National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

ERA24FA300

MATERIALS LABORATORY

Factual Report 24-048

August 7, 2024

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A. ACCIDENT INFORMATION

Location: Palm Beach Gardens, Florida
Date: July 10, 2024
Vehicle: Piper PA-28-161, N81250
Investigator: Daniel Boggs, AS-ERA

B. COMPONENTS EXAMINED

Right wing main spar piece and center wing box piece.

C. EXAMINATION PARTICIPANTS

Specialist — Matthew R. Fox, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

The submitted center wing box piece and right wing main spar piece are shown in figure 1 as received. The right wing main spar upper and lower caps were fractured at the outboard attachment bolt holes. The spar showed general deformation consistent with the wing bending aft relative to the fuselage as shown in figure 2. The spar upper and lower caps had rough, irregular features on slant angles consistent with ductile overstress fractures. A view of the fracture surface on the lower cap is shown in figure 3. The lower cap displayed features consistent with mostly tensile loading whereas the upper cap showed upward bending deformation, a fracture pattern consistent with upward wing bending loads associated with the fracture in addition to the aft bending loads. No evidence of any preexisting cracks or defects were observed associated with the fracture surfaces.

The right wing main spar lower cap was attached to the center wing box with 10 bolts; half located in a spanwise row forward of the spar web, and the other half located in a spanwise row aft of the spar web. For reference, the bolts were labeled by position using the number and letter convention provided in Piper maintenance and service publications with an added letter to denote the left or right wing. The first letter in the bolt labels was R to indicate the right wing. The second letter in the label was a C or D for the row of bolts located forward or aft of the spar web, respectively.[1] The final digit was a number from 1 to 5 indicating the relative position in each row starting with the outboard attachment bolt.

The plate covering the wing attachment hardware was present on the lower surface of the center wing box piece, and when the plate was removed, intact red

[1] Letters A and B are used for labeling attachment bolts associated with the upper cap.

torque paint was observed on each nut. All attachment bolts had a flat head and were marked with an x inside a triangle consistent with Air Force – Navy (AN) standard bolts specified for the wing spar attachment hardware at the time of manufacture.[2]

The main spar lower cap attachment bolts were removed. The torque required to loosen the nut (breaking torque) was measured at each location, including locations RC1 and RD1 that intersected the right wing lower cap fracture, and results are shown in table 1. For reference, the specified installation torque for the attachment bolts is 30 to 32.5 pound feet.

Table 1. Breaking Torque Values

Bolt	Breaking Torque (pound feet)	Bolt	Breaking Torque (pound feet)
RC1	7.6	**RD1**	10.2
RC2	26.3	**RD2**	28.4
RC3	30.6	**RD3**	29.6
RC4	32.8	**RD4**	34.0
RC5	24.1	**RD5**	35.4

During disassembly, most of the bolts required gentle tapping with a hammer and punch to push the bolts out of the respective holes. As bolts were removed, care was taken to note the washer profiles and positions, and relative positions were maintained on the removed bolts as nuts were reattached to the bolt. Each of the bolts had been installed with one washer between the head and the upper side of the doubler and with one or two washers between the nut and the lower skin. All assemblies had washers with rounded and/or squared edges that were installed in the correct orientations and positions as described in Piper Service Bulletin 1366.

A transverse cut was made through the lower cap outboard of the attachment holes to separate the outboard side of the fracture from the remainder of the spar cap piece. The piece was then cleaned using a soft-bristle brush dipped in acetone followed by additional cleaning with an ultrasonic cleaner while submerged in a beaker of acetone. A view of the lower surface after sectioning and cleaning is shown

[2] During inspections completed in accordance with FAA AD 2020-26-16, the outboard two attachment bolts through each main spar lower cap are removed and replaced with bolts in accordance with the applicable Piper Airplane Maintenance Manual (NAS 6606-13 bolts).

in figure 4, and a closer view of the area around hole RC1 is shown in figure 5. The surface around the outboard side of the hole was rough and pitted consistent with fretting damage. A small crack that was partially opened was also observed as indicated. As shown in figure 5, the partially opened crack was oriented in approximately the transverse plane and intersected hole RC1 on the outboard side of the hole aft of the hole centerline.

Additional cuts were made through the lower spar to completely open the crack shown in figure 5 by lab-induced fracture. A view of the lab-induced fracture surface showing the outboard side of the opened crack is shown in figure 6. The crack had a curving boundary with crack arrest features on the fracture surface consistent with fatigue. The fatigue features emanated from an origin area located on the lower surface in the area with fretting damage adjacent to hole RC1. The fatigue crack was up to 0.030 inch deep from the lower surface and was 0.088 inch long in the transverse direction where it intersected the lower surface.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor - Materials

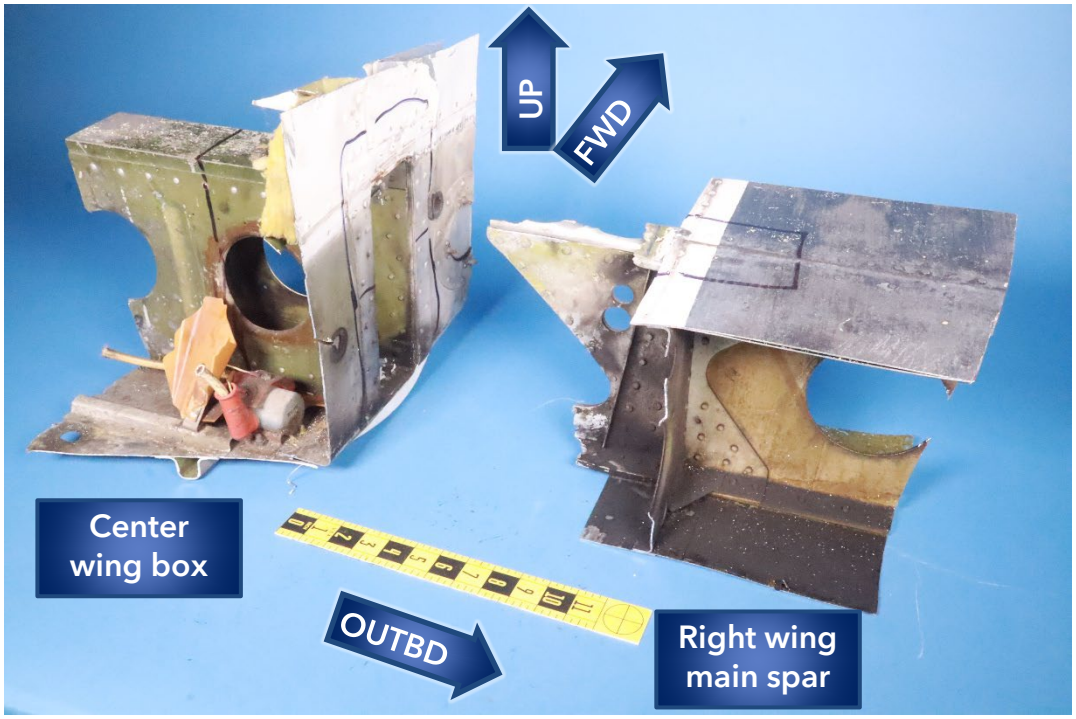

Figure 1. Overall view of the submitted components as received.

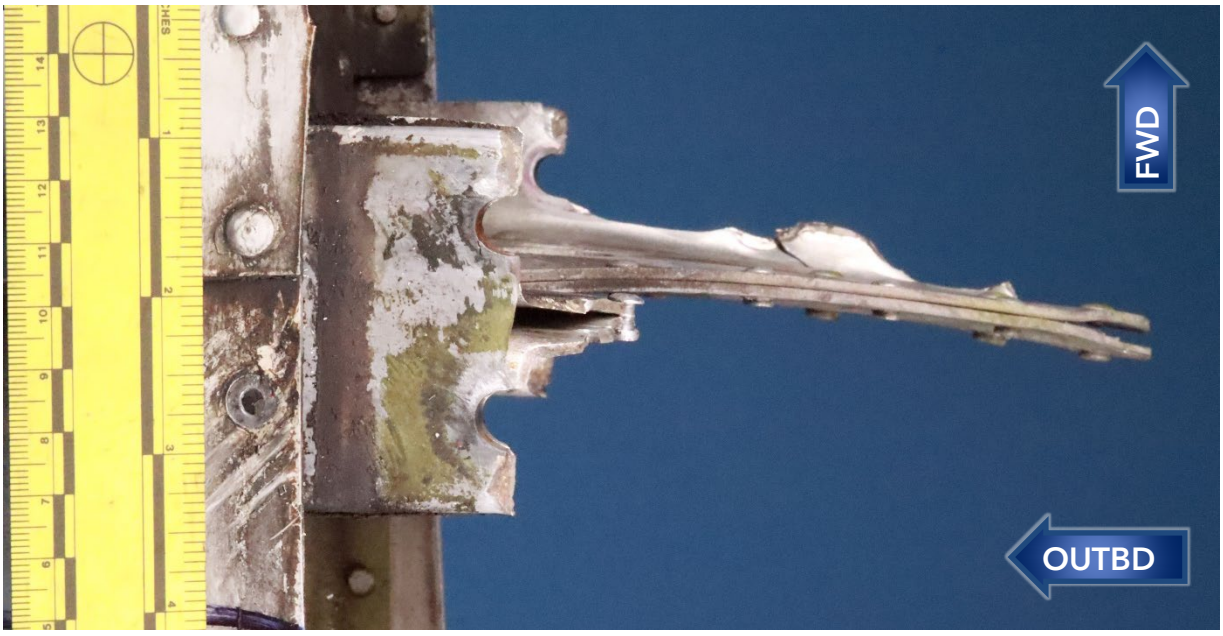

Figure 2. Right wing main spar fracture as viewed looking upward.

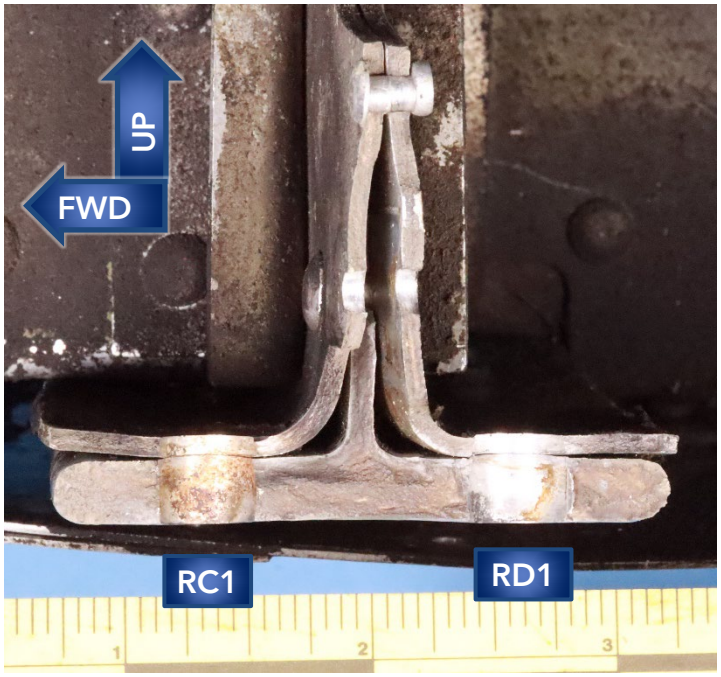

Figure 3. Right wing main spar lower cap fracture surface as viewed looking outboard.

Figure 4. Cleaned right wing main spar lower surface adjacent to the fracture surface. A small partially opened crack intersecting hole RC1 is circled.

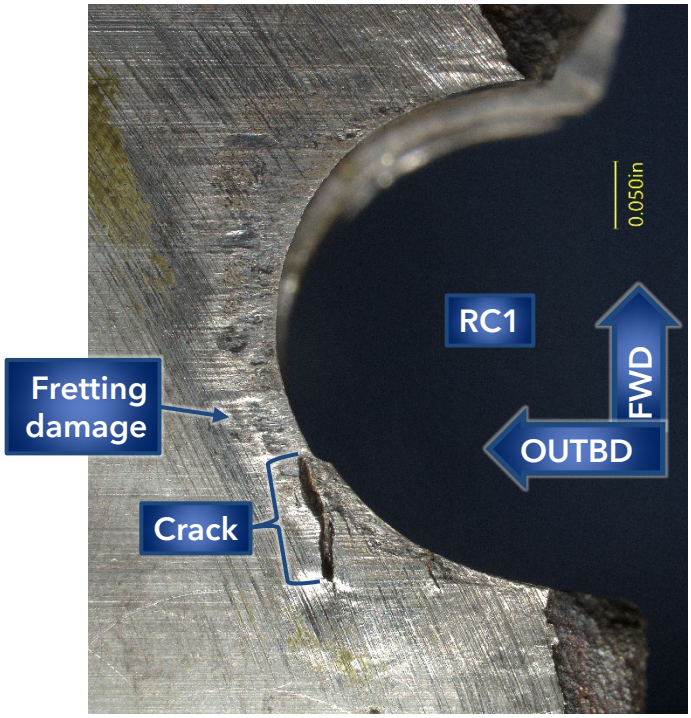

Figure 5. Closer view of the partially opened crack and fretting damage at the outboard side of hole RC1.

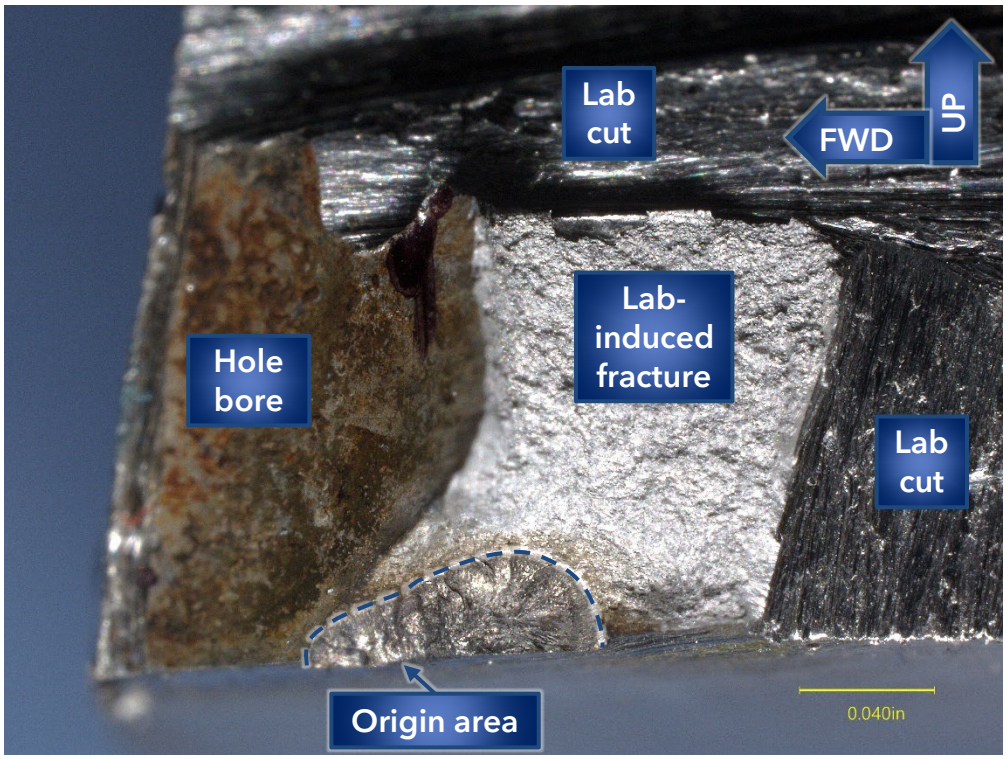

Figure 6. Lab-opened fracture surface after opening the crack intersecting hole RC1 showing fatigue features associated with the crack indicated in the previous figure. A dashed line indicates the fatigue boundary.