Aviation Investigation Final Report

Location:	Lake Havasu City, Arizona	**Accident Number:**	WPR21FA340
Date & Time:	September 12, 2021, 16:09 Local	**Registration:**	N2085Q
Aircraft:	Cessna 177RG	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (partial)	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The airplane was departing at a slow groundspeed, and the engine sounded as if it was producing partial power. The airplane did not ascend as expected and veered to the right of the centerline. The airplane then pitched up to a nose-high attitude and made an aggressive left bank, consistent with pilot attempting to make 180° turn to the runway while making a radio transmission that he did not complete. The airplane's wingspan turned nearly perpendicular to the horizon and then stalled with the left wing dropping toward terrain. The airplane subsequently impacted terrain, and a postcrash fire ensued.

The terrain ahead of the accident site was uninhabited and populated with low brush. If the pilot had considered landing there instead of making a 180° turn, the outcome of this accident might have been different.

A postaccident examination revealed that two piston rings were fractured and that the pistons showed evidence of excessive wear and heat. The extensive wear on the piston ring surfaces indicated that they had fractured before the accident and were continuing to wear during the accident flight when the pistons actuated inside the cylinders. Fracture and wear of the rings likely resulted in blow-by of combustion gases past the cylinder and oil leakage into the combustion chamber. The lifter surfaces were spalled, the cam lobes were worn, and one of the lifter bodies was cracked, all consistent with excessive wear. The fractured rings, a lack of sealing, and blow-by would all have contributed to partial engine power and led to an airplane stall and a loss of altitude.

Three days before the accident, the pilot had sent samples of the engine oil for analysis and did not receive the results before the accident. The oil sample exhibited elevated aluminum, chromium, iron, silicon, and nickel levels. A previous oil sample report had stated that the amounts of aluminum, chromium, and iron would indicate piston, ring, and steel wear. All were

indications of the excessive wear of the engine components and broken piston rings, which likely would result in blowby and contribute to the partial loss of power.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

A partial loss of engine power during the airplane's initial climb due to wear of internal engine components, which prevented the engine from developing full-rated power and resulted in a loss of altitude.

Findings

Aircraft	Recip engine power section - Fatigue/wear/corrosion
Personnel issues	Decision making/judgment - Pilot

Factual Information

History of Flight

Takeoff	Loss of engine power (partial) (Defining event)

On September 12, 2021, about 1609 mountain standard time, a Cessna 177RG, N2085Q, was substantially damaged when it was involved in an accident near Lake Havasu Airport, Lake Havasu, Arizona. The pilot was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot was planning to make a cross-country flight to Reno, Nevada, in the days after the accident, and the purpose of the accident flight was to refuel for the flight to Reno. The airplane was based at Eagle Airpark, Bullhead City, Arizona, and the pilot performed maintenance there earlier in the day, including replacing the bushings on the nosewheel because the airplane had been experiencing a vibration during takeoff and landing. The airplane departed about 1530 and landed at Lake Havasu about 1545. The pilot then purchased 24.8 gallons of fuel at the self-serve fuel tank. According to his wife, the pilot had planned to top off the fuel tanks to full.

Video and audio recordings and Federal Aviation Administration (FAA) automatic dependent surveillance-broadcast (ADS-B) data showed that the pilot taxied the airplane to runway 14, performed a run-up, and departed about 1608. Witnesses reported that the airplane traveled down the runway at a slow groundspeed and noted that the engine sounded abnormal, as if it were producing partial power. The airplane veered to the right of the centerline and ascended 100 to 150 ft above ground level (see figure 1). ADS-B data showed that the airplane accelerated down the runway at airspeeds up to 65 knots.


Figure 1: Security camera video showing initial right veer

The video showed the airplane pitch to a nose-high attitude and banked to the left (see figure 2). Witnesses observed the airplane's wingspan turn nearly perpendicular to the horizon and then stall with the left wing dropping toward terrain.


Figure 2: Security camera video of left bank

At an undetermined time during the takeoff, the pilot stated, on the airport common frequency, "Lake Havasu traffic Cardinal 2085Q making a uh" The next recorded transmission, which occurred less than 1 second later, was a high-pitch tone similar to a stall warning horn. The airplane impacted desert terrain about 830 ft from the end of runway 14, and a postcrash fire ensued.

Pilot Information

Certificate:	Private	**Age:**	64,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	February 4, 2020
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	July 18, 2021
Flight Time:	(Estimated) 1790 hours (Total, all aircraft), 1335 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N2085Q
Model/Series:	177RG	**Aircraft Category:**	Airplane
Year of Manufacture:	1974	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	177RG0485
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	July 16, 2021 Annual	**Certified Max Gross Wt.:**	2800 lbs
Time Since Last Inspection:	25.7 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	3487.3 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	IO-360-A1BD6
Registered Owner:	On file	**Rated Power:**	200 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The pilot's wife stated that he performed most of the airplane's maintenance and that he flew the airplane regularly after purchasing it in 2013. A review of the pilot's logbook revealed that the airplane had a total time of 3,487.3 hours and that the engine had accumulated 1,219.4 hours since the time that it was remanufactured at the manufacturer. The logbook indicated that the camshaft and lifters were replaced with new parts in December 2004, 682 hours before the accident. The logbook also indicated that the No. 1 cylinder had been replaced with an overhauled assembly in March 2020, 75.1 hours before the accident. The last recorded oil change was performed at the airplane's last annual inspection.

To monitor engine component wear rate, the pilot had sent samples of the engine oil for spectrometer analysis multiple times; the most recent of which was September 9, 2021 (3 days before the accident). At that time, the engine had accumulated 1,216.7 hours or 2.7 flight hours. The sample had not been run before the accident occurred; after the accident, the sample showed elevated levels of aluminum, chromium, iron, silicon, and nickel (see figure 3).

ELEMENTS IN PARTS PER MILLION								
	MI/HR on Oil	68	UNIT / LOCATION AVERAGES	34	30	5	5	6
	MI/HR on Unit	1,217		1,141	1,006	622	604	575
	Sample Date	9/9/2021		9/15/2019	6/24/2017	10/8/2012	10/29/2010	12/19/2007
	Make Up Oil Added	10 qts		3 qts	5 qts			
	ALUMINUM	23	3	32	12	2	2	1
	CHROMIUM	61	2	64	35	2	2	2
	IRON	148	12	43	26	9	6	10
	COPPER	35	4	19	3	3	3	3
	LEAD	3606	1385	1921	3468	798	651	522
	TIN	2	1	1	0	0	1	2
	MOLYBDENUM	2	0	0	0	0	0	0
	NICKEL	5	0	1	1	0	0	0
	MANGANESE	2	0	1	0	0	0	0
	SILVER	0	0	0	0	0	0	0
	TITANIUM	0	0	0	0	0	0	0
	POTASSIUM	0	0	0	1	0	0	1
	BORON	0	0	2	0	1	0	0
	SILICON	10	6	23	4	9	7	9
	SODIUM	2	0	1	2	1	0	0
	CALCIUM	40	0	64	69	0	0	0
	MAGNESIUM	0	0	1	2	0	0	0
	PHOSPHORUS	28	102	36	75	137	116	118
	ZINC	4	6	4	4	2	0	1
	BARIUM	0	0	0	0	0	0	0

Figure 3: Oil analysis report showing six samples, including the one taken 3 days before the accident (Source: BlackStone Laboratories).

The laboratory oil report for the September 2019 sample stated that there were elevated levels of metal and that, if work had not been done recently on the engine, the amount of aluminum, chromium, and iron would indicate piston, ring, and steel wear. The oil report further stated that the amount of chrome indicated “a ring problem.”

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KEED,914 ft msl	**Distance from Accident Site:**	17 Nautical Miles
Observation Time:	15:56 Local	**Direction from Accident Site:**	313°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	14 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	190°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.77 inches Hg	**Temperature/Dew Point:**	44°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Lake Havasu City, AZ	**Type of Flight Plan Filed:**	None
Destination:	Bullhead City, AZ (A09)	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

Airport Information

Airport:	LAKE HAVASU CITY HII	**Runway Surface Type:**	Asphalt
Airport Elevation:	782 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	14/32	**IFR Approach:**	None
Runway Length/Width:	8000 ft / 100 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	34.557952,-114.34983

The accident site was at an elevation of 790 ft mean sea level, and the terrain was composed of dry, soft dirt with sparse brush. The terrain ahead of the accident site was uninhabited and populated with low brush. The wreckage was found distributed over a 200-ft distance on a median magnetic bearing of about 60°. The main wreckage included the airframe and engine, most of which had been consumed by fire. The first identified points of contact consisted of

disrupted dirt on the flat desert terrain at the far east-southeast end of the debris field. The markings started as a dirt indentation with shards of red fragments imbedded within the soil, consistent with the left wingtip impacting the ground first. The crater was continuous toward the main wreckage, and the end of the crater had blue/green fragments imbedded (see figure 4). A larger center indentation (referred to in the figure as the middle crater) was found in between the red fragments and the green/blue fragments; this indentation had a large arc-shaped disruption of dirt that was consistent with a rotating propeller blade.

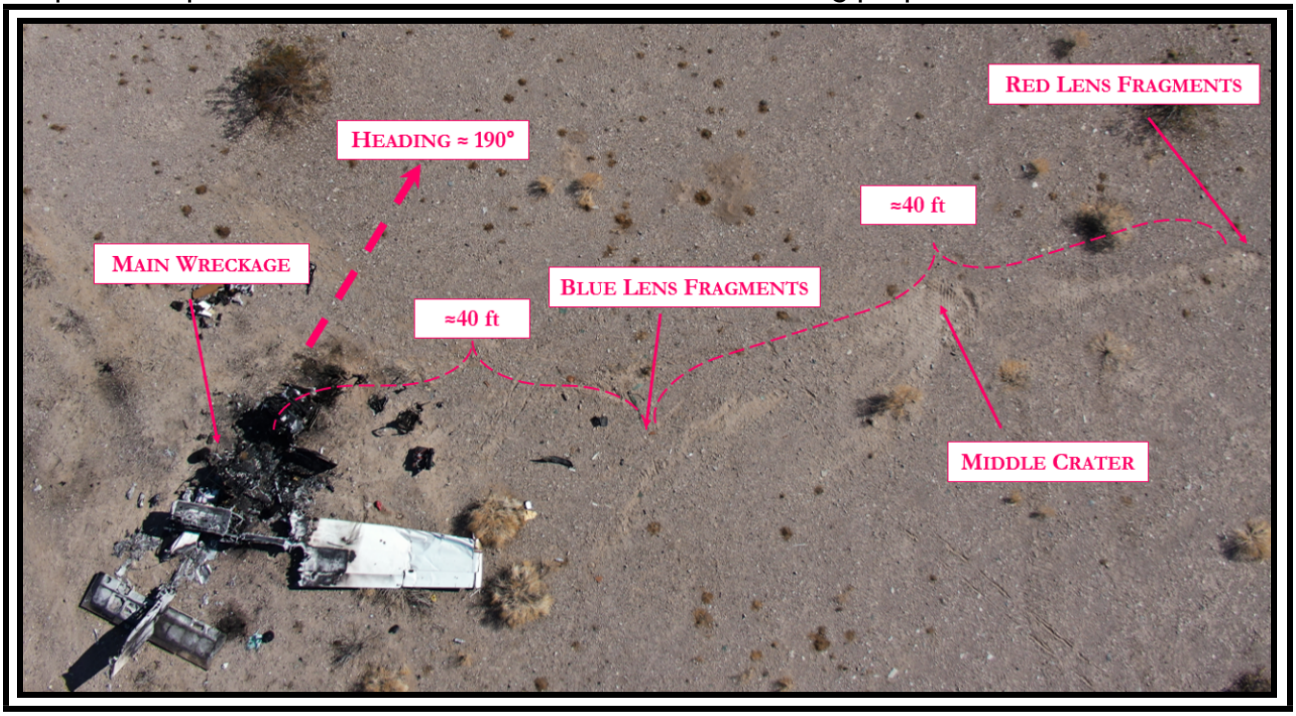

Figure 4: Main wreckage in reference to first identified point of impact.

As part of the postaccident examination, most of the engine and its components were disassembled. The Nos. 1 and 4 top compression piston rings had fractured in multiple locations (see figure 5). All the piston skirts showed evidence of corrosion and wear with light scuffs/grooves oriented from the base to the crowns. Additionally, the piston skirts on all cylinders showed evidence of blow-by, with the No. 3 cylinder exhibiting the least amount of damage.

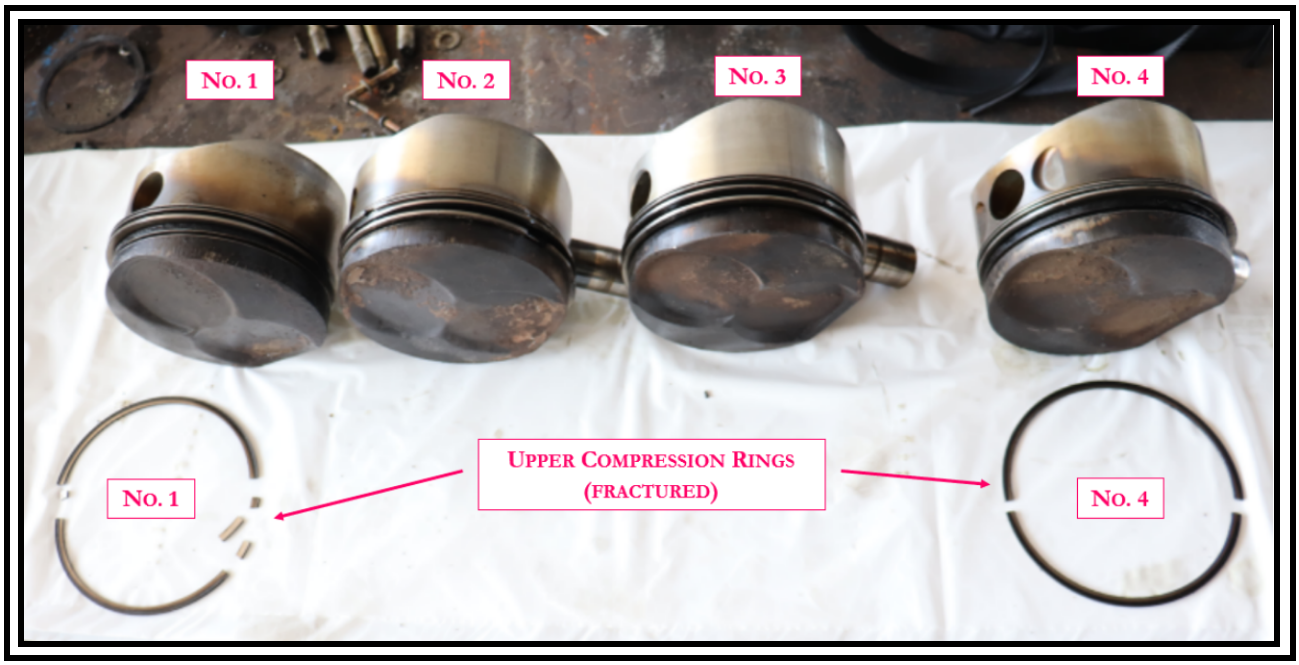

Figure 5: Fractured rings from the Nos. 1 and 4 pistons.

The National Transportation Safety Board Materials Laboratory examined the No. 1 and No. 4 fractured piston rings. The upper compression piston ring from the No. 1 cylinder had fractured in four locations. All fracture and parting surfaces exhibited iron oxides with high amounts of carbon, lead, and bromine, consistent with exposure to combustion gases from airplane fuel. Extensive wear and smoothing were observed on the fracture and parting surfaces, consistent with the fractures occurring before the accident and continuing to wear during the repetitive actuation of the pistons inside the cylinders. Fracture and wear of the rings could allow blowby of combustion gasses past the piston and oil leakage into the combustion chamber.

Separation of the crankcase halves revealed severe spalling on the faces of all the intake lifters and the No. 3 exhaust lifter; evidence of galling was also noted. The remaining lifters showed evidence of wear with a circular pattern and pitting (see figure 6). The camshaft revealed signatures of excessive wear on the cam lobes, including rounding of the lobes, pitting, and material deformation on the lobes.

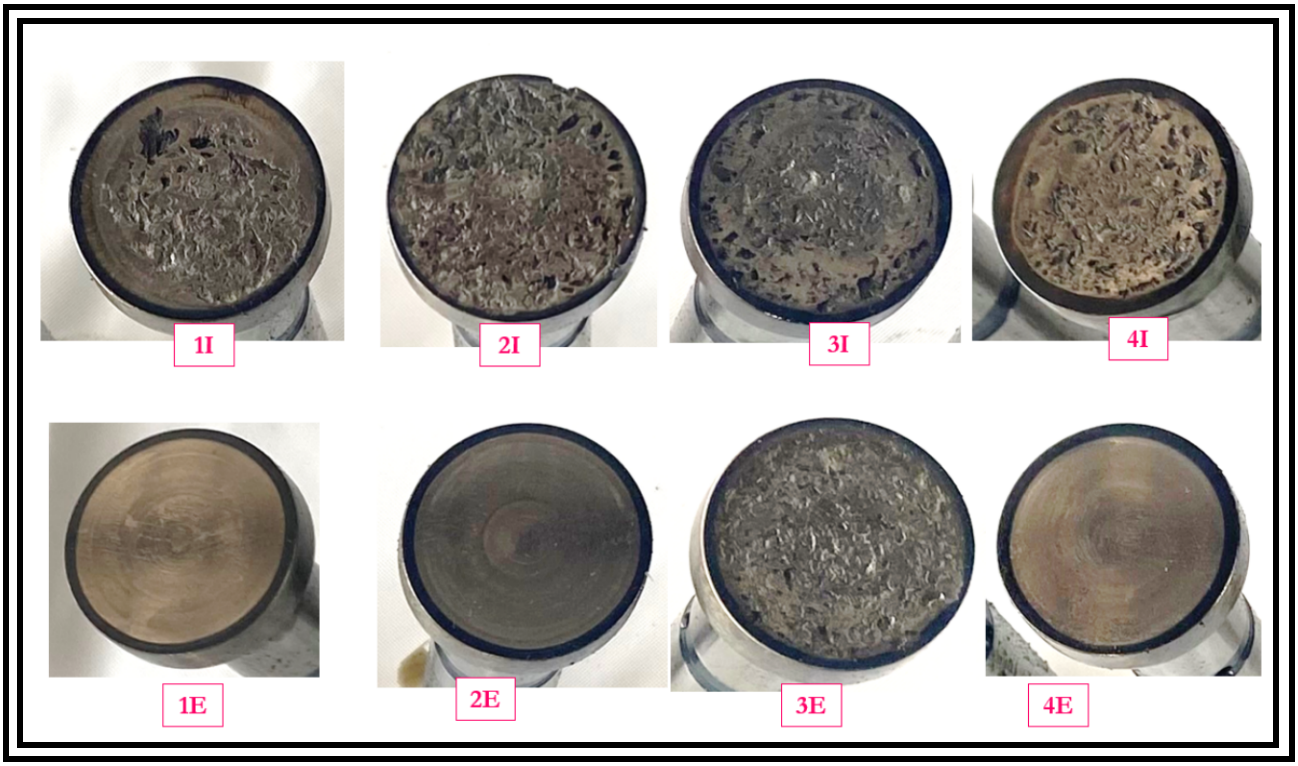

Figure 6: Wear signatures on intake lifter faces (top row) and exhaust lifter faces (bottom row).

The lifter on the No. 4 exhaust valve exhibited a tear in the base of the body, consistent with contact with the hydraulic socket; the pushrods did not show evidence of bending. The bearings showed light wear, and the crankshaft had light rotational scoring.

Administrative Information

Investigator In Charge (IIC):	Keliher, Zoe
Additional Participating Persons:	Leon Kelly; Federal Aviation Administration; Scottsdale, AZ Troy Helgeson; Lycoming Engines; Williamsport, PA Henry Solderlund; Textron (Cessna); Wichita, KS
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