
In-Flight Upset following TCAS maneuvers, Airbus A340-200, D-AIBE, June 21, 1996

Micro-summary: This A340 encountered flight control design problems while reacting to a TCAS advisory.

Event Date: 1996-06-21 at 1428 CDT


Investigative Body: National Transportation Safety Board (NTSB), USA

Investigative Body's Web Site: <http://www.nts.gov/>

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		NTSB ID: FTW96LA269		Aircraft Registration Number: DAIBE	
		Occurrence Date: 06/21/1996		Most Critical Injury: Serious	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place DFW AIRPORT		State TX	Zip Code 75261	Local Time 1428	Time Zone CDT
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer Airbus Industrie		Model/Series A-340-200		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
<p>On June 21, 1996, at 1428 central daylight time, the flight crew of an Airbus A340-200, German Registration D-AIBE, en route from Dallas/Fort Worth Airport (DFW), Texas, climbing to 17,000 feet MSL, responded to a Traffic Alert and Collision Avoidance System (TCAS) alert Traffic Advisory (TA) at 13,800 feet MSL, with a descent maneuver. Operated by Lufthansa Airlines as Flight 436, a Title 14 CFR Part 129 scheduled passenger flight, the airplane was en route to Houston Intercontinental Airport (IAH), Houston, Texas. The two pilot crew, three flight attendants, and 65 passengers were not injured. Four flight attendants sustained serious injuries, and one flight attendant and one passenger received minor injuries. Visual meteorological conditions prevailed and the flight, operating on an IFR clearance, departed at 1418.</p>					
<p>During interviews and on the enclosed statements, company personnel and the flight crew reported that Flight 436 departed Frankfurt, Germany, on June 21, 1996, with planned stops at DFW Airport, Texas and IAH Airport, Houston, Texas. As Flight 437, the airplane would return to DFW Airport, Texas, with the final destination of Frankfurt. Flight 436, flown by the First Officer, and cleared for the JOE POOL TWO DEPARTURE, departed on runway 18L at DFW and was subsequently cleared for a left turn heading 160 with a climb to 17,000 feet MSL.</p>					
<p>After the airplane climbed through 10,000 feet, the flight crew turned the seat belt sign "OFF" and the cabin crew began preparations for serving the passengers. With a climb pitch attitude set at 5 to 6 degrees, the airspeed accelerated from 250 knots toward an en route climb airspeed as the crew reduced the rate of climb from 3,500 fpm to approximately 2,000 fpm. Between 13,000 feet MSL and 14,000 feet MSL, the aircraft TCAS accrued a Traffic Advisory (TA). The Captain recalled the traffic display at the 12:30 o'clock position with vertical separation of 2,000 feet; however, the First Officer recalled the traffic display at the 13:00 o'clock position with vertical separation of 1,200 feet. The captain recalled that the TCAS went from the Traffic Advisory (TA) indication to a Resolution Advisory (RA) indication "with the command descend, descend." The Captain initiated an immediate descent. The Captain did not make a verbal announcement that he was taking command of the left side stick control.</p>					
<p>All Lufthansa A320/A340 aircraft are equipped with a side stick priority feature whereby if the "take-over push button" on either side stick is pressed, the "red arrow" illuminates on the opposite side. The green light illuminates on the side having priority, if the pilot who lost priority moves his side stick out of neutral. In this case, there is also an audio "PRIORITY RIGHT" respectively "PRIORITY LEFT" message. The crew neither recalled observing the lights nor hearing the audio message. Input from both side sticks occurred until the First Officer, noting the Captain's input, moved the right side stick to a neutral position.</p>					
<p>During telephone conferences, conducted by the investigator-in-charge, the airplane manufacturer representative reported that a pilot takes the side stick priority by pressing and keeping pressed their take over priority button (P/B) which inhibits the other side stick inputs regardless of its</p>					
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position. If both pilots press their take over P/B, the last pilot to press will get the priority and if the P/B is pressed more than 30 seconds, the priority is latched to that side stick. However, at any time, a deactivated stick can be reactivated by momentarily pressing its takeover push button. If both pilots press their takeover push buttons, the last pilot to press will get the priority. During normal operation both side sticks are active and associated signals are algebraically added; however, flight control parameters are not exceeded during dual side stick inputs. The pitch control of the electronic flight control system is a load demand system. In clean configuration, maximum pitch up command is +2.5 G and maximum down command is -1.0 G. The manufacturer representative further stated that a dual side stick input is available whereby both green lights will illuminate in case of a simultaneous input on both side sticks and there is also a "DUAL INPUT" audio message. Lufthansa personnel reported that these dual input features would be scheduled for installation on their entire fleet of A340 aircraft in 1997. However, on January 14, 1997, Lufthansa personnel reported that the modifications had not been accomplished due to Airbus Industries not offering the "DUAL INPUT" side stick warning system modification for the A340 aircraft. An Airbus Industries representative confirmed on January 30, 1997, that the audio portion "DUAL INPUT" side stick warning system is an installation for the A320; however, the aural warning is currently under development/testing for the A340 and would be available for the A340 in February 1998.

A review of the ATC data (enclosed) revealed the following information. The Cessna 421, N421LF, owned and operated by Lyddon Aero Center at Liberal, Kansas, was en route VFR to Liberal. The pilot called approach control at 1427:16, reported the aircraft position as 28 miles south southeast at an altitude of 14,500 MSL and requested traffic advisories through the DFW Class B airspace. The Cessna 421, N421LF, was assigned a transponder squawk of 0211. At 1427:51, Lufthansa asked the controller about the traffic and at 1427:59 the controller advised Lufthansa that the traffic was at "one o'clock and a mile northbound fourteen thousand five hundred." At 1428:07 N421LF was advised that "traffic passi' just off right's an airbus." At 1428:11, the pilot of N421LF reported "yeah we've been watching him." At 1428:27, the Lufthansa flight crew, who did not have visual contact on the traffic, inquired if the controller had the traffic on radar and the controller responded that the traffic was past Flight 436 and was not a factor. Subsequently, the Flight 436 crew advised the controller that in response to the TCAS Traffic Advisory, "We had to stop the climb [and] descended to avoid the traffic." The flight requested and received priority handling for the continued flight to Houston. At 1456:32 the flight was cleared to land on runway 08 at Houston Intercontinental Airport and landed without further incident.

During a telephone interview, conducted by the investigator-in-charge, the pilot of N421LF recalled having the Airbus in sight and stated that there was adequate VFR separation. The pilot did not observe and was not aware of evasion action by the Lufthansa crew.

Flight attendant accounts of the time of occurrence varied from 8 to 15 minutes after takeoff and 2 minutes to 5 minutes after the seat belt sign had been turned off for the cabin. Two beverage carts had been placed in the forward section of the aft galley in preparation for service to the cabin. The flight attendants (enclosed statements) described the event with the following phraseology:

three strong consecutive jolts that threw me to the ceiling, floor,
and also against a galley wall 5 times,
hit by beverage carts, containers, and other service items,
hefty jolts which occurred without warning,
thrown approximately 5 times against the ceiling,

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galley looked like a battle field,
 aircraft jolted strongly and we were thrown some 50 centimeters into the air,
 followed by another, much stronger blow,
 thrown against the ceiling with great force several times, each time falling back to the floor,
 thrown around the galley several times without warning,
 thrown against the ceiling and the floor several times, and twice lifted some 10 centimeters from the floor.

The Captain, an Airline Transport Rated Pilot with the A340 type rating, had accumulated 1,930 flight hours in the aircraft. He had completed the company TCAS Computer Based Training; however, the captain had not received simulator TCAS training. The captain had not participated in the Crew Resource Management Course (CRM). The company reported that the "Crew Coordination Concept is a Standard operating crew concept" per Flight Operations Manual paragraph 3.1.1.2. Following the accident, the captain completed the CRM training on October 31, 1996. The captain completed recurrent TCAS training in the simulator on September 12, 1996, and the first officer on November 29, 1996.

The First Officer, an Airline Transport Rated Pilot with the A340 type rating, had accumulated 952 flight hours in the aircraft. He had completed the company TCAS and CRM training.

The Flight Operations Manual 3.1.2 for Crew Coordination Concept states in part:

The "Crew Coordination Concept" (C.C.C.) settles the task organization and distribution in the cockpit.

The "Pilot-in-Command" (PIC) is, within the scope of his directive task, responsible for the entire conduct of the flight (Responsibility of Command).

The entire flight crew shall, as far as possible, be informed about the actual situation as well as the intentions of each individual crew member with regard to the progress of the flight.

The teamwork as per C.C.C. is assisted by a transparent and unambiguous "two way communication." Principally, instructions and their execution as well as part of the information received will be confirmed verbally.

The Airbus A340-200, serial number MSN 019, was delivered to the operator on August 28, 1993, and had 12,996 flight hours at the time of the accident. TCAS equipment on the airplane was an Allied Signal Model CAS-81, Part No. 066-50000-0208, Serial No. 4983.

The operator's Flight Operations Manual Chapter 3.1.22 discusses the crew flight procedures for TCAS. The procedures for the TCAS RA state in part:

PF (pilot flying) shall respond immediately to satisfy RA's, using positive control inputs (manually, AP disconnected) in the direction and with the magnitude TCAS advises while attempting to site the conflicting traffic. Evasive manoeuvring shall be limited to the minimum required to comply with the RA; typically, this will result in altitude deviations in the order of 300-500 feet.

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The operator reported (data enclosed) that following the TCAS (RA) down advisory "don't climb greater than 500 fpm" the Captain operated the left side stick, commanding a forward side-stick deflection of 16-17 degrees with a left roll of 4.92 degrees. During the 5 seconds following the RA, the aircraft pitch change sequence was estimated as +5 degrees, +.07 degree, +4.2 degrees, -2 degrees, and +2.3 degrees. During this sequence the G-load varied from -0.18 G-load to +1.50 G-load. Company engineers mathematically derived the AFT galley G-load variation from a -0.74 G-load to +1.50 G-load.

Notification of the accident to the NTSB occurred after the flight departed the USA for Frankfurt and the Cockpit Voice Recorder (CVR) time expired during that flight. The Flight Data Recorder (FDR) records altitude, attitude, heading, TCAS data, side stick input, wind speed, wind direction true, vertical speed, angle of attack, and other parameters with an elapsed time line for 25 hours before recording over the oldest data. The FDR was recovered by the operator in Germany and discs of the FDR data were obtained by the NTSB.

The NTSB flight data recorder (FDR) Group Chairperson factual report revealed the following information. Five minutes 12 seconds after takeoff, the TCAS accrued a Traffic Advisory and at 5 minutes 28.8 seconds a TCAS Resolution Advisory (RA) down advisory don't climb greater than 500 fpm accompanied by a master warning light. During the next 14 seconds, following the RA, the captain and the first officer simultaneously operated their respective side stick controls.


At 5 minutes 12 seconds after takeoff, during the combined control input, the Captain Side Stick position indicated a full nose down input. The aircraft responded by pitching from approximately 5 degrees nose-up to 0.7 degrees nose-up. Consequently, the airplane descended from 13,836 feet to 13,800 feet MSL.


At 5 minutes 31.2 seconds after takeoff, during the combined control input, the Captain and the First Officer Side Stick Positions in Pitch indicated cumulatively full nose-up. The aircraft responded by pitching from 0.7 degrees nose-up to 4.22 degrees nose-up in about 1 second and the aircraft ascended from 13,800 feet to 13,880 feet MSL. The g load changed from -0.36 g's to 2.27 g's in the aft galley in about 1.1 seconds.

At 5 minutes 32.2 seconds after takeoff, during the combined control input, the Captain Side Stick Position indicated a full nose-down. The aircraft pitch changed from the 4.22 degrees nose-up to 2.11 degrees nose down in about a second and the aircraft began descending at a 1,150 fpm rate. The g load changed from the 2.27 g's to -0.76 g's in the aft galley in less than a second.

At 5 minutes 33.7 seconds after takeoff, both the Captain and the First officer Side Stick Positions in Pitch indicated cumulatively approximately 14 degrees nose-up input. The aircraft responded by pitching from the 2.11 degrees nose down to 1.8 degrees nose-up in less than a second. The g load at the aft galley changed from -0.76 g's to 2.09 g's in about 1.2 seconds.

See the enclosed FDR report for additional details.

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Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation Ft. MSL	Runway Used 0	Runway Length	Runway Width
Runway Surface Type:					
Runway Surface Condition:					
Type Instrument Approach:					
VFR Approach/Landing:					
Aircraft Information					
Aircraft Manufacturer Airbus Industrie		Model/Series A-340-200		Serial Number MSN 019	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 243	Certified Max Gross Wt.	566580 LBS	Number of Engines: 4	
Engine Type: Turbo Jet	Engine Manufacturer: Cfm	Model/Series: CFM 56-5C2	Rated Power: 31200 LBS		
- Aircraft Inspection Information					
Type of Last Inspection Continuous Airworthiness	Date of Last Inspection 05/1996	Time Since Last Inspection 10 Hours	Airframe Total Time 12996 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed?	ELT Operated?	ELT Aided in Locating Accident Site?			
Owner/Operator Information					
Registered Aircraft Owner LUFTHANSA GERMAN AIRLINES		Street Address FEDERAL REPUBLIC OF GERMANY			
		City FRANKFURT	State OF	Zip Code	
Operator of Aircraft Same as Reg'd Aircraft Owner		Street Address Same as Reg'd Aircraft Owner			
		City	State	Zip Code	
Operator Does Business As: LUFTHANSA			Operator Designator Code:		
- Type of U.S. Certificate(s) Held: None					
Air Carrier Operating Certificate(s):					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 129: Foreign					
Type of Flight Operation Conducted: Scheduled; International; Passenger Only					
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First Pilot Information

Name On File	City On File	State On File	Date of Birth On File	Age 49
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number: On File
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Certificate(s): Airline Transport

Airplane Rating(s): Multi-engine Land

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): None

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 12/1995
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time	16388	1931								
Pilot In Command(PIC)										
Instructor										
Last 90 Days	190	190								
Last 30 Days	71	71								
Last 24 Hours										

Seatbelt Used? Yes	Shoulder Harness Used? No	Toxicology Performed? No	Second Pilot? Yes
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Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point Same as Accident/Incident Location	State	Airport Identifier DFW	Departure Time 1420	Time Zone CDT
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Destination HOUSTON	State TX	Airport Identifier IAH	
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Type of Clearance: IFR

Type of Airspace: Class E

Weather Information

Source of Briefing: Company

Method of Briefing:

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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
DFW	1353	CDT	603 Ft. MSL	30 NM	334 Deg. Mag.
Sky/Lowest Cloud Condition: Unknown			0 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: Unknown		0 Ft. AGL		Visibility: 10 SM	Altimeter: 29.00 "Hg
Temperature: 32 °C	Dew Point: 16 °C	Wind Direction: 100		Density Altitude: Ft.	
Wind Speed: 12	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0 SM	Intensity of Precipitation: Unknown			
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information		
Aircraft Damage: None	Aircraft Fire: None	Aircraft Explosion: None

Classification: Foreign Registered/U.S. Soil

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants		4	1	3	8
Other Crew					
Passengers			1	65	66
- TOTAL ABOARD -		4	2	70	76
Other Ground	0	0	0		0
- GRAND TOTAL -	0	4	2	70	76

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Administrative Information

Investigator-In-Charge (IIC)

JOYCE M. SMITH

Additional Persons Participating in This Accident/Incident Investigation: