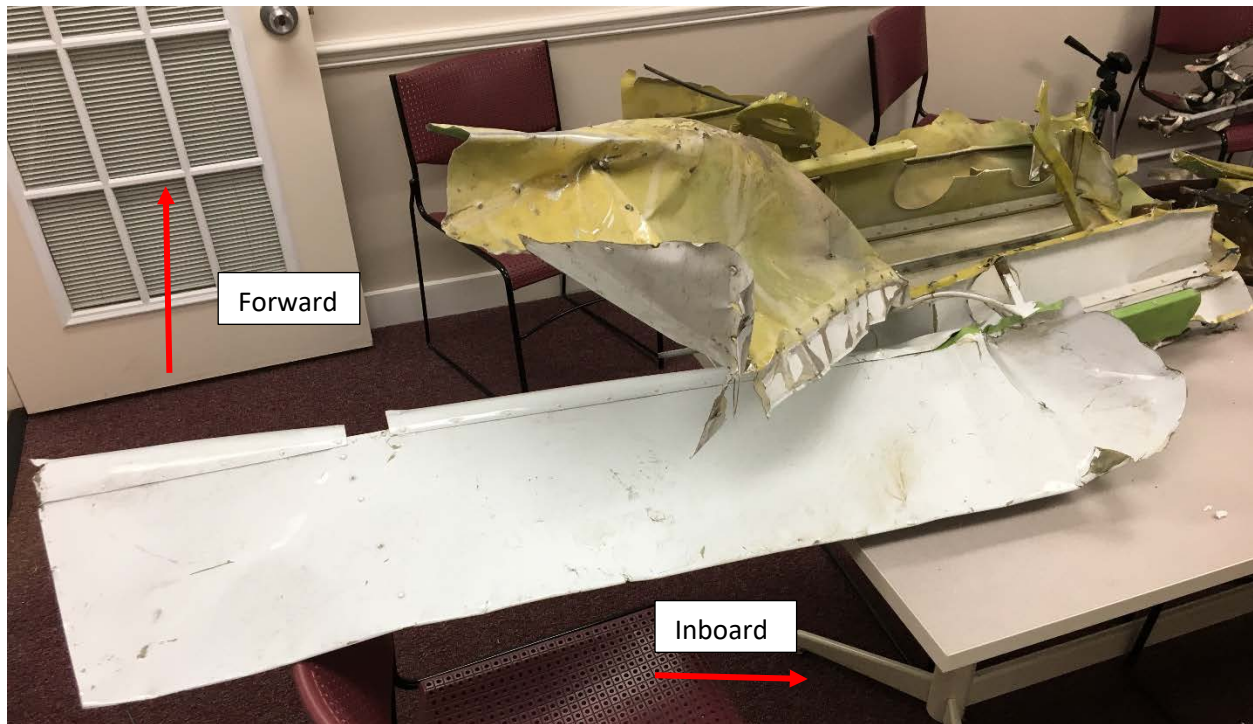


Figure 11 – Left aileron.



Figure 12 – Left aileron with additional skin panel recovered away from the main wreckage and left outboard wing.



Figure 13 - Two additional aileron skin pieces recovered away from main wreckage and outboard left-wing section.



Figure 14 – left wing balance weight cut out damage in rear spar.



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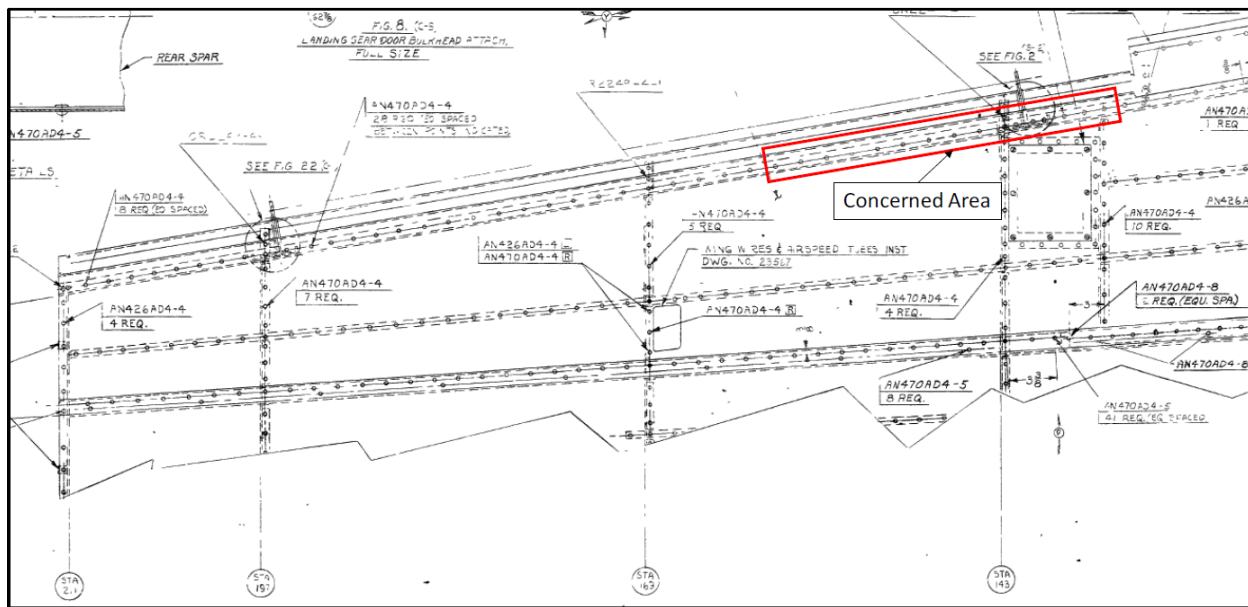


Figure 17 - Overlay of concerned area on drawing 23560

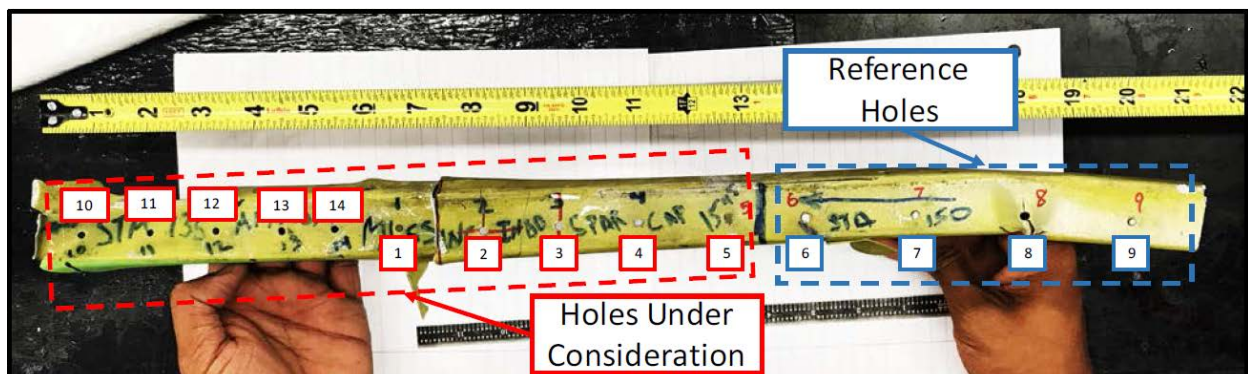


Figure 18 - Destructively separated section under consideration with hole ID

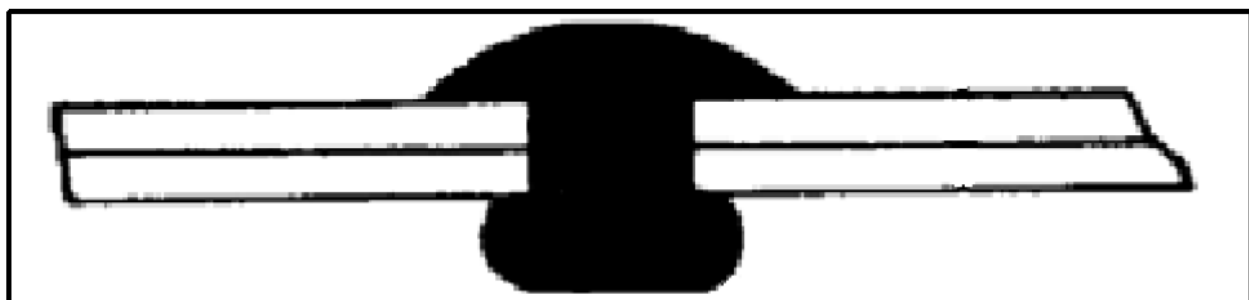


Figure 19 - Pictorial Depiction of a correctly installed solid-shank rivet



Figure 20 – Fastener holes with primer.

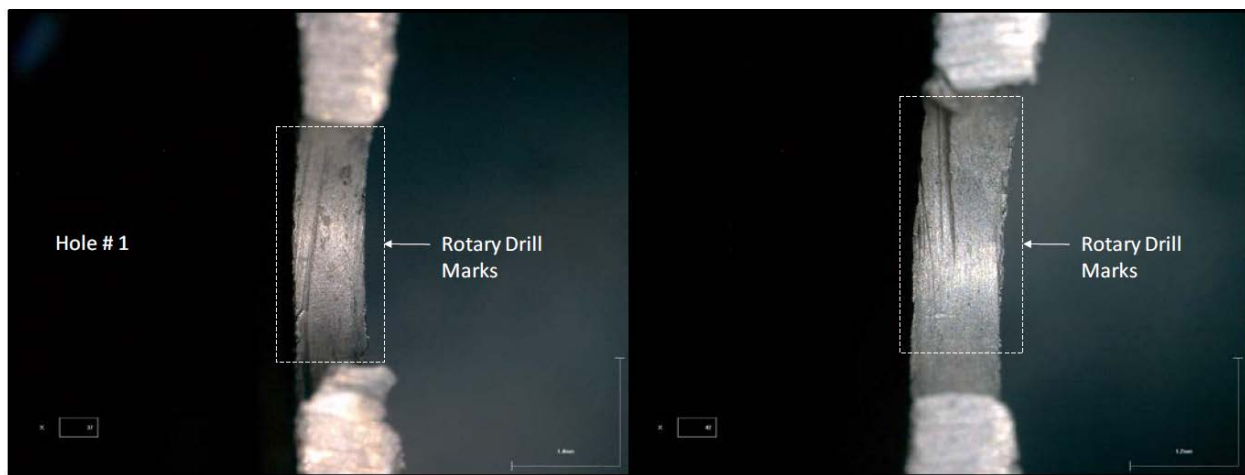


Figure 21 – Typical rotary drill marks after etching in hole #1.

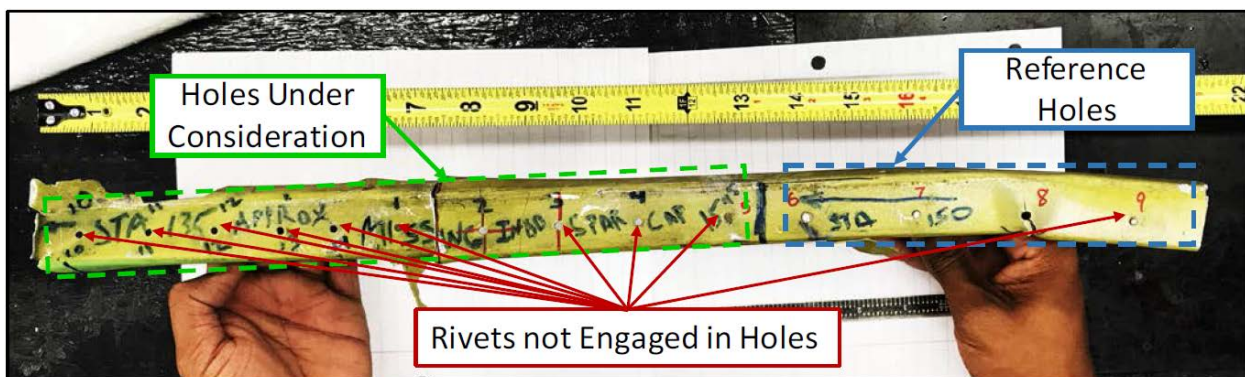


Figure 22 - Pre-etched and post-etched microscopy summary of findings.