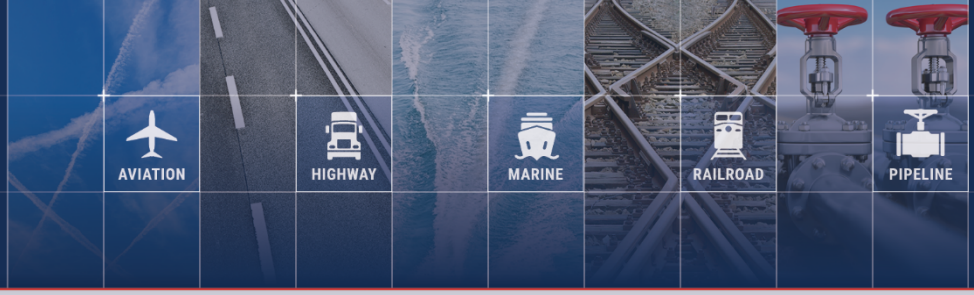

Aviation Investigation Final Report

Location:	DETROIT, Michigan	**Incident Number:**	CHI96IA109
Date & Time:	March 18, 1996, 07:00 Local	**Registration:**	N340NW
Aircraft:	Airbus Industrie A320-211	**Aircraft Damage:**	None
Defining Event:		**Injuries:**	110 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

The captain reported that the crew leveled at flight level 370 and received an elevator aileron computer (ELAC) number two pitch fault message. The message cleared itself. A few minutes later they received servo fault message. The 'pitch jumped +/- 100 feet.' The crew descended to flight level 350. During the level off they received an ELAC number one pitch fault message. The crew declared an emergency and landed uneventfully. The aircraft maintenance log revealed a similar occurrence on the previous flight. Investigation revealed an intermittent fault in the elevator servo controller electrovalve coil and a defective diode in the electronic module for one of the stabilizer actuators. The defective diode produced an intermittent loss of electrical motor power during transient, closed loop control of the actuator.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: a defective diode in the number two stabilizer actuator that produced an intermittent loss of electrical motor power during transient, closed loop control of the actuator. A factor was the intermittent open circuit in the elevator servo controller electrovalve coil.

Findings

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

Findings

1. (F) ELECTRICAL SYSTEM,ELECTRIC WIRING - OPEN
2. (C) FLT CONTROL SYST,FLY-BY-WIRE - FAILURE,PARTIAL

Factual Information

On March 18, 1996, about 0700 eastern daylight time (est), an Airbus A320-211, N340NW, operated as Northwest Airlines Flight 1714, from Detroit, Michigan, to Fort Lauderdale, Florida, experienced an uncommanded pitch excursion during level off at an altitude of 37,000 feet mean sea level (msl). Neither the six crew members nor the 104 passengers were injured. The airplane was not damaged. The 14 CFR Part 121 flight returned to the Detroit Metropolitan Wayne County Airport (DTW), Detroit, Michigan, without further incident. The flight had departed Detroit, Michigan, about 0630 est.

In his air safety report, the captain reported that the crew leveled at flight level 370 and received a fault message of a "F/CTL ELAC 2 PITCH FAULT." The message cleared itself. A few minutes later they received a message of "F/CTL ELEV SERVO FAULT" followed by "FLT/CTL ELAC 1 PITCH FAULT, FLT/ CTL ALTN LAW." The flight crew declared an emergency and returned to Detroit "without any additional problems." In the aircraft maintenance log, the captain reported that the "pitch jumped +/- 100 feet." Download of maintenance messages revealed "ELAC2 OR WIRING FROM RB ELEV MODE XDCR 34CE4", "RB ELEV MODE XDCR 34CE4", and "THS ACTR POS ERROR SCE OF ELAC1."

The aircraft maintenance log revealed an entry from the previous flight, March 17, 1996, "F/CTL ELAC 2 PITCH FAULT during climb. Erratic pitch control during level off. Uncommanded pitch trim up and down +/- 100 feet at cruise. Trim inputs very abrupt. Diverted to DTW. No control problems in descent or approach." Download of maintenance messages for this flight revealed "ELAC2 OR WIRING FROM RB ELEV MODE XDCR 34CE4." Maintenance log entries indicate that multiple operational checks were accomplished, ELAC 2 was replaced, and the airplane was released for service.

Examination of the digital flight data recorder (DFDR) data for the second flight revealed an ELAC 2 fault as the airplane climbed through approximately 36,880 feet. The pitch and altitude subsequently oscillated through about seven cycles with corresponding altitude deviations between 36,920 and 37,060 feet. A slight split elevator condition of about .8 degrees occurred. Erratic THS movement, about .6 degrees, is evident and vertical accelerations were 1 +/- 0.15 Gs. The airplane descended and leveled off at FL350. During the level off, an ELAC 1 fault occurred.

Review of flight control system architecture revealed that under normal operation, elevator control is performed by ELAC 2 via the inboard (green and yellow) elevator servos. The outboard (blue) servos act in the damping mode. Trimmable horizontal stabilizer (THS) control is accomplished by ELAC 2 via pitch trim actuator (PTA) number one.

The ELACs and spoiler elevator computers (SECs) also actively monitor the mode valve

transducer on each elevator servo. A discrepancy results in a mode fault. According to Airbus engineers, "ELAC 2 pitch fault followed by elevator servo fault are a consequence of the mode valve transducer monitoring performed by ELAC2 and SEC2," possibly caused by "defect on the common part of the wiring installation of the transducer between ELAC2 and SEC 2."

During normal operation, detection of an elevator or THS fault disengages the pitch axis of ELAC 2 (both elevators and THS). ELAC 1 assumes control of the elevators, via the outboard (blue) elevator servos, and the THS via PTA number two. According to Northwest Airlines procedures, scheduled operational checks of ELAC 1 are accomplished during the C check.

The ELACs and SECs actively monitor actuator commands (orders) and corresponding positions. A preset bias between the order and position results in a fault. With regard to the THS, a fault is triggered when the discrepancy between the THS order and the measured THS position becomes greater than 0.6 degrees for at least 100 milliseconds. Airbus' evaluation of DFDR traces indicates a THS order occurred immediately prior to the ELAC 1 pitch fault with no corresponding THS movement. "When the order is sufficient, there is a quick THS movement counteracted by the autopilot because this movement is out of phase."

During trouble shooting of the airplane, the elevator servo damping test was completed with no errors and the THS trim functioned normally during the maintenance test. The right outboard (blue) elevator servo was cold soaked with nitrogen. When cooled, a coil in the servo controller electrovalve, part number 30973-222, faulted with an open circuit.

ELAC 2 and THS components were examined under the supervision of the Bureau Enquetes-Accidents. ELAC 2, serial number 1364, was tested, May 9, 1996, by Sextant Industries. During the test, the K10 relay was discovered to be faulty. Sextant's evaluation of the fault disclosed that the faulty relay was not related to the pitch excursions. The failure of the relay was described as a "known" phenomenon covered by Sextant Service Letter SXT/A320-064.

The THS actuator, serial number 454, was tested at Airbus Industries. When installed on the standard test platform (iron bird) the actuator functioned normally.

The servo motor, serial number 1724, and electronic module, serial number 1618, were tested by Lucas Aerospace. The motor functioned normally. The electronic module was found to have a defective diode on the command link of one of the power transistors. The defect produced an intermittent loss of electrical motor power during transient, closed loop control of the actuator.

Pilot Information

Certificate:	Airline transport	**Age:**	40,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	December 7, 1995
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	7774 hours (Total, all aircraft), 3201 hours (Total, this make and model), 191 hours (Last 90 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus Industrie	**Registration:**	N340NW
Model/Series:	A320-211 A320-211	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	372
Landing Gear Type:	Retractable - Tricycle	**Seats:**	156
Date/Type of Last Inspection:	Continuous airworthiness	**Certified Max Gross Wt.:**	14500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo jet
Airframe Total Time:		**Engine Manufacturer:**	Cfm
ELT:	Installed, not activated	**Engine Model/Series:**	CFM56-5-A1
Registered Owner:	NORTHWEST AIRLINES	**Rated Power:**	23500 Lbs thrust
Operator:		**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	NWAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Unknown	**Visibility**	10 miles
Lowest Ceiling:	Overcast / 5500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	0°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	, MI (DTW)	**Type of Flight Plan Filed:**	IFR
Destination:	FORT LAUDERDALE, FL (FLL)	**Type of Clearance:**	IFR
Departure Time:	11:10 Local	**Type of Airspace:**	Class A

Wreckage and Impact Information

Crew Injuries:	6 None	**Aircraft Damage:**	None
Passenger Injuries:	104 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	110 None	**Latitude, Longitude:**	42.230594,-83.390922(est)

Administrative Information

Investigator In Charge (IIC):	Robbins, Wesley
Additional Participating Persons:	WILLIAM E TAKALA; BELLEVILLE , MI TIM LOGAN; ST. PAUL , MN MARTEN BOSMAN; BLAGNAC CEDEX
Original Publish Date:	April 24, 1998
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=10116