AIRCRAFT INCIDENT SHORT REPORT

CA18/3/2/1201: While the ZS-HAI helicopter was hovering in ground effect, the fan-wheel assembly failed and the helicopter was landed safely without further damage or injury.

Date and time	:	19 March 2018 at 0800Z
Location	:	New Tempe Aerodrome (FATP)
Aircraft registration	:	ZS-HAI
Aircraft manufacturer and model	:	Robinson Helicopter Company, R22 Beta
Last point of departure	:	New Tempe Aerodrome (FATP)
Next point of intended landing	:	Bethlehem Aerodrome (FABM)
Location of incident site with reference to easily defined geographical points (GPS readings if possible)		New Tempe Aerodrome (FATP) S29˚01'51.51" E026˚09'33.19", elevation 4 510ft AMSL
Meteorological information	:	Surface wind, 290˚/10kt, temperature, 28˚C, CAVOK
Type of operation	:	Private (Part 91)
Persons on board	:	One (pilot)
Injuries	:	None
Damage to aircraft	:	Substantial

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and not to apportion blame or liability.

Disclaimer:

1. SYNOPSIS

1.1 On 19 March 2018 at 0800Z, the helicopter was established in a low hover. The pilot stated that while he was performing his hover checks, he heard a loud bang from the rear of the helicopter, and he immediately landed. On inspection, it was found that the fan-wheel assembly had failed.

1.2 The pilot did not sustain injuries, and damage was limited to the fan wheel assembly.

1.3 The investigation determined that while the helicopter was in ground effect (IGE), the fan wheel assembly failed. The failure of the fan wheel assembly was attributed to the failure of the fan wheel blades due to a fatigue crack that had propagated near the weld on one of the fan-wheel blades.

2. FACTUAL INFORMATION

2.1 History of flight

2.1.1 On 19 March 2018 at 0800Z, the helicopter with the pilot as the sole person on-board was established in the low hover. The pilot had planned to fly from FATP to FABM on a private flight. He stated that after he had completed his pre-flight inspection on the helicopter, he strapped in and began his pre-start-up checks. Following that, he started the engine and waited until all the warning lights were out. All the pressures and temperatures were in the green arc.

2.1.2 He further stated that he pulled the collective pitch lever and established the helicopter in low hover which, according to him, was approximately five feet (5ft.) above ground level (skid height). He then performed his hover checks which, according to him, were within limits. He started to air taxi from the helipad area to the Taxiway 01 and from there onto Runway 28. Once at Runway 28, he performed his in-ground effect hover checks again. However, before he could commence with forward flight, he heard a loud bang from the rear of the helicopter. The helicopter yawed to the left and started to descend. The pilot lowered the collective pitch lever and landed safely.

2.1.3 Once on the ground, he closed the throttle and could see debris lying on the runway. He proceeded to shut down the helicopter and, after disembarking, he conducted a walk-around inspection and saw that the fan-wheel assembly had failed.

2.1.4 The incident occurred during daylight at geographical position determined to be S29˚01’51.51” E026˚09’33.19” at an elevation of 4 510ft above mean sea level (AMSL).

Figure 1: Debris from the fan-wheel assembly and the scroll scattered on the apron area

2.1.5 Following the incident, the helicopter was taken to an aircraft maintenance organisation (AMO) at FATP, which removed the fan-wheel assembly and then forwarded it to the Accident and Incident Investigation Division (AIID).

2.1.6 Figure 6 shows the maintenance manual inspection requirement on the fan-wheel assembly which stipulates that at every 100-hour inspection or mandatory periodic inspection (MPI) needs to be carried out. The helicopter had flown a total of 1 059.2 hours at the time of this serious incident. The last MPI inspection prior to the incident flight was certified on 24 November 2017 at 988.6 airframe hours.

2.1.7 The State of design and manufacture (United States of America) was notified of the serious incident and they appointed a non-travelling Accredited Representative in accordance with the provisions as contained in ICAO Annex 13. The fan-wheel assembly was sent to the National Transportation Safety Board (NTSB) Materials Division where metallurgical examination on the assembly were conducted. (See Annexure A)

Figure 2: A closer view of the failed fan-wheel assembly

Figure 3: Another view of the damage caused by the fan-wheel assembly

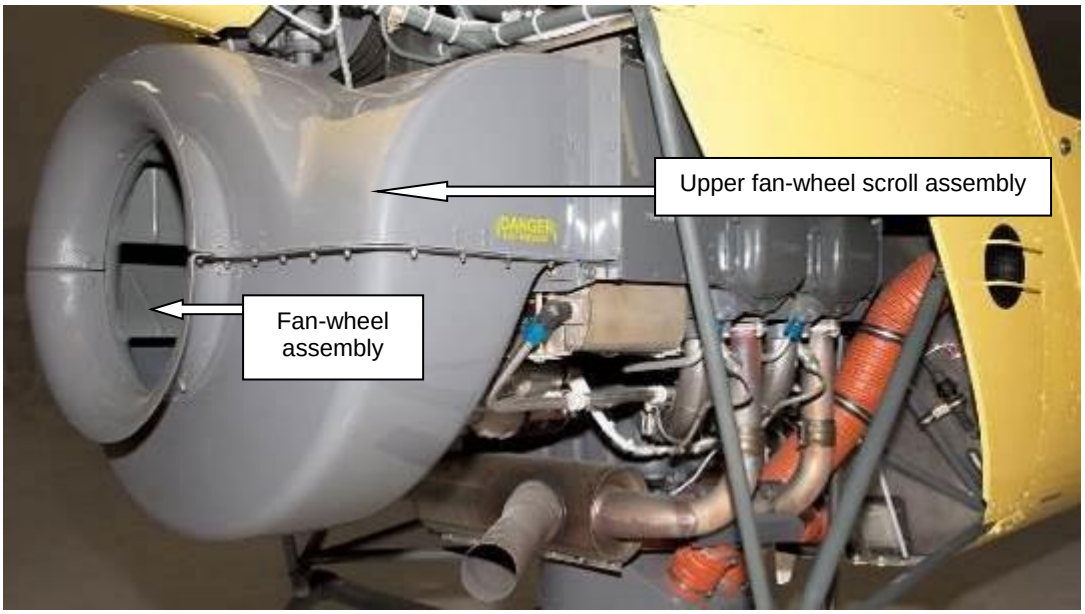
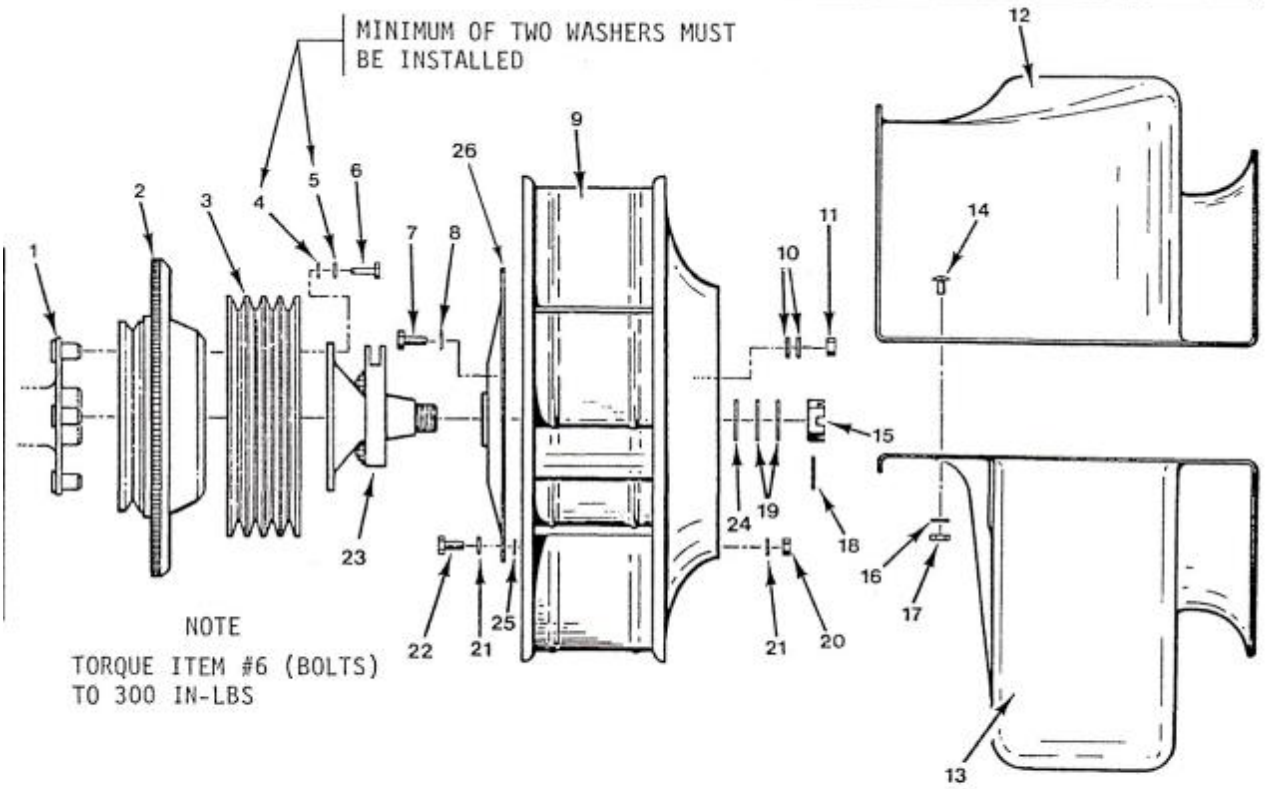


Figure 4: The fan-wheel scroll and fan-wheel assembly (Source: Robinson Helicopters website)



NUMBER	PART NO.	DESCRIPTION
1	-	Engine Flange
2	-	Engine Ring Gear
3	A493-1	Lower Sheave
4	AN960-616L	Washer
5	AN960-616	Washer
6	NAS1306-24H	Bolt
7	NAS1305-11	Bolt
8	AN960-516L	Washer
9	B174-1	Fanwheel Assy
10	AN960-516	Washer
11	NAS679A5	Nut
12	A236-1	Scroll (Upper)
13	A236-2* or A236-3**	Scroll (Lower)
14	AN525-832R6	Screw
15	AN320-15 AN320-18	Nut (For use on A007-3) Nut (For use on A007-5)
16	AN960-8L	Washer
17	NAS679A08	Nut
18	B350-2	Spring Pin
19	AN960-1616L (As req'd) AN960-1818L (As req'd)	Washer (For A007-3) Washer (For A007-5)
20	NAS679A3	Nut
21	AN960-10	Washer
22	NAS1303-3 NAS1303-6***	Bolt Bolt (on B174 Rev F and subsequent)
23	A007-3 A007-5	Shaft Assy Shaft Assy (Must use in Beta II and Mariner II)
24	MS20002-18	Washer (For use with A007-5)
25	NAS1149F0316P***	Washer
26	A187	Cone (Ref)

*Ship 0001 thru 0500
**Ship S/N 0500 and on
***Used on B174-1 Rev "F" and subsequent.

FIGURE 6-5 CENTRIFUGAL BLOWER INSTALLATION

Figure 5: Item No. 9 in the schematic is the fan-wheel assembly

2.410 Inspection Procedures and Checklist (continued)

8. **Remove Tailcone Fairing (8) (continued)**

Actuator Upper Bearing: Inspect condition. Verify no more than 0.060 inch axial play. Verify no fretting between bearing inner race and clutch shaft. Verify bearing inner race has not slipped relative to clutch shaft. Inspect Telatemp per § 2.130. Perform § 2.501 bearing inspection if unexplainable Telatemp increase has occurred. _____

CAUTION

A184 bearing requires periodic lubrication per § 1.101.

Actuator Upper Bearing Lubrication: Perform as required. _____

Clutch Lateral Centering Strut Assembly: Inspect condition. Inspect rod ends per § 2.120. Verify security. _____

Intermediate Flex Plate and Yokes: Inspect condition. If fretting is detected, replace flex plate. Verify no cracks in yoke welds. Verify security. Verify operating clearance (0.25 inch minimum to tail rotor controls with actuator disengaged). _____

Tail Rotor Push-Pull Tubes and A331-1 Bellcrank: Inspect condition. Verify no cracks at tube ends. Inspect rod ends per § 2.120. Verify security and operating clearance. _____

Drive V-Belts: Inspect per § 2.507. _____

Fanshaft: Inspect condition. Perform 360° visual inspection of exposed fanshaft for cracks. Verify security and safety wiring of attaching bolts. _____

Actuator Lower Bearing: Inspect condition, verify bearing inner race has not slipped relative to fanshaft. Inspect Telatemps per § 2.130. Perform § 2.501 bearing inspection if unexplainable Telatemp increase has occurred. _____

CAUTION

A181-4 bearing requires periodic lubrication per § 1.101.

Actuator Lower Bearing Lubrication: Perform as required. _____

Lower Bearing Brackets: Verify no looseness or cracking in A185 brackets which secure actuator lower bearing to scroll. _____

Fiberglass Scroll: Inspect condition. Verify no damage to vane assembly in upper right scroll. Verify security. Verify drain hole is unobstructed. _____

Scroll Metal Inlet Lips & Gap (if installed): Inspect condition. Verify 0.020 to 0.100 inch gap between lips and fanwheel inlet. (Attach holes in lips may be elongated to facilitate gap adjustment.) _____

Fanwheel Assembly: Inspect condition. Verify no cracks or corrosion. Check leading edge of vanes for damage. Verify alignment of roll pin and slippage marks on fanwheel. If marks and roll pin do not align, remove fanwheel and inspect hub and shaft for damage. Verify security. _____

Figure 6: Fan-wheel maintenance inspection requirement every 100 hours

3. FINDINGS

3.1 The pilot held a valid private pilot licence and he had the helicopter type endorsed on his licence.

3.2 The pilot held a valid aviation medical certificate issued by a designated aviation medical examiner.

3.3 The pilot had accumulated a total of 179.3 flying hours, of which 131.0 hours were on the helicopter type. He had flown 16.8 hours on type during the 90 days prior to the incident.

3.4 This was a private flight conducted under the provisions of Part 91 of the CAR 2011.

3.5 The helicopter was issued with a certificate of release to service that was issued on 24 November 2017, with an expiry date of 23 November 2018 or 1088.6 airframe hours, whichever came first.

3.6 The helicopter was issued with a certificate of airworthiness on 21 August 2015 and expiring on 20 August 2018.

3.7 The last maintenance inspection prior to the incident flight was carried out on 24 November 2017 at 988.6 airframe hours. After the inspection was certified, a further 70.6 hours were flown and the total hours since new were 1 059.2. The fan came with the helicopter from the manufacturer, so it had 1 059.2 hours since new.

3.8 The investigation determined that while the helicopter was hovering in ground effect (IGE), the fan wheel assembly failed. The failure of the fan wheel assembly was attributed to the failure of the fan-wheel blades due to a fatigue crack that had propagated on one of the fan-wheel blades.

4 PROBABLE CAUSE

4.1 Failure of the fan wheel assembly due to a fatigue crack, which propagated at the leading edge of the blade near the weld.

5 CONTRIBUTING FACTOR

5.1 None.

6 REFERENCES USED IN THE REPORT

6.1 The Robinson R22 Helicopter Maintenance Manual was used as a reference and further information was obtained from their website: https://robinsonheli.com, sub-heading Publications, R22 series.

6.2 Information and pictures were obtained from the pilot, as well as the AMO who removed the fan wheel assembly.

6.3 SACAA pilot questionnaire (form: CA 12-03).

7 SAFETY RECOMMENDATION

7.1 None.

8 ORGANISATION

8.1 This was a private flight, which was operated under the provisions of Part 91 of the CAR 2011 as amended.

9 SAFETY ACTION

9.1 None.

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

March 26, 2019

MATERIALS LABORATORY FACTUAL REPORT — Report No. 19-008

A. ACCIDENT INFORMATION

Place	:	Bloemfontein, South Africa
Date	:	March 19, 2018
Vehicle	:	Robinson R22 Beta (ZS-HAI)
NTSB No.	:	WPR18WA115
Investigator	:	Jack Vanover (AS-WPR)

B. COMPONENTS EXAMINED

Fan Blade

C. DETAILS OF THE EXAMINATION

The cooling fan from a Robinson R22 helicopter engine was submitted with a separated blade, as shown in Figures 1 and 2. The deformation indicated the separation originated near the leading edge of the blade where it was welded to the aft rim. The fracture surface was adjacent to the toe of the weld, as shown in Figure 3.

The aft leading edge of the blade was sectioned from the separated blade in the laboratory. The sectioned blade portion was cleaned in two steps, first using Evapo-Rust® rust removal solution (Harris International Laboratories, Springdale, AR), and second cleaning in ALCONOX® alkaline soap solution (Alconox, Inc., White Plains, NY). The resulting cleaned fracture surface is shown in Figures 4 and 5.

There were multiple thumbnail-shaped patterns emanating from the toe of the weld (yellow brackets in Figures 4 and 5) at the inboard edge of the fracture surface. The largest thumbnail-shaped pattern was at the approximate tip of the blade leading edge, and had a diffuse initiation zone (purple bracket, Figure 5).

Ratchet marks, indicated by red arrows in Figure 4, were observed on the fracture surface that extended around the pressure and suction sides of the blade. Black arrows in Figure 5 point to a shear lip visible along the outboard edge of the fracture surface.

The thumbnail-shaped patterns and ratchet marks are consistent with multiple initiation fatigue cracking. The fracture surface features indicate the fatigue cracking emanated from the inboard weld toe at the leading edge of the blade, and propagated through most, but not all, of the aft rim thickness before the blade separated.

Adrienne V. Lamm
Materials Engineer

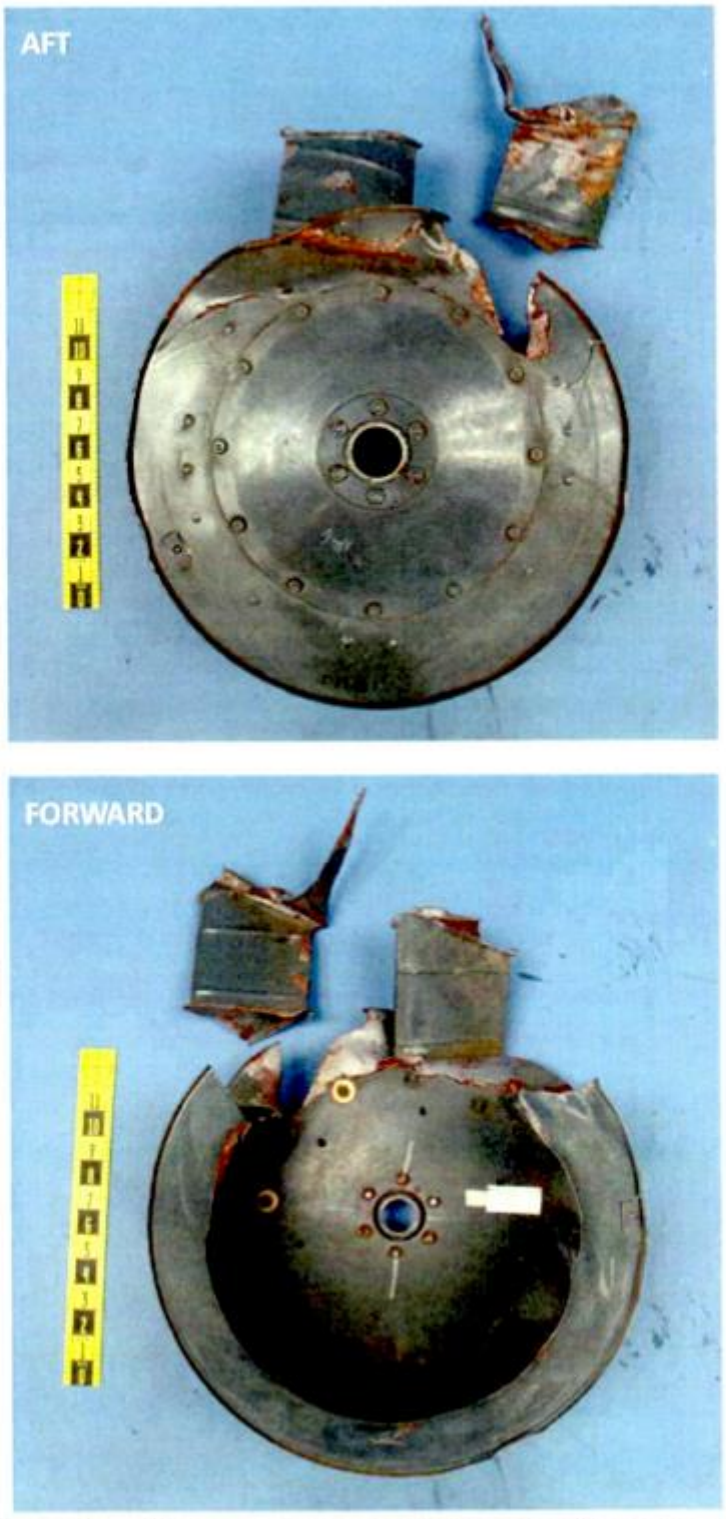


Figure 1: Overall photos of the separated cooling fan as viewed from the aft (top) and forward (bottom) sides.

Figure 2: Overall photo of the separated cooling fan as viewed from the outer diameter.

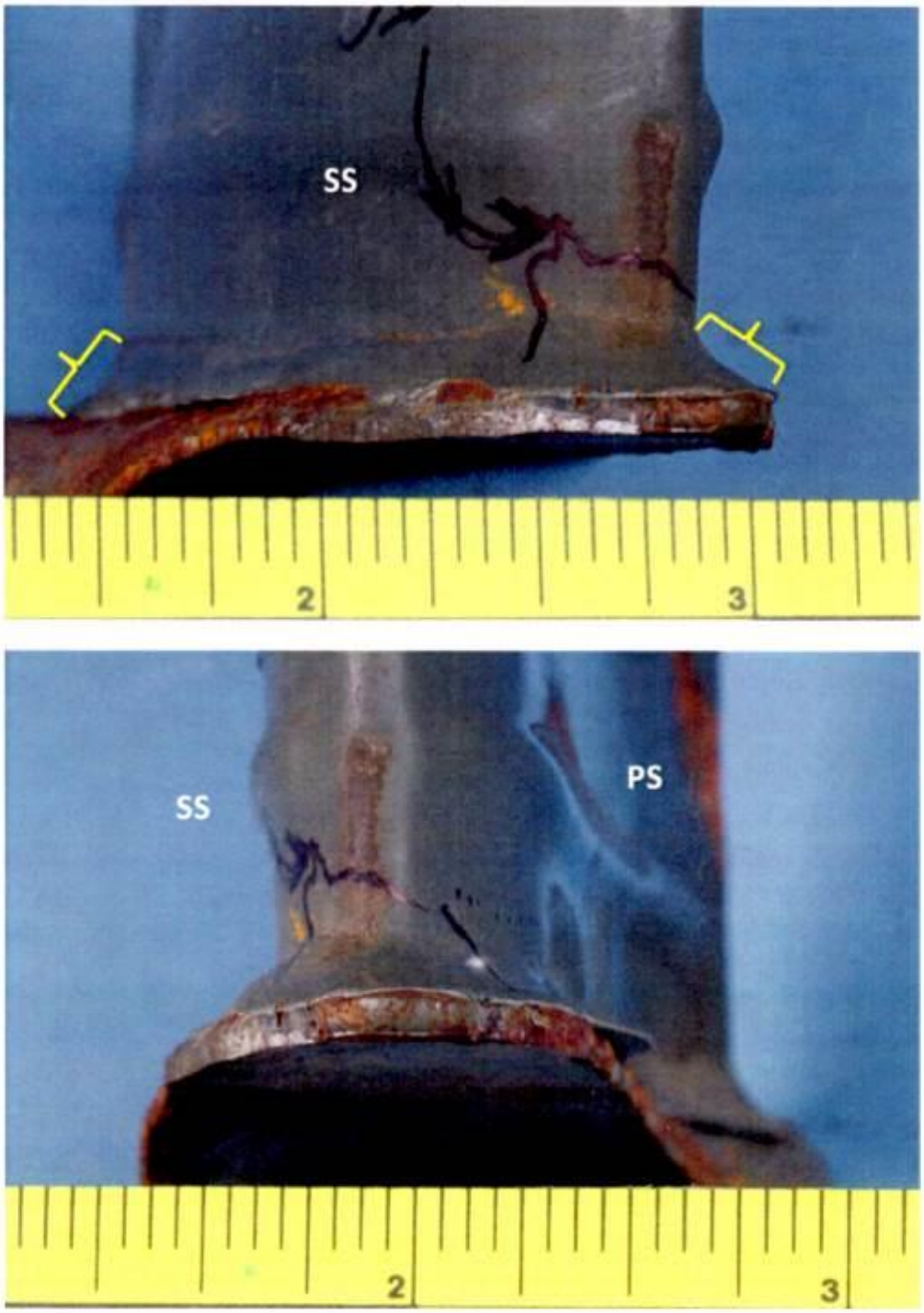


Figure 3: Close-up photos of the fracture surface at the aft side of the blade leading edge. The yellow brackets indicate the weld on the blade.

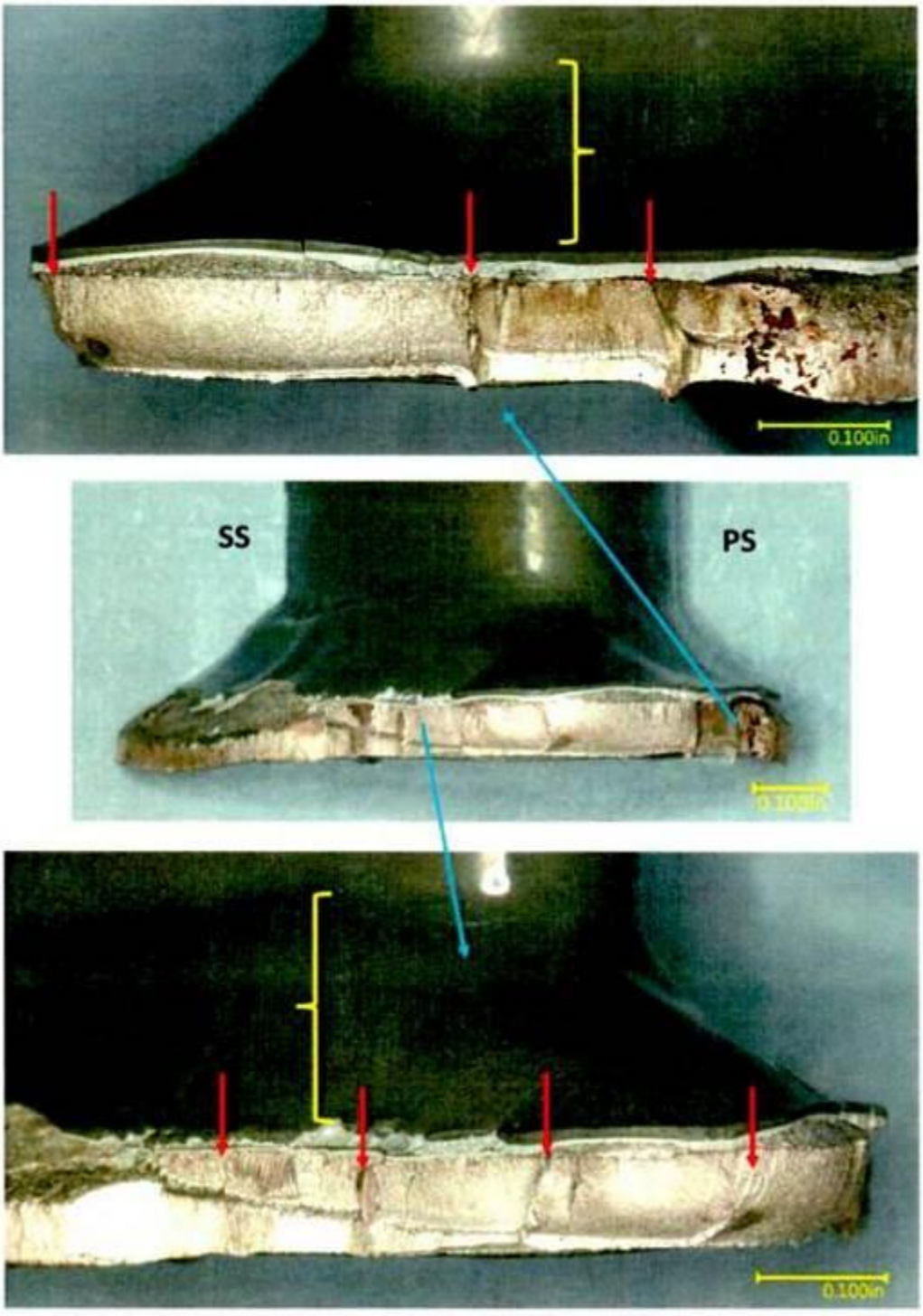


Figure 4: Digital microscope images showing the cleaned fracture surface on the blade. The yellow bracket indicates the weld on the blade. The red arrows point to ratchet marks.

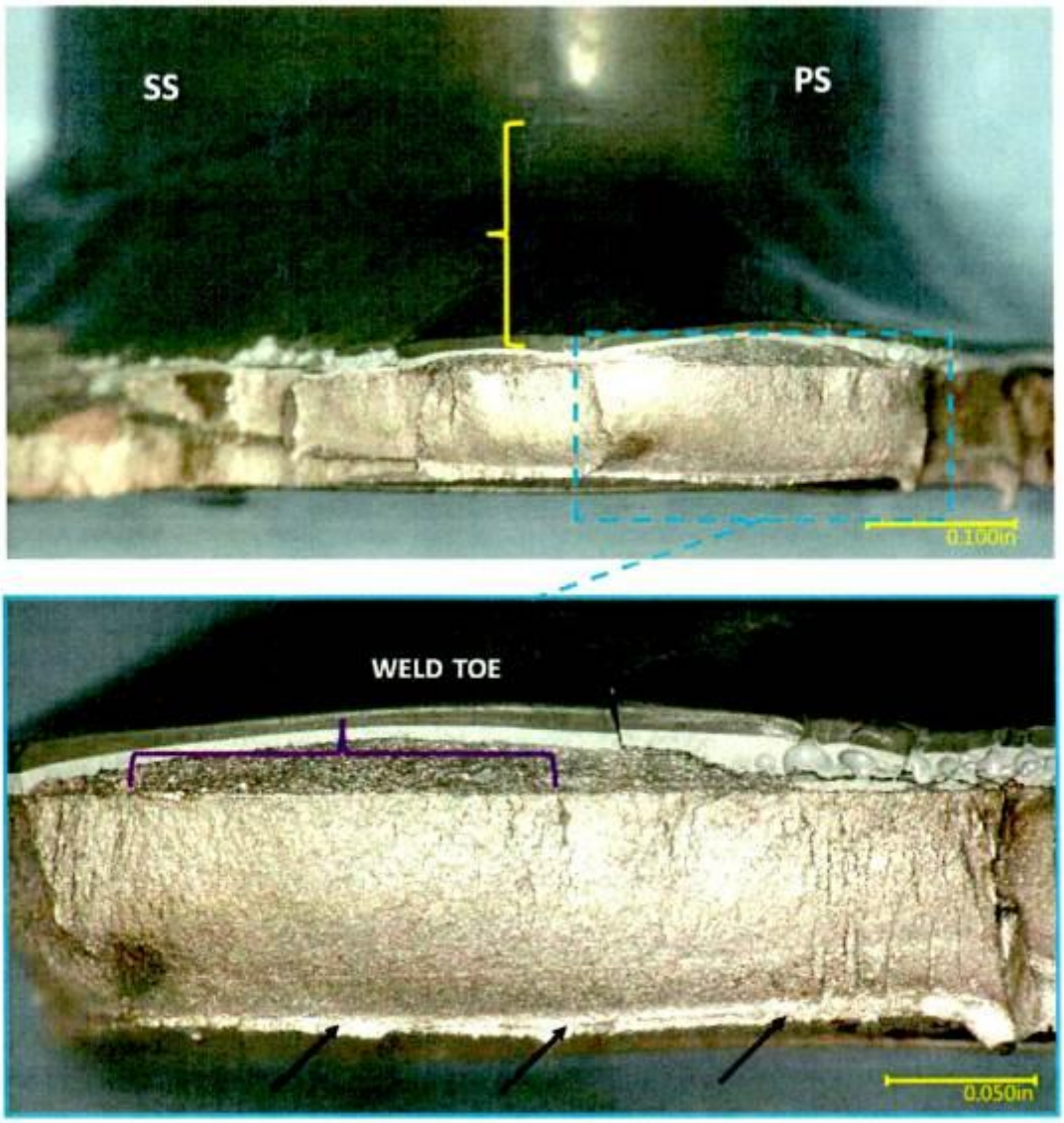


Figure 5: Digital microscope images showing the cleaned fracture surface on the blade. The yellow bracket indicates the weld on the blade. The purple bracket indicates a diffuse fatigue cracking initiation region, while the black arrows point to a shear lip.