Aviation Investigation Final Report

Location:	Hurricane, Utah	**Accident Number:**	WPR16FA036
Date & Time:	December 10, 2015, 13:47 Local	**Registration:**	N307AB
Aircraft:	BARNETT ALLEN S RV7	**Aircraft Damage:**	Substantial
Defining Event:	Aircraft structural failure	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The airline transport pilot was conducting a local personal flight in the experimental amateur built airplane, with one passenger on board. Several witnesses located near the accident site reported that they heard the airplane's engine and that it sounded like it was making power changes. The witnesses added that they then saw airplane debris floating in the air. One witness stated that the engine was running during the entire descent and that he saw the airplane spiraling and descending in a cork-screw type maneuver. Another witness reported seeing the airplane inverted at a low altitude just before impact.

Postaccident examination of the airplane revealed that the vertical stabilizer, with about half the upper rudder still attached, separated from the airplane and was recovered mostly intact farthest from the main wreckage. The vertical stabilizer separated in a leading-edge-left direction in overload. The damage to the horizontal stabilizers and elevators ~~that~~ was consistent with a downward failure in positive overload. The damage observed on the wings was consistent with a downward failure in negative overload. Additionally, there were no indications of any pre-existing cracks in or anomalies with the vertical stabilizer, horizontal stabilizers, elevators, or wing structures, and no pre-accident anomalies were observed that would have precluded normal control of the airplane. ~~The loads required to fail the horizontal stabilizers and elevators cannot be generated from normal flight or control movements. Such failures would have required an abrupt pull back on the stick and corresponding movement of the elevator to a trailing-edge-up position, at speeds greater than the airplane's maneuvering speed. Failure of the horizontal tail first would have caused the airplane to pitch down rapidly, producing air loads on the upper surface of the wing that were sufficient to fail them in negative overload.~~

The recovered photographic information showed the pilot performed a split-S maneuver that likely caused the airplane's speed to increase rapidly. The speed increased above V_{NE} and excited the rudder flutter mode, causing the vertical stabilizer to separate due to overload. The photographs confirmed the vertical stabilizer separation as the airplane

neared completion of the maneuver. The rudder flutter mode excited the horizontal stabilizer flutter mode causing them to fail downward due to overload. The airplane then rapidly pitched over, buckling the right wing and separating the left wing. The photographic evidence confirmed the rapid pitch over after the separation of the vertical stabilizer.

~~A review of the weather information indicated that there were likely low-level winds gusting from 26 to 46 knots at the time of the accident and that moderate-to-severe turbulence likely existed at the accident site. The weather conditions likely contributed to the in-flight breakup by either aggravating a flight maneuver or preventing a recovery from a loss of airplane control.~~

Although doxylamine was detected in the pilot's liver it was not detected in the blood; therefore, it is unlikely that it ~~was causing~~caused any performance decrements that would have affected the pilot at the time of the accident.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's aerobatic maneuver leading to airspeeds above the airplane's never exceed speed, which resulted in rudder flutter and an in-flight breakup. ~~The pilot's abrupt flight control inputs, likely above the maneuvering speed, in severe winds and turbulence conditions, which resulted in an in-flight breakup.~~

Findings

Personnel issues	Use of equip/system - Pilot
	Aircraft control – Pilot
	Monitoring equip/instruments - Pilot
Aircraft	~~(general) - Not attained/maintained~~
	Airspeed – Capability exceeded
	Rudder – Capability exceeded
~~**Environmental issues**~~	~~(general) - Effect on operation~~
~~**Environmental issues**~~	~~(general) - Effect on equipment~~
~~**Environmental issues**~~	~~Gusts - Effect on operation~~

Factual Information

History of Flight

Maneuvering aerobatics	Loss of control in flight
Maneuvering aerobatics	Aircraft structural failure (Defining event)
Maneuvering aerobatics	Part(s) separation from AC
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On December 10, 2015, about 1347 mountain standard time, an experimental amateur built, RV-7 airplane, N307AB, experienced an in-flight break up and then impacted terrain about 3 miles west of General Dick Stout Field Airport, Hurricane, Utah. The airline transport pilot and passenger were fatally injured, and the airplane sustained substantial damage. The airplane was registered to and was being operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions existed near the accident site about the time of the accident, and no flight plan had been filed. The local flight departed from an unknown airport at an undetermined time.

Several witnesses located near the accident site stated that they heard the airplane's engine and that it sounded like it was making power changes. The witnesses added that they saw airplane debris floating in the air. One witness stated that the engine was running during the entire descent and that he also observed the airplane spiraling and descending in a cork-screw type maneuver. Another witness reported seeing the airplane inverted at a low altitude just before impact.

Pilot Information

Certificate:	Airline transport	**Age:**	56,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Unknown
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	October 22, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 17359 hours (Total, all aircraft)		

Passenger Information

Certificate:		**Age:**	49,Female
Airplane Rating(s):		**Seat Occupied:**	Unknown
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	No
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

The pilot~~,~~ held an airline transport pilot certificate with airplane multiengine land, single-engine land, instrument, and instructor single-engine land ratings. The pilot was issued a first-class Federal Aviation Administration airman medical certificate on October 22, 2015, with the limitation that he must have glasses available for near vision. The pilot reported on his most recent medical certificate application that he had accumulated 17,359 total flight hours, 403 ~~flight hours~~ of which were accumulated in the previous 180 days.

Aircraft and Owner/Operator Information

Aircraft Make:	BARNETT ALLEN S	**Registration:**	N307AB
Model/Series:	RV7 UNDESIGNAT	**Aircraft Category:**	Airplane
Year of Manufacture:	2011	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	73395
Landing Gear Type:	Tailwheel	**Seats:**	2
Date/Type of Last Inspection:	May 15, 2015 Condition	**Certified Max Gross Wt.:**	1800 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	258.9 Hrs as of last inspection	**Engine Manufacturer:**	ECI/Titan
ELT:	C91A installed, activated, did not aid in locating accident	**Engine Model/Series:**	IO-360-A4H9N
Registered Owner:	On file	**Rated Power:**	180 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The two-seat, low-wing, fixed-gear airplane~~,~~ was assembled in 2011, and it was issued an airworthiness certificate certified for aerobatic maneuvers in March 2011. It was powered by an experimental 180-~~-~~horsepower ECI/Titan IO-360 reciprocating engine. The engine was equipped with a Whirlwind 200RV propeller. The last documented inspection was a conditional inspection ~~that was completed~~ on May 15, 2015, at an airframe time of 258.9 hours.

The airplane's kit manufacturer website listed the maximum load factor as positive +6 *g*, and athe minimum load factor as -3 *g*, and the never exceed speed (V_{NE}) as 230 mph in Section 15 of the RV-7/7A Construction Manual. Additionally, the kit manufacturerPilot's Operating Handbook listeds the maneuvering speed (Va) as 142 mph a maximum aerobatic gross weight of 1,600 pounds in Section 14 of the Construction Manual. In the remarks, it stated, "do not make full control movements above this speed. Full elevator deflection will result in a 6g load at this speed." Any speed greater than Va with full control application could result in g-loads that exceeded the design limits.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	SGU,2884 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	14:15 Local	**Direction from Accident Site:**	230°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	310°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.86 inches Hg	**Temperature/Dew Point:**	12°C / -2°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:		**Type of Flight Plan Filed:**	None
Destination:	Hurricane, UT	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

The 1355 recorded weather observation at Saint George Regional Airport, Saint George, Utah, located about 12 miles west-southwest from the accident site, reported calm wind, visibility of 10 statute miles, clear skies, temperature 12°C, dew point -2°C, and an altimeter setting of 29.87 inches of mercury.

The accident site was located between a cold front to the northwest and a high-pressure area to the southwest, in an area of strong-pressure gradient. A model sounding, which included a wind profile, for the area over the accident site about the time of the accident, estimated that the surface horizontal wind speed was estimated to be 220° at 8 knots, with winds increasing in speed with height and veering to the west. The mean 0-to-18,000 ft mean sea level (msl) winds were from 250° at 52 knots. The model supported light-to-moderate clear air turbulence from 6,400 through 8,000 ft msl, and mountain wave development from 10,000 to 12,000 ft msl.

Pilot reports noted evidence of mountain wave activity in the region but with moderate-to-severe turbulence near the accident site, at 6,500 ft msl, consistent with the model sounding. An AIRMET for moderate turbulence below 18,000 ft was active over the accident site at the accident time. No SIGMET was active for the accident site at the accident time.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	37.080001,-113.209999

The airplane wreckage was located about 4.2 miles southwest of Hurricane, Utah, on flat sagebrush--covered terrain on top of a mesa. The debris path was about 1,460 ft long and 450 ft wide. All major components of the airplane were located in the debris path.

The main airplane wreckage was located almost at the northern extent of the debris field and included the fuselage, engine, right wing, half of the left wing, a majority of the left and right elevators, and the lower half of the rudder. The vertical stabilizer with the upper half of the rudder attached was located at the southern extent of the debris field, ~~located~~ about 1,420 ft south-southwest of the main wreckage. The left and right horizontal stabilizers were located about 850 ft and 790 ft, respectively, south of the main wreckage. The left aileron was located about 430 ft south-southwest of the main wreckage, and the left outboard wing was located about 320 ft south-southwest of the main wreckage.

The main wreckage was found inverted. There were no noticeable ground scars leading up to the wreckage. The fuselage was intact, but the upper half was crushed. The canopy frame was separated from the airframe and located about 55 ft northeast of the main wreckage. Most of the acrylic canopy was fractured from the frame and found in many pieces in the debris field. The engine remained attached to the fuselage. One of the composite propeller blades was fractured from the hub and the other blade was missing the tip portion. Debris consistent with propeller material was found around the main wreckage. The examination of the engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation. The main landing gear remained attached to the lower fuselage, and there was some deformation at the attachment points.

The entire right wing remained attached to the fuselage with the flap and aileron attached. The right flap was in the "up" position. The outboard half of the right wing was deformed downward about 15° to 20° at the flap/aileron junction, located about 57 inches outboard of the wing attachment point. The upper and lower wing skins were buckled around the area where the wing was deformed downward. The right fiberglass wingtip remained attached to the wing but was splayed open at the trailing edge.

The inboard half of the left wing remained attached to the fuselage with the flap attached. The left flap was in the "up" position. The outboard half of the left wing had separated at the flap/aileron junction located about 57 inches outboard of the wing attachment point. The main spar fractured at the location where the upper and lower spar caps undergo a net section decrease from inboard to outboard. The outboard half of the left wing was mostly intact with minimal damage noted.

Medical and Pathological Information

The Utah Department of Health, Office of the Medical Examiner, conducted an autopsy on the pilot. The medical examiner determined that the cause of death was "blunt force trauma."

The Federal Aviation Administration's Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicological testing of specimens from the pilot. Testing results were negative for carbon monoxide, cyanide, and volatiles. The testing detected doxylamine in the liver but not in the blood, and ibuprofen in the blood.

Doxylamine is an over-the-counter antihistamine medication that can be used in combination with decongestants and other medications to relieve sneezing, runny nose, and nasal congestion caused by the common cold. It can be sedating. Ibuprofen is used to reduce fever and to relieve minor aches and pains from headaches, muscle aches, arthritis, the common cold, and other such ailments.

Tests and Research

Structures Examination

The vertical stabilizer separated mostly intact from the airplane during the accident sequence and had the upper portion of the rudder attached. The forward spar was fractured just above its attachment to the horizontal stabilizer front spar. The rear spar was fractured and twisted just above the stabilizer shelf, consistent with the vertical stabilizer separating leading edge left. Most of the upper half of the rudder remained attached at the upper and center hinge points. The lower half remained attached to the empennage. The rudder trailing edge was splayed open, and the trailing edge strip remained attached to the left rudder skin on both halves. There was evidence of sealant between the rudder skins and trailing edge strip. The rudder was fractured spanwise just below the center hinge. The rudder counterweight was separated from the upper end of the rudder just above the upper skin stiffeners (see figure).

Figure. Vertical stabilizer and attached rudder.

The center portion of the horizontal stabilizer forward spar, most of the horizontal stabilizer rear spar, and most of the left and right elevators remained attached to the fuselage. The horizontal stabilizer forward and rear spars ~~fractured about 2 inches outboard of the side of the fuselage on both sides. Both of the horizontal stabilizer spar caps~~ were deformed down and aft ~~at the fracture location~~. The elevators were deformed down and aft matching the spar deformation. The left and right horizontal stabilizers were found in the debris field. There was buckling damage on the lower skin of both horizontal stabilizers consistent with the stabilizers separating downward.

~~A postaccident e~~Examination of the inboard and outboard left wing sections at the fracture location revealed that the fracture~~s~~ exhibited damage and deformation consistent with the separation of the outboard portion of the wing in a downward direction.

~~The outboard elevator hinges remained attached to both stabilizers and the hinges were pulled from the elevators. About 18 inches of the outboard portion of horizontal stabilizer rear spar on each side remained installed in the horizontal stabilizers. The upper and lower skins separated from the remainder of the rear spar along the rivet lines.~~

Control continuity was established from the cockpit controls to the elevators and the right

aileron. The left aileron control rod aft rod end was fractured from the control rod. The rod end remained attached to the aileron control horn at the inboard aileron hinge. Control continuity was established from the control stick in the cockpit to the left aileron bell crank and aft to the fracture point on the left aileron control rod. The rudder cables were jammed somewhere in the fuselage, and control continuity could not be established, but the cables remained attached at the rudder and the pedals.

All the fractures exhibited a dull, grainy appearance consistent with overstress separation. There was no evidence of progressive or pre-existing fractures on any of the parts.

~~Flutter~~

Flutter is an aeroelastic phenomenon that can occur when an airplane's natural mode of structural vibration couples with the aerodynamic forces acting on the airplane 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.

Van's contracted with an outside company to perform a flutter analysis for the RV-8 airplane. The analysis was completed in October 1998. The company performed a ground vibration test (GVT) on an RV-8 airplane at the Van's factory in the zero fuel and full fuel configurations to establish the natural modes of vibration for the airplane. This information was used to perform a flutter analysis at a simulated altitude of 10,000 ft up to V_d of 256 mph or 220 knots. The results of the analysis showed the RV-8 airplane to be free from flutter above the design envelope with the control surface balance weights provided by Van's.

Since the RV-7 airplane is a derivative of the RV-8 with a wider cabin, the results of the RV-8 flutter analysis were used for the RV-7. The RV-7 flutter analysis was completed by the same company in April 2001. A GVT was performed on the RV-7 airplane with zero fuel to evaluate the changes in vibration modes. The GVT showed that the wing vibration modes differed enough to require a flutter analysis, while the tail modes were essentially the same as for the RV-8. The analysis concluded that the RV-7 wing was free of flutter to speeds well above the dive speed of the airplane. The tail flutter analysis results from the RV-8 were applicable to the RV-7.

According to Van's, the rudder used on the RV-7 airplanes was sized to meet the spin recovery requirements in the Part 23 regulations. The GVTs conducted for the RV-7 airplanes show 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 density of the air flowing over the rudder and thus is dependent on the true airspeed of the airplane. The tests accounted for changes in the rudder counterbalance mass. The tests showed the existing rudder counterbalance

mass was sufficient to account for variations in paint and the addition of a taillight to the rudder. The GVTs and flutter analyses performed showed that the airplanes are free of flutter beyond the design never exceed speed. Van's also showed the airplanes to be free of flutter up to the design demonstrated dive speed for each of the models. Van's noted that the rudders analyzed and tested were built according to the design and did not incorporate any additions such as servo-controlled trim tabs.

Also according to Van's, the GVTs showed that at even higher airspeeds flutter modes involving wing symmetric bending, aileron rotation, and horizontal stabilizer bending and torsion manifest. The tests accounted for changes in the fuel load on the airplane. The analysis indicated that these flutter modes may interact with each other to exacerbate the response. Based on flight testing, GVT results, and flutter analyses, Van's concluded that the airplanes meet the requirements in Part 23 regulations and are free from flutter as designed and built when operated within the prescribed flight envelope.

Electronic Devices

No flight data for the accident flight could be recovered from the electronic devices found in the wreckage. However, a GoPro Hero 4 camera, which had sustained significant impact damage, ~~revealed~~ contained two files recorded on previous flights in which the accident airplane performed an aileron roll to the right. In 2022, the National Transportation Safety Board began using an updated file carving process to retrieve data from electronic devices. The updated file carving method produced a number of video fragments consistent with the files recovered in December 2015; however, the process also produced a number of JPEG files that were not recovered previously. Of the recovered JPEG files, 29 files were consistent with having been recorded on the accident flight. These files' metadata suggested they were captured in a time lapsed still image mode, which is a capture mode that initiates recording of a JPEG sequence when the user presses the device's shutter button. More than half the images in the timelapse mode captured the accident sequence.

Based on comparison of terrain features, buildings, and lakes between several photos and Google Earth, the airplane was initially heading southbound over a sparsely populated mesa southwest of Hurricane. In some of the photos, the pilot and passenger were looking toward the pilot's lap. In some, they were looking towards the GoPro, and at times during the maneuver, the pilot was looking downward. The pilot appeared to roll the airplane right to an inverted position and appeared to pull back into a split-S maneuver that resulted in a northbound heading. As the airplane almost returned to wings level, it appeared that the vertical stabilizer was no longer with the aircraft. Between two of the later photos, the airplane went from an almost wings level attitude to inverted with an apparent substantial negative *g* load.

~~Radar Data:~~

~~A review of the radar track from commercially available sources revealed two tracks that were consistent with the accident airplane. The first track was 17 minutes long and ended at 1332 when the airplane was at 6,150 ft. Altitudes throughout the track varied from 6,150 to 9,350 ft, and the groundspeed varied between 24 and 168 knots. Most of the first half of the track show the airplane climbing, and the second half of the track shows the airplane descending. The track shows the airplane flying west and then performing a couple of circling maneuvers and in slow flight. The airplane then turned south and shortly thereafter, it makes a right northerly turn.~~

~~The second track, which may be associated with the accident airplane, started at 1336 when the airplane was at 6,625 ft. The data only shows 1 minute of flight. The heading is nearly south, and the groundspeed range is between 127 and 133 knots.~~

Weight and Balance

The distribution of the airplane contents throughout the debris field prevented an accurate weight and balance assessment, and the airplane's most recent weight and balance records were not located.

Therefore, an estimated weight and balance calculation was conducted. According to the airplane's kit manufacturer, the airplane had a maximum factory basic weight of 1,114 lbs and a useful load of 686 lbs. The medical examiner reported that the total weight of the occupants was 306 lbs. Assuming a total fuel load of 42 gallons, the airplane would have been about ~~128~~ 72 lbs ~~below~~ above its maximum aerobatic gross weight of 1,68~~-~~00 lbs at the time of the accident.

Administrative Information

Investigator In Charge (IIC):	Nixon, Albert
Additional Participating Persons:	Mark M Rushton; Federal Aviation Administration; Salt Lake City, UT
Original Publish Date:	August 14, 2017
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=92425