



Aviation Investigation Final Report

Location:	Sheboygan, Wisconsin	Accident Number:	WPR18FA200
Date & Time:	July 20, 2018, 16:04 Local	Registration:	N747J
Aircraft:	De Havilland DH112 VENOM	Aircraft Damage:	Destroyed
Defining Event:	Loss of engine power (partial)	Injuries:	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was conducting a formation training flight consisting of two airplanes; the accident airplane was in the No. 2 position. The airplane took off about 8 seconds behind the lead (No. 1 position) airplane. Witnesses described the airplane's takeoff as sluggish and indicated that the airplane's wings rocked back and forth shortly after lifting off. The witnesses' testimony was consistent with one witness' video recording, which showed the airplane climbing away from the runway and making a shallow left turn. As the airplane passed the witness' position, the engine sound decreased and rapidly increased. The airplane reached an altitude of about 200 ft above the ground before descending and impacting a farm structure. Another video captured the airplane descending in a slightly nose-up and wings-level attitude before impact. The flaps and landing gear both appeared retracted in that video.

No preimpact anomalies with the airframe and engine were found that would have precluded normal operation of the airplane. Signatures consistent with circumferential rub marks within the turbine were identified. Although the rate of rotation at the time of impact could not be determined, the retraction of the landing gear at a normal rate showed that the engine was likely producing some power at that time.

One of the witnesses to the accident was a pilot with experience in the accident make and model. He described the engine powering the airplane as "high airflow and thrust" and indicated that the engine could experience a compressor stall when operating at a high angle of attack and a high-power setting. He also stated that the airplane could get into a low energy state if an engine failure occurred and that the airplane would normally accelerate "very quickly" if it leveled off at 200 ft.

The witness accounts of the accident airplane's wings rocking back and forth were consistent with the airplane encountering the wake turbulence of the lead airplane. Wake turbulence can disrupt airflow to the engine of a trailing airplane. The final seconds of the witness' video showed the pilot controlling the airplane during the climb to 200 ft, after which the airplane began descending. Thus, the wake turbulence from the lead airplane likely disrupted airflow to the engine and caused a compressor stall and a partial loss of engine power, which resulted in the airplane's inability to continue to climb.

Toxicology testing identified sedating medications in the pilot's specimens, but the levels of the medications at the time of the crash were well below the levels that would have caused significant effects. Therefore, it is unlikely that impairing effects of these medications contributed to this accident.

Probable Cause and Findings

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

The airplane's encounter with wake turbulence from the lead airplane in the formation flight, which resulted in a compressor stall and the airplane's subsequent inability to climb.

Findings

Environmental issues	Wake turbulence - Effect on equipment
Aircraft	(general) - Capability exceeded
Aircraft	Climb rate - Attain/maintain not possible
Aircraft	Altitude - Attain/maintain not possible

Factual Information

History of Flight

Prior to flight	Miscellaneous/other
Initial climb	Aircraft wake turb encounter
Initial climb	Loss of engine power (partial) (Defining event)
Initial climb	Attempted remediation/recovery
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On July 20, 2018, about 1604 central daylight time, a De Havilland DH112 Venom airplane, N747J, was destroyed when it was involved in an accident near Sheboygan, Wisconsin. The private pilot was fatally injured, and two people in the impacted structure were seriously injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot was conducting a formation training flight that consisted of two airplanes; the accident airplane was in the No. 2 position and was to be staggered behind and to the right of the lead (No. 1 position) airplane. During the flight briefing, the pilot was instructed to take off 10 seconds after the lead airplane. The airplanes departed from Sheboygan County Memorial Airport (SBM), Sheboygan Falls, Wisconsin.

Review of video provided by a witness showed that the accident airplane departed about 8 seconds after the lead airplane. About 6 seconds after the accident airplane lifted off, the left wing rocked downward then up, followed by the right wing rocking downward then up as the airplane returned to wings level. The accident airplane continued to climb at an angle away from the runway and the witness' position on an airport ramp. As the airplane passed the witness' position, the engine sound decreased and then rapidly increased. The video ended about 19 seconds after the airplane lifted off from the runway. The video showed that the accident airplane's flaps were extended throughout the 19-second video and that the landing gear was retracting during the last few seconds of the video. The witness stated that he stopped recording because the airplane "was a little sluggish as it climbed out, but it seemed to be ok" and that he started recording again after he heard someone state that the airplane was not climbing; the witness then saw that the airplane "sank out of sight behind some trees."

Other witnesses observed the takeoff and departure. According to one of these witnesses, the airplane climbed to about 200 ft above ground level (agl) and then started to descend. This witness reported a quartering headwind at takeoff from the left to right side of the runway. Another witness, who was a Venom airplane pilot, indicated that the gear was retracting at a normal rate. None of the witnesses recalled hearing any unusual sounds from the airplane during takeoff, but one witness commented that he could not hear the accident airplane well because of noise from running airplane engines on the airport ramp. Three of these witnesses stated that the accident airplane appeared to have encountered the wake turbulence of the lead airplane.

An additional witness traveling east on a road near the departure end of the runway captured cell phone

video of the final 5 seconds of flight. The airplane is first seen heading away from the witness' position; at that time, the airplane was descending from an altitude of about 75 ft agl and was in a bank of about 25° to the left. The airplane then rolled to a wings-level attitude and continued to descend in a slightly nose-up attitude before impact. The landing gear and flaps appeared retracted in this video. The airplane impacted flat vegetated terrain, slid through a farm structure, and continued about 175 ft before coming to a stop.

Pilot Information

Certificate:	Private	Age:	50, Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	Seat Occupied:	Single
Other Aircraft Rating(s):	None	Restraint Used:	
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	Class 2 Without waivers/limitations	Last FAA Medical Exam:	April 16, 2018
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	De Havilland	Registration:	N747J
Model/Series:	DH112 VENOM FB54	Aircraft Category:	Airplane
Year of Manufacture:	1957	Amateur Built:	
Airworthiness Certificate:	Experimental (Special)	Serial Number:	J1747
Landing Gear Type:	Retractable - Tricycle	Seats:	1
Date/Type of Last Inspection:		Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	1 Turbo jet
Airframe Total Time:		Engine Manufacturer:	De Havilland
ELT:		Engine Model/Series:	Ghost
Registered Owner:		Rated Power:	5000 Lbs thrust
Operator:		Operating Certificate(s) Held:	None

The DH112 Venom airplane was designed as a post-World War II-era fighter jet. The witness who had experience flying Venom airplanes stated that the airplane was equipped with a split flap system and that the flaps were used more to provide drag than lift. The flap selector had three positions: up, ½, and full, and takeoffs were normally made with flaps ½ or up. The landing gear was powered by a hydraulic pump driven by the engine, so the landing gear could not retract if the engine were not rotating. The

Venom airplane pilot described the engine powering the airplane as "high airflow and thrust" and indicated that Venom airplanes could experience flameouts or compressor stalls when operating at high angles of attack and high-power settings. He stated that the Venom airplane had "excess power" and that the only ways for the airplane to be in a low energy state would be an engine flameout, engine failure, or engine shutdown. He added that the airplane would normally accelerate "very quickly" after takeoff if it leveled off at 200 ft.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	KSBM, 746 ft msl	Distance from Accident Site:	1 Nautical Miles
Observation Time:	20:53 Local	Direction from Accident Site:	305°
Lowest Cloud Condition:	Few / 1700 ft AGL	Visibility	10 miles
Lowest Ceiling:	Broken / 5500 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	9 knots /	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	130°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	29.63 inches Hg	Temperature/Dew Point:	24°C / 20°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Sheboygan, WI (SBM)	Type of Flight Plan Filed:	None
Destination:	Sheboygan, WI (SBM)	Type of Clearance:	None
Departure Time:	16:02 Local	Type of Airspace:	Class G

Airport Information

Airport:	SHEBOYGAN COUNTY MEMORIAL SBM	Runway Surface Type:	Asphalt
Airport Elevation:	755 ft msl	Runway Surface Condition:	Soft;Vegetation
Runway Used:	13	IFR Approach:	None
Runway Length/Width:	5002 ft / 75 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:		Aircraft Fire:	On-ground
Ground Injuries:	2 Serious	Aircraft Explosion:	On-ground
Total Injuries:	1 Fatal, 2 Serious	Latitude, Longitude:	43.760833,-87.834999(est)

The airplane came to rest amongst several farm buildings; the debris path was 200 ft in length and 40 ft wide. Postimpact fire consumed a large portion of the fuselage. The entire airplane was located at the accident site.

The engine remained attached to the fuselage. The compressor blades displayed some impact damage from about the five to the nine o'clock positions. No signs of foreign object damage were observed, and no evidence of catastrophic engine failure was noted.

Further examination of the engine showed that the part of the airplane around the tailpipe was still in place. The exterior of the airplane skin was burned and blistered, but the burn pattern was not linear, and there was no burn damage to the interior of the skin. The compressor impeller and turbine disk could not be rotated. The bifurcated inlet at the front of the engine was thermally destroyed. The front bearing could be rotated, but there was some resistance during rotation.

The compressor impeller was intact. Of the 19 impeller vanes, 8 consecutive vanes were missing portions coincident with where the compressor shroud was burned away. Four consecutive impeller vanes had circumferential rubbing on the leading edges with metal displaced opposite the direction of rotation.

The turbine vanes were in place and displayed no damage or thermal distress, and no metal spray was on the airfoils. The tailpipe was in place on the rear of the turbine case with no evidence of thermal distress. The tailcone was in place in the tailpipe, and the forward edge of the tailcone had three areas of circumferential rubbing with heat discoloration. One of these areas also had material transfer. The diameter of the forward edge of the tailcone corresponded to about a 90° arc of turbine blades that had about a 0.5-inch wide circumferential rub on the trailing edge.

No preimpact anomalies with the airframe and engine were found that would have precluded normal operation of the airplane.

Additional Information

Compressor Stall

According to aviationglossary.com

A Compressor Stall in a gas turbine engine is a condition in an axial-flow compressor in which one or more stages of rotor blades fail to pass air smoothly to the succeeding stages. A stall condition is caused by a pressure ratio that is incompatible with the engine rpm. Compressor stall will be indicated by a rise in exhaust temperature or rpm fluctuation, and if allowed to continue, may result in flameout and physical damage to the engine.

The resource indicates that the typical causes of compressor stalls are the following:

- *Excessive fuel flow caused by abrupt engine acceleration when the axial velocity (speed) is reduced by increased pressure in the combustion chamber due to the added combustion and the resultant rotational speed increase*
- *Operation of the engine outside of its RPM design parameters affecting the rotational speed of the compressor blade*
- *Turbulent or distorted / disrupted airflow to the engine inlet reducing the axial velocity*
- *Damage to either the compressor or turbine blades*
- *Low fuel flow due to abrupt engine deceleration causing a decreased back pressure*

The resource also indicates that compressor stalls can be transient and intermittent and provides the following information:

Indications of a transient/intermittent stall are usually an intermittent "bang" as backfire and flow reversal take place. If the stall develops and becomes steady, strong vibration and a loud roar may develop from the continuous flow reversal. Often, the flight deck gauges do not show a mild or transient stall, but they do indicate a developed stall. Typical instrument indications include fluctuations in rpm and an increase in exhaust gas temperature.

Wake Turbulence

The National Transportation Safety Board's report on the September 8, 1994, accident involving USAir flight 427 near Pittsburgh, Pennsylvania ([NTSB/AAR-99/01](#)), provided the following description of a wake vortex, which is also known as wake turbulence:

A counterrotating airmass trailing from an airplane's wingtips. The strength of the vortex is governed by the weight, speed, and shape of the wing of the generating aircraft; the greatest strength occurs when the wings of the generating aircraft are producing the most lift; that is, when the aircraft is heavy, in a clean configuration, and at a slow airspeed.

Medical and Pathological Information

The Sheboygan County Medical Examiner's Office, Sheboygan, Wisconsin, performed an autopsy on the pilot. His cause of death was multiple injuries.

Toxicology testing performed by the Wisconsin State Laboratory of Hygiene, Forensic Toxicology Laboratory, Madison, Wisconsin, identified diazepam (10 ng/ml) and nordiazepam (11 ng/ml) in the pilot's blood specimens.

Toxicology testing performed at the FAA Forensic Sciences Laboratory detected carbon monoxide in

the pilot's blood specimens. No ethanol was detected. In addition, loratadine was identified in the pilot's blood specimens; dextromethorphan and zolpidem were identified in the pilot's blood and urine specimens; and oxazepam, temazepam, and dextrophan were identified in the pilot's urine specimens.

Diazepam (commonly marketed with the name valium) is a long-acting sedating benzodiazepine available by prescription as a schedule IV-controlled substance. It is generally used to treat anxiety and muscle cramping. The lowest amount of diazepam thought to cause psychoactive effects is 100 ng/ml. Nordiazepam, oxazepam, and temazepam are metabolites of diazepam. Zolpidem is a short-acting prescription sleep aid that is considered impairing. Both diazepam and zolpidem carry warnings about driving and operating machinery. Dextromethorphan is an over-the-counter cough suppressant that is not sedating or impairing at usual doses. Dextrophan is a metabolite of dextromethorphan. Loratadine is an over the counter nonsedating antihistamine that is commonly marketed as Claritin and is not considered to be impairing.

Administrative Information

Investigator In Charge (IIC):	Vanover, Jackie
Additional Participating Persons:	Peter T Hupfer; FAA; Milwaukee, WI John Hammans; Ultimate Aviation; Ogden, UT
Original Publish Date:	August 25, 2020
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=97842

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