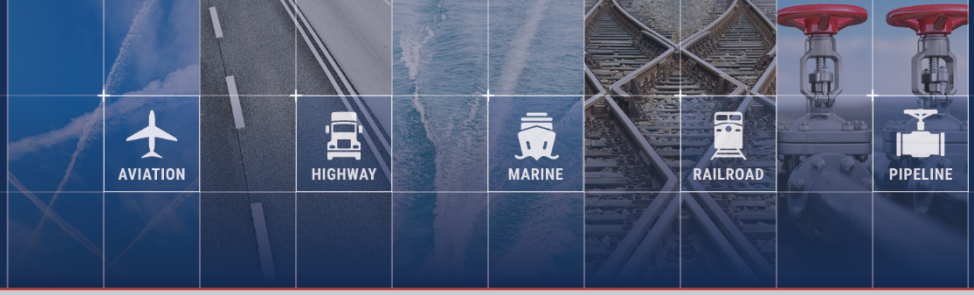

Aviation Investigation Final Report

Location:	INMAN, Kansas	**Accident Number:**	CHI94FA097
Date & Time:	March 5, 1994, 08:30 Local	**Registration:**	N2495L
Aircraft:	PIPER PA-38-112	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

THE PURPOSE OF THE FLIGHT WAS TO PROVIDE A BIENNIAL FLIGHT REVIEW FOR A PRIVATE PILOT WITH ABOUT 100 HOURS TOTAL FLIGHT TIME. WITNESSES OBSERVED THE AIRPLANE SPIN 5 OR 6 TURNS TO THE LEFT & REPORTED THAT THE AIRPLANE STOPPED ROTATING JUST BEFORE IT STRUCK THE GROUND. THE SPIN IS BELIEVED TO HAVE OCCURRED INADVERTENTLY WHILE THE PRIVATE PILOT WAS DEMONSTRATING A STALL OR SLOW FLIGHT. ALTHOUGH THE PA-38 HAS FOUR NON-ADJUSTABLE STALL STRIPS, INTENDED TO IMPROVE ITS LATERAL-DIRECTIONAL CHARACTERISTICS, ITS STALL/SPIN ACCIDENT RATE IS SIGNIFICANTLY HIGHER THAN COMPARABLE TRAINER-TYPE AIRPLANES.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: AN UNINTENTIONAL SPIN WHICH OCCURRED DURING THE MANEUVERING PHASE OF A BIENNIAL FLIGHT REVIEW. A FACTOR RELATED TO THE ACCIDENT WAS: THE AIRPLANE'S LATERAL-DIRECTIONAL CHARACTERISTICS AT OR NEAR THE STALL SPEED.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: MANEUVERING

Findings

1. (C) STALL/SPIN - INADVERTENT - FLIGHTCREW
2. (F) INSUFFICIENT STANDARDS/REQUIREMENTS - MANUFACTURER

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Factual Information

HISTORY OF FLIGHT

On March 5, 1994, at 0830 central standard time (cst), a Piper PA-38-112, N2495L, registered to Marvin Hall dBa Hutchinson Aviation, of Hutchinson, Kansas, with a commercially certificated flight instructor administering a biennial flight review (flight review) to a private pilot, was destroyed during a collision with the ground and subsequent fire. Visual meteorological conditions prevailed at the time of the accident. The 14 CFR Part 91 flight was not operating on a flight plan. Both pilots were fatally injured. The flight departed Hutchinson, Kansas, at 0800 cst.

Three witnesses said they observed the airplane during its descent to the ground. Two witnesses observed the airplane in a five or six turn spin to the left. One witness said he saw the spin stop just above the ground, with the airplane's "...nose pulled up slightly, but then back down before it hit."

During the interview the witnesses were asked to show, with a model airplane, what N2495L had been doing during its descent to the ground. Each witness made a motion with the model airplane that replicated a left spin that had an approximate 45 degree nose down attitude.

PERSONNEL INFORMATION

The logbook for the pilot receiving the flight review was destroyed in the post crash fire. According to Federal Aviation Administration (FAA), the pilot obtained his private pilot certificate on November 27, 1991. The pilot reported he had 50 hours of flight time when he obtained his second class medical certificate on March 20, 1992. The pilot's supervisor said that to his knowledge the pilot was current and had taken annual leave to obtain a biennial flight review before his currency expired.

The flight review recipient's wife stated he had accumulated about 75 to 100 hours of flying time since obtaining his private pilot certificate. She said her husband had told her that his flight check was due before they moved to Des Moines, Iowa, in May 1994. The wife of the flight instructor administering the flight review stated the other pilot had not flown the PA-38 since May 21, 1993, according to company records.

The flight instructor administering the flight review had completed an FAA airman competency flight check according to 14 CFR Part 135.293, .297, and .299 on December 31, 1993. This pilot's number three logbook showed he had a total time of 7,944.9 hours, 1,803.5 hours as a flight instructor, as of January 25, 1994. The logbook began with the entry of August 16, 1985, showing a total flight time of 4,943.2 hours. The first Piper PA-38 (PA-38) logbook entry was

made on August 18, 1985. The pilot's total flying time in the PA-38, as found in the number three logbook, was 104.9 hours. Complete pilot logbook records were not made available for review. The NTSB Form 6120.1/2 that was sent to the pilot's wife was not returned. She did say that he had a total time of 745 hours in the Piper PA-38.

The instructor's flight review methodology was revealed during interviews with two pilots and a written statement from a third pilot. One pilot said the instructor had him do approach to landing, and takeoff and departure stalls on headings and in turns. He said that he demonstrated these stalls to the instructor with landing flaps retracted and extended. The second pilot said the instructor asked to see imminent stalls only. His written statement said, "...I proceeded one time to go to a full stall and Marvin quickly detoured that route."

A pilot, training for a flight instructor rating, said the instructor had spun the PA-38 on several occasions during his training. He said the instructor had demonstrated one turn spins to him and that he had performed spins under his direction. The pilot said the instructor had discussed stalls, spin entry, and spin recovery with him during ground training. He said the instructor had told him to avoid getting the airplane into a spiral and that he had to enter the spin forcefully.

AIRCRAFT INFORMATION

The PA-38 was certified under the Delegated Option Authority granted to manufacturers of aircraft by the FAA. The PA-38 received its airworthiness certificate from the FAA on December 20, 1977. The PA-38 was certified in the utility and normal category by the FAA. This certification allowed it to perform spins when operated in the utility category.

According to the pilots operating handbook (POH), "Normal recoveries may take up to 1 1/2 turns when proper technique is used; improper technique can increase the turns to recover and the resulting altitude loss." The POH continues, "In all spin recoveries the control column should be moved forward briskly, continuing to the full forward stop if necessary. This is vitally important because the steep spin attitude may inhibit pilots from moving the control column forward positively."

The POH says "...one half of the spin [rotation takes]... about one second... . Improper application of recovery controls can increase the number of turns to recover and the resulting altitude loss. Delay of more than about 1-1/2 turns before moving the control wheel forward may result in the aircraft suddenly entering a very fast, steep spin mode which could disorient a pilot. Recovery will be achieved by briskly moving the control wheel fully forward and holding it there while maintaining full recovery rudder." "If such a spin mode is encountered, the increased rate of rotation may result in the recovery taking more turns than usual after the control column has been moved fully forward. A one-turn spin, properly executed, will require 1,000 to 1,500 feet to complete and a six-turn spin will require 2,500 to 3,000 feet to complete."

Three Piper Aircraft Corporation Service Bulletins (Numbers 609, 661 and 800) were issued on

the PA-38's control column. Number 609 dealt with ensuring that the control column (tube) was securely welded to the control wheel. This service bulletin was made into a Federal Aviation Administration Airworthiness Directive (AD). Service bulletin numbers 661 and 800 dealt with the binding of the control column when positioned fully aft (full up elevator).

According to N2495L's airframe logbooks, service bulletins 661 and 800 were complied with. Service Bulletin 609, and its accompanying airworthiness directive, did not apply to N2495L.

WRECKAGE AND IMPACT INFORMATION

N2495L collided with the ground on an approximate magnetic heading of 040 degrees. The first ground scar was oriented on an approximate magnetic heading of 130/310 degrees, measuring about 38 feet. A second ground scar, originating from the midpoint of the first, was about 120 feet long and on a magnetic heading of 345 degrees. The second ground scar led to N2495L's wreckage. The airplane's wreckage heading was 355 degrees magnetic.

The first ground scar varied in depth between two and four inches. It had white paint transferred onto sections of compressed dirt. A piece of curved, green, glass was found at the extreme southeast edge of this ground scar. At the center of this ground scar an elliptically shaped depression measuring about five feet wide and six feet long. It was about seven inches deep at the center. Gouge marks were found in the approximate center of this area. The largest gouge mark matched one of the airplane's propeller blades. Examination of the blade found chordwise scratches, some having the same colored dirt in them as found in the gouge.

The main landing gear legs had separated from the fuselage mounts. One main landing gear was found on top of the left wing at the mid-span position. A second main landing gear leg was found about 100 feet northwest of the first ground scar termination point. The wheel and tire assemblyies were attached to the main landing gear legs. The tires matched ground indentations that were found south of the elliptically shaped ground depression. The ground indentations were equally spaced on either side of the elliptically shaped ground depression.

The inboard sections of the both wings were burnt. The fuselage had burned between the engine compartment and vertical stabilizer. The propeller had partially separated from the crankshaft flange. The propeller was 'S' shaped, one blade curved forward about 90 degrees from its hub. The second blade was curved aft about 40 degrees from its mid-span position.

The right wing was twisted about 70 degrees upward at the mid-span point outward to its wingtip. Leading edge skin on the wing was wrinkled and had separated from the main wing spar. The inboard portion of the leading edge skin was burnt. The ground under the right wing fuel tank area had a strong odor of aviation gasoline. The left wing leading edge skin was wrinkled.

Flight control continuity between the respective surfaces and control yokes and rudder pedals

was confirmed. The left control yoke/mounting sleeve combination had separated from its torque tube. The right control yoke was attached to its torque tube. The control yoke torque tubes, chain sprockets, chains, and tee bar assembly was found complete and unseparated.

The elevator and rudder stops were not damaged. Elevator trim cable and springs were fire damaged. They were attached between the cockpit trim wheel and trim tab. The top of the left rudder stop was 3/8" from the vertical stabilizer spar mount. The top of the right rudder stop was 5/16" from the vertical stabilizer spar mount.

The engine was fire damaged; it was rotated confirming internal component continuity when the magnetos were removed. The right magneto was fire and impact damaged and could not be turned. The left magneto was fire damaged but could be rotated. The carburetor had separated from its mounting flange and was fire damaged. The muffler had been crushed aft and upward into the engine's sump.

ADDITIONAL INFORMATION

Research into the PA-38's design, certification, and manufacture revealed the design originally started out with a conventional tail, i.e., a low mounted horizontal stabilizer/elevator rather than the "T" tail it was certified with. The prototype was designed, built, and test flown during late 1969, 1970 and into 1971. For reasons not defined, the design was placed into storage at the manufacturer for about four years. The PA-38 prototype was taken out of storage and reconfigured with a "T" tail. One of the two original design engineers remained with the company and worked on the resurrected prototype's development.

Originally, the wing was designed using the NASA GAW-1 airfoil and 11 full ribs from wingtip to wing root on each side. This wing had a "U" shaped channel main and secondary spar from wing root to wing tip. The two-piece main spar was joined next to the aileron/flap junction of the wing. Both original design engineers said the PA-38 prototype had been built with a rigid wing structure. One of the design engineers said this type structure is necessary when using the GAW-1 airfoil.

The certificated PA-38 had its main wing spar made from flat aluminum stock. The "U" shaped secondary spar was retained. Lightening holes were cut out along the main spar's outboard half. The main spar had span length "L" shaped extrusions attached to its top and bottom.

The reconfigured airplane retained the same airfoil but had its wing rib numbers reduced to four full sized ribs and four nose ribs per wing. Wing surface shaping extrusions replaced the ribs that were eliminated from the prototype. The extrusions were positioned between the main and secondary spars. There were no vertical braces between the top and bottom extrusions. The original design engineers were asked why the design had been changed. Both said it was their opinion that the airplane's structure had been simplified for manufacturing purposes after it left their design shop. The design engineer said that removing wing ribs and changing the spar design would make the wing less rigid, i.e., "soften" the wing. According to

this engineer, the wing's softened structure would not enhance the wing's stall and spin characteristics. He said the softened wing structure could change the airfoil shape, making the wing a new and unknown commodity in stalls and spins. He said he had inspected a PA-38 wing and found it to be very soft, and able to be torsionally twisted without substantial effort.

FAA Service Difficulty Reports related to the wing were examined for the period between 1986 and April, 1995. Fifteen reports showed loose rivets in the wing, bent aft spar attach fitting, and undertorqued wing spar attachment plate bolts. Before sending the airplane to the production design shop, the remaining design engineer stated the airplane had problems with "A very strong rolloff, I think, to the left." He said he designed a wing root glove that was very effective "...in terms of cooling off the stall characteristics." He also revealed the airflow next to the wing root, aft fuselage, and tailcone was not adhering as it should. He said the purpose of the cuff was to improve the airflow along the aft fuselage and give the airplane better stall characteristics. The company production design shop engineers removed the cuffs from the airplane after they had received it from the design shop. The airplane received its FAA type certificate without the leading edge cuffs.

A NASA aerodynamicist who worked with Piper Aircraft Corporation during the development of the PA-38's wing said the GAW-1 wing requires attention to the wing root area. He said this was due to the airflow separation found at the wing root and along the fuselage during high angles of attack.

The remaining design engineer said that stall strips were installed on the wing's outboard section after the wing root glove had been removed. He said he "...searched all over the wing for a position of the stall strip that would work. And, I was getting, I just couldn't find the location. And, the guys that were doing the flying said, okay, ... where do you want it next? I said, oh, put the .... thing out on the tip [in front of the aileron]. I was just being facetious. They did that and it worked. It got the stall characteristics to the point where they were certifiable." Without the stall strip, the aileron would have "Very little authority...," according to the designer.

The designer was asked if the type ailerons the Piper PA-38 was certified with would be effective in stopping the wing's rolloff at the time the stall occurs. He said, "I doubt it. They're marginal ailerons." He was asked to explain what he meant by his statement. He replied, "They have a big gap at the bottom. And the [air] flow would like to come along the bottom of the wing and follow up on [the] trailing edge [of the] up aileron, but it see this forward facing step [bottom edge of the aileron's leading edge] and it says , pfff, sorry, and it becomes turbulent. So, plain flap [and] ailerons are marginal at slow speeds."

The PA-38 was exclusively built at Piper's Lock Haven, Pennsylvania, manufacturing facility. A production engineer at the manufacturing facility stated, "The production Tomahawks [PA- 38] I eventually became airborne in, only as part of my job, were, to a plane totally unpredictable, one never knew which direction they would roll-off, or to what degree as a result of a stall. The wings flexed noticeably... ." One of the original desginers of the airplane stated, "The aerodynamic performance of a GAW-1 wing is very sensitive to airfoil shape. If the shape

became distorted, the performance would rapidly deteriorate... ." He continued, "... the use of a flexible surface representation of the profile sensitive GAW-1 design opens a Pandora's box regarding its performance. The effects of a wide range of steady and unsteady aerodynamic flows encountered by an aeroelastically soft GAW-1 wing in stalls and spins would be impossible to resolve in a conventional flight test program."

Autopsies on both pilots were conducted at the Ryan Funeral Home in Salinas, Kansas. Toxicological testing was conducted by the FAA's Civil Aeromedical Institute. The results of both tests were negative.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	54,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	August 19, 1993
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	7945 hours (Total, all aircraft), 105 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	PIPER	**Registration:**	N2495L
Model/Series:	PA-38-112 PA-38-112	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal; Utility	**Serial Number:**	38-79A0734
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	February 23, 1994 Continuous airworthiness	**Certified Max Gross Wt.:**	1670 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:		**Engine Manufacturer:**	LYCOMING
ELT:	Installed	**Engine Model/Series:**	O-235-L2C
Registered Owner:	M. HALL	**Rated Power:**	112 Horsepower
Operator:		**Operating Certificate(s) Held:**	None
Operator Does Business As:	HUTCHINSON AVIATION	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	HUT ,1542 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	07:45 Local	**Direction from Accident Site:**	195°
Lowest Cloud Condition:	Clear	**Visibility**	15 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/ None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	0°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	HUTCHINSON (HUT)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	08:00 Local	**Type of Airspace:**	Class G

Airport Information

Airport:		**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	
Runway Length/Width:		**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	Unknown
Total Injuries:	2 Fatal	**Latitude, Longitude:**	38.220001,-97.770355(est)

Administrative Information

Investigator In Charge (IIC):	Gattolin, Frank
Additional Participating Persons:	ERIC JADERBERG; WICHITA , KS MIKE DUCHARME; WICHITA , KS GREG ERIKSON; WAYNE , IL DR. RICH. A KROEGER; HUNTSVILLE , AL
Original Publish Date:	July 12, 1995
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=9371

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