Aviation Investigation Final Report

Location:	White Hills, Arizona	**Accident Number:**	WPR22FA100
Date & Time:	February 19, 2022, 13:28 Local	**Registration:**	N787NV
Aircraft:	MOYNIHAN RICHARD D VANS RV-7A	**Aircraft Damage:**	Destroyed
Defining Event:	Aircraft structural failure	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was conducting a personal flight in his experimental, amateur-built airplane. The flight data revealed that the pilot made multiple 90-degree turns before the airplane's flight path became established over a highway. The airplane then entered a maneuver that was consistent with an aileron roll where it lost about 1,000 ft of altitude. A few minutes later the airplane entered a maneuver consistent with a split-S. Security video near the accident site captured the airplane in a steep nose-down descent before impacting the ground near airport hangars. Several objects from the airplane were seen falling to the ground south of the accident site. In another security video, an image of the airplane showed that the left horizontal stabilizer and elevator and the vertical stabilizer and rudder had separated from the empennage. A portion of the right horizontal stabilizer and elevator remained attached to the empennage. The left wing tip and canopy also separated. The accident site debris field revealed that the rudder and rudder surface skin were the furthest separated components from the impact crater and main wreckage, indicating that the rudder was likely the first component to fail. The remaining separated components were found in the debris field.

The airplane data revealed that the pilot entered the split-S maneuver at an airspeed that exceeded the published manufacturer's airspeed for that maneuver. The airplane then rolled to an inverted position and pitched down causing the airspeed to increase dramatically. The last recorded data point, at an altitude about 3,199 ft, showed the airspeed was 248 KIAS (262 KTAS), well above the published never exceed speed of 200 knots. The high airspeed allowed rudder flutter to occur, resulting in an in-flight breakup and subsequent impact with terrain.

A postaccident examination of the airframe revealed damage consistent with an in-flight rudder flutter event that resulted in an in-flight breakup and subsequent impact with terrain.

There were no indications of any pre-existing cracks or anomalies with the airframe structures, and no pre-accident anomalies were observed that would have precluded normal control of the airplane.

Probable Cause and Findings

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

The pilot's improper aerobatic maneuver leading to an airspeed that exceeded the airplane's design limits, which resulted in rudder flutter and an in-flight breakup.

Findings

Aircraft	Airspeed - Capability exceeded
Aircraft	Airspeed - Capability exceeded
Personnel issues	Aircraft control - Pilot

Factual Information

History of Flight

Maneuvering	Aircraft structural failure (Defining event)

On February 19, 2022, about 1328 mountain standard time, an experimental, amateur-built Vans RV-7A airplane, N787NV, was destroyed when it was involved in an accident near White Hills, Arizona. The pilot was fatally injured. The airplane was operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

Recorded automatic dependent surveillance-broadcast (ADS-B) data and recorded data from the airplane showed that the airplane departed from Boulder City Municipal Airport (BVU), Boulder City, Nevada, about 1315, climbed to about 5,500 ft mean sea level (msl), and traveled east for about 7 minutes, making several wide 90-degree turns. After crossing US Highway 93 the airplane track turned right and tracked above the highway. A few seconds later the airplane data showed a maneuver consistent with an aileron roll followed by a rapid descent about 1,000 ft before regaining its prior altitude and track above the highway. About 2 minutes later, near Triangle Airpark (AZ50), White Hills, Arizona, the airplane data showed a slight turn to the right and a maneuver consistent with a split-S before it descended rapidly to the left over the accident site.

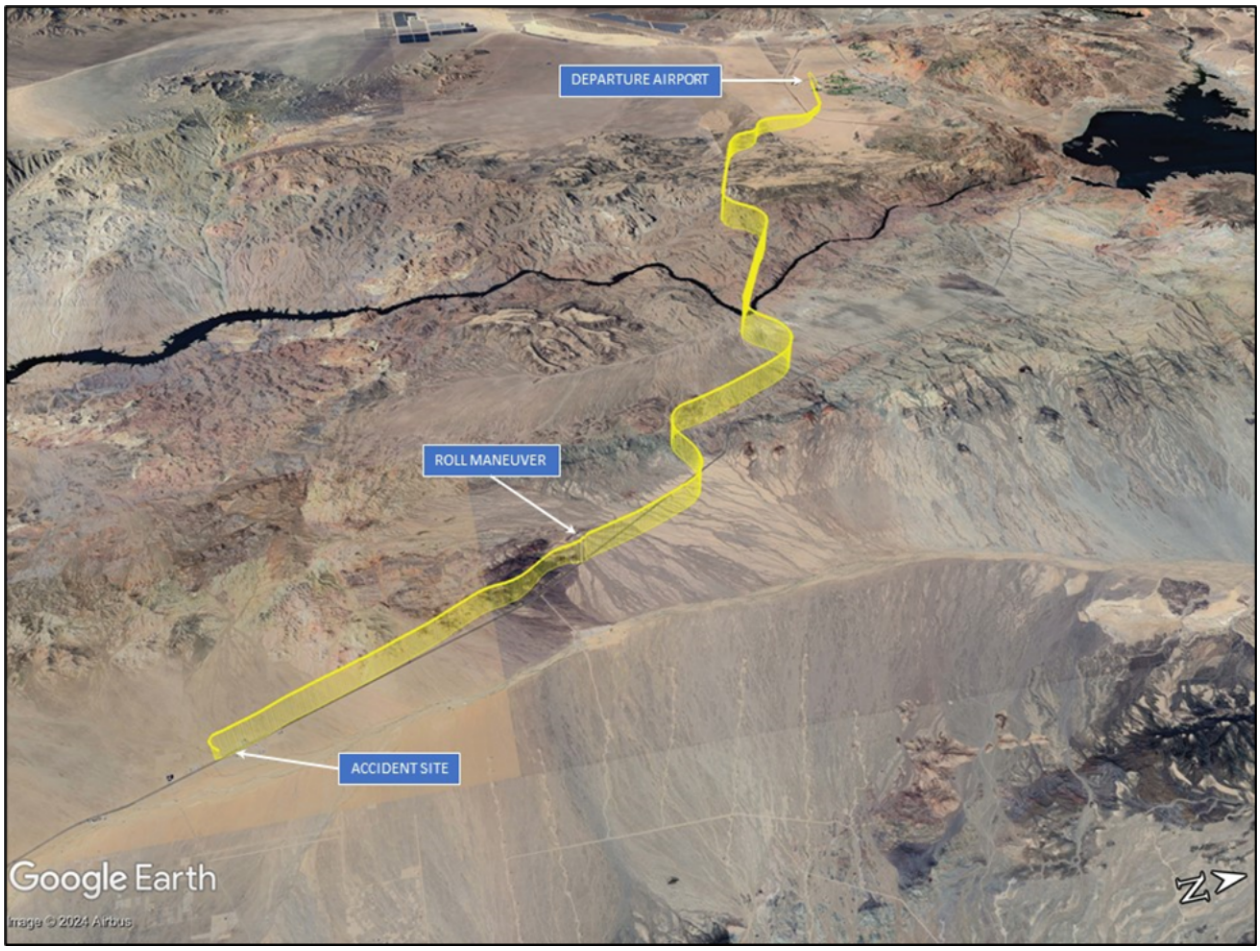

Figure 1. Dynon accident flight track data.

A Dynon SkyView D1000 panel-mounted display was recovered from the wreckage and sent to the National Transportation Safety Board (NTSB) Vehicle Recorders Division. The data showed the airplane was in cruise flight to the southwest at a GPS altitude about 5,600 ft msl in the minutes before the accident. About 3 minutes before the last recorded data point, the data showed the airplane was wings-level about 5,575 ft msl, at an airspeed about 137 KIAS (150 KTAS) when a left roll maneuver began. The airplane rolled more than 360° in about 10 seconds and lost about 1,000 ft of altitude. The throttle was not reduced during the maneuver. During the next 2.5 minutes the airplane was mostly wings-level while climbing to its initial course. About 11.5 seconds before the last recorded data point, the airplane was in a wings-level attitude about 5,609 ft msl, at an airspeed about 138 KIAS (150 KTAS) with a slight nose up-pitch about 1.8° and a vertical climb rate about 215 ft/min, when a right roll maneuver began. During the maneuver the airplane rolled right to a maximum recorded angle about 166° and the pitch angle decreased continuously to about 62° nose down. The descent rate increased to 9,587 fpm in 7 seconds before being recorded at 9,999 fpm for the final 4.5 seconds. The throttle was not reduced during the maneuver. The last recorded data point showed the airplane about 3,199 ft msl, an airspeed about 248 KIAS (262 KTAS), a magnetic

heading about 307°, a nose-down pitch about 61.7°, a right roll about 133.1°, and a vertical acceleration about 4.1 g. (See Figure 2.)

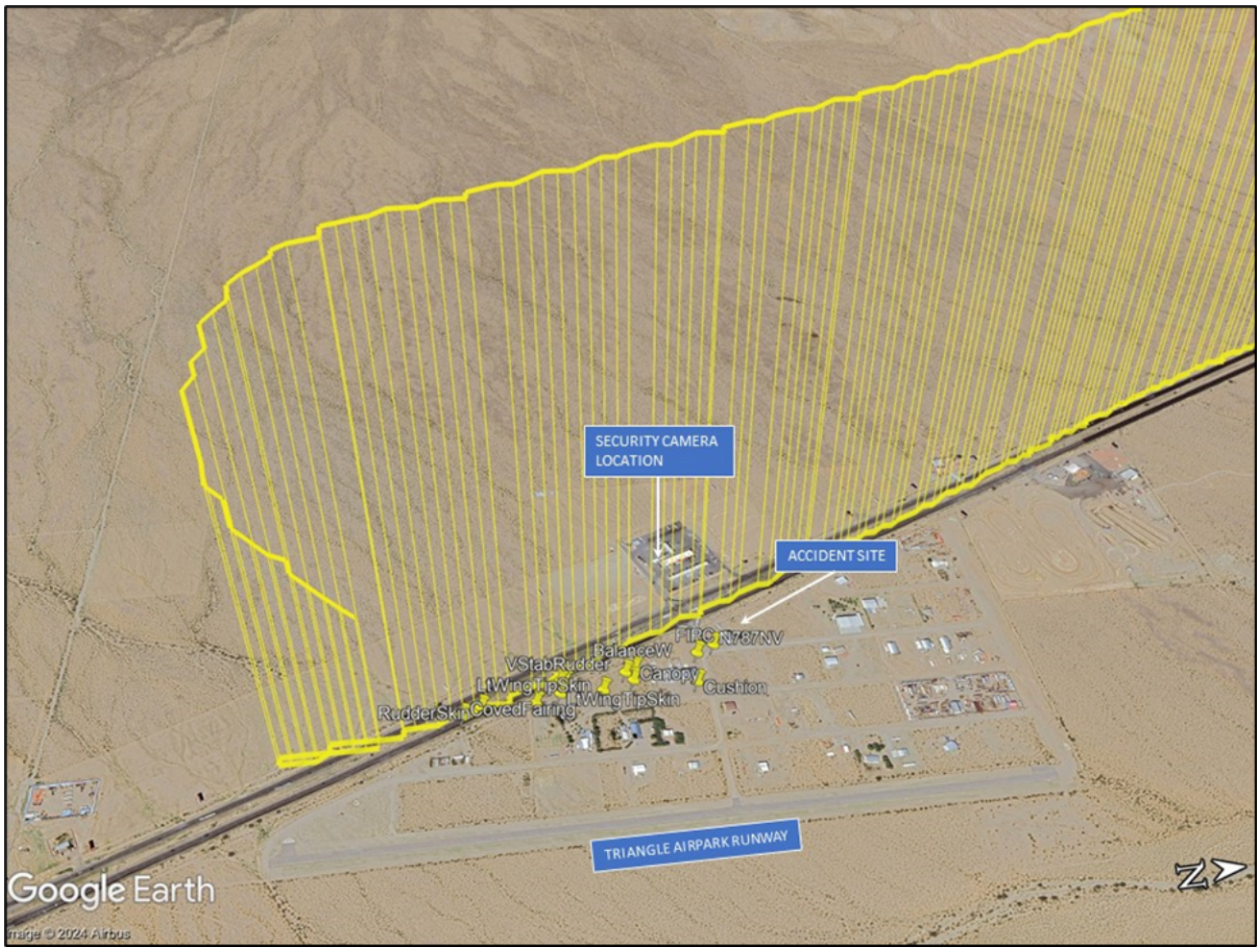

Figure 2. Dynon flight track data.

Security video near the accident site captured the airplane in a steep nose-down descent before impacting the ground near hangars at AZ50. Several other objects were seen falling to the ground south of the accident site. Video image sequencing helped illustrate the accident sequence flight path. (See Figure 3.) Another video near the impact crater captured the airplane moments before impact with the ground. An image of the airplane shows that the left horizontal stabilizer and elevator, and the vertical stabilizer and rudder, were not attached to the airplane. A portion of the right horizontal stabilizer and elevator remained attached. The left wing tip and canopy were also not attached to the airplane. (See Figure 4.)

The pilot held an airline transport pilot certificate with several transport category aircraft type ratings. He held airplane single-engine and multiengine-land endorsements. No evidence of acrobatic training was found during the investigation.

The pilot was the owner/builder of the accident airplane, which was completed in 2019. A section of the airplane's POH titled Aerobatic Information indicated a weight limitation of 1,600

pounds and the following recommended entry speeds for the listed maneuvers: Loops, Horizontal Eights 122-165 knots, Immelmann Turns 130-165 knots, Aileron Rolls, Barrel Rolls 104-165 knots, Snap Rolls 69-95 knots, Vertical Rolls 156-165 knots, and Split-S 87-96 knots. These were consistent with the information published by the manufacturer. The calculated weight of the accident airplane at the time of the left roll maneuver was 1,663.4 pounds and at the time of the split-S maneuver was 1,661.6 pounds, which exceeded the maximum weight for aerobatics for both maneuvers flown during the accident flight.

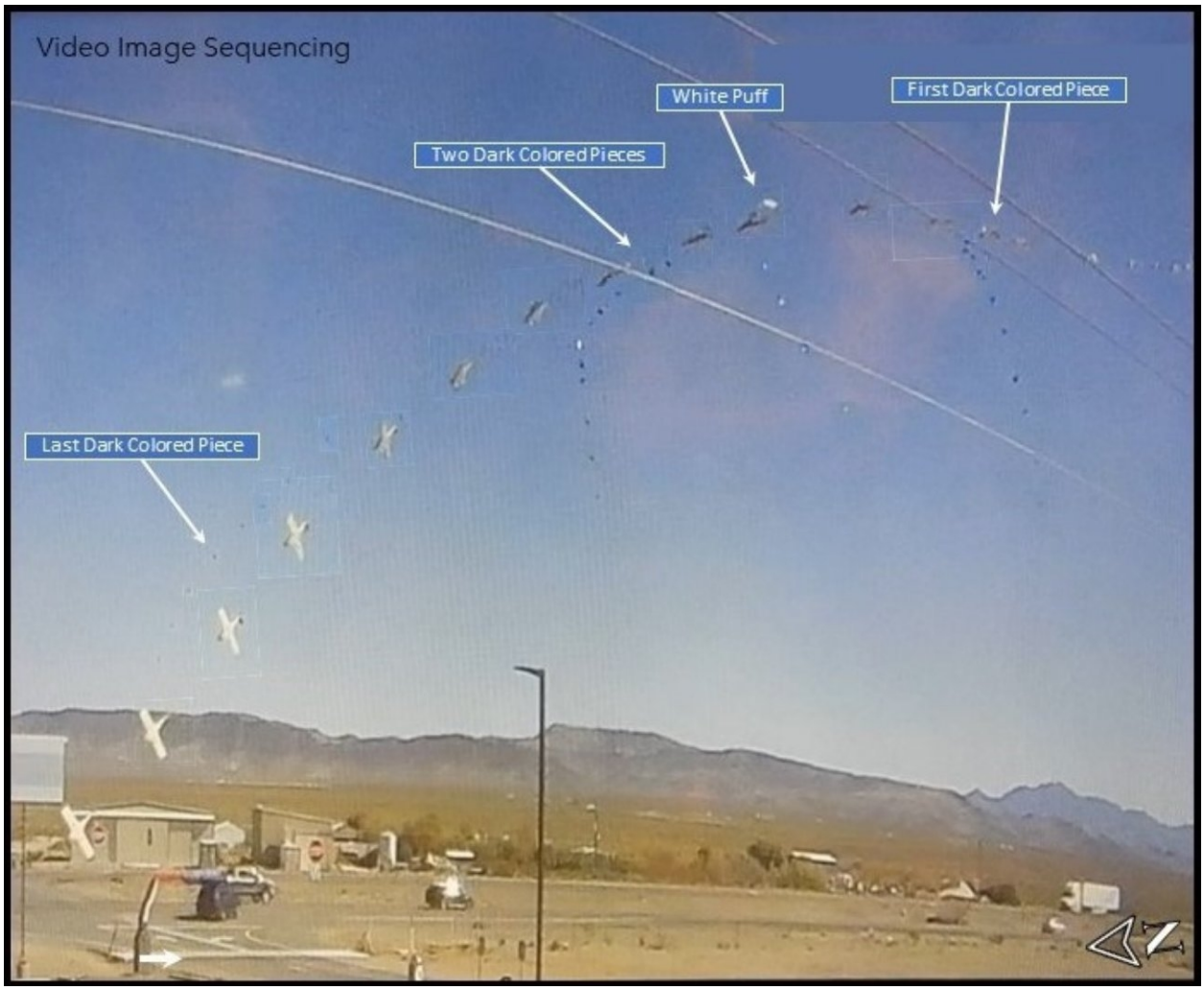

Figure 3. Video image sequencing.

Figure 4. Video image of the airplane before impacting the ground.

A postaccident examination of the accident site revealed that the debris field was about 1,500 ft long and on a directional heading of about 345°. The debris field was located along the north side of the highway and spread along the airport property. The vertical stabilizer and attached upper section of the rudder and rudder surface skin were found along the side of the highway and were the pieces of the airplane furthest from the impact crater and main wreckage. The left horizontal stabilizer, left elevator, left wingtip fairing, and the sliding canopy were found near the middle of the debris field. The remaining flight controls were found near the main

wreckage. The main wreckage was found near the impact crater and had extensive impact damage.

A postaccident examination of the engine did not reveal any preimpact anomalies that would have precluded normal operation. The postaccident examination of the airframe revealed damage consistent with an in-flight rudder flutter event.

Additional Information

During the investigation, several in-flight breakup events were reviewed that involved various Van's airplane models. Each of these events had damage characteristics similar to the accident. (See the Structures Group Chair's Factual Report in the public docket for the details of the events.) The events can be generally grouped into two separate types of events: maneuvering events or weather encounters. In most of the maneuvering type events, the data showed aerobatic maneuvers that preceded the loss of control, an increase in airspeed, and subsequent in-flight breakup. The maximum permissible airspeed under any condition, VNE, should be marked on the airspeed indicator with a red line and is defined by Van's for the RV-7/7A as 200 knots (230 mph). Clarifying information was added to the Construction Manual, Section 15, at Revision 9 on December 5, 2023, specifying that the red line marking for VNE is for both indicated and true airspeeds. Before this the VNE was listed as indicated airspeed.

Flutter is an aeroelastic phenomenon that can occur when an airplane's natural mode of structural vibration couples with the aerodynamic forces to produce a rapid periodic motion, oscillation, or vibration. Flutter can be somewhat stable if the natural damping of the structure prevents an increase in the forces and motions. Flutter can become dynamically unstable if the damping is not adequate or speed is increased, resulting in increasing self-excited destructive forces being applied to the structure. Flutter can range from an annoying buzz of a flight control or aerodynamic surface to a violent destructive failure of the structure in a very short period of time. Due to the high frequency of oscillation, even when flutter is on the verge of becoming catastrophic, it can still be very hard to detect. Aircraft speed, structural stiffness, and mass distribution are three inputs that govern flutter. An increase in airspeed, a reduction in structural stiffness, or a change in mass distribution can increase the susceptibility to flutter.

True airspeed (TAS) represents the actual speed of the airplane through the air or the velocity of the air relative to the aerodynamic surface. The speed information available to the pilot with conventional analog gauges is indicated airspeed (IAS), which is based on the difference between static and dynamic pressure as measured by the pitot-static system. IAS is generally what is displayed on an EFIS but they can be configured to also display TAS. TAS and IAS are the same on a standard day at sea level. Since TAS is directly related to the density of the air, any change in altitude or variation from standard temperature will result in TAS and IAS being different. As altitude or temperature increase, the density decreases, and TAS will be higher than IAS. For airplanes that operate at much higher speeds and altitudes than a typical general aviation airplane such as a Van's, the difference between IAS and TAS can be significant.

The airplane manufacturer had performed flutter testing of the factory prototype of each model to establish the true and indicated never exceed speeds. The RV-7 was flight tested to 220 knots true airspeed (1.1VNE). A design envelope margin of safety was established above the dive test speed based on design standards for ground vibration testing. The airplane manufacturer contracted with an outside company to perform a ground vibration test and flutter analysis for the accident airplane model. The ground vibration test for the RV-7 showed that the first flutter mode that manifests itself with increasing airspeed is a fuselage side bending vibration mode that couples with a rudder flutter mode. The rudder damping for this mode is dependent on the true airspeed. The ground vibration testing results showed that the accident airplane model was free from flutter within the design envelope.

Pilot Information

Certificate:	Airline transport; Commercial; Flight engineer; Flight instructor	**Age:**	72,Male
Airplane Rating(s):	Single-engine land; Single-engine sea	**Seat Occupied:**	Unknown
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine	**Toxicology Performed:**	
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	September 1, 2019
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	25200 hours (Total, all aircraft), 25 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	MOYNIHAN RICHARD D	**Registration:**	N787NV
Model/Series:	VANS RV-7A	**Aircraft Category:**	Airplane
Year of Manufacture:	2019	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	72097
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:		**Engine Manufacturer:**	LYCOMING
ELT:		**Engine Model/Series:**	YIO-360-M1B
Registered Owner:	MOYNIHAN RICHARD D	**Rated Power:**	180 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KBVU,2202 ft msl	**Distance from Accident Site:**	23 Nautical Miles
Observation Time:	13:35 Local	**Direction from Accident Site:**	307°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	50°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.11 inches Hg	**Temperature/Dew Point:**	20°C / -9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Boulder City, NV (BVU)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	13:15 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	TRIANGLE AIRPARK AZ50	**Runway Surface Type:**	
Airport Elevation:	2460 ft msl	**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	35.715546,-114.482

Administrative Information

Investigator In Charge (IIC):	Swick, Andrew
Additional Participating Persons:	Carey Atnip; FAA-FSDO; Las Vegas, NV Mark Platt; Lycoming Engines; Phoenix, AZ Rian Johnson; Van's Aircraft ; Aurora, OR Robert Lind; LTG Aerospace; Seattle, WA
Original Publish Date:	May 1, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=104670

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The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available here.