National Transportation Safety Board
Aviation Accident Final Report

Location:	Coupeville, WA	**Accident Number:**	SEA03FA147
Date & Time:	07/22/2003, 1015 PDT	**Registration:**	N996JR
Aircraft:	Cessna Citation 525	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 None
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The corporate jet airplane experienced a loss of elevator trim control (runaway trim) that resulted in an uncommanded nose-low pitch attitude. The pilot reported that following the loss of elevator trim authority the airplane was extremely difficult to control and the elevator control forces were extremely high. The pilot continued to maneuver the airplane, but eventually ditched it into a nearby marine cove. The runaway trim condition was not immediately recognized by the pilot and he stated that, by that point in the event sequence, the control forces were so great that he had little time to troubleshoot the system and elected to continue on his established heading and ditch the airplane. Pulling the circuit breaker, which is called for by the checklist in the event of a trim runaway, would have arrested the trim movement. Post accident examination and functional testing of the airplane's electric pitch trim printed circuit board (PCB) showed a repeatable fault in the operation of the PCB's K6 relay, resulting in the relay contacts remaining closed. This condition would be representative of the autopilot pitch trim remaining engaged, providing an electrical current to drive continuous nose-down trim to the elevator trim motor. Examination of the airplane's maintenance records showed that the PCB was removed and replaced in conjunction with the phase inspection prior to the accident. Further examination of the airplane's maintenance records revealed that the replacement PCB was originally installed in an airplane that experienced an "electric trim runaway on the ground." Following the trim runaway, the PCB was removed and shipped to the manufacturer. After receiving the PCB the manufacturer tested the board and no discrepancies were noted. The unit was subsequently approved for return to service and later installed on the accident airplane. The investigation revealed a single-point failure of trim runaway (failed K6 relay) and a latent system design anomaly in the autopilot/trim disconnect switch on the airplane's pitch trim PCB. This design prohibited the disengagement of the electric trim motor during autopilot operation. As a result of the investigation, the FAA issued three airworthiness directives (AD 2003-21-07, AD 2003-23-20, and AD 2004-14-20), and the pitch trim printed circuit board was redesigned and evaluated for compliance with safety requirements via system safety assessment

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The loss of airplane pitch control (trim runway and mistrim condition) resulting from a failure in the airplane's electric pitch trim system. Factors that contributed to the accident were the manufacturer's inadequate design of the pitch trim circuitry that allowed for a single-point failure mode, and the absence of an adequate failure warning system to clearly alert the pilot to the pitch trim runaway condition in sufficient time to respond in accordance with the manufacturer's checklist instructions.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: CLIMB - TO CRUISE

Findings
1. (C) ELECTRICAL SYSTEM,ELECTRIC RELAY - FAILURE
2. (F) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER

Occurrence #2: ABRUPT MANEUVER
Phase of Operation: CLIMB - TO CRUISE

Findings
3. (C) FLT CONTROL SYST,ELEVATOR TRIM/TAB CONTROL - UNCOMMANDED
4. (C) ELECTRICAL SYSTEM,ELECTRIC MOTOR - ACTIVATED

Occurrence #3: ALTITUDE DEVIATION,UNCONTROLLED
Phase of Operation: CLIMB - TO CRUISE

Occurrence #4: DITCHING
Phase of Operation: EMERGENCY LANDING

Findings
5. TERRAIN CONDITION - WATER

Factual Information

HISTORY OF FLIGHT

On July 22, 2003, about 1015 Pacific daylight time, a Cessna Citation 525, N996JR, ditched in the waters of Penn Cove, Coupeville, Washington, following a loss of elevator trim control (runaway trim) that resulted in an uncommanded nose-low pitch attitude. The commercial pilot and passenger were not injured. Tango Corporation of Minden, Nevada, operated the cross-country flight under the provisions of Title 14, CFR Part 91. Visual meteorological conditions prevailed for the flight, which was being operated on an instrument flight rules (IFR) flight plan. The flight originated from the Victoria International Airport (YYJ), Sidney, British Columbia, with a planned destination of Gowen Field (BOI), Boise, Idaho.

At about 0950 the airplane departed Sidney, BC, on an IFR flight plan to Boise, Idaho. Shortly after clearing Canadian airspace, Victoria Departure Control instructed the pilot to contact Seattle Center (ZSEA). After establishing communications with ZSEA, the pilot was given a direct clearance to the Boise Airport and instructed to climb to FL330 (flight level 33,000).

After receiving the clearance the pilot turned, via the autopilot, to an on-course heading, reset the altitude pre select to FL330 and set the "...flight director IAS [indicated airspeed] select to 200..." knots. Shortly after climbing through 14,000 feet mean sea level (MSL), at a climb power setting, the pilot noted a decrease in the aircraft's rate of climb and disconnected the autopilot via the autopilot/trim disconnect switch on the control wheel in an attempt to "hand fly" the aircraft.

Immediately after disconnecting the autopilot, the airplane pitched to a negative deck angle approximately 10 degrees below the horizon. The pilot reported "Within seconds it was apparent that level flight was not possible as I applied continued back pressure on the yoke." He reduced engine power to idle, and attempted to electrically re-trim the airplane in an effort to reduce the forward pressure on the control wheel. He reported the elevator trim indicator was in the full forward (nose down) position and that the electric trim would not respond to inputs via the control wheel trim switch.

The passenger, who was seated in the co-pilot seat, assisted the pilot in applying back pressure to the control wheel. The pilot reported the negative deck angle had increased and the airspeed was approaching the "barber pole" (maximum operating speed). He reported that at one point the aircraft's descent rate had reached approximately 2,000 feet per minute and the nose of the airplane was about 40 degrees below the horizon with "...both pilot and passenger exerting maximum yoke back pressure."

The pilot reported that he continued to maneuver the airplane, however the control wheel pressure "...was terrific and required our combined strength to keep the nose from rapidly returning to an extreme angle." The pilot attempted to re-trim via the manual trim wheel, however the wheel would not move.

The pilot maneuvered the airplane in the direction of Whidbey Island, Washington, in an attempt to reach the Coupeville Naval Outlying Field (KNRA). After reaching the island, the pilot elected to call off the landing approach at KNRA, and "...chose a straight in approach into a headwind to land on the water at Penn Cove." Penn Cove was at the pilot's 12 o'clock position at a distance of approximately three miles.

At 1015, the airplane impacted the water approximately 300 yards from the shoreline. The pilot stated the airplane touched down in a wings level tail low attitude. The landing gear was in the up position and the flaps were in the landing position (35 degrees). The pilot estimated that the airplane touched down at 100 knots and traveled less than 50 feet before forward motion ceased.

PERSONNEL INFORMATION

The pilot held a commercial pilot certificate with airplane single-engine land, multi-engine land and instrument airplane ratings. In addition to the commercial certificate, the pilot held a Cessna Citation 500 type rating, issued in May of 1977 and a Cessna Citation 525 type rating issued in February of 1997. The pilot completed Cessna Citation recurrent training in September of 2002.

The pilot's most recent FAA third-class medical certificate was issued on October 8, 2001, and contained limitations that the pilot must possess glasses for near and intermediate vision.

According to the Pilot/Operator accident report (Form 6120.1/2), the pilot's total flight time was approximately 8,500 hours, including 8,000 hours as pilot-in-command and 2,689 hours in make and model. According to the report, the pilot successfully completed a flight review on May 6, 2002. The review was conducted in a Cessna Citation 525.

The pilot completed initial flight training with the US Army Air Corp in 1943.

AIRCRAFT INFORMATION

The accident airplane, a 1996 Cessna Citation Jet model 525, serial number 525-0147, was manufactured in 1996, and issued a standard airworthiness certificate (normal category) on July 25, 1996.

The airplane was certified in accordance with Federal Aviation Regulation (FAR) Part 23 airworthiness standards, and can be operated by either single or two pilot crews. A type rating is required to operate the airplane as pilot-in-command.

The airplane was equipped with two Williams International FJ-44-1A medium bypass turbofan engines, rated at 1900 pounds static thrust.

The airplane was delivered new with a Honeywell SPZ-5000 display and flight guidance system. The system includes, in part, the flight director, electronic attitude director indicator (EADI), electronic horizontal situation indicator (EHSI), altitude alerting system, autopilot, autopilot controller and auto pilot servos.

The primary fight controls are mechanically actuated by cables and have corresponding manual trim control actuators in the cockpit. The elevator trim control can be actuated manually using a trim wheel located on the center pedestal, or electrically via the electric trim switch on the control wheel or the autopilot pitch wheel.

Airplane maintenance records indicated that the airplane's last inspection, a phase 12 continuous airworthiness inspection, was accomplished on August 29, 2002.

The maintenance records indicated that in conjunction with the phase inspection, the airplane's pitch trim printed circuit board (PCB) assembly (Cessna part number 6518351-5 serial number 0305), was removed "...due to failure and replaced with [a] unit inspected by Cessna Aircraft." The replacement PCB (serial number 0154) was installed on the accident

airplane, operationally checked and returned to service.

The replacement PCB (serial number 0154) was originally installed in N312QS, a Cessna Citation model 560, however after the airplane experienced an "electric trim runaway on the ground" the PC board was removed and replaced. The removed PC board was subsequently shipped to Cessna Aircraft where it was tested and returned to service. The Repair Data Report states, in part, "Ran PC board under hot and cold conditions on bench. No discrepancies noted. Performed function test and inspection. Function test and inspection good I/A/W [in accordance with] Cessna Citation Drawing #6518351. Unit approved for return to service." The report makes no mention of the type of repairs made to the PC board. The Cessna Repair Data Report and FAA Form 8130-3 (Airworthiness Approval Tag) are attached.

At the time of the phase inspection, the airframe total time was approximately 508 hours with approximately 302 cycles. The airplane accrued an additional 82 hours from the time of the inspection to the time of the accident.

METEOROLOGICAL INFORMATION

The 0955 METAR observation at Whidbey Island (KNUW), located approximately 7 miles north of the accident location, reported in part, broken clouds at 100 feet; visibility 1 mile; temperature 55 F; altimeter setting 30.13 inches Hg.

WRECKAGE AND IMPACT INFORMATION

Recovery personnel located the airplane wreckage on the evening of July 23. The wreckage came to rest in a level attitude on the ocean floor in approximately 60 feet of water.

On July 24, the wreckage was recovered to a barge and transported to a shipyard in Lake Union, Seattle, Washington.

On July 28, representatives from the National Transportation Safety Board, Federal Aviation Administration and Cessna Aircraft accessed the airplane and began the airframe examination.

The airframe and engines were intact. Hydraulic type deformation and impact damage was noted to the belly of the fuselage and the lower surfaces of both wings. Both wing flaps, and associated support hardware, were damaged. The main lading gear doors were damaged and both up-lock hooks were fractured.

Damage was noted to the inboard section of both wings and associated wing fairings. The damage was later attributed to lifting straps used during the recovery operation.

Flight control system continuity was established for the elevator, ailerons and rudder. The flight controls were attached to their respective attaching points and control cable continuity was established from the cockpit controls to the corresponding flight controls. The controls moved freely from stop to stop and no discrepancies were noted.

The elevator trim tabs were intact and no damage was noted. The elevator trim tabs were deflected to their stop limits, approximately 12 degrees trailing edge up (full nose down). Full travel of the trim tabs is 12 degrees up, +1/-1 degree and 20 degrees down +1/-1 degree. The elevator trim tabs actuator, and actuator chain, were intact and no damage was noted.

Elevator trim control cable continuity was established from the cockpit trim wheel to the trim control actuator. The cables and associated pulley assemblies were intact and no damage or inconsistencies were observed. The elevator trim cable stop block for nose down trim was

observed in the full forward position, touching the stop.

The elevator trim position indicator on the pedestal in the cockpit was observed in the full forward (aircraft nose down) position.

Following the documentation of the elevator trim system, the elevator trim wheel was moved manually. The system was cycled from stop to stop (full nose up to full nose down) with no discrepancies noted. The trim indicator functioned properly and both trim tabs operated through their full range of travel.

During the documentation of the elevator trim system, it was noted that the electric trim circuit breaker was in the full in (closed) position.

Following the onsite portion of the investigation, the pilot's yoke assembly, to include the electric trim switch, the elevator trim motor assembly, the auto pilot control head, the auto pilot torque motors and the elevator trim control printed circuit board, part number 6518351-5, serial number 0154, were removed and secured for additional testing.

SURVIVAL ASPECTS

The airplane occupants were not injured during the water landing. The pilot and passenger exited the airplane by way of the main cabin door and began swimming toward the shoreline. Approximately 10 minutes later, the two were rescued by a local boater and transported to a nearby marina.

The pilot stated that the airplane began to sink shortly after the water landing. The airplane sank in a nearly vertical tail low attitude. He estimated that the airplane was completely submerged approximately 15 minutes after it impacted the water.

At the time of the accident, the surface water temperature was approximately 47 degrees Fahrenheit.

TESTS AND RESEARCH

The elevator actuator, part number 4006719-914, serial number 96038721, was examined and disassembled. A small amount of water was released from the unit as the screws were loosened. The water was not rust-colored, but was cloudy. Some corrosion was noted. Of the three clutch plate screws, two had a noticeable torque on them when released; the third did not. The third screw showed traces of Loctite on the threads. All screws were in place and had not backed out.

The Pitch Trim Printed Circuit Board, part number 6518351-5, serial number 0154, was examined and functionally tested at the Cessna Airplane facilities in Wichita, Kansas. Testing showed a repeatable fault in the operation of the K6 relay, resulting in the relay contacts remaining closed. This condition would be representative of the autopilot remaining engaged and a voltage (signal) present to drive continuous nose-down trim to the elevator servo.

Examination of the relay, part number B46229, at Magnetech Struthers Dunn, Darlington, South Carolina, showed no evidence of electrical arcing or other damage. Wear was noted on the moving parts of the relay, and operation of the relay verified the condition found at Cessna. The designed operational life for this relay is 50,000 cycles. The number of cycles per flight is defined as the number of times that pitch trim is engaged/disengaged by the autopilot, and can vary depending on weather (turbulence) and other flight conditions.

ADDITIONAL INFORMATION

The investigation revealed that the K6 relay failure would constitute a single-point type failure in the electric pitch trim system. Pulling the circuit breaker, which is called for by the checklist in the event of a trim runaway, would have arrested the trim movement provided the circuit breaker was opened prior to the trim reaching its stop. Further examination of the system revealed that the autopilot autopilot/trim disengage switch would not have disengaged the electric trim motor during the type of failure experienced in the accident airplane.

Personnel from the FAA Wichita Aircraft Certification Office reported that post accident simulator testing of the elevator flight control system revealed that full deflection of the trim tab (trailing edge up) would require extremely high control wheel forces to achieve level flight.

On January 4, 2004, the airplane wreckage, and associated components, were released to the operator.

Pilot Information

Certificate:	Commercial	**Age:**	80, 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:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With Waivers/Limitations	**Last FAA Medical Exam:**	10/08/2001
Occupational Pilot:		**Last Flight Review or Equivalent:**	05/06/2002
Flight Time:	8500 hours (Total, all aircraft), 2689 hours (Total, this make and model), 8000 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N996JR
Model/Series:	Citation 525	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	0147
Landing Gear Type:	Retractable - Tricycle	**Seats:**	7
Date/Type of Last Inspection:	08/01/2002, Continuous Airworthiness	**Certified Max Gross Wt.:**	10400 lbs
Time Since Last Inspection:	82 Hours	**Engines:**	2 Turbo Fan
Airframe Total Time:	590 Hours at time of accident	**Engine Manufacturer:**	Williams International
ELT:	Not installed	**Engine Model/Series:**	FJ44-1A
Registered Owner:	Tango Corporation	**Rated Power:**	1900 lbs
Operator:	James C. Ray	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	KNUW, 47 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	0955 PDT	**Direction from Accident Site:**	350°
Lowest Cloud Condition:	Partial Obscuration / 100 ft agl	**Visibility**	1 Miles
Lowest Ceiling:	Broken / 100 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.13 inches Hg	**Temperature/Dew Point:**	13°C / 12°C
Precipitation and Obscuration:			
Departure Point:	Sidney (CYYJ)	**Type of Flight Plan Filed:**	IFR
Destination:	BOISE, ID (BOI)	**Type of Clearance:**	IFR
Departure Time:	1005 PDT	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	48.208056, -122.576389

Administrative Information

Investigator In Charge (IIC):	Dennis J Hogenson	**Report Date:**	10/27/2005
Additional Participating Persons:	Candace Carrera; FAA FSDO; Renton, WA Patrick Atchison; FAA-FSDO; Renton, WA Bruce Kitelinger; FAA-FSDO; Renton, WA Steve M Miller; Cessna Aircraft; Wichita, KS Henry J Soderlund; Cessna Aircraft; Wichita, KS Dan Withers; FAA ACO; Wichita, KS Tim J LeBaron; NTSB; Seattle, WA Dana Schulze; NTSB; Washington, DC Carolyn Deforge; NTSB; Washington, DC		
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