Aviation Investigation Final Report

Location:	Buckingham, Pennsylvania	**Accident Number:**	ERA21FA253
Date & Time:	June 15, 2021, 10:31 Local	**Registration:**	N74MS
Aircraft:	Vans RV6	**Aircraft Damage:**	Substantial
Defining Event:	Powerplant sys/comp malf/fail	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was en route to his home airport. While approaching the airport, the pilot transmitted over the common traffic advisory frequency that he had an emergency and then that he would be making a straight-in landing due to an in-flight. Witnesses stated that the airplane's engine sounded rough and was sputtering before a "pop" sound was heard. The airplane appeared to be on fire with trailing smoke. The airplane then banked right and left, and turned toward the airport while losing altitude quickly. The airplane then struck the tops of trees before it impacted the ground. Security camera video footage confirmed the witness observations that there was an inflight fire, showed that the fire appeared to be near the engine, and that blue-gray smoke consistent with an oil-fed fire was trailing from the airplane.

Postaccident examination of the engine revealed extensive damage both internally and externally, including a crack in the crankcase above the No.1 cylinder and a large hole in the crankcase above the No. 4 cylinder. The No. 4 connecting rod was separated from the connecting rod cap. The crankshaft displayed damage and heat signatures on the No. 4 connecting rod journal that were consistent with an oil starvation event, and a portion of the connecting rod bearing was melted to the crankshaft journal. The 90° fitting on the oil pressure line above the electronic ignition system on the end away from the accessory housing and the fitting at the start of the oil line were blocked. The bulk of the obstruction in the oil line appeared to consist primarily of aluminum and silicon oxides, as well as other ash products with no apparent metal chips or fragments. This evidence showed that a thermal decomposition event had occurred with the ash products collecting at the elbow and backing into the flexible oil line. The connecting rod assembly, connecting rod bearing inserts, end cap attachment bolts, and a main bearing fragment all exhibited indications of thermal distress, likely due to a loss of oil lubrication. Freestanding aluminum chips and smeared metal on the main bearing fragment indicated that the main bearings were made from aluminum, which was stripped from the metal backing. The fatigue fractures observed on the bolts and connecting

rod were likely secondary to the decomposition of the connecting rod bearing insert and the thermal distress event.

The oil quick drain on the engine oil sump was found to be leaking, even though it was in the closed position. Examination of the oil quick drain revealed that it was discolored and that the O-rings were melted, indicating that the oil quick drain had been exposed to a high heat condition. Further examination of the area around the oil quick drain revealed the presence of soot on the bottom of the oil sump downstream of the No. 2 cylinder where the engine's left-side exhaust pipe was separated from the exhaust collector. Additional examination of the exhaust system indicated that the left exhaust pipe was a slip fit design and that no exhaust pipe clamp was present. This evidence indicated that the source of the thermal distress event was most likely an exhaust system leak that impinged on the oil quick drain, melting the O-rings and resulting in the oil draining from the engine and subsequently igniting. A review of the operating temperatures associated with the engine indicated that the exhaust gas temperature was hot enough to exceed the upper limit of the temperature specifications of the oil quick drain and was also hot enough to ignite the oil. This ultimately resulted in the in-flight fire and led to the pilot's subsequent loss of airplane control.

Probable Cause and Findings

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

An exhaust system leak that resulted in failure of the oil quick drain, a loss of oil lubrication, an in-flight fire, and the pilot's subsequent loss of airplane control.

Findings

Aircraft	(general) - Malfunction

Factual Information

History of Flight

Enroute	Powerplant sys/comp malf/fail (Defining event)
Enroute-descent	Fire/smoke (non-impact)
Emergency descent	Fire/smoke (non-impact)
Emergency descent	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On June 15, 2021, about 1031 eastern daylight time, an experimental amateur-built Vans RV-6A airplane, N74MS, was substantially damaged when it was involved in an accident in Buckingham, Pennsylvania. The pilot was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

About 0817 on the morning of the accident, the pilot departed Doylestown Airport (DYL), Doylestown, Pennsylvania, for Sky Manor Airport (N40), Pittstown, New Jersey, arriving about 0827. About 30 minutes later, the pilot departed N40 for South Jersey Regional Airport, VAY, Mount Holly, New Jersey, arriving there about 0913. About 1 hour later, the pilot departed VAY to return to DYL.

About 1020, the pilot transmitted over the common traffic advisory frequency for DYL that he had an emergency and was making a straight-in landing to runway 5. About 1021, the pilot transmitted that the airplane had an in-flight fire, would be landing on runway 5, and was inbound, to DYL. The pilot made no further intelligible transmissions.

According to witnesses, the airplane was flying in a northwest direction just before the accident. The engine sounded rough and sputtered, and then a “pop” sound was heard. The airplane appeared to be on fire with trailing smoke. The airplane then appeared to bank right and left and then appeared to follow a flightpath toward DYL while losing altitude quickly. The airplane was later observed striking the tops of trees, which was followed by the sound of impact. Flames were observed emanating from the airplane.

Review of video camera footage from a home security system indicated that a fire was present on the airplane near the engine and that smoke, which was blue-gray in color, was trailing from the airplane. Review of another video from a home security camera system indicated that the airplane struck a large tree and that a fire around the engine was present before ground impact. A photograph taken by the Township of Buckingham Fire Marshall after the accident also showed that the area near the engine was on fire.

Pilot Information

Certificate:	Airline transport; Commercial; Flight engineer	**Age:**	79,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-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:**	May 13, 2019
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	June 5, 2021
Flight Time:	(Estimated) 12225 hours (Total, all aircraft), 499 hours (Total, this make and model)		

According to Federal Aviation Administration (FAA) records, in addition to the pilot's airmen certifications, he held a mechanic certificate with ratings for airframe and powerplant, and a repairman experimental aircraft builder certificate with an inspection certificate for the Vans RV-6A. The pilot also held type ratings on the B-757, B-767, DC-6, DC-7, DC-9, and L-1011. The pilot reported, at the time of his most recent FAA third-class medical certificate, that he had a total of 12,225 hours of flight experience.

Aircraft and Owner/Operator Information

Aircraft Make:	Vans	**Registration:**	N74MS
Model/Series:	RV6 A	**Aircraft Category:**	Airplane
Year of Manufacture:	2008	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	24821
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	September 21, 2020 Condition	**Certified Max Gross Wt.:**	1592 lbs
Time Since Last Inspection:	15 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	484 Hrs as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	C91A installed, not activated	**Engine Model/Series:**	O-360-A1A
Registered Owner:	On file	**Rated Power:**	180 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The RV-6A was a two-seat, single-engine, low-wing airplane that was sold in kit form. According to FAA and airplane maintenance records, the airplane's experimental airworthiness certificate was issued in 2008. The airplane's most recent condition inspection was completed by the pilot on September 21, 2020. At the time of the inspection, the airplane had accrued a total of about 484 hours.

A review of the National Transportation Safety Board's (NTSB) accident database indicated that the engine in the airplane had been involved in a previous accident on August 8, 1998, in Bainbridge, Georgia (NTSB case no. ATL98LA108); at that time, the engine was installed in an experimental amateur-built Vans RV-6, N245DF. During the 1998 accident, the pilot was seriously injured, and the airplane was substantially damaged.

Review of maintenance records indicated that the engine was removed from the wreckage of N245DF on November 6, 1999. The maintenance records also indicated that an "engine inspection" was conducted due to a "propeller strike" and that the crankshaft, bearings, gear bolt, rod bolts, fuel pump, and the No.1 cylinder stud and rings were replaced. The records further stated that the vacuum pump was rebuilt and that the engine case and camshaft were inspected, with the ferrous parts undergoing non-destructive testing (magnafluxed).

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KDYL,394 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	10:21 Local	**Direction from Accident Site:**	289°
Lowest Cloud Condition:	Scattered / 1800 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.79 inches Hg	**Temperature/Dew Point:**	23°C / 16°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Mount Holly, NJ (VAY)	**Type of Flight Plan Filed:**	None
Destination:	Doylestown, PA (DYL)	**Type of Clearance:**	None
Departure Time:	10:16 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	DOYLESTOWN DYL	**Runway Surface Type:**	Asphalt
Airport Elevation:	393 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	5	**IFR Approach:**	None
Runway Length/Width:	3002 ft / 60 ft	**VFR Approach/Landing:**	Straight-in

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	In-flight
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	40.327769,-75.114718

Examination of the accident site revealed that the airplane came to rest upright in a field on a 148° magnetic heading and about 0.5 nautical miles from runway 5. The airplane struck a tree that was about 50 ft above ground level; impacted, in a nose-down attitude, a tree limb that was about 36 ft above ground level; and pivoted to an upright position before coming to rest on top of a standpipe-mounted sprinkler head, which had vertically punctured and traveled through the right wing.

The wing flaps and ailerons remained attached to their respective wings, but the left aileron displayed bending and impact damage. The vertical stabilizer, rudder, horizontal stabilizers, and elevators also remained attached, but the left stabilizer and elevator displayed impact damage and wrinkling. Control continuity was established for pitch, roll, and yaw. Most of the instrument panel had been consumed by fire, and the forward portion of the cabin back to the front of both seats, had been exposed to the fire, with portions of the right seat displaying fire damage on the upper surface of the bottom seat cushion. The canopy displayed thermal, and impact damage, and was almost completely separated from the fuselage. The exterior of the fuselage and wings also displayed sooting, on the sides and top surfaces, along with more delineated areas which displayed heavy thermal and fire damage toward the front of the airplane, both near, and adjacent to the firewall, and on the sides and bottom of the fuselage

Examination of the propeller and engine revealed that the propeller remained attached to the crankshaft flange and that the engine remained attached to the engine mounts. The propeller displayed minimal damage, and the spinner displayed crush and compression damage primarily on one side. The propeller governor also remained attached along with the governor oil line, which had no oil. The governor could not be rotated by hand, and the gasket installed did not have an oil screen.

The engine was damaged by fire. A crack was observed in the crankcase above the No.1 cylinder, and a large hole appeared in the crankcase above the No. 4 cylinder. The No. 4 connecting rod was separated from the connecting rod cap. The large end of the connecting rod was laying against the camshaft, and the tappets for the No. 4 cylinder were exposed. A borescope inspection of the cylinders noted no abnormalities. A portion of the cap of the dislocated connecting rod was found in the crankcase below the crankshaft.

The carburetor remained attached to the bottom of the engine with the mixture and throttle cables attached. The carburetor displayed minimal impact damage but displayed signs of thermal damage. The fuel inlet screen was found to be contaminated in a manner consistent with thermal exposure, and the floats in the unit were melted. The fuel pump remained attached to the accessory housing but was destroyed by fire. The remaining part of the fuel pump was removed and actuated by hand.

The magneto and the electronic ignition system on the accessory pad were both thermally damaged. The spark plugs remained installed in their cylinder heads with minor thermal signatures noted. The ignition harness was damaged due to impact and fire.

The oil suction screen remained safety-wired into the oil sump. The suction screen contained ferrous and nonferrous metal debris. The oil filter remained attached to the accessory housing but displayed thermal damage. The oil pump displayed thermal damage and remained safety wired in place. The torque on the oil pump body nuts appeared loose. The oil pump body and gears displayed rotational scoring, and a small amount of metal was found in the pump. The oil sump contained ferrous and nonferrous metal, and portions of the connecting rod cap material and connecting rod bolts from the No. 4 connecting rod were present. The oil quick drain was not seating properly, allowing fluid to exit the sump.

The crankshaft was rotated, and thumb compression and valvetrain continuity were established on cylinders Nos. 1, 2, and 3. Compression on the No. 4 cylinder could not be established because of the damage to the connecting rod and valvetrain in that area. The crankshaft displayed damage and heat signatures on the No. 4 connecting rod journal, and a portion of the connecting rod bearing was melted to the crankshaft journal. The faces of the No. 3 exhaust tappet and both tappets for the No. 4 cylinder were fractured.

Oil passages in the crankshaft and crankcase were checked with compressed air for any blockages, and the oil lines for the oil cooler were checked for blockages; none were noted. The oil pressure line above the electronic ignition system was also checked for blockages; the 90° fitting on the end away from the accessory housing and the fitting at the start of the oil line both appeared to be blocked, and the passage through the accessory housing to the oil pressure point appeared not to be blocked.

Oil Quick Drain

The oil quick drain on the oil sump was leaking, even though it was in the closed position. Examination of the oil quick drain revealed that it was gold in color instead of the manufacturer's blue anodized color and that the O-rings were melted.

Further examination of the area around the oil quick drain revealed the presence of soot on the bottom of the oil sump downstream of the No. 2 cylinder where the engine's left-side exhaust pipe was separated from the exhaust collector. Additional examination of the exhaust system indicated that the left exhaust pipe had a slip fit design and that no exhaust pipe clamp was present.

Laboratory Examination of Engine Parts

Pieces of the No. 4 connecting rod assembly, chips from the oil sump, an oil line, and an elbow fitting were submitted to the NTSB Materials Laboratory for examination. The examination determined that the connecting rod, end cap, end cap bolts, and bearing insert all exhibited thermal distress signatures. The bearing insert had fragmented into multiple chips, and both bolts used to secure the end cap had fractured. The fractures exhibited coarse striated features consistent with fatigue separations. One arm of the connecting rod yoke had also fractured in a manner consistent with a bending fatigue separation.

The chips from the oil sump consisted primarily of fragments from the connecting rod bearing inserts. Two chips were determined to be an aluminum/silicon alloy, and another chip was determined to be a fragment of a main bearing insert. The bearing surface was stripped of babbitt material in some regions and coated by a smeared metal in other regions. The smeared metal was determined to be an aluminum/silicon alloy that was similar in composition to the two aluminum/silicon alloy chips.

The oil line and elbow fitting were blocked. The blockages consisted primarily of silicon and aluminum oxides with traces of alkalis, alkaline, and halogens.

Medical and Pathological Information

The Bucks County Coroner's Office, Warminster, Pennsylvania, performed an autopsy on the pilot. His cause of death was smoke inhalation complicating hypertension.

Toxicology testing performed by the FAA Forensic Sciences Laboratory identified salicylic acid, quinine, and azacyclonol in the pilot's specimens. Salicylic acid is a metabolite of aspirin and is used to treat several conditions. The use of aspirin is acceptable for flying if the underlying

condition being treated is also acceptable.
Quinine is commonly used to treat leg cramps and restless leg syndrome. It is also consumed in tonic water. Azacyclonol is both a drug and a metabolite of fexofenadine (Allegra), which is an over-the-counter nonsedating antihistamine used to treat seasonal allergies. The medication is acceptable for pilots.

Additional Information

Engine Operating Temperatures

The engine could be operated at a peak exhaust gas temperature of 1,650°F. Motor oil will burn at temperatures from 302°F to 392°F. The oil quick drain valve was specified for use at temperatures between -60°F and 260°F.

FAA Advisory Circular 91-59A

FAA Advisory Circular (AC) 91-59A, Inspection and Care of General Aviation Aircraft Exhaust Systems, stated in part that a review of accident and incident reports revealed numerous fatalities and injuries to pilots and passengers because of exhaust system component failures. The AC also stated that many light airplane cabins are warmed by air circulating around the engine exhaust pipes and that many of the most common exhaust system component failures are muffler or exhaust gas-to-air heat exchanger related. The AC further stated that potential failures included the following:

> *(1) Escape of exhaust gas into the cabin, possibly through the cabin heat system, when there is muffler or heat exchanger leakage.*
>
> *(2) Material failures in components of heat exchangers and mufflers that function as both, leading to leakage of the exhaust gas directly into the cabin or through the cabin heat system.*
>
> *(3) Partial or full engine power loss caused by loose baffles, cones, or diffusers on mufflers and heat exchangers that partially or completely block the exhaust gas outlet flow. This condition may occur intermittently if internal components are loose within the muffler and move around during subsequent flights.*

(4) Impingement heating or torching of the surrounding structure can occur in any area where exhaust system components exist or are breached and may lead to structural failure or fire conditions. Torching is of particular concern on turbocharged engines, which operate at higher exhaust gas temperatures and pressures.

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	Gary Brown; FAA/ FSDO; Allentown, PA Ryan Enders; Lycoming Aircraft Engines; Williamsport, PA
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