



National Transportation Safety Board Aviation Accident Final Report

Location:	Spanish Fork, UT	Accident Number:	SEA06FA146
Date & Time:	07/25/2006, 1606 MDT	Registration:	N322LA
Aircraft:	Spectrum Aeronautical LLC 33	Aircraft Damage:	Destroyed
Defining Event:		Injuries:	2 Fatal
Flight Conducted Under:	Part 91: General Aviation - Flight Test		

Analysis

The proto-type experimental light jet airplane was departing on a local maintenance test flight. Witnesses reported that the airplane entered a right roll almost immediately after liftoff. The roll continued to about 90 degrees right wing down at which point the right wingtip impacted the ground. During examination of the wreckage, the aileron control system was found connected such that the airplane rolled in the opposite direction to that commanded in the cockpit. The maintenance performed on the airplane before the accident flight included removal of the main landing gear (MLG) in order to stiffen the MLG struts. Interviews with the mechanics who performed the maintenance revealed that during re-installation and system testing of the MLG, it was discovered that the changes to the MLG struts impacted the V-bracket holding the aileron control system's upper torque tube. The V-bracket was removed and a redesigned V-bracket was installed in its place. This work required the disconnection of a portion of the aileron control system, including the removal of the aft upper torque tube bell crank from the torque tube. The mechanic who reinstalled the aft upper torque tube bell crank was under the incorrect assumption that there was only one way to install the bell crank on the torque tube. However, there are actually two positions in which the bell crank could be installed. The incorrect installation is accomplished by rotating the bell crank 180° about the axis of the torque tube and flipping it front to back, and this is the way the bell crank was found installed. With the bell crank installed incorrectly and the rest of the system installed as designed, there is binding in the system. This binding was noticed on the accident airplane during the inspection after initial installation. However, the mechanic did not recognize that the bell crank was improperly installed on the torque tube. Instead of fixing the problem by removing and correctly reinstalling the bell crank, he fixed the problem by disconnecting the necessary tie rods and rotating the upper torque tube so that the arm of the bell crank pointed up and to the left. This action reversed the movement of the ailerons. According to all of the personnel interviewed, there was no maintenance documentation to instruct mechanics how to perform the work since this was a proof-of-concept airplane. None of the mechanics who performed the work could recall if the position of the ailerons in relation to the position of the control stick was checked. Such a position check, if it had been performed by either the mechanics after the maintenance or by the flight crew during the preflight checks, would assuredly have indicated that the system was installed incorrectly.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Incorrect installation by company maintenance personnel of the aft upper torque tube bell crank resulting in roll control that was opposite to that commanded in the cockpit.

Contributing factors were the lack of maintenance documentation detailing the installation of the bell crank, the installing mechanic's incorrect assumption that the bell crank could only be installed in one position, and the failure of maintenance personnel and the flight crew to check the position of the control stick relative to the ailerons after the maintenance and during the preflight checks.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION

Phase of Operation: STANDING - PRE-FLIGHT

Findings

1. (C) FLT CONTROL SYST,AILERON CONTROL - REVERSED
2. (C) MAINTENANCE,INSTALLATION - INCORRECT - COMPANY MAINTENANCE PERSONNEL
3. (F) EXPECTANCY - COMPANY MAINTENANCE PERSONNEL
4. (F) MAINTENANCE,INSPECTION - INADEQUATE - COMPANY MAINTENANCE PERSONNEL
5. (F) CONDITION(S)/STEP(S) NOT LISTED - MANUFACTURER
6. (F) AIRCRAFT PREFLIGHT - INADEQUATE - FLIGHTCREW

Occurrence #2: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

7. AIRCRAFT CONTROL - NOT POSSIBLE - PILOT IN COMMAND

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT - UNCONTROLLED

Findings

8. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On July 25, 2006, approximately 1606 mountain daylight time, a Spectrum 33 experimental twin-engine jet airplane, N322LA, collided with terrain following a loss of control during the initial climb after takeoff from runway 30 at Spanish Fork-Springville Airport, Spanish Fork, Utah. The airplane, which was registered to and operated by Spectrum Aeronautical LLC, was destroyed by impact forces. The two commercial pilots aboard received fatal injuries. Visual meteorological conditions prevailed and no flight plan was filed for the 14 CFR Part 91 local maintenance test flight. The flight was originating when the accident occurred.

Witnesses reported that the airplane entered a right roll almost immediately after liftoff. The roll continued to about 90 degrees right wing down at which point the right wingtip impacted the ground.

PERSONNEL INFORMATION

The pilot-in-command (PIC), who was seated in the left front seat, held a commercial pilot certificate with airplane single engine land, multiengine land, and instrument ratings. Additionally, he held a mechanic certificate with airframe and powerplant ratings. He held a first class medical certificate dated February 14, 2006, with the limitation, must wear corrective lenses. On the application for this medical certificate, the PIC reported that he had accumulated 2,350 hours total flight time with 100 hours flown in the past six months. According to the operator, he had accumulated a total time of 22 hours in the Spectrum 33 of which 16 hours were as pilot-in-command.

The co-pilot, who was seated in the right front seat, held a commercial pilot certificate with airplane single engine land, multiengine land, instrument and glider ratings. Additionally, he held a mechanic certificate with airframe and powerplant ratings and a flight instructor certificate with airplane single engine land, multiengine land, instrument and glider ratings. He held a first class medical certificate dated December 28, 2005, with the limitation, must wear corrective lenses. On the application for this medical certificate, the co-pilot reported that he had accumulated 3,000 hours total flight time with 220 hours flown in the past six months. According to the operator, he had accumulated a total time of 16 hours in the Spectrum 33 of which 13 hours were as pilot-in-command.

AIRCRAFT INFORMATION

The airplane was the prototype for a new all composite, light business jet aircraft. It was issued a special airworthiness certificate in the experimental category for the purpose of research and development by the FAA on November 7, 2005.

According to information provided by the operator, the airplane had accumulated about 44 hours total flight time since its first flight on January 7, 2006. Prior to the accident flight, the airplane's most recent flight, flight number 46, had taken place on June 30, 2006. During the time between flight 46 and the accident flight, the airplane had been undergoing maintenance. The maintenance included removal of the main landing gear (MLG) in order to stiffen the MLG struts. Interviews with the mechanics who performed the maintenance revealed that during removal of the MLG, a portion of the roll control system located in the MLG wheel well and gearbox area was disconnected to facilitate the work.

Roll control on the airplane was from the pilots' side sticks to the ailerons through a mechanical system of torque tubes and push-pull tubes. The left side stick was primary, and the right side stick was slaved to the left side stick. The roll control motion of the left side stick was linked through a quadrant below the cockpit floor to the lower torque tube. The lower torque tube ran from the quadrant to the aft pressure bulkhead. The translation linkage, the linkages and bell cranks that translated the rotational motion of the lower torque tube to a linear motion of the aileron push-pull tubes, was located on the aft side of the pressure bulkhead in the MLG gearbox area. The rotational motion of the lower torque tube was translated through the lower torque tube bell crank to a linear motion of the torque tube interconnect tie rod. The linear motion of the interconnect tie rod was then translated back to a rotational motion of the upper torque tube through the forward upper torque tube bell crank that was attached to the upper torque tube. The forward end of the upper torque tube was installed in a bearing on the pressure bulkhead and was supported in a V-bracket towards the aft end. At the aft end of the upper torque tube, the rotational motion of the torque tube was translated through the aft upper torque tube bell crank to a linear motion of the walking link drive tie rod. The walking link drive tie rod was connected to the left walking link. The left walking link was connected to the right walking link through the walking link interconnect tie rod. The walking link assembly translated the linear motion of the walking link drive tie rod to linear motion of the left and right aileron push-pull tubes.

During re-installation and system testing of the MLG, it was discovered that the changes to the MLG struts impacted the V-bracket holding the upper torque tube. The V-bracket was removed and a redesigned V-bracket was installed in its place. The mechanics who performed the work stated that the tie rod bolts were removed from the aft upper torque tube bell crank and the lower torque tube bell crank and the bolts securing the V-bracket to the bulkhead were removed. The upper torque tube was then removed as an assembly with both the forward and aft upper torque tube bell cranks and V-bracket still attached. The aft upper torque tube bell crank was then removed to install the new V-bracket. Once the new V-bracket was installed the aft upper torque tube bell crank was reinstalled on the upper torque tube. The mechanic who reinstalled the aft upper torque tube bell crank on the torque tube stated that due to the tapered pin used to install the bell crank, he believed there was only one way to install it on the torque tube. The upper torque tube assembly was then reinstalled on the airplane.

Following the reinstallation, a functional check of the roll control system revealed that there was only about 1/4-inch of side-to-side movement at the control stick. Visual examination of the system in the gearbox area by one of the mechanics revealed that the arm of the aft upper torque tube bell crank was pointed down and to the left. The tie rod bolts were removed from the aft upper torque tube bell crank and the lower torque tube bell crank. The upper torque tube was rotated so that the arm of the aft upper torque tube bell crank was pointed up and to the left and the tie rod bolts were reinstalled.

The system was then re-rigged by centering the control stick and adjusting the various tie rod lengths so that the ailerons were faired with the wing. Motion of the system from stop to stop at the control stick and at the left and right ailerons was then verified. One of the pilots was asked to inspect the installation and found that the stick forces required were higher than previously. New washers were installed at the walking link-bulkhead interface that corrected the problem. The system rigging and motion was then checked again by the mechanics. None of the mechanics who performed the work could recall if the position of the ailerons in relation to the position of the control stick was checked.

According to all of the personnel interviewed, there was no maintenance documentation to instruct mechanics how to perform the work since this was a proof-of-concept airplane. All of the work was performed based on experience.

Two different pilot checklists for normal operation of the Spectrum 33 were recovered from the accident site. One checklist dated 7/25/2006 included the item "Flight Controls - CHECK" in both the PreStart and the Before Takeoff sections of the checklist. The other checklist dated 04/17/2006 included the items "Control Locks - REMOVED" and "Flight Controls - CHECKED" in the PreStart section of the checklist and the item "Gust Locks/Controls - OFF/CHECKED" in the Before Takeoff section of the checklist.

METEOROLOGICAL INFORMATION

At 1555, the recorded weather conditions at Provo Municipal Airport, Provo, Utah, located approximately 5 nautical miles northwest of the accident site, were wind from 270 degrees at 4 knots, visibility 10 statute miles, clear skies, temperature 30 degrees C, dew point 14 degrees C, and altimeter 29.97 inches.

WRECKAGE AND IMPACT INFORMATION

Examination of the accident site revealed that the initial impact point was located about 150 feet right of the runway 30 centerline. A ground scar oriented on a magnetic heading of about 330 degrees extended from the initial impact point to a barbed wire fence about 120 feet away. Various pieces of right wing debris were found along the ground scar. The wreckage path veered about 20 degrees right at the fence and then remained essentially straight to the main wreckage site on about a 350-degree magnetic heading. The main wreckage was located about 750 feet from the initial impact point and included the forward fuselage, aft fuselage and a majority of the wing structure. All major components of the airplane were accounted for in the wreckage path or with the main wreckage. There was no evidence found of any pre-existing failures of the airplane's structure.

During examination of the wreckage, aileron control continuity could not be established from the cockpit to the aft pressure bulkhead due to fragmentation of the airplane, however, all of the lower torque tube was accounted for. Control continuity was established from the torque tube input on the aft pressure bulkhead to the aileron bell crank on the right wing and to the torque tube about 50 inches inboard of the aileron bell crank on the left wing. Examination of the translation linkage on the aft side of the aft pressure bulkhead revealed that it was connected in a manner that reversed the roll control. Specifically, the linkage was connected such that left roll input from the side sticks would have deflected the ailerons to produce right roll of the airplane, and right roll input from the side sticks would have deflected the ailerons to produce left roll of the airplane.

For further information on the wreckage distribution and examination of the roll control system, see the Airworthiness Group Chairman's Factual Report in the public docket for this accident.

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsies of both pilots were conducted by the State of Utah's Office of the Medical Examiner in Salt Lake City, Utah. Toxicology tests were conducted by the FAA's Toxicology and Accident Research Laboratory. The results for both pilots were negative for carbon monoxide, cyanide, and ethanol. Acetaminophen was detected in the PIC's urine, and no drugs were detected in

the co-pilot's urine.

TESTS AND RESEARCH

Based on the mechanic interviews, a test plan was developed to verify the state of the roll control system at the time of the accident and to recreate the work performed on the airplane in reverse order. It was determined through movement of the system in the MLG gearbox area that, in the as found condition, a clockwise rotation of the lower torque tube produced a clockwise rotation of the upper torque tube and a counter-clockwise rotation of the lower torque tube produced a counter-clockwise rotation of the upper torque tube, resulting in reverse aileron movement. All of the fasteners in the system were found secure with the cotter pin and/or torque stripe intact. The required tie rod bolts were removed and the upper torque tube was rotated so that the arm of the aft upper torque tube bell crank pointed down and to the left, recreating the initial reinstallation that maintenance personnel described. The tie rod bolts were reinstalled and it was verified that system binding only allowed limited movement of the system. The aft upper torque tube bell crank was then removed and reinstalled after rotating it 180 degrees along the axis of the torque tube and flipping it front to back. The fasteners were reinstalled and it was verified that clockwise rotation of the lower torque tube produced counter-clockwise rotation of the upper torque tube and counter-clockwise rotation of the lower torque tube produced clockwise rotation of the upper torque tube, resulting in correct aileron movement. The system was then returned to its as found condition with the exception of the installation of cotter pins.

Recorded data from the two engine FADECs were downloaded under the supervision of an FAA inspector at the facilities of Williams International in Walled Lake, Michigan, on August 3, 2006. There were no pertinent findings. A copy of the Williams International report on the data download has been placed in the public docket for this accident.

Recorded data from the two Avidyne displays were extracted by Avidyne Corporation at the request of the NTSB investigator-in-charge. There were no pertinent findings. A copy of the Avidyne report on the data download has been placed in the public docket for this accident.

ADDITIONAL INFORMATION

The wreckage was released to a representative of the owner on September 12, 2006.

Pilot Information

Certificate:	Commercial	Age:	53, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	02/01/2006
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	2300 hours (Total, all aircraft), 22 hours (Total, this make and model)		

Co-Pilot Information

Certificate:	Flight Instructor; Commercial	Age:	25, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	Glider	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Glider; Instrument Airplane	Toxicology Performed:	Yes
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	12/01/2005
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	3100 hours (Total, all aircraft), 16 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Spectrum Aeronautical LLC	Registration:	N322LA
Model/Series:	33	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Experimental	Serial Number:	0001
Landing Gear Type:	Retractable - Tricycle	Seats:	2
Date/Type of Last Inspection:	07/01/2006, 100 Hour	Certified Max Gross Wt.:	7300 lbs
Time Since Last Inspection:	0 Hours	Engines:	2 Turbo Fan
Airframe Total Time:	44 Hours	Engine Manufacturer:	Williams International
ELT:	Installed, not activated	Engine Model/Series:	FJ33-4A-15
Registered Owner:	Spectrum Aeronautical LLC	Rated Power:	1562 lbs
Operator:	Spectrum Aeronautical LLC	Air Carrier Operating Certificate:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	PVU, 4497 ft msl	Observation Time:	1555 MDT
Distance from Accident Site:	5 Nautical Miles	Direction from Accident Site:	315°
Lowest Cloud Condition:	Clear	Temperature/Dew Point:	30° C / 14° C
Lowest Ceiling:		Visibility	10 Miles
Wind Speed/Gusts, Direction:	4 knots, 270°	Visibility (RVR):	
Altimeter Setting:	29.97 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Spanish Fork, UT (U77)	Type of Flight Plan Filed:	None
Destination:	(U77)	Type of Clearance:	None
Departure Time:	1606 MDT	Type of Airspace:	

Airport Information

Airport:	Spanish Fork - Springville (U77)	Runway Surface Type:	Asphalt
Airport Elevation:	4529 ft	Runway Surface Condition:	Dry
Runway Used:	30	IFR Approach:	None
Runway Length/Width:	5700 ft / 100 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 Fatal	Latitude, Longitude:	40.141667, -111.661389

Administrative Information

Investigator In Charge (IIC):	Georgia R Struhsaker	Adopted Date:	11/29/2007
Additional Participating Persons:	William T Gierhart; FAA FSDO; Salt Lake City, UT Chris Greene; Williams International; Walled Lake, MI Bryan Winkel; Rocky Mountain Composites; Spanish Fork, UT Jonathan W Adams; Spectrum Aeronautical LLC; Spanish Fork, UT		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov , or at 800-877-6799. Dockets released after this date are available at http://dms.nts.gov/pubdms/ .		

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