06/27/1990

06/27/90

No: 9/90 Ref: EW/G90/06/25 Category: 1b

Aircraft Type and Registration:	Pilatus Britten-Norman BN2T Islander, G-TEMI
No & Type of Engines:	2 Allison 250-B17C turbine engines
Year of Manufacture:	1982
Date and Time (UTC):	27 June 1990 at 1320 hrs
Location:	Bembridge, Isle of Wight
Type of flight:	Private (flight test)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tailplane, fuselage and right wing buckled, main landing gear broken
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	34 years
Commander's Total Flying Experience:	2,729 hours (of which 930 were on type)
Information Source:	Aircraft Accident Report Form submitted by the pilot

A flight test was being carried out in wind conditions of 220°/17 kt, with slight gusts which had not been mentioned in the forecast. The first task was to demonstrate compliance with the requirements of BCAR K2-7 para 3.3, which states that "In the event of sudden failure of the Critical Engine at any point in the take-off conducted in accordance with the recommended technique at any speed up to V_2 it shall be possible to prevent a lateral divergence from the intended take-off path of more than 9.1 m (30 feet)". Paragraph 3.4 goes on to state that "Where the aircraft is airborne at speeds below V_2, it shall be possible......to re-land without the display of undue skill on the part of the pilot". V_2 had been calculated on this occasion as 60 Knots Air Speed Indicator Reading (KASIR) and the pilot had decided to demonstrate compliance by using $V_2 \pm 5$ KASIR. Engine failure, for the purpose of the demonstration, was achieved by closing the low pressure fuel cock at a speed which was judged as likely to produce the (seconds later) engine run-down at the chosen speed (60 KASIR, in this case ± 5 kt).

Failure of the left engine was demonstrated to be satisfactory, with the engine run-down occurring at 63 KASIR and with a lateral divergence of 3 m to the left.

[their "V_2" - smaller category aircraft - is not same as our V_2]

A similar demonstration was carried out with a right engine failure but, on this occasion, the engine run-down occurred at about 70 KASIR (V_2 +.10). Immediately prior to the run-down, the aircraft became airborne, stated by the pilot to be caused by a gust of wind, and drifted further to the right of the runway centreline than would have been induced by the run-down alone. At a height of 35-40 feet and 25-30 feet right of the centreline, the commander decided that there was insufficient distance remaining to accomplish a stop within the TODA. He therefore continued the take-off, believing that the weight of the aircraft would allow an adequate climb performance. However, the airspeed decayed, perhaps as the gust died down, and, despite the use of full power and flap retraction, the aircraft continued to sink to the ground. The height was too low to allow recovery of the airspeed and the aircraft descended in a high nose attitude, which the commander had maintained in order to increase survivability, and impacted with the ground at about 55 KASIR, beyond and to the right of the runway.

There was no fire and having made the aircraft safe the crew vacated it.

08/15/1990

Lori Ann Peplinski Davis, thirty, a lovely woman with the high cheekbones of a fashion model, was pregnant on 15 August 1990 with her first child. She was worrying about when the labor pains would start, not about the routine flight her husband, LT William C. "Catfish" Davis, thirty-three, and CAPT Steven A. "Axle" Hazelrigg, forty-two, chief test pilot of the Strike Directorate, were flying that morning in an old A-6 bomber.

Hazelrigg was in the left seat, flying the bomber away from Pax River and south toward the Northern Neck of Virginia. A divorced and loving father of two daughters, Hazelrigg was widely admired within the Strike Directorate as a leader and an aviator. He was fun loving off duty—had even dared to bring his ski boat with him when he reported to Pensacola as a flight student—and on duty led by example rather than intimidation.

Catfish Davis was sitting on the right side, in the bombardier-navigator's seat. He was an old hand in the A-6. He had bombed Lebanon from one A-6 in 1983 and ejected from another in 1984, miraculously landing safely in the predawn

dark on the flight deck of the USS *John F. Kennedy*. [redacted]sh was a dedicated aviator who had been selected to work on the hush-hush A-12 stealth-bomber program at Pax but never forgot that he had a loving wife at home.

Axle and Catfish were up in the sky in the A-6 because they were testing a new bomb for the plane. The two graduates of TPS were resuming tests of the new dummy bomb they had taken aloft before. They were going along at 500 knots at 5,000 feet, setting up to test how the weapon would withstand the bomber's pitching maneuvers.

Steve Hazelrigg went into the up-and-down, nose-to-tail maneuver called a "sinusoidal stick pump" test to see if the bomb rode all right—if it stayed attached in stressful maneuvers. Suddenly, something broke between the control stick and the horizontal stabilizer on the tail. It could have been a section of rod, a crank—any one of scores of pieces in the control line leading from the stick to the elevator. The leading edge of the horizontal stabilizer slanted upward into the oncoming air, forcing the tail to ride up over a hill of air. This pushed the tail of the bomber up and its nose down. Hazelrigg pulled back on the stick to bring the plane back up to level flight. Nothing happened. The plane stayed in its straight-down dive. Catfish felt the bomber go into a sickening left roll during the dive.

The feeling was like having an elevator break away from its overhead cable and plunge toward the basement at 500 miles per hour. You would find yourself up against the ceiling of the elevator. The lap and shoulder harnesses held Axle and Catfish in their seats. But they were being pushed upward toward the canopy at a force 6.8 times their own weight.

"Pull!" Catfish told Axle, not realizing the pilot had already tried. The horizontal stabilizer was stuck with its full leading edge up. The plane was out of control. The excruciating gravitational force made it difficult for either flier to reach the ejection handles under his seat or behind his head. Somehow Catfish reached down and got his hand around the lower handle. The A-6 was diving at 550 knots. The plane was only 3,500 feet above the ground. Catfish was being pushed up against the canopy roof with more negative Gs than the ejection system was designed to overcome. But it worked. Catfish was shot through the roof one tenth of a second before negative Gs would have incapacitated him. Steve Hazelrigg either did not want to eject, perhaps figuring he could regain control of the bomber, or was so stricken by the negative Gs that he could not reach either of his ejection handles. The A-6 is not rigged so that Catfish could have ejected Axle along with himself—a flaw that infuriates those who fly the bomber. Axle rode the plane down to its head-first crash into the earth. Pilot and plane disintegrated in a farm field near Burgess, Virginia.

Catfish probably never heard the "gotcha" snap of his parachute's opening. He was grievously injured and would never remember exactly what happened immediately before and after his ejection, even under hypnosis. His parachute snagged a treetop, apparently providing a braked rather than sudden stop. An unimpeded smash into the earth probably would have killed him because of his many injuries. He hung suspended in his chute with just the balls of his feet touching the ground. He was conscious but too weakened by his many injuries to extricate himself from his harness.

Hazelrigg and Davis had been in constant electronic contact with engineers at Pax River. The engineers were studying the telemetry coming from the bomber as it went through its maneuvers. Suddenly, the telemetry revealed an unprogrammed dive. Then electronic contact was broken. The engineers sounded the alarm. Salty Dog 505 had gone off the radar scope, and one Emergency Locator Transmitter (ELT) had begun beeping.

06/12/1991

NTSB Identification: DEN91LA082 For details, refer to NTSB microfiche number 44388A

Accident occurred JUN-12-91 at DENVER, CO
Aircraft: BOEING DHC-6-300, registration: N242CA
Injuries: 2 Uninjured.

AT DAWN, THE PILOT AND A MECHANIC WENT OUT TO PREFLIGHT THE AIRCRAT AND THEN FLY IT ON A LOCAL MAINTENANCE TEST FLIGHT. THE HYDRAULIC SYSTEM CIRCUIT BREAKER WAS NOT "IN" WHEN THE AIRCRAFT ENGINES WERE STARTED. AS THE RIGHT ENGINE RPM BEGAN TO INCREASE, THE AIRCRAFT STARTED TO MOVE FORWARD. THE PILOT APPLIED THE BRAKES ONLY TO DISCOVER THERE WAS NO HYDRAULIC PRESSURE IN THE BRAKE LINES. BEFORE CORRECTIVE ACTION COULD BE TAKEN, THE AIRCRAFT STRUCK A PARKED AIRCRAFT.

Probable Cause

THE PILOT'S FAILURE TO PERFORM AN ADEQUATE PREFLIGHT, I.E., NOT FOLLOWING THE CHECK LIST AND THE NORMAL BRAKE SYSTEM WAS INOPERATIVE AS A RESULT OF NO HYDRAULIC SYSTEM PRESSURE (HYDRAULIC SYSTEM CIRCUIT BREAKER NOT "IN").

Index for Jun 1991 | Index of Months

+--- REQUEST 074/98, REPORT 11 ---+
+ DATA REPORT DE HAVILLAND-DHC6-300 ACCIDENT +
+ EVENTS¦PHASES BRAKE-AIRCRAFT STANDING +
+ LOSS OF CONTROL-TAXIING +
+ COLLISION WITH OBJECT-OTHER-TAXIING +

<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 91/0211-0
++ FROM STATE : UNITED STATES

FINAL REP ++

<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->

DATE : 91-06-12 ++ MASS CATEGORY : 2250 - 5700 KG
TIME : 05:00 ++ STATE OF REGISTRY : UNITED STATES
LIGHT : DAWN ++ REGISTRATION : N242CA
GEN WEATHER : VMC ++

<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->

LOCATION : DENVER,CO ++ A/C DAMAGE : SUBSTANTIAL
STATE/AREA : UNITED STATES
DEPARTED : DENVER,CO
DESTINATION : DENVER,CO

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	1	0	1
PAX :	0	0	0	0	0	0

---------------- NARRATIVE ----------------

THE PILOT STARTED THE ENGINES FOR A TEST FLIGHT. THE HYDRAULIC SYSTEM WAS NOT PRESSURIZED. AS NO.2 ENGINE STARTED UP AND THE OIL PRESSURE BEGAN TO COME UP, THE PROPELLER CAME OUT OF THE FEATHER POSITION, PULLING THE A/C INTO A PARKED A/C. DRN: THE HYDRAULIC SYSTEM CIRCUIT BREAKER WAS NOT "IN". THE PILOT APPLIED THE BRAKES ONLY TO DISCOVER THERE WAS NO HYDRAULIC PRESSURE.

------------ SEQUENCE OF EVENTS ------------

EVENT 1 BRAKE - AIRCRAFT STANDING
1.NORMAL BRAKE SYSTEM - NO PRESSURE
2.FL CREW PRE-FLIGHT CHECK PROCEDURE - INADEQUATE
3.USE OF CHECK LIST - NOT FOLLOWED
EVENT 2 LOSS OF CONTROL - TAXIING
EVENT 3 COLLISION WITH OBJECT-OTHER - TAXIING

+--- REQUEST 074/98, REPORT 12 ---+
+ UNOFFICIAL REPORT CESSNA-421 ACCIDENT +
+ EVENTS¦PHASES ATC RELATED EVENT-EN-ROUTE +
+ AIRCRAFT NEAR COLLISION-BOTH AIRBORNE-EN-ROUTE +

<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 91/0485-2
++ FROM STATE :

FINAL REP ++

<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->

DATE : 91-10-22 ++ MASS CATEGORY : 2250 - 5700 KG
TIME : 00:00 ++ STATE OF REGISTRY :
LIGHT : ++ REGISTRATION :
GEN WEATHER : ++

<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->

LOCATION : N/CHICAGO ++ A/C DAMAGE : NONE
STATE/AREA : UNITED STATES
DEPARTED :
DESTINATION :

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	0	0	0
PAX :	0	0	0	0	0	0

09/16/1991

09/16/91

AviationSafetyNetwork

•••••••••••••••••• Accident Description

Home
- sign guestbook
- view guestbook
- editorial
- what's new?

Accident reports
Accident specials
CVR / FDR
Database
Mailing list
News
Other sites
Pictures
Publications
Safety issues
Statistics

Forum
E-mail
About ASN...

Accident description

Date:	**16.09.1991**
Type:	Antonov 74
Operator:	Aeroflot/Tshersk Aviation Plant
Registration:	SSSR-74002
C/n:	07-03 (l/n)
Year built:	1990
Crew:	fatalities / on board
Passengers:	fatalities / on board
Total:	13 fatalities / on board
Location:	Petropavlovsk-Kamchatsky (Russia)
Phase:	Take-off
Nature:	
Flight:	- (Flightnumber)

Remarks:
Caught fire and crashed.

Source:

[disclaimer]

12/10/1991

12/19/91 ✓

NTSB AVIATION ACCIDENT/INCIDENT DATABASE REPORT
Report Number: FTW92LA040
Microfishe 46289

General Information
Local Date: 12/10/1991
Local Time: 08:55 CST
City/State: ARLINGTON, TX
Airport Name: ARLINGTON MUNI
Airport Id: GKY
Event Type: ACCIDENT
Injury Severity: NONE

Operations Information
Category of Operation: GENERAL AVIATION
Aircraft Type: HELICOPTER
Aircraft Damage: SUBSTANTIAL
Phase of Flight: 570 LANDING
Aircraft Make/Model: BELL BHT-206-L3 "LONG RANGER"
Operator Doing Business As:
Operator Name: BELL HELICOPTER TEXTRON
Operator Code:
Operator:
Owner Name: BELL HELICOPTER TEXTRON

Narrative
THE EXPERIMENTAL CERTIFICATED HELICOPTER WAS BEING TEST FLO WN AS PART OF THE HEIGHT VELOCITY DIAGRAM DEVELOPMENT FOR THE 206L4 CERTIFICATION PROGRAM. THE TEST PILOT WAS CONDUCTING ABORTED TAKEOFFS WHEN AT 30 FEET AND 50 KNOTS HE INITIATED AN AUTOROTATION. THE COLLECTIVE WAS LOWERED SLIGHTLY AND A HIGH DESCENT RATE OCCURRED. DURING THE DESCENT THE MAIN ROTOR RPM DECREASED AND THE HELICOPTER LANDED HARD RESULTING IN TAILBOOM BUCKLING AND SEPARATION OF THE TAIL ROTOR DRIVE SHAFT. THE PILOT'S APPLICATION OF COLLECTIVE BEFORE TOUCHDOWN DID NOT ARREST THE DESCENT RATE.

Probable Cause
THE HELICOPTER'S AUTOROTATIONAL LANDING PERFORMANCE CAPABIL ITY WAS EXCEEDED. FACTORS WERE THE PROPER DESCENT RATE WAS NOT POSSIBLE FOR THE PIC AND SUFFICIENT INFORMATION FROM THEMANUFACTURER WAS NOT PROVIDED.

Aircraft Information
Number of Seats: 2
Aircraft Use:
Type of Operation: 14 CFR 91
Domestic/International:
Passenger/Cargo:
Registration Number: 2770X

Air Carrier Operating Certificates:
Aircraft Fire: NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	0	0	2
Pass	0	0	0	0
Other	0	0	0	0

Landing Gear: SKID
Certificated Maximum Gross Weight: 4150
Engine Make: ALLISON
Engine Model: 250C-30P
Number of Engines: 1
Engine Type: TURBO SHAFT

Environment/Operations Information
Basic Weather Conditions:VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg): 0
Wind Speed (knots): 0
Visibility (sm): 12
Visibility RVR (ft): 0
Visibility RVV (sm): 0
Cloud Height Above Ground Level (ft): 25000
Visibility Restrictions: NONE
Precipitation Type: NONE
Light Condition: DAYLIGHT
Flight Plan Filed: NONE
ATC Clearance: NONE
VFR Approach/Landing: SIMULATED FORCED LANDING
Event Location: ON AIRPORT

Pilot-in-Command
Certificates: COMMERCIAL, FLIGHT INSTRUCTOR
Ratings:
Plane: SINGLE ENGINE LAND
Non-Plane: HELICOPTER
Instrument: AIRPLANE, HELICOPTER
Had Current BFR: YES
Months Since Last BFR: 12
Medical Certificate: CLASS 2
Medical Certificate Validity: VALID MEDICAL-WITH WAIVERS/LIMITATIONS

Flight Time (Hours)

Total :	8200	Last 24 Hrs :	2
Make/Model :	100	Last 30 Days:	20
Instrument :	60	Last 90 Days:	50
Multi-Engine:	0	Rotorcraft :	7800

02/29/1992

2/29/92 ✓

NTSB AVIATION ACCIDENT/INCIDENT DATABASE
Report Number: DEN92LA036

General Information

Local Date:Time	02/29/1992:10:22MST
City:State	LEADVILLE: CO
Airport Name:Id	LAKE COUNTY:LXV
Event Type:	ACCIDENT
Injury Severity:	NONE

Operations Information

Category of Operation:	GENERAL AVIATION
Aircraft Type:	HELICOPTER
Aircraft Damage:	SUBSTANTIAL
Phase of Flight:	MANEUVERING
Aircraft Make/Model:	? TH-28
Operator Name:Code	ENSTROM HELICOPTER CORPORATION:EAHA
Operator:	ENSTROM HELICOPTER CORP - EAHA
Owner Name:	ENSTROM HELICOPTER CORPORATION

Narrative

THIS WAS ONE OF A SERIES OF EXPERIMENTAL TEST FLIGHTS LEADI NG TOWARDS FAA CERTIFICATION OF THE MODIFIED HELICOPTER. DATA POINTS FOR THE HEIGHT VELOCITY CURVE HAD BEEN COLLECTED AND THE PILOT WAS ATTEMPTING TO CONFIRM THEIR ACCURACY. AT 46 KNOTS AND 400 FEET AGL, THE PILOT MADE AN INTENTIONAL AUTOROTATION. HE SAID THE SINK RATE WAS HIGHER THAN PREVIOUSLY NOTED, AND HEAVY ROTOR BLADE STALL MADE THE FLARE INEFFECTIVE. THE PILOT SAID A DOWNDRAFT MAY HAVE PRECIPITATED THE ACCIDENT.

Probable Cause

THE PILOT MISJUDGING THE DESCENT RATE AND CONSEQUENTLY DELAYING THE FLARE. A FACTOR WAS: DOWNDRAFT.

Aircraft Information

Number of Seats:	3
Aircraft Use:	
Type of Operation:	14 CFR 91
Registration Number:	8631E
Aircraft Fire:	NONE

Injuries

	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	0
Other	0	0	0	0

Landing Gear: SKID

Certificated Maximum Gross Weight: 2750

Engine Make:Model ALLISON:250-C20W
Number of Engines: 1
Engine Type: TURBO SHAFT

Environment/Operations Information

Basic Weather Conditions:VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg):Speed (knots) 340:5
Visibility (sm): 30
Visibility RVR (ft): 0
Visibility RVV (sm): 0
Cloud Height Above Ground Level (ft): 0
Visibility Restrictions: NONE
Precipitation Type: NONE
Light Condition: DAYLIGHT
Flight Plan Filed: NONE
ATC Clearance: NONE
VFR Approach/Landing:
Event Location: ON AIRPORT

Pilot-in-Command

Certificates: COMMERCIAL, AIRLINE TRANSPORT, FLIGHT INSTRUCTOR
Ratings:
Plane:SINGLE ENGINE LAND, MULTIENGINE LAND, SINGLE ENGINE SEA
Non-Plane: HELICOPTER, FREE BALLOON
Instrument: AIRPLANE, HELICOPTER
Had Current BFR: YES
Months Since Last BFR: 8
Medical Certificate: CLASS 1
Medical Certificate Validity: VALID MEDICAL-NO WAIVERS /LIMITATIONS

Flight Time (Hours)

Total :	6479	Last 24 Hrs :	0
Make/Model :	889	Last 30 Days:	50
Instrument :	668	Last 90 Days:	97
Multi-Engine:	1657	Rotorcraft :	4225

04/25/1992

04/25/92

USAF Will Not Repair YF-22A Following Crash During Flight Test

MICHAEL A. DORNHEIM/LOS ANGELES

The YF-22A prototype will not be repaired following its crash, which abruptly ended the current U.S. Air Force advanced tactical fighter flight test program. Testing will restart with production prototypes, set to fly in 1995.

1992 The Lockheed prototype bellied onto the Edwards AFB runway on Apr. 25 and caught fire while sliding several thousand feet down the concrete strip.

Lockheed test pilot Tom Morgenfeld climbed out of the cockpit by himself after the aircraft came to a halt. He suffered only a sore back. The aircraft pancaked onto the runway after several cycles of severe pitch oscillation that started during a go-around.

Officials believe this was the first time a go-around had been conducted using thrust vectoring in afterburner while retracting the gear. "It's probably a sleeper" problem area in the flight envelope that had not previously been investigated, an executive familiar with the program speculated.

Air Force chief of staff Gen. Merrill A. McPeak said the fly-by-wire flight control system gains will be checked, and if they are deficient then it will be a "relatively straightforward software fix." McPeak noted that the horizontal tail has more motion when the landing gear is down than when it is up.

The Pratt & Whitney YF120-powered YF-22 burned for about a half hour. The other YF-22 prototype powered by GE YF119 engines will not be reactivated. "It's a sad way to end a program," a Lockheed official said.

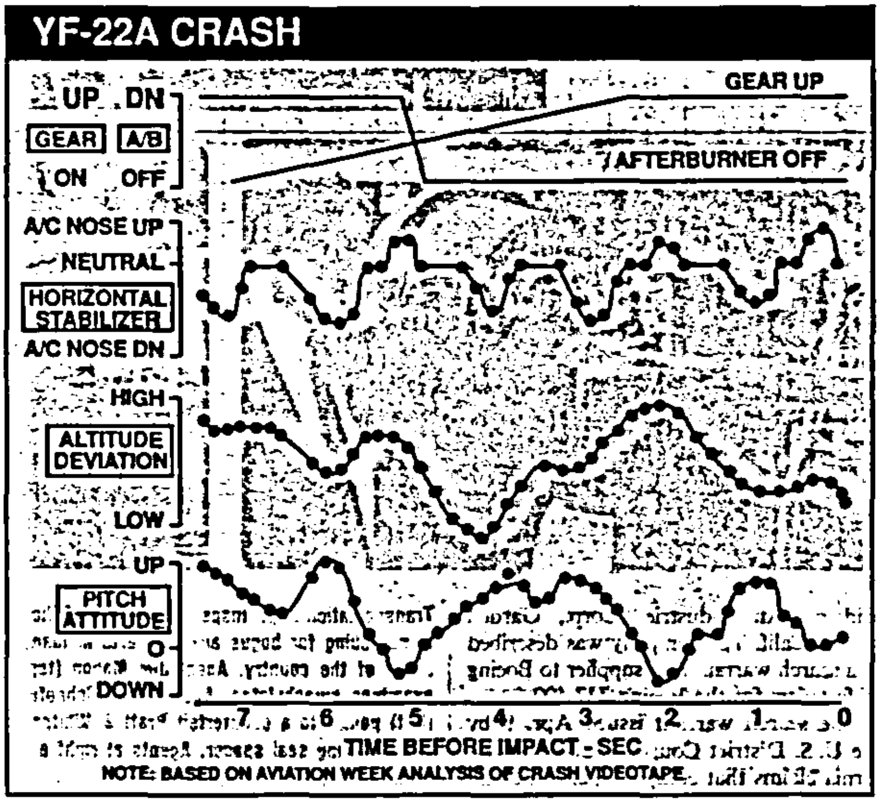
The Air Force portrayed the crash as a minor setback, saying that more than 90% of the EMD test objectives had been accomplished and three-quarters of the test hours had been flown.

All structural loads and all vibration and acoustic data had been measured to help in designing the production aircraft. The last few flights were collecting aeroelastic data, and the final flight was also measuring weapons bay noise. The pilot was conducting flybys at the end of the 2.2-hr. mission when the accident occurred.

Tests that were not performed include maximum performance maneuvers, engine transients and other propulsion checks. The aircraft was owned by Lockheed during dem/val, but it became Air Force property when EMD started Aug. 2.

The aircraft was not ruined, and one official estimated that 20-25% of the structure was destroyed by the fire. The test data recorders in the nose survived and telemetry was being recorded as well, giving investigators information to help determine the cause of the accident.

The first approach was uneventful, and the go-around was initiated routinely by using military thrust and retracting the landing gear. The difference with the second go-around was that the afterburner was activated. The oscillations started immediately after the afterburner was engaged and the gear was commanded up.



THREE UP-DOWN CYCLES

The aircraft appeared steady on approach, with large jerky motions in the tailplanes typical of unstable fly-by-wire aircraft. However, it appeared to be overcontrolled in a tail-aspect videotape that shows the last 7.5 sec. of flight.

There are three irregular cycles of up-down motions in the last 7.5 sec., starting with a nose-up attitude and ending with impact just as the aircraft began to rotate up again from a level attitude. The excursions are bounded by roughly 20 deg. up and 5 deg. down. The videotape shows the tailplanes and thrust-vectoring nozzles moving in concert to drive the pitch motions. Airspeed was in a proper range, an official said, and the aircraft can be seen rising and falling, indicating the wing was not stalled.

During the early part of the pitch oscillations the afterburners were on, but they shut off about 5 sec. before impact. The vectoring nozzles are slaved directly to tailplane motion at a given speed, and the gearing ratio does not depend upon the thrust setting. As a result, operating in afterburner gives more powerful pitch response and could alter pitch stability.

The landing gear was in transit at the beginning of the pitch oscillations, and appeared to be fully retracted 2.5 sec. before impact. Gear retraction reduces pitch authority in the flight control laws.

"My impression is there's nothing wrong with the aircraft," an official said. "From the video, it appears there's no reason to think there's any problem with the thrust vectoring being out of sync. Maybe it was in an area that was not investigated in dem/val. It looks like the pilot ran into something and was too close to the ground to recover."

Afterburner was used with thrust vectoring in dem/val, but at higher altitudes and without gear retraction. No classic pilot-induced oscillation surveys were run in dem/val. The YF-22 has a sidestick controller with about 0.75-in. throw from neutral to full-aft stick. □

USAF will not repair YF-22A following crash during **flight test**

PERSONAL AUTHOR

Dornheim,-Michael-A

SOURCE

Aviation-Week-and-Space-Technology.v. 136 May 4 '92 p. 20.

DESCRIPTORS

Aviation-Accidents; Stealth-aircraft-Testing .

+-- REQUEST 074/98, REPORT 50 --+

+ DATA REPORT — BEECH-90 KING AIR — ACCIDENT +

+ EVENTS|PHASES — DOOR/PANEL FAILURE-CRUISE +

+ PRESSURIZATION FAILURE-CRUISE +

+---+

<---------------------- OPERATION ---------------------->

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

<----------- DATA, TIME AND METEOROLOGICAL DATA ---------->

DATE : 95-11-03
TIME : 15:00
LIGHT : DAYLIGHT
GEN WEATHER : VMC

<---------------------- LOCATION ---------------------->

LOCATION : WICHITA,KS
STATE/AREA : UNITED STATES
DEPARTED : WICHITA,KS
DESTINATION : WICHITA,KS

<---------------------- FILE DATA ---------------------->

ICAO FILE : 95/1150-0
FROM STATE : UNITED STATES

<--------------------- AIRCRAFT DATA --------------------->

MASS CATEGORY : 2250 - 5700 KG
STATE OF REGISTRY : UNITED STATES
REGISTRATION : N93RY

<----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->

A/C DAMAGE : SUBSTANTIAL

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	2	0	2
PAX :	0	0	0	1	0	1

---------------- NARRATIVE ----------------

DURING A MAINTENANCE TEST FLIGHT AT 14,500 FT, THE PILOT NOTICED A WHISTLING NOISE AND DECIDED TO CHECK THE CABIN DOOR FOR AIR LEAKS. HE PUSHED THE CABIN DOOR BUTTON AND TURNED THE HANDLE FROM THE NEUTRAL TO THE LOCKED POSITION, THEN BEGAN PUSHING ON THE CABIN DOOR. THE DOOR OPENED. NO ANOMALIES WITH OF THE CABIN DOOR WERE FOUND. THE PILOT DID NOT OBSERVE THE CAUTION PLACARD ON THE DOOR NOR THE EMERGENCY DOOR WARNING NOTICE IN THE FLIGHT MANUAL.

------------ SEQUENCE OF EVENTS ------------

EVENT 1 DOOR/PANEL FAILURE - CRUISE
1.DOOR - LEAK/LEAKED
2.FLIGHT CREW PROCEDURES - NOT FOLLOWED
3.DOOR - OPEN
EVENT 2 PRESSURIZATION FAILURE - CRUISE

04/29/1992

LCDR Steve Eastburg of TPS Class 100 and LT Sean Brennan of Class 99, both thirty-three years old, were preparing to take the S-3 Viking antisubmarine aircraft up over the Chesapeake Bay to fly a "vomit comet" mission. The idea was to do the aerial equivalent of reverse engineering. First, they would fly the S-3 through a series of precise maneuvers while an elaborate network of instruments monitored and recorded what happened to the plane. Next, engineers and technicians on the ground would study the information gained and use it to fine tune the simulator. The payoff would be a more-realistic simulator for pilots trying to master the S-3 under various flying conditions, including adverse ones.

The flight plan had been studiously developed before Eastburg and Brennan were assigned to execute it. They discussed what they were going to do, step by step, with other aviators and engineers before climbing into the S-3 designated Waterbug 736. Nothing looked particularly risky. Engineers at the Chesapeake Test Range at Pax River would be watching for trouble the whole time they were airborne.

Eastburg, a naval flight officer, would be in the right seat of the S-3, working the radios, studying several of the key instruments in the cockpit, and taking down data. Brennan, the pilot, would be flying from the left seat and taking the plane from one point in the sky to another to complete a long list of maneuvers.

The rough part of their ride—the part that inspired the name "vomit comet"—would come when Brennan pitched the S-3 up and down, rolled it from wingtip to wingtip, and swerved it from left to right in a series of skids called yaws. The first set of these stomach-jolting maneuvers would be done at an altitude of 10,000 feet at a speed of 305 knots. The second set would be down in the rougher air at 5,000 feet at an even faster speed, 365 knots.

The S-3 is a twin-engine jet with thick wings and a tail so tall that it has to be folded over from the top to fit in carrier hangar bays. Pilots regard it as a solid aircraft that flies smoothly. Eastburg and Brennan felt safe in it. They had no fears the airplane would break during the maneuvers that lay ahead of them this sunny afternoon of 29 April 1992.

After a quick lunch and an extensive preflight briefing, the aviators took off without incident and steadied the S-3 at 10,000 feet in clear air over the Chesapeake a few miles east of Pax River. Brennan worked the throttles and trim until he had the plane straight and level at 305 knots. Eastburg watched the gauges and answered such standard radio calls from the ground as "Waterbug 736, you're five miles from the boundary." Sean Brennan pushed the stick forward and backward in ever-decreasing intervals. The plane pitched up and down like a bucking bronco. He swung the stick left and right in the same quickening sequence. The plane rolled like a canoe being smacked on its sides by higher and higher waves. Sean went into rudder sweeps to generate the yawing, pushing the left rudder pedal, then the right, then the left, then the right. The motion causes queasiness in the guts for even veteran pilots.

All that done, with lunch swirling uneasily in their stomachs, Steve and Sean descended to 5,000 feet. Sean put the plane through the same set of punishing maneuvers at 365 knots. The ride became rougher at this faster speed in the thicker air. He was in the middle of the same sickening rudder sweeps when Steve heard the noise of catastrophe coming from somewhere in the aft fuselage.

Craaack!

Steve had never heard such a chilling sound in an airplane. It sounded like a tree snapping in half during a windstorm. They knew the plane had broken, but not where. Telemetry would show that the top of the giant tail had broken off—meaning that Sean could no longer make the plane move left or right with the rudder pedals. At about the same instant one of the elevators needed to make the plane go up or down snapped off. The plane went out of control. It rolled, pitched, and yawed violently. Each new gravitational force pushed or pulled the aviators in a different direction as they sat in their seats, their shoulder and lap harness straining to hold them down. Steve glanced over at Sean and saw he was still fighting the airplane. His body was so twisted by the pile up of gravitational forces that Steve doubted he could reach the ejection handle even though it was now obvious that they had to leave the wrecked plane or die. Steve managed to get his hand around the ejection handle under his seat as Sean started the "Eject, eject, eject" command.

It was less than two seconds between when they were confronted with the emergency and when Steve pulled the ejection handle. They would learn later that waiting another split second would have killed them both. The rockets under the seats of Steve and Sean ignited, blasting them through the plastic roof of the cockpit just before it became a death trap. The S-3 skidded around until it was hurtling through the air tail first, and the right wing broke off at its root in the fuselage, pouring fuel into the onrushing air. The atomized fuel exploded into a fireball, probably from the engine exhaust.

Steve and Sean did not know what was happening to the airplane at the time. Only later would telemetry tell the story: so much force slapped into the sides of the rudder that it could not take it and snapped.

After the accident there was a lot of second guessing within the test-pilot community at Pax River. Questions included: Why had not the engineers at Force Warfare discovered the dangers inherent in such high-speed rudder sweeps * before they wrote the flight plan for Eastburg and Brennan to carry out? Why did not the engineers and technicians watching the telemetry while the flight was in progress see the problems before disaster struck and call off the tests? Eastburg and Brennan did not join in on this second guessing, which comes in the wake of such accidents. I found myself wondering whether the accident showed the need for a better computerized data base of what had happened to the S-3 before on similar tests.

* Mil Test Centers don't/didn't consult manufacturer. Lockheed designed vertical to civil criteria - that is rudder is not assummed to be reversed past neutral when in a sideslip DH 6/98

06/04/1992

.06/24/92

Navy Investigating Crash Of T-45A Test Aircraft

EDWARDS AFB, CALIF.

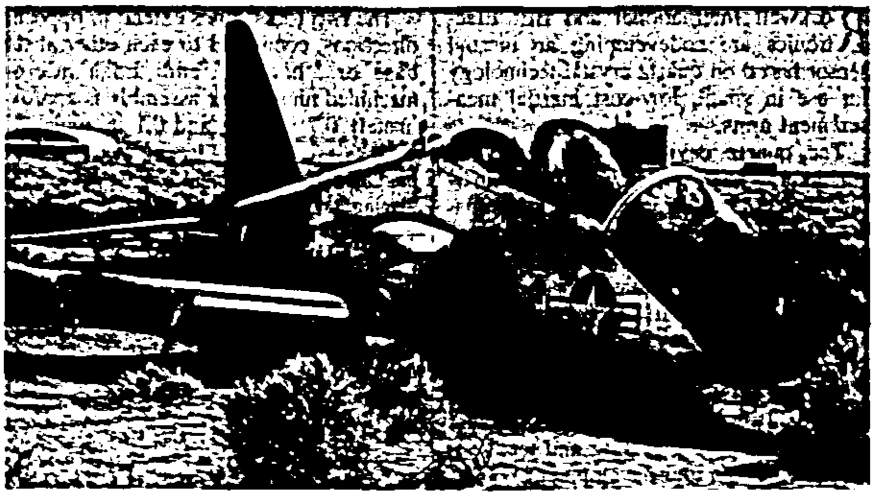
A Navy/McDonnell Douglas T-45A test aircraft suffered extensive damage when it veered off the runway immediately after landing and hit the remains of a building foundation here. The pilot ejected safely.

The 11:33 a.m. accident occurred on June 4 as Lt. Owen P. Honors, a Navy test pilot assigned to the Strike Aircraft Test Directorate at NAS Patuxent River, Md., was completing a ferry flight to Edwards AFB. The Navy's single-engine trainer was to undergo several weeks of engine operability tests here.

Honors made a standard Navy approach to Edwards' Runway 22, landing about 500 ft. beyond the threshold. When all three landing gear contacted the runway, the aircraft immediately veered to the left and ran off the concrete about 1,500 ft. past the touchdown point.

The pilot managed to avoid hitting a truck and two men parked near the runway, then ejected as the trainer became uncontrollable in the rough desert terrain.

After it struck the concrete foundation of an old building site, the aircraft apparently skidded sideways 100 ft. until it stopped, still upright. The right wing tip, nose gear and right main landing gear were ripped off. The left main gear collapsed, but was still attached to the wing. A small fire appeared to have caused minor damage around the engine tailpipe.



No. 1 T-45A test aircraft's nose gear, right main gear and right wingtip were sheared off when the trainer left the runway after landing at Edwards AFB. The pilot ejected safely.

Landing winds were light and variable, measured at less than 10 kt. and generally down the runway, according to Lt. Cdr. James W. Galanie, a pilot and safety officer from NAS Patuxent River.

Cause of the accident is being investigated by a Navy accident board. The full extent of damage to the No. 1 T-45A test aircraft was still being assessed by Navy and McDonnell Douglas officials as of early last week. □

07/21/1992

V-22
OSPREY

standoff jamming for all tactical air operations would be assigned to the Navy. The committee denied the Air Force's request for $68.6 million to upgrade its EF-111 electronic warfare aircraft. Instead, funding for the Navy's EA-6B aircraft would be doubled, to $97.3 million.

Funding for Navy EP-3 and Air Force RC-135 signals intelligence gathering aircraft would be combined in a single account. The Secretary of Defense would determine which of the two aircraft should be upgraded to perform the mission for both services.

In emphasizing the importance of enhancing the services' war-fighting capabilities, the Senate panel proposed terminating the RAH-66 Comanche program outright.

Lawmakers indicated their displeasure with the Army's acquisition strategy for the light attack helicopter. It would require $2 billion to build three prototypes "which have no fighting value whatsoever," Nunn said. "It's not a technology that is going to wait five or ten years on the shelf."

Instead, the panel would accelerate modification of existing McDonnell Douglas AH-64 Apache helicopters.

SERIOUS PRODUCTION PROBLEMS

The Senate panel also called for deeper cuts in the C-17 transport program than proposed by the House. The committee authorized $1.8 billion to build four of the new transports, rather than the eight requested by the Air Force and the six approved by the House. The move reflected "basic skepticism about manufacturing capability," Nunn said. "It is very expensive and the contractor is having serious production problems."

A $232 million contingency fund is available, however, which would allow McDonnell Douglas to produce two more airlifters "if they meet certain manufacturing thresholds," Nunn said.

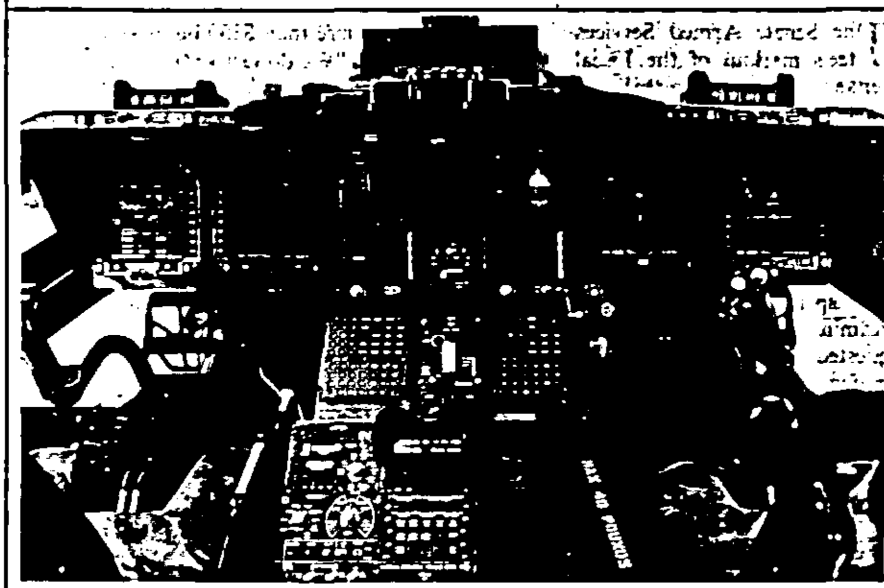
As expected, an additional $755 million was authorized for 3 production configuration V-22 tilt-rotor aircraft. But no more than 50% of the money could be spent until the Marine Corps Commandant provides Congress with an investigation report on the crash of the No. 4 prototype last month (AW&ST July 27, p. 23).

Other major provisions of the bill include:

- Terminating the National Aerospace Plane.
- A $321-million cut in funding for the B-1B bomber. The bill also calls for additional B-1B and B-52 tests to demonstrate conventional bombing capabilities.
- Authorizing $2.6 billion to proceed with work on the last four B-2 bombers.
- A reduction in the total number of Tomahawk cruise missiles to be procured by the Navy, from 200 to 100. □

Probers Eye Fuel Starvation As Factor in V-22 Accident

David A. Brown/Ft. Worth, Stanley W. Kandebo/Philadelphia



Cockpit of Bell/Boeing V-22 tilt-rotor aircraft has aircraft-type power lever immediately right of central console (identified by black and yellow striped circle), rather than a collective control.

Investigators seeking the cause of the crash of a prototype Bell/Boeing V-22 were concentrating on the possibility that fuel starvation caused the aircraft to lose power in both engines as it was approaching a landing at the U.S. Marine Corps air base at Quantico, Va. (AW&ST July 27, p. 23).

The crew is believed to have told the Quantico control tower shortly before the July 21 accident that they had at least 20 min. worth of fuel on board. This would have been the amount normally carried in the two tanks in the engine nacelles.

Accuracy of the fuel quantity indicators for all five tanks was to be checked as was the possibility that the fuel system could have the capability of trapping fuel so it was unusable. About 75 gal. of fuel was found in the tanks after the aircraft was recovered from the Potomac River.

Most of the wreckage of the prototype tilt-rotor aircraft was recovered from the river last week, as were the last of the bodies of the seven persons killed in the accident.

Recovery officials said all of the major components of the V-22 had been located and all were expected to have been recovered within a few days.

Video pictures of the aircraft taken during its fatal plunge into the river apparently showed that while both rotor-props continued to turn, neither appeared to be receiving much, if any, power. The aircraft crashed while it was transitioning from forward, wing-borne flight to helicopter, rotor-borne flight. The nacelles and rotors were traveling through an angle of about 60 deg. from the horizontal when the aircraft suddenly dropped into the river. The V-22 struck the water in an approximate 5 deg. nose down attitude and rolled to the right about 5 deg.

Both of the V-22's Allison T406 free turbine turboshaft engines were recovered from the river and were being sent to the Naval Air Test Center at Patuxent River, Md., for teardown and analysis. The full-authority digital electronic control (FADEC) fuel controllers from each engine also were recovered.

The aircraft's wing was recovered in two pieces, and most of the fuselage, including the cockpit, also was lifted from the river by a salvage barge.

Investigators last week also were looking at a number of other questions which may bear on the accident cause. These include:

- Qualifications of the pilots flying the aircraft. Boeing test pilot Pat Sullivan, was the nominal pilot-in-command during the flight, and Marine Corps Maj. Brian J. James, was copilot. Both died in the crash.
- Preflight planning, including what contingency planning was conducted to permit refueling en route and for other possible inflight emergencies.
- Communications en route and with the control facilities at the final destination and whether the crew reported low fuel or any other emergency during the flight.
- Emergency training received by the flight crew, especially in regard to engine

fire warnings or other inflight emergencies that could require an immediate specific response.

- Layout of the V-22 cockpit, especially regarding the location of emergency controls and how the cockpit may have differed fundamentally from other rotary-wing or fixed-wing aircraft the pilots had previously flown.
- Reasons for seven people flying on board the V-22, which was an experimental flight test vehicle. Flight crews on such aircraft are normally restricted to two or three people.
- Changes or other modifications made to the aircraft while it was at Eglin AFB, Fla., during the four months preceding the accident, especially any modifications that could have affected the engines, power transmission, flight control, emergency warning or fire suppression systems.

Sullivan, 43, served as an Army helicopter pilot in Vietnam and later graduated from the Navy Test Pilot School at Patuxent River. He was a former Bell employee and had flown both the tilt-rotor X-15 and V-22 extensively. He had been a Boeing project test pilot since 1989 and was designated the company's prime pilot for the V-22 program. James, 34, graduated from the same school in June, 1991.

Initial unconfirmed reports last week indicated the V-22 may have been low on fuel when it neared Quantico. Initial flight planning called for a nonstop flight from Eglin to Quantico, with an optional fuel stop en route.

DISCRETIONARY STOP

This stop was to have been made at the flight crew's discretion if stronger-than-forecast headwinds or other conditions made completion of the flight unlikely as planned.

The crew apparently elected to overfly the refueling point.

These reports also indicated the flight crew and the Quantico air traffic control facility discussed the aircraft's fuel supply immediately before the accident. However, the aircraft's crew apparently did not indicate the fuel supply was sufficiently low to declare an emergency.

The V-22 has a maximum range of about 2,000 mi. when carrying a light payload and maximum fuel. The aircraft which crashed, in addition to carrying seven crewmembers, also carried a pallet of test equipment in the aft cargo bay. How much this additional weight could have cost in potential range is being investigated.

The accident investigators also are expected to look at the V-22's power management system. The aircraft is equipped with an aircraft-type throttle lever, which travels forward to increase engine power and—during rotor-borne flight—the collective pitch angle of the blades of the two rotors. Rearward movement of this throttle reduces engine power and—in rotor-borne flight—the collective pitch angle of the blades.

A decision was made during the initial design phase of the program to use the aircraft-type throttle system rather than the standard helicopter-type collective pitch lever, which also acts as a throttle.

In a standard helicopter control system, an upward movement of the collective control increases both the rotor pitch angle and the engine power, while a downward movement reduces both.

All three remaining V-22 flight test vehicles remain grounded pending a determination of the cause of the most recent accident. Another aircraft was destroyed in a crash last year (AW&ST June 17, 1991, p. 53). □

07/20/92

Reprinted From The Philadelphia Inquirer
November 14, 1993

MISSION TO DISPLAY MILITARY AIRCRAFT WAS FATALLY FLAWED

By Nathan Gorenstein
Inquirer Staff Reporter

Pat Sullivan banked his aircraft low over the Potomac River and scanned the two display screens on his instrument panel.

The test pilot saw no sign of a problem, which was a relief. He and his six-man crew had struggled since dawn to get this craft---the experimental V-22 Osprey-- off the ground in Florida and onto its appointment in Quantico.

Now Sullivan leveled the wings, lining up for the final approach.

Moments before, he had made a low pass over the Marine Corps airfield, to show the Osprey off to the VIPs who were gathering below to inspect it.

It was a little flourish to cap a flight that some in the V-22 program disparaged as a "dog and pony show," but Sullivan's boss, Boeing Helicopters, saw it as an expected bit of salesmanship.

Powerful Pentagon civilians wanted to cut the Osprey, with its novel but expensive tilt-rotor technology, from the shrinking defense budget. But Boeing and its partner, Bell Helicopter Textron, remained eager to sell it to the Marines, by the hundreds.

Boeing managers had made it clear that Quantico was an important part of the sales effort. To reach the Marine base on this day, July 20, 1992, Sullivan had skipped a planned refueling stop and pushed through a crescendo of problems--an uncertain fuel system, a balky engine starter and two in-flight warnings that should have prompted an immediate landing.

Out over the Potomac, Sullivan commanded the Osprey to do its revolutionary magic. As it flew, the engines on the tips of its wings began to rotate upward. The giant blades that had pulled the Osprey swiftly through the air like an airplane began to tilt so that it might float to the ground like a helicopter.

Suddenly, the co-pilot, Marine Maj. Brian Jones, let out a sharp breath: "Oooh . . . Noise, a weird sound."

A few seconds later, staring at his color screen, James said, "We just lost the right engine."

The hundred or so dignitaries assembling that day in Quantico included ranking Marine and Navy officers, senior Pentagon civilians and Bell and Boeing executives. The Osprey's backers planned to dazzle them with a glimpse of the hottest advance in vertical flight in decades, a machine twice as fast as any helicopter, an aircraft many Marine aviators ached to fly.

Instead, at 1:42 p.m., the flight of the Osprey ended in 16 seconds of terror over the Potomac as it plunged into the river before the eyes of horrified onlookers, killing all aboard.

The flight became a tale of miscalculated risks, of technology pushed too far by pride, ambition and the pressures created as defense contractors scramble to preserve their piece of a shrinking Pentagon budget.

The first casualty on the flight was the respect for safety drummed into every professional aviator. A manager in the V-22 program said later, "We were pushing it... Nobody thought the aircraft would actually fly that day. It needed more local test flying."

Relatives of some crew members have bitterly faulted Boeing for pressing ahead with the Quantico flight despite what they said were indications that the Osprey wasn't ready. A Navy Court of Inquiry concluded that Boeing "made decisions which were not consistent with flight safety."

In a written statement to the Inquirer, Boeing said it has taken steps to "correct... design and administrative deficiencies," while saying those problems did not cause the accident.

It has also stated that pilot Pat Sullivan was "not under excessive pressure to meet the schedule."

An internal Boeing review of the company's test flight operations--obtained by The Inquirer--concluded that the V-22 and other Boeing Helicopters test flight programs had a "high probability of safety being compromised due to budget and schedule pressure."

The pressures were similar to those felt by millions in the workaday world, multiplied for many V-22 workers by a sense of how much was riding on the Osprey.

Marine fliers wanted it to carry out their combat mission. Bell and Boeing thought it could mean $15 billion or more in military sales, with the potential for billions more in civilian business. And that would create jobs at Boeing's plant in Delaware County and Bell's plant near Fort Worth, Texas--and provide a career boost for many at Boeing, Bell and the Marine Corps.

A Pentagon decision on whether to proceed with the V-22 Osprey program or try an alternative may come at the end of this month.

This account of the Osprey's flight is based on the records of an official naval inquiry obtained through the Freedom of Information Act, on internal Boeing documents obtained by The Inquirer, on interviews with relatives and co-workers of the V-22 crew members, and on interviews with military and test flight experts.

The documents included a transcript of cockpit conversation from takeoff in Florida to the skies over Quantico, and an unusual second-by-second account of the aircraft's final moments recorded by test equipment. Boeing Helicopters discussed the V-22 program in general terms, and along with Bell representatives described design changes now being made. Boeing declined to discuss most questions about the circumstances of the July 20 flight.

■

6:15 a.m. Central Time, Monday July 20, 1992

Dawn is approaching as the V-22 crew gathers at Eglin Air Force Base on the western Florida panhandle.

Sitting on the tarmac, rotors tilted toward the sky, is Aircraft 4, one of four airworthy V-22 Ospreys in the world. Made of lightweight composites, it is not sleek and sharp like a jet, but short, dumpy and odd-looking.

Still, painted in military camouflage, it has an air of dangerous purpose. The V-22 is intended to carry 24 Marines into combat sweeping quietly over enemy territory at 275 knots or more, then dropping precisely onto its landing zone. 'It is a giant leap beyond noisy helicopters chugging along at barely half that speed, easy targets for enemy guns.

One of the first to arrive is Tony Stecyk, a Boeing mechanic and crew chief. Stecyk will fly today because a co-worker skipped the flight to help his family move back to Pennsylvania. That's fine with Stecyk. A flight on an Osprey is something he always craves.

As his wife Michelle drops him off, Tony voices second thoughts. Maybe he shouldn't leave Michelle and their 2-1/2 year old son to drive the thousand miles back to their home in Tinicum, Delaware County. Michelle herself has wondered whether Tony should fly, worrying that the Osprey is not ready for the long trip north.

The V-22 had been at Eglin since January, suffering through a series of high-stress climate tests heated to 125 degrees and frozen to minus 65 degrees as engineers watched to see what would go wrong.

And go wrong things did. The Osprey spent weeks undergoing maintenance and repairs, including replacement of a clutch assembly in the right engine. During that work, a drive shaft oil seal was apparently installed backwards.

Despite her concerns, Michelle knows how much the V-22 means to Tony, how proud he is to be part of the project

Go, she tells him: "You deserve to step down from that airplane with all the people cheering you on."

Tony assures Michelle the V-22 is ready and insists Pat Sullivan wouldn't fly if it weren't safe. "Pat is the best," he says.

Sullivan, recently named Boeing's prime V-22 pilot, has had a busy three days. Friday he got engaged to a co-worker, scheduling the wedding for Las Vegas in two weeks. He has little time to celebrate, spending the weekend grappling with problems that threatened to ground the V-22.

A screw was lost inside the left engine. The V-22s fuel system hadn't worked right in 11 days, and was leaving hundreds of gallons of fuel trapped in the tanks.

The screw was recovered midday Sunday, but repairs in the fuel system dragged on. Sullivan remained with Aircraft 4 until 9 Sunday night. The Boeing mechanics were stretched thin because most support personnel and managers had already left--eager to get home after six months in Florida or to be at Quantico when the V-22 arrives.

Quantico is a big deal. Five days of activities are planned at the base, and Boeing managers have been calling Florida regularly to check on the V-22 status. This morning, three Boeing managers contacted Sullivan in a conference call to find out if he was ready to go, and what time he'd take off.

The Navy Court of Inquiry later said Sullivan was under "tremendous" pressure -- from Boeing and the "government" -- to make the fight.

Sullivan and Stecyk are two of seven men on today's crew, an unusually large number. A basic rule of test flying is to minimize crew on unproven aircraft. And the V-22 is unproven. The four V-22s have completed fewer than 765 of a scheduled 4,100 hours of flight testing typically with two- to four-member crews.

The co-pilot, Brian James, is a Marine astronaut candidate. James, 34, the son of a Baltimore firefighter, is the epitome of a Marine aviator. "The top lieutenant I have worked with in my career," is how one commander described him.

Sullivan and James will sit up front, staring out the Ospreys bug-eyed windows. Behind them will the meticulous, safety-conscious senior flight test engineer, 34 year-old Robert L. Rayburn of Newark, Delaware. A pilot building his own experimental plane, Rayburn joined Boeing in 1981. Years ago, he showed a picture of a V-22 to his wife and said, "I'm going to work on that some day. I just know it."

His commitment to the aircraft is shared by the entire crew. Many have linked their careers to the Osprey.

Gerald W. Mayan, 31, of Dover, Delaware, the second Boeing engineer on board will fly with a motion-sickness patch behind his ear to overcome his chronic ailment. He helped put together the Ospreys sophisticated on-board monitoring system.

With Stecyk in the back, where troops would sit, will be two Marine crew chiefs Sgts. Gary Leader, 43, and Sean P. Joyce, 33. More than comrades, Leader and Joyce are brothers-in-law and best friends.

8:30 a.m.

By now, the V-22 should be thrumming its way north. Instead, it sits on the tarmac. A lubrication problem has arisen in a midwing gear box. Stecyk helps solve that.

Then Sullivan discovers he can't start the engine.

A small auxiliary engine--the APU--that is needed to turn over the two 6,000 horsepower main engines shuts down after its sensors warn that it is overheating.

Sullivan can override the shutdown command by switching to the APUs emergency mode, but the manufacturer has warned that doing so can permanently damage the unit. It also would violate Boeing's rules.

However, the hot APU signal could simply be due to a faulty sensor. If so, Sullivan can turn over the engines safely. But if the warning is real, the V-22s gas turbine engines might not restart after the scheduled refueling stop in Charlotte, N.C.

Sullivan faces a dilemma. If he follows the rules, he can't take off now. But they are expected at Quantico by 3 p.m.--and are already behind schedule.

Sullivan starts the APU on its emergency setting.

The turbines whine louder as he eases the throttle forward. Before him, the high-tech system of color computer screens--two for each pilot--displays the data that fliers once obtained by scanning mechanical dials.

The V-22, its black prop-rotors beating the air, rolls a short distance down the runway, rises into the air, and turns northward. It is 9:55 a.m.

The Osprey climbs above the Florida landscape, an ungainly marvel in flight. In the cockpit, Sullivan twirls a small thumb wheel attached to the throttle lever. The Ospreys nacelles--wingtip pods housing the engines and the heart of the complex system that drives the rotors--rotate from vertical to horizontal. The prop-rotors, each 38 feet across, move with the engines.

For a few crucial seconds, as the hydraulic system rotates the nacelles, the Osprey is a new species of aircraft, neither plane nor helicopter, with aerodynamic and mechanical traits all its own.

■

The V-22s hybrid technology exists because in the early 1980s the Pentagon wanted a single helicopter for a variety of missions: ferrying Marines into combat, dropping Army forces behind enemy lines, searching for downed pilots and flying anti-submarine patrols for the Navy.

Bell and Boeing said their V-22 could do it all, and in 1986 the Defense Department wanted $1.8 billion for an unusual joint effort between Bell and Boeing. They were to design and build six V-22s for flight testing.

Bell was responsible for designing the wings and nacelles. Boeing built the cockpit and fuselage. The companies established separate test flight programs with two different crews and sets of rules.

As the years went by and budgets tightened, the Army and Navy dropped out of the program.

The Marine Corps clung to the V-22 as its replacement for Boeing's H-46 Son Knights, creaky 1960s vintage helicopters whose top speed was no more than 143 knots--167 m.p.h.--compared to almost 300 knots--343 m.p.h.-- for the V-22.

The Marines contended that, without the V-22 or some other replacement, they would be unable to do what the Corps exists to do: assault enemy strongholds and deploy swiftly to trouble spots. They would be like paratroopers without parachutes.

But, because the Pentagon originally wanted the V-22 to be a jack-of-all-trades, the aircraft was designed to fly faster, higher and longer than the Corps required. That helped make the V-22 heavier and more costly than Bell and Boeing had counted on.

By 1992, the companies had spent $2.5 billion and still did not have a design that could meet the ambitious Pentagon specs, much less be ready for production. It needed to be lighter, components had to be redesigned and the engines had to be upgraded.

"We had to put an additional $1.5 billion into what was supposed to be a completed aircraft to finish development," said David Chu, a former assistant secretary of defense for program analysis and evaluation who opposed the V-22 as too expensive.

Boeing disputed Chu's contention, saying the Pentagon knew the design would be modified as the program proceeded.

A source close to the project said Boeing publicly minimized its design problems to keep the flow of development money coming.

"They had to sell the airplane to Congress, and they presented it as being production-ready," the source said. "It's not."

Boeing spokesman Nick Kerbstock disputed that claim: "We never really sold the program on the basis of its being production-ready and trouble-free."

Boeing and Bell have now spent more than a year reworking the craft. The Pentagon has set a December 1994 design deadline.

The source estimated that the redesign will take at least two more years, "If you work the problems really hard." Boeing and Bell have received an extra $1.5 billion to work out the bugs. They obtained the money in 1992 as part of a V-22 truce between then Secretary of Defense Dick Cheney and Congress.

Cheney, trying to manage a shrinking post Cold War defense budget, wanted to kill the program. Pushed by the powerful Marine lobby, members of Congress such as Delaware Countys U.S. Rep. Curt Weldon said building the V-22 would save Marine lives, create jobs and eventually bolster the commercial aircraft industry

This was the compromise Cheney and Congress reached; Bell and Boeing would get the money to build four redesigned models, but the Pentagon would ask five companies in the hotly competitive helicopter industry to submit designs for a traditional alternative. Those proposals will be part of the Pentagon's V-22 review scheduled for November 29.

The deal was disclosed on July 2, 1992, less than three weeks before Quantico.

The V-22 team was pleased to have the money, but uncertain what the deal might mean. Sean O'Keefe, former Defense Department comptroller and ex-secretary of the Navy, described Boeing and Bell as "suspicious," fearful that the agreement gave the Pentagon another chance to kill the Osprey.

But everyone was pleased the first, costly inadequate V-22 design was not being built, O'Keefe said. "No one wanted it," he said.

The lighter, possibly cheaper version Bell and Boeing are now designing carries an estimated price tag of

$29.4 million each, a figure that even V-22 backers say is based on optimistic assumptions.

The source familiar with the V-22 said design problems arose in part because Bell and Boeing figured wrongly that they could easily scale up Bell's experimental XV-15 tilt-rotor into the much larger V-22.

Their optimistic schedule also combined two typically separate stages of aircraft development--full scale test models and "pilot" production, according to the General Accounting Office. That meant production could start while design details were still being ironed out.

With its design problems and Cheney's opposition, the program had fallen years behind schedule by the time the Osprey rose into the Florida sky that July 20.

■

10:16 a.m.

"We're humming," James says as the V-22 climbs into the sky at 170 knots.

Eighteen seconds later, his cheery mood is dampened.

A red light atop the instrument panel flashes on. "RTB rotor," Sullivan says.

RTB: Return To Base

Return to base because sensors in the Osprey's nacelles are reporting that prop-rotor components are being over stressed.

Under the V-22's flight clearance--standing rules that govern how it should be handled in the air--an RTB rotor alert requires landing as soon as possible.

But Sullivan doesn't land. He seeks an analysis of the problem from Rayburn, the cautious senior flight engineer.

Rayburn knows the sensors measure stress on critical components, including one that changes the rotor's pitch--how it bites the air--and another that connects the rotors to the engine.

Rayburn calls out to his fellow engineer, Mayan: "Jerry, you want to take a look . . . back there?"

Back there is the "CONDM" instrument system, which has been installed to monitor key parts of the rotors and engines. It is not intended to be an in-flight diagnostic system.

An expert with the system, Mayan scans the data, and quickly concludes a more detailed analysis is needed.

"You better do it," Rayburn tells him.

"Yeah, no kidding," adds a voice.

While Mayan is analyzing, more trouble develops. A second warning briefly flashes, a yellow "QM" caution. A lower grade warning than the RTB, it has to do with the amount of torque, twisting energy, going to the rotors.

"OK, if we can't isolate that rotor, we're going to have to come down," Rayburn says.

Sullivan responds with a question.

"Come down where, Bob?"

"That's urgent; that's a "return to base," replies Rayburn. "You can't continue."

After a pause, Sullivan seems to agree: "Well, I know, we'll have to go back to Eglin."

But Sullivan hasn't given up. "Any other troubleshooting we can do?" he asks.

Rayburn replies that he and Mayan are "working on it."

With that Sullivan decides to "push on," and tells Rayburn he'll wait to "see what you can come up with. We've got plenty of fuel to turn around."

It is 10:21 a.m., 26 minutes out of Eglin. They are at 15,500 feet, traveling at 200 knots--roughly 230 m.p.h.

At this point, the Navy Court of inquiry later said, Sullivan "should have landed."

Sullivan, like James, is a graduate of the naval test flight school in Patuxent River, Md., where a famous sign reads, "Plan the flight. Fly the plan."

Instructors at "Pax River" explain the theory behind the slogan: Under stress in the air, a test pilot can make a wrong--and possibly fatal--decision. The best way to avoid wrong choices is to stick to a flight path drawn up calmly on the ground.

The V-22s flight rules are clear: An RTB rotor warning means the aircraft must land at the nearest suitable airfield.

But test pilots acknowledge a gray area in which a pilot can exercise judgment. What becomes important is when, where, and how the pilot chooses to do so.

Sullivan chooses to do so now.

He consults again with Rayburn, who reports that readings form the sensor are fluctuating, suggesting the warning could be the result of a loose wire.

"Probably we don't have any kind of clearance to continue with that. How do you call it?" Rayburn asks.

"I say continue, then," says Sullivan. Then addressing his copilot: "Do you have any problem with that?"

"No," James replies. "I can live with that."

■

A 1990 Wilmington News Journal photograph of Sullivan showed him gazing from the Osprey's cockpit with cool steadiness. "I planned my career around this plane," he told the interviewer.

Sullivan was raised in a small town outside Niagara Falls, N.Y. Fed up with antiwar radicals, he dropped out of Columbia University in 1968 and ended up in Vietnam, flying Army transport helicopters. A divorced father of two, he joined Boeing after retiring from the Army in 1989. Through July he had logged 155.2 hours in the V-22.

"Whatever he could do for his country, he wanted to do," said a relative who asked not to be identified. "That sounds corny... [but] he truly believed the Osprey was desperately-needed by the Marines, and by doing this he would help save American lives."

V-22 crew members had great faith in his ability as a pilot, and even now their relatives refuse to criticize him.

"I won't say anything bad about Pat Sullivan," said Kathy Mayan, who said her husband Jerry thought Sullivan was a "great guy...the best."

Mayan's brother, John, recalled that Jerry told him the Friday before the flight: "There is a lot that needs to be done to it yet," but also told him, "If the pilot is confident to fly the plane, then I'm going with him."

Kathy Mayan said her husband told her that the crew felt pressured: "Jerry had said to me..."We have to get to Quantico on Monday."

John Mayan said a co-worker of his brother's took part in a meeting with a Boeing manager the same Friday, at which, according to the account from the co-worker, "Pat was pretty much told this plane has got to be there Monday."

Grady Wilson, a fellow V-22 test pilot and friend, told the Navy inquiry that when he saw Sullivan the day before the flight, the pilot was "wound up...damn tight."

"There was a huge amount of pressure on him," said Wilson, who resigned from Boeing after the crash, told the Navy. "He was very, very dedicated to this machine and to the program."

Sullivan's relative said the pilot reported feeling pushed to make the July 20 flight. The relative also said Sullivan had pinpointed weeks before the flight what he thought would be its most dangerous moment—over Quantico when the nacelles rotate to turn an airplane into a helicopter.

"He felt" the relative said, "that given the stresses the airplane had undergone during the testing, that was point anything would happen."

■

Jobs are why the V-22 is important to the Philadelphia area. If the Osprey goes into production, it could mean a thousand or more jobs for the Boeing plane in Ridley, more jobs for the Boeing plant in Ridley Township, Delaware County, jobs with good pay and health insurance.

Tony Stecyk knew what a job at Boeing could mean to a family. He and his wife Michelle grew up within a block of each other in blue-collar Tinicum Township, where houses nestle against Philadelphia International Airport.

Stecyk started in Boeing's sheet metal shop in 1974 right out of high school, received steady promotions and joined the V-22 program in the mid 1980s.

At his home in Tinicum, the beautifully finished basement includes a display of his awards for restoring Harley Davidson motorcycles. On one wall is an *Easy Rider* poster.

Stecyk was closes friends with the Marines Leader and Joyce, who shared his passion for Harley-Davidsons. When he would invite them to his home for holidays, the three would talk V-22s and motorcycles.

Florida was a wonderful time for Tony, Michelle and their son, Anthony. "It was like a whole new relationship," she said.

Michelle had some bad moments, though, when the crew started making test flights over the gulf near the Stecyks' beachfront condo. She couldn't bear to watch the Osprey whir over the blue water.

"He could not swim, and he was deathly afraid of drowning. That was his worst fear."

■

10:20 a.m. over Eujaula, AL

Through the flight, a chase plane has been following the Osprey, a standard precaution. Sullivan radioed to the chase plane, saying they've trouble-shot the return-to-base warning, and "if things stay as they are, we're going to go ahead and continue."

Flying the chase today are fellow Boeing V-22 pilots Grady Wilson and Tom McDonald. Their passenger is Lt. Col. Paul Martin, deputy manager of the Marines V-22 program. At the Charlotte refueling stop, James is to give his co-pilot's place on the Osprey to his boss, Martin, who long has planned to be the top Marine striding off the plane in Quantico.

That James is aboard the V-22 at all is unexpected. the flight originally was to be nonstop, with Martin as co-pilot and James aboard the chase plane. But uncertainty about the fuel system led to the Charlotte stop being added at the last moment. So James, who had just under four hours flight time in the Osprey, got to co-pilot the first leg.

It has not been boring.

"A little excitement in the beginning, huh?" James says to Sullivan.

They cross into Georgia, changing time zones. In the cockpit, it becomes 11:29 a.m.

A few minutes later, there's a little more excitement.

Torque readings from the left rotor--data needed to ensure safe handling of the craft--are lost.

Sullivan reacts in a laconic voice: "OK"

Wilson later told Navy investigators this problem was more severe than the RTB warning. It "was clear-cut. That's *a Land as soon as possible*."

On board, Sullivan mulls whether he can skip Charlotte, and asks Rayburn whether they can make it to Quantico without refueling.

The crew lacks reliable data on fuel consumption at 15,500 feet--partly because in the rush to get the aircraft ready, they had canceled a high-altitude test flight.

Rayburn uses the facts he did have--speed, fuel, distance--to estimate: "I show us on the ground with 700 pounds total."

"Wow," Sullivan says. The V-22s flight clearance requires at least 1,000 pounds of fuel to be remaining at touchdown.

Just the same, Sullivan doesn't rule out a nonstop journey, figuring that mileage will improve as the Osprey consumes fuel and grows steadily lighter.

He turns to his co-pilot and says "Appreciate your hanging with us, Brian...This has not been an easy start up and go."

"Hey man," James responds, "This is my job. I'm loving it."

■

The first time Brian James met the oh-so-young-looking woman who would become his wife, he lectured her on her choice of friends.

It was 1981 at McGuire's Irish Pub, the place to meet the lean, confident pilots from the military flight school at Pensacola, Fla., where James was training.

Deanna Batton was a local, working days and studying accounting in junior college.

That night, she was out with a Navy pilot.

"When my date...went to the restroom, [Brian] came up and started talking to me. He didn't like the guy I was with, thought I was too young to be out with him, and he let me know about it."

"I was amazed at first, but intrigued too.".

That was August. They were married in February. They had four children while Brian moved up in the Corps.

He volunteered for Lebanon in 1984; became a flight instructor, then a test pilot. Earned a master's in mathematics. Considered a political career after the Corps.

In July 1992, he was a flight safety officer at Pax River.

So when he called home the night before the flight and told his wife the trip was on, she was "a little taken aback."

"I said: How can it be broken all week and be fixed now?"

■

12:06 p.m. Eastern Time

As James handles the Osprey's controls, Rayburn recalculates fuel consumption. They have two hours of fuel left, and 410 nautical miles to go--about an hour and 40 minutes of flying.

"Well, it's doable," Sullivan says. "I think we ought to push on if it's feasible because otherwise, we're...you know, we'd never get out of Charlotte."

The problem is twofold. Because the engines were started on the emergency setting, Sullivan can't be sure he'll be able to restart them once he shuts down - to refuel.

Second, to take off from Charlotte without resolving the rotor problem would be a more severe safety violation than ignoring the RTB warning in the first place.

Fifteen minutes later, Sullivan spots Charlotte and makes his decision: "Anybody have any problem with proceeding?"

Rayburn doesn't object, but warns a landing will be necessary if the fuel system starts to falter. James voices concern that his boss, Martin, will be furious at being stranded at Charlotte, where the shorter range chase plane must stop to refuel.

"You just got to defend me when we get there. Make sure you say you overruled me," James tells the pilot. "He's going to chew my ass, boy. Wooh! It'll be worth it, but I tell you what, I'm going to stay away from him."

A few moments later, Sullivan repeats that the Osprey might not have made Quantico if it had touched down in Charlotte.

"I don't think there's any safety issues," he adds, "I think we're..." Sullivan does not complete the sentence.

He does not know that in the right nacelle a safety problem is developing, undetected by any sensor.

■

Boeing Helicopters consistently has said that no undue pressure was placed on Sullivan and that no special welcome was planned at Quantico.

"No formal arrival ceremonies were planned...the schedule at Quantico was not critical enough to put unusual pressure on the pilot," Boeing said in a written response to Inquirer questions.

A July 13, 1992 memo from Timothy Fehr, then Boeing Helicopters' vice president in charge of the V-22, had described the Quantico event as important and asked for employee cooperation.

"The Quantico Operational Demonstration is the first exposure of the V-22 to... many high level Marine Corps customers" Fehr wrote. "Many Marines, including several Marine Corps General Officers, are expected to visit."

A Boeing official said the stop at Quantico was proposed by the Marine aviators.

Fehr distributed a detailed list of scheduled activities for the Osprey's five-day stay at Quantico, starting with the Monday afternoon display when "VIPs and visitors" were to see the aircraft.

The Osprey was to signal its arrival at around 3 p.m. with a low pass only 200 to 300 feet above the heads of the guests. After landing, it was to taxi to a spot in front of the control tower to begin two hours on display.

That was the moment for which Martin, the Marine colonel left stewing in Charlotte, had been planning. He told the Navy Court of Inquiry that his role at Quantico involved "political considerations" that he had discussed "at length" with James and Sullivan.

"It was critical," Martin said, "that I be the person get out of the aircraft when it landed at Quantico because we had some people that we wanted to talk to about the aircraft."

All week, jut one official test was planned at Quantico. On Tuesday, 24 Marines in full combat gear would try to exit the aircraft in 60 seconds, which few doubted they could.

Boeing has said no flight demonstrations were scheduled at Quantico. According to the Marines and Fehr's memo, they were scheduled for Thursday and Friday.

Boeing's public stance that Sullivan was not unduly pressured is at odds with the internal Boeing Helicopters review of its flight test program, completed in November 1992.

The report by a team of 14 current and former Boeing managers said they were in "general agreement there is a high probability of safety being compromised due to budget and schedule pressures."

"Budget and schedule for flight test is too optimistic, success-oriented" said the report, intended for circulation among high-level Boeing managers. Too little attention was given to the unpredictable effects of weather or mechanical problems, it added.

The review team concluded Boeing managers treated the flight test phase as a place to make up for time and money lost earlier.

"Flight test comes at the end of the development process and is the last place management can save money to get back on budget and on time."

■

12:28 p.m.

As Charlotte recedes on the horizon, Rayburn says, "There's going to be a lot of Monday-morning quarterbacking after this one."

"Think so?" Sullivan replies.

"Yeah," says Rayburn. "I think we're making a sound engineering decision, but, you know, sometimes that doesn't always hold water."

They rehash the issues. Was the rotor warning just a wire? Should they have heeded the return-to-base message?

Rayburn calls back to Joyce, who is with Stecyk, Leader and Mayan. What does Joyce think?

"He's holding a thumbs up," says Rayburn.

James then speculates--probably incorrectly--that the commandant of the Marine Corps will be waiting at the airfield when they land.

One thing the major knows for sure is that he faces a quizzing from superiors about what went on in the cockpit.

"OK. We'll have to have a united position [on the decision to continue]" he tells the crew, "because I guarantee when we stop they're going to be asking us. I feel comfortable. I would not have flown, believe me--I've got four kids--I would not have done it."

"Yeah," Sullivan replies, "I know, I hear you."

■

The V-22 program was a plum assignment not only for officers, but also for non-coms such as Gary Leader and Sean Joyce.

Joyce, who was 17 when he joined the Corps, had found a mentor and friend in Leader, 10 years his senior. Leader introduced Joyce to his sister, Yvonne, who became Joyce's wife. And Leader helped his brother-in-law get into the V-22 program.

"My brother thought it would be good for Sean's career," said Yvonne Joyce. "Gary used to say to Sean: You're like the little brother I never had."

July 20 was the first time they had flown together on the V-22, Yvonne Joyce believes.

How they both ended up on board never has been officially resolved. Boeing officials testified that they expected one but not both of the Marines on the flight.

On the Sunday evening before the flight, according to testimony at the Court of Inquiry, Leader and Joyce told drinking companions at a Florida bar that they were both flying north because an officer with the Marine V-22 program headquarters interceded for them with Boeing.

Col. James Schaefer, then the top V-22 program officer, was identified in testimony as the officer in question. He told the Court of Inquiry that he did not ask anyone to include both sergeants. He did not rule out the possibility that another Marine officer had interceded.

After the crash, Boeing Helicopters said all seven men had duties on the flight. Sullivan and James as pilots, Rayburn and Mayan as engineers monitoring test equipment, and Stecyk, Joyce and Leader as crew chiefs. Boeing said the Marines were getting practice for the possible day the Corps would deploy the V-22.

Noting the V-22 was still "experimental," the internal review team said: "V-22 operating instructions specify minimum crew, but far more individuals were on-board than were required to operate the equipment".

One review team recommendation was: "Establish ground rules in the contract so the customer can't force you to put unnecessary personnel on-board an experimental aircraft."

■

1:06 p.m.

Less than 45 minutes out of Quantico, Rayburn recalculates fuel consumption and estimates that they'll land with a thousand pounds.

"That's acceptable," Sullivan tells James.

James still is fretting about the colonel: "What can I tell him?"

James wonders whether he should have pushed Sullivan to land at Charlotte: "There's nothing I could have done anyway to convince you, would it have?"

Sullivan at first says no, but adds, "Yeah, you could have."

James, as a Marine flight safety officer, knows what he means.

"I could have called it safety, called it safety of flight, but I couldn't I——couldn't do that though," James says.

"No, I don't think so," Sullivan says.

James takes over the flight controls, saying "Might as well enjoy them now. Might be the last time I get them after Col Martin gets ahold of me."

1:23 p.m.

Sullivan replaces James at the controls. They are 10 minutes from touchdown. Looming is Quantico, the huge base south of Washington where the Marine Corps trains officers and plans strategy.

The modest airstrip on the base's eastern edge has a small, brick control tower atop one hangar.

James has flown here before, so he'll talk Sullivan through the final approach. They discuss whether to come in over land or water. Sullivan, worried about air traffic, says "over water is probably best."

The planned low-altitude fly-by has Rayburn concerned. "Make it gentle," Rayburn tells Sullivan, mentioning the loss of torque monitoring on the left rotor.

"Ok. Yeah, it will be," Sullivan says. "I always fly this thing gentle."

"Extra gentle, kid gloves," says Rayburn.

"Extra gentle. OK. I can do that." The pilots ask the tower to clear out air traffic.

"After that we'll do a left downwind over the water and come in for a normal landing." Sullivan says.

"Yay!" says a crew member.

Sullivan drops toward 1,500 feet. They are 10 miles out.

"You guys in the back all set?" James calls out.

"We're all set aft," a voice replies.

1:36 p.m.

Sullivan drops to 1,000 feet.

James is back to wondering who will greet them at landing.

"I'm sure the general will be late at the field," he says.

"If he's here yet," says Rayburn. Having skipped Charlotte, they are, after all, arriving more than an hour early.

"Yeah, that's the problem," says Sullivan.

The visitors "should be sitting in stands just halfway between the runway and the hangars," says James.

But from the air the grounds appear empty.

"I don't see many," Sullivan says.

"Good. I mean good for me," James replies, referring to Martin and the colonel's plans for Quantico. "Make sure the colonel knows that."

Marine enlisted men at the airfield watch as the Osprey slides through the air a few hundred feet above.

Rayburn peers out of the cockpit and observes: "There's a few there."

■

Elsewhere the day is consumed by the business of ordinary life.

Michelle Stecyk and her son begin the long drive to Pennsylvania with her mother following in a truck packed with belongings.

Yvonne Joyce is at Patuxent Rivér, where she works in the Navy's Aegis program.

Deanna James is at home in Lexington Park, Md. The next day, she and the children plan to drive to Quantico, see the V-22 and go for a beach vacation with Brian.

Kathy Mayan is straightening up her home outside Dover, Del. which she found to be "a huge wreck" after driving straight through from Eglin on Sunday.

Dottie Rayburn, Bob's wife is at her parent's home in Greensboro, N.C.

■

1:40 p.m.

"Stand by on flaps," Sullivan says.

The V-22 makes a turn, swinging up and over the river.

With his thumb, Sullivan rotates the small wheel on the end of the throttle control lever. The V-22's hydraulic system kicks in. The nacelles and their powerful rotors move upward, halting midway between horizontal and vertical. In this delicate maneuver, lift is transferred from the wings--as in an airplane--to the rotors--as in a helicopter.

They are 1,300 feet above the Potomac, about a half-mile from the strip, flying at 120 knots, enough speed for the lift from the wings to keep the Osprey in the air.

"Gear down, please," Sullivan says.

"Gear's coming," says James.

Four second pass. The V-22 slows to nearly 100 knots.

In the cockpit, James suddenly exhales: "Oooh...Noise, a weird sound."

The sound is from the right nacelle where a leaking fluid has been pooling. As the nacelle tilts, gravity pulls the liquid into the turbine.

The liquid ignites. The turbine speeds and its combustion chamber wall is torn by a burst of energy from the burning liquid. Temperatures at one sensor jump 350 percent in 1-1/2 seconds.

On the ground, witnesses hear a loud pop and see a brief spurt of flame. Gray smoke puffs out of the right engine as Sullivan continues rotating the nacelle.

Later, some Navy investigators concluded the combustible liquid was probably prop-rotor gearbox oil that leaked through a seal apparently installed backward on the prop-rotor drive shaft.

Other naval officers, along with Boeing officials, disputed that the seal was the problem, saying tests failed to duplicate such a leak. They said the source of the liquid couldn't be determined, and Boeing's mechanics couldn't be blamed. Complex mechanical systems can always drip fluid, a Boeing spokesman said. The redesigned nacelle now includes a drainage system.

Since no one know when the liquid began to pool, it is not known what would have happened had Sullivan returned to Eglin or stopped to refuel.

Despite all the warnings and worries that have plagued the flight, the crew has had no inkling about this final problem.

1:42 p.m.

In the cockpit, a light signals failure of the Primary Flight Control System. "Let's get a reset," says Sullivan.

The system powers back up and automatically revs the damaged right engine. There is a second surge, followed by a third. The right engine fails.

Red and yellow warning lights appear on the pilots' screens. "Looks like an engine fail," Sullivan says, as James says, "We just lost the right engine."

With the nacelles tilted up, an engine failure is particularly dangerous. For the aircraft to stay in the air, both rotors must be turning. To ensure that, Bell and Boeing designed an "interconnect drive system." Using a cross shaft through the wing, it allows either engine to power both rotors.

The system kicks in, but in the next few seconds the heat generated by the burning liquid and fuel--sucked through the right nacelle by a cooling fan--exceeds 1,200 degrees Fahrenheit.

The heat destroys a secondary shaft within the nacelle that is vital to the backup drive system. Made out of composites, not metal, this shaft can withstand temperatures only up to 240 degrees Fahrenheit, barely 20 degrees above the nacelle's likely operating temperature on a hot day in the desert.

With the secondary shaft buckled, the left engine no longer can power the right rotor. The Osprey has no way of staying airborne.

Sullivan does not know that.

The computerized flight warning system is not programmed to register a failure of the interconnect drive system.

The Osprey rolls slightly to the right, then yaws slightly to the left, reacting to the loss of power. Its rate of descent increases.

In the next seconds, the display screens flash warnings about a cascading series of failures.

The account the screens are giving of the Osprey's problems is neither clear nor complete. In fact, one of the warnings flashed--that the left engine has failed--is false.

Sullivan and James do not know what is going wrong around them.

Inside the right nacelle, the flailing remains of the drive shaft slice through electrical and hydraulic lines, knocking out the nacelle rotation system.

The tilt-rotor is no longer a tilt-rotor. The nacelles are motionless at 58 degrees.

Now neither airplane nor helicopter, V-22 Osprey Aircraft 4 is falling from the sky.

Sullivan shoves the throttle forward to full power--a futile gesture with the rotor drive system crippled.

James calls out to the Quantico tower: "Mayday, Mayday, we're going in! We're going in!"

1:42:25 p.m.

The Osprey is slightly nose down, giving the pilots a clear view of the blue Potomac. It is almost out of forward momentum and Sullivan is almost out of time.

In the three seconds before impact, he tries a final desperate maneuver, twirling the control wheel to tilt the nacelles to vertical--into position for what helicopter pilots call autorotation.

The idea is to allow air to rush up through the rotors and spin the blades, generating lift to cushion a crash landing.

But with the hydraulic system gone, it can't be done.

The Court of Inquiry termed the lack of an adequate hydraulic backup a "cause factor" in the accident.

Sullivan's move to full power a few seconds earlier, the court speculated, may actually have been an attempt to start an autorotation, but with the throttle in the wrong position.

The court said the throttle--a hybrid of airplane and helicopter controls that the Marines insisted on--may disorient pilots operating on instinct in an emergency. The Navy has recommended it be redesigned.

Now Sullivan can do nothing. The Osprey is plummeting, a few hundred yards short of Quantico.

Marines and Boeing workers at the airfield watch in shock.

In the last instant before impact, the wounded right rotor spins to a halt.

There is a tremendous splash. The data recorder shuts down and, in a final burst of static, the voice recorder.

The Osprey hits the Potomac with an impact equal to 79 times the force of gravity.

No one survives.

■

Epilogue.

Michelle Stecyk learned the news while standing on the side of I-85 in South Carolina. Her mother had heard a report on the radio and signaled her to pull over.

Yvonne Joyce saw her brother's fiancee waiting in the driveway when she got home from work.

Kathy Mayan's telephone rang while she was cleaning house in Dover. On the other end was one of her brothers.

Dottie Rayburn's father took a call at dinner time, and led his daughter out onto the front porch.

Deanne James found out when she flipped on CNN, because Brian had said the news network might film the landing at Quantico.

Some of the widows--particularly James, Joyce and Mayan--remain angry. Kathy Mayan has filed a lawsuit, and lawyers for other families are considering lawsuits or seeking settlements.

The widows still believe in the Osprey and want it to succeed.

"I hope someday," Yvonne Joyce said "my daughter and I can go on a tilt-rotor and I can say "Your daddy was part of that."

At Edgewood Memorial Park in Delaware County, Tony Stecyk lies buried beneath a bronze marker that has two etchings. One is of the Harley Davidson emblem. The other is of an Osprey, nacelles tilted up.

■

Published on 08/06/1992, SEATTLE POST-INTELLIGENCER

NAVY SAYS IT WANTS A CHEAPER OSPREY -OR AN ALTERNATIVE

Faced with a dwindling post-Cold War budget, the military will ask contractors next week to devise a lower-cost blueprint for developing the controversial V-22 tilt-rotor plane built by Boeing and Bell Helicopter.

But acting Navy Secretary Sean O'Keefe told a joint House subcommittee yesterday that the Pentagon simultaneously will pursue alternatives that could compete with the V-22 to replace the Marines' CH-46 helicopters.

Your search terms appear 4 times in this article.

Complete Article, 454 words ($1.95 to download)

Published on 07/22/1992, SEATTLE POST-INTELLIGENCER

MORE PENTAGON DOUBTS FOLLOW CRASH OF OSPREY

Reacting to the second crash of a V-22 Osprey in 13 months, Pentagon officials yesterday voiced new doubts about the hybrid helicopter-airplane in an apparent effort to stall congressional financing for it.

Defense Secretary Dick Cheney has criticized the project all along, although early this month he did free money to allow work on it to continue.

Your search terms appear 7 times in this article.

Complete Article, 673 words ($1.95 to download)

Published on 07/21/1992, SEATTLE POST-INTELLIGENCER

OSPREY HELICOPTER CRASHES, KILLING 7

A prototype of the V-22 Osprey, a tilt-rotor aircraft whose future was already the subject of furious debate, crashed yesterday in the Potomac River, apparently killing all seven people on board.

The aircraft, which takes off like a helicopter and flies like a plane, was headed for a landing at the Marine air station in Quantico, Va.

Your search terms appear 7 times in this article.

Complete Article, 677 words ($1.95 to download)

Published on 11/11/1992, SEATTLE POST-INTELLIGENCER

NTSB SAFETY RECOMMENDATION AFFECTS ALL 2,300 BOEING 737S

The National Transportation Safety Board yesterday recommended that airlines change their Boeing 737 rudder-control units to avoid steering problems reported in six incidents. All 2,300 737s in service around the world could be affected.

The problems have not caused any injuries to passengers or damage to airplanes, but safety experts said the potential for accidents remains if the units aren't changed.

Your search terms appear 8 times in this article.

Complete Article, 480 words ($1.95 to download)

Published on 10/23/1992, SEATTLE POST-INTELLIGENCER

COLUMBIA ROARS SAFELY INTO ORBIT SHUTTLE BLASTS OFF AFTER NASA WAIVES FLIGHT RULE

Columbia blasted safely into space with six astronauts and a laser-reflecting satellite yesterday after NASA waived a flight rule and launched the shuttle despite excessive wind gusts.

``The flagship of the fleet is back in space again," shuttle commander James Wetherbee said moments after NASA's oldest shuttle reached orbit.

Your search terms appear 7 times in this article.

Complete Article, 607 words ($1.95 to download)

Published on 10/22/1992, SEATTLE POST-INTELLIGENCER

FAA TO WIDEN ITS PROBE OF THE EL AL 747 CRASH

The Federal Aviation Administration said yesterday it will broaden the scope of its El Al 747 crash investigation to include all the mounts that hold the engine struts to the wings.

The agency asked Boeing to test several 747s to see how the different strut mounts stand up to stress during takeoff, landing and flight, officials said.

Your search terms appear 9 times in this article.

Complete Article, 479 words ($1.95 to download)

08/27/1992

08/27/92

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

AVIATION OCCURRENCE REPORT

NEWCAL AVIATION INC.
MODIFIED DE HAVILLAND DHC-4A (PROTOTYPE CONVERSION) N400NC
GIMLI INDUSTRIAL PARK, MANITOBA
27 AUGUST 1992

REPORT NUMBER A92C0154

SYNOPSIS

The aircraft had just taken off on an experimental test flight when it entered a gradually steepening climb. During the climb, the aircraft rolled slowly to the right and, at approximately 200 feet above ground level (agl), it entered a steep nose-down, right-wing-low attitude and crashed. Upon impact, the on-board fuel ignited and the majority of the aircraft wreckage was destroyed by fire. The three crew members aboard the aircraft were fatally injured.

The Transportation Safety Board of Canada determined that the gust lock system was not fully disengaged prior to flight and one or more of the gust locking pins became re-engaged for undetermined reasons after lift-off. It is unlikely that a control check had been completed prior to take-off and, once

airborne, the crew were unable to disengage the gust lock mechanism before losing control of the aircraft.

05 August 1993

NEWCAL AVIATION INC.
MODIFIED DE HAVILLAND DHC-4A (PROTOTYPE CONVERSION) N400NC
GIMLI INDUSTRIAL PARK, MANITOBA
27 AUGUST 1992

REPORT NUMBER: A92C0154 (Accident)
INFORMATION SOURCE: Field Investigation
LOCAL TIME: 1020 CDT
TYPE OF OPERATOR: Other
TYPE OF OPERATION: Experimental
DAMAGE: Destroyed
PILOT LICENCE: Airline Transport

	PILOT-IN-COMMAND		CO-PILOT	
PILOT HOURS:	ALL TYPES	ON TYPE	ALL TYPES	ON TYPE
TOTAL	8,812	4,700	1,542	240
LAST 90 DAYS	138	96	71	6

INJURIES:	FATAL	SERIOUS	MINOR/NONE
CREW	3	-	-
PASSENGERS	-	-	-

1.0 FACTUAL INFORMATION

1.1 History of the Flight

The aircraft had just taken off on an experimental flight when it entered a gradually steepening climb. During the climb the aircraft rolled slowly to the right and, at approximately 200 feet above ground level (agl), it entered a steep nose-down, right-wing-low attitude and crashed. Upon impact, the on-board fuel ignited and the majority of the aircraft wreckage was destroyed by fire. The three crew members aboard the aircraft were fatally injured.

1.2 Aircraft History

The aircraft was manufactured on 18 November 1965 and was sold to the Kenyan Air Force, with whom it spent the next 21 years. On 05 June 1986, the aircraft was purchased from the Kenyan Air Force by NewCal Aviation Incorporated, of Little Ferry, New Jersey; the aircraft was assigned U.S. registration markings N400NC and was issued a Certificate of Airworthiness for operation as a Transport Category aircraft.

1.2.1 Turbine Engine Conversion Program

In August 1988, NewCal Aviation Inc. applied for a Supplemental Type Certificate (STC) to change the powerplant installation on the aircraft from reciprocating to turboprop engines. NewCal Aviation of Canada was formed to undertake the turbine engine conversion program and, for the purpose of this program, DHC 4 (Caribou) serial number 240 was granted approval to operate under the EXPERIMENTAL category of CAR 4b. The original manufacturer, de Havilland Inc, was not involved in the flight test program.

The modification project involved the removal of the original Pratt & Whitney R-2000-7M2 piston engines and the installation of Pratt & Whitney PT6A-67R turbo-prop engines and associated equipment. This new configuration included the addition of a five-bladed Hartzell propeller system, along with new engine mounts and cowlings. Other systems affected by the modification included the fuel system, powerplant controls, powerplant instruments, hydraulic system, fire protection system, electrical system, and the engine oil system. This conversion significantly modified the aircraft from the original DHC-4 Caribou as type certificated.

The turbine conversion was accomplished at the Gimli Industrial Park and the first flight tests of the modified aircraft began on 16 November 1991. A total of 12 test flights were carried out between 16 and 28 November 1991, with an accumulated flight time of 22.9 hours; the aircraft was then hangared over the winter.

Results of the evaluation flight test program conducted in late 1991 indicated that minor design changes were required to several of the aircraft systems. These changes included the replacement of the aircraft's mechanical vacuum pumps with a Bendix suction system, the addition of in-line fuel boost-pumps, and the installation of a newly designed hydraulic pump.

Data acquired during earlier taxi tests indicated that, with the new in-line fuel boost pumps installed, the fuel flow corresponding to a normal take-off power setting of 100 per cent torque was 740 pounds per hour (pph).

1.3 Purpose of the Occurrence Flight

The occurrence flight was intended to be the first of several trips designed to flight-check the fuel and hydraulic systems. On the morning of the accident, the crew attended a pre-flight briefing, which included a thorough review of the flight test plan. The aircraft was lightly loaded at a mid centre of gravity (C of G) position. In-flight checks were scheduled to include simulated failures of both the wing fuel pumps and the in-line pumps; records were to be maintained regarding the resulting fuel pressures.

A company engineer who had been involved in the design of the fuel and hydraulic modifications was included on this flight to record flight test results and to evaluate in-flight performance of the two systems.

1.3.1 Flight Profile

The crew completed a pre-flight inspection of the aircraft, started the engines, and spent approximately 45 minutes doing a ground run and systems check before proceeding to the button of runway 14.

The aircraft was taxied onto the runway surface and brought to a full stop. Approximately 20 seconds later, the engine power was advanced and the brakes were released. Directional control of the aircraft was maintained throughout the ground run and the aircraft became airborne in approximately 900 feet.

The entire flight was recorded on amateur eight millimetre (mm) videotape and in a series of 35 mm still photographs. This photographic information confirmed that elevator authority existed at rotation and that the aircraft's pitch attitude increased to a position significantly higher than had been observed on previous take-offs under similar environmental conditions. With the exception of a higher-than-normal nose attitude at lift-off, the aircraft's initial climb appeared normal. At about 35 feet agl, the aircraft made a noticeable pitch-up movement; from that point onwards, the elevator control surfaces were observed to remain in their neutral position.

The aircraft completed a gradually steepening wing-over manoeuvre, then it entered a steep dive and struck the ground. Airspeed remained above the stall speed throughout the manoeuvre. Careful examination of the photographic evidence revealed that there were no discernable control surface deflections throughout the entire manoeuvre, from the point where the in-flight pitch-up movement occurred through to the point where the aircraft struck the ground. Enhancement of the photographic images made it possible to identify an upward deflection of the elevator spring tabs with no corresponding movement of the control surfaces.

1.4 Wreckage Examination

The aircraft struck the ground in a near vertical, right-wing-low attitude. Primary wreckage was distributed within a 50-foot radius of the aircraft and, except for the detached outboard portion of the right wing, the entire aircraft had been engulfed in an intense post-crash fire. The landing gear was confirmed to be down and locked; the aircraft's tail section and front fuselage section were located forward of the left engine area and were completely destroyed. Both wings outboard of the engine nacelle area were torn open and severely burnt. The outboard wing sections contained an internal, eight-cell, wet-wing-design fuel tank arrangement, which burst open upon ground impact.

1.4.1 Flight Control System Examination

An examination of the flight control system revealed no pre-impact faults; continuity of the entire flight control system was confirmed. The flaps were determined to be at a seven-degree setting at impact, and the aileron and elevator trim tabs were near their neutral positions. The rudder trim tab was located half-way between the neutral and full-nose-left position.

1.4.2 Propeller Examination

Both the left and right propeller systems were examined following the accident. Damage to these systems indicates that the blades contained significant rotational energy at the time of the crash. Blade angles had been captured at approximately 26 degrees; that blade angle is in the normal in-flight governing range, and is consistent with values that would be expected when the engines are producing high power.

1.4.3 Engine Examination

Teardown and examination of the engines revealed high internal rotational damage, consistent with a high power setting at impact. Neither engine displayed any pre-impact anomaly or distress that would have prevented normal operation prior to impact.

1.4.4 Instrument Examination

The TSB Engineering Laboratory determined that both of the fuel flow indicators were captured at 740 lb/hour. No useful data was derived from the remaining instruments.

1.4.5 Aircraft Gust Lock System

The aircraft is equipped with an internal gust lock system for locking the control surfaces in neutral when the aircraft is parked or is being taxied. The system is controlled by a gust lock handle which is located on the overhead console, forward of the throttles. The handle has two positions, marked LOCKED and UNLOCKED. When the handle is moved aft to the LOCKED position and the control surfaces are moved to their neutral position, the gust locks will engage and secure the ailerons, elevator, and rudder from further movement. However, if the control surfaces are out of position when the gust lock handle is moved to the LOCKED position, any subsequent deflection of the control surfaces through their neutral position will cause them to automatically lock.

1.4.6 Gust Lock Lever/Power Lever Relationship

The aircraft controls are designed such that, when the gust lock handle is moved aft to the LOCKED position, it prevents the throttles from being advanced to their full power position. This relationship between the throttles and the gust lock handle provides a safety feature which is designed to ensure that a take-off cannot be attempted while the control locks are engaged.

The throttle quadrant of the accident aircraft had been re-designed as part of the engine modification project. The resultant changes to the throttle system did not adversely affect the positional relationship between the gust lock handle and the throttle levers; in the newly designed system, the throttle levers still could not be advanced to achieve take-off power when the gust lock lever was in its LOCKED position.

1.4.7 Elevator Gust Lock System

The elevator gust lock mechanism is mounted to a channel on the bottom surface of the horizontal stabilizer, located to the right of the aircraft centre-line. This mechanism is operated by the gust lock system's chain and cable circuit. When the gust lock is actuated to its LOCKED position, the elevator lock pivots and, provided that the elevators are in their neutral position, a slot in the gust lock engages with the spring-loaded plunger of the lock arm to prevent the control surface from moving. If the elevators are not in neutral when the gust lock system is actuated, the spring-loaded plunger will be depressed against the face of the elevator lock, and will engage with the slot only when the elevators are later moved to their neutral position.

The elevator gust lock assembly was recovered intact from the tail section of the aircraft wreckage and was found in the spring-loaded DISENGAGED position. The mechanism was exercised and found to operate normally through its full travel range. This assembly was confirmed to have been rigged in accordance with the manufacturer's rigging instructions, although the gust lock tension spring appeared weak and exhibited evidence of fire damage.

1.4.8 Rudder Gust Lock System

The rudder gust lock mechanism is mounted at the aft end of the rear fuselage, and is operated by the rear sprocket of the gust lock system's chain and cable circuit. Operation of the rudder gust lock mechanism is similar to that of the elevator gust lock system described above.

The rudder gust lock assembly was recovered from the wreckage and the gust lock's mechanical actuating lever-arm was captured in the ENGAGED position. In addition, the spring-loaded plunger was jammed in its fully extended position, and had been rotated approximately seven degrees in its guide boss. The rotational damage to the plunger is consistent with torsional loading damage that would be expected if the plunger had been engaged, and had subsequently rotated during ground impact.

A sprocket assembly that interconnects the rudder and elevator control lock actuation mechanisms was also recovered from the wreckage. A number of the sprocket's gear teeth had been bent in overload at impact, causing the assembly's chains to jam. By measurement, and comparison with a serviceable control lock mechanism, it was determined that the sprocket was oriented midway between the gust lock ENGAGED and DISENGAGED positions.

1.4.9 Aileron Gust Lock System

The aileron gust lock mechanism was recovered in its spring-loaded DISENGAGED position. However, further examination of the aileron system revealed that the heads of all eight (AN470-3) rivets used to secure the aileron control quadrant's centre pivot-bearing structure had failed in tensile overload. This damage is believed to have occurred when the aileron cables were stretched beyond their normal loading limits while the control quadrant was locked and unable to rotate. The two devices in the system that could prevent free rotation of the control quadrant are the quadrant stops and the spring-loaded plunger when it is in the ENGAGED position. Both of these devices were examined and no unusual damage was apparent.

1.4.10 Gust Lock Handle

Portions of the gust-lock handle assembly were recovered from the cockpit wreckage. These components exhibited severe impact deformation and overload failure. Examination of the relationship between several of the moveable components of this control system indicated that the gust lock lever was in a fully DISENGAGED position when recovered.

The aircraft captain had been seated in the left crew-seat position. A knob from the gust lock control handle was found embedded in his right wrist.

1.5 Gust Lock Operation

Following the accident, a number of tests were conducted on a serviceable Caribou aircraft to determine how the gust lock mechanism would operate under circumstances in which one of the locking pins was jammed and unable to be released. During these tests, the rudder locking pin was held in place, and the gust lock handle in the cockpit was released. The consistent result was that the gust lock handle moved forward, under spring power, to a position approximately one-half the distance between its LOCKED and UNLOCKED positions. The flight controls were then exercised and it was found that, under these conditions, the flight crew would have aft (nose-up) elevator authority but no forward (nose-down) elevator authority. Although the rudder itself remained securely in place because of the actuation of the locking pin, it was easily possible to deflect the rudder spring tabs by applying pressure to the rudder pedals.

During follow-up testing, the elevator gust lock mechanism was rotated to a mid-range position between its fully LOCKED and UNLOCKED station. It was noted that, at this mid-point, the elevator gust lock pin disengaged sufficiently to allow the elevator to be deflected to command a nose-up pitch attitude. However, because of the system design, when the elevator controls were moved forward to command a nose-down pitch attitude, the control lock would re-engage as the elevator returned to its neutral position. Further forward movement of the elevator control column caused the elevator spring tabs to deflect upward, and out of their neutral position without a corresponding deflection of the elevator control surface.

From these tests, it was also determined that it is not possible to move the gust lock handle fully forward unless the locking pins have been completely released.

1.6 Aircraft Performance - General

Aircraft performance figures available from the aircraft flight manual, the servicing manuals, and from previous flight test records were carefully reviewed.

1.6.1 Aircraft Performance - Weight and Balance

Loading for the accident flight was within the constraints of the weight and balance envelope. All ballast used on previous test flights had been removed. The total take-off weight for the accident flight is estimated to be 22,000 pounds. The maximum gross weight allowable under the conditions of the day was 28,500 pounds.

1.6.2 Aircraft Performance - Take-off Power

The normal maximum-power permissible for take-off corresponds to 1,281 Static Horse-Power (SHP) at 1,700 rpm and 100 per cent output torque. Either engine is capable of producing 1,424 SHP at 1,700 rpm, which corresponds to 111 per cent torque.

The engine manufacturer estimates that, with the control lock handle in the LOCKED position, the engines may have been capable of producing between 400 and 800 SHP, with the most likely value falling to the low end of that range.

1.6.3 Aircraft Performance - Take-off Distance

Aircraft performance charts indicate that the expected take-off distance for the conditions of the day should have been 700 feet. The ground run of the accident flight was measured to be approximately 900 feet and was therefore more than 20 per cent longer than the performance charts predict.

1.6.4 Aircraft Performance - Take-off Speed

Actual lift-off speeds are not available; however, take-off performance charts in the draft Aircraft Flight Manual, which was developed and compiled by Newcal Aviation during the flight test program, indicate that both the engine failure speed and the take-off safety speed for the conditions of the day would have been approximately 87 miles per hour (mph).

The aircraft did not stall throughout the entire in-flight manoeuvre. The Aircraft Flight Manual indicates that the normal 1-g stall speed for take-off configuration is 71 mph when at zero thrust. The power-on stall speed, in take-off configuration, is not published but would be lower than the published value of 71 mph.

1.7 Pre-Flight Checks

Standard procedures for the operation of the Caribou aircraft include the execution of a six-point control check prior to take-off. This check is essential to assure the crew that it has full and unimpeded operation of the primary control surfaces. This check is especially important on any aircraft that has the capability of locking the flight controls while manoeuvring on the ground.

No control check was seen by witnesses on the ground, nor was one captured on videotape or 35 mm film.

1.8 Weather

The Area Forecast for the time of the accident predicted that the Gimli region would be under the influence of an unstable airmass, a light to moderate southwesterly flow, and patchy, moist mid-level clouds. An automated weather observation system (Auto5) is located at the Gimli Industrial Park. That system indicated that the surface winds at the time of the accident were from 200 degrees (True) at 15 knots.

1.9 Flight Crew

Both flight crew members were licensed and qualified to conduct this flight. Experience of either crew member on the turbo-conversion aircraft was limited in that it was a newly modified, "one-of-a-kind" aircraft. Neither pilot was an experienced flight test crew.

Autopsy and toxicology examinations did not reveal any physiological, toxicological, or pathological factors that would have had a bearing on this accident.

2.0 ANALYSIS

2.1 Pre-Flight Preparation

This flight was pre-briefed in detail and was intended to form part of an on-going flight test program that was being conducted as part of the aircraft modification.

2.2 Elevator Authority

The aircraft rotated at lift-off to a pitch attitude that was slightly higher than that used on previous take-offs. The smooth nose-rotation seen on the videotape indicates that the crew did have up-elevator authority at lift-off. However, in subsequent video frames, the elevator is seen to remain in its neutral position with the spring tab deflected upwards; this situation is known to occur when the elevator movement has been impeded while pressure is being applied to the control column.

During its initial climb, the aircraft's pitch attitude continually increased. It would be logical to expect the crew to counter this continuous upward movement of the aircraft's nose by applying forward control column pressure. Photographic evidence of this occurrence does show an upward deflection of the spring tab but does not show any corresponding control surface movement. Such a situation can be duplicated on the ground, with the gust locks ENGAGED, by applying a forward control column pressure against the locked elevator system. In the air, the resultant spring tab deflection would cause an aerodynamic effect that is the reverse of the commanded control input. The photographic information, coupled with the dynamics of the aircraft's flight profile, corroborates physical evidence which indicates that the elevator system was being restricted from moving toward a commanded nose-down position. It is therefore concluded that the crew was likely attempting to lower the nose by applying forward control column pressure, but that the elevator system was either locked or otherwise restricted from movement. The crew's continuing effort to apply forward control column pressure deflected the spring tabs, and caused a further increase to the aircraft's pitch attitude.

2.3 Rudder Gust Locks

Damage to the rudder gust lock mechanism indicates that it was ENGAGED at the time of the impact. With the rudder locks ENGAGED in flight, any attempt by the crew to counter an uncommanded right roll by using left rudder inputs would have deflected the rudder spring tab towards the right and increased the right-hand roll rate; this movement would be consistent with the roll profile observed on the videotape.

2.4 Aileron Gust Locks

Damage to the aileron control quadrant suggests that the aileron gust lock may have been engaged at impact. If the ailerons had been available for use throughout this flight, it would be logical to have expected some attempt by the crew to control the aircraft's roll rate throughout the wing-over manoeuvre; no change in roll rate was observed. It is therefore unlikely that aileron control was available to the crew during the in-flight portion of this trip.

2.5 Gust Lock Handle Release

The aircraft gust lock handle is designed to restrict forward throttle movement when the lock is ENGAGED. Estimates by the engine manufacturer indicate that the maximum throttle setting that would be possible with the gust lock handle ENGAGED would have provided approximately 30 per cent to 40 per cent of the available engine power - an amount considered insufficient to complete a take-off even under light weight conditions.

In this occurrence, the aircraft became airborne in approximately 900 feet and flew the entire flight profile above its stall speed. The stalling speed for this aircraft under take-off power is not published, but would be less than 71 mph. The aircraft's acceleration to speeds above the stall, along with its subsequent lift-off and climb performance as observed on the videotape, would not be expected if the aircraft throttles were restricted to allow the engines to produce less than 40 per cent of their maximum power. It is therefore concluded that the gust lock handle had been released from its LOCKED position prior to, or during, the take-off roll.

2.6 Crew Activity

During this flight, the aircraft entered a gradually steepening, nose-high, attitude which eventually progressed to become a very steep dive. It would be reasonable to expect that, if either pilot had been holding the throttle levers throughout this manoeuvre, some attempt would have been made to adjust the throttle position to compensate for the steep pitch attitudes.

An examination of the aircraft flight instruments provided indications that both engine fuel flow readings were 740 pph at the time of the crash. This figure is significant, in that it represents the precise fuel flow value that corresponds to normal take-off power; the engine is capable of producing power at levels either above or below this particular setting. Because the fuel flow readings at the time of the impact relate precisely to take-off power, it can be concluded that no throttle adjustments were attempted after take-off power was set. It is therefore unlikely that either crew member had his hand on the throttle levers throughout the flight phase of this occurrence.

During the autopsy, a knob from the gust lock handle was found embedded in the captain's right wrist. It follows, then, that the captain's right hand was elevated and positioned in the region of the gust lock handle at the time of the crash. Based on this information, it is likely the captain was attempting to operate the gust lock handle at the time that the aircraft hit the ground.

2.7 Six-Point Control Check

Standard procedures for the Caribou aircraft allow for locking the flight controls during ground operation. The aircraft flight manual indicates that a six-point control check is required prior to take-off to ensure free and proper movement of the flight control system. No control check was seen by witnesses on the ground, nor was one captured on videotape or 35 mm film. It is likely that if the controls were locked prior to take-off because of some unknown component failure or system jamming, a full control check would have identified the restriction. It is therefore concluded that the control check was likely omitted for undetermined reasons.

3.0 CONCLUSIONS

3.1 Findings

1. The occurrence aircraft was operating under an EXPERIMENTAL category of CAR 4b; the aircraft had acquired an accumulated flight time of 23 hours in its modified configuration.

2. The aircraft was loaded within the weight and balance constraints published in the Aircraft Flight Manual.

3. The aileron and elevator trim tabs were near their neutral positions.

4. No flight control check was observed prior to commencement of the take-off roll.

5. The take-off ground run was 20 per cent longer than the performance charts predict.

6. Aft elevator authority existed at rotation.

7. The aircraft's initial climb attitude was significantly higher than on previous take-offs under similar environmental conditions.

8. At approximately 35 feet agl, the aircraft made a noticeable pitch-up movement; from that point onwards, the elevator control surfaces remained in their neutral position.

9. Airspeed remained above the stall speed throughout the in-flight manoeuvre.

10. The flight control system had not been modified during the conversion process; there was no evidence of pre-impact faults in this system.

11. The propeller blades contained significant rotational energy at the time of the crash; blade angles had been captured at approximately 26 degrees and were consistent with a high engine power setting.

12. Both engines were under high power at impact; neither engine displayed any pre-impact anomaly or distress that would have prevented normal operation prior to impact.

13. While the aircraft was in flight, the elevator spring tabs were deflected upward with no corresponding movement of the elevator; this situation occurs when forward control column pressure is applied and the elevator control lock is engaged.

14. The rudder gust lock's mechanical actuating lever-arm was captured in the ENGAGED position at impact.

15. A sprocket assembly that interconnects the rudder and elevator control lock actuation mechanisms was oriented midway between the gust lock ENGAGED and gust lock DISENGAGED position.

16. Damage to the aileron control quadrant's centre pivot-bearing structure is consistent with the aileron control lock being engaged at impact.

17. Post-accident tests show that, in situations where one or more gust lock pins does not fully disengage, it is possible to have aft (nose-up) elevator authority with no forward (nose-down) elevator control.

3.2 Causes

The gust lock system was not fully disengaged prior to flight and one or more of the gust locking pins became re-engaged for undetermined reasons after lift-off. It is unlikely that a control check had been completed prior to take-off and, once airborne, the crew were unable to disengage the gust lock mechanism before losing control of the aircraft.

4.0 SAFETY ACTION

4.1 Action Taken

4.1.1 Aircraft Gust Locks

Subsequent to this occurrence, the Transportation Safety Board forwarded an Aviation Safety Advisory to Transport Canada concerning the adequacy of pre-take-off checklists and procedures pertaining to the removal of aircraft control gust locks.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Gerald E. Bennett, Zita Brunet, the Hon. Wilfred R. DuPont and Hugh MacNeil, has authorized the release of this report.

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+------------------------------------------ REQUEST 074/98, REPORT 15 ------------------------------------------+
+ DATA REPORT                                        LEARJET-24                                        ACCIDENT +
+ EVENTS¦PHASES                      GEAR FAILURE-TAXIING -PUSHBACK/TOW                                        +
+                                    GROUND LOOP/SWERVE-LANDING ROLL                                           +
+                                          OVERRUN-LANDING ROLL                                                +
+                                   COLLISION WITH DITCH-LANDING ROLL                                          +
+                                COLLISION WITH OBJECT-OTHER-LANDING ROLL                                      +
+---------------------------------------------------------------------------------------------------------------+
                                                       ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          : MISCELLANEOUS - TEST/EXPERIMENTAL        ++ ICAO FILE        : 92/0137-0
                                                         ++ FROM STATE       : SOUTH AFRICA
FINAL REP                                                ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <------------------- AIRCRAFT DATA -------------------->
DATE          : 92-07-25                                 ++ MASS CATEGORY     : 5701 - 27 000 KG
TIME          : 14:00                                    ++ STATE OF REGISTRY : SOUTH AFRICA
LIGHT         : DAYLIGHT                                 ++ REGISTRATION      : ZS-MGJ
GEN WEATHER   : VMC                                      ++
                                                         ++
<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      : LANSERIA A/P                             ++ A/C DAMAGE        : SUBSTANTIAL
STATE/AREA    : SOUTH AFRICA                             ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      : LANSERIA A/P                             ++ CREW   :       0      0      0     2     0      2
DESTINATION   : LANSERIA A/P                             ++ PAX    :       0      0      0     0     0      0
                                                         ++
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---------------- NARRATIVE ----------------

THE NOSE GEAR CENTRALIZING CAM WAS DAMAGED WHEN THE A/C WAS TOWED UP A STEEP INCLINE. WHEN THE OLEO EXTENDED AFTER TAKE-OFF, THE NOSEWHEEL ADOPTED AN OFF-SET POSITION AND REMAINED IN THAT POSITION AFTER THE GEAR WAS EXTENDED FOR LANDING. ON LANDING THE A/C SLEWED VIOLENTLY TO THE LEFT AS THE NOSEWHEEL TOUCHED THE RWY SURFACE. THE A/C LEFT THE RWY, THE GEAR COLLAPSED, AND THE A/C COLLIDED WITH METEOROLOGICAL OBSERVATION EQUIPMENT ADJACENT TO THE RWY.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   GEAR FAILURE - TAXIING -PUSHBACK/TOW
           1.APRON SURFACE STATE - ABNORMAL
           2.NOSE GEAR DOOR - DAMAGED
EVENT  2   GROUND LOOP/SWERVE - LANDING ROLL
           1.DIRECTIONAL CONTROL - COMPLETE LOSS OF
           2.NOSEWHEEL STEERING - PREVIOUS DAMAGE
EVENT  3   OVERRUN - LANDING ROLL
EVENT  4   COLLISION WITH DITCH - LANDING ROLL
EVENT  5   COLLISION WITH OBJECT-OTHER - LANDING ROLL
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+------------------------------------------ REQUEST 074/98, REPORT 16 ------------------------------------------+
+ PRELIMINARY REPORT                          DE HAVILLAND-DHC4 CARIBOU                                ACCIDENT +
+ EVENTS¦PHASES                            LOSS OF CONTROL-INITIAL CLIMB                                      +
+                           COLLISION WITH TERRAIN-EMERGENCY/UNCONTROLLED DESCENT                               +
+                                              FIRE-POST-IMPACT                                                 +
+---------------------------------------------------------------------------------------------------------------+
                                                       ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          : MISCELLANEOUS - TEST/EXPERIMENTAL        ++ ICAO FILE        : 92/0359-0
                                                         ++ FROM STATE       : CANADA
FINAL REP                                                ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <------------------- AIRCRAFT DATA -------------------->
DATE          : 92-08-27                                 ++ MASS CATEGORY     : 5701 - 27 000 KG
TIME          : 10:20                                    ++ STATE OF REGISTRY : UNITED STATES
LIGHT         : DAYLIGHT                                 ++ REGISTRATION      : N400NC
GEN WEATHER   : VMC                                      ++
                                                         ++
<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      : GIMLI                                    ++ A/C DAMAGE        : DESTROYED
STATE/AREA    : CANADA                                   ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      : GIMLI                                    ++ CREW   :       3      0      0     0     0      3
DESTINATION   : GIMLI                                    ++ PAX    :       0      0      0     0     0      0
                                                         ++
```

---------------- NARRATIVE ----------------

THE A/C WAS TAKING OFF ON A TEST FLIGHT FOR A TURBINE-ENGINE CONVERSION PROGRAMME. IT CLIMBED STEEPLY, ROLLED TO THE RIGHT AND CRASHED IN A NEAR-VERTICAL, NOSE-DOWN, RIGHT-WING-LOW ATTITUDE. THE A/C WAS DESTROYED BY FIRE.

09/16/1992

09/16/92

NTSB Identification: LAX92IA390 For details, refer to NTSB microfiche number 47665A

Incident occurred SEP-16-92 at YUMA, AZ
Aircraft: MCDONNELL DOUGLASS MD-11, registration: N90187
Injuries: 8 Uninjured.

MCDONNELL DOUGLAS INSTRUMENTED A FLIGHT TEST MD11 TO EXPLORE TWO PREVIOUS IN SERVICE INCIDENTS OF CENTER MAIN BODY LANDING GEAR DRAG LINK FAILURES. THE TEST PROTOCOL WAS DESIGNED TO REPLICATE THE KNOWN CIRCUMSTANCES OF THE TWO IN SERVICE FAILURES. DURING THE LANDING ON THE TEST FLIGHT, A FAILURE OF THE DRAG LINK WAS INDUCED, WHICH ALLOWED THE CENTER MAIN BODY GEAR TO FOLD AFT DAMAGING THE WHEEL WELL AND ADJACENT SKIN PANELS. EXAMINATION OF THE INSTRUMENTATION DATA REVEALED THAT THE DRAG LINK FAILURE WAS THE RESULT OF A DYNAMIC INSTABILITY OF THE CENTER BODY GEAR DUE TO AN UNFAVORABLE INTERACTION BETWEEN THE CENTER BODY LANDING GEAR AND THE BRAKE CONTROL SYSTEM (INCLUDING THE ANTI SKID AND AUTO BRAKE SUB SYSTEMS). AS A CORRECTIVE ACTION, THE MANUFACTURER DEVELOPED A MODIFICATION TO THE ANTI SKID CONTROL UNIT.

Probable Cause

AN UNSTABLE INTERACTION BETWEEN THE CENTER BODY MAIN LANDING GEAR AND THE BRAKE SYSTEM.

Index for Sep 1992 | Index of Months □□□□


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+-------------------------------------------- REQUEST 074/98, REPORT  17 ----------------------------------------+
+ DATA REPORT                                  MCDONNELL-DOUGLAS-MD-11                                   INCIDENT +
+ EVENTS|PHASES                        OTHER GEAR COLLAPSED/RETRACTED-LANDING ROLL                                +
+---------------------------------------------------------------------------------------------------------------+
                                                          ++
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FINAL REP                                                 ++
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GEN WEATHER   :  VMC                                      ++
                                                          ++
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LOCATION      :  YUMA,AZ                                  ++ A/C DAMAGE         :  MINOR
STATE/AREA    :  UNITED STATES                            ++ INJURY :      FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  YUMA,AZ                                  ++ CREW   :        0      0      0     3     0      3
DESTINATION   :  YUMA,AZ                                  ++ PAX    :        0      0      0     0     0      0
                                                          ++
```

---------------- NARRATIVE ----------------

THIS WAS A MANUFACTURER FLIGHT TEST OF CENTRE MAIN BODY LANDING GEAR DRAG LINK FAILURES ON THIS A/C TYPE. DURING LANDING, A FAILURE OF THE DRAG LINK WAS INDUCED. THE CENTRE MAIN BODY GEAR FOLDED AFT, DAMAGING THE WHEEL WELL AND ADJACENT SKIN PANELS. THE DRAG LINK FAILURE WAS THE RESULT OF A DYNAMIC INSTABILITY OF THE CENTRE BODY GEAR DUE TO AN INTERACTION BETWEEN THE CENTRE BODY LANDING GEAR AND THE BRAKE CONTROL SYSTEM (INCLUDING THE ANTI SKID AND AUTOBRAKE SUB SYSTEMS). THE MANUFACTURER DEVELOPED A MODIFICATION TO THE ANTI SKID CONTROL UNIT.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   OTHER GEAR COLLAPSED/RETRACTED - LANDING ROLL
           1.NORMAL BRAKE SYSTEM - ERRATIC
              1.MANUFACTURER-DESIGN-INADEQUATE
           2.MAIN GEAR - FAILED/COLLAPSED
```

09/18/1997

09/18/92

NTSB Identification: **FTW92LA228**

Accident occurred SEP-18-92 at SAN ANTONIO, TX
Aircraft: FAIRCHILD SA-227-AC, registration: N2183A
Injuries: 2 Uninjured.

THE PILOT WAS CONDUCTING A FUNCTIONAL TEST FLIGHT AND QUALITATIVE ENGINEERING EVALUATION OF THE AIRPLANE'S LONGITUDINAL CONTROL DURING LANDING. DURING FINAL APPROACH TO RUNWAY 12L, HE REDUCED THE ENGINES TO THE FLIGHT IDLE POSITIONS AND ESTABLISHED 95 KIAS. HE WAS UNABLE TO RAISE THE NOSE OF THE AIRPLANE DURING THE FLARE TO ARREST THE DESCENT RATE AND LANDED HARD ONTO THE RUNWAY. THE AIRPLANE WAS TAXIED TO THE RAMP AND SECURED. NO MECHANICAL FAILURE WAS FOUND OR REPORTED.

Probable Cause

THE LANDING CAPABILITY OF THE AIRPLANE WAS EXCEEDED. THE LACK OF PERFORMANCE DATA WAS A FACTOR IN THE ACCIDENT.

Index for Sep 1992 | Index of Months □□□□□

```
+-------------------------------------------- REQUEST 074/98, REPORT  18 -------------------------------------------+
+ DATA REPORT                                        FAIRCHILD-SA227 III                                    ACCIDENT +
+ EVENTS|PHASES                               HARD LANDING-LEVEL OFF/TOUCHDOWN                                       +
+-------------------------------------------------------------------------------------------------------------------+
                                                                 ++
<----------------------- OPERATION -----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL           ++ ICAO FILE          :  92/1130-0
                                                             ++ FROM STATE         :  UNITED STATES
FINAL REP                                                    ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <--------------------- AIRCRAFT DATA -------------------->
DATE          :  92-09-18                                    ++ MASS CATEGORY      :  5701 - 27 000 KG
TIME          :  13:10                                       ++ STATE OF REGISTRY  :  UNITED STATES
LIGHT         :  DAYLIGHT                                    ++ REGISTRATION       :  N2183A
GEN WEATHER   :  VMC                                         ++
                                                             ++
<----------------------- LOCATION ------------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  SAN ANTONIO,TX                              ++ A/C DAMAGE         :  SUBSTANTIAL
STATE/AREA    :  UNITED STATES                               ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  SAN ANTONIO,TX                              ++ CREW   :       0      0      0     2     0      2
DESTINATION   :  SAN ANTONIO,TX                              ++ PAX    :       0      0      0     0     0      0
                                                             ++

                                         ---------------- NARRATIVE ----------------
THE PILOT WAS CONDUCTING AN EVALUATION OF THE A/C'S LONGITUDINAL CONTROL DURING LANDING. DURING FINAL APP TO RWY 12L, HE
REDUCED THE ENGINES TO THE FLIGHT IDLE POSITIONS AND ESTABLISHED 95 KIAS. HE WAS UNABLE TO RAISE THE NOSE OF THE A/C DURING
THE FLARE AND LANDED HARD ON THE RWY. NO MECHANICAL FAILURE WAS FOUND.

                                          ------------ SEQUENCE OF EVENTS ------------
EVENT  1    HARD LANDING - LEVEL OFF/TOUCHDOWN
            1.RATE OF DESCENT - EXCESSIVE
            2.A/C PERFORMANCE - EXCEEDED
            3.USE OF PERFORMANCE DATA - INADEQUATE
               1.MANUFACTURER-PUBLICATIONS-INADEQUATE
```

Registered to Fairchild AC INC ; San Ant Tx
S/N 422B

REQUEST 074/98, REPORT 47

PRELIMINARY REPORT	CONAIR-FIRECAT	INCIDENT
EVENTS¦PHASES	FUMES/SMOKE-INITIAL CLIMB	
	POWER LOSS-FIRST ENGINE-INITIAL CLIMB	
	DIVERSION - DUE TO TECHNICAL REASONS-INITIAL CLIMB	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 95/2127-0
FROM STATE : CANADA

DATE, TIME AND METEOROLOGICAL DATA

DATE : 95-05-25
TIME : 14:30
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 5701 - 27 000 KG
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : PRINCE ALBERT
STATE/AREA : CANADA
DEPARTED : PRINCE ALBERT
DESTINATION : PRINCE ALBERT

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : MINOR

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	1	0	1
PAX :	0	0	0	0	0	0

NARRATIVE

SHORTLY AFTER TAKE-OFF DURING A TEST FLIGHT THERE WAS A FIRE WARNING LIGHT ACCOMPANIED BY FUMES IN THE COCKPIT. THE PILOT SHUT DOWN THE RIGHT ENGINE, DISCHARGED THE FIRE EXTINGUISHER BOTTLE AND RETURNED TO LAND. SHORTED AND BURNED WIRES IN THE FUSELAGE AND ELECTRICAL OVERHEAT DAMAGE TO THE RIGHT NACELLE FIRE WARNING CONTROL BOX WERE FOUND.

REQUEST 074/98, REPORT 48

PRELIMINARY REPORT	MCDONNELL-DOUGLAS-DC-3 DAKOTA/C-47	INCIDENT
EVENTS¦PHASES	FLIGHT CONTROL SYSTEM FAILURE-CRUISE	
	DIVERSION-CRUISE	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 95/2644-0
FROM STATE : CANADA

DATE, TIME AND METEOROLOGICAL DATA

DATE : 95-10-31
TIME : 09:15
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 5701 - 27 000 KG
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : RED LAKE,20 NM S
STATE/AREA : CANADA
DEPARTED : RED LAKE
DESTINATION : RED LAKE

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : NONE

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	2	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

THE A/C WAS ON A MAINTENANCE CHECK WHICH HAD REQUIRED A WING REMOVAL. AS THE CREW LEVELLED THE A/C IN CRUISE AND USED THE AILERON TRIM TO CORRECT A LEFT-WING-DOWN TENDENCY, THEY FOUND THAT APPLICATION OF THE AILERON TRIM AGGRAVATED THE CONDITION, AND REVERSED THE TRIM INPUT. THE CREW RETURNED AND LANDED SAFELY. THE AILERON TRIM SYSTEM HAD BEEN OPERATING IN REVERSE.

```
+------------------------------------------- REQUEST 074/98, REPORT  13 ------------------------------------------+
+ UNOFFICIAL REPORT                                  ROCKWELL-SABRE 40                                    INCIDENT +
+ EVENTS|PHASES                              UNKNOWN-TAXIING TO/FROM RUNWAY                                        +
+-----------------------------------------------------------------------------------------------------------------+
                                                          ++
<---------------------- OPERATION ---------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE           :  MISCELLANEOUS - TEST/EXPERIMENTAL       ++ ICAO FILE          :  92/0452-0
                                                          ++ FROM STATE         :
FINAL REP                                                 ++
<---------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE           :  92-03-26                                ++ MASS CATEGORY      :  5701 - 27 000 KG
TIME           :  00:00                                   ++ STATE OF REGISTRY  :
LIGHT          :                                          ++ REGISTRATION       :
GEN WEATHER    :                                          ++
                                                          ++
<---------------------- LOCATION ----------------------> ++ <---------- DAMAGE, INJURY AND TOTAL ON BOARD ---------->
LOCATION       :  OPA LOCKA                               ++ A/C DAMAGE         :  MINOR
STATE/AREA     :  UNITED STATES                           ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED       :                                          ++ CREW   :      0      0      0     2     0       2
DESTINATION    :                                          ++ PAX    :      0      0      0     0     0       0
                                                          ++

                                       ---------------- NARRATIVE ----------------
AIRCLAIMS: WHILST TAXIING, BRAKE PRESSURE WAS LOST AND THE PILOT SUBSEQUENTLY STEERED THE AIRCRAFT OFF THE TAXIWAY ONTO THE
GRASS. AFTER LEAVING THE TAXIWAY THE AIRCRAFT'S NOSE UNDERCARRIAGE STRUCK A CONCRETE BLOCK AND COLLAPSED. IT IS UNDERSTOOD
THAT, ON START UP, THE CREW FOGOT TO TURN ON THE HYDRAULIC PUMPS.


+------------------------------------------- REQUEST 074/98, REPORT  14 ------------------------------------------+
+ PRELIMINARY REPORT                                     MIL-MI-6                                         ACCIDENT +
+ EVENTS|PHASES                       TRANSMISSION FAILURE-FIRST ENGINE-CRUISE                                     +
+                                                       FIRE-CRUISE                                                +
+-----------------------------------------------------------------------------------------------------------------+
                                                          ++
<---------------------- OPERATION ---------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE           :  MISCELLANEOUS - TEST/EXPERIMENTAL       ++ ICAO FILE          :  92/0291-0
                                                          ++ FROM STATE         :  RUSSIAN FEDERATION
FINAL REP                                                 ++
<---------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE           :  92-07-22                                ++ MASS CATEGORY      :  27 001 - 272 000 KG
TIME           :  00:00                                   ++ STATE OF REGISTRY  :  RUSSIAN FEDERATION
LIGHT          :                                          ++ REGISTRATION       :  RA21896
GEN WEATHER    :                                          ++
                                                          ++
<---------------------- LOCATION ----------------------> ++ <---------- DAMAGE, INJURY AND TOTAL ON BOARD ---------->
LOCATION       :  NEAR MUNY MATERIK                       ++ A/C DAMAGE         :  DESTROYED
STATE/AREA     :  RUSSIAN FEDERATION                      ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED       :                                          ++ CREW   :      0      0      0     5     0       5
DESTINATION    :                                          ++ PAX    :      0      0      0     0     0       0
                                                          ++

                                       ---------------- NARRATIVE ----------------
DURING A CHECK FLIGHT THE RIGHT ENGINE DEVELOPED SEVERE VIBRATION AND WAS SHUT DOWN. THE CREW NOTICED FLAMES COMING FROM IT
AND SMOKE IN THE CARGO COMPARTMENT. THE ENGINE FAILURE WAS CAUSED BY FAILURE OF THE INTERMEDIATE TRANSMISSION SHAFT FRONT
BEARING. FOLLOWING A FORCED LANDING THE A/C WAS DESTROYED BY FIRE.
```

09/24/1992

NTSB Identification: **CHI92LA289** For details, refer to NTSB microfiche number **50976A**

Accident occurred SEP-24-92 at HUTCHINSON, KS
Aircraft: LEARJET LR-60, registration: N602LJ
Injuries: 4 Uninjured.

THE FLIGHT WAS ENGAGED IN A TEST FLIGHT THAT INVOLVED AN INTENTIONAL INDUCED AUTOPILOT MALFUNCTION AT 80 FEET ABOVE THE RUNWAY SURFACE. THE CREW IS REQUIRED TO DELAY RECOVERY FOR 2.0 SECONDS AND THEN RECOVER FROM THE MALFUNCTION. THE AIRCRAFT MADE A HARD LANDING DURING THE ATTEMPTED RECOVERY RESULTING IN SUBSTANTIAL DAMAGE TO THE AIRPLANE. THE MALFUNCTION INPUT WAS MADE BY AN AVIONICS ENGINEER IN THE AFT CABIN WHO DID NOT HAVE A READOUT OF RADAR ALTITUDE. THE COMPANY AND THE FEDERAL AVIATION ADMINISTRATION HAVE MODIFIED THEIR FLIGHT TEST GUIDANCE FOR LOW ALTITUDE INTENTIONAL MALFUNCTIONS SINCE THIS ACCIDENT.

Probable Cause

INADEQUATE FLIGHT TEST METHODS BY THE MANUFACTURER AND THE FAA WHICH DID NOT PERMIT SAFE OPERATING CLEARANCES.

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+--------------------------------------------- REQUEST 074/98, REPORT  19 --------------------------------------------+
+ DATA REPORT                                          LEARJET-60                                            ACCIDENT +
+ EVENTS¦PHASES                              HARD LANDING-LEVEL OFF/TOUCHDOWN                                         +
+---------------------------------------------------------------------------------------------------------------------+
                                                              ++
<----------------------- OPERATION ----------------------->  ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL            ++ ICAO FILE           :  92/0196-0
                                                              ++ FROM STATE          :  UNITED STATES
FINAL REP                                                     ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------->  ++ <--------------------- AIRCRAFT DATA -------------------->
DATE          :  92-09-24                                     ++ MASS CATEGORY       :  5701 - 27 000 KG
TIME          :  10:55                                        ++ STATE OF REGISTRY   :  UNITED STATES
LIGHT         :  DAYLIGHT                                     ++ REGISTRATION        :  N602LJ
GEN WEATHER   :  VMC                                          ++
                                                              ++
<------------------------ LOCATION ----------------------->  ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  HUTCHINSON,KS                                ++ A/C DAMAGE       :  SUBSTANTIAL
STATE/AREA    :  UNITED STATES                                ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  WICHITA,KS                                   ++ CREW   :      0      0      0     2     0       2
DESTINATION   :  HUTCHINSON,KS                                ++ PAX    :      0      0      0     0     0       0
                                                              ++
```

---------------- NARRATIVE ----------------

THE PROTOTYPE A/C LANDED HARD AFTER AN INTENTIONALLY INDUCED MALFUNCTION ON APP DURING A TEST FLIGHT.DRN: THIS WAS A TEST OF AN INTENTIONAL INDUCED AUTOPILOT MALFUNCTION AT 80 FT. THE CREW WAS REQUIRED TO DELAY RECOVERY FOR2 SEC AND THEN RECOVER. THE MALFUNCTION INPUT WAS MADE BY AN AVIONICS ENGINEER IN THE AFT CABIN WHO DID NOT KNOW THEALTITUDE. THE OPERATOR AND THE FAA HAVE MODIFIED THEIR GUIDANCE FOR LOW ALTITUDE INTENTIONAL MALFUNCTIONS.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   HARD LANDING - LEVEL OFF/TOUCHDOWN
           1.AUTOPILOT - FAILED/INTENTIONAL
              1.CAA - AIRWORTHINESS STAFF-ORDERS-INADEQUATE
```

++ REQUEST 140/94, REPORT # 219
++

+ DATA REPORT MISCELLANEOUS - EXPERIMENTAL ACCIDENT +

+ EVENTS | PHASES: HARD LANDING | LEVEL OFF/TOUCHDOWN +

+++

++

<--------------- OPERATION ---------------> ++ <--------------- FILE DATA ---------------

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 92/0196-0

++ FROM STATE : UNITED STATES

++

<------------------- WHEN -------------------> ++ <------------ AIRCRAFT DATA ------------

DATE : 92-09-24 ++ MASS CATEGORY :

TIME : 10:55 ++ STATE OF REGISTRY : UNITED STATES

LIGHT : DAYLIGHT ++ REGISTRATION : N602LJ

++

<------------------- WHERE -------------------> ++ <-------- DAMAGE, INJURY AND TOTAL ON BOARD -------->

LOCATION : HUTCHINSON,KS ++ A/C DAMAGE : SUBSTANTIAL

STATE/AREA : UNITED STATES ++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL

DEPARTED : WICHITA,KS ++ CREW : 0 0 0 2 0 2

DESTINATION : HUTCHINSON,KS ++ PAX : 0 0 0 0 0 0

OTHER DAMAGE : ++ GROUND : 0 0 0 0 0 0

THE PROTOTYPE A/C LANDED HARD AFTER AN INTENTIONALLY INDUCED MALFUNCTIO ON APP DURING A TEST FLIGHT.

---------------- EVENTS AND FACTORS ----------------

1. EVENT | PHASE: HARD LANDING | LEVEL OFF/TOUCHDOWN

10/06/1992

****

A/C Type	Operator	Regn	Location	Date	Occnum	P/Pub
JSTREAM 32	BAE	G -SUPR	PRESTWICK	6 OCT 92	9204093D	P

CAA Narrative:

UK REPORTABLE ACCIDENT : WING DROPPED AFTER TAKE-OFF - A/C CRASHED & CAUGHT FIRE. 2 POB, BOTH KILLED.
WHEN THE TAKE OFF BEGAN THE FIRST OFFICER WAS AWARE THAT IT WAS THE INTENTION OF THE COMMANDER TO GIVE A PRACTICE ENGINE FAILURE AT AN APPROPRIATE POINT. THE COMMANDER INITIATED THE SIMULATED ENGINE FAILURE AT A TIME WHEN CONTROL OF THE A/C HAD BEEN HANDED OVER TO THE FIRST OFFICER IN ACCORDANCE WITH NORMAL PROCEDURES. THEREAFTER THE A/C LEFT THE GROUND AND CLIMBED AT A GRADIENT SLIGHTLY STEEPER THAN USUAL WHILE THE LANDING GEAR REMAINED IN THE EXTENDED POSITION. ABOUT 10 SECONDS AFTER THE A/C WAS ROTATED THE COMMANDER REMINDED THE FIRST OFFICER FORCEFULLY ABOUT THE LANDING GEAR AND THE COMMANDER MADE THE "UP" SELECTION ON THE INSTRUCTION OF THE FIRST OFFICER TWO SECONDS LATER. AT THIS MOMENT THE LANDING GEAR WARNING HORN SOUNDED ALMOST SIMULTANEOUSLY WITH ONE OF THE STALL WARNING HORNS. WITHIN A FURTHER TWO SECONDS THE COMMANDER TOOK OVER THE CONTROLS OF THE A/C AND RESTORED POWER TO THE RETARDED ENGINE BUT THE A/C CONTINUED TO ROLL TO THE RIGHT UNTIL IT STRUCK THE GROUND INVERTED. THE TOTAL TIME FROM ROTATION UNTIL IMPACT WAS APPROXIMATELY 18 SECONDS. THERE WAS NO EVIDENCE OF A/C MALFUNCTION OR OF MEDICAL FACTORS WHICH MIGHT HAVE CAUSED OR CONTRIBUTED TO THE ACCIDENT. AAIB FIELD INVESTIGATION. FOUR SAFETY RECOMMENDATIONS RECEIVED CALLING FOR :1) A POSITVE REQUIREMENT FOR A FLIGHT TEST AFTER ANY FLIGHT IDLE ADJUSTMENT OR FUEL CONTROL UNIT (FCU) CHANGE AND THAT THE MM SHOULD EMPHASISE THE SIGNIFICANT DIFFERENCES BETWEEN THE FLIGHT IDLE FUEL FLOW SETTING FOR AN ENGINE FITTED WITH A DOWTY PROPELLER TO THAT OF A McCAULEY PROPELLER; 2) THE A/C MANUFACTURER TO MAKE EVERY EFFORT TO ENSURE THAT ALL OPERATORS OF JETSTREAM A/C CHECK THAT THEY HAVE CORRECTLY SET THE FLIGHT IDLE FUEL FLOWS; 3)THAT THE A/C MANUFACTURER REVIEW THEIR OPERATING MANUAL, FLIGHT MANUAL AND ASSOCIATED FLIGHT TRAINING PUBLICATIONS TO ENSURE THAT THEY REFLECT THE IMPORTANCE OF MAINTAINING AN ACCEPTABLE LEVEL OF FLIGHT IDLE TORQUE DURING ASYMMETRIC POWER FLIGHT TRAINING EXERCISES; 4) THAT THE CAA CONTINUE TO POSITIVELY ENCOURAGE THE DEVELOPMENT AND USE OF FLIGHT SIMULATORS RATHER THAN A/C FOR INITIAL AND RECURRENNT TRAINING IN ASYMMETRIC POWER EXERCISES ON ALL PUBLIC TRANSPORT AEROPLANES. CAA CLOSURE: FACTOR F3/94 PUBLISHED 26 JAN 94,

NUMBER OF DOCUMENTS : 1

AAIB Bulletin No: 11/93 Ref:EW/C92/10/2 Category: 1.1

Aircraft Type and Registration:	British Aerospace Jetstream 3202, G-SUPR
No & Type of Engines:	2 TPE 331-12UAR-704H turboprop engines
Year of Manufacture:	1991
Date & Time (UTC):	6 October 1992 at 1422 hrs
Location:	South side of Runway 13, Prestwick Airport
Type of Flight:	Private (Training)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - Fatal Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	5,210 hrs (of which 1,398 were on type)
Information Source:	AAIB Field Investigation

History of the Flight

The aircraft was operated by the manufacturer as a company demonstrator. On the day of the accident there was a requirement for the aircraft to be positioned from Prestwick to East Midlands Airport, in order that certain modifications could be carried out to the flight deck for development purposes.

It was decided that the flight could also be utilised to complete the flying exercises required for the renewal of the Certificate of Test in the first officer's Commercial Pilot's Licence. These exercises consisted of a take off with simulated failure of one engine between V1 (decision speed) and V2 (take-off safety speed), followed by a climb to circuit configuration, an ILS approach to Decision Height and go-around solely by reference to instruments, and an approach and full-stop landing, all with one engine simulated failed. It was planned that the first three items would be carried out at Prestwick, followed by the transit flight to East Midlands, where the last item of the test was to be completed.

It was known to be the standard practice for the commander to give a thorough pre-flight briefing prior to the conduct of a test. No witnesses were found who could confirm that such a briefing took place for this flight.

The departure time from Prestwick to East Midlands was planned to be 1420 hrs UTC, and a request was made for an ATC Approved Departure Time (ADT) during the morning. No evidence could be found from ATC Flow Control records of any ADT being allocated to the aircraft, and flow control was not in force on the aircraft's planned route around the time of the accident. However, the crew were under the impression that 1420 hrs was a firm ADT, and attempted to arrange their flight accordingly.

Information from the Cockpit Voice Recorder (CVR) provided the basis for constructing the history of flight and assisted in assessing the actions of the flight crew. The first officer entered the aircraft at approximately 1354 hrs, ahead of the commander, to commence the "Flight Deck Preparation" items of the aircraft checklist. He contacted the Prestwick Tower ATC controller by VHF radio and advised him of the aircraft's ADT, and of the intention to carry out one ILS approach and go-around prior to departure for East Midlands. Start clearance was given by ATC for the flight. The commander was seated on the flight deck some five minutes after the first officer, having completed the external inspection in accordance with normal practice. Witnesses indicated that the commander occupied the left seat.

The "Engine Start" checklist was read out by the commander, and responded to by the first officer. The first officer started both engines at 1400 hrs, and the "After Start" checklist was completed. Taxi clearance was obtained at 1404 hrs, the aircraft being initially cleared from the company apron area to the holding point 'T' on the north side of Runway 13. During taxi, the commander would have controlled the aircraft using the nosewheel steering handle on the left side of the flight deck. The first officer carried out the "Taxi" checklist items in conjunction with the commander, including the selection of 10° Flap for take off, and confirmation that the flap indication was correct on the flight deck gauge. It was also confirmed that the three flight control trim indications were correct for take off (normally neutral for the aileron and rudder trims, and within the "green band" take-off range for the elevator trim). The flying control gust lock lever was released, and all flying controls were checked for full and free movement. The stall protection systems were also confirmed to be selected 'ON' at this stage. Take-off speeds of 107 kt for V1 and Rotate speed VR, with 110 kt for V2, were confirmed by the crew. The commander gave a short take-off brief, stating that it would be the first officer handling the take off, with an engine failure between V1 and V2, and that the first officer should "fly the aeroplane". The first officer confirmed that he had understood the briefing.

At 1406 hrs, the aircraft was cleared by ATC to cross Runway 13 behind a departing aircraft, and to taxi along the parallel taxiway to the holding point 'J' at the western end of the airfield, so that a take off could be made using the whole of the available Runway length. The aircraft was photographed by a casual observer while approaching this holding point. These photographs confirm that the commander was occupying the left seat, that flaps were set at the take-off position, and that the elevator was fully down, indicating that the elevator gust lock was not engaged. The aircraft reached holding position 'J' at 1408 hrs, but was instructed by ATC to wait, pending other aircraft and the co-ordination of the flight into the traffic pattern.

There was little conversation between the two pilots during the waiting period, and at 1414 hrs the commander enquired as to what flight details the first officer had passed to ATC. The first officer responded that he had requested an ILS and go-around, and that the departure slot (ADT) had been communicated to ATC as 1420 hrs. (The ADT referred to the time that the aircraft would set course for East Midlands after completion of the ILS approach and go-around, therefore the aircraft would normally have had to be airborne several minutes prior to this time in order to complete the positioning for and conduct of the ILS approach). There was then some discussion between the two pilots as to how much leeway was available on the ADT. At 1415 hrs, the commander contacted ATC to say that if the ILS approach was going to cause the flight to be delayed further at Prestwick, then he was prepared to cancel it and continue in accordance with the ADT for the flight direct to East Midlands. In response to this, ATC passed departure instructions to the aircraft, giving a heading and altitude to achieve after take off in order to carry out the local flying, along with a radar transponder code. However, due to the amount of traffic around the airfield, the aircraft was not cleared to line up on Runway 13 until 1420 hrs. No revision to the take-off brief was made by either crew member.

A minor revision to the departure instructions was passed by ATC as the aircraft lined up on the Runway, and the "Runway" checklist items were completed, with the exception of the Torque/Temperature Limiter test. This is required to be carried out on the first flight of each day, but was declined by the commander, probably in the interests of expediency. Once the aircraft was lined up on the Runway, the commander passed control to the first officer.

Just prior to 1422 hrs, ATC cleared the aircraft for take off. The first officer applied the power, and 100% RPM was confirmed by the commander, along with the fact that all warning lights on the Central Annunciator Panel (CAP) were extinguished. Confirmation that full power (100% torque) on both engines had been achieved was given by the commander, and that the air speed indications were rising on both instruments. At the 70 kt speed cross-check, the first officer took control of the aircraft steering (aerodynamic directional control through the rudder pedals). At this point, the commander relinquished control of the nosewheel steering handle, and took control of the power levers. The take off proceeded normally, the commander calling "V1, Rotate" as the aircraft apparently achieved the appropriate speed. The first officer responded that he was rotating. The procedures set out in the Company Manufacturer's Operating Manual defining crew duties were adhered to up to this point.

Between approximately 6 and 10 seconds after the "V1, Rotate" call the first officer stated with considerable hesitation "OK....it's the...ah...left engine..." but was interrupted by the commander who reminded him forcefully about the landing gear. The first officer immediately responded with a call for the landing gear to be retracted and, almost coincident with the start of the landing gear retraction sequence (evidenced by the landing gear warning horn sounding), the audible stall warning system activated. The commander quickly took over the flying controls, which was acknowledged by the first officer. The landing gear warning horn ceased sounding after approximately 2 seconds, apparently as the commander advanced the power lever which had been retarded, but he was unable to maintain or regain control of the aircraft.

There were many eyewitnesses to the aircraft's final flight path, including the personnel in the ATC Control Tower Visual Control Room and several Qualified Flying Instructors from the Flying College on the airfield. The aircraft was also observed from a point just after becoming airborne by several personnel employed by the aircraft's manufacturer, from the offices adjacent to the north side of the Runway. Witness statements which described the final flight path produced a range of perceived pitch attitudes and heights to which the aircraft climbed above the runway. A review of these statements suggested that the aircraft had initially attained a somewhat higher pitch attitude than those observed in the normal course of Jetstream take offs at Prestwick, and had climbed to a height of approximately 150 feet above the runway. Witnesses further along the Runway were sure that the aircraft had not yawed significantly after lift-off. All were in agreement that the aircraft began to bank smoothly to the right. The landing gear was observed to start retraction only after the aircraft had attained a significant bank angle. The aircraft continued to climb and to bank beyond the wings vertical attitude. It then began to lose height and to pitch such that it impacted the ground in a steep nose down and almost inverted attitude some 18 seconds after the initiation of rotation. It slid along the ground briefly with the fuselage pitching towards an almost vertical attitude, and erupted in a large fireball. The emergency services were quickly at the scene to extinguish the fire, but both occupants had sustained fatal impact injuries.

One radar return was received from the aircraft by the Lowther Hill Radar site, which gave a altitude indication of 100 feet amsl, positioned over the Runway. The sweep period of the station was approximately 5.5 seconds, and the single return was timed at approximately 1422 hrs and 15 seconds. Altitude resolution on this system is to the nearest 100 feet increment.

The Met observation, taken just after the accident, gave the surface wind as 060°/8 kt, visibility 30 km, no significant weather or low cloud, temperature +13°C, QNH 1027 mb, QFE 1024 mb. The threshold elevation of Runway 13 is 38 feet amsl, and the airfield elevation is 66 feet amsl. An aftercast obtained from the Met Office indicated that the wind at 1,000 feet was 050°/10 kt.

Prior to the flight, the aircraft was loaded with full fuel, giving a take-off weight of 6,444 kg, and a centre of gravity of 5.557 metres, both of which were within the permitted envelope. The corresponding take-off speeds were checked, and were found to be within 1 kt of those calculated by the crew.

For the actual take-off weight and the ambient conditions at the time of the accident, the following data was extracted from the Aircraft Flight Manual (AFM):

Take-off (Flap 10°) Minimum Control speed in the Air (Vmca):	99 kt IAS
Stall Warning Speed (Flight Idle Power):	101 kt IAS
Stick Pusher Activation Speed (Flight Idle Power):	92 kt IAS
Minimum Speed in the Stall (Vms) (Zero Thrust):	92 kt (Zero Bank) EAS
	94 kt (20° Bank) EAS
	104 kt (40° Bank) EAS
	128 kt (60° Bank) EAS

The figures quoted with bank assume a co-ordinated turn. No data is presented in the AFM to indicate the reduction in stall warning speed or stall identification speed with values of torque above the Flight Idle setting, for the Flap 10° take-off configuration.

The V2 speed used in G-SUPR was almost coincident with a factor of 1.2 x the minimum speed in the stall (Vms), and 1.1 x the take-off minimum control speed in the air (Vmca). This is consistent with the requirement to utilise a V2 which is equal to the greater of these two calculated speeds.

The AFM states that failure of the right engine gives the more adverse effect on the handling and performance characteristics of the aircraft during take off (critical engine). The handling techniques and the scheduled performance in the AFM are based on this case.

The engines and propellers on Jetstream 31/32 aircraft operate at a selected constant RPM, the normal take-off setting being 100% RPM indicated on the flight deck, which equates to 1,591 RPM at the propeller, and 41,730 RPM at the engine. The power settings (Torques) used in flight are achieved by variation of the propeller blade angles, rather than any significant change in engine rotational speed.

The lowest available power setting in flight is with the power lever in the flight idle position, and unintentional movement of either power lever below this position is prevented by a physical latch mechanism. Any movement of either power lever below the flight idle position into the ground (Beta) range while the aircraft is in flight will result in a high pitch audio warning tone on the flight deck. No such warning was evident during the accident flight.

Crew Details

The commander held an Airline Transport Pilot's Licence and had a total of 5,210 hrs flying experience, of which 1,398 hrs was on Jetstream aircraft. He was a CAA Type Rating Examiner on the Jetstream 31/32, and was also a Training Captain on the Jetstream 41 aircraft, having around 170 hours total training flight time on all Jetstream variants. During the month prior to the accident, he had carried out flight training for overseas customers on the Jetstream 32. His last previous Certificate of Test renewal examination on a UK pilot was conducted on 25 September. Jetstream 41 flight training was also interspersed during this period. There are significant differences between the handling characteristics of the Jetstream 31/32 series, and those of the Jetstream 41.

The first officer held a Commercial Pilot's Licence and had a total of 1,798 hrs flying experience, of which 912 hrs was on Jetstream aircraft. He had previously undertaken a Certificate of Test and Instrument Rating renewal flight on 9 April 1992, with satisfactory results. It was also established that he had the opportunity to practice a simulated engine failure after take off on 25 July 1992, while accompanied by another Training Captain. On that occasion, he had dealt with directional control satisfactorily after the simulated failure, but did allow the airspeed to exceed V2 by some 20 kt on that occasion. (It is normal practice, on this type of aircraft, to maintain the airspeed at or just above V2, in order to achieve the scheduled climb performance on one engine). The remainder of the procedures were carried out satisfactorily, and the relevant points from the exercise were debriefed accordingly. No record has been found to indicate that any further refresher training of this type was carried out prior to the accident flight.

No pilot training records were kept by the company relating to performance during initial or refresher training or periodic flight checks.

Wreckage and Impact Information

The aircraft impacted a disused taxiway in an inverted attitude and on a track of 180°M (aircraft heading 196°M), the initial impact being by the right wingtip and upper nose fuselage area. This was followed by the aircraft rolling to the right, which resulted in the left wing impacting the taxiway and the fuselage going into an almost vertical position whilst the whole wreckage slid on its forward fuselage for some 240 feet before coming to rest. Both wing fuel tanks ruptured at the initial impact point and an intense fuel fire started almost immediately. This fire continued to burn for some minutes after the aircraft came to rest.

Examination of the wreckage at the accident site showed that at impact the aircraft was structurally complete and that all the flying control surfaces were attached and functional. The wing flaps were set at the take-off position (extended to 10°), the main landing gears were retracted and locked, and the nose landing gear was retracted but unlocked. Both propeller hubs had shattered at the initial impact which caused the propeller blades and the internal hub mechanisms to be thrown with considerable energy in various directions.

Subsequent detailed examinations were conducted at AAIB Farnborough and component manufacturer's facilities. All flying, engine and propeller control systems were examined for evidence of pre-impact failure or restriction. None was found, although due to post-impact disruption a 100% check on any control restrictions could not be carried out. The three control surface trim positions as indicated in the cockpit at the trim wheels, and at the flying control surface trim actuators, were examined to determine the trim positions that were set at impact, but again due to post-impact disruption no reliable pre-impact trim positions could be established. The three flying control surface ground gust lock systems were examined in detail and positive evidence was found to show that they were disengaged at impact.

Both propeller governors were taken to the manufacturer in the USA for examination and functional testing. Both were found to be in a serviceable condition. The propeller blades and hubs were reconstructed at the propeller manufacturer's facility in the USA, but the extent of the disintegration of both hubs prevented accurate assessment of the blade angles at impact. From this examination it was concluded that: the damage to the blades was as a result of the impact and that there was no indication of any failure prior to the impact; both propellers were operating under high power and RPM at impact; and neither propeller was in reverse pitch or feather position at impact. Exact blade angles of each propeller at impact were not determined, however based on various witness marks within the propeller mechanisms, it is estimated that both propellers were operating within the range of 25 to 35° of pitch at the 30 inches reference station.

Analysis of the bulb filaments in the CAP panel, and glareshield Stall Identification lights, indicated that at impact all the bulbs except those from the right Stall Identification caption were off. The filaments of both bulbs from the right Stall Identification caption showed classic evidence of being hot (bulbs illuminated) at the moment of impact. The stick push hydraulic actuator was undamaged by the impact and post impact fire. Examination of the actuator's ram showed that the stick push system had not been in operation at impact. It was not possible to establish by examination of the stick shake mechanism whether this had been operating at impact.

Both pilots' seats and their adjustment mechanisms were examined for positioning and serviceability at impact. Both seat adjustment mechanisms were found to be in a serviceable condition. The commander's seat was found to be at the fully rearward fore/aft position, with the height adjustment at the minimum seat height position. The first officer's seat was found to be just to the rear of the mid fore/aft position, with the height adjustment at the minimum seat height position.

Flight Data Recorder (FDR)

The FDR was of no assistance in the investigation of this accident. As a result of a previous internal failure, it did not contain any data relating to the accident flight.

The recorder was a Loral Fairchild Model F1000 Solid State Flight Data Recorder (SSFDR), serial number No. 00320. This recorder uses semiconductor memory technology in the form of Electrically Erasable and Programmable Read Only Memory (EEPROM). The specific type of EEPROM is known as "Flash" memory, the term Flash is used to indicate that the memory can be erased in a flash.

The SSFDR was connected to the AAIB replay facilities and the contents of the memory module downloaded. Data is held in memory module in a compressed form. Before it can be interpreted it must be de-compressed and then reduced to engineering values. Examination of the SSFDR data in engineering values revealed that data from the accident flight had not been recorded. The data that was present was compared with information on previous flights obtained from the aircraft's technical log, and it was discovered that the last recorded data related to flights that had taken place in late March and early April 1992.

The SSFDR was taken to the Loral Fairchild factory in Sarasota, Florida, USA where it was discovered that a semiconductor device with the function of providing an electrical supply to memory devices had failed. It was further shown that this fault activated the fault circuits within the SSFDR and that the SSFDR "FDR FAIL" lamp on the flight deck should have illuminated.

In conjunction with British Aerospace personnel, the drawings for the SSFDR installation were examined and it was apparent that the SSFDR fault alert signal was incorrectly wired, and that a fault in the SSFDR could not illuminate the flight deck SSFDR "FDR FAIL" lamp.

An Alert Service Bulletin, with CAA Mandatory status, has already been issued by the aircraft manufacturer in order to correct the wiring defect in all aircraft fitted with this system.

Cockpit Voice Recorder (CVR)

The CVR recording was of 30 minutes duration. The track allocation was as follows:

Track 1	First Officer's microphone
Track 2	Cockpit area microphone
Track 3	Not used
Track 4	Commander's microphone

The initial part of the recording was fragmented (due to aircraft electrical power interruptions), and contained conversation between the engineers conducting the pre-flight inspection of the aircraft. Continuous recording then commenced when the first officer entered the flight deck and switched on the electrical power. The commander was heard to enter the flight deck and the crew began working through the "Flight Deck Preparation" checklist. The history of the flight detailed above was compiled with reference to the recording, and no other technical or operational problems were discussed by the crew.

After achieving V1, and at the end of the first officer's response of "Rotating", there was a click audible on the CVR. It is possible that this noise might have been made by one of the power levers striking the Flight Idle (FI) baulk when it was retarded, but it was not possible to confirm this from the CVR analysis of subsequent flights in other aircraft. An analysis of the CVR recording was made to ascertain if it was possible to determine which power lever was retarded on take off to simulate the engine failure. This involved using CVR recordings from other Jetstream aircraft undertaking the same exercise, but it was not possible using the CVR recording alone to determine conclusively which power lever was retarded.

Stall Protection System

The aircraft was fitted with the enhanced Jetstream 32 Stall Protection System. This comprises two stall warning systems (stick shakers and horns) and one automatic stall recovery (stick pusher) system. The stall warning systems give separate warnings for the left and right wings. Two airflow angles of attack are sensed by the stall warning vane mounted on the leading edge of each wing. The first is the stall warning angle, which activates the control column stick shaker and stall warning horn if either wing stall warning angle is reached. If the wing angle of attack continues to increase, and the stall identification angle is sensed, the appropriate stall identification red light is illuminated on the glareshield in front of each pilot. If both wings achieve the stall identification angle, both glareshield lights illuminate and an hydraulically powered stick pusher operates to move the elevator to approximately 8° nose down, and thus reduce the angle of attack. The stick push is stopped when either wing returns to the stall warning range. It is possible to cancel a stick push by pressing one of the illuminated stall identification captions which then causes the amber 'STALL' caption on the CAP to illuminate. Stick push is automatically cancelled if the aircraft pitches down and results in an acceleration of less than 0.5g absolute. A pull force of more than 80 lb applied to the pilot's control column will also override the stick push.

Failure of the stall protection system is signalled to the crew by illumination of the appropriate amber 'STALL' caption on the CAP, which would also be illuminated if the system is selected 'OFF'.

Landing Gear

From the production flight test report on G-SUPR, the time taken to complete the Landing Gear retraction sequence was 6-7 seconds. The nose landing gear doors on Jetstream 31/32 aircraft initially open during the retraction sequence, before closing over the retracting leg. The effect of this on an aircraft subjected to sideslip at the time of retraction was measured during the post accident flight test programme, and was found to be of the order of a 3° increment in that sideslip for the duration of the retraction.

The landing gear warning horn fitted to Jetstream 32 aircraft will sound if any gear leg is not locked down (or the landing gear is selected up), AND either power lever is near FI (or the flaps are selected to 20° or more). If either power lever is pulled back to FI, the horn operation may be cancelled by pressing the 'Landing Gear Horn Cancel' switch on the lower centre panel on the flight deck.

Aircraft History

G-SUPR, aircraft serial number 956, made its first flight on 15th December 1991. After the standard production aircraft test programme, it was ferried to East Midlands Airport for finishing and painting. This was completed, and the aircraft returned to Prestwick on 16 February 1992. Three further test flights were then carried out at Prestwick in order to gain the initial Certificate of Airworthiness (Private Category), which was achieved on 18th February 1992. The aircraft departed during the next day for a company demonstration tour to the Far East.

After a flight on 7 March 1992, from Brunei to Manila, the aircraft technical log indicated that the right engine had "overfuelled in flight". As a result, the Fuel Control Unit (FCU) on the right engine was changed. Engine ground runs were then carried out, and adjustments were made to the FI and maximum fuel flow adjusters in the FCU. No evidence could be found that a flight test was subsequently carried out to establish that the FI fuel flow setting was correct. Although it was the aircraft manufacturer's standard practice to carry out such a flight test after an FCU change, none was required in the Aircraft Flight/Maintenance Manual or the Engine Maintenance Manual, except if the engine had been torque limited which was not applicable in this case.

The replacement FCU had been removed from a spare 'new' engine, and had been part of that engine's equipment during the engine manufacturer's test runs prior to its release to service. During these pre-release test runs the FI and maximum fuel flow adjusters in the FCU had been altered.

After this change of FCU, the aircraft had flown approximately 318 hours, and made over 300 landings, without adverse comment on the engine FI fuel flow setting. During this period, it had been flown by at least 12 company pilots. This included 7 days of flight training, with company Type Rating Examiners carrying out some 35 landings, all without adverse comment. No records were available to indicate whether the aircraft had carried out any engine failure after take-off simulations prior to the accident flight.

On two occasions, 16 April and 22 June 1992, the aircraft technical log indicated that the right engine had been slow to reach target torque on take off. Adjustments to the propeller governor had been carried out in response to these reports, and there were no further recurrences of the problem recorded in the technical log.

Prior to the accident, the aircraft had visited the USA, departing Prestwick on the 18 September and returning on the 30 September 1992, with no significant recorded defects. It did not then fly again until the accident flight.

US Operator Training Flight Incident

Some five weeks after this accident it came to the knowledge of the manufacturer that a Jetstream 32, belonging to an overseas operator, had experienced handling problems while undertaking a training flight involving simulation of engine failure after take off. Even though the correct airspeeds were apparently being adhered to, the aircraft became difficult to control directionally, and the commander had to take over and regain control by applying power on the "failed" engine. The exercise was repeated several times to confirm that there was something unusual about the handling of that particular aircraft. The manufacturer further established that it was the standard practice of this operator's instructors to select the power lever to the FI stop despite the manufacturer's recommendations to set 10% torque when practising engine failure on take off. Furthermore, it was not the normal practice of this operator to carry out a flight test following FI fuel flow adjustments.

The manufacturer informed the AAIB of this incident and to investigate further, a pilot and a flight test engineer from the manufacturer visited the operator to assess the aircraft involved. They discovered that the right engine, which had been operating at FI power during the exercises, had an unusually low FI fuel flow setting, resulting in an indicated in flight FI torque of 0% (the manufacturer's recommended minimum FI torque is 8%), and the handling difficulties were able to be confirmed. In addition the left engine was also found to exhibit a lower than normal value of FI torque. Once the

FCU's had been correctly adjusted so that the minimum recommended flight idle torque now coincided with the FI stop, there were no further problems with the asymmetric power handling of that aircraft.

G-SUPR Engine/FCU Investigation

Both engine FCU's and P2/T2 Sensing Units were taken to the manufacturer in the USA for examination and functional testing. The left engine FCU was relatively undamaged and, after a locally manufactured adapter was fitted, it was connected to a functional test facility and put through the manufacturer's test schedule. The unit performed satisfactorily for an in-service item, and had a FI fuel flow of 251 to 268 lb per hour. The right engine FCU had suffered more damage than the left, the significant damage being to the fuel flow adjustment lever and the rear casing. As with the left engine FCU, after a locally manufactured adapter was fitted, it was connected to a functional test facility and put through the manufacturer's test schedule. The unit performed satisfactorily for an in-service item, except for the fuel flows - specifically the FI fuel flow which was extremely low, of the order of 210 lb per hour. The evidence very strongly suggested that this was as a result of the impact damage to the unit. It was not possible to determine by test the pre-impact FI fuel flow. Inspection of the FI fuel flow adjuster inside the unit indicated that it had been adjusted by one 'click' in the increase sense from that set at manufacture. Inspection of the manufacturers pre-release test results for this unit showed that the FI fuel flow was 232 lb per hour, and one 'click' was 2 lb per hour, which indicated that the pre-impact FI fuel flow for this unit may have been in the order of 234 lb per hour. A variation of FI fuel flow of 2 lb per hour produces a change of flight idle torque of approximately 1%.

This model of Jetstream aircraft may be fitted with either the McCauley or the Dowty propeller, utilising the same engine and FCU. The FI fuel flows, as measured on several production aircraft flight tests, which are required to achieve the correct FI rates of decent and Torques are of the order of 240 lb per hour for the McCauley propeller, and 220 lb per hour for the Dowty propeller.

It could not therefore be shown conclusively that the right engine had the correct FI fuel flow setting at the time of the accident, although the evidence suggested that it might have been set marginally lower than the optimum setting. However, the amount of flying undertaken after the right engine FCU change, without adverse comment by a number of company test pilots and training captains, would suggest that the in flight FI fuel flow setting was not markedly below the normal value.

Flight Test Programme

In order to understand the effects of low FI fuel flow settings on the aircraft performance and handling, a joint test programme was devised by the aircraft manufacturer and the AAIB. A standard production Jetstream 32 fitted with a baggage pod and McCauley propellers, to make it as identical as possible to the accident aircraft, was specially instrumented to record various engine, fuel flow and handling parameters. A series of flights was undertaken, progressively reducing the values of FI fuel flow for each engine, and assessing the effects on performance and handling characteristics.

The results of these tests show that the zero thrust condition for the McCauley propeller on the Jetstream 32 is around 8 to 11% torque, depending on aircraft configuration. It was also shown that, at FI torque settings lower than the correct 8% to 11%, the McCauley propeller produces progressively more negative thrust (drag), at the airspeeds associated with take off, approach and landing, which is significantly greater than the small drag produced by a failed engine, and that there is an associated degradation in the handling and performance of the aircraft. It was also apparent that the practice of setting up the FI fuel flow on the ground, without carrying out an associated flight test on each occasion, was not a reliable method of achieving a correct FI fuel flow setting.

Performance Data

The manufacturer provided the following data from the net take-off performance charts from the UK CAA AFM, for the Jetstream 32 (equipped with McCauley propellers), for the conditions prevailing at the time of the accident:

Take-off distance required : (to 35 feet agl, one engine failed)	1,170 metres
First segment climb gradient : (Flap 10°, gear down, one engine failed)	2.1 % (234 feet/min at V2)
Second segment climb gradient : (Flap 10°, gear up, one engine failed)	4.5 % (500 feet/min at V2)

From the initiation of rotation to initial stall warning was approximately 12 seconds, and the aircraft impacted the ground abeam a point approximately 1,200 metres along the Runway. A normal initial rate of rotation would be of the order of 3°/second. At a 2.0% climb gradient, over the time taken, the aircraft would have been expected to climb less than 47 feet, and witnesses clearly indicated that the aircraft was higher than this, using the wing semi-span of 26 feet as a guide.

Data obtained during the flight test programme described above indicated that when pitched up to an attitude of 10° nose up, with the gear down, the aircraft typically decelerated at a rate of between 1.0 and 1.5 kt/second. The amount by which the aircraft climbed during this period was dependant upon the FI Torque setting. At normal FI setting, the aircraft climbed some 200 feet, while decelerating from V2 to stall warning speed. With the FI Torque of 6%, the aircraft climbed some 120 feet for the same loss of airspeed. The margin between V2 and the stall warning speed was 9 kt, and between V2 and Vmca was 11 kt.

Standard Operating Procedures

The following extract is taken from the Manufacturer's Operating Manual, Part 1, Section 16, Flight Guide, relating to Abnormal Handling, Engine Failure After V1:

If an engine failure occurs after V1, the take-off should be continued, accelerating to V2 for the climb.

The landing gear must be retracted as soon as the aircraft is safely airborne.

Directional control should be maintained by full use of rudder. Aileron may be used, if required, to maintain up to 5° bank towards the live engine.

Best Performance is gained by accurate speed control and gentle control movements to keep the correct attitude.

When established in a steady climb, positively identify the failed engine and carry out the appropriate feathering drill.

At a height of 500 feet above the runway and when obstacle clearance is certain, the aircraft should be accelerated to the required en-route climb speed and the flaps retracted.

If engine failure occurs above V2 the higher speed can be maintained provided obstacle clearance can be achieved.

Note: During training, the training captain may simulate engine failure on take-off by retarding a power lever to 10% torque which simulates the zero thrust condition.

The diagram produced to illustrate this exercise is reproduced at Figure 1.

The Civil Aviation Authority publishes a Pink (safety related) Information Circular entitled "Guidance to Training Captains - Simulation of Engine Failure in Aeroplanes". The circular was re-issued as AIC103/1992 on the 12th November 1992, after this accident. The following extracts are taken from the AIC:

Section 3. In-Flight Procedures

3.2 Immediately before failure is simulated, the Training Captain must position his feet so that he can prevent any application of wrong rudder by the trainee. During and after the simulation he must be particularly vigilant in monitoring heading, pitch and roll attitude, rudder position and yaw indication. He must also carefully monitor engine instruments especially on those types of aeroplane in which a genuine failure of the idling engine would produce an abnormal hazard. He must ensure that any recommended bank angle is correctly applied and after ensuring safe initial rudder application he should monitor the trainee's rudder input by resting his feet lightly on the rudder pedals. He should bring to the trainee's attention any tendency for flight parameters to move significantly from their target values.

Section 6. Recommended Techniques for Simulating Engine Failure on Take-off

6.2 Turbo-prop Engines

6.2.1 The simulation of engine failure by throttling back can introduce particular handling and performance problems. The primary problem arises from the fact that a turbo-prop engine which has been throttled back to flight idle will produce very much more drag than an engine which has failed and auto-feathered. A further problem is that any automatic feathering or drag limiting devices fitted are usually made inoperative when the throttle is closed. Consequently, if an engine which has been throttled back to simulate failure suffers a real failure, it may go to a very high drag 'windmilling' condition, remaining unfeathered unless correct feathering action is taken by the crew. Furthermore, because the engine is in a low power condition, failure may not be noticed until after severe handling difficulties have arisen.

6.2.2 There will also be a reduction in performance which may well lead to decay in airspeed and an inability to maintain adequate clearance over obstacles. Any such loss in airspeed can of course contribute to the loss of directional control.

6.2.3 These potential problems can best be avoided by appropriate methods of simulating engine failure. Advice from engine or aircraft manufacturers specific to type should be followed but where this is lacking the following general advice is likely to be appropriate:

(a) On aircraft equipped with auto-feather, the throttle should be moved smoothly towards the closed position until a pre-determined torque reading, approximating zero thrust, is obtained. In this condition the Flight Manual speeds and performance - which are based on a feathered engine - will be valid and the handling qualities will match a real failure situation. The torque meter should be monitored during the remainder of the take-off and initial climb and if the torque falls the throttle should be opened fully;

(b) on aircraft not equipped with auto-feather the throttle may be moved smoothly to the closed position because an actual failure of the idling engine does not present an abnormal hazard. When the trainee has identified the 'failed' engine and completed the 'touch only' feathering drill the throttle should be advanced to a zero thrust setting.

Note: The engines on Jetstream 31/32 aircraft are fitted with a Negative Torque Sensing system, intended to drive the propeller blades most of the way towards the feathered position in the event of a real engine failure.

Flight Deck Management

One of the most significant differences between the testing of a crew member with a simulated failure and any actual engine failure on take off event is in the area of two crew co-operation. In the (very rare) real event of an engine failure during take off and initial climb, both flight deck crew would work together as a team, to ensure that the correct drills were applied in a timely manner, and indeed current multi-crew Flight Deck Management training is intended to enhance such behaviour. In the testing environment, however, where the event is being simulated in an aircraft in flight, the current standard practices laid down by the CAA require that the Training Captain should generally act only upon the command of the pilot under test. In effect, he should undertake the duties of the non-handling pilot, but without exercising any personal initiative. At the same time he must be aware of and anticipate any possible mishandling, while adjusting the power output of the simulated failed engine to the recommended setting. The Training Captain must assess the capabilities of the pilot under test, and his ability to correct any deteriorating situation. It is thus left to the Training Captain to decide at what point to intervene and take over control in the event that the procedures or handling techniques are not achieving the desired result. The flight test is therefore conducted under the simultaneous influences of "single pilot" and "multi-crew" philosophies, which results in a fine dividing line between the requirements of crew co-operation and the conduct of the test.

Summary of the accident

When the take off began the first officer was aware that it was the intention of the commander to give him a practise engine failure at an appropriate point. The commander initiated the simulated engine failure at a time when control of the aircraft had been handed over to the first officer in accordance with normal procedures. Thereafter the aircraft left the ground and climbed at a gradient slightly steeper than usual while the landing gear remained in the extended position. About 10 seconds after the aircraft was rotated the commander reminded the first officer forcefully about the landing gear and the commander made the UP selection on the instruction of the first officer 2 seconds later. At this moment the landing gear warning horn sounded almost simultaneously with one of the stall warning horns. Within a further 2 seconds the commander took over the controls of the aircraft and restored power to the retarded engine but the aircraft continued to roll to the right until it struck the ground inverted. The total time from rotation until impact was approximately 18 seconds.

There was no evidence of aircraft malfunction or of medical factors which might have caused or contributed to the accident.

Safety Recommendations

93-53 It is recommended that British Aerospace (Jetstream Aircraft Ltd.) incorporate into the Maintenance Manual, for Jetstream 32 aircraft, a positive requirement for a flight test after any Flight Idle adjustment or FCU change. The Maintenance Manual and associated publications should emphasise the fact that there are significant differences between the Flight Idle fuel flow setting for an engine fitted with a Dowty propeller and that for a McCauley propeller. The FCU's in both cases have the same component part numbers, and it should be clearly stated that the correct adjustment techniques should be utilised. (Issued 17 September 1993)

93-54 It is recommended that British Aerospace (Jetstream Aircraft Ltd.) make every effort to ensure that all operators of Jetstream 32 aircraft check that they have correctly set the Flight Idle fuel flows on all their aircraft. Operators, pilots and engineers should be informed by means of Newsletter, Service Bulletin and Flight Safety Publications, of the possible effects of incorrectly adjusted Flight Idle fuel flows on aircraft handling and performance, especially when conducting simulated single engine training or testing. (Issued 17 September 1993)

93-55 It is recommended that British Aerospace (Jetstream Aircraft Ltd.) review their Manufacturer's Operating Manual, Aircraft Flight Manual and associated flight training publications, to ensure that they reflect the importance of maintaining an acceptable level of Flight Idle torque during asymmetric power flight training exercises. The associated briefing material should also be reviewed, in order to ensure that all pilots are aware of the possible adverse effects of incorrect Flight Idle power settings on aircraft handling and performance characteristics, especially those associated with McCauley propeller equipped Jetstream 32 aircraft. These effects, and their prevention, should be clearly noted as guidance to Training Captains in the appropriate section of the Manufacturer's Operating Manuals. The review should also consider, in consultation with the Civil Aviation Authority, the possible benefits of applying increased safety margins to the aircraft speeds associated with these exercises. (Issued 17 September 1993)

93-56 In view of the relatively high proportion of accidents and incidents associated with the training and testing of pilots under conditions of simulated asymmetric power, as compared with those occurring as a result of any real engine failure on take-off and initial climb, it is recommended that the Civil Aviation Authority continue to positively encourage the development and use of flight simulators, rather than aircraft, for initial and recurrent training in asymmetric power exercises, on all Public Transport Aeroplanes classified as Aeroplanes of Performance Group A in their Certificates of Airworthiness. (Issued 17 September 1993)

10/13/1992

10/13/92

AviationSafetyNetwork

Accident Description

Home
- sign guestbook
- view guestbook
- editorial
- what's new?

Accident reports
Accident specials
CVR / FDR
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Pictures
Publications
Safety issues
Statistics

Forum
E-mail
About ASN

Accident description

Date: 13.10.1992
Type: Antonov 124-100
Operator: Aeroflot / Aviastar ?
Registration: SSSR-82002
C/n: 19530501003
Year built:
Crew: 8 fatalities / 9 on board
Passengers: 0 fatalities / 0 on board
Total: 8 fatalities / 9 on board
Location: Kiev (Ukraine)
Phase: Descent
Nature: Test
Flight: - (Flightnumber)

Remarks:
The Antonov freighter was in a high-speed descent (part of a special test flight) when the upward-hinged nose door broke loose, causing the aircraft to lose control. The aircraft crashed in a forest.

Source:
S161+S162+ST94

[disclaimer]


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+-------------------------------------------- REQUEST 074/98, REPORT  20 ------------------------------------------+
+ UNOFFICIAL REPORT                               ANTONOV-AN-124                                            ACCIDENT +
+ EVENTS|PHASES                            AIRFRAME FAILURE-MANOEUVRING                                            +
+                                  COLLISION WITH TERRAIN-EMERGENCY/UNCONTROLLED DESCENT                           +
+----------------------------------------------------------------------------------------------------------------+
                                                          ++
<----------------------- OPERATION -----------------------> ++ <--------------------- FILE DATA --------------------->
TYPE         :  MISCELLANEOUS - TEST/EXPERIMENTAL           ++ ICAO FILE          :  92/0456-0
                                                            ++ FROM STATE         :  USSR
FINAL REP                                                   ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA ------------------->
DATE         :  92-10-13                                    ++ MASS CATEGORY      :  ABOVE 272 000 KG
TIME         :  00:00                                       ++ STATE OF REGISTRY  :  USSR
LIGHT        :                                              ++ REGISTRATION       :  CCCP-82002
GEN WEATHER  :                                              ++
                                                            ++
<------------------------ LOCATION -----------------------> ++ <---------- DAMAGE, INJURY AND TOTAL ON BOARD ---------->
LOCATION     :  NR. KIEV                                    ++ A/C DAMAGE         :  DESTROYED
STATE/AREA   :  UKRAINE                                     ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED     :                                              ++ CREW   :      8      0      0    0      1      9
DESTINATION  :                                              ++ PAX    :      0      0      0    0      0      0
                                                            ++
```

---------------- NARRATIVE ----------------

AIRCLAIMS: THE AIRCRAFT WAS DESTROYED WHEN IT CRASHED NEAR KIEV DURING A TEST FLIGHT. THE ACCIDENT OCCURRED WHILE THE ANTONOV WAS BEING USED TO EXPLORE 'EXTREME FLIGHT REGIMES', APPARENTLY BEYOND THE NORMAL FLIGHT ENVELOPE. ACCORDING TO REPORTS, DURING A CONTROLLED HIGH SPEED DESCENT IT IS BELIEVED THAT THE AIRCRAFT'S NOSE CARGO DOOR BEGAN TO BREAK AWAY. THE REPORTS SUGGEST THAT THE CREW WERE INITIALLY ABLE TO MAINTAIN CONTROL AS IT IS SAID THAT AN ATTEMPT WAS MADE TO CARRY OUT AN EMERGENCY LANDING. HOWEVER, THE AIRCRAFT CRASHED IN WOODS 30 MILES FROM THE AIRFIELD. (KIEV MANUFACTURING PLANT)

12/14/1992

12/14/92

+--- REQUEST 074/98, REPORT 22 ---+

+ DATA REPORT — DORNIER-328 — ACCIDENT +

+ EVENTS|PHASES — LOSS OF CONTROL-EN-ROUTE +

PROPELLER SEPARATION-EN-ROUTE

PROPELLER/ROTOR/JET BLAST DAMAGE-EN-ROUTE

OPERATION

TYPE	:	MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE	:	92/0162-0
FROM STATE	:	GERMANY

DATE, TIME AND METEOROLOGICAL DATA

DATE	:	92-12-14
TIME	:	11:49
LIGHT	:	DAYLIGHT
GEN WEATHER	:	VMC

AIRCRAFT DATA

MASS CATEGORY	:	5701 - 27 000 KG
STATE OF REGISTRY	:	GERMANY
REGISTRATION	:	D-CHIC

LOCATION

LOCATION	:	MEMMINGEN
STATE/AREA	:	GERMANY
DEPARTED	:	OBERPFAFFENHOFEN
DESTINATION	:	OBERPFAFFENHOFEN

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : SUBSTANTIAL

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	2	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

DURING A TEST FLIGHT THE A/C BECAME UNCONTROLLABLE. DURING RECOVERY, ALL PROPELLER BLADES OF THE LEFT ENGINE SEPARATED FROM THE PROPELLER HUB. THE FUSELAGE WAS SEVERELY DAMAGED BY SUBSEQUENT PROPELLER STRIKE. THE A/C LANDED SAFELY.
DRN: A MANUFACTURER TEST FLIGHT TO PROVE COMPLIANCE WITH JAR 25.177 WAS CARRIED OUT. WITH THE A/C IN LANDING CONFIGURATION AT MAX TAKE-OFF POWER, THE TEST WAS ABORTED DUE TO HEAVY BUFFETING AND THE TENDENCY TO PITCH DOWN AT A HIGH SIDESLIP ANGLE. RELEASING RUDDER AND AILERON THE PILOT TRIED TO RECOVER FROM NOSE-DOWN PITCH BY PULLING UP WITH HIGH FORCE. THE A/C BANKED TO THE LEFT WITH INCREASING AIRSPEED AND NOSE-DOWN ATTITUDE. THE PILOT INSTRUCTED THE CO-PILOT IN GERMAN TO REDUCE THE ENGINE POWER. THIS WAS NOT UNDERSTOOD BY THE U.S. TEST PILOT. SHORTLY AFTERWARDS ALL SIX BLADES OF THE LEFT ENGINE SEPARATED INSTANTANEOUSLY WHEN THE A/C PASSED AN INVERTED POSITION.
SAFETY RECOMMENDATION: THAT THE AIRWORTHINESS AUTHORITIES REVIEW JAR 25.177 WITH RESPECT TO RISKS WHEN FLIGHT TESTING AN A/C AT MAXIMUM SIDESLIP ANGLES. THIS IS ASSUMED TO BE NOT REALISTIC IN VIEW OF OPERATION OF MODERN TRANSPORT CAT A/C, WHEN FULL RUDDER IS USED ONLY IN AN ENGINE FAILURE SITUATION TO AVOID A HIGH SIDESLIP ANGLE AND NOT TO CREATE IT.

SEQUENCE OF EVENTS

EVENT 1 LOSS OF CONTROL - EN-ROUTE
- 1.LONGITUDINAL CONTROL - PARTIAL LOSS
  - 1.PILOT-EXPERIENCE ON A/C TYPE-INCOMPLETE
  - 2.CO-PILOT-PHRASEOLOGY-NOT UNDERSTOOD - LANGUAGE BARRIER

EVENT 2 PROPELLER SEPARATION - EN-ROUTE
- 1.PROPELLER BLADE - FRACTURED

EVENT 3 PROPELLER/ROTOR/JET BLAST DAMAGE - EN-ROUTE

SAFETY RECOMMENDATIONS

RELATED TO AIRCRAFT/EQUIPMENT	:	AIRWORTHINESS DIRECTIVE
MISCELLANEOUS	:	INFORMATION/DISSEMINATION/ETC

++ REQUEST 140/94 REPORT # 221
++

+ DATA REPORT DORNIER - 328 ACCIDENT +
+ EVENTS | PHASES: LOSS OF CONTROL | EN-ROUTE +
+ PROPELLER SEPARATION | EN-ROUTE +
+ PROPELLER/ROTOR/JET BLAST DAMAGE | EN-ROUTE
+

++
++
++

<--------------- OPERATION ---------------> ++ <--------------- FILE DATA ---------------
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 92/0162-0
++ FROM STATE : GERMANY
++

<-------------------- WHEN --------------------> ++ <------------ AIRCRAFT DATA ------------
DATE : 92-12-14 ++ MASS CATEGORY : 5701 - 27 000 KG
TIME : 11:49 ++ STATE OF REGISTRY : GERMANY
LIGHT : DAYLIGHT ++ REGISTRATION : D-CHIC
++

<------------------- WHERE -------------------> ++ <-------- DAMAGE, INJURY AND TOTAL ON BOARD -------->
LOCATION : NEAR MEMMINGEN ++ A/C DAMAGE : SUBSTANTIAL
STATE/AREA : GERMANY ++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED : OBERPFAFFENHOFEN ++ CREW : 0 0 0 2 0 2
DESTINATION : OBERPFAFFENHOFEN ++ PAX : 0 0 0 0 0 0
OTHER DAMAGE : NO

DURING A TEST FLIGHT THE A/C BECAME UNCONTROLLABLE. DURING RECOVERY, ALL PROPELLER BLADES OF THE LEFT ENGINE SEPARATED FROM THE PROPELLER HUB. THE FUSELAGE WAS SEVERELY DAMAGED BY SUBSEQUENT PROPELLER STRIKE. THE A/C LANDED SAFELY.

DRN: A MANUFACTURER TEST FLIGHT TO PROVE COMPLIANCE WITH JAR 25.177 WAS CARRIED OUT. WITH THE A/C IN LANDING CONFIGURATION AT MAX TAKE-OFF POWER, THE TEST WAS ABORTED DUE TO HEAVY BUFFETING AND THE TENDENCY TO PITCH DOWN AT A HIGH SIDESLIP ANGLE. RELEASING RUDDER AND AILERON THE PILOT TRIED TO RECOVER FROM NOSE-DOWN PITCH BY PULLING UP WITH HIGH FORCE. THE A/C BANKED TO THE LEFT WITH INCREASING AIRSPEED AND NOSE-DOWN ATTITUDE. THE PILOT INSTRUCTED THE CO-PILOT IN GERMAN TO REDUCE THE ENGINE POWER. THIS WAS NOT UNDERSTOOD BY THE U.S. TEST PILOT. SHORTLY AFTERWARDS ALL SIX BLADES OF THE LEFT ENGINE SEPARATED INSTANTANEOUSLY WHEN THE A/C PASSED AN INVERTED POSITION.

SAFETY RECOMMENDATION: THAT THE AIRWORTHINESS AUTHORITIES REVIEW JAR 25.177 WITH RESPECT TO RISKS WHEN FLIGHT TESTING AN A/C AT MAXIMUM SIDESLIP ANGLES. THIS IS ASSUMED TO BE NOT REALISTIC IN VIEW OF OPERATION OF MODERN

TO CREATE IT.

---------------- EVENTS AND FACTORS ----------------

1. EVENT | PHASE: LOSS OF CONTROL | EN-ROUTE
   FACTORS: LONGITUDINAL CONTROL -PARTIAL LOSS
   PILOT -EXPERIENCE ON A/C TYPE -INCOMPLETE
   CO-PILOT -PHRASEOLOGY -NOT UNDERSTOOD - LANGUAGE BARR
2. EVENT | PHASE: PROPELLER SEPARATION | EN-ROUTE
   FACTORS: PROPELLER BLADE -FRACTURED
3. EVENT | PHASE: PROPELLER/ROTOR/JET BLAST DAMAGE | EN-ROUTE

------------ SAFETY RECOMMENDATIONS ------------

RELATED TO AIRCRAFT/EQUIPMENT: AIRWORTHINESS DIRECTIVE
RELATED TO MISCELLANEOUS SUBJECTS: INFORMATION/DISSEMINATION/ETC

REPORT
on the Investigation of the Flight Accident
with the Dornier DO 328-100
on 14 December 1992 in the Area of Memmingen

Summarization

On December 14, 1992, flight tests were conducted in the area around Memmingen with the prototype DO 328-100, built by Dornier Aircraft Co. These tests were conducted to investigate, among other things, the aircraft directional stability. At approximately 1149*, the test point with the aircraft in the landing configuration was broken off by the responsible pilot, due to bobbing of the aircraft's nose combined with strong shaking (buffeting). The aircraft immediately entered an uncontrollable condition, and subsequently suffered the breakup of all six propeller blades of the propeller assembly of the left engine. The result of this was heavy damage to the left engine as well as resultant propeller impact and severe damage to the fuselage and to the cabin.

The responsible pilot was successful in bringing the aircraft under control, and in spite of the severe damage and engine failure brought the aircraft to a safe landing.

The accident is attributable to the fact that at the conclusion of the test point, a return to normal flight conditions was made difficult because the effectiveness of the elevator, which was in a nose-up condition, was adversely affected by flow field separation. This condition was not recognized by the pilot in time to allow a release of the elevator at the end of the test point.

A factor contributing to destruction of the propeller blades was a failure to reduce engine output. This resulted from a communications breakdown between flight test personnel.

1.0 Investigation of the Facts

1.1 Course of the Flight

In the program of developmental flight tests conducted by the aircraft manufacturer Dornier Aircraft Co., a test flight was planned on the prototype DO 328-100, serial number 3001 (Dornier internal designation TAC1). In the course of this flight an investigation into directional stability in various configurations was to be conducted.

Basis for test flight number F1 0101 was the associated flight test plan (Appendix 5.3).

On board the aircraft as responsible pilot (PIC) was the manufacturer's project pilot. Also on board as second pilot was a pilot from Dornier Aviation (North America).

During the flight the responsible flight test engineer was stationed in the Dornier Flight Test

* Times are local times unless otherwise indicated

telemetry ground station. From there, this individual coordinated the testing with the PIC and over radio provided the crew with necessary information from the ground data recorders.

The takeoff of TAC1 occurred at 0921 hrs from Oberpfaffenhofen, the Dornier company factory airport.

Up to the time of the incident at 1149 hrs, individual test points from the test plan were conducted without incident.

A critical point in the test plan were the T.O.P. 13 tests for investigation of static directional stability, in accordance with the airworthiness provisions JAR •25.177.

The tests for T.O.P. 13 were flown in various configurations starting around 1035 hrs. The results of these tests were quite variable. The opinion of the PIC regarding the flight characteristics ranged from "no problem" to "unacceptable".

The starting point of the incident was the test T.O.P. 13.14, which was begun around 1149 hrs at an altitude of 14,000 ft while in the following configuration:

Flap Position:	25 deg
Landing Gear:	extended
Engine Power:	2 x MTOP
Speed:	1.13 VSlg (98 KCAS)

Close to the point at which the maximum left rudder deflection was reached, a strong shaking (buffeting) began of such strength that the PIC could no longer maintain controlled flight. The PIC released the rudder and aileron and broke off the test. Immediately the aircraft went into a steep bank to the left along with a severe pitch-over. Airspeed continued to rise.

At an approximate roll angle of -90 deg the PIC assisted the rolling motion by an aileron deflection to the left, in order to, in his words, "roll the aircraft through".

The PIC, who was fully occupied with trying to bring the aircraft under control, requested the second pilot to reduce engine power with the words "Gase raus" (something like "chop the power"). This request was not followed.

Approximately 5.5 seconds later followed the structural failure, recognizable by noise on the audio recordings. At this point in time the aircraft was in a condition described by the following recorded data:

Airspeed:	171 kts	Sideslip angle:	19 deg
Pitch angle:	-48 deg	Normal acceleration:	-0.82 g
Roll angle:	-185 deg	Lateral acceleration	-0.82 g

Within a fraction of a second all six propeller blades on the left engine failed. At least two of the blades caused severe damage to the fuselage and to the interior of the cabin.

After the structural failure occurred, data transmission to the telemetry station was interrupted due to destruction of the transmitter antenna. Data transmission was later restored by switching to another antenna. Data recording on board the aircraft was, however, not interrupted except for a short drop-out. This enabled comprehensive data from throughout the period of the incident to be available post flight.

The PIC succeeded in bringing the aircraft under control, at which time airspeed had reached 250 kts. This speed was far over the allowable speed as specified in the flight manual 3001-5 Pkt.1.2.5 of:

180 KCAS	gear extended
145 KCAS	flaps > 15 deg extended

Also, the power level for the engines at pitch and roll angles exceeding +/- 35 deg, which are specified in flight manual 3001-5D from 22 Oct 92, were exceeded by these maneuvers. The altitude loss during the incident was 4,800 ft. The heavily damaged aircraft was landed safely on one engine at 1221 hrs at the factory airport at Oberpfaffenhofen.

1.2 Personnel Injury

None

1.3 Damage to Aircraft

All six propeller blades of the left engine were broken off. The left engine including its mount were heavily damaged.

At least two of the six blades damaged the fuselage section immediately forward of the wing leading edge, as well as the interior of the cabin. The control cable to the left engine control was cut through.

In addition one on-board antenna was damaged which lead to a brief interruption in data transmission to the telemetry station.

1.4 Auxiliary Damage

None.

1.5 Crew Information

1.5.1 Responsible Pilot

License: ATPL 1
Entitlements:
Flight Test Entitlement TB1, aerobatic flight

Type Permit:	DO 228, DO 328
	CL 600/601
Instruction Permit:	DO 228, DO 328
Instrument Flight Permit:	up to 200 ft
Total Flight Experience:	3,830 hours
Flight Experience in the DO 328:	200 hours
As PIC:	200 hours
Flight Medical Fitness:	Class 1
	without limitations

The Pilot was assigned as Project Pilot (Order No. 363 according to Developmental Handbook C-1.2) for conduct of the test flight. This was in conformity with conditions mentioned under Point C-2.1.9 of the company's Developmental Handbook (EBH).

1.5.2 Second Pilot

License: ATPL

Entitlements:	
Flight Test Entitlement:	Certificate as Graduate of the U.S. Naval Test Pilot School
Instrument Flight Entitlement:	yes
Total Flight Experience:	4,000 hours
Flight Experience with the DO 328 as 2nd Pilot:	8 hours
Flight Medical Fitness:	valid
	without limitations

The second pilot did not possess a German license as pilot and also did not have a type entitlement for the DO 328

1.6 Aircraft Information

The aircraft was the prototype of a passenger transport. Power was provided by two turbine engines, each equipped with a six-blade variable-pitch propeller installation. The propeller blades were of composite construction.

Construction:	Shoulder wing with pressurized cabin
Model:	DO328-100
Year Built:	1991
Series No:	3001
Plant Designation:	TAC1
Total Flight Time:	207 hours
Max. T.O. Mass:	13,670 Kg
	(include. 2% test equipment)
Weight at time of Incident:	12,300 Kg
Center of Gravity:	38% MAC
Engine:	P&W ZBE 119A

Left Engine:	S/N 116008	Operating time 139 hrs
Right Engine:	S/N 116006	Operating time 134 hrs

Checkout of the aircraft was accomplished at established intervals. The last maintenance check (200 hour check) was accomplished at 193 hours. Since that time the aircraft had an operating time of 13 hours.

The aircraft was undergoing testing for the purpose of extending the type permit according to airworthiness requirements of JAR 25.

For the conduct of the flights a temporary transport permit was provided by the Federal Aviation Office. Date of the permit was 21 August 1992. An element of the temporary permit was both the General Flight Instruction 3001-5 (EL549/92), Version A (6 Aug 92), as well as the Flight Instruction 3001-50, published 22 Oct 92.

The operating limitations and boundaries established in these documents were observed up until the occurrence of the incident.

In order to conduct the flight tests, the aircraft was equipped with numerous sensors to record flight test data. For on-board recording and for data transmission to the ground telemetry station, the cabin of TAC1 was outfitted with a flight test installation.

For measurement of angle of attack and angle of sideslip, a nose-boom was installed.

For visualization of the flow field, the upper side of the wing was tufted, and on the tail a video camera was installed.

The cockpit instruments and other flight deck equipment was consistent with that of the projected production aircraft with minor exceptions. Special flight test cockpit instrumentation was not provided.

The possibility of an emergency crew escape was provided for by the installation of an emergency exit in the rear of the cabin. Guide lines were installed between the flight deck and the emergency exit. Before leaving the flight deck, the pilot could lock the steering yoke in place in order to stabilize the flight attitude.

1.7 Meteorological Information

Visual flight rules were in effect and the crew view of the ground was unimpeded.

1.8 Navigation Aids

Not applicable

1.9 Radio Traffic

From takeoff to landing, TAC1 was in contact with the Oberpfaffenhofen Tower on

Frequency 119.55 Mhz. Besides this, radio communication was maintained between TAC1 and the telemetry station on frequency 135.875 Mhz. This contact was for coordination of the test flight.

1.10 Airfield Information

Not applicable

1.11 Flight Recorder

The aircraft was equipped with an on-board data system which allowed the recording of more than 900 parameters. Besides the "on line" data transmission from the aircraft to the telemetry station, the flight data was recorded on magnetic tape for later analysis.

1.12 Information on the Impact and Wreckage

Not applicable

1.13 Medical and Pathological Information

Not applicable

1.14 Fire

Not applicable

1.15 Survivability

Not applicable

1.16 Further Investigation

1.161 Propeller Strength

Before the incident, in the course of inspections, delamination was discovered on individual propeller blades. This delamination was in the area of the blade root parallel to the trailing edge. This discovery led to limitations on the propeller (in accordance with flight instruction EL-979/92 of 10 Dec 92) to the extent that daily visual post-flight inspections were conducted. Limitations in angle of attack or sideslip were not made.

After the incident the left engine propeller assembly was subjected to a thorough damage analysis by Hartzell in the USA, assisted by the Dornier Company. the result was contained in the Hartzell Engineering Report No. 1232 of 8 Feb 1993.

Findings of Hartzell

During the test flight the destruction of the left propeller assembly occurred during a very short span of 0.6 seconds. The propeller loads which existed at this point in time were impossible to quantify, because the measured parameters, especially the sideslip angle, were outside the values used by Hartzell in the load assumption calculations of propeller strength.

As a final conclusion, it was accepted by Hartzell, that destruction of the propeller assembly was finally due to a low cycle high stress event.

Findings of the Flight Accident Investigation Center (FUS)

On the basis of the assertions in the above-mentioned Hartzell report, FUS comes to the following determination.

The delamination of the carbon-fiber composite layers of the destroyed blades, and the indications of a heating effect on the carbon fibers and on the foam core, could not be traced with complete certainty to deformation due to oscillating stress. The heavy damage in the area of the blade supports was more an indication of an excessive bending moment on the blade roots. In the end these roots were also unable to hold the carbon composite layers of the blades.

These bending moments could have been caused by aerodynamic loads and centrifugal moments on the blades or impact of the blades with each other.

A quantification of the loads which lead to the blades' destruction was not possible due to the skewed airflow into the left propeller as a result of the sideslip of the aircraft.

The following measures resulted from the findings:

By the Hartzell Company a modification and strengthening of the propeller blade feet was carried out.

In order to be able to determine propeller loads in extreme sideslip conditions, the modified blade assemblies were put through an interim series of appropriate flight tests.

1.16.2 Sound Recordings

A transcription was made of the sound recordings from the beginning of the test T.O.P. 13.14 to the point of the structural failure. A signal analysis of this recording over this span of time served to arrange the commentary of the flight in exact order.

A judgment concerning the engine and propeller behavior immediately before the point in time of the structural failure was only partially possible.

The speech transmissions from aircraft and telemetry station are clearly recognizable and distinguishable from each other in the signal analysis.

In the signal analysis, the structural failure was recognizable some 42 seconds after beginning of test T.O.P. 13.14. It was recognizable as a distinct amplitude increase which ended in a strongly pronounced noise. This signal behavior was consistent with the structural failure and following wind noises, which markedly increased as a result of the punctured fuselage skin.

1.17 Additional Information

1.17.1 Organization of the Flight Test

The Developmental Company DORNIER AVIATION Ltd.

The Dornier Company is a developmental company recognized by the Federal Aviation Office (LBA). This company carries out the development of an aircraft up until maturity, including responsibility for the model tests, under the oversight of the LBA. At the end of this process, the LBA grants the type certificate, as long as it is an exclusively national project.

Concerning the DO 328 a European certificate was desired on the basis of JAR 25. This had, however, no effect on the type and extent of investigation of this accident by the FUS.

The tasks and responsibilities relative to the conduct of the flight tests was in agreement with the Company Developmental Handbook (EBH) and was regulated by DORNIER AVIATION Ltd. as follows:

Within the Department for Developmental Flight Physics and Flight Test, the Division of Flight Test, along with other affected divisions of the Department, was responsible for the conduct of the flight tests in accordance with the test plan, as well as for the pilots used during the test flights. The pilots were appointed by the Flight Operations Department upon request by Flight Test.

Flight Test Personnel

For the test flight F1 0101 on 14 Dec 92, the crew of TAC1 consisted of the Dornier Project Pilot as responsible pilot, and a transport pilot of the company DORNIER AVIATION (NORTH AMERICA) as second pilot.

The responsibility of the Project Pilot, In accordance with the EBH, was the guidance and control of the test aircraft. The appointment of the second pilot also lay within his field of responsibility.

In accordance with the Flight Handbook for the DO 328, the minimum crew was two. This meant that, apart from instructional flights, the second pilot for a flight test was also required to possess a type permit for the DO 328. This, however, was not the case.

It was one of the tasks of the FUS to clarify whether the appointment of the second pilot, who was not a member of the development company DORNIER AVIATION Ltd., was technically consistent with regulations in the EBH or with other aviation rules.

The crucial point of the investigation was directed toward the matter of the degree to which the second pilot was able to carry out the tasks required of him, or whether actions relevant to the accident were to some degree caused by him.

The task of the second pilot during the conduct of the individual test points consisted of monitoring in particular the engine instruments. In addition, between test points he relieved the PIC by taking over control of the aircraft and setting up test conditions for the next test point.

On the basis of the sound and data recordings of the test flight, one gains the impression that the second pilot was able to assume, without problems, control of the aircraft after handoff from the PIC. Also other tasks, including monitoring of instruments, was assummed by the second pilot, insofar as this was discernible from the conversations. Since the second pilot, as a U.S citizen, apparently had a limited knowledge of German, communications between the two pilots was conducted exclusively in English.

Additional flight test personnel located in the telemetry station consisted of the responsible flight test engineer , the competent systems engineer, and data engineers. The duties and responsibilities of the flight test engineer was regulated in accordance with the EBH C-1.2 Order No. 362.

The coordination of the test flight was assumed by the flight test engineer, who also passed on significant flight test data to the crew of TAC1 via radio.

Verification of Directional Stability T.O.P. 13

The crucial point of this flight consisted of testing under T.O.P. 13 of the verification of directional stability in accordance with air worthiness requirements JAR • 25.177.

Earlier tests in this area had already been conducted with unsatisfactory results, so that a modification in the wing-fuselage interface area had ben made.

Tufts were installed on the upper side of the wing, and a video camera was installed in the tail which allowed observation of the flow in this surface.

The progress of the tests were thoroughly documented data and by audio recordings.

For the tests for static directional stability, the aircraft was first put into the configuration corresponding to the respective test point. The configuration was defined by flap and landing gear position, engine power, and trimmed airspeed.

An increasing rudder deflection was input while maintaining stable level flight using proper elevator and airleron inputs. Sideslip angle built up until either maximum rudder deflection or maximum allowable rudder pedal force was reached. For fulfillment of air worthiness requirements, after removal of the pedal force the aircraft had to return to its intial conditions.

The test could, however, be broken off early if one of the following break-off criteria occurred:

- inpermissibly high control forces
- flow separation, made apparent by strong buffeting
- uncontrollable flight attitude changes

During the flight test the sideslip angle observed in the telemetry station was relayed to the pilot for his information. Relative to the sideslip angle, there was no limit corresponding to points (?) 1.2.8 of the general flight instruction EL 549-92. Therefore sideslip angle was not a break-off criteria for the test.

Progress of the Flight Test T.O.P. 13.14

On the basis of the on-board data recordings, the progress of the test could be comprehensively analyzed. The local time as recorded in the data is used as a time reference for the following events.

Three interconnected phases of the flight were identified:

Phase 1: Test T.O.P. 13.14

The test was announced at 11:48:51 by the PIC with the words "to the left", and simultaneously initiated by left deflection of the rudder.

The sideslip angle built up with increasing rudder deflection, which was relayed to the crew by the test engineer. The sideslip angle called out, however, was lower than the actual measured values due to improper calibration. This was only discovered after the flight.

Close to the point where, at 11:49:24, the maximum rudder angle deflection was reached, a strong buffeting began, and the PIC could no longer control the aircraft. This lead to breaking off the test.

Phase 2: Break-off of the Test

This section was closely tied to Phase 1 and ended with the structural failure at 11:49:33.4. Since this Phase lasting roughly ten seconds was especially significant for the course of of the incident, evaluation of the data is particularly important to above all determine steering inputs made by the PIC. (Appendix 5.4)

Note:

As time reference in this Phase only the seconds of the 49th minute will be given. This corresponds also to the scaling of the time axis in the data presentations in Appendix 5.4, to which reference will later be made.

The break-off of a test was intended to occur in a way that by the pilot releasing the control forces, the aircraft would return to stable flight conditions

The following describes the driving back of the deflected controls following break-off of the test.

The rudder deflection was taken out by the PIC, which was recognizable by a sharp reduction in pedal force from 35 to 10 daN. (Newtons ?) This resulted in a reduction in rudder deflection from 23 degrees to at first only 16 degrees and later to 8 degrees, after a further reduction in pedal force of some 4 daN.

The neutral rudder position was not reached, but rather the rudder deflection to the left grew greater as a result of the increased pedal force shortly before the end of Phase 2. As a result, sideslip angle again began to increase.

The aileron deflection was taken out by the PIC, which was recognizable by a sharp reduction in the hand forces from 12 daN to about 3 daN. As a result the tahe aileron deflection decreased from17 to just 8 degrees. The rolling movement of the aircraft continued with a roll rate to the left of -17 deg/sec. As -90 degrees was reached, aileron deflection to the left caused an increase in roll rate to -40 deg/sec. This occurred, according to the PIC, in an attempt to "roll the aircraft through". The structural failure of the propeller blades followed shortly after the aircraft was rolled over on its back.

A relaxation of the elevator at the end of the test was not apparent, which differed from earlier tests. To be sure, the elevator deflection changed during the Phase from 0 to 9 degrees, in the "pushover" direction, yet the hand force of the PIC exhibited fluctuating values which averaged about 20 daN in the "pull-up" direction. Not until 29.7 seconds was a temporary relaxation of the hand force apparent, which apparently was related to changes in aileron deflection.

In this Phase, the PIC tried if possible to prevent the aircraft nose from bobbing down by the application of positive hand force (pull-up).

The break-off of the test at the end of Phase 1 was commented on by the PIC with the words "and now it's going over the nose ..... with buffeting".

The buffeting was readily noticable in the data recording by fluctuations in measured parameters. This was shown in the recording of the second pilot's elevator force which, starting at 23.5 seconds, exhibited increasingly fluctuating values about an average of 2 daN. This corresponded apparently to the measured value of a released 2nd pilot's control column. The turbulent flow of the horizontal tail or also flow separation on the tail itself caused the measurement of an apparent hand force on the released 2nd pilot's control column.

The flight path of TAC1 was marked in this Phase by large changes in the following parameters:

After the nose bobbing, the pitch angle decreased very rapidly to -60 degrees, during which the nose-boom measured angle of attack decreased from 7 to -15 degrees. The sideslip angle decreased from 22 to 7 degrees following the break-off of the test, before it again increased and at the end of Phase 2 reached a value of nearly 19 degrees.

The airspeed increased, particularly under the influence of the steep flight path under full engine power, from 103 to 171 kts.

Phase 3: Reestablishment of normal flight attitude

This section was marked by reestablishment of a normal flight attitude, in close connection to Phase 2.

The PIC was successful in bringing the aircraft under control, at which time the aircraft rapidly reached an airspeed of 250 kts. The total altitude loss during the incident amounted to 4,800 ft.

1.17.3 Meaning of Airworthiness Requirement JAR • 25.177

The verification of static directional stability airworthiness requirements is accomplished through flight test and commonly accepted practices. This requires stability verification up to the full rudder deflection or up to the maximum allowable sideslip angle. During these test, sideslip angles can be reached which have no practical meaning for later flight operations, if the possibility of uncoordinated rudder deflections are not envisioned.

The conduct of these tests has had a not inconsiderable adverse effect on flight safety, as has been shown in the past occasionally during flight trials of this type. Since rudder measurement and deflection is an essential factor for minimum control speed, and therefore for takeoff field length, the aircraft manufacturer strives for a high rudder effectiveness, which makes the verification of directional stability more difficult.

The question can be asked whether the airworthiness requirements, which have been used in this form for decades, still has the meaning that it previously did. At the time of the origin of these requirements, side-slipped flight was a possible conscious maneuver used to correct the flight path.

While, as always, changes to the flight attitude about the lateral axis with elevator (pitch angle), and about the longitudinal axis with aileron (roll angle) still have their essential meaning for flight controls, the rudder has only the task of making changes to flight attitude about the z-axis and of avoiding sideslip angle. This means, in one case, a relatively low rudder deflection is required in flight to compensate for side-rolling moment in curved flight and, eventually, for cross-wind landings, while in the case of a failed engine, a greater rudder deflection is required to compensate for the associated upsetting moment. Exactly in this last case, the rudder has the primary task for a civil transport of working against sideslip angle, and not of producing it.

The question can be asked whether the flight test verification of static directional stability using full rudder deflections justifies the associated risk for aircraft and crew.

2.0 Evaluation

In the investigation of the accident, particular attention had to be paid to the fact that the aircraft was under test and that the incident occurred on a test flight dedicated to the verification of various airworthiness requirements.

However, it could not be a matter for the investigation to make conclusions about the future fulfillability of the airworthiness regulations or to express recommendations about them.

Likewise it was not possible, and was not in this case, the task of the accident investigation, to investigate the detailed causes for the structural destruction of the propeller blades. On the basis of the extreme flight conditions immediately before the failure of the blades began, the blades clearly were subjected to extreme forces, the type and magnitude of which could not be quantified. Inertial forces, the high engine output, as well as the high aerodynamic forces on the blades, especially considering the unsteady flow at increasing sideslip angles, all could explain the destruction of the propeller blades on the left engine, while those on the right engine remained undamaged.

The investigation into the accident by the FUS concentrated therefore on the findings and analysis related to the uncontrolled flight attitude after breaking off the test point T.O.P. 13.14.

In accordance with the Airworthiness Requirements JAR • 25.177 the directional stability of the aircraft was tested in various configurations. During this testing, some of the results had been termed "unacceptable" by the PIC, even before test point T.O.P. 13.14 was reached. In spite of this, the planned order of test points was continued. During flight testing it is not unusual to continue a series of tests even if interim results are unacceptable. This enables a comprehensive evaluation of a series of tests to be made. Moreover, the crew did not perceive any impact to flight safety due to the occasional uncontrolled "pitch down" behavior of the aircraft.

During T.O.P. 13.14 the test was initiated by a rudder deflection to the left. The test was broken off shortly before reaching maximum rudder deflection due to bobbing of the aircraft nose and strong buffeting.

An essential part of the investigation consisted of an analysis of the ten second Phase following break-off of the test, during which a normal flight attitude could not be reestablished, and at the end of which structural failure of the propeller blades on the left engine occurred.

A relaxation of the elevator at the end of the test was not apparent, which differed from earlier tests, but at least a high force in the pull-up direction was maintained, without being able to prevent an increasing pitch down of the aircraft.

In contrast to this, the tests resulting from T.O.P. 13.14 were conducted in such a manner that the control deflections in all three axes were driven back, and the aircraft was able to return to its normal flight attitude due to its stability. (Trans. Note: This paragraph, like some others, is written in a very confusing manner and its meaning [and the previous one as well] is not entirely clear.)

The data (RT. CTRL. WHEEL FORCE - Elevator), show increasingly oscillatory values about the nominal value beginning at the break-off of the test. On the basis of this data, it is apparent that in this case flow separation on the elevator impacted its effectiveness such that control forces increased to the extent, that in spite of a "Pull-up" on the control wheel, the elevator deflection increased downward.

The aileron deflection to the left, some three seconds before the structural failure, in order to support the rolling movement was a conscious input made by the pilot with the intent of "rolling the aircraft through". The simultaneous rudder deflection to the left could also have been a conscious input of the PIC made in order to "coordinate" the roll. In consideration of the inverted attitude of the aircraft which occurred, this must have had the opposite effect, that is, a renewed increase of the sideslip angle.

It cannot be excluded, that the control inputs of the responsible pilot in this phase were decisively influenced by the accelerations and severe flight attitude changes which occurred. Outside of this, it must be taken into consideration that the rapid pace of events scarcely gave the PIC time for decision-making and for taking proper corrective measures.

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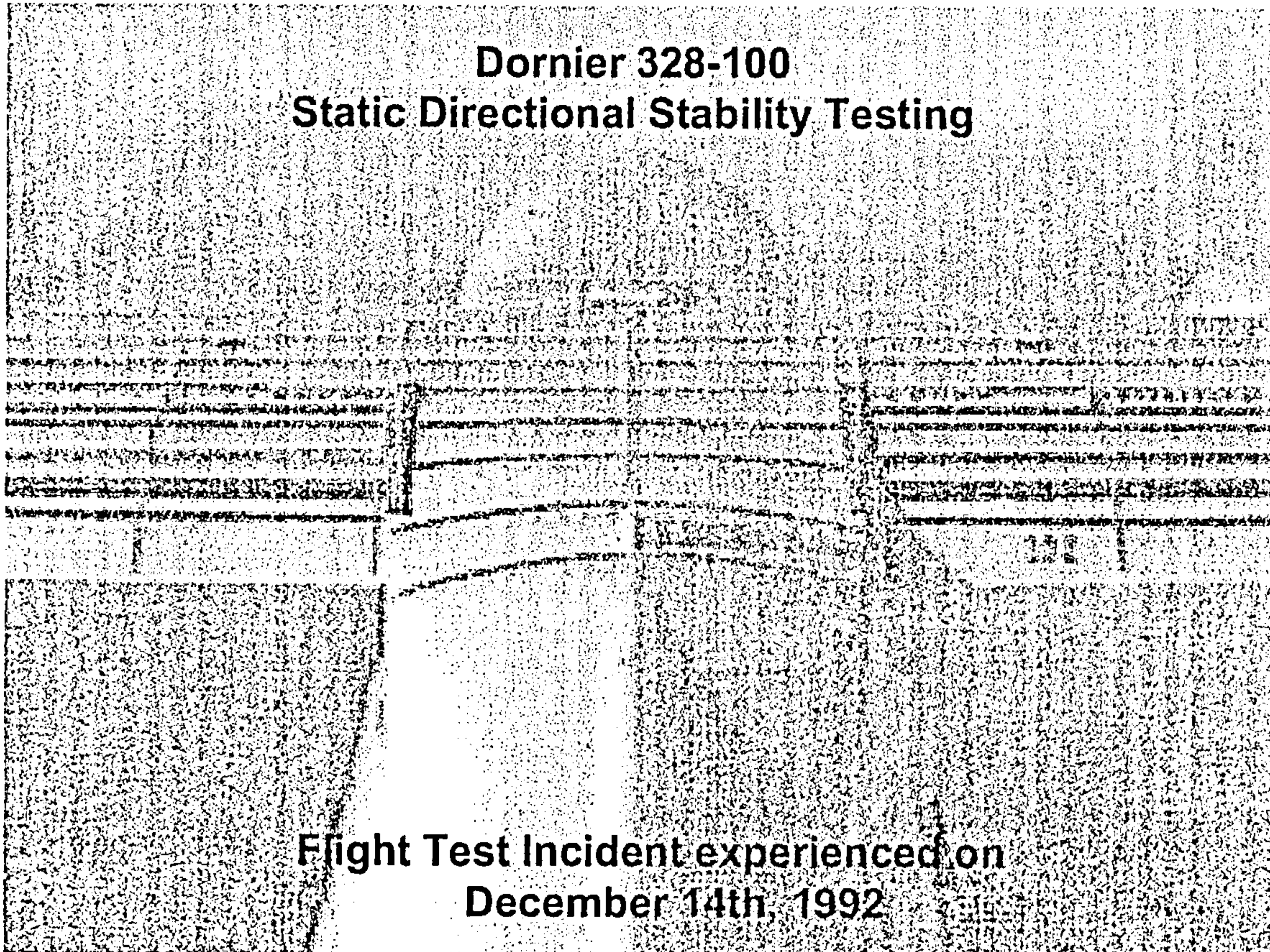
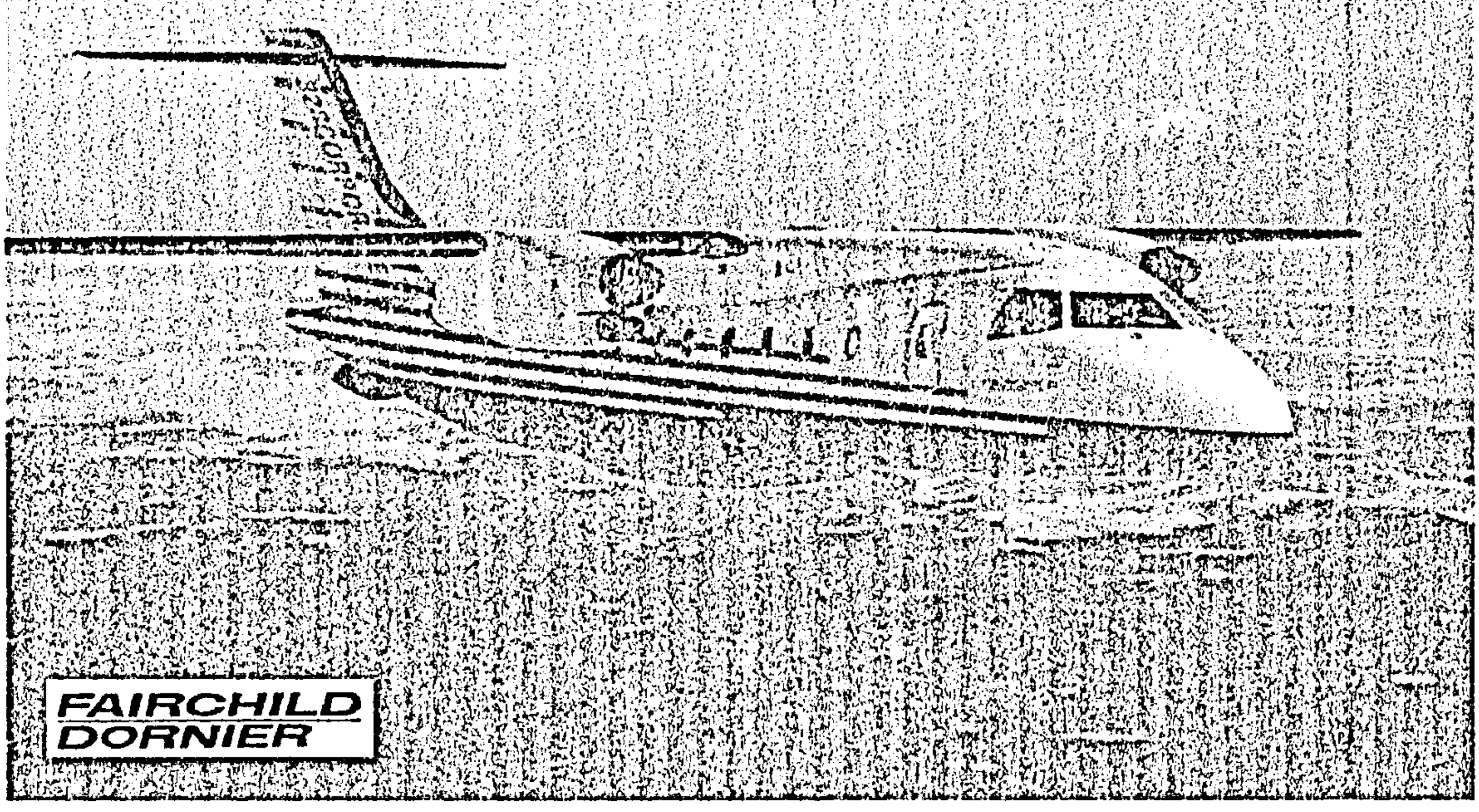
Dornier 328-100
Static Directional Stability Testing



Flight Test Incident experienced on December 14th, 1992

Dornier 328-100

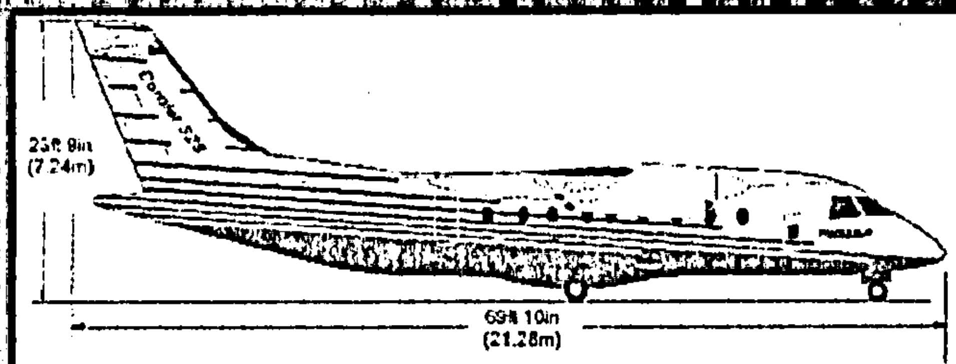


Test Objective:

- Investigation of directional stability after a modification of the wing fuselage fairing

Test condition:

- Weight : Maximum Landing Weight, Aft CG (38%)
- Configuration: Flaps 25, Gear Down
- Trim Speed 1.13 VS1g
- 2 x 95% Torque
- 100 % RPM
- Test Altitude 14000 ft



- It was flight #101 of the Dornier 328-100 prototype aeroplane TAC 1 operated under the experimental flight permit under the registration D-CHIC.
- The test program asked for sideslip testing in all 4 configurations at several speeds and power settings. The critical testpoint #14 was run after #15 in the same configuration but 95% torque instead of idle power.
- The test procedure asked for slow increase of sideslip and slow rudder release on recovery.
- The test were performed as wings level sideslips.

- By actuating the rudder to the left, with a pedal force of 35 daN (77 lbs), full rudder deflection of 22 degrees was achieved at a yaw angle of 20.5 degrees.
- During the build up of sideslip it was necessary to pull more and more elevator to counteract the increasing nose down moment. Maximum pull force was 20 daN (44 lbs).
- Briefly before reaching full rudder deflection, the aeroplane started buffeting. The stick was slightly released and the nose dropped significantly.
- During this time the required rudder forces decreased from 35 to 25 daN. Gradient reversal with positive force.

- The rudder pedal force was partly released (5-12 daN remaining) resulting in only a slow reduction of sideslip.
- During that pitching manoeuvre the g-load reduced to 0.6g and the aeroplane rolled to the left and pitch attitude reached -60 degrees before recovery became effective with positive pitch rates at a speed of 160 KIAS.
- During the whole manoeuvre the engines remained at the initial takeoff torque setting although the pilot asked briefly for a reduction of power.
- At this time, 8 seconds after the rudder was reduced and the pitch angle decreased to 50 degrees, the left propeller, still at high RPM and torque, disintegrated.

- Propeller blades hit the fuselage and caused significant damage.
- This aeroplane condition resulted in a brief reduction in pitch and obviously asymmetric power effects.
- The control could be regained by continuation of the left rolling motion through inverted attidude to 360 degrees.
- The pitch angle was then continuously increased and g-loads during that recovery reached up to 3g.
- The maximum speed reached during the manoeuver was 250 KIAS.
- Flap/Gear limit speeds were exceeded without further damage on the structure.
- The Aeroplane landed safely in Oberpfaffenhofen, nobody got hurt.

- The crew consisted of two pilots only, data were transmitted via telemetry and a flight test engineer on ground co-operated during the conduct of the testing following established procedures.
- The test was still in a development configuration and buffeting and pitching problems were already identified.
- The aeroplane was tufted to observe flow separations during the tests by video camera.
- The aeroplane was an instrumented prototype with a noseboom however there was no direct sideslip indication for the pilots. These data were given by the FTE from ground via voice communication only.
- The language used on the flight deck during conduct of the testing was German.

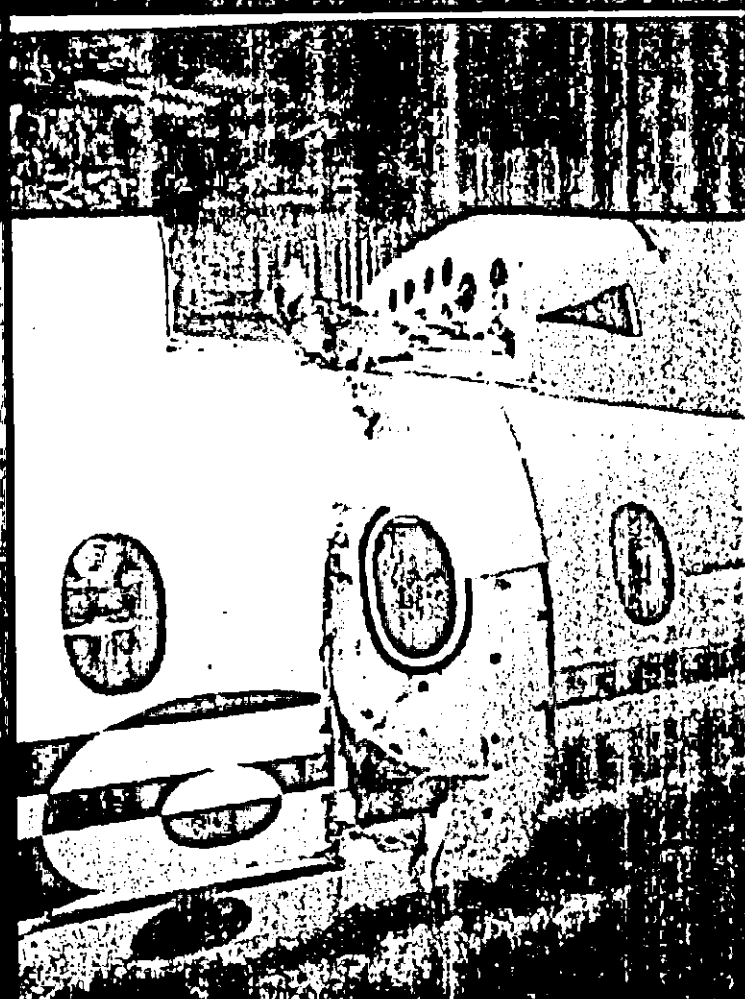
- One propeller blade penetrated the cabin through the ice protection shield, hit an internal steel construction for flight test purpose, then hit the cockpit wall on the right behind the observer seat and came to rest.
- One propeller bade hit the upper wing fuselage fairing and actually was found sticking out of the right top side of the fuselage.
- Both pitch and roll disconnect clutches had opened during the recovery manoeuvre.
- The failed propellers engine control cables were cut by one propeller blade; the engine stopped on its own.
- No damage was caused by exceeding structural limitations during the recovery.

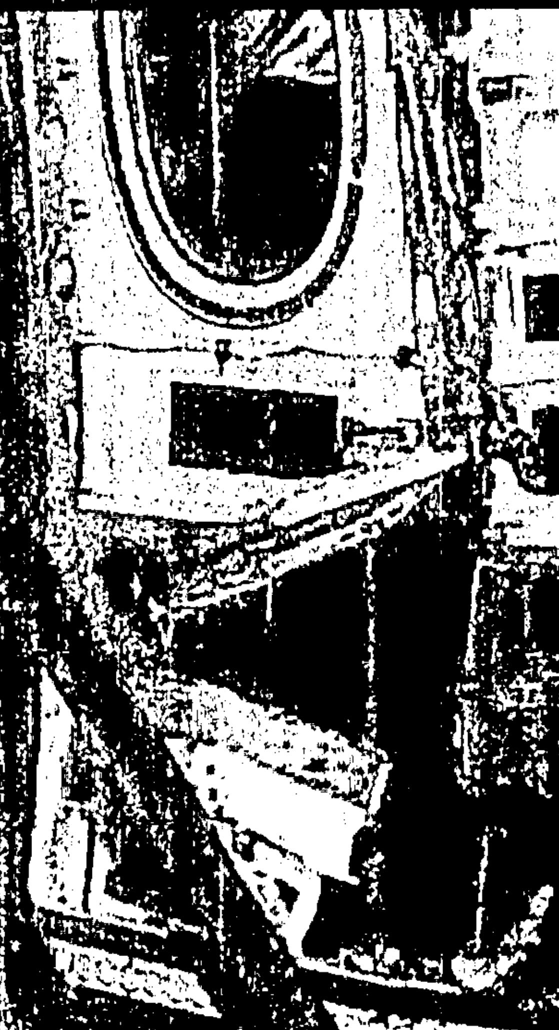
- Type Hartzell, six blade composite type.
- All six blades broke essentially at the same time within approximately 0.2 seconds at the hub.
- Both propellers had a operation time of 140 hours at the time of the incident.
- In the process of investigation, it was found that the propeller had a structural design problem at the root that could not stand the forces of such sideslip testing for a prolonged time period.

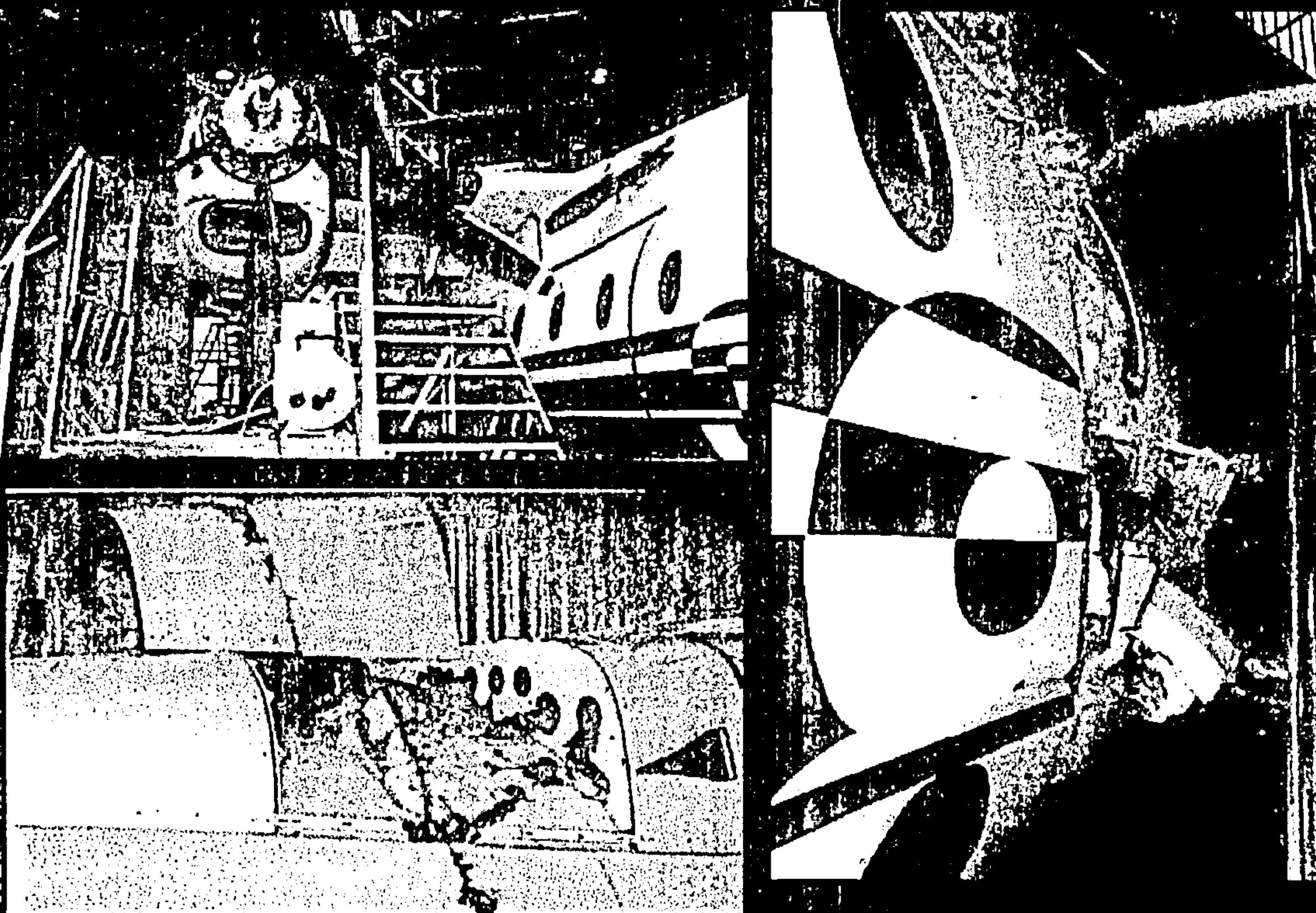
- Although sideslip tests have been performed with the propeller for its initial certification on a test bed aeroplane; on these tests the propeller is experiencing generic sideslip conditions, lacking the flow distortion caused by the fuselage when installed on the wing of the Dornier 328 aeroplane.
- THIS CONTINUOUS BENDING MOTION DURING EACH REVOLUTION HAD NOT BEEN CONSIDERED.
- In retrospective the fatigue life for this condition was estimated to be far less than one hour total.
- The propeller root was structurally reinforced for the serial propeller certificated with the aeroplane.

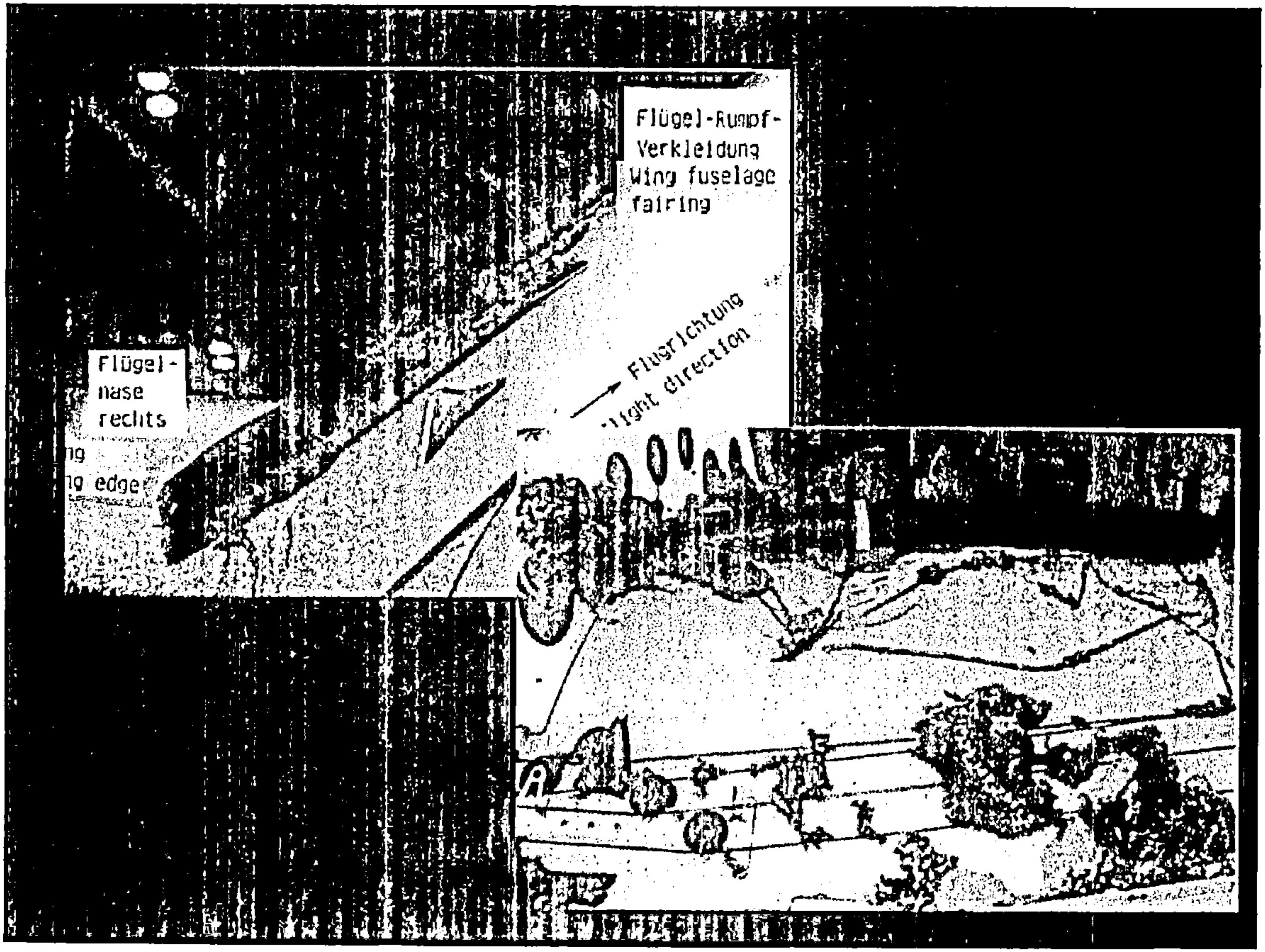
- Rudder limit introduced.
- Wing-Fuselage fairing redefined.
- Ventral Fins added.
- Vortex flow generators introduced on the vertical fin to improve stabiliser and elevator airflow flow.
- Landing Flap setting reduced to 20 degrees.

- Redefined larger ventral fins.
- Roll Spoilers added.
- REDS, Rudder Expanded Deflection System








Flügel-Rumpf-
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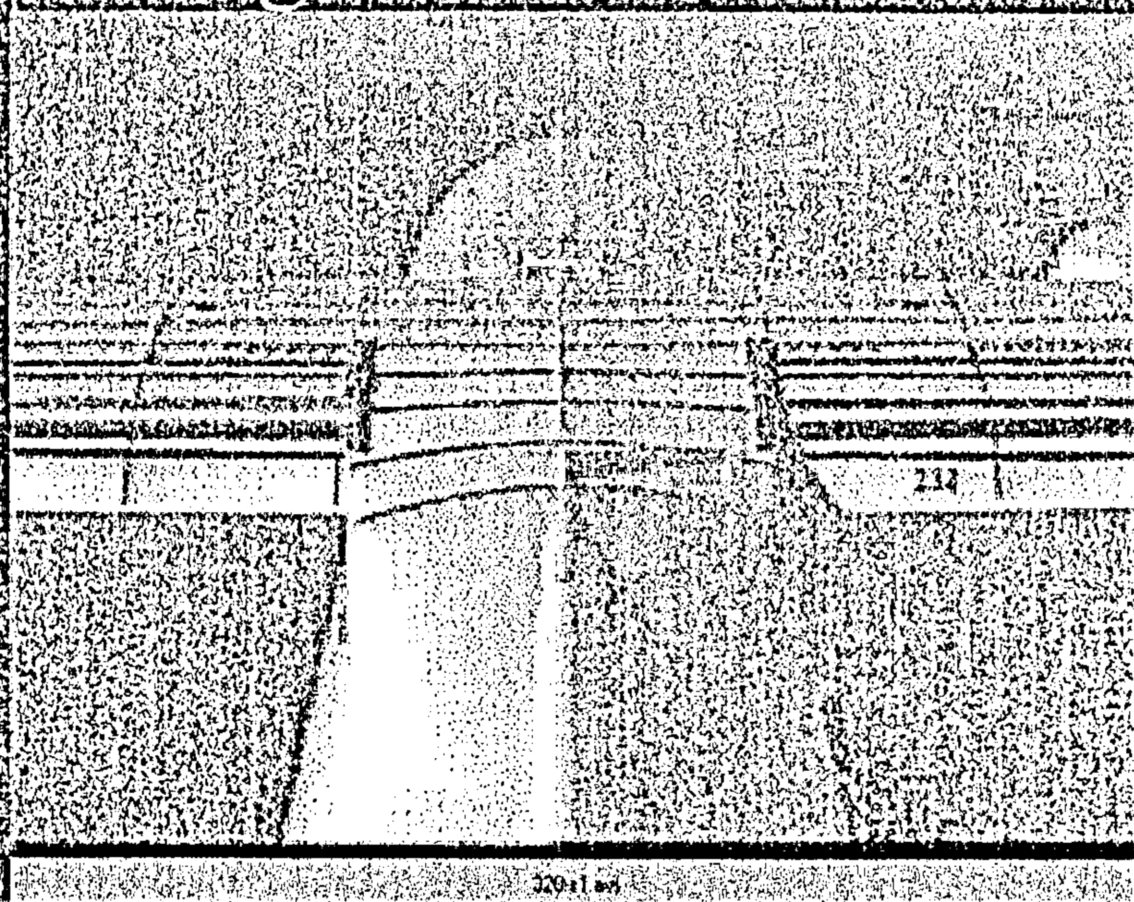
Flight Test D328-100



Information and Data were provided by

FAIRCHILD DORNIER

This Presentation was prepared for the 19th meeting of the Flight Test Harmonisation Working Group on Nov 30 - Dec 3rd, 1999 in Wichita, KS.

by Armin Kaiser

LBA

REPORT
on the Investigation of the Flight Accident
with the Dornier DO 328-100
on 14 December 1992 in the Area of Memmingen

Summarization

On December 14, 1992, flight tests were conducted in the area around Memmingen with the prototype DO 328-100, built by Dornier Aircraft Co. These tests were conducted to investigate, among other things, the aircraft directional stability. At approximately 1149*, the test point with the aircraft in the landing configuration was broken off by the responsible pilot, due to bobbing of the aircraft's nose combined with strong shaking (buffeting). The aircraft immediately entered an uncontrollable condition, and subsequently suffered the breakup of all six propeller blades of the propeller assembly of the left engine. The result of this was heavy damage to the left engine as well as resultant propeller impact and severe damage to the fuselage and to the cabin.

The responsible pilot was successful in bringing the aircraft under control, and in spite of the severe damage and engine failure brought the aircraft to a safe landing.

The accident is attributable to the fact that at the conclusion of the test point, a return to normal flight conditions was made difficult because the effectiveness of the elevator, which was in a nose-up condition, was adversely affected by flow field separation. This condition was not recognized by the pilot in time to allow a release of the elevator at the end of the test point.

A factor contributing to destruction of the propeller blades was a failure to reduce engine output. This resulted from a communications breakdown between flight test personnel.

1.0 Investigation of the Facts

1.1 Course of the Flight

In the program of developmental flight tests conducted by the aircraft manufacturer Dornier Aircraft Co., a test flight was planned on the prototype DO 328-100, serial number 3001 (Dornier internal designation TAC1). In the course of this flight an investigation into directional stability in various configurations was to be conducted.

Basis for test flight number F1 0101 was the associated flight test plan (Appendix 5.3).

On board the aircraft as responsible pilot (PIC) was the manufacturer's project pilot. Also on board as second pilot was a pilot from Dornier Aviation (North America).

During the flight the responsible flight test engineer was stationed in the Dornier Flight Test

* Times are local times unless otherwise indicated

telemetry ground station. From there, this individual coordinated the testing with the PIC and over radio provided the crew with necessary information from the ground data recorders.

The takeoff of TAC1 occurred at 0921 hrs from Oberpfaffenhofen, the Dornier company factory airport.

Up to the time of the incident at 1149 hrs, individual test points from the test plan were conducted without incident.

A critical point in the test plan were the T.O.P. 13 tests for investigation of static directional stability, in accordance with the airworthiness provisions JAR □25.177.

The tests for T.O.P. 13 were flown in various configurations starting around 1035 hrs. The results of these tests were quite variable. The opinion of the PIC regarding the flight characteristics ranged from "no problem" to "unacceptable".

The starting point of the incident was the test T.O.P. 13.14, which was begun around 1149 hrs at an altitude of 14,000 ft while in the following configuration:

Flap Position:	25 deg
Landing Gear:	extended
Engine Power:	2 x MTOP
Speed:	1.13 VSlg (98 KCAS)

Close to the point at which the maximum left rudder deflection was reached, a strong shaking (buffeting) began of such strength that the PIC could no longer maintain controlled flight. The PIC released the rudder and aileron and broke off the test. Immediately the aircraft went into a steep bank to the left along with a severe pitch-over. Airspeed continued to rise.

At an approximate roll angle of -90 deg the PIC assisted the rolling motion by an aileron deflection to the left, in order to, in his words, "roll the aircraft through".

The PIC, who was fully occupied with trying to bring the aircraft under control, requested the second pilot to reduce engine power with the words "Gase raus" (something like "chop the power"). This request was not followed.

Approximately 5.5 seconds later followed the structural failure, recognizable by noise on the audio recordings. At this point in time the aircraft was in a condition described by the following recorded data:

Airspeed:	171 kts	Sideslip angle:	19 deg
Pitch angle:	-48 deg	Normal acceleration:	-0.82 g
Roll angle:	-185 deg	Lateral acceleration	-0.82 g

Within a fraction of a second all six propeller blades on the left engine failed. At least two of the blades caused severe damage to the fuselage and to the interior of the cabin.

After the structural failure occurred, data transmission to the telemetry station was interrupted due to destruction of the transmitter antenna. Data transmission was later restored by switching to another antenna. Data recording on board the aircraft was, however, not interrupted except for a short drop-out. This enabled comprehensive data from throughout the period of the incident to be available post flight.

The PIC succeeded in bringing the aircraft under control, at which time airspeed had reached 250 kts. This speed was far over the allowable speed as specified in the flight manual 3001-5 Pkt.1.2.5 of:

180 KCAS	gear extended
145 KCAS	flaps > 15 deg extended

Also, the power level for the engines at pitch and roll angles exceeding +/- 35 deg, which are specified in flight manual 3001-5D from 22 Oct 92, were exceeded by these maneuvers. The altitude loss during the incident was 4,800 ft. The heavily damaged aircraft was landed safely on one engine at 1221 hrs at the factory airport at Oberpfaffenhofen.

1.2 Personnel Injury

None

1.3 Damage to Aircraft

All six propeller blades of the left engine were broken off. The left engine including its mount were heavily damaged.

At least two of the six blades damaged the fuselage section immediately forward of the wing leading edge, as well as the interior of the cabin. The control cable to the left engine control was cut through.

In addition one on-board antenna was damaged which lead to a brief interruption in data transmission to the telemetry station.

1.4 Auxiliary Damage

None.

1.5 Crew Information

1.5.1 Responsible Pilot

License: ATPL 1
Entitlements:
Flight Test Entitlement TB1, aerobatic flight
Type Permit: DO 228, DO 328
CL 600/601
Instruction Permit: DO 228, DO 328
Instrument Flight Permit: up to 200 ft
Total Flight Experience: 3,830 hours
Flight Experience in the DO 328: 200 hours
As PIC: 200 hours
Flight Medical Fitness: Class 1
without limitations

The Pilot was assigned as Project Pilot (Order No. 363 according to Developmental Handbook C-1.2) for conduct of the test flight. This was in conformity with conditions mentioned under Point C-2.1.9 of the company's Developmental Handbook (EBH).

1.5.2 Second Pilot

License: ATPL

Entitlements:

Flight Test Entitlement: Certificate as Graduate of the U.S. Naval Test Pilot School

Instrument Flight Entitlement: yes

Total Flight Experience: 4,000 hours

Flight Experience with the DO 328 as 2nd Pilot: 8 hours

Flight Medical Fitness: valid without limitations

The second pilot did not possess a German license as pilot and also did not have a type entitlement for the DO 328

1.6 Aircraft Information

The aircraft was the prototype of a passenger transport. Power was provided by two turbine engines, each equipped with a six-blade variable-pitch propeller installation. The propeller blades were of composite construction.

Construction:	Shoulder wing with pressurized cabin
Model:	DO328-100
Year Built:	1991
Series No:	3001
Plant Designation:	TAC1
Total Flight Time:	207 hours
Max. T.O. Mass:	13,670 Kg (include. 2% test equipment)
Weight at time of Incident:	12,300 Kg
Center of Gravity:	38% MAC
Engine:	P&W ZBE 119A
Left Engine:	S/N 116008 Operating time 139 hrs
Right Engine:	S/N 116006 Operating time 134 hrs

Checkout of the aircraft was accomplished at established intervals. The last maintenance check (200 hour check) was accomplished at 193 hours. Since that time the aircraft had an operating time of 13 hours.

The aircraft was undergoing testing for the purpose of extending the type permit according to airworthiness requirements of JAR 25.

For the conduct of the flights a temporary transport permit was provided by the Federal Aviation Office. Date of the permit was 21 August 1992. An element of the temporary permit was both the General Flight Instruction 3001-5 (EL549/92), Version A (6 Aug 92), as well as the Flight Instruction 3001-50, published 22 Oct 92.

The operating limitations and boundaries established in these documents were observed up until the occurrence of the incident.

In order to conduct the flight tests, the aircraft was equipped with numerous sensors to record flight test data. For on-board recording and for data transmission to the ground telemetry station, the cabin of TAC1 was outfitted with a flight test installation.

For measurement of angle of attack and angle of sideslip, a nose-boom was installed.

For visualization of the flow field, the upper side of the wing was tufted, and on the tail a video camera was installed.

The cockpit instruments and other flight deck equipment was consistent with that of the projected production aircraft with minor exceptions. Special flight test cockpit instrumentation was not provided.

The possibility of an emergency crew escape was provided for by the installation of an emergency exit in the rear of the cabin. Guide lines were installed between the flight deck and the emergency exit. Before leaving the flight deck, the pilot could lock the steering yoke in place in order to stabilize the flight attitude.

1.7 Meteorological Information

Visual flight rules were in effect and the crew view of the ground was unimpeded.

1.8 Navigation Aids

Not applicable

1.9 Radio Traffic

From takeoff to landing, TAC1 was in contact with the Oberpfaffenhofen Tower on Frequency 119.55 Mhz. Besides this, radio communication was maintained between TAC1 and the telemetry station on frequency 135.875 Mhz. This contact was for coordination of the test flight.

1.10 Airfield Information

Not applicable

1.11 Flight Recorder

The aircraft was equipped with an on-board data system which allowed the recording of more than 900 parameters. Besides the "on line" data transmission from the aircraft to the telemetry station, the flight data was recorded on magnetic tape for later analysis.

1.12 Information on the Impact and Wreckage

Not applicable

1.13 Medical and Pathological Information

Not applicable

1.14 Fire

Not applicable

1.15 Survivability

Not applicable

1.16 Further Investigation

1.161 Propeller Strength

Before the incident, in the course of inspections, delamination was discovered on individual propeller blades. This delamination was in the area of the blade root parallel to the trailing edge. This discovery led to limitations on the propeller (in accordance with flight instruction EL-979/92 of 10 Dec 92) to the extent that daily visual post-flight inspections were conducted. Limitations in angle of attack or sideslip were not made.

After the incident the left engine propeller assembly was subjected to a thorough damage analysis by Hartzell in the USA, assisted by the Dornier Company. the result was contained in the Hartzell Engineering Report No. 1232 of 8 Feb 1993.

Findings of Hartzell

During the test flight the destruction of the left propeller assembly occurred during a very short span of 0.6 seconds. The propeller loads which existed at this point in time were impossible to quantify, because the measured parameters, especially the sideslip angle, were outside the values used by Hartzell in the load assumption calculations of propeller strength.

As a final conclusion, it was accepted by Hartzell, that destruction of the propeller assembly was finally due to a low cycle high stress event.

Findings of the Flight Accident Investigation Center (FUS)

On the basis of the assertions in the above-mentioned Hartzell report, FUS comes to the following determination.

The delamination of the carbon-fiber composite layers of the destroyed blades, and the indications of a heating effect on the carbon fibers and on the foam core, could not be traced with complete certainty to deformation due to oscillating stress. The heavy damage in the area of the blade supports was more an indication of an excessive bending moment on the blade roots. In the end these roots were also unable to hold the carbon composite layers of the blades.

These bending moments could have been caused by aerodynamic loads and centrifugal moments on the blades or impact of the blades with each other.

A quantification of the loads which lead to the blades' destruction was not possible due to the skewed airflow into the left propeller as a result of the sideslip of the aircraft.

The following measures resulted from the findings:

By the Hartzell Company a modification and strengthening of the propeller blade feet was carried out.

In order to be able to determine propeller loads in extreme sideslip conditions, the modified blade assemblies were put through an interim series of appropriate flight tests.

1.16.2 Sound Recordings

A transcription was made of the sound recordings from the beginning of the test T.O.P. 13.14 to the point of the structural failure. A signal analysis of this recording over this span of time served to arrange the commentary of the flight in exact order.

A judgment concerning the engine and propeller behavior immediately before the point in time of the structural failure was only partially possible.

The speech transmissions from aircraft and telemetry station are clearly recognizable and distinguishable from each other in the signal analysis.

In the signal analysis, the structural failure was recognizable some 42 seconds after beginning of test T.O.P. 13.14. It was recognizable as a distinct amplitude increase which ended in a strongly pronounced noise. This signal behavior was consistent with the structural failure and following wind noises, which markedly increased as a result of the punctured fuselage skin.

1.17 Additional Information

1.17.1 Organization of the Flight Test

The Developmental Company DORNIER AVIATION Ltd.

The Dornier Company is a developmental company recognized by the Federal Aviation Office (LBA). This company carries out the development of an aircraft up until maturity, including responsibility for the model tests, under the oversight of the LBA. At the end of this process, the LBA grants the type certificate, as long as it is an exclusively national project.

Concerning the DO 328 a European certificate was desired on the basis of JAR 25. This had, however, no effect on the type and extent of investigation of this accident by the FUS.

The tasks and responsibilities relative to the conduct of the flight tests was in agreement with the Company Developmental Handbook (EBH) and was regulated by DORNIER AVIATION Ltd. as follows:

Within the Department for Developmental Flight Physics and Flight Test, the Division of Flight Test, along with other affected divisions of the Department, was responsible for the conduct of the flight tests in accordance with the test plan, as well as for the pilots used during the test flights. The pilots were appointed by the Flight Operations Department upon request by Flight Test.

Flight Test Personnel

For the test flight F1 0101 on 14 Dec 92, the crew of TAC1 consisted of the Dornier Project Pilot as responsible pilot, and a transport pilot of the company DORNIER AVIATION (NORTH AMERICA) as second pilot.

The responsibility of the Project Pilot, In accordance with the EBH, was the guidance and control of the test aircraft. The appointment of the second pilot also lay within his field of responsibility.

In accordance with the Flight Handbook for the DO 328, the minimum crew was two. This meant that, apart from instructional flights, the second pilot for a flight test was also required to possess a type permit for the DO 328. This, however, was not the case.

It was one of the tasks of the FUS to clarify whether the appointment of the second pilot, who was not a member of the development company DORNIER AVIATION Ltd., was technically consistent with regulations in the EBH or with other aviation rules.

The crucial point of the investigation was directed toward the matter of the degree to which the second pilot was able to carry out the tasks required of him, or whether actions relevant to the accident were to some degree caused by him.

The task of the second pilot during the conduct of the individual test points consisted of monitoring in particular the engine instruments. In addition, between test points he relieved the PIC by taking over control of the aircraft and setting up test conditions for the next test point.

On the basis of the sound and data recordings of the test flight, one gains the impression that the second pilot was able to assume, without problems, control of the aircraft after handoff from the PIC. Also other tasks, including monitoring of instruments, was assummed by the second pilot, insofar as this was discernible from the conversations. Since the second pilot, as a U.S citizen, apparently had a limited knowledge of German, communications between the two pilots was conducted exclusively in English.

Additional flight test personnel located in the telemetry station consisted of the responsible flight test engineer , the competent systems engineer, and data engineers. The duties and responsibilities of the flight test engineer was regulated in accordance with the EBH C-1.2 Order No. 362.

The coordination of the test flight was assumed by the flight test engineer, who also passed on significant flight test data to the crew of TAC1 via radio.

Verification of Directional Stability T.O.P. 13

The crucial point of this flight consisted of testing under T.O.P. 13 of the verification of directional stability in accordance with air worthiness requirements JAR □ 25.177.

Earlier tests in this area had already been conducted with unsatisfactory results, so that a modification in the wing-fuselage interface area had ben made.

Tufts were installed on the upper side of the wing, and a video camera was installed in the tail which allowed observation of the flow in this surface.

The progress of the tests were thoroughly documented data and by audio recordings.

For the tests for static directional stability, the aircraft was first put into the configuration corresponding to the respective test point. The configuration was defined by flap and landing gear position, engine power, and trimmed airspeed.

An increasing rudder deflection was input while maintaining stable level flight using proper elevator and airleron inputs. Sideslip angle built up until either maximum rudder deflection or maximum allowable rudder pedal force was reached. For fulfillment of air worthiness requirements, after removal of the pedal force the aircraft had to return to its intial conditions.

The test could, however, be broken off early if one of the following break-off criteria occurred:

- inpermissibly high control forces
- flow separation, made apparent by strong buffeting
- uncontrollable flight attitude changes

During the flight test the sideslip angle observed in the telemetry station was relayed to the pilot for his information. Relative to the sideslip angle, there was no limit corresponding to points (?) 1.2.8 of the general flight instruction EL 549-92. Therefore sideslip angle was not a break-off criteria for the test.

Progress of the Flight Test T.O.P. 13.14

On the basis of the on-board data recordings, the progress of the test could be comprehensively analyzed. The local time as recorded in the data is used as a time reference for the following events.

Three interconnected phases of the flight were identified:

Phase 1: Test T.O.P. 13.14

The test was announced at 11:48:51 by the PIC with the words "to the left", and simultaneously initiated by left deflection of the rudder.

The sideslip angle built up with increasing rudder deflection, which was relayed to the crew by the test engineer. The sideslip angle called out, however, was lower than the actual measured values due to improper calibration. This was only discovered after the flight.

Close to the point where, at 11:49:24, the maximum rudder angle deflection was reached, a strong buffeting began, and the PIC could no longer control the aircraft. This lead to breaking off the test.

Phase 2: Break-off of the Test

This section was closely tied to Phase 1 and ended with the structural failure at 11:49:33.4. Since this Phase lasting roughly ten seconds was especially significant for the course of of the incident, evaluation of the data is particularly important to above all determine steering inputs made by the PIC. (Appendix 5.4)

Note:

As time reference in this Phase only the seconds of the 49th minute will be given. This corresponds also to the scaling of the time axis in the data presentations in Appendix 5.4, to which reference will later be made.

The break-off of a test was intended to occur in a way that by the pilot releasing the control forces, the aircraft would return to stable flight conditions

The following describes the driving back of the deflected controls following break-off of the test.

The rudder deflection was taken out by the PIC, which was recognizable by a sharp reduction in pedal force from 35 to 10 daN. (Newtons ?) This resulted in a reduction in rudder deflection from 23 degrees to at first only 16 degrees and later to 8 degrees, after a further reduction in pedal force of some 4 daN.

The neutral rudder position was not reached, but rather the rudder deflection to the left grew greater as a result of the increased pedal force shortly before the end of Phase 2. As a result, sideslip angle again began to increase.

The aileron deflection was taken out by the PIC, which was recognizable by a sharp reduction in the hand forces from 12 daN to about 3 daN. As a result the tahe aileron deflection decreased from17 to just 8 degrees. The rolling movement of the aircraft continued with a roll rate to the left of -17 deg/sec. As -90 degrees was reached, aileron deflection to the left caused an increase in roll rate to -40 deg/sec. This occurred, according to the PIC, in an attempt to "roll the aircraft through". The structural failure of the propeller blades followed shortly after the aircraft was rolled over on its back.

A relaxation of the elevator at the end of the test was not apparent, which differed from earlier tests. To be sure, the elevator deflection changed during the Phase from 0 to 9 degrees, in the "pushover" direction, yet the hand force of the PIC exhibited fluctuating values which averaged about 20 daN in the "pull-up" direction. Not until 29.7 seconds was a temporary relaxation of the hand force apparent, which apparently was related to changes in aileron deflection.

In this Phase, the PIC tried if possible to prevent the aircraft nose from bobbing down by the application of positive hand force (pull-up).

The break-off of the test at the end of Phase 1 was commented on by the PIC with the words "and now it's going over the nose ..... with buffeting".

The buffeting was readily noticable in the data recording by fluctuations in measured parameters. This was shown in the recording of the second pilot's elevator force which, starting at 23.5 seconds, exhibited increasingly fluctuating values about an average of 2 daN. This corresponded apparently to the measured value of a released 2nd pilot's control column. The turbulent flow of the horizontal tail or also flow separation on the tail itself caused the measurement of an apparent hand force on the released 2nd pilot's control column.

The flight path of TAC1 was marked in this Phase by large changes in the following parameters:

After the nose bobbing, the pitch angle decreased very rapidly to -60 degrees, during which the nose-boom measured angle of attack decreased from 7 to -15 degrees. The sideslip angle decreased from 22 to 7 degrees following the break-off of the test, before it again increased and at the end of Phase 2 reached a value of nearly 19 degrees.

The airspeed increased, particularly under the influence of the steep flight path under full engine power, from 103 to 171 kts.
<u>Phase 3: Reestablishment of normal flight attitude</u>

This section was marked by reestablishment of a normal flight attitude, in close connection to Phase 2.

The PIC was successful in bringing the aircraft under control, at which time the aircraft rapidly reached an airspeed of 250 kts. The total altitude loss during the incident amounted to 4,800 ft.

1.17.3 Meaning of Airworthiness Requirement JAR □ 25.177

The verification of static directional stability airworthiness requirements is accomplished through flight test and commonly accepted practices. This requires stability verification up to the full rudder deflection or up to the maximum allowable sideslip angle. During these test, sideslip angles can be reached which have no practical meaning for later flight operations, if the possibility of uncoordinated rudder deflections are not envisioned.

The conduct of these tests has had a not inconsiderable adverse effect on flight safety, as has been shown in the past occasionally during flight trials of this type. Since rudder measurement and deflection is an essential factor for minimum control speed, and therefore for takeoff field length, the aircraft manufacturer strives for a high rudder effectiveness, which makes the verification of directional stability more difficult.

The question can be asked whether the airworthiness requirements, which have been used in this form for decades, still has the meaning that it previously did. At the time of the origin of these requirements, side-slipped flight was a possible conscious maneuver used to correct the flight path.

While, as always, changes to the flight attitude about the lateral axis with elevator (pitch angle), and about the longitudinal axis with aileron (roll angle) still have their essential meaning for flight controls, the rudder has only the task of making changes to flight attitude about the z-axis and of avoiding sideslip angle. This means, in one case, a relatively low rudder deflection is required in flight to compensate for side-rolling moment in curved flight and, eventually, for cross-wind landings, while in the case of a failed engine, a greater rudder deflection is required to compensate for the associated upsetting moment. Exactly in this last case, the rudder has the primary task for a civil transport of working against sideslip angle, and not of producing it.

The question can be asked whether the flight test verification of static directional stability using full rudder deflections justifies the associated risk for aircraft and crew.

2.0 Evaluation

In the investigation of the accident, particular attention had to be paid to the fact that the aircraft was under test and that the incident occurred on a test flight dedicated to the verification of various airworthiness requirements.

However, it could not be a matter for the investigation to make conclusions about the future fulfillability of the airworthiness regulations or to express recommendations about them.

Likewise it was not possible, and was not in this case, the task of the accident investigation, to investigate the detailed causes for the structural destruction of the propeller blades. On the basis of the extreme flight conditions immediately before the failure of the blades began, the blades clearly were subjected to extreme forces, the type and magnitude of which could not be quantified. Inertial forces, the high engine output, as well as the high aerodynamic forces on the blades, especially considering the unsteady flow at increasing sideslip angles, all could explain the destruction of the propeller blades on the left engine, while those on the right engine remained undamaged.

The investigation into the accident by the FUS concentrated therefore on the findings and analysis related to the uncontrolled flight attitude after breaking off the test point T.O.P. 13.14.

In accordance with the Airworthiness Requirements JAR □ 25.177 the directional stability of the aircraft was tested in various configurations. During this testing, some of the results had been termed "unacceptable" by the PIC, even before test point T.O.P. 13.14 was reached. In spite of this, the planned order of test points was continued. During flight testing it is not unusual to continue a series of tests even if interim results are unacceptable. This enables a comprehensive evaluation of a series of tests to be made. Moreover, the crew did not perceive any impact to flight safety due to the occasional uncontrolled "pitch down" behavior of the aircraft.

During T.O.P. 13.14 the test was initiated by a rudder deflection to the left. The test was broken off shortly before reaching maximum rudder deflection due to bobbing of the aircraft nose and strong buffeting.

An essential part of the investigation consisted of an analysis of the ten second Phase following break-off of the test, during which a normal flight attitude could not be reestablished, and at the end of which structural failure of the propeller blades on the left engine occurred.

A relaxation of the elevator at the end of the test was not apparent, which differed from earlier tests, but at least a high force in the pull-up direction was maintained, without being able to prevent an increasing pitch down of the aircraft.

In contrast to this, the tests resulting from T.O.P. 13.14 were conducted in such a manner that the control deflections in all three axes were driven back, and the aircraft was able to return to its normal flight attitude due to its stability. (Trans. Note: This paragraph, like some others, is written in a very confusing manner and its meaning [and the previous one as well] is not entirely clear.)

The data (RT. CTRL. WHEEL FORCE - Elevator), show increasingly oscillatory values about the nominal value beginning at the break-off of the test. On the basis of this data, it is apparent that in this case flow separation on the elevator impacted its effectiveness such that control forces increased to the extent, that in spite of a "Pull-up" on the control wheel, the elevator deflection increased downward.

The aileron deflection to the left, some three seconds before the structural failure, in order to support the rolling movement was a conscious input made by the pilot with the intent of "rolling the aircraft through". The simultaneous rudder deflection to the left could also have been a conscious input of the PIC made in order to "coordinate" the roll. In consideration of the inverted attitude of the aircraft which occurred, this must have had the opposite effect, that is, a renewed increase of the sideslip angle.

It cannot be excluded, that the control inputs of the responsible pilot in this phase were decisively influenced by the accelerations and severe flight attitude changes which occurred. Outside of this, it must be taken into consideration that the rapid pace of events scarcely gave the PIC time for decision-making and for taking proper corrective measures.

trans-2b.wps

Feb 3, 1993

HTTB
C-130 Type
Test bed
Lockheed

02/03/93

NTSB Identification: ATL93MA055 For details, refer to NTSB microfiche number 52843A

Accident occurred FEB-03-93 at MARIETTA, GA
Aircraft: LOCKHEED L382E-44K-20, registration: N130X
Injuries: 7 Fatal.

THE ACFT WAS DESIGNED & USED AS THE COMPANY'S ENGINEERING TEST BED. AN EVALUATION OF THE FLY-BY-WIRE RUDDER ACTUATOR & GROUND MINIMUM CONTROL SPEED (VMCG) WAS BEING CONDUCTED. DURING THE FINAL HI-SPEED GROUND TEST RUN, THE ACFT ABRUPTLY VEERED LEFT & BECAME AIRBORNE. IT ENTERED A LEFT TURN, CLIMBED TO ABOUT 250 FT, DEPARTED CONTROLLED FLT & IMPACTED THE GRND. INVESTIGATION REVEALED A DESIGN FEATURE IN THE RUDDER ACTUATOR THAT REMOVES HYD PRESSURE WITHIN THE ACTUATOR IF THE RUDDER POSITION COMMANDED BY THE PILOT EXCEEDED THE ACTUAL RUDDER ACTUATOR POSITION FOR A SPECIFIED TIME, AND THE RUDDER AERODYNAMICALLY TRAILS. THE ACTUATOR PREVIOUSLY DISENGAGED IN FLT. THE COMPANY DID NOT CONDUCT A SYSTEM SAFETY REVIEW OF THE RUDDER BYPASS FEATURE & ITS CONSEQUENCES TO ALL FLT REGIMES, NOR OF THE VMCG TEST. THE FLT TEST PLAN SPECIFIED THAT ENGINE POWER BE RETARDED IF THE RUDDER BECAME INEFFECTIVE. NEITHER PLT HAD RECEIVED TRAINING AS AN EXPERIMENTAL TEST PLT. THE COMPANY ALLOWED EXPERIMENTAL FLT TESTS AT A CONFINED, METROPOLITAN ARPT.

Probable Cause

DISENGAGEMENT OF THE RUDDER FLY-BY-WIRE FLIGHT CONTROL SYSTEM RESULTING IN A TOTAL LOSS OF RUDDER CONTROL CAPABILITY WHILE CONDUCTING GROUND MINIMUM CONTROL SPEED TESTS. THE DISENGAGEMENT WAS A RESULT OF THE INADEQUATE DESIGN OF THE RUDDER'S INTEGRATED ACTUATOR PACKAGE BY ITS MANUFACTURER; THE OPERATOR'S INSUFFICIENT SYSTEM SAFETY REVIEW FAILED TO CONSIDER THE CONSEQUENCES OF THE INADEQUATE DESIGN TO ALL OPERATING REGIMES. A FACTOR WHICH CONTRIBUTED TO THE ACCIDENT WAS THE FLIGHT CREW'S LACK OF ENGINEERING FLIGHT TEST TRAINING.

Index for Feb 1993 | Index of Months □□□□□□□

REQUEST 074/98, REPORT 23

DATA REPORT — LOCKHEED-382B/100 HERCULES — ACCIDENT

EVENTS|PHASES:
FLIGHT CONTROL SYSTEM FAILURE-TAKE-OFF RUN
SPIN-INITIAL CLIMB
COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 93/0414-0
FROM STATE : UNITED STATES

DATE, TIME AND METEOROLOGICAL DATA

DATE : 93-02-03
TIME : 13:27
LIGHT : DAYLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 27 001 - 272 000 KG
STATE OF REGISTRY : UNITED STATES
REGISTRATION : N130X

LOCATION

LOCATION : MARIETTA,GA
STATE/AREA : UNITED STATES
DEPARTED : MARIETTA,GA
DESTINATION : MARIETTA,GA

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	7	0	0	0	0	7
PAX :	0	0	0	0	0	0

NARRATIVE

THE A/C WAS DESIGNED AND USED AS THE COMPANY'S ENGINEERING TEST BED. AN EVALUATION OF THE FLY-BY-WIRE RUDDER ACTUATOR AND GROUND MINIMUM CONTROL SPEED (VMCG) WAS BEING CONDUCTED. DURING THE FINAL HIGH SPEED GROUND TEST RUN, THE A/C ABRUPTLY VEERED LEFT AND BECAME AIRBORNE. IT ENTERED A LEFT TURN, CLIMBED TO ABOUT 250 FT, LOST CONTROL AND IMPACTED TERRAIN. INVESTIGATION REVEALED A DESIGN FEATURE IN THE RUDDER ACTUATOR THAT REMOVES HYDRAULIC PRESSURE WITHIN THE ACTUATOR IF THE RUDDER POSITION COMMANDED BY THE PILOT EXCEEDED THE ACTUAL RUDDER ACTUATOR POSITION FOR A SPECIFIED TIME, AND THE RUDDER AERODYNAMICALLY TRAILS. THE ACTUATOR PREVIOUSLY DISENGAGED IN FLIGHT. THE COMPANY DID NOT CONDUCT A SYSTEM SAFETY REVIEW OF THE RUDDER BYPASS FEATURE AND ITS CONSEQUENCES TO ALL FLIGHT REGIMES, NOR OF THE VMCG TEST. THE FLIGHT TEST PLAN SPECIFIED THAT ENGINE POWER BE RETARDED IF THE RUDDER BECAME INEFFECTIVE. NEITHER PILOT HAD RECEIVED TRAINING AS AN EXPERIMENTAL TEST PILOT. THE COMPANY ALLOWED EXPERIMENTAL FLIGHT TESTS AT A CONFINED, METROPOLITAN A/P'S.

SEQUENCE OF EVENTS

EVENT 1 FLIGHT CONTROL SYSTEM FAILURE - TAKE-OFF RUN
- 1.RUDDER SYSTEM - INADEQUATE/NOT ENGAGED
  - 1.MANUFACTURER-DESIGN-INADEQUATE
  - 2.MANUFACTURER-QUALITY CONTROL-INSUFFICIENT
- 2.DIRECTIONAL CONTROL - IMPOSSIBLE
- 3.FLIGHT CREW PROCEDURES - NOT FOLLOWED
  - 1.OPERATOR - MANAGEMENT-TRAINING-INADEQUATE

EVENT 2 SPIN - INITIAL CLIMB
- 1.LIFT-OFF - PERFORMED
- 2.AIRCRAFT CONTROL - IMPOSSIBLE
- 3.SPIN - INADVERTENT

EVENT 3 COLLISION WITH LEVEL TERRAIN/WATER - EMERGENCY/UNCONTROLLED DESCENT

++ REQUEST 140/94, REPORT # 222
++

+ UNOFFICIAL REPORT LOCKHEED - 382B/100 HERCULES ACCIDENT +

+ EVENTS | PHASES: FLIGHT CONTROL SYSTEM FAILURE | TAKE-OFF RUN +

+ COLLISION WITH LEVEL TERRAIN/WATER | EMERGENCY/UNCONTROLLED DESCENT +

++

++

<---------------- OPERATION ---------------> ++ <---------------- FILE DATA -----------------

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 93/0414-0

++ FROM STATE :

++

<--------------------- WHEN -------------------> ++ <------------ AIRCRAFT DATA ------------

DATE : 93-02-03 ++ MASS CATEGORY : 27 001 - 272 000 KG

TIME : 13:30 ++ STATE OF REGISTRY :

LIGHT : DAYLIGHT ++ REGISTRATION : N130X

++

<-------------------- WHERE -------------------> ++ <-------- DAMAGE, INJURY AND TOTAL ON BOARD -------->

LOCATION : MARIETTA, GA ++ A/C DAMAGE : DESTROYED

STATE/AREA : UNITED STATES ++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL

DEPARTED : MARIETTA, GA ++ CREW : 7 0 0 0 0 7

DESTINATION : MARIETTA, GA ++ PAX : 0 0 0 0 0 0

OTHER DAMAGE :

---------------- EVENTS AND FACTORS -----------------

1. EVENT | PHASE: FLIGHT CONTROL SYSTEM FAILURE | TAKE-OFF RUN
2. EVENT | PHASE: COLLISION WITH LEVEL TERRAIN/WATER | EMERGENCY/UNCONTROLLED DESCENT

CATHAY PACIFIC AIRWAYS has bested China Southern Airlines for a 75% stake in Air Hong Kong, a struggling cargo carrier that reportedly has seen a dramatic financial turnaround in the past year. Air Hong Kong operates three Boeing 747-100/200s from Polaris Aircraft Leasing on European routes to Brussels and Manchester and Asian routes to Singapore, Ho Chi Minh City, Nagoya and Kuala Lumpur.

ATL93MA055

A NATIONAL TRANSPORTATION safety board report identified a faulty actuator design as the probable cause of the Feb. 3, 1993, crash of Lockheed's High Technology Test Bed (HTTB) aircraft. The NTSB said the "disengagement of the rudder fly-by-wire flight control system" resulted in a total loss of rudder control during high-speed taxi tests. "The disengagement was a result of the inadequate design of the rudder's integrated actuator package" by manufacturer Lucas Aerospace. The report also faulted Lockheed for failing to conduct a "safety review of the rudder bypass feature and its consequences to all flight regimes" after the actuator disengaged during a previous flight. All seven crewmembers were killed in the crash of the highly modified L-100-20 transport (*AW&ST* Feb. 8, 1993, p. 17).

National Transportation Safety Board
Washington, DC 20594

Printed on : 7/7/2011 5:35:03 PM

Brief of Accident

Adopted 03/18/1994

ATL93MA055
File No. 736 | 02/03/1993 | MARIETTA, GA | Aircraft Reg No. N130X | Time (Local): 13:27 EST

Make/Model:	Lockheed / L382E-44K-20
Engine Make/Model:	Allison / 501-M71K
Aircraft Damage:	Destroyed
Number of Engines:	4
Operating Certificate(s):	None
Type of Flight Operation:	
Reg. Flight Conducted Under:	Part 91: General Aviation

	Fatal	Serious	Minor/None
Crew	7	0	0
Pass	0	0	0

Last Depart. Point:	Same as Accident/Incident Location
Destination:	Local Flight
Airport Proximity:	On Airport/Airstrip
Airport Name:	DOBBINS AFB
Runway Identification:	11
Runway Length/Width (Ft):	10000 / 300
Runway Surface:	Concrete
Runway Surface Condition:	Dry

Condition of Light:	Day
Weather Info Src:	Weather Observation Facility
Basic Weather:	Visual Conditions
Lowest Ceiling:	None
Visibility:	7.00 SM
Wind Dir/Speed:	130 / 003 Kts
Temperature (°C):	10
Precip/Obscuration:	

Pilot-in-Command Age: 42

Certificate(s)/Rating(s)
Airline Transport; Flight Instructor; Flight Engineer; Multi-engine Land; Single-engine Land

Instrument Ratings
Airplane

Flight Time (Hours)

Total All Aircraft:	7658
Last 90 Days:	74
Total Make/Model:	1260
Total Instrument Time:	1124

THE ACFT WAS DESIGNED & USED AS THE COMPANY'S ENGINEERING TEST BED. AN EVALUATION OF THE FLY-BY-WIRE RUDDER ACTUATOR & GROUND MINIMUM CONTROL SPEED (VMCG) WAS BEING CONDUCTED. DURING THE FINAL HI-SPEED GROUND TEST RUN, THE ACFT ABRUPTLY VEERED LEFT & BECAME AIRBORNE. IT ENTERED A LEFT TURN, CLIMBED TO ABOUT 250 FT, DEPARTED CONTROLLED FLT & IMPACTED THE GRND. INVESTIGATION REVEALED A DESIGN FEATURE IN THE RUDDER ACTUATOR THAT REMOVES HYD PRESSURE WITHIN THE ACTUATOR IF THE RUDDER POSITION COMMANDED BY THE PILOT EXCEEDED THE ACTUAL RUDDER ACTUATOR POSITION FOR A SPECIFIED TIME, AND THE RUDDER AERODYNAMICALLY TRAILS. THE ACTUATOR PREVIOUSLY DISENGAGED IN FLT. THE COMPANY DID NOT CONDUCT A SYSTEM SAFETY REVIEW OF THE RUDDER BYPASS FEATURE & ITS CONSEQUENCES TO ALL FLT REGIMES, NOR OF THE VMCG TEST. THE FLT TEST PLAN SPECIFIED THAT ENGINE POWER BE RETARDED IF THE RUDDER BECAME INEFFECTIVE. NEITHER PLT HAD RECEIVED TRAINING AS AN EXPERIMENTAL TEST PLT. THE COMPANY ALLOWED EXPERIMENTAL FLT TESTS AT A CONFINED, METROPOLITAN ARPT.

ATL93MA055

File No. 736	02/03/1993	MARIETTA, GA	Aircraft Reg No. N130X	Time (Local): 13:27 EST

Occurrence #1: LOSS OF CONTROL - ON GROUND/WATER
Phase of Operation: OTHER

Findings
1. (C) FLT CONTROL SYST,RUDDER CONTROL - INADEQUATE
2. (F) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER
3. (C) INADEQUATE SUBSTANTIATION PROCESS,INSUFF REVIEW - COMPANY/OPERATOR MGMT
4. (C) FLT CONTROL SYST,RUDDER - DISENGAGED
5. (C) DIRECTIONAL CONTROL - NOT POSSIBLE - PILOT IN COMMAND
6. PROCEDURES/DIRECTIVES - NOT FOLLOWED - PILOT IN COMMAND
7. (F) INADEQUATE TRAINING - COMPANY/OPERATOR MANAGEMENT

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings
8. LIFT-OFF - PERFORMED - PILOT IN COMMAND
9. (C) AIRCRAFT CONTROL - NOT POSSIBLE - PILOT IN COMMAND
10. STALL/SPIN - INADVERTENT - PILOT IN COMMAND

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings Legend: (C) = Cause, (F) = Factor

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
DISENGAGEMENT OF THE RUDDER FLY-BY-WIRE FLIGHT CONTROL SYSTEM RESULTING IN A TOTAL LOSS OF RUDDER CONTROL CAPABILITY WHILE CONDUCTING GROUND MINIMUM CONTROL SPEED TESTS. THE DISENGAGEMENT WAS A RESULT OF THE INADEQUATE DESIGN OF THE RUDDER'S INTEGRATED ACTUATOR PACKAGE BY ITS MANUFACTURER; THE OPERATOR'S INSUFFICIENT SYSTEM SAFETY REVIEW FAILED TO CONSIDER THE CONSEQUENCES OF THE INADEQUATE DESIGN TO ALL OPERATING REGIMES. A FACTOR WHICH CONTRIBUTED TO THE ACCIDENT WAS THE FLIGHT CREW'S LACK OF ENGINEERING FLIGHT TEST TRAINING.

April 29, 1993

DASA
FR06

04/29/93

```
+------------------------------------------ REQUEST 074/98, REPORT  24 ------------------------------------------+
+ UNOFFICIAL REPORT                          MCDONNELL-DOUGLAS-DC-9-10                                 ACCIDENT +
+ EVENTS¦PHASES                      COLLISION WITH LEVEL TERRAIN/WATER-EN-ROUTE                                 +
+----------------------------------------------------------------------------------------------------------------+
                                                           ++
<----------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL         ++ ICAO FILE          :  93/0268-0
                                                           ++ FROM STATE         :
FINAL REP                                                  ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ---------> ++ <--------------------- AIRCRAFT DATA -------------------->
DATE          :  93-04-02                                  ++ MASS CATEGORY      :  27 001 - 272 000 KG
TIME          :  00:00                                     ++ STATE OF REGISTRY  :  VENEZUELA
LIGHT         :  DAYLIGHT                                  ++ REGISTRATION       :  YV-03C
GEN WEATHER   :  VMC                                       ++
                                                           ++
<----------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  NEAR MARGARITA ISLAND                     ++ A/C DAMAGE         :  DESTROYED
STATE/AREA    :  VENEZUELA                                 ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :                                            ++ CREW   :       3      0      0     0     0      3
DESTINATION   :                                            ++ PAX    :       7      0      0     0     0      7
                                                           ++
```

---------------- NARRATIVE ----------------

DURING A TEST FLIGHT FOLLOWING ROUTINE MAINTENANCE, THE AIRCRAFT APPEARS TO HAVE GOT INTO DIFFICULTIES AND CRASHED INTO THE SEA OFF MARGARITA ISLAND. THE ACCIDENT HAPPENED IN DAYLIGHT AND IN GOOD WEATHER. THE DC-9 HAD DEPARTED CARACAS SOME 37MIN. EARLIER AND ALL SEEMS TO HAVE BEEN WELL UNTIL SOME 9MIN. AFTER THE START OF TEST MANOEUVRES WHEN A BRIEF 'MAYDAY' WAS PICKED UP BY ATC.

```
+------------------------------------------ REQUEST 074/98, REPORT  25 ------------------------------------------+
+ PRELIMINARY REPORT                        DEUTSCHE AEROSPACE (DASA)-                                  ACCIDENT +
+ EVENTS¦PHASES                        SEPARATION IN FLIGHT - GEAR DOOR-CRUISE                                   +
+                                WHEELS-UP LANDING-INTENTIONAL-LEVEL OFF/TOUCHDOWN                               +
+----------------------------------------------------------------------------------------------------------------+
                                                           ++
<----------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL         ++ ICAO FILE          :  93/0134-0
                                                           ++ FROM STATE         :  GERMANY
FINAL REP                                                  ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ---------> ++ <--------------------- AIRCRAFT DATA -------------------->
DATE          :  93-04-29                                  ++ MASS CATEGORY      :  2250 - 5700 KG
TIME          :  17:10                                     ++ STATE OF REGISTRY  :  GERMANY
LIGHT         :  DAYLIGHT                                  ++ REGISTRATION       :  D-FANA
GEN WEATHER   :  VMC                                       ++
                                                           ++
<----------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  MANCHING                                  ++ A/C DAMAGE         :  SUBSTANTIAL
STATE/AREA    :  GERMANY                                   ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  MANCHING                                  ++ CREW   :       0      0      0     1     0      1
DESTINATION   :  MANCHING                                  ++ PAX    :       0      0      0     0     0      0
                                                           ++
```

---------------- NARRATIVE ----------------

DURING A TEST FLIGHT UNDER HIGH SPEED CONDITIONS (375 KT) THE GEAR DOORS WERE OPENED MANUALLY AND SEPARATED. THE RIGHT GEAR WAS LOCKED BECAUSE OF A HYDRAULIC FAILURE. THE A/C WAS LANDED ON THE LEFT MAIN GEAR AND NOSE GEAR.

Bundesstelle für Flugunfalluntersuchung
Hermann-Blenk-Straße 16
D-38108 Braunschweig

15

Datensatz

Unfall eines deutschen Lfz. im Inland
ohne Verletzte

Luftfahrzeugart	:	Flugzeug
Luftfahrzeughersteller	:	DASA
Muster/Typ	:	FR06
Eintragungsstaat	:	Deutschland
Datum der Störung	:	29/04/1993
Uhrzeit der Störung	:	17.10 Uhr
Störungsort Location	:	Manching
Regierungsbezirk/Staat	:	Oberbayern (BY)

1.0 Tatsachenermittlung

1.1 Flugverlauf

Betriebsart - Allgemeine Luftfahrt	:	verschiedene Betriebsarten
	:	- Versuchs-, Forschungs-, Erprobungsflug
Art des Halters - Allgm. Luftfahrt	:	Hersteller
FS-Flugplan/Freigabe	:	ohne Flugplan
Letzter Abflugort	:	Manching
Zielort	:	Manching
1. Betriebsphase	:	Flugphase
	:	- Reiseflug
1. Art der Störung	:	Ausfall der Fahrwerksanlage, ATA 32
2. Betriebsphase	:	Landephase
	:	- Abfangen/Aufsetzen
2. Art der Störung	:	Landung mit nicht/teilw. ausgefahrenem Fahrw.
Art der Notlage	:	vermutete oder bemerkte Schäden am Lfz.
	:	Fahrwerkfehlfunktion
Notlandung / Vorsorgliche Landung	:	Notlandung auf einem Flugplatz
Geschwindigkeit bei Störungsbeginn	:	375 kt
Flughöhe bei Eintritt der Störung	:	20000 Fuß ü.NN

1.2 Personenschäden

keine Verletzten

1.3 Schaden am Luftfahrzeug

Luftfahrzeug : schwer beschädigt

1.4 Sachschaden Dritter

keiner

...

1.5 Angaben zur Besatzung

Luftfahrzeugführer am Steuer : verantwortlicher Luftfahrzeugführer

Verantwortlicher Luftfahrzeugführer
Lebensalter : 48 Jahre
Erlaubnis : Verkehrsluftfahrzeugführer
Luftfahrerschein - erstmal.Ausstllg: Luftfahrt-Bundesamt
- Jahr der Ausstellung : 86
Gültigkeit der Erlaubnis : am Unfalltage gültig
Berechtigungen - Kategorie u.Klasse: einmotorige Land-Flugzeuge - bis 5700 kg
Musterberechtigung : erforderliche Berechtigung vorhanden
Sonstige Berechtigungen : Testflug-Berechtigung
Gültigkeit der maßgebl. Berechtig. : Berechtigung gültig

Gesamtflugerfahrung : 4074 Stunden
Flugerfahrung auf dem Muster : 12 Stunden
Landungen auf dem Muster
- Gesamt : 5 bis 10
- in den letzten 90 Tagen : 5 bis 10
Fliegerärztl. Tauglichkeitsklasse : tauglich ohne Auflagen und Beschränkungen

1.6 Angaben zum Luftfahrzeug

Luftfahrzeughersteller : DASA
Muster/Typ : FR06
Luftfahrzeug-Werknummer : RF01
Luftfahrzeugart : Flugzeug
Flugmasse : über 2 000 kg - 5 700 kg
Fluggewicht : innerhalb der zulässigen Grenzen
Schwerpunktlage : innerhalb der zulässigen Grenzen
Fahrwerksart : einziehbares Bugradfahrwerk
Triebwerksart : Zweikreis-Turbinen-Strahltriebwerk
Gesamt-Betriebszeit des Lfz. : 56 Stunden
Nachprüfungs- und Wartungskontrolle
Art der letzten Wartungskontrolle : sonstige

1.7 Meteorologische Informationen

Lichtverhältnisse : Tageslicht
Windrichtung : 050 Grad
Windgeschwindigkeit : 13 kt
Sicht am Boden : mehr als 10 km
Örtliche Sichtbehinderung : keine
Bewölkung : heiter - 1/8 bis 4/8 über 1 000 ft
Haupwolkenuntergrenze : keine
Niederschlag : keiner
Flugwetterbedingungen : Sichtwetterbedingungen

1.8 Navigationshilfen

...

1.9 Funkverkehr

Sprechfunkverbindg.m.Bodenfunkstel.	: vorhanden und zufriedenstellend
Bodenfunkstelle	: Platzkontrolle

1.10 Angaben zum Flugplatz

Name des Flugplatzes	: Manching
Flugplatzart	: Militärflugplatz/zivile Mitbenutzung
Luftaufsicht/Flugleitung	: Luftaufsicht/Flugleitung - in Betrieb
Höhe des Flugplatzes	: 1207 Fuß
Bahnart - Start- und Landebahn	: Beton
Verfügbare Bahnlänge	: 4000 Meter
S/L-Bahn - Richtung	: 07R
Bahnzustand	: normaler Bahnzustand

1.11 Flugschreiber

1.12 Angaben über Wrack und Aufprall

Geländeart - Oberflächenzustand	: Beton, Pflaster, Asphalt usw.
Lage des Wracks	
- Abstand von der Bahnschwelle	: 600 Meter
- Richtung von der Bahnmittellinie	: 0 Grad

1.13 Medizinische und pathologische Angaben

1.14 Brand

Entstehung/Fortsetzung des Brandes : Brand nicht entstanden

1.15 Überlebensmöglichkeiten

2.0 Auswertung

Von den möglichen Ursachen sind ermittelt	: Flugwerk durch
	: - Befund am Luftfahrzeug
	: sonstiges Luftfahrtpersonal durch
	: - Befund am Luftfahrzeug

3.0 Schlußfolgerungen

1. Betriebsphase	: Flugphase
	: - Reiseflug
1. Art der Störung	: Ausfall der Fahrwerksanlage, ATA 32
2. Betriebsphase	: Landephase
	: - Abfangen/Aufsetzen
2. Art der Störung	: Landung mit nicht/teilw. ausgefahrenem Fahrw.
Notlandung / Vorsorgliche Landung	: Notlandung auf einem Flugplatz
Ursachen	
- der 1. Störungsart	: Flugwerk

...

Ursachen

- der 1. Störungsart	: Rumpf
	: - Fahrwerkklappen
	: - im Flug vom Luftfahrzeug abgelöst
- der 2. Störungsart	: Flugwerk
	: Fahrwerk
	: - Ein- und Ausfahrmechanismus - Normalbetrieb
	: - Leck/Undichtigkeit
	: Flugwerk
	: Fahrwerk
	: - Hauptfahrwerksbeine, Streben, Befestigungen
	: - blockiert
- beider Störungsarten	: sonstiges Personal
	: Entwicklungs-/Fertigungspersonal
	: - Konstruktionsmängel

Bemerkungen:

Im Schnellflug wurden die Hauptfahrwerkklappen aufgezogen und abgerissen. Die Fahrwerklappen sollen künftig verriegelt werden.

4.0 Empfehlungen

keine

Verteiler	: Bundesminister für Verkehr
	: Luftfahrt-Bundesamt Abt. Technik und Gruppe Recht
	: Bayerisches Staatsministerium für Wirtschaft und Verkehr
	: International Civil Aviation Organization
	: Deutscher Aero-Club
	: General Flugsicherheit in der Bundeswehr
	: Leiter der Voruntersuchung

Braunschweig, den 08/06/1993

gez. (Büttner)

June 10, 1993

Fokker-100

Gear Collapse

08/10/93

REQUEST 074/98, REPORT 28

UNOFFICIAL REPORT	FOKKER-100	INCIDENT
EVENTS¦PHASES	GEAR COLLAPSED/RETRACTED-LANDING ROLL	
	OVERRUN-LANDING ROLL	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 93/0442-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 93-06-10
TIME : 00:00
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 27 001 - 272 000 KG
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : GRONINGEN
STATE/AREA : NETHERLANDS KINGDOM OF THE
DEPARTED :
DESTINATION :

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : MINOR

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	7	0	7
PAX :	0	0	0	0	0	0

NARRATIVE

AIRCLAIMS: DURING A PLANNED TOUCH AND GO ON RUNWAY 23, WITH THE LANDING PORTION OF THE MANOEUVRE BEING CARRIED OUT WITH ZERO FLAPS, THE AIRCRAFT TOUCHED DOWN 'FIRMLY' AND BOUNCED BEFORE TOUCHING DOWN AGAIN ON ITS MAIN UNDERCARRIAGE. ALMOST IMMEDIATELY AFTER THE SECOND TOUCH DOWN THE CREW FELT A MARKED VIBRATION AND THEREFORE ELECTED TO ABORT THE TAKE-OFF. REVERSE THRUST WAS SELECTED BUT IT IS REPORTED THAT ONLY THE NO. 1 ENGINE'S THRUST REVERSER DEPLOYED. THE AIRCRAFT SUBSEQUENTLY VEERED TO THE LEFT AND RAN OFF THE SIDE OF THE RUNWAY ABOUT 850M INTO THE LANDING ROLL. AFTER LEAVING THE RUNWAY THE LEFT AND RIGHT MAIN UNDERCARRIAGE COLLAPSED. THE ACCIDENT HAPPENED DURING A DEVELOPMENT TEST FLIGHT WITH THE AIRCRAFT FITTED WITH A NEW MENASCO UNDERCARRIAGE.

REQUEST 074/98, REPORT 29

UNOFFICIAL REPORT	ILYUSHIN-IL-62	ACCIDENT
EVENTS¦PHASES	UNSPECIFIED FAILURE-FIRST ENGINE-TAKE-OFF RUN	
	SPIN-INITIAL CLIMB	
	MUSH/STALL-INITIAL CLIMB	
	COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 93/0287-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 93-07-05
TIME : 00:00
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 27 001 - 272 000 KG
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : RAMENSKOYE
STATE/AREA : USSR
DEPARTED : RAMENSKOYE
DESTINATION :

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	5	4	0	0	0	9
PAX :	0	0	0	0	0	0

July 5, 1993

7/5/93
IL-114

IL-114 CRASHES DURING FLIGHT TEST

MOSCOW

A prototype Ilyushin Il-114 turboprop regional transport aircraft crashed after takeoff from the Russian Flight Research Institute July 5, killing three of the eight crewmembers on board and injuring the others. (5)

The accident is expected to significantly delay certification of the 60-seat transport, which already had slipped from its original schedule of 1992 (*AW&ST* Apr. 9, 1990, p. 32).

Industry officials said the prototype crashed shortly after lifting off from the flight institute's airfield at Zhukovsky, near Moscow.

Officials said the aircraft had been undergoing certification flight tests and was not covered by insurance. An investigation to determine the cause of the accident is underway.

Ilyushin's first Il-114 made its maiden flight in March, 1990, in a test, development and certification program that was to log about 1,000 hr.

The twin-engine aircraft is powered by Klimov design bureau TV7-117 engines, each driving a six-blade Russian Stupino composite propeller. The TV7-117 has a 2,500-shp. takeoff rating for its application on the Il-114 (*AW&ST* Mar. 30, 1992, p. 52).

The aircraft's elevator and rudder are mechanically driven by rods (*AW&ST* Apr. 16, 1990, p. 70).

The prototype crashed shortly after lifting off from Zhukovsky airfield near Moscow

The Ilyushin design bureau developed the Il-114 for regional operations in the former Soviet Union and for export. Production of about 1,500 Il-114s is planned to replace aging Antonov An-21 transports in service throughout the Commonwealth of Independent States.

Ilyushin teamed with the Russian government-run Aviaexport organization to market the aircraft in former Soviet-bloc countries, as well as to China, India, Egypt and Turkey.

Uzbekistan Airways ordered 10 Il-114s, and the airline has been performing operational tests with two of them. A firm contract for five was received from the Arkhangelsk civil aviation department in northern Russia.

The primary production factory for Il-114 is at Tashkent, where 10 aircraft are in various stages of manufacture and assembly. Moscow's MAPO Dementiev Aircraft Production Assn. also is building the aircraft. ■

Certification of Ilyushin Il-114 (foreground) is expected to be delayed by the crash of a prototype. The aircraft is being developed for regional airline operations.

07/05/93

AviationSafetyNetwork

Accident Description

Accident description

Date: **05.07.1993**
Type: Ilyushin 114
Operator: Ilyushin
Registration: RA-54001
C/n: 01-05?
Year built:
Crew: 5 fatalities / 9 on board
Passengers: 0 fatalities / 0 on board
Total: 5 fatalities / 9 on board
Location: Ramenskoye (Russia)
Phase: Initial Climb
Nature: Test
Flight: - (Flightnumber)

Remarks:
The no.2 engine didn't develop enough power on takeoff and a problem occurred with the electrical system. The Il-114 rolled and pitched steeply nose-up following takeoff, stalled and crashed.

Source:
S170 + ST94

[disclaimer]

Flight International

Title: Gradual development.
(development of Ilyushin Il-114)

Summary: The Ilyushin Il-114, a twin turboprop capable of carrying 64 passengers 1,000 km with fuel consumption of 20 g/km is due for certification in Apr 1997 after many delays due to funding and technical problems.

Source: **Flight International**
Date: April 23 1997
Price: $2.95
Document Size: Short (up to 2 pages)
Document ID: PC19970926560003345
Subject(s): Airplanes--Design and construction
Citation Information: (v151 n4571) Start Page: p61(2) ISSN: 0015-3710
Author(s): Duffy, Paul
Document Type: Article

07/05/93

++ REQUEST 140/94, REPORT # 224
++

?

+ UNOFFICIAL REPORT ILYUSHIN - IL-62 ACCIDENT +
+ EVENTS | PHASES: UNSPECIFIED FAILURE -FIRST ENGINE | TAKE-OFF RUN +
+ SPIN | INITIAL CLIMB +
+ MUSH/STALL | INITIAL CLIMB +
+ COLLISION WITH LEVEL TERRAIN/WATER | EMERGENCY/UNCONTROLLED DESCENT +

+++

<---------- OPERATION ---------->	++ <---------- FILE DATA ----------
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL	++ ICAO FILE : 93/0287-0
	++ FROM STATE :
<---------- WHEN ---------->	++ <---------- AIRCRAFT DATA ----------
DATE : 93-07-05	++ MASS CATEGORY : 27 001 - 272 000 KG
TIME : :	++ STATE OF REGISTRY :
LIGHT :	++ REGISTRATION :
<---------- WHERE ---------->	++ <------- DAMAGE, INJURY AND TOTAL ON BOARD ------->
LOCATION : RAMENSKOYE	++ A/C DAMAGE : DESTROYED
STATE/AREA : USSR	++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED : RAMENSKOYE	++ CREW : 5 4 0 0 0 9
DESTINATION :	++ PAX : 0 0 0 0 0 0
OTHER DAMAGE :	

+------------------------------------ REQUEST 075/98, REPORT 3 ------------------------------------+
+ UNOFFICIAL REPORT ILYUSHIN-IL-62 ACCIDENT +
+ EVENTS|PHASES UNSPECIFIED FAILURE-FIRST ENGINE-TAKE-OFF RUN +
+ SPIN-INITIAL CLIMB +
+ MUSH/STALL-INITIAL CLIMB +
+ COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT +
+---+

<---------- OPERATION ---------->	++ <---------- FILE DATA ---------->
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL	++ ICAO FILE : 93/0287-0
	++ FROM STATE :
FINAL REP	++
<------ DATE, TIME AND METEOROLOGICAL DATA ------>	++ <---------- AIRCRAFT DATA ---------->
DATE : 93-07-05	++ MASS CATEGORY : 27 001 - 272 000 KG
TIME : 00:00	++ STATE OF REGISTRY :
LIGHT :	++ REGISTRATION :
GEN WEATHER :	++
<---------- LOCATION ---------->	++ <------ DAMAGE, INJURY AND TOTAL ON BOARD ------>
LOCATION : RAMENSKOYE	++ A/C DAMAGE : DESTROYED
STATE/AREA : USSR	++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED : RAMENSKOYE	++ CREW : 5 4 0 0 0 9
DESTINATION :	++ PAX : 0 0 0 0 0 0

07/26/1997

7/26/93

CHI93MA276

HISTORY OF FLIGHT

On July 26, 1993, at 1352 central daylight time, a Canadair CL-600-2B19 airplane, Canadian registry C-FCRJ, departed controlled flight while maneuvering, and descended to ground collision near Byers, Kansas. The two test pilots and flight test engineer aboard were fatally injured. The airplane was destroyed by impact and postcrash fire. Visual meteorological conditions existed. The airplane was operated by the manufacturer on a performance improvement test, designated as flight 388. The flight originated at 1331 from Wichita, Kansas and operated VFR under 14 CFR 91; a flight plan had not been filed with the FAA.

The test flight was part of the Regional Jet Performance Improvement Flight Test Program (Canadair report number RAG-601R-106). The program was to repeat all portions of certification testing which pertained to configuration changes or expanded capabilities. At its conclusion, Canadair would apply to Transport Canada (TC) and present the test data for amendment to the airplane's type certificate. On the accident flight, tests encompassed a new flap setting, a leading edge fairing to smooth the sweep transition at wing station (WS) 148, and a lower reference operating speed (1.13 Vs) allowed by TC and the FAA.

Before flight, an engineering brief convened among flight crew, engineers, technicians and aerodynamicists. The captain chaired the briefing; the chief test pilot attended to observe. Topics included airplane configuration, load, maintenance status, and instrumentation. The flight test engineer briefed an outline he had written, called the flight plan. The flight plan bundled tests from RAG-601R-106 and was conditioned on preceding accomplishment of other tests. The flight plan listed tests to be conducted, their sequence, conditions, and data to be obtained.

Flight 388 was the first on which any of the operator's pilots attempted a steady heading sideslip (SHSS) maneuver at 1.13 Vs with flaps 8 degrees and WS148 fairing. The SHSS is a trial of lateral and directional stability in a configuration. It is performed at constant speed with aft center-of-gravity (CG), by deflecting rudder while opposing with aileron to hold heading. In the maneuver, increasing rudder deflection should generate proportionate sideslip (beta), and control force should not drop off. The maneuver concludes with releasing control deflections. The low wing's rising at aileron release indicates positive static lateral stability; nose movement toward center at rudder release indicates positive static directional stability.

The stall protection system (SPS) shaker and pusher activation points for flaps zero, 20, 30 and 45 degrees were based on natural stalls without sideslip in an airplane without the WS148 fairing. Activation points for flaps-8 were based on engineering estimates of lift improvement from the WS148 fairing, and were at higher angles-of-attack than would be interpolated from points for other flap settings. Sideslip influence on angle-of-attack sensors for the SPS had not been established at the new flap setting and was to be refined with data from the flight.

Aerodynamicists told the crew data would be sufficient if the SHSS terminated at onset of the stall warning or 15 degrees beta.

Not correct

The latter is a minimum criterion for certification. The pilots' practice in SHSS had been to proceed to full rudder deflection if performance during the maneuver appeared predictable. The aerodynamicists explained that while reviewing data from flight 386 they observed shaker initiation during SHSS. They stated they had never encountered pusher activation during SHSS and did not want one. It was agreed among crew and aerodynamicists to cut off the maneuver at stall warning shaker.

Before taxi, the captain electrically powered and armed the anti-spin parachute system and cycled the hooks which clasp the parachute shackle to the airframe. He cycled them from unlocked to locked and unlocked again. Before takeoff, he briefed the copilot about aborting takeoff, "if I ask for it, you'll lock, deploy the chute."

The flight took off, and the crew completed a longitudinal trim test while flying west to the test area. In the setup for the first SHSS, the test engineer read from the flight plan the conditions: 146 knots (calculated 1.13 Vs), flaps-8, gear up, "to the shaker." The captain and copilot acknowledged.

Commencing about 12,500 feet MSL with idle power, the captain gradually increased right rudder, and the copilot read beta. The captain remarked "buffet starts" after the copilot read 12 beta. The chief test pilot later explained this was random airframe buffet from sideslip, and stated the airplane exhibits little or no aerodynamic buffet before stall.

Shaker onset occurred at 17 beta. The captain remarked shaker and continued without pause. The copilot began reading alpha (angle-of-attack) with beta. At 11 alpha and 19 beta, the captain remarked, "a little bit of pitch instability," then reported, "on the stop" (full rudder). The copilot read 21 beta.

As the captain reported releasing aileron, a tone similar to the stall identification horn sounded. The airplane rolled rapidly right toward inverted. Recorded data show the roll began near time 1351:25.

The copilot told the captain, "just keep going." The roll continued toward upright. Altitude was about 11,500 feet MSL. Angle-of-attack after the roll was at least 35 units (recording limit), and remained there from 1351:32 to :52.

The copilot asked, "want me to release the chute?" The captain's response was unclear on the cockpit voice recorder, "stop (at)" The copilot asked, "at eight?" The captain commanded, "chute out." Five seconds later, the captain asked if the chute were out; the copilot answered, "yeah."

Angle-of-attack decreased below stall angle at 1351:56, with the airplane rolling beyond 60 degrees right wing down, and pitched 60 degrees nose down. Altitude was about 6800 feet MSL, airspeed about 190 knots.

A witness described the airplane heading slowly north before rolling 1 1/2 or 2 1/2 times, during which the nose came down. The airplane changed heading through west, and roll abated near a south heading. The airplane was slightly left wing down, and vapor trailed the wingtips as the nose appeared to rise. The airplane descended from view, and a fireball erupted.

Another witness recounted a parachute issuing from the tail and continuing away from the airplane.

The Pratt County Sheriff department first received telephone notification of the accident from a witness at 1356 CDT.

OTHER DAMAGE

Several acres of grain stubble and standing corn were fuel-soaked and scorched.

PERSONNEL INFORMATION

The first pilot, as captain, occupied the left pilot seat. He joined Canadair in 1978 as an engineer. He joined the flight test section around 1980 as flight test engineer. At intervals of about 5 years, he advanced to copilot, then to captain. He flew various jet and propeller airplanes in the manufacturer's inventory, lately the CL-600 Challenger and the accident model. The current program was the first for which he had been assigned lead test pilot. He held a Canadian air transport pilot certificate, and FAA commercial pilot certificate with instrument rating. No record was found of flight background in aerobatics or formation, nor formal training in swept wing or jet aircraft. His jet aircraft experience was obtained in the course of flight test involvement. He had 875 total hours in model, about 200 hours as pilot-in-command.

The copilot joined Canadair in 1991 as a test pilot after 9 years in the Royal Canadian Air Force. He had flown Grumman S-2 and Lockheed T-33 airplanes, and had been an instructor and check pilot in the military. He held a degree in mechanical engineering. He held a Canadian air transport certificate. Since joining Canadair, he had flown the Challenger and the accident model. He had 756 total hours in model, about 65 hours as pilot-in-command.

The third crewman, a British emigre to Canada, joined Canadair in 1979 as an aeronautical engineer. He was the senior flight test engineer for this model's certification program. He held no airman credential, nor was any required. As a flight test engineer, he had been aboard airplanes about 2600 flight hours, 600 in the accident model. His flight task was to monitor tests' setup and conduct, note observations and assure data were adequate to the test purpose. His task involved extensive preparation and coordinating with engineering and support personnel, and included writing a plan for the test flight.

Both pilots were Canadian citizens. Both applied to TC in 1992 for type rating in model, with recommendation from the chief test pilot, who is not an instructor or examiner. The ratings were issued without examination or flight check, there being no examiner designated by TC at the time. Neither pilot attended a training course in model which the manufacturer began offering customers' pilots after type certification. Neither attended a test pilot course. The pilots had flown together 165 hours, usually with the first pilot commanding and occupying the left seat. They flew together twice Friday, July 23, with another flight test engineer.

The 3 crewmen moved to Wichita in 1991 to conduct flight tests in model from a facility owned by Learjet, a subsidiary of Bombardier as is Canadair. All were off duty over the weekend before the Monday flight.

AIRCRAFT INFORMATION

The airplane was completed in 1991 and was the first of its model. Its U.S. model designator is CL-600-2B19. An equivalent airplane in commercial service is a 50-passenger transport airplane called Regional Jet. The airplane was powered by 2 General Electric CF34-3A1 turbofan engines, each with 8730 pounds takeoff thrust.

Transport Canada issued annual flight permits for experimental use. The airplane was moved in 1991 to Wichita for continuing tests and development. FAA issued Special Flight Authorizations annually for flights in U.S. airspace.

Transport Canada issued type approval for the model July 31, 1992. The FAA issued type certification January 21, 1993.

The manufacturer used the airplane and two like it for flight tests. The usual crew compliment was two pilots in the cockpit and a flight test engineer at an instrumented console in the cabin.

The accident airplane was extensively instrumented. Flight control displacement and force were measured at the left column and pedals, necessitating most tests be flown by the left seat pilot. Controls at both pilot stations were functional.

Among custom instrumentation were indicators for alpha and beta sensed at a noseboom. The sensors' remote mounting permitted readings less subject to airflow disturbance over the fuselage. The standard instrument suite's angle-of-attack sensors on either side of the fuselage drive the stall protection computer. Test sensors and instruments provided no input to the SPS.

Airplane records were examined at the test facility. The maintenance program, called preventive maintenance schedule, was unique to the airplane's test use, involving extensive preparation for each flight. Before the accident flight, the airplane operated 770.5 flight hours since new. Recent maintenance inspections had been performed as follows: 12 and 24-month inspections at 750 flight hours, a 400-hour check at 700 flight hours, and a 100-hour check at 689 flight hours. The quality control manager likened the airplane's daily inspection to a 100-hour inspection for a commercial airliner. A daily inspection involved 80 man-hours by a detail of 4 mechanics and 3 avionics technicians.

Airframe and system modifications effecting configuration, maintenance or operating procedure were documented in serialized bulletins called RSIs (restrictions and/or special instructions).

The airplane's flight permit, amended March 12, 1993, authorized 53,000 pounds maximum takeoff weight. The load on the accident flight consisted of 12,500 pounds of fuel, 5,500 pounds of lead bricks fixed in trays under the cabin floor, and 1,200 pounds of water-glycol solution. The flight test engineer adjusted CG in flight by redistributing solution between tanks at the cabin front and rear. The airplane weighed 52,032 pounds at takeoff, with CG at 23.1 per cent MAC (mean aerodynamic chord). Weight at control departure was 51,030 pounds, with CG at 35.6 percent MAC.

An anti-spin parachute was mounted under the vertical tail to induce nosedown pitch should the airplane enter a spin or deep stall. It also served as a drag chute for takeoff abort or landing. Switches and indicator lamps were located either side of alpha and beta indicators on the glareshield. The chute system was tested once after installation by deploying it during high speed taxi; there was no flight test. There had been no occasion requiring its use since installation. Maintenance personnel checked the system weekly and when directed by the flight test section before a hazardous flight. A weekly check was performed on the accident date.

RSI F-0085R, Anti-Spin Chute Operation, states the POWER switch remains ON continuously for flight. The ARM switch is OFF for normal flight, but is selected ON during a pre-stall check. The HYDLOCK switch is selected to UNLOCK for normal flight, and to LOCK in a prestall check. Chute deployment from the normal flight switch positions required 3 switch movements: HYDLOCK switch down to LOCK, ARM switch up to ON, then lift guards and move the ganged DEPLOY switches up to FIRE. System design permitted chute deployment when electrical power was available, regardless of hook position about the shackle. The appended Systems Group Chairman's Report discusses the chute and controls.

The chief test pilot stated the chute system design and their practice were based on concern for uncommanded chute deployment at low altitude or high true airspeed. He emphasized a captain's discretion to configure and use the system as deemed fit. He stated when he was pilot-in-command only he exercised system controls, calling it a critical aspect which he did not delegate.

METEOROLOGICAL INFORMATION

Surface weather observations at 3 facilities surrounding the accident site gave like reports of winds from the southeast 10 to 15 knots and clear skies.

COMMUNICATIONS

The flight called Wichita ground control for taxi for VFR departure to the west. The flight notified Wichita tower when clear of the airport traffic area.

The flight test location was in uncontrolled airspace about 70 miles west of Wichita. The airspace was not designated for special use. Communication with air traffic control was not required and was not established.

Telemetry was not in use, and communication was not established with the base radio at the test facility.

FLIGHT RECORDERS

A Loral airborne data acquisition system (ADAS) recorder lay among cabin wreckage. The recorder was destroyed, but substantial magnetic tape remained at the spindle for the shattered takeup reel. The unit recorded GMT-indexed output of various instruments and sensors; an audio channel recorded the crew's intercom; radio reception was not recorded. Unless remarked otherwise, data presented herein was derived from this recorder. Data indicated no system discrepancies, no uncommanded flight control displacement, and engine operation as commanded. In proximity to the stall, landing gear were up, auxiliary power unit on, flaps 8 degrees, and water ballast did not shift. Data ended at a tear in the tape; the remainder was not recovered. The last altitude recorded was about 5700 feet MSL.

A Loral solid-state flight data recorder (FDR), model F1000, scattered as 3 pieces. Its Crash Survivable Memory Unit lay 715 feet from impact; lack of identifying marks on the unit delayed its recovery by one day. Data recovered from the storage unit indicated the recorder operated, however, more than 20 recording parameters were inactive. Inactive parameters included altitude, airspeed, angle-of-attack, vertical speed and Greenwich mean time. FDR data were correlated with the ADAS recording and extended 8 seconds beyond available ADAS data. Approaching the end of FDR data, engines operated at high rpm, pitch changed from more than 62 degrees nose low to 38 degrees nose low, and acceleration increased to more than 4.5 G. Component examination and data are discussed in the appended Flight Data Recorder Factual Report.

A Fairchild cockpit voice recorder (CVR), model A100A, was recovered with slight impact damage. The 30-minute recording spanned checks before takeoff and the descent following control departure. Sound of a ground impact was not audible on the CVR. The recorder circuit incorporated an acceleration-sensing switch.

A partial transcript of the recording is in the appended Group Chairman's Report of Investigation, Cockpit Voice Recorder.

The FDR and CVR were typical of installations on airplanes in revenue service. Neither was required for flight under FAR 91.

WRECKAGE AND IMPACT INFORMATION

The airplane struck the ground in a flat, cultivated field. Site elevation was 1960 feet MSL. Wreckage cast about 750 feet, heading 200 degrees from impact. The cockpit and tail with engines cast 650 to 700 feet. The most distant pieces were engine subassemblies and auxiliary power unit.

Imprints of the left wing and rear fuselage were discernable at the north end of the wreckage field; portions of wing flap hinge faring and of fiberglass tail cone lay in the respective ground scars. Parallel on either side of the fuselage imprint were linear engine imprints, with puffed dust settled over the first 10 feet. The fuselage imprint aligned 183/003 degrees. All flight control surfaces and airplane extremities were accounted for at the crash site. There was no appearance of breakup, bird strike or collision in flight.

The cockpit was extensively damaged by impact and fire. The fuselage broke into sections.

Flap actuating jackscrews in the wreckage were extended to a length consistent with 8 degrees flap extension. Control surfaces on the severed tail moved freely. Control continuity could not be established. Stabilizer trim was about 1 degree nosedown. Ground spoilers were stowed; flight spoilers were damaged beyond impact position determination.

The anti-spin parachute lock/unlock hooks and actuator were damaged by airframe breakup and fire. Hydraulic lines were severed and the actuator held no fluid. The actuator rod extended 1.5 inches, placing the hooks near the locked position. The parachute control box was battered and burned; ARM and POWER switches were found ON, and DEPLOY switches in FIRE. The HYDLOCK switch was damaged beyond determination. Hydraulic pumps which power the hooks had apparent crash damage.

Fan blades on both engines bent opposite their rotation direction. Thrust reversers were closed. Compressor guide vane actuators from both engines were removed and disassembled: one from the left engine bore a piston imprint consistent with compressor speed of 82 per cent rpm. Separation of subassemblies was symmetrical between engines and occurred across flange fasteners.

The parachute fell 3 miles, 025 degrees from the site. The risers extended full length from a lunchbox-size metal shackle to the canopy. The parachute lay with shackle southeast and canopy northwest. The risers were intact and retained distinctive packing folds. The canopy was intact without fabric tear. The chute and risers appeared pristine and unstressed. A canister lid which separates at chute deployment fell 2.3 miles, 040 degrees from the site.

Components are further described in reports of the powerplants and systems groups. Wreckage distribution is described in the structures group report. The reports are appended.

MEDICAL AND PATHOLOGICAL INFORMATION

The first pilot held an FAA first class medical certificate issued May 20, 1993 with limitation for eyeglasses. The certificate application declared no medications were being taken.

The FAA airman medical record showed no remarkable medical history. The report of autopsy remarked minimal atherosclerosis and death due to multiple impact injuries with vertical and right frontal aspect. Toxicological testing showed 7.5 ug/ml acetaminophen and 6.8 ug/ml salicylate in the blood; both are nonprescription pain relievers.

The second pilot held a Canadian category 1 medical certificate issued July 9, 1992 with notation for eyeglasses; the certificate remained valid through July 1993. The certificate application stated no medications were being taken, and remarked no previous medical condition. The report of autopsy remarked no preexisting disease and death due to multiple blunt force injuries with right and frontal aspect. Toxicological testing showed 29 mg/dl ethanol and 24 mg/dl acetaldehyde in the blood, and 14 mg/dl ethanol in lung fluid. Sec-butanol, 5 mg/dl, and 1 mg/dl of 1-butanol were detected in the blood. The report stated the majority of blood ethanol was likely postmortem formation.

The test engineer was 48 years of age. No record was found of his holding an airman medical certificate, nor was one required. He had no vision in his right eye. The report of autopsy remarked death due to multiple impact injuries, largely frontal aspect. No preexisting disease was remarked. No toxicological test was requested.

FIRE

The aircraft held about 11,000 pounds of fuel at accident. Tanks ruptured during the crash. Fuel ignited, and fire flashed over the debris field from 100 feet south of impact to 700 feet south of impact. Portions of the wreckage were consumed. Fire burned along crop furrows well outside the area wetted by fuel. No witness reported fire on the airplane in flight, nor did the crew remark fire or smoke. The witness who recounted vapor trailing the wingtips construed it as fuel dumping.

TESTS AND RESEARCH

Data from ADAS recordings for flights 386 and 388 were examined at length. Results of the study are cited throughout this report. The Group Chairman's Airplane Performance Study is appended.

A test was conducted using a like airplane with identical parachute system. Hydraulic lines to its hook actuator were disconnected and fluid drained to simulate a system breach: the hooks moved easily by hand. The accident airplane's actuator was hydraulically powered, selected to the unlocked position and hook contact with a position-sensing microswitch affirmed. Details are in the systems group report.

The control box for the anti-spin chute was examined by the engineering branch of Transportation Safety Board of Canada to determine status of 8 indicator lamps; the report is appended. Four lamps were damaged beyond determination, including both for the HYDLOCK switch. Filaments of 3, variously damaged, appeared distended consistent with illumination at impact: one for the ARM switch and 2 for the POWER switch. Another for the POWER switch, labeled DEP(loy), was intact and its filament was not distended. Lamps for the ARM switch light only in the ON position. The POWER switch operates similarly: the 4 lamps light only in the ON position.

ADDITIONAL DATA/INFORMATION

In interviews with the operator's personnel, the terms "hazardous" and "critical" recurred to describe flights or maneuvers which invoked additional preparation or procedure for support personnel or flight crew: telemetry, anti-spin parachute check and arming, ad hoc checklist, personal parachutes. Planned stalls were unanimously characterized as hazardous or critical. Others variously mentioned were initial flights in model, flutter tests, and unspecified maneuvers which might precipitate stall departure. The SHSS with 1.13 Vs was characterized as delicate for the slow airspeed, but not hazardous. No document was obtained which named discrete tests or maneuvers as hazardous.

FAR 21.35(d) states each applicant for an aircraft type certificate must show for each test flight that adequate provision is made for the crew for emergency egress and the use of parachutes. The preceding was not listed among other FARs cited for operator compliance in the most recent Special Flight Authorization from FAA, dated April 1, 1993. Personal parachutes were not carried on the airplane; the test section's practice was to don parachutes and helmets for flights deemed hazardous.

There is no U.S. or Canadian certificate or endorsement for a test airman. The chief test pilot described training for a company test pilot as an apprenticeship. A typical pilot had both engineering background and airman credentials when hired, entered the production flight test section as copilot, and might later be designated captain. The chief pilot selected a pilot for engineering flight test from production test airmen he assessed had aptitude, attention to detail and disposition for demanding work. Pilots learned maneuvers and procedure by observing from a jumpseat or second pilot seat. Acquaintance with an airplane could be obtained from an engineer, technician or pilot familiar with the model; the accident copilot's introduction consisted of briefings by system engineers. The pilots obtained no external training, and did not use the company's simulator. There were no recurrent checks or training, and no company pilot was yet designated check airman for the model. The pilots observed TC licensure requirements and intervals for airmen not involved in revenue flight operations.

The pilots did not use the certificated airplane's flight manual, and none existed for the experimental airplane. The chief pilot explained changing configurations and varying test sequences could make fixed procedures impracticable and required deliberate action by pilots. For selected flights, a checklist might be drafted and posted in the cockpit. Single-engine trials were cited as example: the engine relight procedure would be posted for ready reference. No checklist was created for flight 388.

Aircraft wreckage was released to Canadair July 30, 1993. The CVR was returned November 18, 1993. Canadair consented to NTSB's request to retain the FDR for study.

Parties to the investigation participated in a review of findings before adjournment of the field portion of the investigation.

Use your browsers 'back' function to return to synopsis
Return to Query Page

07/26/93

NTSB Identification: **CHI93MA276**. The docket is stored in the (offline) NTSB Imaging System.

Accident occurred JUL-26-93 at BYERS, KS
Aircraft: CANADAIR CL-600-2B19, registration: CFCRJ
Injuries: 3 Fatal.

THE CREW WAS PERFORMING A LATERAL & DIRECTIONAL STABILITY TEST. CHANGES FROM EARLIER TESTS COMBINED NEW LEADING EDGE FAIRING, NEW FLAP SETTING, LOWER REFERENCE AIRSPEED, AND TRIAL SETTINGS FOR THE STALL PROTECTION SYSTEM (SHAKER & PUSHER). ENGINEERS HAD BRIEFED THE CREW DATA WOULD BE SUFFICIENT IF THE STEADY HEADING SIDESLIP (SHSS) MANEUVER ENDED AT A 15 DEG SIDESLIP, OR AT ONSET OF STALL WARNING; CREW AGREED TO END AT STALL WARNING. DURING THE TEST THE CAPT CONTINUED PAST STALL WARNING TO 21 DEG SIDESLIP AT FULL RUDDER. THE AIRPLANE ROLLED RAPIDLY THROUGH 360 DEG & ENTERED A DEEP STALL. THE COPILOT ATTEMPTED TO DEPLOY THE ANTI-SPIN CHUTE. HOWEVER, ALL THE CHUTE SYSTEM COCKPIT SWITCHES WERE NOT PROPERLY PRESET; INSTEAD OF ASSISTING RECOVERY, THE CHUTE PARTED FROM THE AIRPLANE. FULL CONTROL WAS NOT REGAINED BEFORE IMPACT. THE CHUTE SYSTEM DESIGN ALLOWED DEPLOYMENT OF THE CHUTE EVEN WHEN THE HYD LOCK SWITCH WAS IN THE UNLOCKED POSITION & THE HOOKS CLASPING THE CHUTE SHACKLE TO THE AIRFRAME WERE OPEN. SYSTEM TESTED OK BEFORE FLIGHT.

Probable Cause

THE CAPTAIN'S FAILURE TO ADHERE TO THE AGREED UPON FLIGHT TEST PLAN FOR ENDING THE TEST MANEUVER AT THE ONSET OF PRESTALL STICK SHAKER, AND THE FLIGHTCREW'S FAILURE TO ASSURE THAT ALL REQUIRED SWITCHES WERE PROPERLY POSITIONED FOR ANTI-SPIN CHUTE DEPLOYMENT. A FACTOR WHICH CONTRIBUTED TO THE ACCIDENT WAS THE INADEQUATE DESIGN OF THE ANTI-SPIN CHUTE SYSTEM WHICH ALLOWED DEPLOYMENT OF THE CHUTE WITH THE HYDRAULIC LOCK SWITCH IN THE UNLOCKED POSITION. (WHEN IN THE UNLOCKED POSITION, THE HOOKS CLASPING THE CHUTE SHACKLE TO THE AIRFRAME ARE OPEN.)

Full narrative available

Index for Jul 1993 | Index of Months □□□□□□□□□□□□□□□□□□□

++ REQUEST 140/94, REPORT # 225
++

+ PRELIMINARY REPORT   CANADAIR - CL-601   ACCIDENT
+
+ EVENTS | PHASES: LOSS OF CONTROL | MANOEUVRING
+
+ COLLISION WITH LEVEL TERRAIN/WATER | EMERGENCY/UNCONTROLLED
DESCENT +

++
+++++++++++++++++++++++++++++++++++++

++
<---------------- O P E R A T I O N ----------------> ++ <---------------- F I L E D A T A ----------------
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 93/0126-0
++ FROM STATE : UNITED STATES
++
<-------------------- W H E N --------------------> ++ <------------ A I R C R A F T D A T A ------------
DATE : 93-07-26 ++ MASS CATEGORY : 5701 - 27 000 KG
TIME : 13:55 ++ STATE OF REGISTRY : CANADA
LIGHT : DAYLIGHT ++ REGISTRATION : C-FCRJ
++
<------------------- W H E R E -------------------> ++ <------- DAMAGE, INJURY AND TOTAL ON
BOARD -------->
LOCATION : BYERS, KS ++ A/C DAMAGE : DESTROYED
STATE/AREA : UNITED STATES ++ INJURY : FATAL SERIOUS MINOR NONE
UNKNOWN TOTAL
DEPARTED : WICHITA, KS ++ CREW : 3 0 0 0 0 3
DESTINATION : WICHITA, KS ++ PAX : 0 0 0 0 0 0
OTHER DAMAGE :
DURING A TEST FLIGHT WHILE MANOEUVRING, THE PILOT LOST CONTROL AND THE A/C
COLLIDED WITH TERRAIN. WEATHER:
VMC.

--------------- E V E N T S A N D F A C T O R S ----------------
1. EVENT | PHASE: LOSS OF CONTROL | MANOEUVRING
2. EVENT | PHASE: COLLISION WITH LEVEL TERRAIN/WATER | EMERGENCY/UNCONTROLLED
DESCENT

AviationSafetyNetwork

Accident Description

Accident description

Date:	**26.07.1993**
Time:	13.52 CDT
Type:	Canadair RJ100 Regional Jet
Operator:	Bombardier
Registration:	C-FCRJ
C/n:	7001
Year built:	1991
Total airframe hrs:	771 hours
Cycles:	800 cycles
Crew:	3 fatalities / 3 on board
Passengers:	0 fatalities / 0 on board
Total:	3 fatalities / 3 on board
Location:	Byers, KS (USA)
Phase:	Cruise
Nature:	Test
Flight:	Wichita-Mid Continent APT, KS - Wichita-Mid Continent APT, KS (Flightnumber)

Remarks:
The Canadair plane was on a test flight out of Wichita, KS to evaluate flying qualities in a new 8deg. takeoff flap setting and to demonstrate compliance with US 14 CFR 25.177 rules. The aircraft lost control during a low speed steady-heading sideslip test maneuver at FL120. The crew were to end a Steady Heading Sideslip (SHSS) maneuver at a 15deg sideslip, but continued to 21deg. at full rudder. The plane rolled rapidly through 360deg and entered a deep stall. As it descended through 8000ft the captain requested the copilot to deploy the anti-spin parachute, which he complied with. The copilot however, didn't close the jaws (which connect/disconnect the parachute from the airplane) before chute deployment. The chute thus fell free of the plane. Control was not regained and the aircraft crashed and skidded for about 200 yards through several cornfields. PROBABLE CAUSE: "The captain's failure to adhere to the agreed upon flight test plan for ending the test maneuver at the onset of prestall stick shaker, and the flightcrew's failure to assure that all required switches were properly positioned for anti-spin chute deployment. A factor which contributed to the accident was the inadequate design of the anti-spin chute system which allowed deployment of the chute with the hydraulic lock switch in the unlocked position. (When in the unlocked position, the hooks clasping the chute shackle to the airframre are open.)"

Source:
S170; Air International September 1993, p.127; NTSB Safety Recommendation A-94-101; AW&ST 02.08.1993 (39-40)

REQUEST 074/98, REPORT 7

+ DATA REPORT — NORTH AMERICAN-COMMANDER 680/SUPERAERO — ACCIDENT +
+ EVENTS¦PHASES — MUSH/STALL-CIRCUIT PATTERN/BASE LEG +
+ COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT +

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 90/0455-0
FROM STATE : UNITED STATES

DATE, TIME AND METEOROLOGICAL DATA

DATE : 90-11-03
TIME : 10:25
LIGHT : DAYLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 2250 - 5700 KG
STATE OF REGISTRY : UNITED STATES
REGISTRATION : N541F

LOCATION

LOCATION : FORT LAUDERDALE,FL
STATE/AREA : UNITED STATES
DEPARTED : FT LAUDERDALE,FL
DESTINATION : FORT LAUDERDALE,FL

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	2	0	0	0	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

THE A/C WAS ON A LEFT DOWNWIND FOR LANDING AT 300 FT/AGL WHEN THE NOSE PITCHED UP 15 DEG. AS THE A/C STARTED A LEFT TURN, THE LEFT WING DROPPED AND THE NOSE PITCHED DOWN 90 DEG IN A SPIRAL. THE A/C COLLIDED WITH THE WATER.
DRN: THE A/C HAD NOT FLOWN SINCE JUNE, 1989. THE CREW HAD MADE TWO HIGH-SPEED TAXI RUNS BEFORE TAKE-OFF. IMMEDIATELY AFTER TAKE-OFF THE CREW CALLED TO LAND. THE A/C WAS OBSERVED ON DOWNWIND 200-800 FT AGL, 15-25 DEG NOSE HIGH. THE A/C THEN STALLED. THE COMPRESSOR SURGE VALVES FOR THE LEFT AND RIGHT ENGINES WERE FOUND IN THE OPEN POSITION.

SEQUENCE OF EVENTS

EVENT 1 MUSH/STALL - CIRCUIT PATTERN/BASE LEG
1.AIRSPEED - NOT MAINTAINED
EVENT 2 COLLISION WITH LEVEL TERRAIN/WATER - EMERGENCY/UNCONTROLLED DESCENT

REQUEST 074/98, REPORT 8

+ UNOFFICIAL REPORT — DORNIER-228 100/200 — ACCIDENT +
+ EVENTS¦PHASES — UNDERSHOOT-APPROACH +

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 91/0632-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 91-01-15
TIME : 00:00
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 5701 - 27 000 KG
STATE OF REGISTRY : GERMANY
REGISTRATION : D-CICE

LOCATION

LOCATION :
STATE/AREA :
DEPARTED :
DESTINATION :

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	2	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

AIRCLAIMS: FOLLOWING A VISUAL APPROACH TO AN ICE-STRIP THE AIRCRAFT UNDERSHOT TOUCHING DOWN A FEW METRES SHORT OF THE RUNWAY. AFTER TOUCH DOWN THE 228 VEERED OFF TO ONE SIDE INTO DEEP SNOW SUSTAINING SUBSTANTIAL DAMAGE. THERE WERE NO REPORTED INJURIES. AT THE TIME OF THE ACCIDENT, THE WEATHER WAS FAIR WITH VISIBILITY 4,500M., HOWEVER, THERE WAS APPARENTLY A STRONG CROSSWIND.

REQUEST 074/98, REPORT 30

DATA REPORT — CANADAIR-CL-600 Regional Jet — ACCIDENT

EVENTS|PHASES — MUSH/STALL-MANOEUVRING

COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 93/0126-0
FROM STATE : UNITED STATES

DATE, TIME AND METEOROLOGICAL DATA

DATE : 93-07-26
TIME : 13:52
LIGHT : DAYLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 5701 - 27 000 KG
STATE OF REGISTRY : CANADA
REGISTRATION : C-FCRJ

LOCATION

LOCATION : BYERS,KS
STATE/AREA : UNITED STATES
DEPARTED : WICHITA,KS
DESTINATION : WICHITA,KS

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	2	0	0	0	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

DURING A TEST FLIGHT WHILE MANOEUVRING, THE PILOT LOST CONTROL AND THE A/C COLLIDED WITH TERRAIN.
DRN: THE CREW WAS PERFORMING A LATERAL AND DIRECTIONAL STABILITY TEST. DURING THE TEST THE PILOT CONTINUED PAST STALL WARNING TO 21 DEG SIDESLIP AT FULL RUDDER. THE A/C ROLLED RAPIDLY THROUGH 360 DEG AND ENTERED A DEEP STALL. THE CO-PILOT ATTEMPTED TO DEPLOY THE ANTI-SPIN CHUTE, HOWEVER, ALL THE CHUTE SYSTEM COCKPIT SWITCHES WERE NOT PROPERLY PRESET. INSTEAD OF ASSISTING RECOVERY, THE CHUTE SEPARATED. FULL CONTROL WAS NOT REGAINED BEFORE IMPACT. THE CHUTE SYSTEM DESIGN ALLOWED DEPLOYMENT OF THE CHUTE EVEN WHEN THE HYDRAULIC LOCK SWITCH WAS IN THE UNLOCKED POSITION AND THE HOOKS CLASPING THE CHUTE SHACKLE TO THE AIRFRAME WERE OPEN. THE SYSTEM TESTED CORRECTLY BEFORE FLIGHT.

SEQUENCE OF EVENTS

EVENT 1 MUSH/STALL - MANOEUVRING
- 1.SPIN - INADVERTENT
- 2.FLIGHT CREW PROCEDURES - NOT FOLLOWED

EVENT 2 COLLISION WITH LEVEL TERRAIN/WATER - EMERGENCY/UNCONTROLLED DESCENT
- 1.TAIL CHUTE/DRAG CHUTE - INADEQUATE/SEPARATED
- 2. -
  - 1.MANUFACTURER-DESIGN-INADEQUATE

NTSB Report ID CHI93MA276

07/27/1993

Summarization

On 27 July 1993 at 1645 hrs* the Flight Accident Investigation Center (FUS) was notified by the aircraft manufacturer about the accident with the second prototype of the Ranger 2000. Immediately an official was sent to the accident site to take charge of the investigation. Two co-workers from Braunsweig met him there in the evening and together they began the investigation.

The aircraft took off for a test flight on 27 July 1993 at 1633 hrs from the Military Air Base at Manching, during which flight characteristics were to have been investigated. The last test point in this test series was the investigation of flying qualities with speedbrakes extended during gentle roll maneuvering. To accomplish this, the pilot stabilized the aircraft at an altitude of 5,700 ft MSL at a speed of 330 kt IAS. At 1606 hrs he began a gentle right roll and several seconds later extended the speedbrakes. After a roll angle of 60 deg. had built up, he began to roll to the left. At this point in time a sideslip angle (nose right) began to build up, and the rudder blew out towards the right. A short time later a negative angle of attack and negative normal load factor developed, apparently as a result of the high sideslip angle, which reached a maximum of -32 deg. When the pilot attempted to correct the sideslip situation with the application of force on the left rudder pedal, the required force was already so great that he was not able to drive the rudder back. The aircraft was no longer controllable for him and went into a steep dive. The pilot had already reduced the throttle to idle, but the speedbrakes had not yet been retracted.

At an altitude of approximately 500 ft AGL the pilot activated the ejection seat.

The seat firing proceeded correctly, however, due to the high speed of 315 kt and the extreme flow field and flight attitude, the ejection was unsuccessful. The pilot was severely injured and died several days later. The aircraft was destroyed on impact.

The accident is apparently attributable to the following factors:

- the directional stability of the aircraft with extended speedbrakes was reduced and due to the additional factor of a deflected rudder was practicably unstable.

- the pilot recognized the existence of a critical situation too late and delayed taking appropriate corrective measures.

1.0 Factual Investigation

1.1 Course of the Flight

On the morning of 27 July 1993 the subject aircraft and two pilots took off from

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* All times are in Central European Standard Time

the Military Air Base at Manching for a test flight during which it was intended to investigate engine characteristics, inflight starting of the engine, and handling characteristics. The pilot involved in the later accident was for this flight in the rear seat. This flight had to be interrupted early due to a generator malfunction. After a checkout of the aircraft it was prepared for an afternoon flight, which was to be flown by a single pilot. After a conversation between the flight test engineer and the pilot, it was established that on this flight, an investigation of handling qualities would be conducted, as would a study of entry airspeeds for flight demonstration maneuvers. It was also planned to fly a simulated flameout landing. Flight cards were prepared by the flight test engineer without delay.

The subsequent pre-flight briefing was conducted using this flight test card. The briefing lasted from 1430 to around 1455 hrs, and besides the pilot and flight test engineer several systems engineers took part. According to statements of the participating engineers, the briefing specifically referred to the fact that for the planned tests with extended speedbrakes, only moderate rolling maneuvers were to be conducted, and that with extended speed brakes crossed control surfaces were not allowable. This reference resulted from previous flights, during which, with sideslip conditions, partially unacceptable flying qualities were experienced with speedbrakes extended. The engineers and test pilots saw in these perceptions no indications that with extended speedbrakes and moderate roll maneuvering the aircraft could go out of control.

The takeoff for the test flight was at 1533 hrs, and the pilot first flew a simulated flameout landing, which was conducted without problem. Subsequently the pilot flew into the restricted area ED-R 63, which is intended for test flights, and began the investigation of flight characteristics. At the end of this test block were tests with extended speedbrakes. First, the pilot extended the speedbrakes twice in straight and level flight without maneuvering and retracted them respectively eight and two seconds later. The aircraft reacted with a light bobbing in the nose up direction and a light roll to the right. The next tests were to be moderate roll maneuvers with speedbrakes extended. For this the pilot stabilized the aircraft at an altitude of 5,700 ft MSL at a speed of 330 kts IAS, and began at 16:06:23 a gentle roll to the right and extended the speedbrakes. After reaching a roll angle of 60 deg., he input left aileron and began rolling to the left. Coincident with the change in bank angle a sideslip angle built up (nose to the right), and the rudder deflected to the right. The pilot at first did not oppose the rudder deflection. Only when the sideslip angle reached -10 deg and the rudder deflection reached -11 deg did the pilot attempt to correct the situation by application of 550 N on the left rudder pedal. However, this force was insufficient to move the rudder pedal. He was only able to prevent a further deflection. A short time later the sideslip angle increased to -32 deg, and subsequently stabilized at approximately -20 deg. The rudder deflected further right to its physical limit of -17 deg, although the pilot rapidly increased the force on the rudder pedal to 1,200 N. This rudder deflection and sideslip angle remained until impact. Coincident to the build-up in sideslip angle, angle of attack changed from positive to negative, and normal acceleration reached a value of -2 g. Nose-up elevator was only able to slow down this process, positive values of load factor were not reached until impact. As a result of the negative load factor the aircraft went into a dive. The pilot had brought the throttle back to idle, which essentially did not affect the dive. The speedbrakes were not retracted. At an altitude of approximately 500 ft AGL the pilot activated the ejection seat. Impact of the aircraft followed at 16:06:50 hrs, 27 seconds after the last test point had been begun.

1.2 Personal Injuries

During the ejection attempt the pilot was severely injured. He died on 2 August 1993.

1.3 Damage to Aircraft

The aircraft was destroyed upon impact with the ground.

1.4 Property Damage

Moderate damage to the field occurred.

1.5 Crew Information

The 46-year-old pilot was in possession of a valid American pilot's license for transport pilots with the entitlements: single and multi-engine land aircraft, professional pilot, sail-plane tow, L-300, B-707. It was issued on 28 March 1992. His first class flight certificate was obtained from the FAA on 3 May 1993 and was unlimited.

In 1976 he had graduated from the "experimental test pilot course" at Edwards AFB and participated in several test projects of the USAF.

In order to fly the Ranger 2000, an application was made to the (German) Federal Transportation Ministry for recognition of the American Pilot's License. This recognition was granted on 17 June 1993 and was valid until 31 October 1993.

Until April the pilot had a total flight time of 7,160 hours. The flight time in the last three months totaled 64 hours.

The pilot began flying the Ranger 2000 on 18 June 1993. Until the accident he had 9 hours in 8 flights as responsible pilot and 10 hours in 9 flights as second pilot. The accident flight was his 5th flight in the second prototype and 2nd as responsible pilot..

1.6 Aircraft Information

The two-seat aircraft was a jet trainer, built in response to an American request (see Appendix 1). Since later use as a German military aircraft was not intended, a military certification process was not conducted, but rather a civilian program was begun.

The aircraft is a single-engine, mid-wing aircraft of composite construction with a retractable landing gear. It is equipped with a two-spool turbine engine, JT 15D-5C built by Pratt & Whitney. Maximum takeoff mass is 3,855 kg.

The aircraft is equipped with speedbrakes, with are arranged on both sides of the fuselage above the trailing edge of the wing. When they are extended they rotate 60 deg around their axis. The extend/retract control knob is located on the throttle on the left side of the cockpit.

Both seats of the aircraft are equipped with and ejection seat SIIIS-3RW manufactured by the company Universal Propulsion Company (UP-CO). A pyrotechnic device is installed in the canopy, which blows away the canopy glass when the seat is fired.

For the conduct of flights for qualification testing, investigation flights, and test flights the Federal Aviation Office issued a temporary permit on 6 May 1993 which was valid until 6 November 1993. Elements of the permit were the "Preliminary Pilot's Operating Handbood and Airplane Flight Manual" and the Flight Instruction 92-1/2. The limitations and conditions specified in these documents were adhered to throughout the accident flight.

The first flight of the aircraft was on 18 June 1993. From this point in time to the time of the accident flight a total of 12 hours in 11 flights were accomplished with the aircraft. Maintenance of the aircraft was accomplished in accordance with a predetermined plan.

Before the flight the aircraft was fully fueled with 1,640 pounds of JP-8 fuel. This was the wish of the pilot. With this load the aircraft takeoff mass was in the upper allowable area. The center of gravity was within the allowable extremes.

(Translation from the German "FUS" report by US SFTE member - DJH 1994)

Summarization

On 27 July 1993 at 1645 hrs* the Flight Accident Investigation Center (FUS) was notified by the aircraft manufacturer about the accident with the second prototype of the Ranger 2000. Immediately an official was sent to the accident site to take charge of the investigation. Two co-workers from Braunsweig met him there in the evening and together they began the investigation.

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At an altitude of approximately 500 ft AGL the pilot activated the ejection seat.

The seat firing proceeded correctly, however, due to the high speed of 315 kt and the extreme flow field and flight attitude, the ejection was unsuccessful. The pilot was severely injured and died several days later. The aircraft was destroyed on impact.

The accident is apparently attributable to the following factors:

- the directional stability of the aircraft with extended speedbrakes was reduced and due to the additional factor of a deflected rudder was practicably unstable.

- the pilot recognized the existence of a critical situation too late and delayed taking appropriate corrective measures.

* All times are in Central European Standard Time

1.0 Factual Investigation

1.1 Course of the Flight

On the morning of 27 July 1993 the subject aircraft and two pilots took off from the Military Air Base at Manching for a test flight during which it was intended to investigate engine characteristics, inflight starting of the engine, and handling characteristics. The pilot involved in the later accident was for this flight in the rear seat. This flight had to be interrupted early due to a generator malfunction. After a checkout of the aircraft it was prepared for an afternoon flight, which was to be flown by a single pilot. After a conversation between the flight test engineer and the pilot, it was established that on this flight, an investigation of handling qualities would be conducted, as would a study of entry airspeeds for flight demonstration maneuvers. It was also planned to fly a simulated flameout landing. Flight cards were prepared by the flight test engineer without delay.

The subsequent pre-flight briefing was conducted using this flight test card. The briefing lasted from 1430 to around 1455 hrs, and besides the pilot and flight test engineer several systems engineers took part. According to statements of the participating engineers, the briefing specifically referred to the fact that for the planned tests with extended speedbrakes, only moderate rolling maneuvers were to be conducted, and that with extended speed brakes crossed control surfaces were not allowable. This reference resulted from previous flights, during which, with sideslip conditions, partially unacceptable flying qualities were experienced with speedbrakes extended. The engineers and test pilots saw in these perceptions no indications that with extended speedbrakes and moderate roll maneuvering the aircraft could go out of control.

The takeoff for the test flight was at 1533 hrs, and the pilot first flew a simulated flameout landing, which was conducted without problem. Subsequently the pilot flew into the restricted area ED-R 63, which is intended for test flights, and began the investigation of flight characteristics. At the end of this test block were tests with extended speedbrakes. First, the pilot extended the speedbrakes twice in straight and level flight without maneuvering and retracted them respectively eight and two seconds later. The aircraft reacted with a light bobbing in the nose up direction and a light roll to the right. The next tests were to be moderate roll maneuvers with speedbrakes extended. For this the pilot stabilized the aircraft at an altitude of 5,700 ft MSL at a speed of 330 kts IAS, and began at 16:06:23 a gentle roll to the right and extended the speedbrakes. After reaching a roll angle of 60 deg., he input left aileron and began rolling to the left. Coincident with the change in bank angle a sideslip angle built up (nose to the right), and the rudder deflected to the right. The pilot at first did not oppose the rudder deflection. Only when the sideslip angle reached -10 deg and the rudder deflection reached -11 deg did the pilot attempt to correct the situation by application of 550 N on the left rudder pedal. However, this force was insufficient to move the rudder pedal. He was only able to prevent a further deflection. A short time later the sideslip angle increased to -32 deg, and subsequently stabilized at approximately -20 deg. The rudder deflected further right to its physical limit of -17 deg, although the pilot rapidly increased the force on the rudder pedal to 1,200 N.

This rudder deflection and sideslip angle remained until impact. Coincident to the build-up in sideslip angle, angle of attack changed from positive to negative, and normal acceleration reached a value of -2 g. Nose-up elevator was only able to slow down this process, positive values of load factor were not reached until impact. As a result of the negative load factor the aircraft went into a dive. The pilot had brought the throttle back to idle, which essentially did not affect the dive. The speedbrakes were not retracted. At an altitude of approximately 500 ft AGL the pilot activated the ejection seat. Impact of the aircraft followed at 16:06:50 hrs, 27 seconds after the last test point had been begun.

1.2 Personal Injuries

During the ejection attempt the pilot was severely injured. He died on 2 August 1993.

1.3 Damage to Aircraft

The aircraft was destroyed upon impact with the ground.

1.4 Property Damage

Moderate damage to the field occurred.

1.5 Crew Information

The 46-year-old pilot was in possession of a valid American pilot's license for transport pilots with the entitlements: single and multi-engine land aircraft, professional pilot, sail-plane tow, L-300, B-707. It was issued on 28 March 1992. His first class flight certificate was obtained from the FAA on 3 May 1993 and was unlimited.

In 1976 he had graduated from the "experimental test pilot course" at Edwards AFB and participated in several test projects of the USAF.

In order to fly the Ranger 2000, an application was made to the (German) Federal Transportation Ministry for recognition of the American Pilot's License. This recognition was granted on 17 June 1993 and was valid until 31 October 1993.

Until April the pilot had a total flight time of 7,160 hours. The flight time in the last three months totaled 64 hours.

The pilot began flying the Ranger 2000 on 18 June 1993. Until the accident he had 9 hours in 8 flights as responsible pilot and 10 hours in 9 flights as second pilot. The accident flight was his 5th flight in the second prototype and 2nd as responsible pilot..

1.6 Aircraft Information

The two-seat aircraft was a jet trainer, built in response to an American request (see Appendix 1). Since later use as a German military aircraft was not intended, a military certification process was not conducted, but rather a civilian program was begun.

The aircraft is a single-engine, mid-wing aircraft of composite construction with a retractable landing gear. It is equipped with a two-spool turbine engine, JT 15D-5C built by Pratt & Whitney. Maximum takeoff mass is 3,855 kg.

The aircraft is equipped with speedbrakes, with are arranged on both sides of the fuselage above the trailing edge of the wing. When they are extended they rotate 60 deg around their axis. The extend/retract control knob is located on the throttle on the left side of the cockpit.

Both seats of the aircraft are equipped with and ejection seat SIIIS-3RW manufactured by the company Universal Propulsion Company (UP-CO). A pyrotechnic device is installed in the canopy, which blows away the canopy glass when the seat is fired.

For the conduct of flights for qualification testing, investigation flights, and test flights the Federal Aviation Office issued a temporary permit on 6 May 1993 which was valid until 6 November 1993. Elements of the permit were the "Preliminary Pilot's Operating Handbook and Airplane Flight Manual" and the Flight Instruction 92-1/2. The limitations and conditions specified in these documents were adhered to throughout the accident flight.

The first flight of the aircraft was on 18 June 1993. From this point in time to the time of the accident flight a total of 12 hours in 11 flights were accomplished with the aircraft. Maintenance of the aircraft was accomplished in accordance with a predetermined plan.

Before the flight the aircraft was fully fueled with 1,640 pounds of JP-8 fuel. This was the wish of the pilot. With this load the aircraft takeoff mass was in the upper allowable area. The center of gravity was within the allowable extremes.

+-- REQUEST 074/98, REPORT 31 --+

+ DATA REPORT — DEUTSCHE AEROSPACE (DASA)- — ACCIDENT +

+ EVENTS¦PHASES — LOSS OF DIRECTIONAL CONTROL-MANOEUVRING +

+ LOSS OF PITCH CONTROL/PORPOISE-MANOEUVRING +

<---------------------- OPERATION ---------------------->

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

<---------------------- FILE DATA ---------------------->

ICAO FILE : 93/0114-0

FROM STATE : GERMANY

<----------- DATE, TIME AND METEOROLOGICAL DATA ----------->

DATE : 93-07-27

TIME : 16:07

LIGHT : DAYLIGHT

GEN WEATHER : VMC

<---------------------- AIRCRAFT DATA ---------------------->

MASS CATEGORY : 5701 - 27 000 KG

STATE OF REGISTRY : GERMANY

REGISTRATION : D-FANB

<---------------------- LOCATION ---------------------->

LOCATION : EICHSTAETT

STATE/AREA : GERMANY

DEPARTED : MANCHING

DESTINATION : MANCHING

<----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	1	0	0	0	0	1
PAX :	0	0	0	0	0	0

---------------- NARRATIVE ----------------

THE A/C, WHICH IS A MILITARY TRAINER, WAS ON A TEST FLIGHT FOR CERTIFICATION. DURING ROLL MANOEUVRES IN LEVEL FLIGHT, IT LOST DIRECTIONAL AND PITCH CONTROL AND ENTERED A STEEP DIVE. THE PILOT EJECTED AT ABOUT 1,500 FT AGL.
DRN: THE PILOT EJECTED WITH THE EJECTION SEAT BUT THE ALTITUDE WAS TOO LOW TO LAND SAFELY.

------------ SEQUENCE OF EVENTS ------------

EVENT 1 LOSS OF DIRECTIONAL CONTROL - MANOEUVRING
- 1.SPEEDBRAKES/SPOILERS - KNOWN DEFICIENCY
  - 1.MANUFACTURER - DESIGN STAFF-INSTRUMENTS/CONTROLS DESIGN-POOR
- 2.DIRECTIONAL CONTROL - POOR EXECUTION
  - 1.PILOT-ACTION-WRONG

EVENT 2 LOSS OF PITCH CONTROL/PORPOISE - MANOEUVRING

++ REQUEST 140/94, REPORT # 226
++

+ DATA REPORT DEUTSCHE AEROSPACE (DASA) - OTHER (FR 06)
ACCIDENT +
+ EVENTS | PHASES: LOSS OF DIRECTIONAL CONTROL | MANOEUVRING
+
+ LOSS OF PITCH CONTROL/PORPOISE | MANOEUVRING
+

++
++++++++++++++++++++++++++++++++++++

++

<---------------- O P E R A T I O N ----------------> ++ <---------------- F I L E D A T A ----------------
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 93/0114-0
++ FROM STATE : GERMANY
++

<-------------------- W H E N --------------------> ++ <------------ A I R C R A F T D A T A ------------
DATE : 93-07-27 ++ MASS CATEGORY : 2251 - 5700 KG
TIME : 16:07 ++ STATE OF REGISTRY : GERMANY
LIGHT : DAYLIGHT ++ REGISTRATION : D-FANB
++

<------------------- W H E R E -------------------> ++ <-------- DAMAGE, INJURY AND TOTAL ON BOARD -------->
LOCATION : NEAR EICHSTAETT ++ A/C DAMAGE : DESTROYED
STATE/AREA : GERMANY ++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED : MANCHING ++ CREW : 1 0 0 0 0 1
DESTINATION : MANCHING ++ PAX : 0 0 0 0 0 0
OTHER DAMAGE : YES

THE A/C, WHICH IS A MILITARY TRAINER, WAS ON A TEST FLIGHT FOR CERTIFICATION. DURING ROLL MANOEUVRES IN LEVEL
FLIGHT, IT LOST DIRECTIONAL AND PITCH CONTROL AND ENTERED A STEEP DIVE. THE PILOT EJECTED AT ABOUT 1,500 FT AGL.

DRN: THE PILOT EJECTED WITH THE EJECTION SEAT BUT THE ALTITUDE WAS TOO LOW TO LAND SAFELY.

---------------- E V E N T S A N D F A C T O R S ----------------

1. EVENT | PHASE: LOSS OF DIRECTIONAL CONTROL | MANOEUVRING
   FACTORS: SPEEDBRAKES/SPOILERS -KNOWN DEFICIENCY
   MANUFACTURER - DESIGN STAFF -INSTRUMENTS/CONTROLS DESIGN -POOR
   : DIRECTIONAL CONTROL -POOR EXECUTION
   PILOT -ACTION -WRONG
2. EVENT | PHASE: LOSS OF PITCH CONTROL/PORPOISE | MANOEUVRING

------------ S A F E T Y R E C O M M E N D A T I O N S ------------

RELATED TO PERSONNEL: NONE MADE
RELATED TO AIRCRAFT/EQUIPMENT: NONE MADE
RELATED TO MISCELLANEOUS SUBJECTS: NONE MADE

8-15-93

JAS-39 Preliminary Accident Report

On August 18, 1993, the Swedish Government Accident Investigation Board presented the preliminary report on the August 8th accident involving the JAS-39 Gripen. The accident occurred during a flight demonstration at the Stockholm Water Festival.

According to the government investigation, "The accident was caused by the flight control system's high amplification of stick commands in combination with large, rapid stick movements by the pilot. This led to the stability margin being exceeded and the aircraft entering a stall."

The report went on to say, "A contributing factor was the late display of the flight attitude warning system (STYRSAK) which gave the pilot too little time to react."

In a response to the report, the JAS Industry Group (IG JAS) concurred with the board's view on the cause of the accident. IG JAS said, "Our development process identified the particular problem, but the judged margins have proved inadequate. An error of judgment, therefore has been made. There was no system or design fault, the system operated in accordance with the type specification during the flight."

The IG JAS response continued, "The aircraft entered an uncontrollable position owing to an unfortunate combination of man-machine behavior. Corrective action to introduce the necessary margins will be implemented in a relatively short time and is the responsibility of IG JAS."

The development process is well-controlled and comprises a large number of quality assurance procedures. The development utilized both theoretical calculations, simulations and tests in simulators and test rigs where both software and hardware are evaluated. Flight testing follows a thorough and carefully controlled process with successive enlargement of the flight envelope. The process has been designed following the unfortunate accident of the first JAS-39 prototype in January, 1989. The extensive results are considered to fully meet applicable requirements for safety.

The objective of the development process includes optimizing aircraft performance and flying characteristics. To this aim, margins are established for the limits of the aircraft's operation. This forms part of the routine work and test deviation reports generated during design review group consisting of systems designers and pilots from both the manufacturer and officials making an assessment. IG JAS states that the development process and the methods used operated correctly and identified the particular problem prior to the accident on August 8th. Based on available knowledge, margins were set up concerning the demonstration flight and were judged small but sufficient. It has been shown, however, that in extreme combination of pilot input and control systems characteristics, the margin is inadequate.

Since the January, 1989 accident involving the first JAS-39 prototype, more than 1,200 flights have been successfully completed during the flight test program. IG JAS has acquired far greater knowledge and confidence in the Gripen's characteristics. There is nothing to indicate the development of the Gripen involves a higher risk level than earlier development projects.

During any aircraft development, it is impossible to avoid accidents with total certainty. High performance aircraft systems are designed to minimize the risk of malfunctions and to meet the requirements of the flight test program. When an aircraft encounters an uncontrollable flight situation, both the pilot and the aircraft are provided with a recovery mode. In this case, the pilot's recovery, or rescue, mode worked as designed. The minimum altitude of the aircraft did not allow the pilot to initiate the aircraft recovery mode.

JAS 39 GRIPEN

JAS 39 GRIPEN EFCS

HOW TO DEAL WITH RATE LIMITING

by

Jan Angner (M), Test Pilot, Saab Military Aircraft
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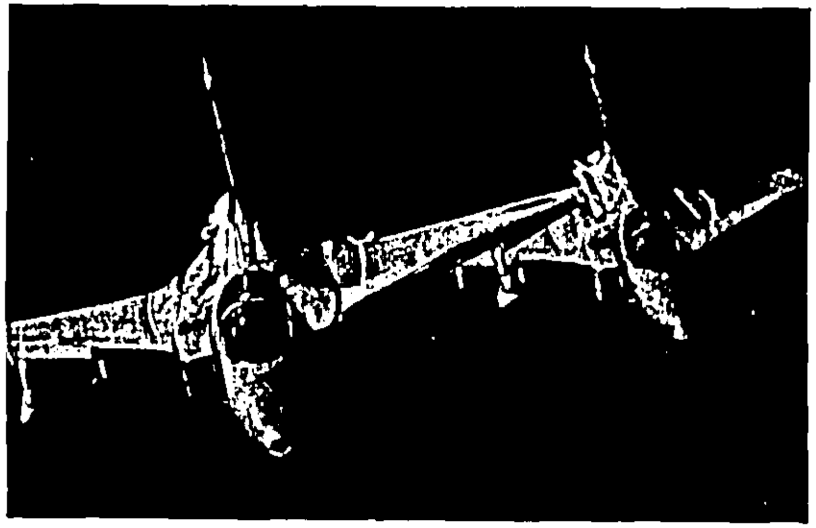

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6 How to fix it
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1 INTRODUCTION

The JAS 39 GRIPEN flight test program has been running since 1988. Many design items have been of great concern to us during this period but nothing as much as the complexity and the performance of the EFCS. There is no doubt that we early in the program underestimated the challenge of designing and building an EFCS for a highly maneuverable and statically unstable aircraft such as the JAS 39 GRIPEN.

At Saab Military Aircraft we were confident that we knew how to design, build and test flight control systems. That was probably true for traditional configurations and control systems as proven in the VIGGEN program. But the design and testing of the EFCS for the JAS Gripen proved to be more difficult than expected and required us to invent new processes for software validation and flight test methods.

Today, 8 years after the first flight, and after some 2200 test flights including more than 10 upgrades of the EFCS software and 2 accidents, we feel that we have reached an EFCS status that will satisfy customers regarding both safety and performance. We have achieved almost all of our performance and safety commitments and are now delivering aircraft to the Swedish Air Force at a rate of 18 per year.

This paper deals with the JAS 39 Gripen accident that occurred during an airshow over Stockholm in 1993. Including the reason for the accident, the short term solution in order to resume flight test and the long term (hopefully permanent) solution to ensure safety and performance for future production aircraft. The paper also covers the credibility process that the design and test team has to face when an accident occurs as a result of inadequate design.

2 BACKGROUND

The JAS 39 Gripen is a lightweight multi role combat aircraft powered by a single GE F404-400 engine rated at 80kN with max. afterburner. Basic empty weight is about 7 metric tons and max. take-off weight 13 metric tons. The aircraft has a shortcoupled delta canard configuration with all-moving canards. It has negative inherent stability in pitch for improved performance and a full time three channel digital electrical flight control system (EFCS), with two separate digital back-up modes. To improve turn performance and decrease buffeting the aircraft has automatically actuated leading edge flaps. The trim function is automatically balanced between canards and elevons for optimum performance.

The Swedish Air Force has so far ordered a total of 140 JAS 39 Gripen's which are scheduled to replace all versions of the SAAB Viggen and Draken aircraft and remain in service well into the next century. As of today we have delivered a total of 20 production aircraft to the Swedish Air Force which are routinely used in operational trials.

The future for the program looks promising. This year we hope for an order from the Swedish Air Force for an additional 60-80 aircraft, and we are also marketing the aircraft outside Sweden together with BAe.

However, though we feel confident with how the program is running today we have had our share of problems. The main problem area throughout the flight test program has been the complexity and the performance of the EFCS. There is no doubt that early in the program we underestimated the challenge of designing and building an EFCS for a highly maneuverable and statically unstable aircraft such as the JAS 39 Gripen. We have worked a lot with this particular problem during the last couple of years and believe our knowledge in this area could be of interest to those involved in flight testing modern flight control systems.

3 THE STOCKHOLM ACCIDENT

In June 1993 the Swedish Air Force took delivery of its first JAS 39 production aircraft. The aircraft was operated by the Swedish Air Force Test Center (FMV) and was used for initial release to service trials. In August of that year the aircraft was scheduled to take part in an airshow over Stockholm. At this time, this sole production aircraft, had flown a total of 40 hours only. Due to the limited maturity of the aircraft the operator restricted the airshow maneuvers to cover steep turns and lazy eights only.

The airshow began according to plan but about half way through the display program, as the aircraft was rolling out of a steep turn, the pilot lost control of the aircraft and ejected. This was a very spectacular event since it took place in view of more than 100 000 people watching the airshow. Fortunately no one was injured.

The accident resulted in a complete stop of all flight test activities with the JAS 39 Gripen. This, together with the way the accident occurred, put tremendous pressure on everyone involved. The credibility of the whole project was questioned by the media and the parliament, and unless we were able to quickly find out what went wrong, fix it and resume flying the future of the project would be endangered.

4 WHAT WENT WRONG

Immediately after the accident a thorough investigation was commenced by the official Accident Investigation Board, and an internal investigation by Saab. We all took part in the Saab investigation and it very soon became obvious what had happened that day over Stockholm.

In fact the day after the accident we repeated the maneuvers performed over Stockholm in our simulator used for JAS 39 EFCS development work. The result from this first test was successful in the sense that we were able to repeat what actually happened, but also surprising in that it could happen so easily when several (minor) negative factors co-operated.

Data from the aircraft crash recorder together with our simulator findings enabled us to reconstruct the flight profile in detail.

"The pilot was flying a steep turn at 20 deg AoA/300 km/h and was planning to roll out of the turn in front of the spectators whilst maintaining level flight. As the pilot rolled out of the turn by use of full lateral stick command the aircraft responded in an unnatural way. A slight undesired nose up response was experienced together with an overshoot in bank angle. The pilot tried to counter these motions with prompt control stick inputs and when doing so entered a divergent PIO which quickly resulted in loss of stability which caused the aircraft to depart".

The investigation showed that the undesired nose up movement was caused by an asymmetric roll command limiter. As the pilot quickly tried to reestablish his desired flight path by use of control stick commands he began to command more surface rate than the control system could provide. The control surfaces were driven at their rate limit and the phase lag in the control-loop became too large and consequently the aircraft lost its stability.

The reason for the accident was that the aircraft entered a divergent PIO which resulted in loss of control. The reason for the PIO was excessive control activity driving the control system to its rate limit and beyond. The trigger for the PIO was an unexpected nose up pitch motion caused by an asymmetric roll command limiter.

Was the fact that the aircraft could be rate limited known at this time to the manufacturer and the operator? The answer is yes, and we were working on a solution to just this problem. We had seen in the simulator that prolonged aggressive maneuvering could result in rate limiting leading to departure. But it was accepted that the aircraft at that time was not to be treated as if it was "care-free". What we didn't understand however, was that under certain conditions loss of control could occur very easily.

5 UNDERSTANDING RATE LIMITING

Before we could start to work on a solution for our rate limiting problem we first had to make sure that we fully understood the problem. As mentioned earlier we were aware of the problem but obviously we didn't understand everything. Below follows a brief description of the reasons for and the effects of rate limiting in a flight control system.

A servo actuator or control servo is a device whose purpose is to produce an output signal proportional to the input signal. When a servo is commanded to move faster than it can, the servo actuator is said to be moving at its rate limit. Although control surface rate limiting has been a potential problem for aircraft control since the advent of powered actuators, it was not until the introduction of highly augmented, unstable aircraft, such as the JAS 39 Gripen, that it became a hazardous problem.

To meet the specified requirements, an aerodynamically pitch unstable, artificially stabilized configuration was chosen for the JAS 39 Gripen. In an artificially stabilized aircraft, the pitch stabilization must have access to all the control surface rate it requires, otherwise aircraft stability will be degraded or lost. Very short and temporary rate limitations are no major problems. However, if the percentage of time in rate limit increases this will severely effect handling qualities and eventually result in loss of control when the aircraft no longer can be artificially stabilized.

The control surface servos must respond continuously to the sum of the commands from the pilot and from the stabilization system. When the sum of the commands exceeds the servo performance the system will be rate limited. When a servo reaches its rate limit its performance degrades. To avoid this degradation, the control system normally incorporates software rate limiters upstream of every servo, the value of which being slightly less than that of the servo.

If the pilot's authority is high enough, he can cause rate limitation by sudden large commands. If so, he will get an unexpected (delayed and crossfed) response from the aircraft, which may cause him to counteract with an abrupt control input in the other direction. This may eventually result in a PIO which will force the system deeper into rate limitation and thereby closer to instability. Therefore any PIO tendencies must be eliminated.

Figure 1 illustrates the effect of rate limiting. As can be seen the input rate exceeds the output rate. The output moves as fast as it can until it reaches the commanded amplitude, then reverses direction and moves as fast as possible in the new direction. Note that the peaks in the output (T_2) occurs later then those of the input (T_1). This illustrates how rate limiting will cause time delays or phase lag. It's essentially this time delay that starts and maintains the PIO. Eventually the time delays will become so large that the artificial stability of a pitch unstable aircraft will be lost.

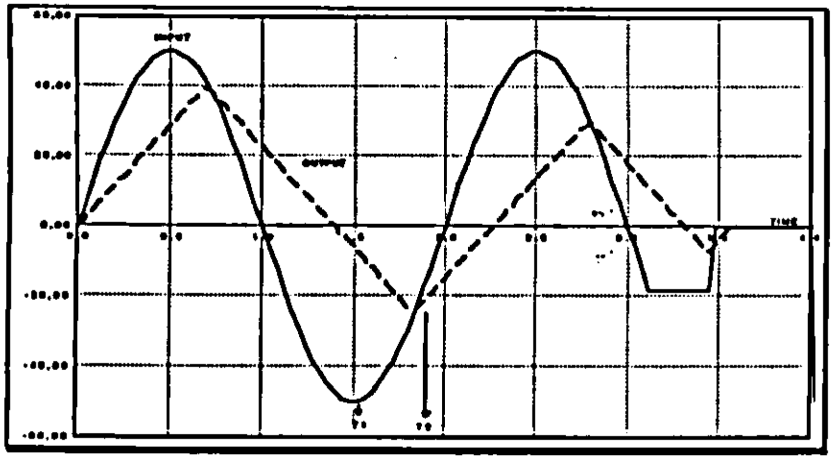

Figure 1. Effects of rate limiting.

The following factors may contribute to a rate limiting problem:

- Electrical flight control system which has no mechanical connection between stick and control surfaces.
- Pitch unstable platform requiring a high amount of continuous feedback.
- Control surface servos of limited rate (do not exclude degraded modes such as reduced hydraulic supply!).
- Same control surfaces for pitch and roll.
- High maneuver performance (command authority).
- Small unconventional control stick with high bandwidth.

6 HOW TO FIX IT

Once we had found out what went wrong and analyzed the problem, the next step was to fix it and resume flight test.

Since the servo rates available could not be increased without basically rebuilding the entire airplane, the fix had to be done within the EFCS software.

Since it was considered important to resume flight test as soon as possible and we knew an operationally acceptable EFCS software change would take time to implement, we decided to work simultaneously on two solutions:

- A short term solution. Software changes that would allow us to quickly resume flight test.
- A long term solution. Software changes that would be operationally acceptable.

7 THE SHORT TERM SOLUTION, SAFETY IS IMPERATIVE

One thing we knew; whatever we came up with, had to be extremely SAFE. Regardless what the pilot did to the stick, the aircraft MUST remain within the envelope.

We immediately recognized that the short term software solution meant that performance had to be sacrificed.

The EFCS designers worked with the short term solution in parallel with the long term solution. We, as test pilots, initially concentrated on the short term solution. Having the maximum servo rate we had, we needed to maximize the percentage of rate that the pitch feedback utilized. This, of course, meant that the pilot would have less "servo rate" at his disposal. We also knew, from the accident, that the mix of pitch/roll command signals was not optimal. We also had a number of functions within the system, incorporated to minimize pilot work load, that had also contributed to the accident.

The designers changed various software parameters and we as test pilots flew the simulator to decide whether or not the result was acceptable. At this stage we only looked for handling qualities (HQ) good enough to get the aircraft airborne safely, perform simple (from an EFCS point of view) flight tests, and safely land the aircraft. We wanted ABSOLUTE safety. At the same time we wanted to avoid changes to the structure of the software program. We didn't want to feel any uncertainty regarding the integrity of the software.

With these criteria in mind the following changes were incorporated:

1. Several small changes to "automatic functions" such as automatic trim in roll. These functions "consumed" control surface rate.
2. Change of trim setting on the elevons to minimize the risk for control surface position limiting.
3. Maximum n_z and AoA limits were decreased from 9.0 to 7.0g and from 26 to 20 deg respectively.
4. Pitch and roll roll stick gradients were changed to reduce initial response.
5. Maximum roll deflection was decreased from 9 to 7 degrees in order to reduce the maximum attainable roll command.

6. Changes in the design of the MLL (Maneuver Load Limiter) essentially making it more conservative. AoA and n_z responses were decreased for step inputs.

7. Changes in the scheduling of maximum commandable control surface rate as a function of hydraulic pressure. Essentially the attainable surface rate was tailored to the hydraulic pressure in order not to "drain" the system.

8. Considerably longer time constants were introduced in both the pitch and the roll forward command path. This resulted in a somewhat more sluggish airplane response with somewhat less predictability.

9. Roll authority was decreased at low speeds, giving priority to the pitch feedback loop.

10. The proportional part of the pitch forward command path was significantly reduced at low speeds.

11. The asymmetric roll limiter was removed.

These changes to the software all aimed to reduce the effect of a harsh pilot input. This normally is something every pilot dislikes, however, our situation was not normal. As test pilots at this time we had to accept decreased performance, but of course not to the extent that the pilot would feel "locked out" of the control loop.

Hundreds of hours were spent in the simulator to tailor something that could be accepted from a HQ point of view and at the same time fulfill the most important goal: The airplane was not to depart whatever the pilot did to the control stick. Once we had something we believed we could fly, we had to make sure it didn't depart. This was probably our deepest concern. How do we come up with a test method that we can trust? Early in the process we learned that full stick inputs, approximately 180 deg out-of-phase with the airplane response, seemed to be the worst we could do to saturate the system. Consequently we developed a method to test our system doing just this. We spent hours in the simulator pumping the stick 180 deg out-of-phase with the airplane. Doing so induced a "clonk" sound, thus clonk testing was invented!

Simultaneously the EFCS engineers were trying to come up with a computer model to test the system. During the first months of our work we, the humans, were ahead of the computers. It seemed there was always yet another way to get the airplane to depart. We could spend days with a set of control laws we really believed in, just to find out it didn't work if we changed our input just a little bit. The system was sensitive to the mix of pitch and roll inputs. A couple of pure pitch inputs were not a problem. Full pitch and roll inputs in combination were OK. But, if we blended the pitch input with, say, 50% roll the airplane might depart.

We soon found that the airplane was most sensitive to large control stick inputs at speeds around 400 km/h. Thus, the design work was initially concentrated to this speed range. However, since the system was sensitive to variations in control stick inputs, the computer models had a hard time to keep up with our work in the simulator. For example, if the computer predicted that the control laws could manage, say, 8 full inputs, we already knew from the simulator that the system only could handle 4. This was an ongoing evolution. Finally a computer model was designed which predicted departures correctly.

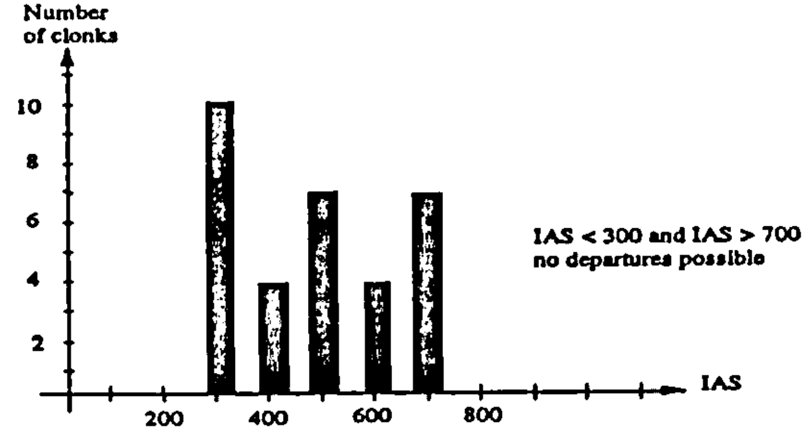

Figure 2. Number of "clonks" to departure as a function of IAS (km/h).

As indicated in figure 2 the aircraft was as most sensitive to large control inputs at 400 km/h and 600 km/h. The reasons for this is illustrated in figure 3 where forward path gain is plotted versus IAS. As can be seen maximum pilot command gain is available at these speeds.

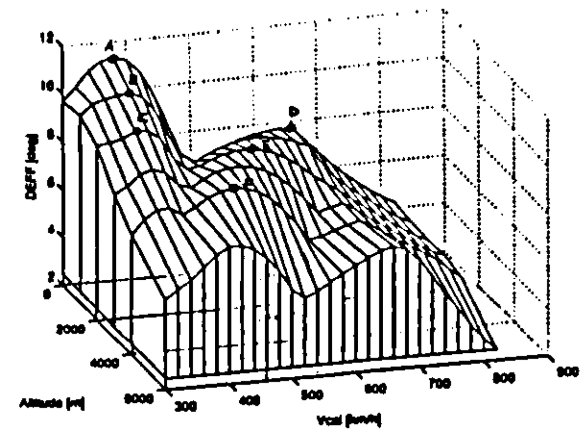

Figure 3. Forward path gain as a function of Indicated Air Speed (km/h).

The maximum number of clonks before departure was a much discussed topic at this time. We all knew we had made an incorrect assumption earlier, so who was prepared to say that 4, 5 or 10 full stick inputs were enough for safe flight? However, we finally came to a decision in which all Saab and FMV test pilots took part. We decided the system had to tolerate at least 4 full stick inputs at the worst assumed condition.

The critical envelope was divided into two segments. One segment was, at low altitude, where we could not rule out PIO triggers such as sudden encounters with birds. In this segment no flying would be allowed except for takeoff and landing. Within the rest of the critical envelope it was decided that no maneuvers that could trigger a PIO, such as formation flight, were to be performed. Outside these two segments the airplane could be flown "as usual".

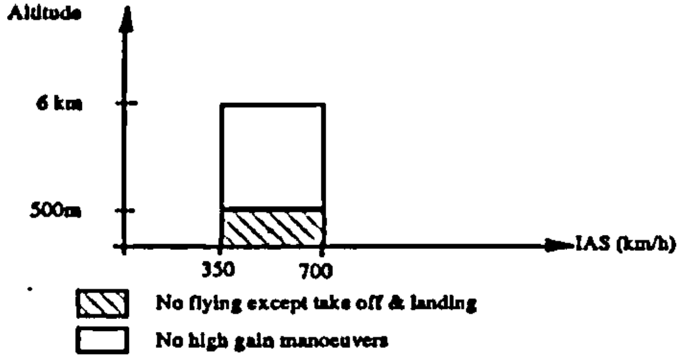

Figure 4. The flight envelope with the short term fix.

We knew early on that two basic parameters affect the risk of departure due to clonk. One was the pitch gain, or actually the maximum n_z allowed by the system. The other parameter was aircraft mass. We found that we could not meet our "4 clonk criteria" everywhere in the envelope with a maximum allowed n_z of 7.0 g. Therefore we manually reduced the n_z-bias to 5.0 g when inside the critical part of the envelope. This was a practical use of the Flight Test Functions (FTF) panel incorporated in the EFCS for flight test use.

We learned that if the airplane weighed more than 8.5 metric tons, it was not possible to depart even if the n_z-bias was set to 7.0 g. Therefore the loaded weight had to be above 8.5 metric tons.

With the new set of control laws, the restrictions mentioned above, and months of computer simulation, we felt ready to resume flying. On December 29, 1993, 4 1/2 months after the Stockholm accident we flew. The concerns about sluggishness and unpredictability due to the changes in the control laws proved to be groundless. Actually, apart from losing some performance due to the lowered maximum n_z/AoA and a tendency to float during landing flare, the airplane flew extremely well. In fact it flew better than before within some areas of the envelope, such as fine tracking during aiming.

It is well worth remembering that with a maximum n_z-bias of 5.0 g in the EFCS, the airplane could not be departed at any speed. Keeping out of the "critical part" of the envelope was just another safety net. With this in mind it was decided to develop an operational flight program for the initial batch of production aircraft to be delivered to the Air Force.

Production aircraft do not incorporate any FTF's, therefore another method had to be found to ensure that a max. 5.0 g's could be commanded by the pilot. An ingenious solution to this problem was invented by the designers. In essence it was done by sending a false message to the EFCS making it believe that the aircraft weight was above 10.000 kg at all times, thus reducing the maximum allowed n_z-bias to 5.0 g.

FMV accepted production aircraft with this configuration in March 1995. Since then the FMV and the Swedish Air Force have taken delivery of 20 aircraft. FMV has flown a series of technical/tactical tests to further investigate operational suitability and the SAF has started initial training.

What was meant to be a temporary fix to a serious problem in order t[illegible]kly resume flight test at Saab, in reality became a versatile, safe software edition. The performance was reduced, but still features good flying qualities and serves well within both FMV and the Air Force. This story started in August 1993 and will end this summer when the Air Force starts to use EFCS edition P11 which incorporates the long term solution.

8 THE LONG TERM SOLUTION, SAFETY & PERFORMANCE

Rate limiting is an undesired quality in the Flight Control System of an unstable aircraft. The safe approach is to design the system so it will never occur. This can be done by selecting fast servos capable of high rates, typically 60°/s to 100°/s and/or by eliminating adverse effects by intelligent EFCS software design.

Rate limiting is a nonlinearity that should be avoided as far as possible. But even systems that have access to high servo rate performance are likely to reveal rate limiting in certain normal mode situations as well as in failure cases. For instance, an aircraft with just one hydraulic system in operation has to be flown at the same level of instability as the fully functional system.

It has been known for a long time that delays occur between input and output as a result of rate limiting. The phase lag should be eliminated. Various filter designs have been presented in the literature claiming to have this provision. The "only" problem has been to mechanize a solution that will work correctly in all situations. The two figures below illustrate this:

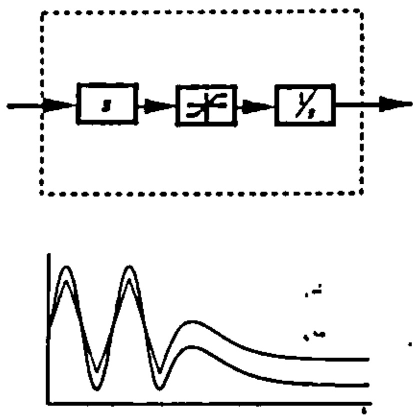

Figure 5. This filter produces rate (by differentiation), limits the rate and integrates back again. Note that this method preserves the rate, but causes loss of trim setting.

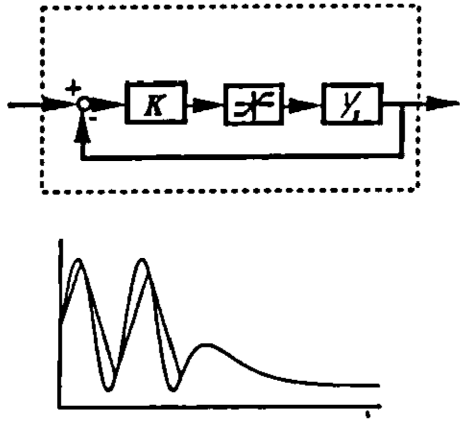

Figure 6. Another way of producing the derivative (rate). Now with a feedback that keeps the integration going until output = input; no loss of trim setting, but an awkward loss of phase. This can be seen as the standard method.

The design of the Saab rate limiting filter, RLIMFB filter, was started after the accident. The objective was to design a simple filter that could be incorporated in several places within the digital control loop. It was clearly understood that the Gripen EFCS should be inherently designed such that servo rate limiting would seldom occur. In rare cases with hard maneuvering the RLIMFB filter should act as a safety "fence" against bad HQ that might lead to loss of control. It was stated early that one could not expect the same good HQ with the RLIMFB filter active as without rate limiting, e.g. the presence of RLIMFB filters should not be expected to compensate for the need of "enough servo rate" in normal flight situations.

The RLIMFB filter is a fairly simple control system block with no switching logic. Filters designed using switching logic can have fairly good characteristics but tend to be complicated. The RLIMFB filter is designed as illustrated in figure 7. The diagram shows that the output signal changes sign as desired, just slightly delayed, and there is no mistrim present when the input signal goes to zero.

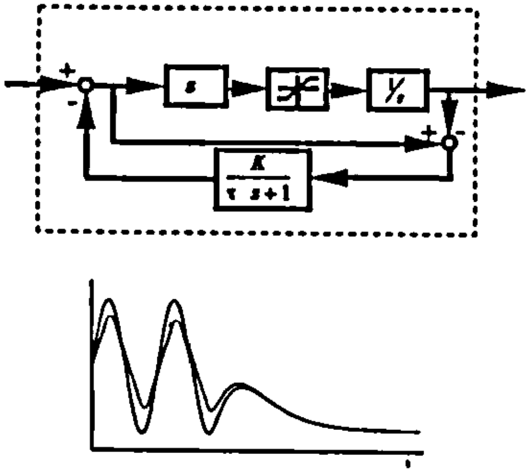

Figure 7 illustrates the RLIMFB filter. With no rate limiting present the feedback loop is not active. In a rate limit situation however the difference between input and output signal is subtracted from the input signal. This feedback reduces the input so that, in a limitation case, when input reverses, the output follows with just a slight delay. The filter has soft behavoir and minor trim offset and other properties can be adjusted by filter parameters.

Extensive analytic design work as well as simulator trials have been performed in order to optimize the filter parameters. You seldom gets something for free - the price although small, was a "drool" experienced for step inputs during pilot in the loop simulations see figure 8.

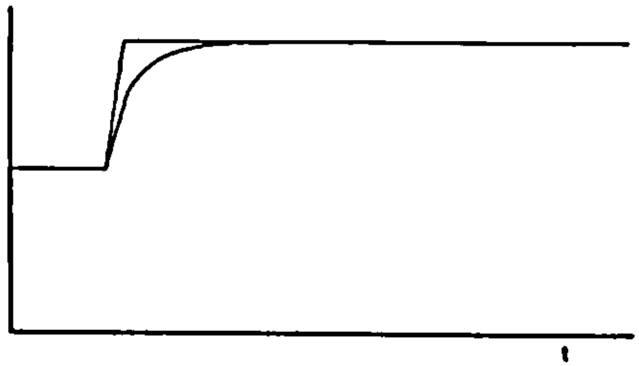

Figure 8. "Drool" for step input in the Saab RLIMFB filter design

A fixed base simulator is not the best device to find delicate HQ degradations, even if you know what to look for. To increase the knowledge of the filter behavior during real flying an In-Flight Simulation was performed in a Calspan Learjet. This flight test session was performed with simulated very low available maximum rate (20°/s) to force the pilot to control the aircraft during the test tasks with a high percentage of the time in rate limit.

Two tasks were performed: an up and away HUD tracking task, and a close to ground fairly extreme offset landing maneuver. Two filter designs in addition to two variants of the RLIMFB filter were tested, as well as a no filter variant with limited and full rate capability.

Both tests suffered from "scale effect" due to the selected low maximum servo rate: an airplane with extreme low max rate has basically bad HQ that hides qualities, good or bad, of a filter. Best results were obtained, as expected, with the "full rate" system and the worst HQ with the rate limited system without filter. The RLIMFB filter results from the two tasks did not indicate the RLIMFB filter to be far superior to the other filter designs tested. But, more importantly, no specific bad HQ were revealed, just a "general degradation" compared to a system with no rate limitation.

Finally, flight test results in a Gripen test aircraft with EFCS of "full performance" have shown that the RLIMFB filters are rarely activated even during hard maneuvering. During "clonk" maneuvering, when servo max. rate are reached on some surfaces, the aircraft has performed well. No type of advanced maneuvering has shown any signs of bad behavior.

The "drool" effect found in the simulator has proven not to affect the HQ during real flying. This is likely due to the fact that square type inputs are softened by lag lead filters in the forward loop and that several RLIMFB filters are interacting in the system. As seen in figure 9 RLIMFB filters are present at several places in the forward and feedback loops.

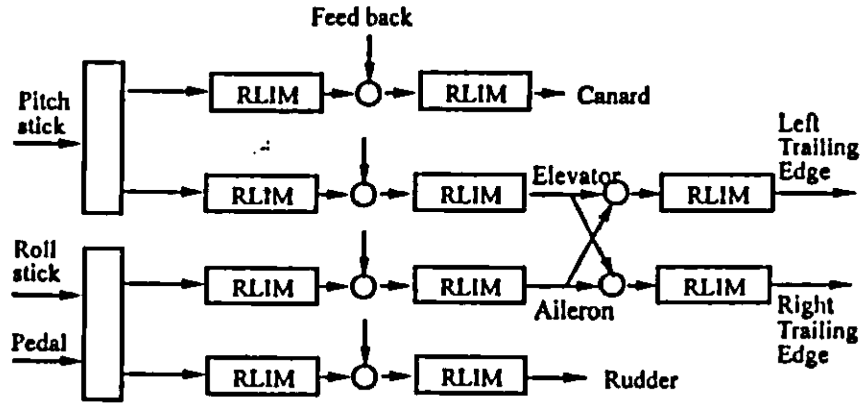

Figure 9. RLIMFB filter location in the Gripen EFCS.

The RLIMFB filter works well without affecting HQ regardless of EFCS mode. HQ degradations that have impact on flight safety are prevented. The filter design is patented and is available to others under license.

9 LESSONS LEARNED

The analysis work performed after the Stockholm accident, including understanding the problems in depth and the design and test process of the new filter have given us a lot of experience and knowledge in the probably still not fully explored field of EFCS for unstable aircraft.

Some of the lessons learned are listed below:

- **Test and production aircraft differ.** The flight over Stockholm was performed with a production aircraft which is some 10-15% lighter than test aircraft. This meant more performance and control power, due to the way the EFCS was designed, and resulted in a more PIO prone aircraft compared to the heavier test aircraft.
- **Ministick.** A small stick has many advantages but can be moved quickly between max. positions if the pilot feels he needs to.
  The natural position feed back is less in a mini stick than with a conventional stick. The EFCS design has to compensate for this.
- **Search for the worst case.** In the digital world simulators in most cases reveal the true airplane behavior. The risk of departure with the EFCS incorporated in the Stockholm airplane was misjudged. The worst case was present but not discovered. There is no simple and unambiguous method to find worst excitation of a multi input, multi output, nonlinear system such as a modern, artificially stabilized aircraft. Professional judgement and common sense are needed now more than ever!
- **Available PIO criteria has been of little help.** The Gripen has been tested with all known types of PIO criteria. None indicated the risk of divergent PIO similar to the Stockholm accident.
- **Do not design with "overperformance".** The high performance present in the EFCS of the Stockholm aircraft, especially in roll at low speed was considered "nice to have" by all pilots. But "overperformance" is also an unnecessary exposure to problem areas. Do not design with more response than is needed in each situation.
- **Servo rate limit situation can occur in all aircraft of this type.** You need to consider this fact during the design process. There are likely to be situations when more servo rate is demanded than available, these have to be handled in a way that will not compromise HQ or safety.
- **New technology - do not think you know everything.** Be critical, always ask the "what if" questions. Look for the worst case, investigate minor anomalies, play the devil's advocate, be suspicious... New test methods also have to be developed.
- **Maturity.** Maturity of a new design is not reached just because an extensive flight test program has been successfully passed. The production aircraft EFCS design in our case was not mature enough for operational use. Always ensure that flight tests are also performed in production aircraft.
- **Surface deflections as well as the presence of surface moment limitations** need to be dealt with in a similar way to rate limiting. Try to avoid these limitations also.
- **Anti servo rate limiting filters are good to have** but should not be activated during normal maneuvering.

10 CONCLUSION

The design and testing of the Gripen EFCS has truly been a challenge for both the designers and test pilots. As is often the case when new technology is introduced things do not always work out the way you expect. In our case little help was available from others when problems due to rate limiting occurred simply because we discovered the problem first in an operational system. It can be costly to be in the front line...

Our way of solving the situation after the accident by simultaneously working on a short term solution in order to create time for finding a permanent solution proved to be successful.

Today the Gripen operates with full performance. Flight tests have proven that the aircraft can no longer be departed due to rate limiting. Flight tests have also uncovered no negative HQ effects with the filter design during all types of maneuvering. This opinion is shared by all participating test pilots, including test pilots from outside Saab MA.

11 ACKNOWLEDGMENT

The authors acknowledge Erik Kullberg at Saab Military Aircraft for his contribution to this paper.

June 30, 1994

Airbus A330-321

Toulouse

T/O Test

06/30/94

AviationSafetyNetwork

The Aviation Safety Network

Accident Description

300 BEST

Accident description - Status: Preliminary - official

Date:	30.06.1994
Time:	17.41
Type:	Airbus A 330-321
Operator:	Airbus Industrie
Registration:	F-WWKH
C/n:	042
Year built:	1993
Total airframe hrs:	360 hours
Crew:	3 fatalities / 3 on board
Passengers:	4 fatalities / 4 on board
Total:	7 fatalities / 7 on board
Location:	Toulouse-Blagnac (France)
Phase:	Take-off
Nature:	Test
Flight:	Toulouse-Blagnac - Toulouse-Blagnac (Flightnumber 129)

Remarks:
The testflight was part of the preparation required for the certification of the Pratt & Whitney equipped Airbus A.330 autopilot to Cat. III standards (approach and go-around under very bad visibility conditions). The first part of the testflight was completed successfully when the aircraft landed on Runway 15L. A 180deg turn was made for a Runway 33R takeoff. The second takeoff was to be performed under conditions similar to those of the first takeoff. For this test however, the autopilot would incorporate the modification under study (Spatiaal with Bubble in 3972 state). The aircraft weighed 147,700kg and a centre of gravity of 42%. The takeoff was performed by the co-pilot with TOGA (takeoff Go Around) power, instead of Flex 49 (a lower power setting). Rotation was positive and pitch input was stopped when the attitude changed from 12deg to 18deg nose-up. Within 5 seconds after takeoff several attempts were to engage the autoilot were unsuccessful. After it was engaged, activation was delayed by 2 sec because the 1st officer was exerting a slight nose down input on the sidestick. The aircraft, still trimmed at 2.2deg nose-up pitched up to reach 29deg and the speed had decreased to 145kts. The captain meanwhile reduced thrust on the no.1 engine to idle and cut off the hydraulic system in accordance with the flight test order. Immediately after it activated, the autopilot switched to altitude acquisition mode (altitude had been set at 2000ft on the previous flight phase). This caused the pitch attitude to increase to 32deg in an attempt to reach 2000ft. The speed decreased further to 100kts (minimum conrol speed=118ts!). Roll control was lost and the captain reduced no.2 engine thrust to idle to recover symmetry on the roll axis. Bank and pitch attitudes had reached 112deg left and -43deg resp. before the pilotmanaged to regain control. It was however too late to avoid ground impact at a pitch attitude of around -15deg. PROBABLE CAUSES: "At the present stage of its work, the commission estimates that the accident can be explained by a combination of several factors none of which, taken separately, would have led to an accident. The initial causes are primarily related to the type of the

test and its execution by the crew during the last takeoff: 1) choice of maximum power (TOGA) instead of Flex 49; 2) very aft CG for the last takeoff; 3) trim set in the takeoff range, but in too high a nose-up position; 4) selected altitude of 2000ft; 5) imprecise and late definition of the test to be conducted and the tasks to be performed by the captain and first officer, respectively; 6) positive and very rapid rotation executed by the First Officer; 7) the Captain was busy with the test operations to be performed immediately after take off (engagement of the autopilot, reduce thrust on the engine and cut off the blue hydraulic system) which temporarily placed him outisde the control loop; 8) in addition the absence of pitch attitude protection in the autopilot altitude acquisition mode played a significant role. The following is also contributed to the accident: 1) The inability of the crew to identify the mode in which the autopilot was placed; 2) the confidence of the vrew in the expected reactions of the aircraft; 3) the late reaction from the flight test engineer when faced with a potentially hazardous change in parameters (speed in particular); 4) the time taken by the Captain to react to an abnormal situation."

Source: (also check out sources used for every accident)
S183 + S184; FI 10-16.8.94(6); AW&ST 11.07.94(26-27) + 3.4.95(72-73) + 10.4.95(60) + 17.04.95(44-45) + 15.05.95(58-59) + 22.05.95(54,56) + 29.05.95(69-70); TT + Ceefax; ASW 23.01.95(4)

- Investigation report

[disclaimer]

```
+------------------------------------------------ REQUEST 075/98, REPORT   4 ------------------------------------------------+
+ UNOFFICIAL REPORT                                 AIRBUS INDUSTRIES-A330                                          ACCIDENT +
+ EVENTS|PHASES                            SIMULATED FAILURE-FIRST ENGINE-INITIAL CLIMB                                     +
+                              COLLISION WITH LEVEL TERRAIN/WATER-EMERGENCY/UNCONTROLLED DESCENT                           +
+                                                   FIRE-POST-IMPACT                                                        +
+----------------------------------------------------------------------------------------------------------------------------+
                                                                 ++
<---------------------- OPERATION -----------------------> ++ <-------------------- FILE DATA ---------------------->
TYPE          :  NON-SCHEDULED/DOMESTIC/TRAINING/CHECK       ++ ICAO FILE          : 94/0173-0
                                                             ++ FROM STATE         :
FINAL REP                                                    ++
<---------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE          :  94-06-30                                    ++ MASS CATEGORY      :  27 001 - 272 000 KG
TIME          :  17:50                                       ++ STATE OF REGISTRY  :  FRANCE
LIGHT         :                                              ++ REGISTRATION       :  F-WWKH
GEN WEATHER   :                                              ++
                                                             ++
<---------------------- LOCATION ------------------------> ++ <---------- DAMAGE, INJURY AND TOTAL ON BOARD ---------->
LOCATION      :  TOULOUSE/BLAGNAC                            ++ A/C DAMAGE         :  DESTROYED
STATE/AREA    :  FRANCE                                      ++ INJURY :   FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  TOULOUSE/BLAGNAC                            ++ CREW   :     7      0      0     0      0      7
DESTINATION   :  TOULOUSE/BLACNAC                            ++ PAX    :     0      0      0     0      0      0
                                                             ++
```

---------------- NARRATIVE ----------------

AIRCLAIMS: THE AIRCRAFT WAS DESTROYED WHEN IT CRASHED DURING A TEST FLIGHT. THE FLIGHT HAD BEEN UNDERTAKEN TO TEST A NEW AUTOPILOT STANDARD INTENDED FOR CERTIFICATION FOR ALL-WEATHER CAT. III OPERATIONS WITH A330S POWERED BY PRATT & WHITNEY ENGINES. THE TEST CALLED FOR THE AIRCRAFT TO BE FLOWN AT MINIMUM SPEED WITH MAXIMUM ANGLE OF CLIMB AND WITH MAXIMUM AFT COFG. IMMEDIATELY AFTER TAKE-OFF, ONCE THE MAXIMUM FLIGHT ATTITUDE OF BETWEEN 25 AND 30DEG. WAS REACHED, THE TEST SEQUENCE INVOLVED SWITCHING ON THE AIRCRAFT'S AUTOPILOT, SIMULATING AN ENGINE FAILURE (IN THIS INSTANCE A FAILURE OF THE LEFT ENGINE) AND CUTTING OFF THE ENGINE'S ASSOCIATED HYDRAULIC CIRCUIT. FOR THIS PARTICULAR TAKE-OFF THE AIRCRAFT'S CONFIGURATION WAS: GROSS WEIGHT, 147.2 TONNES, COFG 42%, PITCH TRIM, 2.2 NOSE-UP AND FCU TARGET ALTITUDE 2,000FT. DURING THE SUBJECT FLIGHT, POWER WAS INITIALLY INCREASED SLOWLY DUE TO THE COFG BEING OUTSIDE THE AFT LIMIT FOR TAKE-OFF BUT THEN TOGA (TAKE-OFF/GO-AROUND) THRUST WAS SELECTED. THE AIRCRAFT WAS THEN, REPORTEDLY, ROTATED 'STEEPLY' AND 'RAPIDLY' BY THE CO-PILOT WHO WAS FLYING. AFTER GETTING AIRBORNE, THE 'EXTREME' AFT COFG, COUPLED WITH THE NOSE-UP TRIM, LED THE AIRCRAFT TO ADOPT A 'SEVERE' ANGLE OF ATTACK WITH IT EVENTUALLY PITCHING 29DEG NOSE-UP. THE MAXIMUM SPEED ACHIEVED WAS 155KT. BUT THIS THEN BEGAN TO DECAY AS THE AIRCRAFT'S PITCH ATTITUDE INCREASED. THE CAPTAIN TOOK OVER CONTROL AS THE SPEED FELL THROUGH 100KT, DISCONNECTED THE AUTOPILOT AND PUSHED THE SIDE-STICK FULLY FORWARD. THE SPEED INITIALLY CONTINUED TO DECREASE BY ABOUT 4KT/SEC UNTIL AT 90KT (28KT BELOW VMCA) LATERAL CONTROL WAS LOST AND THE AIRCRAFT BANKED 'QUICKLY' TO THE LEFT REACHING A BANK ANGLE OF 112DEG. THE MINIMUM SPEED REACHED WAS 77KT. MEANWHILE, POWER ON THE NO.2 ENGINE WAS REDUCED TO IDLE AND LATERAL CONTROL WAS RECOVERED. THE AIRCRAFT WAS BROUGHT BACK TO WINGS LEVEL WITH ITS SPEED INCREASING, HOWEVER, ITS STEEP NOSE-DOWN ATTITUDE AND HIGH RATE OF DESCENT (12,000FT/MIN) MENT THAT FULL RECOVERY COULD NOT BE COMPLETED BEFORE IMPACT WITH THE GROUND. THE ENTIRE FLIGHT, FROM BRAKE RELEASE TO IMPACT, LASTED 60SEC. THE ACCIDENT HAPPENED IN WHAT HAS BEEN DESCRIBED AS 'NEAR PERFECT WEATHER'.

☐ **Entry 2 of 4 in Applied Sci&Technol Abst 10/83-5/98**

TITLE

Autopilot a factor in A330 accident

PERSONAL AUTHOR

Sparaco,-Pierre

SOURCE

Aviation-Week-and-Space-Technology.v. 141 July 11 '94 p. 26-7.

ABSTRACT

French aviation authorities are investigating the crash of an Airbus A330 on June 30. The aircraft was performing an engine-out go-around under autopilot control as part of the Category 3 certification test. The aircraft pitched up following an unexpected autopilot mode activation during the test flight at Toulouse-Blagnac airport, France.

DESCRIPTORS

Automatic-pilots; Aviation-Accidents; Jet-transports-Testing .

☐ **Entry 3 of 4 in Applied Sci&Technol Abst 10/83-5/98**

TITLE

COMMISSION D'ENQUETE SUR L'ACCIDENT SURVENU LE 30 JUIN 1994 A TOULOUSE-BLAGNAC (31) A L'AIRBUS A330 N°42 D'AIRBUS INDUSTRIE IMMATRICULE FWWKH

RAPPORT PRELIMINAIRE

28 JUILLET 1994

2

AVERTISSEMENT

Le présent document a été établi par la commission d'enquête sur la base des renseignements disponibles.

Il présente des éléments factuels recueillis sur les circonstances de l'accident, une première analyse provisoire de cet accident et les premières recommandations que la commission estime devoir formuler avec pour objectif fondamental la prévention de futurs accidents.

Il est rappelé que cette enquête ne vise nullement à la détermination de fautes ou de responsabilités.

3/4

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Date de l'accident:
jeudi 30juin 1994
à 17h41 locales (15h41 TU.)

Lieu de l'accident:
En bordure ouest de l'aérodrome
de Toulouse-Blagnac (Hte Garonne)

Nature du vol:
vol d'essais

Aéronef:
AIRBUS A330-322
numéro de série : 42
Immatriculation : FWWKH

Propriétaire:
GIE Airbus Industrie

Occupants:
- Equipage (3):
Commandant de bord : Nicholas WARNER
Pilote : Michel CAIS
Ingénieur navigant d'essais : Jean Pierre PETIT
- Observateurs : 4

RESUME DE L'ACCIDENT:

Dans le cadre d'un vol d'essai, après un décollage à un centrage très arrière, en vol de montée à forte assiette, l'équipage effectue une simulation de panne du moteur gauche après avoir engagé le pilote automatique. La vitesse diminue rapidement et malgré la reprise en mains par le commandant de bord, l'avion embarque vers la gauche. La reprise du contrôle du vol intervient trop tard pour éviter l'impact avec le sol.

Conséquences:

	PERSONNES			APPAREIL	DEGATS AUX TIERS
	Tués	Blessés	Indemnes		
Equipage	3	-	-	Détruit	Sans objet
Observateurs	4	-	-		

COMPOSITION DE LA COMMISSION D'ENQUETE ET RESUME DES TRAVAUX:

Composition de la commission:

La commission d'enquête instituée par message n°8522 DEF/DGA/DCAé du 1er juillet 1994 est composée de:
- M. François Gonin, ingénieur général de l'armement, président,
- M. Jacques Rosay, pilote d'essais du Centre d'essais en vol,

- M. Dominique Deschamps, ingénieur en chef de l'armement du Centre d'essais en vol,
- M. Henri Marotte, médecin-chef du Centre d'essais en vol,
- M. Yves Lemercier, ingénieur au bureau Enquêtes-accidents de l'Inspection Générale de l'Aviation Civile et de la Météorologie (IGACEM),
- M. Bernard Marcou, ingénieur au Service de la formation aéronautique et du contrôle technique de la

Direction Générale de l'Aviation civile,
- M. Paul Arslanian, chef du bureau Enquêtes-accients, observateur (IGACEM).

Conformément aux principes de l'annexe 13 et dans le cadre des accords généraux entre le Bureau Enquêtes-accidents et le National Transportation Safety Board (NTSB - USA), un représentant du NTSB, assisté d'un représentant de la FAA et de conseillers de Pratt et Whitney, a eu accès aux résultats d'exploitation des enregistreurs de bord.

Résumé des travaux:

Le président de la commission d'enquête instituée le 1er juillet, accompagné de plusieurs membres de la commission, s'est rendu sur les lieux le même jour en fin de matinée. A cette occasion, il a pris contact avec les autorités judiciaires concernées qui ont défini les modalités de transfert et d'exploitation des enregistreurs de vol qui avaient pu être récupérés sur l'épave de l'avion.

Il a également visité l'épave et donné son accord pour transférer ses éléments dans un hangar après avoir défini des précautions particulières à prendre concernant les moteurs et certains éléments.

La première réunion plénière de la commission d'enquête a eu lieu le 5 juillet à Toulouse. Elle a permis de recenser les données disponibles relatives à l'accident et de définir un programme de travail pour les jours suivants.

La deuxième réunion plénière a eu lieu le 8 juillet à Toulouse. Au cours de cette journée, la commission a procédé à l'écoute de la bande de télémesure enregistrée pendant le vol de l'accident* ainsi qu'à des essais au simulateur de développement de l'Airbus A330 en conditions d'utilisation normales et en conditions similaires à celles du vol du 30 juin. A cette occasion, elle a élaboré les premières recommandations qu'elle estimait devoir formuler concernant le mode d'acquisition d'altitude du pilote automatique.

Les travaux de la commission ont été poursuivis par chacun de ses membres, conformément au programme de travail défini le 5 juillet.

La troisième réunion plénière de la commission a eu lieu les 26 et 27 juillet à Paris. Elle a été consacrée à la mise au point du présent rapport préliminaire.

* s'agissant d'un avion en essais. l'Airbus A330 n°42 était équipé d'une installation d'essais spécifiques en sus des enregistreurs de vol.

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I - RENSEIGNEMENTS DE BASE:

1.1 - Déroulement du vol:

Ce vol d'essais entrait dans le cadre de la préparation de la certification du pilote automatique aux standards de catégorie III (approche et remise de gaz par très mauvaises conditions de visibilité), pour cette version de l'Airbus A330 équipée de moteurs Pratt et Whitney.

copilote effectue la rotation puis le commandant de bord enclenche le pilote automatique, réduit un moteur et coupe le circuit hydraulique correspondant). La chronologie des événements a ensuite été la suivante:

- le copilote a demandé confirmation de la puissance à afficher au décollage (TOGA ou Flex49),

- le copilote a affiché la puissance maximale (TOGA) sur les deux moteurs conformément à la procédure indiquée par le commandant de bord, alors que, comme pour le premier décollage, l'ordre d'essais prévoyait une puissance Flex 49,

- le copilote a conservé une action à pousser sur le manche jusqu'à la rotation,

- la rotation a été réalisée franchement et l'action à la profondeur a été arrêtée, l'assiette évoluant de 12 à 18°,

- plusieurs tentatives d'engagement du pilote automatique avant les 5 secondes succédant au décollage ont été infructueuses. Le pilote automatique n'a été actif que deux secondes après l'engagement car le copilote exerçait un léger ordre à piquer sur le manche à ce moment (déplacement supérieur à 0,5°). Pendant cette période, l'avion, toujours trimé à 2,2°, s'est cabré jusqu'à atteindre une assiette de 29°. La vitesse de l'avion, après avoir atteint 155 Kt, n'était que de 145 Kt au moment ou le pilote automatique a été connecté (Vobjectif > 150K),

- l'assiette longitudinale de l'avion a diminué ensuite légèrement vers 25°,

- le commandant de bord a réduit le moteur gauche dès l'engagement du pilote automatique puis a coupé le circuit hydraulique bleu. Immédiatement après être passé actif, le pilote automatique est passé en mode Acquisition d'altitude ou ALT* compte tenu du fort taux de monntée de l'avion (une altitude sélectée de 2000 ft avait été affichée au cours de la première phase de vol, lors de la descente à partir du niveau 100 pour la première approche),

- dès lors, la loi de pilotage du mode ALT* a fait cabrer l'avion pour rejoindre l'altitude sélectée. L'assiette est montée vers 32° et la vitesse de l'avion a chuté rapidement,

- lorsque le commandant de bord a repris l'avion en mains, la vitesse avion n'était que de 100Kt en forte diminution (vitesse minimale de contrôle air: 118Kt),

- la fonction Alpha prot des commandes de vol qui restitue une stabilité longitudinale statique positive s'est activée normalement, juste après la reprise en mains de l'avion par le pilote, qui n'a pas pu éviter une perte de contrôle en roulis,

- une remise des gaz automatique (protection alpha floor) s'est ensuite activée, elle a été immédiatement stoppée par le commandant de bord qui a réduit le moteur droit au ralenti dès la perte de contrôle en roulis pour resymétriser rapidement l'avion,

- les assiettes latérale et longitudinale ont atteint respectivement 112° gauche et - 43°. Dans ces conditions des informations invalides ont alors été envoyées aux calculateurs de commandes de vol par les centrales à inertie entraînant un passage des commandes de vol en loi directe, Le programme général des vols correspondants était fixé par le document Airbus Industrie n°460/94 issue n°1 du 27 juin 1994.

L'ordre d'essais du vol n°129 fait l'objet d'un document daté du 30 juin 1994.

Tout le vol jusqu'à l'instant précédant l'accident s'est déroulé conformément à l'ordre d'essai, hormis la puissance affichée au premier décollage : TOGA (Take Off Go Around : puissance maximale) au lieu de Flex 49 (puissance inférieure à la puissance maximale égale à celle qui serait disponible avec une température extérieure de 49° c):

- décollage en configuration 2 de becs et volets, engagement du pilote automatique (en version de base) à 157 Kt en mode de tenue de vitesse (SRS : Speed Reference System) 6,5 secondes après le décollage puis réduction d'un moteur et coupure du circuit hydraulique correspondant.

- montée au niveau 100, moteurs en fonctionnement normal. Réalisation de virages au pilote automatique en mode de tenue d'altitude, en configuration pleins becs et volets à Vmin + 5 et à Vmax - 10Kt pour étudier les problèmes de coordination des commandes en virage.

- approche automatique suivie d'une remise de gaz avec panne simulée d'un moteur (pilote automatique en version basique).

- manoeuvre identique à la précédente après introduction d'une modification du pilote automatique (Spatiaal avec Bulle état 3972, cf paragraphe 1.6).

- approche automatique en monomoteur simulé, atterrissage automatique et utilisation d'une seule reverse.

Durant toute cette partie du vol le travail en équipage était le suivant:

- le premier décollage a été effectué par le commandant de bord en place gauche,

- la suite du vol a été effectuée en pilotage automatique. Les actions ont été réalisées et commentées par le commandant de bord. Le copilote vérifiait les actions du commandant de bord et observait le fonctionnement de l'avion sans intervenir sur les essais,

- le copilote a réalisé tous les échanges radio avec le contrôle aérien.

A l'issue de cette partie du vol, et toujours conformément à l'ordre d'essai, un décollage devait être réalisé dans des conditions semblables au premier, hormis l'état du pilote automatique qui comportait la modification étudiée (Spatiaal avec bulle état 3972). L'avion qui s'était posé en piste 15G a effectué sur la piste un demi tour avec l'accord du contrôle d'aérodrome pour s aligner en piste 33D. Durant cette phase, l'avion a été préparé pour le décollage et le trim a été positionné de 4° à cabrer à 2,2° à cabrer sans dialogue équipage. La masse et le centrage étaient alors respectivement 147 700 Kg et 42%. L'ingénieur d'essais a ensuite expliqué la nature de l'essai à réaliser et sa chronologie. Une fois aligné sur la piste 33D, avion prêt au décollage, le commandant de bord a proposé au copilote de réaliser ce décollage puis a explicité la répartition des tâches (le

- le pilote est parvenu à reprendre le contrôle de son appareil mais trop tardivement pour éviter l'impact avec le sol. L'avion s'est écrasé avec une assiette longitudinale d'environ - 15°.

1.2 - Conséquences sur les personnes:

	Equipage	observateurs	Tieres
Tués	3	4	0
Blessés	-	-	-
Indemnes	-	-	-

1.3 - Dommages à l'aéronef:

L'avion a été totalement détruit par les impacts successifs et l'incendie très violent qui a suivi.

1.4 - Autres dommages:

Sans objet.

1.5 - Renseignements sur le personnel:

L'équipage technique comprenait trois personnes : un commandant de bord, un copilote, un ingénieur navigant d'essais.

Quatre autres observateurs étaient à bord : deux pilotes de ligne italiens, deux cadres technicocommerciaux d'Airbus Industrie.

- **1.5.1 - Commandant de bord:**

WARNER Nicholas, né le 7 janvier 1943 à Colchester (Royaume-Uni), chef pilote d'essais à Airbus Industrie.
Brevet de pilote d'essais obtenu en 1971, délivré par l'ETPS (école de formation des équipages d'essais britannique).
Licence de pilote d'essais n°119965 délivrée le 10 novembre 1978 par la Civil Aviation Authority (Royaume-Uni).
Dernière visite médicale passée le 28 avril 1994, certificat d'aptitude délivré le 28 avril 1994 par la Civil Aviation Authority (Royaume-Uni).

Expérience:
Heures de vol totales : 7713, dont 345 sur A330
Heures de vol effectuées dans les 6 derniers mois : 258 dont 123h30 sur A330.
Heures de vol effectuées dans les 30 derniers jours: 34h25 dont 21h15 sur A330.

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1.5.2 - Copilote:

CAIS Michel, né le 4 novembre 1940 à Paris (18ème).
Licence de pilote de ligne délivrée le 20 octobre 1980 par la Direction générale de l'aviation civile.
Dernière visite médicale passée le 02 mai 1994 devant le Centre d'expertise médicale du personnel navigant (CEMPN) du Service de santé des armées de Toulon : apte.
Qualification instructeur pilote de ligne délivrée en mars 1989.
Qualification de type sur plusieurs types d'avions, dont celle pour l'Airbus A330 délivrée le 16 novembre 1993.

Expérience:
Heures de vol totales : 9558, sur A330 : 137.
Heures de vol effectuées dans les 6 derniers mois : 151, dont 130 sur A330.

1.5.3 - Ingénieur navigant d'essais:

PETIT, Jean-Pierre, né le 23 août 1943 à Boulogne sur Mer.
Licence d'ingénieur navigant d'essais délivrée le 29 juillet 1969 par le Centre d'essais en vol.
Licence de pilote de ligne délivrée le 5 septembre 1989 par la Direction générale de l'aviation civile.
Dernière visite médicale passée le 17 septembre 1993 devant le Centre principal d'expertise médicale du personnel navigant (CPEMPN) du Service de santé des armées à Paris apte.

Expérience:
Heures de vol totales dans la spécialité: 6255.
Heures de vol dans les 6 derniers mois dans la spécialité : 234 dont 103 heures sur A330.

1.5.4 - Observateurs:
NASSETTI, Alberto, pilote de ligne de la compagnie Alitalia.
RACCHETTI, Pier Paulo, pilote de ligne de la compagnie Alitalia.
TOURNOUX, Philippe, cadre Airbus Industrie.
HULSE, Keith, cadre Airbus Industrie.

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1.6. Renseignements sur l'aéronef:

Propriétaire et exploitant: Airbus Industrie.

Planeur: Constructeur: Airbus Industrie.
Type: A330-322
Numéro de série: 42
Premier vol effectué le 14 octobre 1993
Total d'heures de vol le 30 juin 1994: 360 heures 30
Laissez passer exceptionnel délivré le 29 mars 1994, par la Direction générale de l'aviation civile, valable du 1er avril au 1er octobre 1994.

Moteurs : Constructeur: Pratt et Whitney.
Type PW 4168
Heures de fonctionnement (et nombre de démarrages):
- moteur gauche: 366h42 (173)
- moteur droit : 363h17 (183).

Définition:
S'agissant d'un avion en essais chez son constructeur, l'Airbus A330 n°42 n'était pas en tous points conforme à la définition de série certifiée en cours de livraison aux utilisateurs. Les principales spécificités de définition qui méritent d'être relevées dans le cadre de l'enquête sont les suivantes:

- l'utilisation d'un système dénommé Spatiaal qui permet de contrôler l'état effectif de certains paramètres internes aux calculateurs de l'avion (en particulier ceux du pilote automatique et des commandes de vol) et de les modifier à la diligence de l'ingénieur navigant d'essais à partir de données inscrites dans une mémoire amovible (dénommée "Bulle") programmée avant le vol par le bureau d'études. L'un des objets du vol était de comparer le comportement du pilote automatique en fonction de deux états de la "bulle 203" : "OFF" (standard de base pour le pilote automatique) et "3972" (état dans lequel l'ordre en vitesse de tangage du pilote automatique est deux fois plus fort). Dans cette définition, les calculateurs de l'avion sont fonctionnellement conformes aux calculateurs des avions de série mais matériellement différents pour pouvoir accepter des ajustements internes par sélection de données préprogrammées dans ces calculateurs.

- l'installation en cabine passagers d'un pupitre à la disposition de l'ingénieur navigant d'essais qui lui permet d'une part de conduire l'essai (visualisations, télécommunications), d'autre part de mettre en oeuvre l'installation d'essais.

- enfin, l'avion était équipé d'une installation d'essais en vol enregistrant et transmettant au sol par télémesure à cadence élevée les paramètres et la phonie du téléphone de bord (voie G - cf paragraphe 1.11).

Mentions portées sur les comptes rendus mécaniques

Il n'a pas été relevé sur les observations formulées par les équipages lors des vols précédents de remarques ayant une relation possible avec l'accident.

Masses et centrages :

Au démarrage, l'avion avait une masse de 152 700 kg et un centrage de 40,2%.

Avant le dernier décollage, la masse de l'avion était de 147 700 kg et le centrage de 42%.

1.7 - Conditions météorologiques:

La situation météorologique du jeudi 30 juin 1994 donnait un régime de beau temps ensoleillé sur Toulouse, associé à des vents faibles à basse altitude. Les observations effectuées sur le terrain à 17h30 locales (15h30 TU) montraient un vent de secteur nord-est d'environ 4Kt, conditions "CAVOK" (visibilité supérieure à 10 km, pas de nébulosité en dessous de 1500 m, pas de précipitation), température 34°, point de rosée 20°, pression au sol 997 hPa. D'autre part, les relevés météorologiques effectués entre 13h00 et 14h00 locales confirment que ces paramètres étaient stables.

A la mise en route, l'équipage a écouté l'ATIS de Toulouse. Le message était l'information enregistrée à 14h25 T.U: ILS 15G, niveau de transition 50, vent 170°/10 Kt, CAVOK, température 33° point de rosée 20°, QNH 1016, QFE 998 hPa.

Juste avant le dernier décollage (en piste 33D), la tour de contrôle a annoncé un vent du 040° pour une force de 3 à 8 Kt.

1.8 - Aides à la navigation, moyens de radio-navigation:

L'analyse des documents de suivi de l'avion ainsi que l'exploitation des différents paramètres et conversations enregistrés (par télémesure, sur les enregistreurs de vol ou par le contrôle aérien) montrent que les moyens de radio-navigation de l'avion étaient en parfait état de fonctionnement.

1.9 - Télécommunications:

Les transcriptions des radio-communications entre l'avion, la tour de contrôle et/ou l'approche de Toulouse-Blagnac ont été effectuées.

Pendant le vol, toutes les émissions de l'avion ont été effectuées par le copilote.

Les radio-communications avec l'organisme de contrôle de la circulation essais-réception ont également été transcrites. On note qu'avant le décollage, l'équipage signale une modification du profil de vol envisagé par l'ordre d'essais, prévoyant, après l'exécution de l'ensemble des manoeuvres consignées dans l'ordre d'essais, une phase complémentaire d'évolutions au niveau 100 à titre de démonstration au profit des pilotes italiens présents à bord.

1.10 - Renseignements sur l'aérodrome:

Les NOTAM en vigueur le jour de l'accident et la disponibilité réelle des moyens font apparaître une indisponibilité de l'ILS 15D ainsi que le remplacement du VOR. Ces données étaient connues de l'équipage. Les approches automatiques ont été réalisées en piste 15G à cause de l'indisponibilité du glide 15D. Les autres restrictions sur l'aérodrome ne concernaient que la circulation au sol et les postes de stationnement; elles n'avaient aucune influence sur le déroulement du vol.

1.11 - Enregistreurs de bord - télémesure:

Conformément à la réglementation en vigueur, l'A330 n°42 était équipé d'un enregistreur de conversations et d'alarmes sonores émises dans le poste de pilotage (CVR : Cockpit Voice Recorder) et d'un enregistreur de paramètres (SSFDR : Solid State Flight Data Recorder). Les deux enregistreurs ont été retrouvés sur l'épave de l'avion et transférés par l'officier de police judiciaire désigné, à Brétigny, le 1er juillet enfin d'après-midi.

L'avion était également équipé d'une installation d'essais qui transmettait par télémesure au sol les paramètres de vol à une cadence beaucoup plus élevée que celle des paramètres enregistrés sur le SSFDR, ainsi que la phonie enregistrée sur le téléphone de bord ("voie G" de la télémesure). Les données transmises par télémesure ont été enregistrées au sol pendant le vol et étaient visualisées en salle d'écoute.

1.11.1 - Exploitation des enregistreurs:

SSFDR:

L'enregistreur de paramètres a été amené par l'officier de police judiciaire (OPJ) désigné au Centre d'essais en vol (CEV) sur la base de Brétigny le 1er juillet en fin d'après-midi. Les travaux d'ouverture de l'enregistreur ont commencé le même jour dans le laboratoire du CEV en présence de l'OPJ. L'ouverture de l'enregistreur et l'extraction du boitier mémoire ont été assurées sans difficulté particulière.

L'acquisition des 48 dernières minutes de vol a été effectuée sur la station Reseda du CEV permettant une visualisation ainsi qu'une première mise en grandeur physique des paramètres de vol en utilisant l'outillage et le logiciel de la société SFIM fabricant de l'enregistreur.

Des sauvegardes de travail ont été faites sur disquettes (copie totale de la mémoire de l'enregistreur). L'enregistreur et son boitier mémoire ont été remis à l'OPJ le soir même.

Les travaux ont ensuite porté sur la vérification des étalonnages, le tracé de courbes et la corrélation avec les autres informations disponibles et sont encore poursuivis en ce sens.

La lecture et la restitution des paramètres de vol enregistrés sont jugées satisfaisantes (aucune perte de synchronisation constatée) sauf pour les deux dernières secondes du vol.

CVR:

L'enregistreur CVR a été amené par l'OPJ à Paris dans les laboratoires du bureau Enquêtes-accidents le 2 juillet matin. Les travaux d'ouverture de l'enregistreur ont commencé immédiatement en présence de l'OPJ. L'ouverture de l'enregistreur et l'extraction de la bande magnétique ont été assurées sans difficulté particulière.

Quatre copies ont été réalisées. La lecture et l'écoute de l'enregistrement qui restitue les 30 dernières minutes de vol se sont effectuées dans de bonnes conditions. Une première transcription des cinq dernières minutes de vol a été effectuée le 2 juillet. L'enregistreur et la bande magnétique originale ont été remis à l'OPJ le même jour. Les travaux de transcription se sont ensuite poursuivis à partir du 4 juillet.

Télémesure:

Les données transmises par télémesure ont été exploitées pendant et après le vol du 30 juin.

Les premiers résultats de cette exploitation (tracés de courbes, visualisation et écoute des données transmises, première transcription de la phonie voie G de la fin du vol) ont été fournis à la commission d'enquête le 4 juillet. Des résultats complémentaires, ainsi qu'une copie de la phonie voie G concernant la totalité du vol ont été fournis par la suite à la commission.

Les données transmises par télémesure sont exploitables pendant la quasi totalité du vol, sauf pendant les toutes dernières secondes (2 à 3 secondes).

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1.11.2 - Fonctionnement des enregistreurs (SSFDR, CVR télémesures):

Le fonctionnement des enregistreurs est en première analyse parfaitement correct pendant tout le vol, sauf pour les 2 à 3 dernières secondes (SSFDR et télémesures).

En première analyse également la corrélation entre les paramètres enregistrés par le SSDFR et par télémesures est très bonne. Il faut noter par ailleurs que la télémesure fournit des données complémentaires utiles à celles restituées à partir du SSDFR et du CVR, en particulier:

- la restitution complète des conversations de l'équipage pendant tout le vol (alors que le CVR ne restitue que les 30 dernières minutes du vol),

- la restitution des modes d'activation du pilote automatique et/ou des commandes de vol : alors que le SSFDR enregistre ce qui est présenté au pilote pour ce qui concerne les modes d'activation du pilote automatique, les données télémesurées concernent l'état réel de ces modes.

1.11.3 - Restitution des conversations et des alarmes sonores (CVR et voie G de la télémesure):

Le CVR (type Loral Fairchild A 100 A - SN 57719)

Les conversations ont été entièrement restituées. La signification ne présente aucune ambiguité malgré le jargon spécifique aux essais.

Divers bruits, manoeuvres du levier de train, variations de régime des moteurs, ont été reconnus.

Les alarmes sonores et les signaux annonciateurs ont été identifiés.

La datation chronologique fournie par l'horloge interne du CVR est excellente. Elle a permis de caler différents éléments de conversation, de radio-communication et autres actions effectuées en cabine de pilotage.

La transcription du CVR est fournie en annexe.

La voie G de la télémesure:

Cet enregistrement est véritablement une sorte de CVR qui couvrirait tout le vol.

Après une écoute complète, la première partie de cet enregistrement peut être schématiquement présentée en cinq parties:

- la préparation et la mise en route de l'avion,

- le premier décollage et la panne simulée du moteur gauche au cours desquels le commandant de bord commente la réponse du pilote automatique à cette panne simulée,

- la manoeuvre (virages coordonnés) faite en altitude, au pilote automatique, ainsi que les commentaires du commandant de bord,

- les approches de catégorie III avec remise de gaz suivies de panne simulée, ainsi que les commentaires à chaud du commandant de bord,

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- l'atterrissage complet effectué en mode automatique et en mono-moteur simulé, avec activation d'une seule reverse, ainsi que les commentaires en temps réel du commandant de bord.

L'enregistrement de cette dernière partie recouvre l'enregistrement du CVR; il a été entièrement transcrit.

La seconde partie, celle couvrant l'accident, de 3 minutes 30 de durée, peut être scindée en cinq séquences:

- le rappel des intentions de l'équipage d'essai et le briefing particulier du copilote par le commandant de bord,

- le décollage, jusqu'à l'engagement du pilote automatique,

- l'engagement du pilote automatique, la simulation de panne moteur puis la montée en pilotage automatique jusqu'à ce que le commandant de bord réalise que l'essai ne se déroule pas normalement,

- la reprise en mains par le commandant de bord, la perte de contrôle et les actions de rattrapage,

- les deux secondes avant l'impact.

Dans les deux dernières séquences, les signaux sonores, alarme et messages GPWS, sont nombreux et se recouvrent parfois.

Exploitation:

- de l'écoute de la première partie de ces enregistrements, on retire l'impression d'une ambiance harmonieuse de travail méthodique du commandant de bord et de l'ingénieur d'essai, le copilote suivant les essais sans intervenir.

Aucune anomalie de fonctionnement de l'avion, des moteurs et des systèmes n'est signalée par l'équipage ou par l'équipe d'écoute au sol.

- de l'écoute de la deuxième partie, se dégage l'impression d'un équipage d'essais conscient de la manoeuvre spécifique qu'il va entreprendre en toute confiance.

On peut percevoir que le commandant de bord sort temporairement de la boucle de pilotage lorsqu'il exécute les actions propres à l'essai (engagement du pilote automatique, manette de gaz du moteur gauche sur ralenti, pompe hydraulique coupée). L'ingénieur d'essais signale l'engagement de l'avion dans une phase critique de façon relativement tardive (après que le commandant de bord ait repris les commandes).

1.11.4 - Restitution des paramètres enregistrés (SSFDR et télémesure):

La commission a essentiellement étudié la dernière phase du vol depuis le deuxième décollage. Toutefois, elle a également considéré l'évolution des paramètres lors du premier décollage et des deux remises de gaz effectuées au cours des premières phases du vol, ainsi que les affichages d'altitude présélectée réalisés par l'équipage.

Premier décollage : Il a été réalisé par le commandant de bord dans les conditions prévues par l'ordre d'essais, sauf pour ce qui concerne la puissance maximale affichée sur les moteurs (TOGA) au lieu du réglage Flex 49.

Les conditions étaient similaires à celles du deuxième décollage, avec toutefois les différences suivantes:
- avion plus lourd (+ 5 tonnes environ),
- centrage avant décollage : 40,2% (42% au deuxième décollage),
- altitude présélectée par l'équipage 7000 pieds (6969 sur le SSFDR) au lieu de 2000 (1982 sur le SSFDR) pour le deuxième décollage,
- "Bulle 203" sur OFF (Etat 3972 au deuxième décollage),
- réglage du trim proche de 0°(0,4° à cabrer au lieu de 2,2° à cabrer au deuxième décollage).

La mise de gaz est très progressive après le lacher des freins, la rotation est franche mais bien contrôlée, le pilote automatique est engagé 6,5 secondes après le décollage, la vitesse étant de 157 Kt et l'assiette longitudinale de 14,5°. Le pilote automatique est immédiatement activé en mode de tenue de vitesse (SRS). Le facteur de charge maximum atteint est 1,27 g.

Le moteur gauche est réduit 2 secondes après l'engagement du pilote automatique puis le circuit hydraulique bleu est coupé. Pendant la réduction effective de la poussée du moteur gauche, le pilote automatique maintient sensiblement constantes la vitesse et l'assiette longitudinale, puis il ramène progressivement l'assiette à 8° pour permettre le maintien de la vitesse à environ 160 Kt après une excursion à 150 Kt.

La vitesse verticale moyenne de montée pendant les 40 secondes qui suivent la simulation de panne du moteur gauche est de 1750 pieds par minute.

En latéral, les paramètres sont bien maintenus par le pilote automatique.

Affichage des altitudes présélectées par l'équipage (temps avion relevés sur le SSFDR, heures TU):
- 7000 pieds (6969 sur le SSFDR) avant le premier décollage,
- 10 000 pieds (9974 sur le SSFDR) pendant la montée vers 10 000 pieds (14h57'10),
- 8 000 pieds (7992 sur le SSFDR) avant le début de descente à partir de 10 000 pieds (15h06'59),
- 5 000 pieds (4987 sur le SSFDR) après un palier à 8 000 pieds (15h10'53),
- 3 000 pieds (2941 sur le SSFDR) en cours de descente (15h1 1'52),
- 2 000 pieds (1982 sur le SSFDR) après un palier à 3 000 pieds (15h14'48).

Cette dernière valeur n'est pas modifiée par l'équipage pendant tout le reste du vol.

Remise de gaz en pilotage automatique avec simulation de panne moteur:

Première remise de gaz : la première remise de gaz est effectuée après une approche au pilote automatique en configuration "full" (pleins becs et volets) à 130 Kt. Le centrage est de 40,2%, la "Bulle 203" en état "OFF".

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Très près du sol, la pleine poussée sur le moteur droit est affichée et le moteur gauche est réduit simultanément (15h19'37 TU, temps avion), la vitesse est de 128 Kt, le mode de tenue de vitesse (SRS) est activé au même moment. La configuration de becs et volets est modifiée (passage à la configuration 3) 5 secondes après les mouvements des manettes des gaz.

Le pilote automatique maintient 130 Kt avec des excursions maximales de ± 5 Kt l'assiette longitudinale maximale obtenue est de 12,7° puis se stabilise à environ 11°. Le facteur de charge maximum atteint est 1,18 g.

La vitesse verticale moyenne en fin d'essai est de l'ordre de 1500 pieds par minute. Le mode d'acquisition d'altitude du pilote automatique est activé lorsque l'avion passe 1 750 pieds en montée (15h20'42).

Deuxième remise de gaz : même configuration initiale que la première, sauf centrage (40,5%) et "Bulle 203" état "3972".

La pleine poussée sur le moteur droit est affichée à 15h28'45 TU, la vitesse est de 128Kt. La configuration de becs et volets (configuration "full" vers configuration 3) est modifiée 4 secondes après, puis le moteur gauche est réduit (15h28'51), la vitesse étant de 142 Kt.

Dès l'affichage de la pleine poussée sur le moteur droit, le pilote automatique est activé en mode de tenue de vitesse (SRS). Après l'excursion signalée à 142 Kt, le pilote automatique fait rejoindre 130 ± 2 Kt à l'avion en pilotant l'assiette longitudinale dont la valeur maximale atteinte est de 15,5° (15h28'53). Le facteur de charge maximum atteint est de 1,19 g.

La vitesse verticale moyenne en fin de montée est voisine de 1 000 pieds par minute. Le mode d'acquisition d'altitude du pilote automatique est activé lorsque l'avion passe 1 800 pieds en montée.

Dernière phase du vol: avant le deuxième décollage, la masse est de 147 700 Kg et le centrage de 42%, le trim de profondeur est positionné à 2,2° à cabrer, les becs et volets sont en configuration 2, la "Bulle 203" est dans l'état "3972".

L'affichage de la poussée maximale pour le décollage est effectuée très progressivement. La position plein avant des manettes de gaz est obtenue à partir du temps avion 1 5h40'28, la vitesse étant de 47 Kt.

Pendant la course au décollage, le copilote qui a les commandes exerce une action à pousser sur le manche (environ 6° à piquer) jusqu'au moment où il initie la rotation; la vitesse est alors de 132 Kt. Le manche atteint la position 10° à cabrer et la rotation est franche trois secondes après, la vitesse est de 144 Kt en augmentation, l'assiette longitudinale est de 6° en augmentation (temps avion 15h40'46 : To).

A To + 2 secondes, le manche est ramené au neutre, la vitesse est de 147 Kt, l'assiette longitudinale est de 14° en augmentation. Le facteur de charge maximum atteint est de 1,4 g.

A To + 4 secondes, la vitesse passe par une valeur maximale de 155 Kt, l'assiette longitudinale est de l'ordre de 20° en augmentation. La commande de rentrée du train a été actionnée (la séquence de rentrée du train s'achève entre To + 16 et To + 20 secondes).

Sensiblement à To + 6 secondes, le pilote automatique est engagé, la vitesse est de 150Kt et l'assiette longitudinale est de 24, 6° en augmentation.

Au moment où le pilote automatique est engagé le copilote exerçait depuis environ une seconde une faible action à piquer sur le manche (il maintient cette action environ 0,5 seconde après l'engagement du pilote automatique).

L'assiette longitudinale étant supérieure à 25° après l'engagement du pilote automatique, les informations concernant les modes d'activation du pilote automatique et du directeur de vol ne sont plus présentées au pilote et ne sont plus transcrites sur le SSFDR. En effet, ce dernier enregistre les données présentées à l'équipage sur les visualisations primaires de pilotage (PFD). Ces informations sont toutefois transmises par la télémesure et sont donc disponibles dans le cas présent.

Après engagement du pilote automatique, et avant son activation effective, l'assiette longitudinale passe par un premier maximum de 29° à To + 8 secondes (la vitesse est alors de 145 Kt).

Immédiatement après l'engagement du pilote automatique, le moteur gauche est réduit, son paramètre de conduite (EPR) decroît à partir de To + 7,5 secondes. Puis le circuit hydraulique bleu est coupé entre To + 10 secondes et To + 12 secondes (donnée SSFDR enregistrée toutes les deux secondes).

Le pilote automatique est activé à To + 8 secondes (2 secondes après son engagement) et passe presque immédiatement (à environ To + 8,4 secondes) en mode d'acquisition d'altitude. Au moment du passage dans ce mode, les paramètres de vol sont les suivants:

- assiette longitudinale 28° en diminution,
- vitesse 145 Kt,
- altitude pression 950 pieds (500 pieds par rapport au sol),
- vitesse de montée: environ 6 000 pieds par minute,
- incidence 6°,
- inclinaison proche de 0 (0,7° à droite),
- vitesses de lacet et de roulis nulles.

Après activation du pilote automatique en mode d'acquisition d'altitude, la vitesse décroit de façon sensiblement linéaire : 129 Kt à To + 12 secondes, 113 Kt à To + 16 secondes (taux moyen de diminution proche de 4 Kt par seconde). Dans le même temps, l'assiette longitudinale décroît jusqu'à 25° atteints à To + 12 secondes puis réaugmente de façon sensiblement linéaire : 28,5° à To + 15 secondes, 31,6° à To + 19 secondes. A ce dernier instant, la vitesse est de 100 Kt.

En latéral et après activation du pilote automatique, la gouverne de direction est amenée progressivement en butée à droite par le pilote automatique entre To + 10 secondes et To + 16,5 secondes, les ailerons à partir de To + 10 secondes et les spoilers n° 4, 5 et 6 à partir de To + 14 secondes contrent l'inclinaison à gauche qui apparaît à partir de To + 10,5 secondes et oscille autour de 7° entre To + 12 secondes et To + 19 secondes.

A To + 19 secondes, le commandant de bord déconnecte le pilote automatique. Les paramètres de vol sont :

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- vitesse 100 Kt en diminution,
- assiette longitudinale 31,6° en augmentation,
- incidence proche de 14° (légèrement inférieure) en augmentation,
- inclinaison 7,7° à gauche,
- vitesse de roulis faible à gauche,
- vitesse de lacet 2,5°/s vers la gauche,
- altitude pression 1 668 pieds (1 278 pieds par rapport au sol).

L'incidence de 14° est immédiatement atteinte activant le mode alpha prot des commandes de vol.

Le commandant de bord amène la commande profondeur en butée à piquer atteinte à To + 20 secondes, progressivement la commande de gauchissement en butée à droite atteinte à To + 25,5 secondes, maintient la direction en butée à droite et réduit le moteur droit entre To + 23 secondes et To + 25 secondes (position manette des gaz).

La remise de gaz automatique du moteur gauche (protection alpha floor) initiée à To + 24 secondes est de ce fait désactivée.

L'évolution des paramètres est très rapide (décrochage de l'aile gauche):

- à To + 25,5 secondes, la vitesse passe par un minimum (77 Kt), l'assiette longitudinale est de 15° en décroissance rapide, l'inclinaison est de l'ordre de 43° gauche, en augmentation rapide.

L'incidence passe par un maximum à To + 26 secondes (légèrement supérieure à 26°).

- à To + 27,5 secondes, la vitesse est de 85 Kt, l'assiette longitudinale proche de 00, l'inclinaison de 85° gauche et la vitesse de lacet atteint son maximum (14°/seconde à gauche).

- à To + 29,5 secondes, la vitesse est de 106 Kt, l'assiette longitudinale de - 28° à piquer et l'inclinaison de 110° à gauche.

- à To + 30,5 secondes, le commandant de bord amène la commande de profondeur qu'il avait gardée sensiblement au plein piqué au plein cabré, pratiquement simultanément les commandes de vol passent en loi directe.

L'assiette longitudinale passe par un minimum de 43° à piquer à To + 32 secondes, la vitesse est de 125 Kt, l'inclinaison est encore de 43° à gauche mais en diminution rapide. La vitesse verticale est de 7 500 pieds par minute vers le bas, l'altitude pression est de 1 088 pieds (638 pieds par rapport au sol).

Les dernières informations valides sont enregistrées à To + 36 secondes, la vitesse est de 156 Kt, l'inclinaison est de 18,3° à gauche, l'assiette est toujours négative (- 16°).

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1.12 - Epave:

L'épave est dispersée au sol sur un terrain situé en bordure ouest de l'aéroport de Toulouse-Blagnac. L'altitude du lieu de l'accident est de 499 pieds, ses coordonnées géographiques sont 43°38,10 Nord, 01°21,50 Est.

Le premier impact avec le sol a été effectué par la voilure gauche. Des pièces et des débris de l'avion jonchent le sol sur une longueur de 180 mètres environ. L'épave est divisée en quatre parties principales au-delà du point d'impact:

- dérive verticale, APU et fuselage arrière à proximité du point de l'impact avec le sol,
- aile gauche et jambe de train gauche au centre de l'épave,
- moteur gauche, fuselage avant comportant le poste de pilotage,
- aile droite et moteur droit.

1.13 - Renseignements médicaux et pathologiques:

1.13.1 - L'examen des dossiers médicaux des trois membres d'équipage ne fait apparaître aucun élément pathologique. Ils passaient leurs visites médicales périodiques d'aptitude dans les conditions réglementaires. ils étaient reconnus aptes.

Les résultats anatomo-pathologiques n'ont pas encore été communiqués à la commission.

1.13.2 - Emploi du temps des membres de l'équipage le 30 juin reconstitué suivant divers témoignages (heures locales):

- Nicholas Warner:

08h15	Arrivée et rencontre avec des pilotes de la compagnie Northwest Airlines puis embarquement à bord de l'A321 n°364,
09h12	Départ comme commandant de bord à bord de l'A321 n°364 pour un vol de démonstration aux pilotes de Northwest Airlines (vol n°288),
10h30	Retour au parking de l'A321 n°364,
10h45 à 12h00	Simulateur A340 au "Training Center" pour un vol d'approbation,
12h15 à 14h00	Déjeuner avec les pilotes de Northwest Airlines,
14h00 à 16h00	Réunion avec des journalistes de la chaîne de télévision japonaise NHK
16h45	Départ du vol 129 de l'A330 n°42.

- Michel Cais:

Aurait passé la journée à son bureau situé au "Training Center" avant d'être appelé vers 15 heures pour être copilote sur le vol 129 de l'A330 n°42.

Arrivée vers 16 heures aux bureaux de la direction des essais en vol d'Airbus Industrie.
16h45 Départ du vol 129.

- Jean-Pierre Petit:

08h00	Arrivée,
08h42	Départ pour un vol d'essais d'atterrissages automatiques sur l'avion n°475 (vol n° 12),
09h26	Retour au parking de l'A320 n°475,
10h00 à 12h00	Réunion de certification,
12h00 à 14h00	Déjeuner probable à l'extérieur d'Airbus Industrie,
14h00 à 16h30	Réunion de certification en salle n°6 à Airbus Industrie,
16h45	Départ du vol 129 de l'A330 n°42.

1.14 - Incendie:

L'avion s'est écrasé à 17h41 locales. Les pompiers de l'Aérospatiale et de l'aéroport sont arrivés sur les lieux de l'accident en moins de 4 minutes, ceux de Colomiers et de Toulouse sont arrivés peu de temps après. L'avion a pris feu lors de l'impact avec le sol, dégageant une épaisse fumée et des flammes d'environ 20 mètres de hauteur. L'incendie a pu être circonscrit en moins de 7 minutes.

Aux environs de 18h24, les hélicoptères du SAMU, de la Gendarmerie et de l'Armée de l'air sont arrivés sur les lieux.

Cinq des corps des victimes ont été découverts dans les débris de l'appareil à 18h25 par les pompiers et les différents services de secours; les deux autres n'ont été retrouvés que vers 20h00. Les corps ont été transférés à l'institut médico-légal de l'hôpital Rangueil de Toulouse.

1.15 - Essais et recherches:

Les essais et recherches conduits par la commission d'enquête ont eu pour objet principal de vérifier si le déroulement du vol avait pu être affecté par une défaillance de l'avion, de ses moteurs ou de ses équipements. Les travaux ont porté sur l'exploitation des enregistrements et ont ete également conduits sur le simulateur de vol de l'A330 par les membres de la commission.

1.15.1 - Objet des simulations effectuées:

Confirmer certaines logiques de dégagement du pilote automatique et de sortie du mode de remise de gaz automatique (alpha floor) en relation avec l'accident.

Confirmer le scénario enregistré de l'accident. Apprécier la situation du pilote devant les informations de pilotage présentées au cours du scenario.

Evaluer approximativement le point à partir duquel l'évolution effectuée au cours de l'accident n'est plus récupérable, selon les techniques de récupération envisageables.

Fournir des éléments contribuant à étudier si le scénario de l'accident peut ou ne peut pas correspondre à un cas susceptible d'être rencontré en utilisation opérationnelle.

1.15.2 - Programme des simulations:

A - confirmation des logiques de fonctionnement des sécurités

Tous les points sont effectués dans la configuration de l'avion lors de l'accident (volets, carburant, masse, centrage).

1 - Déconnexions du pilote automatique sur l'activation de la fonction alpha prot des commandes de vol.

2 - Déconnexions alpha floor sur réduction de la deuxième manette des gaz..

B - Simulations du scénario de l'accident

Tous les points sont effectués dans la configuration de l'avion lors de l'accident (moteurs, volets, carburant, masse, centrage).

1 - Dans des conditions identiques.

2 - Avec différents points de reprise en pilotage manuel (tous les 10 Kt par exemple).

3 - Idem 2 avec remise de gaz sur le moteur gauche.

4 - Idem 2 avec action simultanée sur les moteurs (réduction partielle à droite et augmentation à gauche).

C - Vérification du fonctionnement au cours de procédures normales.

Dans les conditions de l'accident, puis dans des conditions également jugées critiques, reproduire le scénario en respectant les assiettes opérationnelles, aux dispersions de pilotage près.

1.15.3 - Conclusions des simulations:

1 - Vérification des logiques associées aux protections alpha prot et alpha floor. Les caractéristiques particulières de ces logiques sont confirmées par la simulation.

2 - Autorité du pilote automatique en mode d'acquisition d'altitude (Alt*) le pilote automatique ne comporte pas de limite d'autorité en assiette dans ce mode. Par conséquent, aux vitesses relativement faibles, lorsqu'un changement important de poussée intervient après l'entrée dans ce mode, le pilote automatique peut commander des assiettes aberrantes puisqu'il cherche à décrire une trajectoire de capture de l'altitude qui est devenue impossible. Le dégagement du pilote automatique intervient après alpha prot. La loi normale des commandes de vol provoque alors une réduction d'assiette. Cependant au cours de cette phase très dynamique, la vitesse continue à décroître fortement. L'alarme "stall" et le décrochage lui-même peuvent être rencontrés alors que

c'est en principe impossible lorsque l'avion est piloté manuellement par la loi normale des commandes de vol. Bien entendu, lorsque ce phénomène est provoqué en conditions de poussée dissymétrique, un fort effet latéral intervient de surcroît lorsque la vitesse passe franchement au dessous de VMCA.

3 - Scénario de l'accident: on arrive, non systématiquement, à le reproduire jusqu'aux abords de la vitesse correspondant à l'incidence maximale (alpha max). Bien souvent le pilote automatique se désengage peu de temps après qu'il a été connecté. Cependant la simulation des phenomenes latéraux à ces très faibles vitesses n'est pas correcte. On ne peut donc pas répondre précisément aux questions concernant l'efficacité des techniques de récupération envisageables et le point extrême de récupération possible. Il semble cependant que les reprises en mains intervenant avant le passage par VMCA, bien que la dynamique conduise à décélérer encore un peu mais sous faible incidence, permettent de garder le contrôle de l'avion.

4 - Il est noté par ailleurs que la position de trim affichée avant le décollage a une influence certaine

sur les conditions d'évolution de l'assiette longitudinale après la rotation.

5 - Utilisation opérationnelle: certaines simulations de décollage effectuées pourraient représenter des cas se produisant en utilisation opérationnelle, c'est-à-dire avec une prise d'assiette initiale voisine de celle commandée par le directeur de vol. Les résultats obtenus n'ont pas conduit à une situation critique . Les ne permettent cependant pas de conclure que dans d'autres conditions des situations dangereuses, voire une perte de contrôle, ne pourraient être observées pour les raisons suivantes:

- on rencontre systématiquement des regressions de vitesse importantes, dont une jusqu'à la vitesse correspondant à l'activation de la sécurité alpha prot,

- toutes les conditions possibles n'ont pas été étudiées, en particulier l'exercice n'a été effectué qu'avec une seule altitude présélectée (2 000 pieds) pour un terrain à 500 pieds et rien n'indique que la différence d'altitude de 1500 pieds est le cas le plus critique,

1.15.4 - Des travaux complémentaires sont prévus par la commission dans les prochains mois. Ils concerneront notamment:

- la corrélation des données disponibles,

- l'identification plus précise du système Spatiaal,

- des essais et recherches complémentaires sur le mode d'acquisition d'altitude du pilote automatique, comportant également la recherche des résultats d'essais de même nature effectués antérieurement,

- des études sur le comportement des commandes de vol (mouvements des commandes et actions des gouvernes après la reprise en mains de l'avion par le commandant de bord),

- des travaux sur les aspects de conduite et d'exécution des essais en vol.

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II - ANALYSE PRELIMINAIRE:

2.1 - Considérations générales:

Au stade actuel des travaux de la commission, il ne peut être envisagé de présenter une analyse complète de l'accident. Des travaux complémentaires de corrélation des données disponibles (incluant l'analyse de vols de même nature effectués précédemment) d'une part, d'investigations sur le fonctionnement de l'avion et de ses systèmes d'autre part, restent en effet à effectuer (cf 1.15.4.).

Toutefois, les travaux conduits ont permis de préciser l'enchainement des faits ayant conduit à une situation dangereuse, de reconstituer un scénario plausible de l'accident et donc de présenter une analyse préliminaire (objet de ce chapitre).

En première analyse, il apparaît qu'il n'y a pas eu de panne de l'avion, de ses moteurs ou de ses équipements de nature à avoir contribuer à l'accident. Cette conclusion est certaine pour ce qui concerne le fonctionnement des moteurs.

La commission a déterminé que les conditions météorologiques n'ont joué aucun rôle dans l'accident, non plus que l'infrastructure de l'aérodrome, les aides à la navigation ou les télécommunications.

Elle a donc été conduite jusqu'à présent à centrer son analyse sur les conditions dans lesquelles le vol a été préparé et réalisé par l'équipage de conduite en tenant compte de la définition technique de certains systèmes de l'avion.

2.2 - Préparation du vol:

2.2.1 - Contexte général technique:

La commission a examiné le contexte général technique dans lequel se situait l'exécution du vol de l'accident. Sur un plan général, elle considère qu'il est normal et nécessaire que soient effectuées en essais en vol des manoeuvres aux limites du domaine qui sera normalement utilisé en ligne et même au-delà de ces limites pour couvrir de possibles dispersions en utilisation en ligne. Elle considère également que la recherche de l'optimisation de l'avion et de ses systèmes fait partie du travail normal à effectuer au cours des essais en vol de développement.

Dans ce cadre général, elle considère que le document Airbus Industrie 460/94 Issue I du 27 juin 1994 qui fixait le programme général des vols à entreprendre pour préparer la certification du pilote automatique aux standards de catégorie III pour cette version de l'Airbus A330 équipée de moteurs Pratt et Whitney est approprié.

Elle observe toutefois que ce programme prévoyait la réalisation des décollages à la masse de 160 tonnes et au centrage de 38% avec simulation de panne d'un moteur après activation du pilote automatique. Pour mémoire, à cette masse, le centrage limite arrière autorisé au décollage en utilisation normale en ligne est de 36,5% et les centrages limites arrière autorisés en utilisation normale en ligne en approche et en vol de croisière sont respectivement de 41 et 42%.

Elle a noté par ailleurs que lors de ces essais, le document cité demande de contrôler les diminutions de vitesse et d'assiette longitudinale ainsi que la stabilité en tangage.

2.2.2 - Contexte général du type de vol:

Les activités d'essais en vol sont régies au sein d'Airbus Industrie par le document Operations Manual Flight Activities, chapitre 02.10.00, édition 3 d'avril 1994. Ce document précise les types de vols envisageables (vols d'essais, vols de réception, vols standards, vols

d'entraînement) et définit en fonction du type de vol les compositions d'équipage autorisées ainsi que les conditions dans lesquelles la présence d'observateurs ou de passagers à bord peut être autorisée.

Le vol ayant conduit à l'accident était sans contestation possible un vol d'essais. Le document cité recense trois catégories de vols d'essais, ceux de:

- classe 1 : vols d'essais comportant un risque particulier, incluant les vols d'ouverture et d'extension de domaine de vol ainsi que les premiers vols avec configuration de systèmes nouveaux dans le cas où les caractéristiques de vol sont affectées de manière significative.

- classe 2: vols d'essais comportant un risque normal, à l'intérieur du domaine de vol déjà ouvert et au cours desquels le domaine de vol normal peut être dépassé de façon intentionnelle ou non.

- classe 3 : vols d'essais de routine effectués à l'intérieur du domaine de vol normal.

La commission constate que le cadre général dans lequel les compositions d'équipage étaient définies et la présence d'observateurs ou de passagers à bord était autorisée était donc défini.

Dans ce contexte, Airbus Industrie considérait que le vol ayant conduit à l'accident était un vol de classe 3.

A ce titre, l'équipage de conduite du vol était constitué
- d'un pilote d'essais, commandant de bord,
- d'un copilote, détenteur d'une licence de pilote de ligne,
- d'un ingénieur navigant d'essais

et la présence de passagers à bord pouvait être autorisée. L'analyse de ce point par la commission est présentée au paragraphe 2.2.4 ci-après.

2.2.3 - Préparation du vol de l'accident (aspects techniques):

L'ordre d'essais du vol, établi le 30juin 1994 en fixe les modalités d'exécution:
- composition de l'équipage,
- observateurs à bord,
- masse et centrage de l'avion à la mise en route,
- description de l'ensemble des manoeuvres à réaliser au titre des essais.

Il ne semble pas qu'il y ait eu de réunion formelle de préparation du vol par l'équipage. il est certain toutefois que le commandant de bord et l'ingénieur navigant d'essais avaient une parfaite connaissance des essais à effectuer avant le vol. Il parait clair également que la répartition des tâches à effectuer entre le commandant de bord et le copilote n'avait pas été discutée avant le vol.

La rédaction de l'ordre d'essais appelle quelques observations:

a) Il est noté que pendant les phases de vol succédant à la simulation d'une panne de moteur après décollage, il est demandé à l'équipage de vérifier:

- l'attitude longitudinale lors du premier décollage,

- la vitesse et l'attitude longitudinale lors du second.

b) la commission observe par ailleurs qu'une phase de vol complémentaire, non consignée dans l'ordre d'essais, est prévue par l'équipage pendant son installation à bord : à l'issue des essais prévus par l'ordre d'essais, phase de démonstration au profit des pilotes italiens au niveau 100.

c) l'ordre d'essais prévoit enfin un centrage à la mise en route de 40,2%, soit un centrage pour les décollages prévus nettement plus arrière que celui fixé par le programme général des essais.

Sur ce point, il ressort des investigations conduites par la commission, que les décollages étaient effectués volontairement dans des conditions de centrage très arrière, proches de la limite de centrage arrière autorisée en utilisation normale en vol. Selon Airbus Industrie, l'objectif était en effet de réaliser un essai permettant de couvrir le cas d'une remise de gaz après une approche de catégorie 3 interrompue volontairement par l'équipage en pilotage manuel, suivie après la prise de montée d'une réactivation du pilote automatique puis d'une panne de moteur. La commission a vérifié que ce type d'essai à centrage très arrière au décollage avait déjà été réalisé plusieurs fois tant au simulateur qu'en vol, en particulier lors des essais en vol de même nature effectués précédemment sur l'A330 équipé de moteurs General Electric.

La réalisation d'essais dans les conditions de masses et centrages effectives lors des deux décollages effectués, bien que très en dehors des limites de centrage arrière pour une utilisation en ligne, paraît acceptable à la commission dans la mesure où l'équipage est averti et conscient des caractéristiques de l'avion dans ces conditions.

2.2.4 - Préparation du vol (type de vol):

L'ordre d'essais définit la composition de l'équipage et prévoit la présence des quatre observateurs à bord, conformément aux stipulations en vigueur pour un vol d'essais de classe 3.

La commission estime qu'il était tout-à-fait légitime a priori de ne pas considérer le vol comme un vol de classe 1 : les essais prévus devaient se dérouler à l'intérieur du domaine déjà ouvert et les modifications étudiées ("Bulle 203" OFF ou 3972) n'étaient pas de nature à affecter de façon significative les caractéristiques de vol.

Les arguments pour le considérer a priori comme un vol de classe 2 ou de classe 3 sont les suivants:

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- pour un classement en classe 2 : le fait que le centrage au décollage dans les deux cas prévus par l'ordre d'essais dépassait très largement le centrage limite arrière autorisé en utilisation normale en ligne (impliquant dépassement intentionnel du domaine de vol normal, à l'intérieur du domaine déjà ouvert dans la mesure où par "domaine de vol normal" il faudrait entendre "domaine d'utilisation normale en ligne");

- pour un classement en classe 3 : le fait que le centrage au décollage dans les deux cas prévus était à l'intérieur du domaine déjà ouvert sans difficulté particulière et où on interpréterait "domaine de vol normal" pour les essais avec cette signification.

Sur le fond, la commission considère que, si le document définissant les types de vols et les catégories de vols d'essais a le mérite d'exister, il est insuffisamment précis pour ce qui concerne la notion de "domaine de vol normal" apparaissant dans la définition des vols de classe 2 et 3 (cf Recommandations). Elle estime que le vol concerné était à la limite entre les classes 2 et 3 compte tenu des centrages très arrière pratiqués au décollage. Elle observe qu'en tout état de cause, en cas d'incertitude, il est préférable a priori de surclasser la catégorie d'un vol d'essais.

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2.3 - Déroulement du vol:

Les points les plus significatifs concernant l'analyse du déroulement du vol relevés par la commission au stade actuel de ses travaux sont précisés ci-après pour les différentes phases.

2.3.1 - Installation à bord:

- le dialogue entre les membres d'équipage avant la mise en route des moteurs est serein. Il révèle un emploi du temps chargé pour les deux pilotes et l'ingénieur d'essais avant le vol le même jour et une occupation de chacun à des tâches de natures très diverses. Le vol concerné prenant place en fin d'après-midi du 30juin, il a pu en résulter une certaine fatigue de l'équipage.

- l'adjonction aux essais prévus dans l'ordre d'essais d'une phase de vol complémentaire destinée à effectuer une démonstration au profit des pilotes italiens observateurs de ce vol, paraît avoir été décidée au tout dernier moment. Ce fait n'a aucune relation avec l'accident, ne concerne que des manoeuvres de routine pour l'équipage mais dénote une certaine improvisation.

2.3.2 - Première phase de vol (jusqu'au premier atterrissage):

- le premier décollage effectué par le commandant de bord dans les conditions prévues n'a posé aucune difficulté. Ce constat est de nature à avoir donné confiance à l'équipage vis-à-vis du comportement de l'avion et à l'avoir conforté dans l'idée que le vol avait un caractère de routine (pour mémoire, dès ce décollage le centrage est très en arrière par rapport aux limites admises pour un décollage en ligne à cette masse).

- les affichages d'altitudes pré-sélectées par l'équipage en montée vers le niveau 100 (7000 puis 10000 pieds), puis en descente du niveau 100 (8000, 5000, 3000 puis 2000 pieds) n'appellent pas d'observation particulière. Le maintien de l'affichage de 2000 pieds pour la suite du vol n'a pas été commenté aucun échange vocal entre les membres d'équipage n'en fait état. La commission ne peut déterminer s'il était volontaire et conscient ou non. il se peut qu'il l'ait été (échanges de signes entre le commandant de bord et le copilote). On peut noter que l'ingénieur navigant d'essais, qui n'est pas dans le poste de pilotage, n'en fait pas état.

- les remises de gaz effectuées en pilotage automatique avec simulation de panne de moteur n'ont, elles non plus, posé aucun problème particulier. Les conditions diffèrent de celles des décollages (initial et prochain): c'est le pilote automatique qui effectue la prise d'assiette et la configuration de becs et volets affichée après remise de gaz est la configuration 3 (configuration 2 pour les décollages). Il convient de noter trois points:

- les assiettes maximales observées lors de ces remises de gaz sont voisines de celle obtenue lors du premier décollage (12,7° et 15,5° respectivement, pour 14,5° au premier décollage),

- l'altitude de 2000 pieds est restée présélectée dans les deux cas et ce fait n'a pas créé de difficulté particulière,

- enfin les deux remises de gaz ont été effectuées chacune avec un état différent de la "Bulle 203" et l'équipage n'a noté aucune différence significative entre ces deux états (s'il y a une différence, elle est "subtile" dit le commandant de bord).

La réalisation des essais de remise de gaz a donc certainement conforté la confiance de l'équipage dans le comportement de l'avion et l'avait convaincu qu'il n'y avait pas de différence sensible entre les deux états de réglages du pilote automatique essayés.

2.3.3 - Préparation du deuxième décollage:

- le sentiment de confiance acquis au cours de la première partie du vol et le fait que le commandant de bord n'ait pas identifié de différence entre les deux états de la "Bulle 203" peuvent expliquer qu'il ait décidé tardivement (après le rappel par l'ingénieur navigant d'essais des conditions de l'essai), de confier la réalisation du deuxième décollage au copilote qui n'avait jusqu'alors pas touché aux commandes.

- la position du trim de profondeur qui était à - 4° (4° à cabrer) à l'issue de l'atterrissage précédent a été modifiée pour être amenée à - 2,2° avant le décollage. Cette action n'a pas été commentée par l'équipage. On peut noter qu'elle est effectuée avant que le commandant de bord ne décide de confier la réalisation du décollage au copilote.

Il convient également de souligner que:

- le trim ainsi affiché est dans la plage normale pour le décollage, mais ne correspond pas au réglage préconisé pour les centrages limites arrières (0°),

- pour le centrage très arrière pratiqué lors du deuxième décollage, l'influence de la position du trim sur la rapidité et l'ampleur de la prise d'assiette longitudinale est sensible car elle conduit à une rotation spontanée et prématurée que le pilote peut néanmoins contrer (étude conduite au simulateur par différents pilotes dans la configuration du deuxième décollage avec position du trim de profondeur à 0° et à - 2,2°),

- la décision a été prise d'effectuer le décollage avec affichage de la puissance maximale (TOGA) au lieu de la puissance Flex 49, contrairement à ce qui était prévu à l'ordre d'essais. Ce choix a contribué à obtenir une rotation franche, une vitesse verticale initiale élevée et un effet de dissymétrie accentué après la simulation de la panne de moteur,

- l'équipage était conscient que le décollage était effectué à un centrage très arrière et, à ce titre, le commandant de bord rappelle au copilote la nécessité de ne mettre les gaz que progressivement au départ, consigne destinée à tempérer l'effet du couple cabreur dû aux moteurs et bien appliquée par le copilote.

2.3.4 - Dernière phase du vol:

- durant la course au décollage, le copilote maintient le manche à piquer jusqu'à la rotation ce qui n'est pas conforme à la procédure. Cette action lui a masqué l'effet du réglage incorrect du trim.

- lors du deuxième décollage, la rotation a été très franche et la prise d'assiette très rapide. On observe toutefois une timide action à pousser sur le manche au moment où le commandant de bord engage le pilote automatique. Cette action contribue à retarder l'activation effective du pilote automatique qui a lieu deux secondes après l'engagement.

- juste avant que le pilote automatique ne soit engagé, la vitesse passe par un maximum de 155 Kt et commence à décroître lentement, les deux moteurs étant encore à la puissance maximale.

- à partir du moment où le pilote automatique a été engagé dans les conditions de vitesse prévues (supérieure à 150 Kt) et que l'essai a débuté, le copilote a pu considérer qu'il était dégagé de son rôle de pilotage.

- au moment où le commandant de bord engage le pilote automatique, l'assiette longitudinale approche 250. Au-delà de cette valeur de l'assiette, les informations présentées sur les visualisations primaires du poste de pilotage (PFD) sont simplifiées; seuls subsistent l'attitude (assiette longitudinale et inclinaison), la vitesse, la tendance d'évolution de la vitesse, le cap, l'altitude, la vitesse verticale et le mode de poussée des moteurs (THR). Les modes d'activation du pilote automatique et les informations du directeur de vol en particulier ne sont plus présentés. Or, au moment où le pilote automatique est activé, les conditions d'entrée dans le mode d'acquisition d'altitude sont réunies (altitude pré-sélectée 2000 pieds, vitesse verticale importante) et l'équipage n'a pas la possibilité de contrôler le mode dans lequel le pilote automatique est active.

- pendant la phase succédant au décollage, le commandant de bord concentre son attention sur l'engagement du pilote automatique, puis sur la réduction du moteur, enfin sur la coupure du circuit hydraulique correspondant (circuit bleu). Cette dernière manoeuvre nécessite une action sur le panneau supérieur en arrière du pilote. Il l'effectue et la confirme ("pump fault"). La vitesse en diminution est de l'ordre de 135 Kt lorsqu'il a terminé ces actions. C'est vraisemblablement à ce moment seulement qu'il tourne son attention sur l'évolution de l'avion (jusque-là il n'était pas dans la boucle de pilotage).

- en mode d'acquisition d'altitude et dans ces conditions, le pilote automatique commande une variation progressive du facteur de charge pour rejoindre l'altitude pré-sélectée sans qu'il existe de limitation en assiette.

- il s'écoule 5 secondes entre le moment où le commandant de bord a confirmé la coupure du circuit hydraulique et le moment où il réalise qu'il se passe quelque chose d'anormal ("what has gone?"). La vitesse de l'avion est alors voisine de VLS (Velocity Lower Selectable : 120 Kt) et l'assiette de l'ordre de 28°.

- il s'écoule encore 3 secondes avant que le commandant de bord décide de reprendre les commandes. Lorsqu'il déconnecte le pilote automatique, la vitesse est de 100 Kt et l'assiette de 32° mais l'incidence est encore légèrement inférieure à 140 et la protection en incidence (alpha prot) qui

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aurait désengagé le pilote automatique ne s'active que juste après sa déconnexion par le commandant de bord. A cet instant, l'alarme "Low speed" est activée mais la perte de contrôle est très certainement inévitable en poussée dissymétrique.

- la commission ne trouve pas de raison technique pouvant expliquer ce dernier délai de 3 secondes. L'imprécision de la répartition des tâches au sein de l'équipage a pu contribuer à ce retard de reaction du commandant de bord..

- à partir du moment où le commandant de bord reprend les commandes, il agit très rapidement manche en butée à piquer, maintien de la direction en butée droite, gauchissement progressivement amené en butée à droite pour contrer le roulis à gauche encore modéré constaté, puis réduction du moteur droit pour resymétriser l'avion alors que l'inclinaison atteint 17 à 18° à gauche.

- cette dernière manoeuvre a pour effet de stopper la remise de gaz automatique (alpha floor) sur le moteur gauche qui s'était activé lorsque l'incidence atteignait 21°.

- malgré l'ensemble de ces actions, l'aile gauche décroche et l'assiette longitudinale décroît rapidement, l'incidence maximale atteinte est légèrement supérieure à 26°.

- pendant l'abattée de l'avion, la vitesse qui avait atteint un minimum de 77 Kt, réaugmente et les commandes de vol passent en loi directe.

- la vitesse passant par 112 Kt, l'assiette longitudinale par - 35° et l'inclinaison atteignant la valeur maximale de 112° gauche, le commandant de bord qui avait maintenu le manche à plein piqué l'amène au plein cabrer pour tenter une ressource.

- bien que l'avion soit pratiquement contrôlé, l'équipage ne peut éviter l'impact avec le sol.

Il n'y a pas eu d'action aux commandes du copilote après l'activation du pilote automatique, à l'exception d'un mouvement réflexe à cabrer dans les toutes dernières secondes avant l'impact avec le sol.

Il est noté par ailleurs que l'ingénieur navigant d'essais attire l'attention des pilotes sur l'évolution de la vitesse mais très tardivement (3 puis 5 secondes environ après que le commandant de bord ait déconnecté le pilote automatique) et que l'alarme de l'avertisseur de proximité du sol (GPWS) a fonctionné pendant les dernières secondes du vol.

Il n'est pas possible à la commission de conclure sur la possibilité d'éviter le décrochage par d'autres manoeuvres que celles effectuées par le commandant de bord à partir du moment où il a repris les commandes. Les manoeuvres réflexes (position des commandes) ou réfléchies (réduction du moteur droit) étaient en première analyse bien appropriées mais initiées trop tardivement, en particulier la réduction du moteur droit.

Il est par contre possible de conclure que si une reprise en pilotage manuel avait été effectuée 3 à 4 secondes plus tôt et conduite rapidement, l'accident aurait pu être évité (reprise en mains à vitesse supérieure à VMCA soit 118 Kt).

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III - CONCLUSIONS PROVISOIRES:

Pour les raisons exposées au paragraphe 2.1 ci-dessus, la commission ne peut présenter, au stade actuel de ses travaux, de conclusions définitives sur les circonstances de l'accident. Elle peut par contre présenter certaines conclusions provisoires.

3.1 - Faits établis par l'enquête:

L'avion Airbus A330 n°42 était en état de vol.

Le vol concerné était un vol d'essais ayant pour objet de préparer la certification de l'avion aux standards de catégorie III pour cette version de l'A330 équipée de moteurs Pratt et Whitney.

La masse et le centrage étaient bien connus de l'équipage avion léger, centrage très arrière, au-delà des limites normalement autorisées pour un décollage en ligne à cette masse, mais déjà pratiquées en essais en vol.

La commission n'a pas mis en évidence de panne de l'avion, de ses moteurs et de ses équipements.

L'équipage désigné pour le vol et la présence d'observateurs à bord étaient conformes au document Airbus Industrie stipulant la composition des équipages et autorisant la présence de passagers à bord en fonction du type de vol à réaliser dans la mesure où ce vol d'essais était considéré comme un vol de classe 3. En particulier, le commandant de bord, chef pilote d'essais d'Airbus Industrie et l'ingénieur navigant d'essais étaient particulièrement qualifiés pour ce vol.

Il n'a pas été mis en évidence, en ce qui concerne l'équipage, d'antécédent médical ayant pu jouer un rôle dans l'accident. Ses membres avaient eu toutefois un emploi du temps dense le 30 juin avant le vol.

Les conditions météorologiques, l'infrastructure au sol, les aides à la navigation et les moyens de télécommunications n'ont joué aucun rôle dans l'accident.

Les paramètres de vol et l'enregistrement des conversations de l'équipage ont pu être restitués avec un très bon degré de certitude compte tenu du nombre et de la qualité des moyens d'enregistrement.

3.2 - Causes probables:

Au stade actuel de ses travaux, la commission estime que l'accident peut être expliqué par la concomitance de plusieurs causes dont aucune, prise séparément, ne devait conduire à un accident:

- les causes initiales sont a priori liées au type d'essai et à ses modalités d'exécution par l'équipage lors du dernier décollage:

  - choix de la puissance maximale TOGA au lieu de Flex 49,
  - centrage très arrière au dernier décollage,
  - trim affiché dans la plage de décollage mais trop à cabrer,
  - présence de l'altitude sélectée de 2000 pieds,
  - définition imprécise et tardive des tâches respectives du pilote et du copilote pour le dernier décollage et le point d'essai à effectuer,

- rotation franche et très rapide effectuée par le copilote,

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  - commandant de bord occupé par les manoeuvres d'essais à effectuer immédiatement après le décollage (engagement du pilote automatique, réduction du moteur et coupure du circuit hydraulique bleu) le mettant temporairement hors de la boucle de pilotage.

- de plus, l'absence de protection en assiette dans le mode d'acquisition d'altitude du pilote automatique a joué un rôle déterminant.

- ont également contribué à l'accident:

  - l'impossibilité pour l'équipage d'identifier le mode dans lequel le pilote automatique s'est placé.
  - la confiance de l'équipage dans les réactions prévisionnelles de l'avion.
  - le retard de la réaction de l'ingénieur navigant d'essais devant une évolution préoccupante des paramètres (vitesse en particulier).
  - le délai mis par le commandant de bord à réagir devant une situation anormale.

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IV - PREMIERES RECOMMANDATIONS:

Compte tenu de l'analyse préliminaire effectuée et des conclusions provisoires précédentes, la commission, sans préjuger d'autres recommandations qu'elle pourra être amenée à formuler ultérieurement, est conduite à émettre les premières recommandations suivantes:

4.1 - Concernant le mode d'acquisition d'altitude du pilote automatique de l'Airbus A330:

- sensibiliser les utilisateurs des compagnies aériennes utilisant l'Airbus A330 sur la nécessité de surveiller les évolutions de la vitesse chaque fois que ce mode est actif et en particulier en vol de montée, en cas de panne de moteur (les consignes proposées à ce titre par le télex d'information des opérateurs de référence AI 999065/94 du 5 juillet1994 sont à appliquer),

- conduire les travaux permettant de vérifier si l'emploi de ce mode en utilisation en ligne comporte ou non un risque particulier,

- en tout état de cause, étudier en parallèle des solutions permettant d'améliorer les protections dans ce mode pour les rendre homogènes avec les protections implantées dans les autres modes..

4.2 - Concernant le mode d'acquisition d'altitude du pilote automatique sur tous types d'avions:

- étendre les réflexions et les études conduites pour l'Airbus A330 au titre de la recommandation précédente à tout autre type d'appareil disposant de modes de pilotage automatique similaires.

4.3 - Concernant la composition des équipages et la présence de passagers observateurs lors de vols d'essais

- préciser les notions permettant de déterminer les catégories de vols d'essais, les compositions d'équipages et la présence de passagers ou d'observateurs en liaison entre le constructeur et son autorité de tutelle pour les essais en vol,

- étendre la réflexion aux autres sociétés constructeurs d'avions et de moteurs disposant de directions d'essais en vol.

4.4 - Concernant la préparation des vols d'essais:

Effectuer systématiquement une réunion de préparation des vols d'essais même en cas d'essais réputés de routine. En particulier, au cours de cette réunion, traiter de la répartition des tâches au sein de l'équipage d'essais en conformité avec les dispositions approuvées par l'autorité de tutelle.

ANNEXE 1 - TRANSCRIPTION DU C.V.R.
HTML: 56KB

ANNEXE 2

EVOLUTION DES PARAMETRES ENREGISTRES SUR SSFDR
POUR LA DERNIERE PHASE DU VOL:

HTML + GIF: 44KB

ANNEXE 1 - TRANSCRIPTION DU C.V.R.

Avertissement

Ce qui suit représente la transcription des éléments qui ont pu être compris, au jour de l'édition du présent rapport, par l'exploitation de l'enregistreur phonique (CVR). Cette transcription comprend les conversations entre les personnes en poste de pilotage, avec les personnels au sol et des bruits divers correspondant par exemple aux alarmes.

Les parties de l'enregistrement non comprises ou restant douteuses sont indiquées par le symbole (*), avec mention le cas échéant du nombre de mots correspondants. Les échanges sans rapport avec l'événement sont signalés comme tels et ne sont pas transcrits.

L'attention du lecteur est attirée sur le fait que la transcription d'un enregistrement CVR ne constitue qu'un reflet partiel de la trace sonore des événements et de l'atmosphère passées d'un poste de pilotage. Cette trace est elle-même déformée par la disparition de toute communication non verbale. En conséquence l'interprétation d'un tel document requiert la plus extrême prudence.

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* GLOSSAIRE *

UTC	:	Temps codé indiquant le temps UTC avion
CVR	:	Temps relatif de lecture du CVR
Voie 1	:	Transcription des paroles enregistrées sur la voie une correspondant au microphone de l'ingénieur d'essai
Voie 2	:	Transcription des paroles enregistrées sur la voie deux correspondant au microphone du Commandant de Bord
Voie 3	:	Transcription des alarmes et échanges entre personnes à bord du poste de pilotage par l'intermédiaire du microphone d'ambiance (CAM)
Voie 4	:	Transcription des paroles enregistrées sur la voie quatre correspondant au microphone du Copilote
ATC	:	Transcription des communications radio émanant du contrôle
(*)	:	Mots douteux ou non compris
(@)	:	Bruits divers, alarmes

T CVR	T UTC	Voie 2	Voie 4	Voie 1
00.05			Kilo hotel quatre vingt	
00.08			cinq mille pieds mille seize	
00.13				
00.16		OK		
00.19			idde(?) open-descent cinq mille/mille seize one zero one six (bis)	
00.21		mille seize... five thousand		
			two thirty knots on elevator	
00.37		The flight director is now giving me pitch information just maintain speed on elevator		
00.47		both .. come to iddle(?)		

T:CVR	T:UTC	Voie 2	Voie 4
01.01		oh c'est chargé, il y a du monde	
01.08			
01.13			trois mille pieds mille seize et cap nord
01.16		cap nord cap nord	
01.18		all right ...to turn pretty soon	
01.28		flight control page shows the.....	
01.29			
01.32			Kilo hotel zero vingt par la

			droite trois mille-zero vingt
01.35		zero vingt par la droite trois mille activate the approach config full decision height	

T:CVR	T:UTC	Voie 2	Voie 4
02.25			
02.30			Kilo hotel cap cent pour ILS quinze gauche rappelle établi
02.33		cap cent OK ya	
02.41		I lift the speed brake off a little bit	
02.55		after this is an other auto pilot exercise. Auto Pilot one in	

T:CVR	T:UTC	Voie 2	Voie 4
03.03		did he confirm quinze right it's quinze droite	
03.07			no they said fifteen left
03.13			Bon kilo hotel vous confirmez la droite ou la gauche
03.17			
03.20		moving very close to the center-line	
03.24		ILS quinze gauche insert	
03.30		there is localizer coming in ... coming out the trois mille feet	
03.38		approach is on..... north	
03.56		we will go right	
03.59			kilo hotel on intercepte l'ILS quinze gauche là

T:CVR	T:UTC	Voie 2	Voie 4

04.03			
04.09			OK on descend deux mille rappelle établi sur loc et glide
04.12		take conf one please	
04.16			
04.19		Gear,	on est à deux cent cinq noeuds en réduction
04.21		le train	
04.25		no no	spoilers armed or not
04.30		if we can't do a go around, normally we will, but ....toghin....by	
04.38		so we have three green, the second auto pilot in	
04.41			cat three dual
04.42		cat three dual	
04.43			Auto Pilot one plus two
04.46		OK ....very close	
04.49			we are flaps one
04.51		OK I come back to air speed she wants cent quatre vingt knots	
04.59		lock star Sir	
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**
05.02		we'll get to reduce our speed to normal speed - conf two please	
05.06			conf two
05.21		another this is an India alpha	
05.23			
05.26		speed managed .. conf three	
			au revoir

05.30			tour whisky whisky kilo hotel en finale quinze gauche	
		ya	it would be a go around	
05.35				
05.38			ce sera une RDG et circuit bleu	.....circuit t
05.45		on voit déjà qu'avec conf three çà fait une petite....		
05.52			ILS normal classical ILS	
05.56		right		
05.59				OK so it is around at e

T:CVR	T:UTC	Voie 2	Voie 4	
06.00				with an eng around tha throttle, yo OK you ke you retard
06.10		I'll do ... the thrust you do the flaps so as soon as we say GO, you bring the flaps up to one, positive rate		
06.17		...Gear up	OK OK	
06.21		I retard number one throttle we switch off the blue you moving in the glide, we'll go to flaps full	- I'll put flaps full to maintain... - flaps full	
06.25			OK actually we make a go	
		flaps three right	around I retract flap three	
06.43		glide is star full flaps		
06.52			full flaps	
06.54		cat three go	gear down	
06.59			below one thousand five hundred feet we have the	

		près ....quatre noeuds		
09.35		et maintenant c'est pas mal, pour moi c'est deux noeuds au dessus de le target		
				au dessus
09.43		maintenant c'est above, maintenant	oui, above	
09.46		OK		
09.50		c'est bon	Kilo hotel en virage à droite ...FRANCAZAL	OK c'est b
09.55		OK on commence celui là, on peut virer à droite, j'imagine droite		

T:CVR	T:UTC	Voie 2	Voie 4	
10.06				for your in Go around eight feet a feet minim
10.13		voilà très bien voilà		
10.19			OK on a passé S	
10.22		can you recenter the rudder trim please		
10.29				et tu as réd ?
10.31		oui	non le moteur 1	moteur 1 !
10.33			oui, oui	
10.40			on a passé S, je peux te mettre flaps ONE si tu veux	
10.43		oui flaps ONE		
10.45			cent vingt-et-un dix	
10.53			approche whisky hotel whisky hotel rebonjour en circuit bleu	
10.59				

			landing memo appearing	
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**	
07.11		check list is done		
07.12		OK some of things are blue ..because we haven't done them		
07.23		for instance if I do that... that will go to green		
07.27			ce sera donc une remise de gaz suivie d'un circuit bleu	
07.31				
07.38		you never know we might touch Ah Ah		
			I hope not	
07.43		we might		
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**	
08.08		il a tendance légère légère à osciller	 ....à osciller....	 ouais
08.31		de temps en temps il renvoie une petit peu coup de Beta		
08.41		deux cent pieds		oh have th
08.51		flare Go engine failure	....flare...	
08.59		couf three Gear up	positive rate Gear up	
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**	
09.03		blue hydraulic pump off		
09.13			Kilo hotel en remise le gaz	
09.21		il a touché VLS puis remonte		
09.27				ouais donc noeuds qu
09.29		on a perdu oui ..cinq noeuds à peu		

			oui Kilo hotel	

T:CVR	T:UTC	Voie 2	Voie 4	
11.04				
11.11			320, on rappelle prêt à virer	
11.14			je te remets le bleu	
		oui, s'il te plait		
			tu veux les flaps UN	
11.17		oui je vais accelérer un tout petit peu, je laisse les flaps		
11.21				
11.36		pour moi, euh.....c'était bon		
			oui oui c'était bon	
			on active la	
11.43		OK oui bonne idée, bonne idée oui		
11.47				next one is spatial thre
11.52		OK quand tu veux		
				three nine :
11.56		d'accord he's what...		
11.58		so what is done there, he's introduced through what we call spatial a different control law for the auto-pilot - for the Go around		

T:CVR	T:UTC	Voie 2	Voie 4	
12.05		so the next time we do that manoeuvre, we are going to do exactly the same manoeuver, but we'll have a slightly different law mainly in the pitch axis I think for the speed control euh...		For the Go
12.15				ya ya ya

12.19		land inhibit is when you see land have below I think it's eight hundred feet euh... euh any non necessary warning on the ECAM is inhibited	
12.29		to stop disconcentring the crew for the landing phase ... a minor ECAM message is inhibited for the landing	
			four miles from touch down
12.42		Ah OK très bien on va légèrement plus loin	
12.49			
12.52		ce qu'on va faire .. je vais faire ça... et quand on commencera, tu vas faire ça	
12.56			d'accord .. OK merci

T:CVR	T:UTC	Voie 2	Voie 4
13.19			Ah ça c'est spécial... j'ai jamais vu les tendances sur l'horizon de secours
13:23		c'est THAI, Thai c'est spec Thai	
13.30		on peut virer si	
13.35			whisky whisky kilo hotel pour virer en finale quinze gauche?
13.50			Kilo hotel on est passé à virer en finale
13.55			

T:CVR	T:UTC	Voie 2	Voie 4
14.02			au revoir
14.09			la tour whisky whisky kilo, rebonjour on tourne en étape de

			base quinze gauche
14.14		non !	Roger et elles sont conjuguées avec celles là, ce sont les mêmes. Apparemment ça ne correspond pas.
14.20		Pourquoi c'est VOR Delta ILS... quand on arrive sur l'ILS	
14.27		c'est un.....sécurité	
			ah d'accord OK... d'accord ça servirait si on était en double panne FMGS..de ça....
14.43	arme	bon .... voilà la cheminée donc je vais engager le pilote automatique. arm the approach phase, deuxième pilote automatique et on continue comme ça	
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**
15.14		lock star raw data localiser	
15.28		on va faire exactement la même, Michel	
			oui, d'accord
15.38		conf two please	
			flaps two
15:54		glide siope star conf trois et le train	glide star
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**
16.06		conf full	
16.13		cat three Dual remise de gaz vingt pieds	Kilo hotel quatre nautiques en finale quinze gauche
16.22			
16.26			oui, ce sera encore une remise de gaz
16.32			
16.43		de temps en temps, je vois un	

petit coup dans le Beta là qui

T:CVR	T:UTC	Voie 2	Voie 4	
17.21		moi, je vois la bille qui bouge de côté de côté		
			Land green	
		ya some how it's seems to be oscillatory in bank		
				like yesterd heading th
			ya	
17.49		ya		
17.50		OK deux cent pieds - cent pieds		

T:CVR	T:UTC	Voie 2	Voie 4	
18.02		flare		
18.06		Go conf flaps, Gear up	positive rate	quarante-q
18.11		hydraulic failure		
18.44		ya	hydraulic failure	
			VLS	now we ar
18.49		on speed, ya	on speed	
18.56				did you see
		pour moi, c'est, je ne vois pas la différence non. Si il y a une différence est subtile		the two Gc

T:CVR	T:UTC	Voie 2	Voie 4	
19.08		ya ya	three hundred	we lost the three hund so end of t
19.10		I....I dont really see the other advantage over there, to be honnest(?)		
19.16		end of the test OK - Bring in up the engine		As far as t concerned, something? ..OK?

19.26		No, I did not - no, no		
19.36		bringing his one back.. that one up		
19.40		conf ONE please	flaps one one hundred twenty one ten	
19.50		put that in the middle stay about there		
			oui	

T:CVR	T:UTC	Voie 2	Voie 4	
20.03		OK..... on fait un full stop maintenant		
20:21		Cette remise de gaz c'était quiet easy d'abord ou quoi, c'était faible, on avait eu un point faible là ou quoi		.......c'était
20.36		pourquoi on fait des révisions maintenant?		
20.40		Ah. d'accord		oui
20.43		ça veut dire que les deux solutions paraissent raisonnables		oui. tout à
20.58		OK so we do a full stop Michel	OUI. on fait une approche simple(?) engine ?	

T:CVR	T:UTC	Voie 2	Voie 4	
21.03		single engine approach - Full stop		
21.05		then w'll take off and do four other lands...		activate the
21.13		oui, s'il te plaît		
			OK	

T:CVR	T:UTC	Voie 2	Voie 4
22.01		Approach. conf. three - autoland so w'll take the conf three option on this one	Oh ya
22.10			conf three OK bon Approach speed one hundred

			thirty one	
22.17		OK, and I think we can turn in whenever he wants		
22.27			Kilo hotel on tourne en étape de base	
			A tout à l'heure La tour Kilo hotel on tourne en étape de base	
22.36				
			Kilo hotel	

T:CVR	T:UTC	Voie 2	Voie 4	
23.06		I'll stick the	Auto pilot IN ;OK	
23.09		Approach armed	Auto Pilot ONE	
23.14		quelque chose comme ça	cat three single	
23.17		second auto pilot going in		
23.29		And you'd like to have an engine failed, right Sir	cat three Dual	
23.32		number ONE engine is failed	hydraulic	ya
23.36		ouais s'il te plaît - ouais	ouais	
23.39		putting it up, to	ouais	
23.50		lock star		
23.58		glide slope star		

T:CVR	T:UTC	Voie 2	Voie 4	
24.01		config two please and the gear down	conf two	
24.08		ouais	spoilers armed	Normaly w decision he
24.16		Excuse-me		at decsion l

			fifty norma
24.21	Pourquoi?		we are cat
24.25	ya ya		ya ya OK
24.29	we are cat three single euh ...one engine throttle back and config three please		adjusted ?
24.46	And landing check, please	Landing gear down, Flaps three Spoilers armed	
24.54		Kilo hotel en finale quinze gauche un atterrissage complet	
24.58			

T:CVR	T:UTC	Voie 2	Voie 4	
25.08			d'accord	
25.30			Land green	
25.31		OK checked		So, autom: reverse onl
25.47		OK checked		
25.54			flare	I

T:CVR	T:UTC	Voie 2	Voie 4
26.00		OK it's, touch down about one and a half meters right	
26.04		derotation is nice	
26.08		on the center-line, now a tendancy to go to the right again	
26.13		number two - reverse only	reverse green
26.15			spoilers

26.17	15.36.57	one hundred knots		
26.18			one hundred knots	
26.20		starting to brake		
26.27	15.36.07		eighty knots	
26.30		Nicely on the center line		
26.31			sixty knots	
26.33	15.37.13	reverse idle		
26.35				excellent
26.38		Ya, I dont(?) see much to complain about there	ya	
26.44		and what we'd really like to do now		
26.49	15.37.29		ouais	
26.52		is to do a demi-tour here and take off	Kilo hotel demande autorisation - faire demi-tour et décollage in trente-trois Droite	

T:CVR	T:UTC	Voie 2	Voie 4	
27.00			OK merci	
26.56				
27.03	15.37.39	OK		
27.11				j'active le s
27.13	15.37.49		ouais	
27.15		on va décoller et rester en circuit la chose important est la piste pour décollage		
27.21			we are very light anyway	
27.28				
27.29	15.38.09	Ya, what we would do Michel, you'll take off, turn out to the left over the forest des bluecon then go down wind and turn right to come in for an ILS on fifteen	ya	

27.38			OK - OK	
27.40				So we hav failure at ta you have t knots abou the auto-pi engine and two is acti
27.43	15.38.23	OK		
27.49		ya		
27.55		OK		
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**	
28.03	15.38.43	so the wheels are all good - we have config two	OK OK euh Elect IDG, one minor fault	
28.10		ya, well we know about that but we can just clear that ya'll....		
28.16		and.. we have the same speeds as last time		
28.17			OK ya ya	
28.19		flight director is ON		
28.23	15.39.03	spoilers cat three dual	spoilers on va décoller et ensuite virage à gauche, quatre-vingt-dix deux cent soixante dix, et ensuite à nouveau approche ILS quinze gauche	
28.42		you take...., you have the airplane ?	I fly now ya	
28.46		what you do now is... rotate, let the speed go above V2... and put the Auto Pilot one in...	ya	
28.55		OK as soon as Auto Pilot one is in, throttle one engine back, and I will take the hydraulics off...OK	OK OK	

T:CVR	T:UTC	Voie 2	Voie 4	
29.05		OK	Kilo hotel paré à décoller quand vous voudrez	
29.08				
			we keep runway heading and ready for ...	
29.16		OK runway heading		
29.21	15.40.01	tu est prêt derrière ?		
29.22		donc on est tout paré, on y va Michel		ouais
29.27	15.40.07	ça... carefull with the power initially	toujours TOGA hein ?	
29.30		...cause of the Cdg tilh we get the ...wait till we see the air speed		
29.37	15.40.17	until we go to full power	OK	
29.45		voilà, tu peux aller maintenant		
			TOGA SRS	
29.49		TOGA SRS		
29.59		cent knots		
T:CVR	T:UTC	Voie 2	Voie 4	
30.03		rotate		
30.07				
30.08		(...) one hundred fifty - gear up		
30.10		auto-pilot IN		
30.11		and again.... and again.....		
30.14		engine failure		
30.17	15.40.57	pump fault		

			OK	
30.22		and I... I don't know what's gone ?		
30.25	15.41.05	tha....that's not correct - I have control		
30.26				
30.27	15.41.07	I have control		
30.29	15.41.09			
30.31	15.41.11			take care the speed
30.33				take care
30.34				
30.35	15.41.15			
30.36				
30.39	14.41.19			
30.42				
			FIN DE L'ENREGISTREMENT	
T:CVR	**T:UTC**	**Voie 2**	**Voie 4**	

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THE RISKS DIGEST

Forum on Risks to the Public in Computers and Related Systems

ACM Committee on Computers and Public Policy, Peter G. Neumann, moderator

Volume 16, Issue 39

Tuesday 6 September 1994

Forum on Risks to the Public in Computers and Related Systems

ACM Committee on Computers and Public Policy, Peter G. Neumann, moderator

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- PKZIP encryption broken (known plaintext attack)
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- Some privacy notes
  Phil Agre
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  Peter Ladkin
- ESORICS 94 Program

by the earlier and very well documented problems. It is simply not advisable to have a single character buried in a 1000+ line "include" file radically change the behavior of:

```
{
   double my_angle,result1,result2;

   /* we can't make my_angle const, because it needs to be
    * "tweaked" on a per-run basis, so neither prototypes
    * nor MMU's can save us...
    */
   my_angle = get_current_operating_assumptions();

   result1 = some_library_function(1,my_angle);
   result2 = some_library_function(2,my_angle);
}
```

In C, one can be confident that no matter what else mat be wrong with some_library_function(), it will _NOT_ damage my_angle. In C++, the addition of a single '&' character destroys the basis of that confidence. I can forgive Backus for "changeable constants", but Stroustrup should have known better :-)

The average sailor will not spit into the wind a second time. The average computer scientist does not, apparently, learn from experience.

Mike Albaugh, Atari Games Corp (Arcade Games, soon Time Warner Interactive)
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Some comments on the A330 accident

Peter Ladkin <Peter.Ladkin@loria.fr>
Sat, 27 Aug 1994 19:02:00 +0200

There are a few points worth emphasising which follow from the Air et Cosmos issue 1482 summary of the A330 accident preliminary report, along with the 1480/1 AeC summary of the preliminary-preliminary findings from the telemetry data.

The A330 preliminary accident report singles out lack of pitch protection with the autopilot in ALT* mode as a determining factor.

According to the report by Casamayou in Air et Cosmos 1480 (11-16 July), the copilot rotated to 28deg to hold 150kts of speed (the airplane actually went to 29deg), and the autopilot was engaged by Warner, who also retarded the left engine and cut the left hydraulic pump to simulate an engine failure: `As planned, the pitch of the aircraft started to diminish and passed from 29deg to 25deg, the [pitch] limit authorised by the [flight] envelope protection system FMGES (flight management guidance and envelope system).'

It is presumed that the pilots were expecting that the autopilot was to remain in SRS mode (`Speed Reference System') under which there is automatic pitch protection. However, because the altitude was set too low (2000ft) in the flight director (FCU), the autopilot reverted almost immediately to ALT* mode, under which there is no pitch protection. However, it was non-obvious for the pilots to know they were in ALT* mode since it wasn't displayed on the PFD under those flight conditions - mode info disappears from the PFD at 25deg, **the same point to which pitch is protected by the FMGES**.

The preliminary report noted the lack of PFD display of mode as a contributing factor, but not a cause. Bernard Ziegler, technical director of Airbus, singled out in interviews the action of achieving 25deg of pitch as one of his main contributing factors [RISKS-16.35, also the specific figure of 25deg, a `particularly high pitch angle' is found in Flight International, 17-23 Aug 1994, p4]. (The other two factors mentioned in the Speigel interview were the 2000ft altitude setting and that the pilots waited too long to recover.)

However, if you want to test pitch protection it follows you have to put the airplane into more than 25deg of pitch, which is what the pilots did. But this is a flight condition such that you can't tell on the PFD what AP mode you're in, and hence whether pitch is actually protected! This info might be available, but it is not displayed on the PFD.

Contributory factors that were also noted by the report: the full-aft center of gravity, and the TOGA thrust on the engines. However, the airplane may be legally loaded to full-aft CG, and if a go-around is needed on an automatic landing, that's what TOGA thrust is for. TOGA conditions are statistically the most likely conditions under which there is an engine failure.

All of the above is a matter of record, or of common knowledge. I'd like to add a few comments and questions of my own.

Firstly, the report implies that autopilot mode confusion played a role in the late reaction of the pilots to the flight condition. They were expecting SRS mode and got ALT* (for whatever reason) - they were expecting pitch protection when there was none - they were waiting for something that wouldn't happen, and they couldn't tell from the PFD. Pete Mellor, in his article `CAD: Computer Aided Disaster' and Robert Dorsett have noted that mode- or control-law-confusion seems to have played a role in many of the A320 accidents as well.

Secondly, this airplane was loaded to within legal limits and was using thrust appropriate to a go-around situation. There are US airports at which commercial flights take place at which the missed-approach procedure requires one to climb-and-maintain altitudes in the region of 2000ft. So, one might consider the possibility that these three of the identified `causes' of the accident were plausible, although maybe unusual, operating conditions. The airplane was pitched up by the copilot to 28 deg, in order (I would surmise) to activate the automatic pitch protection mechanism, under conditions of engine failure. Under these conditions, under autopilot control, the airplane flew itself into an flight condition from which an experienced test pilot was unable to recover in time. I wonder why more attention is not paid to this feature of the accident?

The trim setting was singled out as a cause, but the report also says that the accelerated rotation caused by this was controlled by the copilot, so I don't see how it figures as a cause, unless it was seen as one-task-too-many.

For comparison and discussion in RISKS, I'd like to mention a possible point of view different from that provided by Airbus [Ziegler interviews, Der Speigel 15.8.94, RISKS-16.35, and Flight International, 17-23 Auf 1994, p4]. Namely: if the airplane had not crashed, seven more people would be alive - but we also wouldn't have known that an A330 with full aft CofG is unable to fly itself out of an engine-out-during-go-around situation if the altitude-select on the AP is set at or near 2000ft and the pitch is slightly above its 25deg limit of protection.

Is this computer-related? I'm sure the A330 software will be changed. If only because the Commission of Inquiry recommended it.

Peter Ladkin

ESORICS 94 Program

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Tue, 6 Sep 1994 14:17:01 +0100

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PROVISIONAL PROGRAM ESORICS-94
(European Sympoisum on Research in Computer Security)

THE OLD SHIP HOTEL, BRIGHTON, UK0
7TH - 9TH NOVEMBER, 1994

ESORICS-94 is organised by the IMA in co-operation with AFCET (creator), BCS Computer Security Specialist Group, CERT-ONERA, AICA and GI

ESORICS-94
Provisional Program

Monday, 7th November, 1994

9.15 - 9.30 a.m. Introduction - Roger Needham and Gerard Eizenberg

9.30 - 10.30 a.m. Session 1 - Measures (Chair: Dieter Gollmann)

Valuation of Trust in Open Networks
T. Beth, M. Borcherding, B. Klein

Performance Requirements in Data Communication Systems
V. Zorkadis

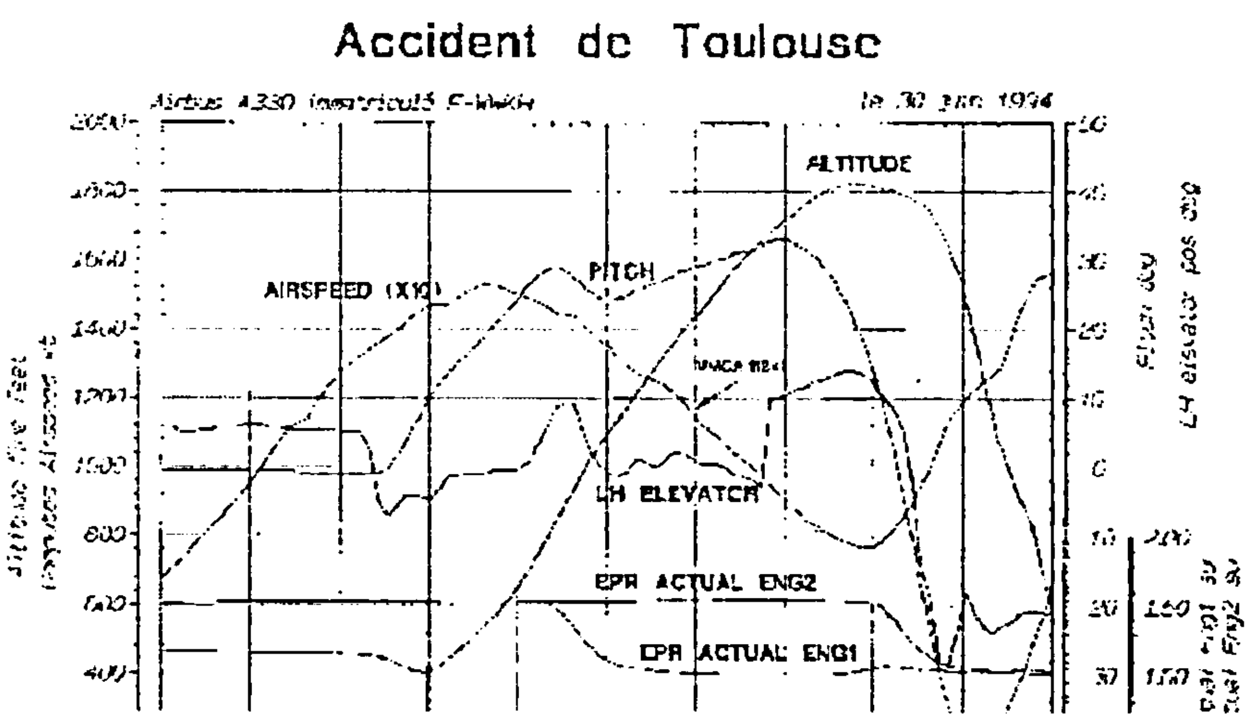
11.00 - 12.30 p.m. Session 2 - High Assurance Software
(Chair: John McLean)

ANNEXE 2

EVOLUTION DES PARAMETRES ENREGISTRES SUR SSFDR POUR LA DERNIERE PHASE DU VOL:

- ALTITUDE
- VITESSE
- ASSIETTE LONGITUDINALE
- GOUVERNE DE PROFONDEUR
- EPR DES MOTEURS
- ETAT DU PILOTE AUTOMATIQUE

(GIF: 44KB)



BACK TO "RAPPORT"

Peter B. Ladkin, 1999-02-08

Last modification on 1999-06-15
by Michael Blume

ANNEXE 2

EVOLUTION DES PARAMETRES ENREGISTRES SUR SSFDR POUR LA DERNIERE PHASE DU VOL:

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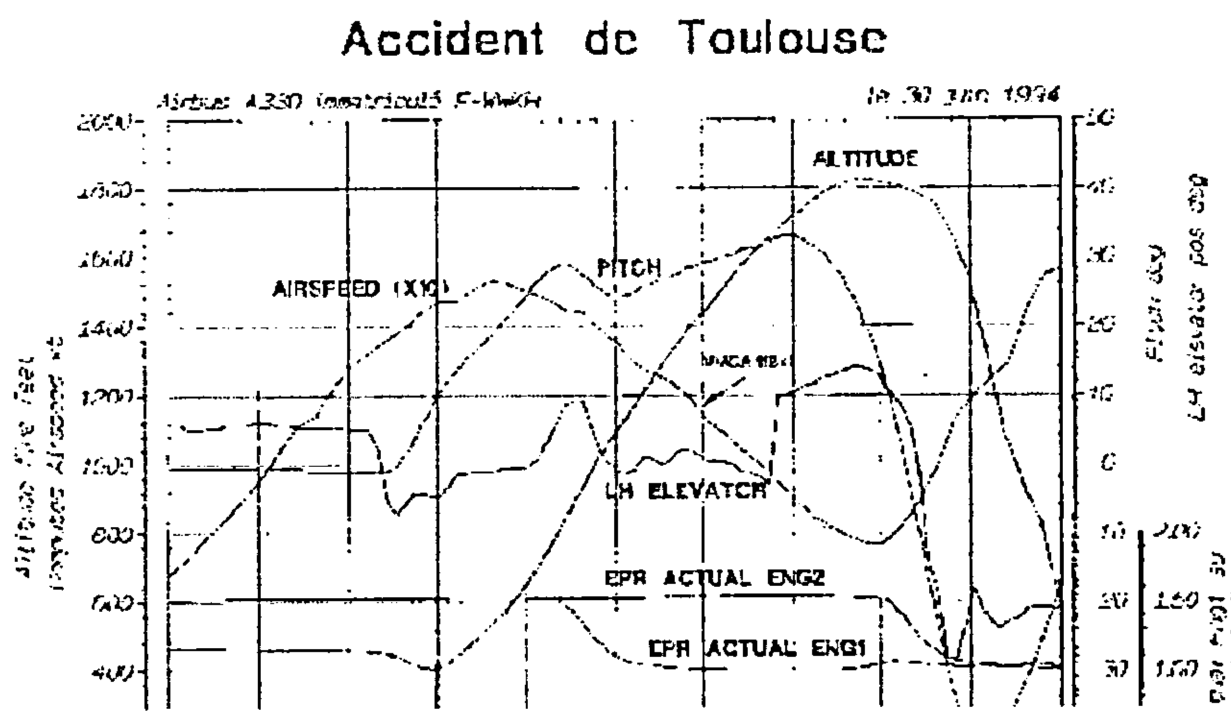

BACK TO "RAPPORT"

Peter B. Ladkin 1999-02-08

Last modification on 1999-06-15
by Michael Blume

REQUEST 074/98, REPORT 10

DATA REPORT	PIPER-PA-31	ACCIDENT
EVENTS¦PHASES	PANEL SEPARATION IN FLIGHT-CLIMB TO CRUISE	
	AIRCRAFT STRUCK BY OBJECT-CLIMB TO CRUISE	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 91/0240-0
FROM STATE : SWEDEN

DATE, TIME AND METEOROLOGICAL DATA

DATE : 91-04-12
TIME : 14:30
LIGHT : DAYLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 2250 - 5700 KG
STATE OF REGISTRY : SWEDEN
REGISTRATION : SE-FLI

LOCATION

LOCATION : STOCKHOLM/SKAVSTA
STATE/AREA : SWEDEN
DEPARTED : STOCKHOLM/SKAVSTA
DESTINATION : STOCKHOLM/SKAVSTA

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : SUBSTANTIAL

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	1	0	1
PAX :	0	0	0	0	0	0

NARRATIVE

DURING A TEST FLIGHT AFTER MAINTENANCE, THE LEFT ENGINE COWLING SEPARATED AND STRUCK THE TAILPLANE LEADING EDGE, WHICH WAS DEFORMED ALONG ITS ENTIRE LENGTH. THE AFT FUSELAGE WAS BENT TO THE RIGHT AT THE TAILPLANE. ALL THIS OBSTRUCTED MOVEMENT OF THE ELEVATOR. NONE OF THE 3 RIGHT SIDE COWLING SAFETY LATCHES HAD BEEN LOCKED.
DRN: BY USE OF BRUTE FORCE, THE PILOT WAS ABLE TO FREE THE ELEVATOR FOR RESTRICTED USE AND A SAFE LANDING.
RECOMMENDATION: THAT QUICK- LOCKING MECHANISMS OF THIS TYPE SHOULD BE COLOUR- CODED TO FACILITATE VERIFICATION OF LOCKED STATE.

SEQUENCE OF EVENTS

EVENT 1 PANEL SEPARATION IN FLIGHT - CLIMB TO CRUISE
- 1.COWLING - NOT FASTENED/NOT LOCKED /SEPARATED
  - 1.MANUFACTURER-WORKPLACE DESIGN-DIFFICULT
  - 2.TECHNICIAN-MONITORING-INADEQUATE
- 2.A/C MAINTENANCE PROCEDURE - INADEQUATE/INEFFECTIVE
  - 1.A/C MAINTENANCE ENGINEER-SUPERVISION-INADEQUATE
  - 2.MAINTENANCE/REPAIR - OPERATIONS-QUALITY CONTROL-SUBSTANDARD
- 3.FL CREW PRE-FLIGHT CHECK PROCEDURE - INEFFECTIVE
  - 1.PILOT-MONITORING-INADEQUATE

EVENT 2 AIRCRAFT STRUCK BY OBJECT - CLIMB TO CRUISE
- 1.COWLING - SEPARATED
- 2.ELEVATOR - FOREIGN OBJECT DAMAGE
- 3.FORCED LANDING - PERFORMED

SAFETY RECOMMENDATIONS

RELATED TO AIRCRAFT/EQUIPMENT : INSPECTION
MODIFICATION OF AIRCRAFT

07/04/1994

07/04/94

REQUEST 074/98, REPORT 35

UNOFFICIAL REPORT	BOEING-707	INCIDENT
EVENTS¦PHASES	WHEELS-UP LANDING-LANDING ROLL	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 94/0545-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 94-07-04
TIME : 00:00
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 27 001 - 272 000 KG
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : TEL AVIV
STATE/AREA : ISRAEL
DEPARTED :
DESTINATION :

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : MINOR

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	12	0	12
PAX :	0	0	0	0	0	0

NARRATIVE

AIRCLAIMS:ACCORDING TO PRESS REPORTS, DURING A TEST FLIGHT 'A MALFUNCTION DISABLED THE AIRCRAFT'S RIGHT MAIN UNDERCARRIAGE'. ATTEMPTS WERE MADE TO FREE THE UNDERCARRIAGE BUT WITHOUT SUCCESS AND THE PILOT THEREFORE ELECTED TO CARRYOUT AN EMERGENCY LANDING AT BEN GURION INTERNATIONAL AIRPORT. THE AIRCRAFT TOUCHED DOWN AT 115KT AND THE PILOT SHUT DOWN THE NO.4 ENGINE AT THE START OF THE LANDING ROLL. AS THE AIRCRAFT'S SPEED REACHED 40KT., THE RIGHT WING BEGAN TO SETTLE AND THE NO.3 ENGINE STRUCK THE GROUND. THE AIRCRAFT CAME TO REST ON THE RUNWAY. THE AIRCRAFT WAS ENGAGED IN DEVELOPMENT TEST FLYING AS PART OF THE SIGINT (SANTIAGO SIGNALS INTELLIGENCE AIRCRAFT) PROGRAMME

09/01/1994

9-1-94

SEA94LA228

On September 1, 1994, approximately 1210 mountain daylight time (mdt), a Sikorsky S-64F helicopter, N165AC, registered to and operated by Erickson Air Crane Company, and being flown by Gary M. Wiltrout and Jimmy R. Tipler, two commercially certificated pilots, was destroyed when the aircraft settled into Hanging Flower Lake, while in a hover, seven nautical miles southwest of Libby, Montana. The pilot-in-command was not injured, however, the co-pilot and the crewman received minor injuries. Visual meteorological conditions prevailed and no flight plan had been filed. The flight, which was a maintenance check flight, was to have been operated in accordance with 14CFR91, and originated from the Libby Airport, Libby, Montana, at 1200 hours.

In a written statement, the pilot reported that a retardant tank had been installed on the helicopter the previous day. Also at the conclusion of the flight on the previous day, the pilot stated that the number two engine had failed. A fuel control unit was changed which required a power check adjustment before the next flight. After the power adjustment was completed, the pilot did a control check on the retardant tank and found that the snorkel pump was not operating, however, the emergency dump system was operational. The isolation valve was found to be the problem and it was corrected.

The flight then departed for the required test flight to Hanging Flower Lake where the tank system could be tested. The pilot stated that the flight to the lake was uneventful and the engines were performing normally. When the flight arrived at the lake, the pilot hovered the helicopter down until the snorkel was submerged in the water. The pump was turned on and the pilot asked the crewman if water was being taken on. The co-pilot stated that the quantity indicator was erratic and he was unsure if they were taking on water, however, the crewman stated that he thought that they were as he saw water leaking from around the top of the snorkel hose. After approximately 15 seconds, the pilot pulled the helicopter up into a 20 foot hover with very little power required. The pilot felt that they probably did not take on very much water. The pilot stated that he then hovered back to the water and again submerged the snorkel for another 15 seconds. The pilot was unsure if they were taking on water and decided to pull up and check the system by dumping the water. The pilot stated that as he was departing the area, it did not feel like the helicopter was responding to the collective setting and the rate of climb was slow. The pilot attempted a momentary drop of the water by using the collective dump button, however, there was no indication that any water dumped. At this time the pilot asked the co-pilot how the power was and the co- pilot responded that they were losing rotor RPM and that they were also going to lose the generators. The pilot realized that they would not clear nearby trees and started to slide the helicopter to the right over the lake. The pilot tried to jettison the tank but stated that the tank would not jettison as the helicopter descended and touched down lightly on the surface.

The helicopter then hovered back to five feet above the water, then began to settle back into the water. As the helicopter made contact with the surface, it rolled to the left and sank.

After the helicopter was retrieved from the lake and secured, the engines were examined. During the teardown inspection, there was no evidence found to indicate a mechanical failure or malfunction. (see attached Investigation of the Crash of N165AC).

The emergency load release system was inspected and found that the quantity indication system was inoperative, therefore the fire tank doors would not open to release water. The emergency tank drop system was inspected and tested and found to be operational. The emergency drop hydraulic valve tested normal both electrically and hydraulically, however, it was suspected that the dump valve was unreliable.

Further study into the environmental conditions at the time of the accident (i.e. 6,000 feet and 10 degrees C), the estimated loading of the helicopter with remaining fuel, and the estimated amount of water added during the snorkel pump test, it was determined that helicopter was operating above maximum gross weight. It was also noted that the performance data available for this make and model helicopter is limited, and that estimates were used. Company personnel were using performance data from another make and model helicopter similar to the accident helicopter. This helicopter was found to be power limited for this operation.

Use your browsers 'back' function to return to synopsis
Return to Query Page

09/01/94

NTSB Identification: **SEA94LA228**. The docket is stored in the (offline) NTSB Imaging System.

Accident occurred SEP-01-94 at LIBBY, MT
Aircraft: SIKORSKY S-64F, registration: N165AC
Injuries: 2 Minor, 1 Uninjured.

THE HELICOPTER WAS ON A MAINTENANCE TEST FLIGHT TO TEST A RETARDANT TANK SYSTEM THAT WAS USED TO CARRY AND DISPENSE WATER. AFTER ARRIVING AT A LAKE, THE FLIGHT CREW HOVERED THE HELICOPTER WHILE LOWERING THE SNORKEL TO ONLOAD WATER. HOWEVER, THE QUANTITY INDICATOR WAS MALFUNCTIONING, AND THE CREW MEMBERS WERE UNSURE IF WATER WAS BEING ONLOADED. THE PILOT OPTED TO FLY OUT OF THE HOVER AND DUMP THE WATER FROM THE RETARDANT TANK. AS THE FLIGHT BEGAN TO DEPART THE AREA, THE PILOT NOTED THAT THE HELICOPTER WAS LACKING RESPONSE TO THE COLLECTIVE AND THE RATE OF CLIMB WAS SLOW. WHEN THE WATER WOULD NOT DUMP FROM THE TANK, THE FLIGHT CREW TRIED TO JETTISON THE TANK. NEITHER SYSTEM WOULD WORK. THE ROTOR RPM BEGAN TO DECREASE AND THE HELICOPTER SETTLED INTO THE WATER AND SANK. DURING AN INVESTIGATION, NO MECHANICAL FAILURE OR MALFUNCTION OF EITHER ENGINE WAS FOUND. WHEN CHECKED, THE RETARDANT (WATER) QUANTITY INDICATOR SYSTEM WAS INOPERATIVE AND WOULD ONLY SENSE THAT THERE WAS NO WATER IN THE TANK. TO RELEASE WATER, THE SYSTEM NEEDED TO SENSE THAT THERE WAS ENOUGH WATER FOR THE SELECTED SETTING; THEREFORE, THE TANK DOORS WOULD NOT OPEN TO DUMP WATER WITH THIS MALFUNCTION. NO EVIDENCE WAS FOUND TO DETERMINE WHY THE EMERGENCY TANK DROP SYSTEM DID NOT FUNCTION. USING ESTIMATES, PERFORMANCE DATA INDICATED THE HELICOPTER WAS ABOVE THE MAXIMUM GROSS WEIGHT AND WAS POWER LIMITED FOR THE ENVIRONMENTAL CONDITIONS. ELEVATION OF THE LAKE WAS ABOUT 6500 FEET; AIR TEMPERATURE WAS ABOUT 63 DEGREES.

Probable Cause

THE FLIGHT CREW ALLOWED THE HELICOPTER'S WEIGHT AND BALANCE TO BE EXCEEDED, AND THE EXTERNAL LOAD (TANK) JETTISON SYSTEM FAILED TO OPERATE. A FACTOR RELATED TO THE ACCIDENT WAS: THE FALSE INDICATION ON THE RETARDANT QUANTITY INDICATOR.

Full narrative available

Index for Sep 1994 | Index of Months □□□□□□□□□□□□□□□□

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+--------------------------------------------- REQUEST 074/98, REPORT  37 ---------------------------------------------+
+ PRELIMINARY REPORT                            LEARJET-35 TRANSCONTINENTAL                                    INCIDENT +
+ EVENTS|PHASES                 LOSS OF SEPARATION-POSSIBLE RISK OF COLLISION-CRUISE                                   +
+-----------------------------------------------------------------------------------------------------------------------+
                                                                ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL          ++ ICAO FILE          :  94/2219-1
                                                            ++ FROM STATE         :  CANADA
FINAL REP        Y                                          ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <--------------------- AIRCRAFT DATA --------------------->
DATE          :  94-07-20                                   ++ MASS CATEGORY      :  5701 - 27 000 KG
TIME          :  10:35                                      ++ STATE OF REGISTRY  :
LIGHT         :  DAYLIGHT                                   ++ REGISTRATION       :
GEN WEATHER   :  VMC                                        ++
                                                            ++
<---------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  TORONTO                                    ++ A/C DAMAGE         :  NONE
STATE/AREA    :  CANADA                                     ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  TORONTO                                    ++ CREW   :       0      0      0     3     0      3
DESTINATION   :  HAMILTON                                   ++ PAX    :       0      0      0     0     0      0
                                                            ++
```

----------------- NARRATIVE ----------------

A CONVAIR 580 HAD COMPLETED A SERIES OF PRACTICE APPS AT HAMILTON WHEN IT WAS CLEARED TO 6,000 FT, DIRECT ROUTING TO TORONTO. AT THE SAME TIME, THIS A/C DEPARTED TORONTO FOR HAMILTON AND WAS CLEARED TO 5,000 FT. THE CONVAIR WAS LATER CLEARED TO MAINTAIN 5,000 FT BECAUSE THE HAMILTON CONTROLLER ANTICIPATED THIS A/C TO BE AT 6,000 FT. THE A/C PASSED EACH OTHER WITH ABOUT 2 MI HORIZONTAL SEPARATION WHERE 5 MI HORIZONTAL OR 1,000 FT VERTICAL SEPARATION IS REQUIRED.

```
+--------------------------------------------- REQUEST 074/98, REPORT  38 ---------------------------------------------+
+ DATA REPORT                                    SIKORSKY-S64 SKYCRANE                                         ACCIDENT +
+ EVENTS|PHASES                                  OTHER-HOVERING/LIFTING                                                +
+                           COLLISION WITH LEVEL TERRAIN/WATER-HOVERING/LIFTING                                        +
+                                            A/C SANK IN WATER-POST-IMPACT                                             +
+-----------------------------------------------------------------------------------------------------------------------+
                                                                ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL          ++ ICAO FILE          :  94/0404-0
                                                            ++ FROM STATE         :  UNITED STATES
FINAL REP                                                   ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <--------------------- AIRCRAFT DATA --------------------->
DATE          :  94-09-01                                   ++ MASS CATEGORY      :  5701 - 27 000 KG
TIME          :  12:10                                      ++ STATE OF REGISTRY  :  UNITED STATES
LIGHT         :  DAYLIGHT                                   ++ REGISTRATION       :  N165AC
GEN WEATHER   :  VMC                                        ++
                                                            ++
<---------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  LIBBY,MT                                   ++ A/C DAMAGE         :  DESTROYED
STATE/AREA    :  UNITED STATES                              ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  LIBBY,MT                                   ++ CREW   :       0      0      1     1     0      2
DESTINATION   :  LIBBY,MT                                   ++ PAX    :       0      0      0     0     0      0
                                                            ++
```

----------------- NARRATIVE ----------------

THE HELICOPTER WAS ON FLIGHT TO TEST A TANK SYSTEM. WHILE LOADING WATER FROM A LAKE THE QUANTITY INDICATOR MALFUNCTIONED. THE PILOT DECIDED TO TRANSITION TO FORWARD FLIGHT AND DUMP THE WATER. THE HELICOPTER WOULD NOT CLIMB AND THE CREW COULD NOT DUMP OR JETTISON THE TANK. THE HELICOPTER SETTLED INTO THE LAKE AND SANK. NO MECHANICAL FAILURE OF EITHER ENGINE WAS FOUND. THE WATER QUANTITY INDICATOR SYSTEM WAS INOPERATIVE AND WOULD ONLY READ THAT THERE WAS NO WATER IN THE TANK. HOWEVER, THE SYSTEM WOULD NOT RELEASE UNLESS IT SENSED THAT THERE WAS WATER IN THE TANK. NO EVIDENCE WAS FOUND TO DETERMINE WHY THE EMERGENCY TANK JETTISON SYSTEM DID NOT FUNCTION. PERFORMANCE DATA INDICATED THE HELICOPTER WAS ABOVE THE MAXIMUM WEIGHT AND WAS LIMITED BY THE POWER AVAILABLE IN THE ENVIRONMENTAL CONDITIONS. ELEVATION OF THE LAKE WAS ABOUT 6,500 FT. AIR TEMPERATURE WAS ABOUT 17 DEG C.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   OTHER - HOVERING/LIFTING
EVENT  2   COLLISION WITH LEVEL TERRAIN/WATER - HOVERING/LIFTING
           1.EMERGENCY JETTISON SYSTEM - FAILED
           2.CARGO DUMPING - IMPOSSIBLE
           3.A/C PERFORMANCE - EXCEEDED
EVENT  3   A/C SANK IN WATER - POST-IMPACT
```

09/09/~~1~~1994

09/09/94

++ REQUEST 140/94, REPORT # 230
++

+ UNOFFICIAL REPORT TUPOLEV - TU-134 ACCIDENT
+ EVENTS | PHASES: COLLISION WITH AIRCRAFT -BOTH AIRBORNE | MANOEUVRING
+

++
++

<--------------- OPERATION ---------------> ++ <--------------- FILE DATA ---------------

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 94/0274-0
++ FROM STATE :
++

<--------------- WHEN ---------------> ++ <--------------- AIRCRAFT DATA ---------------

DATE : 94-09-09 ++ MASS CATEGORY : 27 001 - 272 000 KG
TIME : : ++ STATE OF REGISTRY :
LIGHT : ++ REGISTRATION : RA65760
++

<--------------- WHERE ---------------> ++ <------- DAMAGE, INJURY AND TOTAL ON BOARD ------->

LOCATION : YEGORYEVSKY ++ A/C DAMAGE : DESTROYED
STATE/AREA : RUSSIAN FEDERATION ++ INJURY : FATAL SERIOUS MINOR NO UNKNOWN TOTAL
DEPARTED : ++ CREW : 8 0 0 0 0 8
DESTINATION : ++ PAX : 0 0 0 0 0 0
OTHER DAMAGE :

+-- REQUEST 074/98, REPORT 40 --+
+ UNOFFICIAL REPORT TUPOLEV-TU-134 ACCIDENT +
+ EVENTS¦PHASES COLLISION WITH AIRCRAFT-BOTH AIRBORNE-MANOEUVRING +
+--+
++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 94/0274-0
++ FROM STATE :
FINAL REP ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE : 94-09-09 ++ MASS CATEGORY : 27 001 - 272 000 KG
TIME : 00:00 ++ STATE OF REGISTRY : RUSSIAN FEDERATION
LIGHT : ++ REGISTRATION : RA65760
GEN WEATHER : ++
++
<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION : YEGORYEVSKY ++ A/C DAMAGE : DESTROYED
STATE/AREA : RUSSIAN FEDERATION ++ INJURY : FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED : ++ CREW : 8 0 0 0 0 8
DESTINATION : ++ PAX : 0 0 0 0 0 0
++

---------------- NARRATIVE ----------------

AIRCLAIMS: THE AIRCRAFT WAS DESTROYED WHEN IT WENT OUT OF CONTROL AND CRASHED FOLLOWING A COLLISION WITH A TU22. THE TU22 LANDED SAFELY. THE TU134 WAS APPARENTLY ACTING AS A PHOTOGRAPHIC CHASE AIRCRAFT TO THE TU22 AT THE TIME OF THE ACCIDENT.

09/27/1994

MDC Helicopter Collision

LAX94FA383A

On September 27, 1994, at 2043 hours mountain standard time, a McDonnell Douglas MD520N (NOTAR), N520NT, collided with a McDonnell Douglas AH-64D (Longbow), R00324, while on final approach to the McDonnell Douglas Heliport, Mesa, Arizona. Both helicopters were operated by McDonnell Douglas Helicopter Systems, in conjunction with a flight test/evaluation by foreign military officials under 14 CFR Part 91. The Longbow was owned by the U.S. Army and leased to McDonnell Douglas Helicopter Systems.

The NOTAR was destroyed and the certificated airline transport pilot was fatally injured. A foreign military observer in the NOTAR was seriously injured. The Longbow sustained substantial damage. The Longbow crew, a certificated commercial pilot and a foreign military pilot were not injured. The flight departed the Williams Gateway Airport, Chandler, Arizona about 2035 hours. Night visual meteorological conditions prevailed at the time, and both helicopters were operating on a company VFR flight plan filed at the McDonnell Douglas Heliport.

The Longbow was conducting a night evaluation of the pilot's night vision system (PNVS). Use of the PNVS restricts the pilot's peripheral vision and the nature of the evaluation directed the attention of the Longbow pilots inside the cockpit.

The NOTAR was assigned the task of "chase aircraft", whose duties in part were surveillance of and monitoring the Longbow, and provide traffic advisories concerning other aircraft in the area.

Voice communications between the two helicopters was made via VHF radio frequencies.

All three pilots had flown the route from the Gateway Airport to the McDonnell Douglas Helicopter facility in the past, or before the accident flight. The return flight of the AH-64 departed Williams AFB to the north to a point northeast of the McDonnell Douglas facility and east of Granite Reef Dam, a VFR reporting point for Falcon Field, Mesa, Arizona.

The route of the NOTAR is not exactly known. There were no radar services requested by the pilots, and the test aircraft was not squawking a discreet transponder code. Radar data provided by the Federal Aviation Administration depicted unidentified aircraft departing the Gateway Airport at the approximate time of the AH-64 and NOTAR. The data revealed aircraft tracking north along a route described by the AH-64 pilots. The data did not distinguish the flight path of two aircraft. The track of the aircraft was lost in ground clutter and radar returns from vehicles traveling on east-west roads near Falcon Field. The radar data also revealed aircraft in the Falcon Field traffic pattern throughout the period of the return flight.

During the flight from Williams Gateway Airport, the NOTAR pilot asked the Longbow pilots to slow their airspeed. The Longbow slowed from 130 knots to 105 knots. The AH-64 pilots contacted the NOTAR pilot(Chase) as they approached the Granite Reef Dam VFR reporting point. The AH-64 pilots informed the NOTAR they were going to change VHF radio frequency from the mission control frequency to the Falcon Field air traffic control tower (ATCT) frequency. The NOTAR pilot acknowledged the AH-64 pilots transmission. There were no other recorded communications from the NOTAR pilot. There was no evidence found indicating the NOTAR pilot had lost visual contact with the Longbow helicopter.

At 2040 hours, the AH-64 crew contacted the Falcon Field ATCT via the VHF radio and reported over

Granite Reef Dam with a chase aircraft. The ATCT local controller cleared the flight for a north arrival.

The AH-64 crew then changed VHF radio frequencies from Falcon ATCT to McDonnell Douglas Company's "Apache Ramp Control" frequency. The ground control radio operator (GIRO) monitoring the frequency cleared the AH-64 to land runway 22, and informed the AH-64 crew of the current wind conditions and altimeter setting.

The GIRO observed the AH-64 final approach and observed flashing lights approaching the AH-64 from its left side at an approximate angle of 90 degrees. The GIRO indicated that the events he witnessed happened rapidly and there was insufficient time to warn the pilots. The GIRO told the Safety Board by the time he recognized the flashing lights as another aircraft it was too late. The GIRO indicated the collision occurred about 30 feet above the ground. After the collision the NOTAR appeared to flip and the AH-64 landed on Pad #3. The GIRO further indicated that there were no communications with the chase aircraft (NOTAR) after he cleared the AH-64 to land.

The AH-64 crew reported they did not see the NOTAR during the final approach phase of the flight. The rear seat pilot was recorded stating, "I just caught sight of something coming on the left hand side as it hit." The AH-64 crew indicated they were performing the final tasks of the test flight/evaluation using the PNVS at the time of the collision, and that their anti-collision lights were on.

CREW INFORMATION

McDonnell Douglas MD520N

First Pilot (NOTAR)

The NOTAR pilot was formerly employed by McDonnell Douglas Helicopter Systems, and had accepted an early retirement. At the time of the accident, the NOTAR pilot was employed by a personnel company under contract with McDonnell Douglas Helicopter Systems, to provide pilots. The NOTAR pilot was seated in the left front seat of the helicopter at the time of the collision.

The NOTAR pilot held an Airline Transport Pilot certificate with single and multiengine airplane ratings and a helicopter rating. The most recent second-class medical certificate was issued to the pilot on December 1, 1993, and contained the limitation that correcting lenses be worn while exercising the privileges of his airman certificate.

No personal flight records were located for the pilot and the aeronautical experience listed on this report was obtained from the accident report submitted by McDonnell Douglas Helicopter Systems.

According to the operator's accident report, the pilot's total aeronautical experience consists of about 17,795 hours, of which about 1,550 hours were accrued in the MD500 series helicopters, of which the MD520N is a derivative. In the preceding 24 hours before the accident, the pilot flew 4.3 hours, of which 2.8 hours were in the accident helicopter.

Flight Test Engineer

A British Army Flight Test Engineer was seated in the right front seat of the NOTAR for the purpose of observing the flight evaluations. He had no crew responsibility for the operation of the NOTAR. After the accident, the Flight Test Engineer indicated he saw the AH-64 in the right window the instant before the collision, but was not sure whether it was a dream or actual memory.

McDonnell Douglas AH-64D (Longbow)

First Pilot (AH-64)

The first pilot was employed by McDonnell Douglas Helicopter Systems, as an engineering test pilot. The first pilot held a commercial pilot certificate with a multiengine airplane rating and a helicopter rating. The first pilot also held a flight instructors certificate for helicopters. The most recent second-class medical certificate was issued to the pilot on January 20, 1994, and contained no limitations.

The first pilot's total aeronautical experience consists of about 8,239 hours, of which about 3,066 hours were accrued in the AH-64. The first pilot had flown about 1.5 hours in the 24 hours preceding the accident, all in the accident AH-64. The first pilot was seated in the front seat of the AH-64 and was performing instructor pilot duties at the time of the collision. The first pilot indicated he did not see the NOTAR in the moment before the collision.

Second Pilot (AH-64)

The second pilot held a foreign military aeronautical designation for helicopters issued by the United Kingdom. The second pilot's total aeronautical experience was about 3,700 hours, of which about 3,590 hours were in helicopters. The second pilot indicated he had flown attack helicopter's in the British Army and had logged several thousand hours in the Westland Lynx. The second pilot had flown the AH-64 previously on two occasions accruing about 14 hours, of which about 5 hours were at night. The second pilot had flown in the accident helicopter about 2.5 hours in the 24-hour period preceding the accident. The second pilot was seated in the rear seat of the AH-64 and was evaluating the capabilities of the helicopter for purposes of acquisition by the British Army.

AIRCRAFT INFORMATION

McDonnell Douglas MD520N (NOTAR)

The McDonnell Douglas MD520N is owned and operated by McDonnell Douglas Helicopter Systems. The helicopter was originally certified as an experimental helicopter. The experimental airworthiness certificate found on the helicopter had expired.

The helicopter was not equipped with any night vision devices for use by the crew. The NOTAR pilot was required to survey the AH-64 through the cockpit windows.

According to McDonnell Douglas Helicopter Systems, the visibility from the pilot's position is good. Representatives from the company's Product Flight Safety Department provided the Safety Board a Transportation Safety Board (TSB) of Canada report concerning a midair collision involving a McDonnell Douglas MD369E. According to McDonnell Douglas Helicopter Systems, the visibility from the MD369E is similar to that of the NOTAR.

The TSB Canada report states "The pilot of the MD369E was sitting in the left front seat of the helicopter. From this position, although the field of view to the front of the helicopter is good, there are some obstructions to the left. In the horizontal plane, the pilot view aft of the nine o'clock position is masked by the aft left door frame assembly; the forward frame assembly; which angles downwards roughly 45 degrees, obstructs about 10 degrees of view at the pilot's ten-thirty position. In the vertical plane, the 6-inch portion of the door frame on the topside of the left door masks about 40 degrees of the pilot's field of vision. From the nine o'clock position to the ten-thirty positions, this upper door frame masks the pilot's view from about the horizon to approximately 40 degrees above the horizon."

The construction of the NOTAR cockpit windows is symmetrical from right to left. The Canadian TSB report is based on the collision geometry of that particular accident, and does not take into account obstructions on the pilot's right side, such as a person occupying the right seat and the right upper door frame, which would also obstruct the pilot's vision.

The helicopter was equipped with two VHF radios with digital displays. The radios incorporated a preselect feature which allows the pilot to store a frequency in an active and standby digital numeric display. Displayed frequencies are held in non-volatile memory circuits when the radios are not powered. When power is restored, the same frequencies will be displayed that were selected before shutdown.

After the accident, both radios were removed and power was applied to read the displayed frequencies. The frequency readings were the same for both VHF communication radios. The Falcon ATCT frequency, 124.6 MHZ, was selected in the active display window of both radios, and McDonnell Douglas Helicopter Systems, ramp operations frequency, 123.35 MHZ, was selected in the standby display window.

The McDonnell Douglas AH-64D (Longbow)

The Longbow is owned by the U.S. Army, and at the time of the accident, it was leased to McDonnell Douglas Helicopter Systems, for purposes of "handling characteristic/demonstration flights" for the United Kingdom. The AH-64 is a twin-engine military attack helicopter primarily designed as a day-night weapons platform. The helicopter is not certified in any airworthiness categories by the Federal Aviation Administration. The helicopter seats a crew of two in tandem with the pilot's position in the rear seat and the copilot-gunner's seat in the front.

The Pilot's Night Vision System (PNVS) is used by the pilot for externally aided night vision, or during adverse weather. The PNVS consists of a stabilized Forward Looking Infra Red (FLIR) contained in a rotating turret mounted in the nose of the helicopter. The turret rotates 90 degrees right and left, and 20 degrees up and 45 degrees down. The PNVS is slaved to the crew's flight helmets, which present a FLIR image on helmet-mounted displays. The field of view on the display is 30 degrees vertical and 40 degrees horizontal. The all-around aided night vision is restricted during forward flight by the limits of the helmet displays field of view combined with the rotation limits of the turret.

The helicopter's exterior lighting equipment consists of two high intensity red and white anti-collision strobe lights located on each engine nacelle; three navigation lights located on each engine nacelle and the top of the vertical stabilizer; and the retractable landing light/search light.

The helicopter was equipped with UHF, VHF, and FM voice communication radios. The VHF radio was the only radio installed in the Longbow that was compatible with voice communications with the NOTAR helicopter. The Longbow VHF radio is capable of storing preselected radio frequencies, but only one frequency can be used at a time. The Longbow pilots did not report any problems with the helicopter VHF voice communications.

COMMUNICATIONS

THE AH-64 was equipped with a video recorder that recorded all communications transmissions both internal and external. Review of the radio communications revealed that the AH-64 successively and successfully communicated with the chase helicopter, Apache Ramp Control, and Falcon ATCT. No unusual communications were noted between any of the participating entities and the AH-64 during a review of the tape. A transcript of the communications between the aircraft and the above mentioned is attached to this report.

Additionally, the communications with the Falcon Field ATCT were recorded. Review of the transcripts did not reveal any information not consistent with other statements. In addition, at 2043:24 hours a transmission of unknown source was recorded on the tower tapes. The unknown source stated, "oh (expletive)." A copy of the ATCT tapes is also attached to this report.

AERODROME AND GROUND FACILITIES

The McDonnell Douglas Helicopter Systems, facility is equipped with four concrete helipads aligned on a 220- to 040-degree magnetic orientation. The pads are VFR only, and are perimeter lighted for night operations.

The helipads are monitored by Apache Ramp Control. The ground control radio operator is located in a elevated tower cab attached to one of the hangars. The tower cab is equipped with radio communications equipment and telephones. The ground control radio operator is able to survey the helipads and approach paths from the tower location.

There were no reports of equipment outages at the facility that would have precluded the pilots from identifying the facility and landing on the helipads.

WRECKAGE AND IMPACT INFORMATION

Both aircraft came to rest within the confines of the McDonnell Douglas Systems, facility. The AH-64 landed and shutdown on helipad 3 without incident after the collision. The anti-collision lights were tested after the collision and were found operational.

Examination of the wreckage revealed four of the NOTAR's five main rotor blades contacted the Longbow's left wing and wing stores. The 2.75-inch empty rocket launcher, mounted on the outboard hard point, was struck from behind and was sliced horizontally about half its length. The Hellfire missile launcher was also struck from behind in the same place as the rocket launcher. The upper surface of the Longbow's left wing had evidence of three rotor strikes from the NOTAR main rotor system. Shrapnel from the collision damaged the AH-64 main rotor blades and fuselage. A small portion of the left wing had entered the rear cockpit through the left canopy and was found lying on the floor.

After the impact the NOTAR descended uncontrolled and came to rest on its left side about 50 feet northeast of the helipad threshold. The main rotor hub was separated from the fuselage at the mast. Three of the five main rotor blades were found separated from the main rotor hub.

ADDITIONAL INFORMATION

10/10/1994

St. Louis Hosts STOL Maneuver Technology Program

by Walt Corwin, Publicity Chairman, St. Louis Chapter

Modify the F-15 Eagle to take-off and land on a runway long instead of the usual 8000 feet. That's 1500 feet ay only 50 feet wide with poor braking action in a 26-0 knot cross wind at night.

Recently McDonnell Aircraft was awarded a development ntract to achieve these objectives and provide design opons for future fighter aircraft. Mr. Bill Brinks, 'STOL faneuver Technology Program Manager, was guest speaker t a joint technical/dinner meeting of Chapter 8 and the Intitute of Environmental Sciences in St. Louis.

According to Mr. Brinks, the existing F-15 engines will be itted with independently articulated vectoring/reversing ozzles. Operation of the nozzles will be integrated into the ontrol system so they will operate in conjunction with the ontrol surfaces for increased maneuverability.

A set of F-18 elevons will be installed on the fuselage, forard of the wings, as canards for the greater control. Other hanges includes modifying landing gear struts for ough/soft capability and installing an advanced cockpit esign. The aircraft, however, will maintain it's basic strucural design since there must be no degradation of previous ission capability.

Mr. Brinks, a former McDonnell Aircraft test pilot with ver 4000 hours in high performance fighter aircraft, rovided members and guest with an informative and inresting evening.

to R) Mr. Steve Podry, President of St. Louis Chapter of e SFTE; Mr. Bill Brinks, Guest Speaker; Mr. Carl Hilgarth, resident of the St. Louis Chapter of the IES.

Photo by John Whicker

"Kelly" Johnson Award Nominations Due

Letters requesting nominations for the "Kelly" Johnson ward have been sent to all SFTE members. Individual embers and chapters should give this serious conderation.The award provides recognition for excellence in ight Test Engineering. Nominations are due in the Society fice by April 15, 1985. The award will be given at the Anal Symposium banquet, Wednsday evening, July 31, 1985.

SEATTLE CHAPTER REMINDER

The Seattle Chapter of the Society of Flight Test Engineers will host the 1985 SFTE Symposium in the birthplace of the SFTE, Seattle, Washington, gateway to the beautiful Pacific Northwest. The theme of this 16th Annual Symposium will be "Flight Testing - Evolution and Revolution" with papers on the innovative techniques evolving in the application of new technology in solving the challenging problems in today's flight test programs.

Persons involved in flight testing and related fields are invited to submit abstracts for papers to the Seattle Chapter by March 15, 1985, for review by Technical Papers Committee. Selection for presentation and notification will be made by April 15, 1985. For those selected, final manuscripts for publication are due June 15, 1985.

Mail abstracts to:

SFTE Seattle Chapter
Technical Papers Committee
P.O. Box 80561
Seattle, WA 98108

Abstracts should be 200 to 500 words in length and may include problem, objectives, approach, and results statements. Illustrations and data may be included as appropriate. A summary of the important conclusions and a statement of the relevance to the Symposium theme may be included. Be sure to include a Title for the paper, an author's name, organization, mailing address and phone numer. All sessions and publications will be unclassified. Approval for release should be obtained by the submitter prior to submitting the abstract, if possible.

The Symposium will be held July 29, 1985 - August 2, 1985, in the Stouffer Madison Hotel in downtown Seattle, Washington, USA.

Roger Jones (206) 655-4021
Technical Papers Committee Chairman

Three-Month Investigation Finds F-20 Crash Was Pilot-Induced

A three-month investigation into the crash last year of a Northrop F-20 Tigershark in Suwon, Republic of Korea, has found that the aircraft and all its systems functioned properly, and the inverted stall which led to the accident was pilot-induced.

The accident, in which Northrop chief test pilot Darrell Cornell lost his life, occurred Oct. 10, 1994.

At the end of a demonstration flight and in preparation for landing, the pilot began a climbing roll and stopped the roll while inverted at low speed with the landing gear and flaps extended. The aircraft was at an altitude of 1,200 to 1,800 feet above the ground, insufficient to recover from the stall.

Although the F-20, was designed and built by Northrop at its own expense, the U.S. Airforce participated with Northrop as advisors in the accident investigation. The next F-20 Tigershark is now being built, with no technical or design changes to the aircraft required or contemplated as a result of the investigation.

Two other F-20s have continued the test flight and demonstration program at Edwards AFB, Calif. Over 100 flights have been carried out since the accident, and total F-20 flights now exceed 1,075.

11/02/1994

11/02/94

++ REQUEST 140/94, REPORT # 232
++

+ UNOFFICIAL REPORT TUPOLEV - TU-204 INCIDENT
+ EVENTS | PHASES: UNSPECIFIED FAILURE -FIRST ENGINE | EN-ROUTE
+

++

<------------- OPERATION -------------> ++ <------------- FILE DATA -------------
TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL ++ ICAO FILE : 94/0380-0
++ FROM STATE :
++
<---------------- WHEN ----------------> ++ <---------- AIRCRAFT DATA ----------
DATE : 94-11-02 ++ MASS CATEGORY : 27 001 - 272 000 KG
TIME : : ++ STATE OF REGISTRY :
LIGHT : ++ REGISTRATION :
++
<---------------- WHERE ----------------> ++ <------- DAMAGE, INJURY AND TOTAL ON BOARD ------->
LOCATION : EN-ROUTE ++ A/C DAMAGE : NONE
STATE/AREA : RUSSIAN FEDERATION ++ INJURY : FATAL SERIOUS MINOR NO UNKNOWN TOTAL
DEPARTED : SOCHI ++ CREW : 0 0 0 0 0 1
DESTINATION : MOSCOW ++ PAX : 0 0 0 0 0 0
OTHER DAMAGE :

+------------------------------ REQUEST 074/98, REPORT 41 ------------------------------+
+ UNOFFICIAL REPORT TUPOLEV-TU-204 INCIDENT +
+ EVENTS¦PHASES UNSPECIFIED FAILURE-FIRST ENGINE-EN-ROUTE +
+--+

```
                                                           ++
<--------------- OPERATION ---------------> ++ <--------------- FILE DATA --------------->
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                                                           ++ FROM STATE       :
FINAL REP                                                  ++
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DATE         :  94-11-02                                   ++ MASS CATEGORY    :  27 001 - 272 000 KG
TIME         :  00:00                                      ++ STATE OF REGISTRY :
LIGHT        :                                             ++ REGISTRATION     :
GEN WEATHER  :                                             ++
                                                           ++
<--------------- LOCATION ---------------> ++ <------- DAMAGE, INJURY AND TOTAL ON BOARD ------->
LOCATION     :  EN-ROUTE                                   ++ A/C DAMAGE       :  NONE
STATE/AREA   :  RUSSIAN FEDERATION                         ++ INJURY :  FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED     :  SOCHI                                      ++ CREW   :    0      0      0     0     0      0
DESTINATION  :  MOSCOW                                     ++ PAX    :    0      0      0     0     0      0
                                                           ++
```

12/30/1994

12/30/94

LAX95LA067

On December 30, 1994, at 1630 Pacific standard time, an experimental BD-10 jet aircraft, N9WZ, was destroyed in an in- flight breakup while conducting a flight test program near Gardnerville, Nevada. The aircraft was operated by Peregrine Flight International (PFI), Inc., of Minden, Nevada, and was engaged in a test program for the purposes of qualifying for a Federal Aviation Administration (FAA) Production Type Certificate. Visual meteorological conditions prevailed. The aircraft was demolished in the breakup, impact, and postcrash fire sequence. The certificated commercial pilot, the sole occupant, sustained fatal injuries. The flight originated from the company's production facility at the Minden airport on the day of the accident about 1530.

On the day of the accident, the pilot flew two prior flights in the accident aircraft completing test card items. On the flight immediately prior to the accident flight, the speed envelope was expanded to 370 knots indicated air speed (KIAS). No discrepancies were reported at the conclusion of these two flights.

The test card for the accident flight concerned the further expansion of the speed envelope. The aircraft departed Minden on an IFR clearance and proceeded to the Reno Military Operating Area (MOA). It performed the test card elements to expand the speed envelope to Mach .82 at an altitude in excess of 30,000 feet msl. At the conclusion of the high altitude work, the aircraft descended to between 14,000 and 15,000 feet to complete the remaining test card items to expand the envelope from 370 to 380 KIAS.

On an earlier test flight at speeds between 345 and 350 KIAS, the side load forces on the vertical stabilizers reached a company imposed limit in pounds of force. The limit was established at 40 percent of the force, as demonstrated in tests by Bede Jet Corporation, to cause a yield failure of the vertical stabilizer spars at the fuselage attach point. Due to encountering the self-imposed 40 percent force limit, no rudder pulses were allowed. Only stick raps in the longitudinal and lateral modes were to be accomplished during the accident test run.

According to the pilot of the chase aircraft, one run was completed at 375 knots. During the next run, the speed was increased to 380 knots when the aircraft suddenly pitched violently nose up, followed by a general breakup. Engineering estimates by the company indicate that the pitch up exceeded 20g's. This was done by evaluating the force necessary to fail the landing gear actuators and struts (the main landing gear was forcibly ejected from the aircraft during the breakup sequence).

No reports were found that any ground station or aircraft received a distress call from the aircraft prior to the accident.

Recorded radar data was obtained from the FAA Oakland Air Route Traffic Control Center. The data retrieved included: 1) the known discrete code assignment for the aircraft while in Class A airspace; 2) code 1200 beacon returns tracked from the target identified from the discrete assigned code after the aircraft descended below Class A airspace; 3) all mode C altitude reports associated with the beacon returns; and 4) all primary skin radar returns. The recorded radar data encompassed a time period from 1615:08, to the last recorded primary skin paint return at 1634:55, in the area where the 1200 code beacon return stopped. The last 1200 code beacon return, believed to be the aircraft, was recorded at 1629:43. The location of the last beacon return was latitude 38.53.24, longitude 119.45.28.

After the recorded radar data was received, the data points were sorted by track progression and time sequence to match the flight history of N9WZ. The data points retrieved were then processed through a Safety Board computer program. The program requires altitudes to successfully run, and altitudes were supplied for those data points where the mode C report is missing by simple averaging. Once altitude points were derived, the data was processed through the programs and graphic print-outs obtained. The raw radar data as received from the FAA, and the processed data at each stage, to include the graphic chart presentations, are attached to this report.

The data starts at 1615:08 (times in parentheses are elapsed minutes and seconds from this time), with the aircraft at 31,800 feet (all mode C altitudes referenced are msl), as the target tracks a relatively straight southerly course and descends. By 1625:30 (10:12), the aircraft is at 14,300 feet and begins an assent to 15,500 feet, which is attained at 1627:42 (12:34). The target then descends again to 14,900 feet by 1629:18 (14:10). At 1629:31 (14:23), a mode C report of 500 feet is recorded, along with a primary skin paint target which exhibits retrograde motion. The last mode C report of 14,600 feet occurs at 1629:43 (14:35). Primary skin paint targets are then recorded until 1634:55 in the immediate area.

The ground speed profile generated by the computer program ranges from 500 knots to about 420 by 5:00 elapsed minutes. The speed then increases to an average between 470 and 490 knots until about 13 elapsed minutes. It then falls to 420 knots by 13:10 elapsed time, then rapidly to near zero by the end of data.

The processed data reflects a right turn, achieving a rate of 4 degrees per second, between about 12:40 and 13:00 elapsed time. The turn rate reduces to zero by about 14:20, then increases to 14 degrees per second right to end of data.

PILOT INFORMATION

The pilot held a commercial pilot certificate with airplane ratings for single engine land, multiengine land, and instruments. According to the company, he graduated from U.S. Air Force flight training in 1967, and flew single and twin engine fighter-type aircraft for 9 years. The pilot's total flight time was estimated by the company as 11,433, with 63 hours accrued in the BD-10 aircraft.

AIRCRAFT INFORMATION

The aircraft is a two-place single engine turbo jet powered airplane of conventional metal construction. Company literature states the aircraft is capable of "mach plus" airspeeds. The aircraft was originally designed by the Bede Jet Corporation (BJC) of St. Louis, Missouri, as an amateur built kit aircraft.

In December of 1993, Peregrine Flight International purchased the design, production, and marketing rights for the aircraft.

The aircraft was manufactured during 1994, and issued an FAA experimental airworthiness certificate on November 7, 1994. The first flight of the aircraft was accomplished on November 11. At the time of the accident, the aircraft had completed 24 flights, for a total accrued flight time of 29 hours.

Review of the aircraft maintenance records revealed no unresolved discrepancies prior to the accident flight.

According to the company, the original BD-10 prototype constructed by BJC sustained a failure of a vertical stabilizer during flights at the 1994 Reno Air Races. BJC subsequently designed a fix which strengthened the vertical stabilizers. Ground substantiation load tests to failure were conducted by BJC, and the resulting yield-failure load limit was provided to PFI. The yield-failure load limit supplied by BJC was used by PFI to establish the 40 percent flight test limit. The new fix was incorporated into the accident aircraft.

METEOROLOGICAL INFORMATION

The pilot obtained a preflight weather briefing.

Postaccident examination of the meteorological reports and forecasts available at the time, revealed that no significant weather was observed or forecasted for the area of flight. Pilot reports on the dissemination circuits disclosed no reports of turbulence or other unusual meteorological phenomena.

The winds aloft forecast for Reno, Nevada, was examined. Based upon the 1609 observation, the wind direction and speed at 12,000 and 18,000 feet, respectively, were 280 degrees at 10 knots and 290 degrees at 15 knots. The observed temperature lapse rate was 2.33 degrees celsius.

The pilot of the chase aircraft reported that the flight conditions were smooth.

WRECKAGE EXAMINATION

The wreckage was examined at the PFI production facilities after recovery from the accident site. The examination was conducted by a Safety Board Aerospace Engineer, with assistance from an FAA Engineer from the Kansas City Aircraft Certification Office. Initial on-site documentation, to include locations of aircraft components, was overseen by FAA inspectors from the Reno, Nevada, Flight Standards District Office. The Structures Group Chairman factual report completed by the Safety Board engineer, is attached to this report. Wreckage distribution diagrams produced during recovery of the wreckage are also attached.

According to the Structures Group Chairman's factual report, the examination revealed that the airplane's horizontal and vertical tail assemblies sustained structural overloads and separated from the aircraft in flight. Both the left and right main wings failed as a result of gross positive overloads. The left wing separated from the aircraft, while the right wing remained attached to the fuselage.

The left vertical tail assembly was found early in the wreckage distribution path, and is largely intact with the rudder attached.

The report notes that the unit appears to have sustained a clean, almost instantaneous failure load, at the spar attachment points to the fuselage boom structure. Evidence of a bending failure mode toward the right side of the airplane was apparent.

The right vertical tail assembly was found later in the distribution path, and is distorted and partially fragmented. The structures report notes that evidence of impact with a wing flap or other wing structure is present. The unit failed and separated from the aircraft towards the right side. The left side skin assembly was pulled away from the fin and was grossly distorted and torn. The rudder separated from the unit.

MEDICAL AND PATHOLOGICAL INFORMATION

PFI company personnel who reported seeing and speaking with the pilot just before departure on the accident flight, reported that he appeared normal and rested. According to PFI company representatives, the pilot had no known illnesses and was not taking any medications.

The pilot sustained fatal injuries and an autopsy was conducted by the Douglas County Coroner's Office, with specimens retained for toxicological analysis. The results of the toxicological examinations were negative for alcohol and all screened drug substances.

TESTS AND RESEARCH

PFI constructed a production configuration left side fuselage tail boom, complete with vertical and horizontal tail components. The unit was built to the same configuration as the accident aircraft components. This assembly was then mounted on a test fixture, with strain gages installed on the vertical stabilizer spars. The vertical tail was then loaded to failure. The failure mode and separation point was the same as that seen on the accident aircraft left vertical tail assembly. The test revealed that the vertical stabilizer spars began to yield at 40 percent of the failure load limit supplied by BJC (see AIRCRAFT INFORMATION section). Spar failure occurred at 65 percent of the BJC supplied load limit.

Return to synopsis

□□

02/02/1995

B777
Loss of Pressurization

Published on 02/04/1995, SEATTLE POST-INTELLIGENCER

'WE HEARD A LOUD BANG' 2 CREWMEN PASSED OUT WHILE SCRAMBLING FOR OXYGEN MASKS

The first indication of trouble came at 3:02 p.m., three and a half hours after the Boeing 777 took off from Boeing Field for a routine test flight over Washington.

The airplane, the second 777 produced by Boeing, was flying 30 miles north of Seattle using only battery power. It was flying at 43,100 feet - higher than normal cruising altitude but necessary for its test maneuvers.

Your search terms appear 14 times in this article.

Complete Article, 716 words ($1.95 to download)

Published on 02/03/1995, SEATTLE POST-INTELLIGENCER

4 HURT ON 777 FLIGHT AS IT LOSES PRESSURE

Four people were treated for decompression sickness last night when a new Boeing 777 jetliner on a test flight over Puget Sound was forced to make an emergency landing at Boeing Field after a sudden loss of cabin pressure.

The plane, which took off from Boeing Field at 11:19 a.m., landed safely at 3:21 p.m.

Your search terms appear 40 times in this article.

Complete Article, 973 words ($1.95 to download)

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Complete Article, 973 words ($1.95 to download)

02/10/1995

02/10/95

REQUEST 074/98, REPORT 45

UNOFFICIAL REPORT — ANTONOV-AN-70 — ACCIDENT

EVENTS¦PHASES
LOSS OF CONTROL-EN-ROUTE
COLLISION WITH AIRCRAFT-BOTH AIRBORNE-EN-ROUTE
COLLISION WITH TERRAIN-EMERGENCY/UNCONTROLLED DESCENT

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 95/0034-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 95-02-10
TIME : 17:30
LIGHT : NIGHT/MOONLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 27 001 - 272 000 KG
STATE OF REGISTRY : UKRAINE
REGISTRATION : UR

LOCATION

LOCATION : NEAR KIEV
STATE/AREA : UKRAINE
DEPARTED : KIEV
DESTINATION : KIEV

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : DESTROYED

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	7	0	0	0	0	7
PAX :	0	0	0	0	0	0

NARRATIVE

DURING A TEST FLIGHT FROM GOSTOMEL, THE AIRCRAFT COLLIDED WITH ITS CHASE PLANE (AN AN-72), WENT OUT OF CONTROL AND CRASHED. THE OTHER AIRCRAFT, ALTHOUGH DAMAGED, CARRIED OUT A SAFE BELLY LANDING AT GOSTOMEL. THE TEST FLIGHT WAS INTENDED TO EXPLORE THE AIRCRAFT'S PERFORMANCE AT VARIOUS SPEEDS WITH DIFFERENT CONTROL-SURFACE DEPLOYMENTS. ACCORDING TO UNCONFIRMED REPORTS, WHILST FLYING AT 3,200M THE AN-70 EXPERIENCED A RAPID DEPARTURE FROM ITS INTENDED FLIGHT PATH . THE AIRCRAFT PASSED UNDER THE CHASE PLANE AND ITS VERTICAL STABILISER STRUCK THE AN-72'S FUSELAGE. THE AN-70'S FIN WAS EFFECTIVELY DESTROYED IN THE COLLISION AND ONE OF ITS PROPFAN ENGINES TOOK OFF PART OF THE AN-72'S WING. THE AN-70 ENTERED A SPIN AND IMPACTED THE GROUND IN WOODS NEAR GOSTOMEL AIRFIELD IN AN ALMOST VERTICAL ATTITUDE. ACCORDING TO PRESS REPORTS SHORTLY AFTER THE ACCIDENT, THE INITIAL FINDINGS OF THE INVESTIGATING COMMISSION WAS THAT THE ACCIDENT WAS MAINLY DUE TO A LOSS OF VISUAL CONTACT DURING MANOEUVERS AND A LACK OF TWO WAY RADIO COMMUNICATION BETWEEN THE AIRCRAFT . THE ACCIDENT HAPPENED IN DAYLIGHT (1730L). THE AN-70 HAD REPORTEDLY COMPLETED A TOTAL OF ONLY THREE FLIGHT HOURS WHEN THE CRASH OCCURRED.

AviationSafetyNetwork
Accident Description

Accident description

Date:	**10.02.1995**
Type:	Antonov 70
Operator:	Antonov Design Bureau
Registration:	UR-
C/n:	
Year built:	1994
Total airframe hrs:	3 hours
Crew:	7 fatalities / 7 on board
Passengers:	0 fatalities / 0 on board
Total:	7 fatalities / 7 on board
Location:	Gostomel; nr (Ukraine)
Phase:	Cruise
Nature:	Test
Flight:	- (Flightnumber)

Remarks:
The Antonov 70 prototype (ff 16.12.1994; TT 3hrs) took off from Gostomel APT with an An-72 as its chase-plane. Whilst flying at 3200m the An-70 lost altitude causing the tail to collide with the An-72's fuselage and of its propfan

Source:
S190(49); FI 22-28.2.95(18) + 1-7.03.95(5) + 22-28.3.95(19); AW&ST 20.2.95(19); Tel. 13.2.95(5); 10 Uur journaal

[disclaimer]

Flt Intl 1-7 March 1995
pg 5

Lucas with Pentagon problems

...hts US defence ...gearbox failures

RIES is ...tempts by ...om com- ...S military ...p is also ...front to ...ction for ...brought ...tern and ...

...om mid- ...rged that ...d falsified ...S defence ...tra... ...ry... ...op... by

Lucas Western for US Navy McDonnell Douglas F-18s.

The complaints led to a criminal action, which was eventually settled in January, with Lucas agreeing to pay a $18.5 million fine. The US Navy is still claiming damages for non-performance of the gearbox units.

Lucas believes that the latest threats to bar the group from further military work are "designed to bring maximum pressure to bear" on negotiations to settle the claims.

Lucas questions the legality of barring the whole group from bidding for defence contracts and the likely severity of the penalties given its rapid actions to correct the faults once they were uncovered. The group inherited many of the quality problems when it purchased the Lucas Western and

HEADLINE

An-70 investigators face FDR problems

KIERAN DALY/LONDON

THE INVESTIGATION of the fatal crash of the first and only Antonov An-70 prototype may be hampered by a lack of useable information from the flight-data recorder (FDR).

Sources close to the Antonov flight-test operation allege that pressure on staff to accelerate the flying programme led to the final flight being conducted without the FDR having been calibrated. Antonov has refused to comment on the allegations.

It is understood, however, that a video film exists of the aircraft's sudden departure from control, taken from the chase aircraft — now thought to have been an An-74 — which itself was nearly destroyed in the ensuing mid-air collision (*Flight International*, 22-28 February).

The sources — former Antonov flight-test engineering and piloting staff who remain closely connected with the Kiev-based operation — say that the An-70 suddenly veered sideways and the pilot was heard to transmit the words "yaw, yaw".

According to them, the flight-test staff were under intense pressure to put more hours on the aircraft, despite numerous technical snags which, they say, created a high risk of an accident. The aircraft crashed two months after its first flight.

They allege that the An-70 first officer, who was also a qualified captain, had just been told that, once the flight on which he subsequently died was over, he was to be relieved of his position because of his repeated questioning of the technical risks being taken.

The faults are understood to have afflicted the fly-by-wire flight-control system and the aircraft's novel contra-rotating propfans. Failures in either system could potentially lead to the observed aircraft behaviour, although there is no confirmed evidence that these systems were actually at fault on the day.

Antonov has been urged by the Ukrainian Government to hurry the much-delayed programme because of its potential earning power and, in particular, because the Russian rival Tupolev-Tu 330 is in advanced development.

The design bureau is understood to hope now to use a static-test fuselage as the basis for another flying An-70.

US Coast Guard ups Schweizer order

?/?/1993

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04/07/1995

4/07/95.

BRITAIN, ITALY PROBE CAUSE OF EH101 CRASH

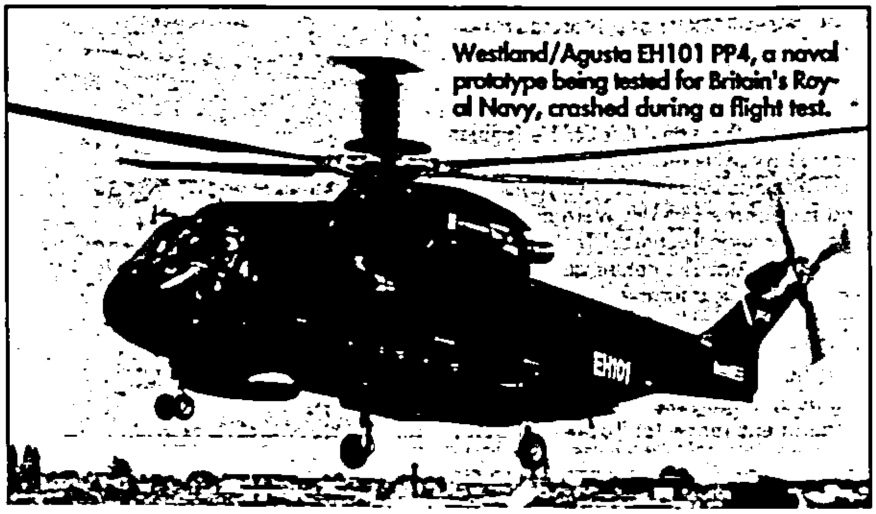
CAROLE A. SHIFRIN/LONDON

Officials of Westland Helicopters and Agusta, partners in EH Industries, are assessing the potential impact of the crash of an EH101 naval prototype during a flight test on Apr. 7.

The four-man crew parachuted to safety before the Anglo/Italian helicopter crashed in the English countryside, about 30 mi. from Westland's Yeovil facilities.

The fourth preproduction aircraft, designated PP4, was being put through maneuvers at an altitude close to 12,000 ft., when the crew identified they had a problem. Eyewitnesses said the aircraft was spinning, suggesting some type of tail rotor problem.

Pilot Donald Maclaine and two flight test engineers, Alisdair Wood and Geoffrey Douthwaite, bailed out at about



Westland/Agusta EH101 PP4, a naval prototype being tested for Britain's Royal Navy, crashed during a flight test.

HEADLINE NEWS

10,000 ft., via the designated emergency exits while senior pilot Capt. John Dickens attempted to hold the aircraft level. Eyewitnesses said that after the three crew had parachuted out, Dickens steered the helicopter away from houses and over a field, ejecting from the aircraft from a side window in the cockpit, at less than 3,000 ft., near Honiton in Devon.

Dickens suffered minor injuries as his parachute did not have enough time to open fully before he hit the ground. He landed less than 100 yd. away from the aircraft crash site.

INVESTIGATORS FROM the ministries of defense of both the U.K. and Italy involved in the accident inquiry are expected to be able to pinpoint the cause of the crash. The aircraft was equipped with cockpit voice and data recorders and a substantial amount of test equipment, including full-time telemetry. In addition, despite the heavy fuel load the helicopter was carrying and the force with which it hit the ground, there was no post-impact fire to burn or further damage the aircraft's components.

The crashed helicopter, powered by Rolls-Royce Turbomeca RTM322 engines, was being tested close to its operational ceiling of 12,000 ft., when it began to have problems. The aircraft, in its support role, has an operational ceiling of 15,000 ft., so it was well within its design specifications, an official said.

THE ABILITY OF THE CREW to escape safely in an emergency and the fact that there was no explosion or fire on impact reflected well on the crashworthy design of the aircraft, an official said.

PP4 was the second of nine prototypes to crash. The crash of PP2 in Italy in early 1993, which killed all four crew, was attributed to an uncommanded application of the rotor brake in flight (*AW&ST* Aug. 9, 1993, p. 26; Feb. 1, 1993). PP4 was not equipped with a rotor brake.

The EH101 that crashed this month was one of two naval prototypes being tested for Britain's Royal Navy, which has ordered 44 "Merlin" aircraft in the antisubmarine warfare role. First deliveries are scheduled for late 1996. The Royal Air Force ordered 22 EH101s in a utility configuration last month (*AW&ST* Mar. 13, p. 23).

Manufactured at Westland facilities in Yeovil, PP4 had accumulated 463 flying hr. in 385 separate flights since its first flight in June, 1989. It had flown just under 200 hr. with the RTM322 engines, which were installed in mid-1993.

The EH101 development program is close to completion, with just 200 more flight hr. in a 3,600-hr. total program remaining. Westland expects production of the aircraft, which started last year, to continue.

Besides its military application, the Anglo-Italian EH101 has been certificated by the aviation authorities in Britain, Italy and the U.S., paving the way for civil operations. Both the 30-seat passenger transport and a passenger-cargo version with a rear ramp were certificated in December by the U.K.'s Civil Aviation Authority, Italy's Registro Aeronautico Italiano and the U.S. Federal Aviation Administration (*AW&ST* Dec. 12/19, 1994, p. 67).

The EH101 consortium has no sales of the civil versions as yet.

THE CIVIL AND NAVAL/MILITARY EH101 was developed over a ten-year period at a cost of more than 2-billion pounds ($3.2 billion). This includes 60-million pounds ($96 million) in launch aid from the U.K.'s Department of Trade and Industry, which has to be paid back as sales are made.

EH Industries partners continue to expect an order for 16 AWS helicopters, with options for eight more, from the Italian navy.

April 17, 1995

ITALY PROBES EH101 CRASH

Italian authorities have begun an inquiry into the crash of an Anglo-Italian EH101 test helicopter during noise level testing.

The crash of PP2, the second of nine EH1010 prototypes, killed all four crewmen: Agusta chief test pilot Raffaele Longobardi; and Agusta flight test engineers Gilberto Tintori, Massimo Colombo and Stefano Novelli.

The development aircraft crashed Jan. 21 at Cameri Airport, about 10 mi. northwest of Agusta's Cassina Costa flight facility. The aircraft had been engaged in test flights designed to measure noise levels of the aircraft from the ground. It had completed morning test flights at Cameri Airport, returned to Cassina Costa for refueling and was about 15 min. into the afternoon program.

The weather was said to be fair, and the pilot was able to radio one Mayday message before the EH101 crashed. It was damaged badly by fire, but there were conflicting eyewitness reports about whether the helicopter had caught fire in the air or upon impact.

The EH101 is being developed and produced jointly by Agusta and Britain's Westland Helicopters. The nine prototypes had a total of 2,200 flying hours out of a planned program of 3,500. PP2 first flew in 1987 and had flown slightly less than 400 hr.

The U. K. Ministry of Defence has ordered 44 of the antisubmarine warfare version and Canada has ordered 50, including 15 for search and rescue.

Canadian EH-101 will use GE T700 engines while the British Royal Navy EH-101 version shown here uses Rolls Royce Turbomeca RTM 322s. Extensive flight tests are underway.

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Applied Sci&Technol Abst 10/83-5/98

Search Results: 4 Entries

Search: 'FLIGHT TEST' AND ACCIDENTS

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Entry 1 of 4 in Applied Sci&Technol Abst 10/83-5/98

TITLE
Britain, Italy probe cause of EH101 crash

PERSONAL AUTHOR
Shifrin,-Carole-A

SOURCE
Aviation-Week-and-Space-Technology.v. 142 Apr. 17 '95 p. 21-2.

ABSTRACT
Officials from Westland Helicopters and Agusta, which are partners in EH Industries, are assessing the potential ramifications of the crash of an EH 101 naval prototype during a **flight test** on Apr. 7. The Italian/Anglo helicopter crashed in the English countryside, about 30 mi. From Westland's Yeavil facilities. The crew parachuted to safety. The fourth preproduction aircraft, it was being put through maneuvers at an altitude close to 12,000 ft. when a problem developed.

DESCRIPTORS
European-Helicopter-Industries; Aviation-Accidents; Military-helicopters .

08/04/1995

08/04/95

LAX95LA278

On August 4, 1995, at 0926 hours Pacific daylight time, a Fox Aircraft Corp., Peregrine PJ-2, N62PJ, collided with terrain after an in-flight loss of control during a go-around from runway 34 at the Douglas County Airport, Minden, Nevada. The airplane was being operated as a developmental test flight under 14 CFR Part 91 when the accident occurred. The airplane was destroyed. The commercial pilot was fatally injured. Visual meteorological conditions prevailed at the time.

The pilot reported a split flap situation by radio to his company during the go-around. Witnesses reported seeing the airplane turn left to the crosswind leg of the traffic pattern and then roll to the right. The airplane pitch attitude was observed decreasing and the airplane continued to roll until colliding with terrain.

Examination of the flap system revealed a pin sheared on the left-hand drive shaft. The flaps are driven by a single electric motor which rotates two independent flexible drive shafts that actuate the right and left flap panels. Examination of system drawings and descriptions revealed that a sheared pin would break the continuity of the respective flap panel drive, stopping the flap panel while the other flap panel would continue to extend or retract. There was no system or mechanism in the airplane that detected an asymmetrical flap condition.

The pin was submitted to metallurgical lab for analysis. According to the metallurgist, the pin conformed to the material specifications of the pin manufacturer and had failed due to overload shear forces on an approximate 45-degree plane. The metallurgist indicated the orientation of the direction of shear would indicate that a combination of torsional and axial loads were being applied at the time of the shear failure.

The airplane manufacturer conducted tests of the flap system. The manufacturer determined the electrical motor in the flap system was capable of shearing the pin before a circuit breaker would interrupt electrical power to the flap motor.

Return to synopsis

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S/N 001

11/21/1995

11/21/95 ✓

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 19951121042269G

General Information

Local Date:	11/21/1995
Local Time:	16:00
City:	BIG BEAR
State:	CA
Airport Name:	BIG BEAR CITY
Airport Id:	L35

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight: (ROTORCRAFT)	SETTLE WITH POWER
Aircraft Make/Model:	ROBSIN R-22-BETA
Airframe Hours:	
Operator Code:	
Operator:	
Owner Name:	

Narrative

NARRATIVE: THIS WAS AN EXPERIMENTAL HELICOPTER OPERATED BY THE MANUFACTURER. THE PILOT STATED THAT HE WAS CONDUCTING CERTIFICATION FLIGHT TEST FOR A NEW VARIATION OF THE ROBINSON R-22 BETA. HE WAS ATTEMPTING TO ESTABLISH THE HIGH ALTITUDE DATA FOR THE HEIGHT VELOCITY DIAGRAM. HE ENTERED AUTOROTATION AT 200 FT AGL & 60 KT WITH APPROX. 12-13KT HEADWIND. DURING TERMINATION ECELERATION, THE HEAD WINDS DECREASED TO LESS THAN 5 KTS. PILOT ATTEMPTED TO TERMINATE THE AUTOROTATION WITH POWER AND WHEN HE REALIZED IT WOULD NOT BE SUCCESSFUL POWER OFF. THE MANEUVER RESULTED IN A HARD LANDING. THIS INCIDENT IS CLOSED.

Detail

Primary Flight Type:	OTHER
Secondary Flight Type:	TEST FLIGHT
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	8312T
Total Aboard:	1
Fatalities:	0
Injuries:	0
Landing Gear:	
Aircraft Weight Class:	UNDER 12501 LBS
Engine Make:	
Engine Model:	
Engine Group:	
Number of Engines:	1
Engine Type:	

Environmental/Operations Information

Primary Flight Conditions:	VISUAL FLIGHT RULES
Secondary Flight Conditions:	WEATHER NOT A FACTOR
Wind Direction (deg):	24
Wind Speed (mph):	05
Visibility (mi):	10
Visibility Restrictions:	
Light Condition:	DAY
Flight Plan Filed:	NONE
Approach Type:	

Pilot-in-Command

Pilot Certificates: AIRLINE TRANSPORT

Pilot Rating:

ROTORCRAFT/HELICOPTER/AIRPLANE SINGLE ENGINE LAND

Pilot Qualification: QUALIFIED

Flight Time (Hours)

Total Hours: 7800

04/24/1996

4/24/96 ✓

CHI96FA141

HISTORY OF FLIGHT

On April 24, 1996, at 1107 central daylight time (cdt), a Piper PA-25-150, N6254Z, registered to D and E Company, Republic, Missouri, and piloted by an FAA test pilot, was destroyed by an impact with terrain, and a post crash fire. The airline transport pilot sustained serious injuries and the Federal Aviation Administration (FAA) flight engineer received fatal injuries. The purpose of the flight was for a Supplemental Type Certificate (STC) approval on the airplane. The 14 CFR Part 91 flight was operating in visual meteorological conditions. No flight plan was on file. The test flight originated from Buffalo, Missouri, at 1105 cdt.

The airplane was used by a private individual who had developed a STC for a dual seated Piper Pawnee 150. The purpose of this flight was to perform airspeed calibrations at the maximum gross weight with a forward center of gravity (CG). Seven (7), eighty pound bags of dry concrete had been placed in various locations on the airplane as ballast. The total fuel tank capacity is forty gallons. The pilot elected to takeoff with thirty-five gallons of automotive fuel to compensate for the extra weight of the calibration equipment.

According to the pilot's written statement and interviews, he said he conducted one training flight on February 29, 1996, followed by a second flight which entailed an airspeed calibration test on the same day. The third flight was conducted on March 1, 1996. This flight consisted of stalls and climb performance tests. The pilot and flight engineer calculated a weight and balance for the third flight to load the airplane at a maximum gross weight and with a forward center of gravity. The pilot was unable to explain why the airplane was configured that way since the hopper had been removed. The temperature for the first three flights was 28 to 32 degrees fahrenheit. The pilot said it lacked overall performance but felt comfortable with the airplane. The fourth flight was conducted on April 24, 1996, the day of the accident. The temperature that day was 64 degrees fahrenheit. The airplane was modified to accommodate an external airspeed and static bomb which was routed around the forward right battery compartment door and hung down between the landing gear. The flight engineer would hold the airspeed bomb by a reel in his lap and unravel the airspeed bomb inflight to perform the airspeed calculation tests.

The pilot said that the runup was normal. The takeoff was at the same spot on the runway as all the previous flights conducted. He said the takeoff was normal but as he maneuvered to stay clear of some objects south of the runway, the airplane felt as if it was not climbing but sinking. He said he maintained the best rate of climb airspeed of 70 MPH and 2525 to 2550 engine RPM. He then went down to the best angle of climb airspeed of 63 MPH. He felt the airplane was not climbing and began to turn downwind for landing. The pilot stated, "...Sink increased such that I would not reach the airport. Airplane contacted trees prior to reaching field... ." The pilot's weight and balance sheet indicated a gross weight of 2,331 pounds at a CG of 10.99 inches aft of datum. The pilot's weight and balance is included as a supplement to this report.

A witness reported seeing the airplane takeoff on runway 21 and stated, "He wasn't very high over the park, but was kind of flying through the clearing of the trees. ... As the plane was coming closer to my house I thought he was going to hit the tree in my front yard. ...[the airplane] almost clipped a tree in my neighbors yard. ...When they were flying north [downwind to runway 21], they flew over the top of [neighbor's house down the street] house. They missed his house by probably 2 or 3 feet... ." The witness remembered hearing two boom sounds after the airplane disappeared behind the trees.

A second witness also stated that after takeoff, "...the engine sounded good, but it sounded like it was laboring... ." The airplane turned downwind and disappeared behind the trees.

A third witness who is an employee of the STC holder was interviewed by a FAA Principal Operations Inspector and said in his written statement, "...(airplane) went down the runway and lifted off. It looked like the airplane was having trouble getting enough lift to go. After they lifted off and got about 1/2 way down the runway, they turned left. The aircraft appeared to porpoise slightly as if it was stalling out. As they got maybe 1/4 mile east of the airport, they turned downwind and the aircraft stopped climbing and started sinking, wings level, nose slightly up, engine full power... ." The pilot had flown the airplane about 6 weeks earlier in the same weight configuration and seemed happy with it, however, the previous time, it was a much colder day... ."

The company's test pilot for the STC holder was interviewed by the FAA Principal Operations Inspector and stated in his written statement that, "...according to his experience in the PA-25-150, the aircraft was loaded with the center of gravity too much forward. He further stated that he had not flown the aircraft nor would he have flown the aircraft loaded in this fashion... . He said as the company test pilot, that he flew the aircraft 20 to 25 times (without the seven, 80 pounds bags of quikcrete) and that all appeared normal. He said that he had calibrated the airspeed to within 1-3 NM per hr but that the FAA wasn't satisfied with that and wanted to test it more... ." The test pilot also commented on the fact that the airplane was not outfitted with a standard wing root fairing. Without this fairing the drag coefficient of the airplane is increased and it also affects the stall characteristics. The company test pilot said the reason why he would not fly the airplane loaded the way the FAA test pilot had it loaded was because the ballast could not be dumped if an emergency occurred inflight.

PERSONNEL INFORMATION

The pilot was born May 9, 1946. He was the holder of an airline transport pilot certificate for single engine land/sea and multi- engine land ratings. He held a second class medical issued on May 5, 1995. His most recent biennial flight review was on April 19, 1996. He had accumulated a total of 3,296 hours of flight time, 3 hours of which were in Piper PA-25-150 airplane at the time of the accident.

AIRCRAFT INFORMATION

The airplane was a Piper Pawnee manufactured in 1960, serial number 25-314. The airplane's airframe and engine logbooks were in the airplane at the time of the accident, consequently, the logbooks were destroyed by the post crash fire. According to the STC application dated on February 26, 1996, the airframe had accumulated 3,068 hours time in service. The engine had 1,591 hours total with 38 hours since its last overhaul.

WRECKAGE AND IMPACT INFORMATION

The NTSB on-scene investigation began at 0800 cdt on April 25, 1996. The wreckage was located one-half mile east of the Buffalo Airport, in a hilly wooded area. The accident site was the highest elevation in the vicinity of the airport. The airplane impacted numerous trees during its descent, leaving the right wing tip in a tree and pieces of wing ribs along the ground. The airplane came to rest almost upright with a slight left wing low attitude. A post crash fire engulfed the airplane.

The right wing was bent aft and lay along the right side of the fuselage with numerous impacts to the forward spar. Most of the right wing ribs were destroyed and burned away. The front and rear wing attach points were secure. The left wing was destroyed by multiple tree impacts and post crash fire. The left wing ribs had melted and were deformed by the fire.

The fuselage was found on its left side on top of the left wing. The occupiable space in both the front and rear cockpit area was not compromised. The front seat was welded to the frame and was cut loose during removal of the flight engineer. The seat belt and shoulder harness attach points were not evident for the front seat passenger; however, the five-point seat and shoulder belt buckle was found fastened near the front seat. The rear seat was found attached to the seat tracks, but the supporting structure had burned away. The rear seat belt cables and attach points were secure and in place. Dual flight controls from a Piper Cub, PA-18 had been installed. The empennage exhibited compression bending to the lower longerons and the fabric had been destroyed by fire. The horizontal stabilizer fabric, elevator fabric, vertical stabilizer fabric and rudder fabric were all destroyed by fire. Control continuity was verified to the elevator and rudder. The elevator trim spring was in place, and the trim cable was connected to the trim control located in the cockpit area. Engine controls were provided to the front seat passenger by means of metal rods extended from the rear seat occupant's engine controls. The elevator trim handle was relocated between the seats to allow access by both occupants. The center flap handle was not accessible to the front occupant, but only to the rear seat occupant. Flight control continuity to the ailerons and flaps was verified. All flight and engine instruments were destroyed by the post crash fire.

The engine was turned by way of the propeller and continuity was established through all pistons and the accessory section. The propeller was attached to the severely damaged propeller flange which was still partially attached to the crankshaft. An outboard propeller blade section approximately 15 inches long had been sheared off. This section of the propeller was sent to the NTSB Materials Laboratory Division. See enclosed Metallurgist's Factual Report.

Numerous pieces of hardwood (oak) were found with clean cuts that appear to have been made by the propeller. Some pieces of tree limbs were found as thick as 5 inches in diameter. The IIC calculated a forward speed of 36.2 MPH from one of the wood pieces found near the impact crater.

MEDICAL AND PATHOLOGICAL INFORMATION

A post mortem examination of the FAA Flight Engineer was conducted on April 25, 1996 at Cox South, Springfield, Missouri. No pre-existent anomalies were noted during this examination.

TESTS AND RESEARCH

The airspeed indicator was ordered by the FAA Test Pilot to be calibrated after the flight that was conducted on March 1, 1996. The airspeed indicator had a functional test performed by Aero-Mach Labs, Inc., of Wichita, Kansas, on March 5, 1996 and they reported their findings to the pilot. The airspeed indicator was later reinstalled into the airplane and a leak check was performed on the pitot-static system.

ADDITIONAL DATA

The IIC calculated the experimental airplane's weight and balance to indicate a gross weight of the airplane to be 2,319 pounds and the center of gravity to be approximately 10.87 inches aft of datum at the time of the accident. The purpose of the flight testing was to bring the airplane back into compliance as a Piper Pawnee through the STC. The pilot operating handbook for a Piper PA-25-150 specifies a center of gravity envelope at maximum allowable gross weight (2,300 lbs) is 11.70 to 15.25 aft of datum. The Piper Pawnee is also rated at 150 HP at 2,700 RPM. See also the enclosed Piper Aircraft's estimated weight and balance sheet.

Parties to the investigation were the Federal Aviation Administration; The New Piper Aircraft Corporation; Textron Lycoming.

Following the on-scene portion of the investigation, the wreckage was released to owner on April 25, 1996.

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4/24/96 ✓

NTSB Identification: **CHI96FA141** . The docket is stored in the (offline) NTSB Imaging System.

Accident occurred Wednesday, April 24, 1996 at BUFFALO, MO
Aircraft:Piper PA-25-150, registration: N6254Z
Injuries: 1 Fatal, 1 Serious.

The Piper PA-25 (acft), being used to develop an STC, was modified by installing 2nd seat in hopper area & extending canopy forward. On 6/30/95, operator reported to FAA that flight conformance testing to date had reflected no change in acft performance versus original configuration. Acft was equipped with external airspeed calibration device for an airspeed calibration flight, & it was loaded with 560 lbs of ballast to meet max gross wt & forward CG requirements for STC testing. Wind was gusty, & temp was 64 deg (about 30 deg warmer than on day of previous test flight). Pilot reported that after takeoff from runway 21, he maintained best rate of climb speed & 2525-2550 engine rpm, then best angle of climb speed, but acft would not climb. He then turned downwind & attempted to return to same runway; however, acft collided with trees & crashed about 1/2 mi east of airport. A witness said that during takeoff, acft lifted off, then began a left turn about half way down the runway. Pilot said that a climbing turn was made to allow for more clearance from obstacles at south end of airport. Witnesses said acft then turned north & remained at low altitude & airspeed until it hit trees & crashed. Fire then erupted, & acft was demolished. Investigation revealed that standard (original) wing root & landing gear (strut) fairings were not installed. Piper reported that removal of wing root fairings would significantly reduce wing lifting capability & change airflow over horizontal tail, requiring more elevator deflection for maneuvering. Absence of landing gear fairings would have increased drag, slightly.

The National Transportation Safety Board determines the probable cause(s) of this accident was:

failure of company/operator personnel to install the wing and landing gear (strut) fairings after modifying the airplane for a supplemental type certificate (STC), and improper planning/decision by the pilot. Factors relating to the accident were: the airplane's reduced performance, and high obstructions.

Full narrative available
See preview

Index for Apr1996 | Index of months

05/24/1996

05/24/96

Transportation Safety Board
Aviation Safety Information System (ASIS)
Data Printout - Aviation Occurrence A96O0089

This printout is issued to provide information on the general circumstances of this occurrence. The information is based upon details provided by participants and other data uncovered to date by the investigation staff. The Transportation Safety Board of Canada (TSB) gathered this information for the purpose of advancing transportation safety. It is not the function of the TSB to assign fault or to determine civil or criminal liability.

A word of caution, some of the information in this document is as provided to the TSB and has not been subjected to further confirmation. Also, the investigation may still be in progress, and therefore, the information is subject to change.

Occurrence Type: INCIDENT REPORTABLE **Class:** CLASS 5
Reportable Incident Type: D. DIFFICULT TO CONTROL
Location: OTTAWA INTERNATIONAL
Country: CANADA **Province:** ONTARIO
Date: 24-MAY-1996 **Time:** 11:45

Aircraft Operator	Aircraft Model	Registration
NATIONAL RESEARCH COUNCIL CANADA	205A-1	C-FYZV

Injuries	Fatal	Serious	Minor	None	Total
Crew	0	0	0	2	2
Passenger	0	0	0	0	0
Ground	0	0	0	N/A	0
Total	0	0	0	2	2

Transportation Safety Board
Aviation Safety Information System (ASIS)
Data Printout - Aviation Occurrence A96O0089

2/2

Aircraft Data

Registration: C-FYZV

Operator: NATIONAL RESEARCH COUNCIL CANADA
Type of Operator: GOVERNMENT
Type of Operation: EXPERIMENTAL/TEST
Make: BELL HEL.
Model: 205A-1 **Category:** HELICOPTER
Common Name: BELL 205 **Damage:** NONE

Injuries	Fatal	Serious	Minor	None	Total
Crew	0	0	0	2	2
Passenger	0	0	0	0	0
Total	0	0	0	2	2

Individual Information

			Crew Hours			
			All Types		This Type	
Individual Type	**Licence Type**	**Seat No**	**Total**	**Last 90**	**Total**	**Last 90**
PILOT-IN-COMMAND			0	0	0	0

Occurrence Summary

A96O0089: SHORTLY AFTER THE ENGAGEMENT OF A RESEARCH FLY-BY-WIRE SYSTEM, THE BELL 205A-1 HELICOPTER WAS SUBJECTED TO LARGE SPURIOUS INPUTS GENERATED BY THE SYSTEM. DURING RECOVERY FROM THE ENSUING UNUSUAL ATTITUDE, SIGNIFICANT VIBRATION WAS FELT FROM THE ENGINE/TRANSMISSION AREA. THE AIRCRAFT WAS LANDED IN THE NRC GRASS OPERATING AREA AS A PRECAUTION AND TOWED BACK TO THE HANGAR FOR INSPECTION.
INITIAL INSPECTION OF THE AIRCRAFT INDICATES A DISTORTION OF THE FORWARD FIRE-WALL RESULTING FROM EXCESSIVE ENGINE MOVEMENT AND MARKS ON THE INPUT DRIVE SHAFT FROM CONTACT WITH THE INTAKE COWLING. THE ENGINE MOUNTS APPEAR TO BE UNDAMAGED. THERE WAS NO EVIDENCE OF MAST BUMPING OR DAMAGE TO THE TAIL ROTOR DRIVE SHAFT.

05/28/1996

5/28/96

LAX96LA207

On May 28, 1996, about 0711 hours Pacific daylight time a McDonnell Douglas MD-600 helicopter, N600RN, was destroyed during flight tests at Thermal, California. The pilot was not injured. The helicopter was in a flight test program for FAA certification under 14 CFR Part 27. The specific test point at the time of the mishap was part of a flight strain survey and involved cyclic control reversals.

The pilot set the parameters and executed the cyclic inputs as planned. Almost simultaneous with the aft movement of the cyclic there was a loud noise and immediate vibrations in the aircraft and controls. There was a chase aircraft for the mission and the chase pilot advised that the tail boom had been struck by a main rotor blade and had separated from the airframe. The pilot of the mishap aircraft then experimented with powered flight, but found that the right yaw was not controllable. He elected to continue the power off autorotation with a controllable left yaw. The autorotation was continued to a vacant field with some piles of brush and other desert debris. The pilot used available rotor rpm, cyclic, and collective control to execute a modified autorotation landing. The resultant landing was onto a brush pile with some skid and main rotor blade damage. The engine exhaust was adjacent to dry brush and grass which resulted in a grass fire. The ground fire destroyed the helicopter.

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S/N RN007

06/19/1996

F/A-18
Airshow Practice

6/19/96

CHI96FA211

HISTORY OF FLIGHT

On June 19, 1996, at 1448 central daylight time (cdt), a Department of the Navy F/A-18C, Buno Number 165189, leased and operated by McDonnell Douglas Aerospace (MDA), was destroyed after it impacted the terrain while performing a reverse one-half Cuban eight maneuver during a practice airshow at the St. Louis Regional Airport, Alton, Illinois. The commercial pilot sustained fatal injuries. The local 14 CFR Part 91 flight was operating in visual meteorological conditions. No flight plan was on file. The practice airshow flight departed St. Louis Regional Airport, Alton, Illinois, at 1447 cdt.

On the morning of the accident, the airplane preflight was initiated by the launching Quality Assurance (QA) inspector. Another QA inspector began to preflight the cockpit and the ejection seat. This inspector was called away to perform a final go/no-go inspection on another airplane that was ready to depart.

This inspector stated that while at the other airplane, he received a call, from another McDonnell Douglas inspector, inquiring if he had finished his portion of the preflight. He replied that he still needed to run the seat up and inspect the cockpit lights. By the time this inspector returned to the airplane the pilot had already pulled the ejection seat and canopy pins. The pilot had given the pins to the ground crew to be stored in the 14L door for use upon landing at the St. Louis Regional Airport, if needed. The inspector stated this was not normal procedure and that the pilot should have waited for his return. This procedure is enclosed with the report under the Maintenance Group Chairman's item 14, Aircraft Flight and Inspection Release Form. The preflight was completed and the airplane was taxied to the runway where the go/no-go inspection was performed.

The accident occurred during the second demonstration flight for the pilot on June 19, 1996. The first flight on June 19, 1996, was a functional check flight followed by a high altitude practice airshow sequence while en route from the McDonnell Douglas plant (Lambert International Airport, Bridgton, Missouri) to the St. Louis Regional Airport.

The airplane departed Lambert Field at 1318 cdt and proceeded to a test area north of St. Louis where the pilot performed some routine inflight systems checks due to recently completed maintenance on the airplane. After performing a partial practice airshow sequence north of Alton, Illinois, the airplane arrived at the St. Louis Regional Airport. The tower cleared the airplane from 500 feet above ground level (agl) to 8,000 feet agl with a 3 mile radius around show center (approximately the center of the airport). The pilot then entered at 1,000 foot agl baseline into the practice airshow routine. The airshow routine, established by MDA in 1993, included the following sequence of events: Takeoff, gear down roll, slow loop, reverse one-half Cuban eight, high speed roll, inverted pass, roll over break, maximum g turn, immelmann, high AOA turn, high AOA pass, high AOA roll, minimum radius 180 degree turn, square loop, barrel roll, and landing. While nearing the top of a loop, the pilot broke off the maneuver because of a cloud that moved over the airport. After a few minutes, the remainder of the practice airshow routine was completed and the airplane landed at 1350 cdt. The airplane was refueled with 6,600 pounds of Jet A. The pilot had invited his family and some friends to watch his practice airshow demonstration and some were in attendance at St. Louis Regional Airport. The pilot met with family and friends both before and after his debrief/brief with the MDA Chief Test Pilot.

The second practice flight departed the St. Louis Regional Airport at 1447 cdt. The routine began with a maximum afterburner takeoff, followed by a dirty roll (landing gear extended). After the aircraft completed the roll, the landing gear was retracted and a slow loop was executed. The slow loop was followed by entry to a reverse one-half Cuban eight. The airplane was observed to be low by the Chief Test Pilot who was acting as a safety observer on the St. Louis Regional Airport Air Traffic Control Tower catwalk. He called abort on a hand held radio to the pilot. The transmission of the abort was not acknowledged by the pilot. He did see that the airplane had a positive AOA before impact. Videotape of the accident indicates the airplane impacted the ground at the bottom of the reverse one-half Cuban eight. The time of the impact was approximately 1448 cdt.

OTHER DAMAGE

Multiple trees, one telephone pole, and a residential garage were damaged during impact sequence.

PERSONNEL INFORMATION

The pilot was born May 22, 1952. He was the holder of a commercial certificate with single/multi engine land and instrument ratings. The pilot also held a acrobatic competency certificate level two issued on May 20, 1996, with an altitude limitation to 250 feet agl. The acrobatic certificate included the following airplanes; Beech D17S, Beech BE-33C, and a Pitts Special. He held a second class medical issued on June 13, 1996.

His most recent biennial flight review was on March 26, 1996. He had accumulated a total of 6,218 hours of flight time.

The pilot was trained as a United States Naval Aviator and qualified in the F/A-18. During his military flying career he accumulated approximately 2,255 hours in the F/A-18 airplane prior to coming to MDA Flight Operations in March of 1996. The pilot was also a graduate of the Naval Test Pilot School, located at Naval Air Test Center, Patuxent River, Maryland. The pilot had the following 30/60/90 day flight hour totals in the F/A-18: 3.0/3.9/10.7 hours. The pilot had the following 30/60/90 day simulator hour totals in the F/A-18: 9/27/37 hours.

AIRCRAFT INFORMATION

The airplane was a McDonnell Douglas F/A-18C, serial number 165189. The airplane had accumulated 20.8 hours time in service at the time of the accident. The engines had 26 hours total hours in service. The most recent continuous inspection was conducted on June 19, 1996.

FLIGHT RECORDERS

The Deployable Flight Incident Recorder Set (DFIRS) was salvaged from the wreckage. The data was printed out and down loaded prior to NTSB involvement with the accident investigation. The data was loaded into the recovery analysis and presentation system (RAPS) program for visual display of the data collected. In addition, a visual 8MM tape of the right Digital Display Indicator (DDI) showed the Flight Control System (FCS) status display selected with no warnings displayed prior to impact with the terrain. The left 8MM tape was destroyed by the post-crash fire.

The DFIRS data was broken down into the four parts of the reverse one-half Cuban eight;

Pull-up 180 degree roll Top Bottom

High Low Low High OK Low

1. Airspeed (knots) 236/176/180/144 2. Baro Alt (ft agl) 1212/1192/2008/472 3. Radar Alt (ft agl) 576 1408 invalid 0 4. AOA (degrees) 25.2/14/12.6/40.6 5. Pitch (degrees) 16.8/58.8/-7.0/22.4 6. Power Lever Angles Left/Right (degrees) 128.1/127.4 full after burner position though out the complete maneuver.

The briefed target parameters were;

Pull-up 180 degree roll Top Back side

1. Airspeed (knots) 260-280/280-200/200-230/250-270 2. Baro Alt (ft agl) 700-800/2700min/3500min/2000min 3. Radar Alt (ft agl) 700-800 Invalid Invalid Invalid 4. AOA (degrees) 25max/20/0-10/25max 5. Pitch (degrees) 50-55/50-55/0/-90 6. Power Lever Angles Left/right (degrees) 90-102/90-102 Military power position (maximum power needed without afterburner at low airplane weights)

See four graphs enclosed with this report.

At impact the DFIRS recorded the following throttle and engine parameters;

Left Engine Right Engine

1. Power Lever Angle: 128.1 degrees 127.4 degrees 2. High Press Rotor: 16256 RPM 16256 RPM 3. Low Press Rotor: 13568 RPM 13632 RPM 4. Fuel Flow: 9280 Lbs/Hr 9280 Lbs/Hr 5. EGT: 896 Degrees C 896 degrees C 6. Exhaust Nozzle: 68 percent 68 percent

At impact the airplane parameter's were recorded by DFIRS;

1. Airspeed: 144 knots 2. Angle of attack: 40.6 degrees 3. Pitch: 22.4 degrees nose up 4. Roll: 9.8 degrees to the left 5. Vertical Velocity: -3840 feet per minute

WRECKAGE AND IMPACT INFORMATION

The NTSB on-scene investigation began at 0830 on June 24, 1996. There were questions immediately following the accident regarding the ownership of the aircraft and who had responsibility for the investigation. Before the NTSB took over the investigation, a joint investigation between the Naval Safety Center and MDA was in progress. The wreckage had already been removed from the accident site and placed in a MDA hangar. Several inspections of the airplane's components were being performed by the U.S. Navy, MDA and its vendors.

The accident site was surveyed by the U. S. Air Force Air Mobility Command, based at Scott Air Force Base, O'Fallon, Illinois. A copy of the survey is attached to this report. The airplane flight path angle at impact was calculated to be minus 16 degrees. This value was calculated from the survey data of the initial impact point and a tree that was struck by the airplane prior to ground impact. The airplane slid between two houses, impacting a telephone pole, several trees and a detached garage structure before breaking up and coming to rest approximately 360 feet from the initial impact point. Evidence of a post crash fire was evident in the general direction of flight from the garage structure forward. Several afterburner flaps were found at the initial impact point, followed in the direction of flight by two distinct furrows corresponding to the outside diameter of the afterburner casings. Scars to either side of these furrows were made by the horizontal stabilators. The airplane's centerline pylon was found between the initial impact point and the garage. The left side leading edge extension was found embedded in the garage structure. The airplane's canopy was recovered 250 feet from the majority of the main wreckage in an area not burned by the ground fire. The canopy unlatch thruster and rocket motors had fired. Most of the glass was broken out in small pieces and scattered over a large area.

MEDICAL AND PATHOLOGICAL INFORMATION

A post mortem examination of the pilot was conducted on June 20, 1996, at the Madison County Morgue, Edwardsville, Illinois. No pre-existent anomalies were noted during this examination.

The pilot's toxicological analysis was performed by both the Federal Aviation Administration (FAA) Civil Medical Institute in Oklahoma City, Oklahoma and the Madison County Corner. The toxicological examination of specimens from the pilot were negative for the drugs scanned.

TESTS AND RESEARCH

Several F/A-18's pilots were asked to perform the same flight profile as the data obtained from the DFIRS in two F/A-18 simulators. With all aircraft systems operating normally, impact with the ground occurred whenever the top altitude of the Split-S maneuver was less than 2,500 feet agl. In support of this, Split-S maneuvers were flown in the simulator at speeds of 125 to 325 knots, in 25 knot increments, with the top altitude from 3,000 feet agl with 5,500 pounds fuel and max afterburner thrust. Altitude needed to successfully complete this maneuver were constant at 2,500 feet plus or minus 100 feet. When starting the maneuver at 3,500 feet agl, the maneuver could be completed by 1,000 feet agl with altitude available for a smooth transition down to the 500 feet agl minimum. In addition, thrust deficiencies were simulated but, did not replicate data collected from the accident airplane.

There were many eyewitnesses to the accident flight. None reported seeing any airplane anomalies. Witnesses were in agreement that the accident airplane took off, performed a slow loop and then initiated a reverse one-half Cuban eight prior to impacting the ground at the bottom of the maneuver. For further information see Operation Group Chairman's report enclosed with this report.

According to the Chief Test Pilot, the debrief of the first routine outlined a few constructive comments and finesse techniques on the maneuvers being performed. The comments primarily addressed horizontal maneuvers as all of the vertical maneuvers had been observed to be satisfactory. On one maneuver, the Chief Test Pilot told the accident pilot that he did not like the high speed turn after the inverted pass. The accident pilot agreed stating that he wanted to pull 6.5gs but he only got 5.5 or 6.0gs. The Chief Test Pilot stated that he explained to the pilot that as a result of the turn and the ground track, the next maneuver was rushed. The accident pilot told the Chief Test Pilot that he concurred and explained that it was because he missed the g but it would not be a problem the next time. According to the Chief Test Pilot they then reviewed the parameters for each maneuver. For the reverse one-half Cuban eight, the Chief Test Pilot asked the accident pilot what parameters he was looking for. The accident pilot stated he would be in full burner, looking for 300 (knots) to 320 (knots) going up in the Cuban eight and that he would be playing the back side of the loop with altitude and acceleration. The Chief Test Pilot asked the accident pilot what altitude he would be looking for during the reverse one-half Cuban eight. The accident pilot replied that he would be looking for 3,000 and would pull at 3,500 minimum. The accident pilot told the Chief Test Pilot he would play with the power a little bit depending on his speed and climb angle. He continued to state that he would be pulling 4 to 5 gs on the back side. He then stated that he probably would not get that and he would be switching to 20 to 25 alpha (angle of attack). The Chief Test Pilot questioned the 25 alpha to which the accident pilot responded 20 alpha. The Chief Test Pilot then asked what he would be looking for on the back side. The accident pilot replied that he would probably have to play this to get to his altitude and exit speeds for the rolls and that he would be coming back in with power and accelerating. He stated that he would be playing his altitude to come out at 700 feet (agl) then he would enter the roll. The Chief Test Pilot asked what speed he would be looking for; to which the accident pilot replied he should be around 350 (knots) accelerating close to 400 to do the roll inverted and to brake to the hard turn.

According to the Senior Test Pilot who performed previous airshow demonstrations and trained the pilot, he conducted a few one- on-one training sessions with the pilot during which they went over the parameters for each of the maneuvers. The Senior Test Pilot described the parameters shown to the pilot in the company's simulator for the reverse one-half Cuban eight maneuver. The Senior Test Pilot said, as you [the pilot] are completing the back side of the slow loop maneuver, "...Normally you have to play altitude down; there was never a problem with being low on that maneuver. You would normally pull out at 1000 to 900 feet agl and have the airplane fly down to five hundred feet while accelerating to set up for the reverse half Cuban eight. The acceleration takes airspeed up to 260, 270, 280 knot area. That's with mil power, you don't need more than that. If you needed a little bit more, after burner would shoot you up to 300 knots. At that point, use a pretty smart pull to set the attitude for reverse one-half Cuban eight. Looking for 50 to 55 degrees but could go as high as 65. You may be down as low as 45. The range here would be where you are accommodating different winds; headwinds or tailwinds. You are looking to get distance so that you can come down the back side of that and be able to get speed up for the rolling sequence which follows. Pulling the aircraft up, set the attitude again, or the flight path at this point since angle of attack is relatively low. Just watching altitude now. Altitude, I use 2700 to 2800 feet agl as the point to roll the airplane inverted and then just pause there because the maneuver looks better rather than just a roll and pull and then just extend on up. Plus you are looking for 3500 feet agl. That was the constant minimum that we used for these two overhead maneuvers." The Senior Test Pilot said that he never really considered the reverse one-half Cuban eight maneuver to be a particularly challenging one nor the rest of the maneuvers used in the airshow routine.

Initial on-scene inspection of the engines indicated the left engine showed less rotational damage than the right engine, which showed high rotational damage. The left engine was selected for shipment to Naval Aviation Depot (NADEP) Jacksonville for teardown and detailed investigation under the supervision of the NTSB. In addition, the left variable exhaust nozzle (VEN) assembly, both high pressure compressors (HPC) variable geometry actuators, the fan variable geometry actuator, the power lever control and throttle box, the VEN position transmitter and the main and afterburner fuel pumps and controls, were also sent to NADEP Jacksonville for teardown and investigation. The right engine VEN assembly, HPC and fan variable geometry actuators, power lever control and throttle box and main fuel control, the VEN position transmitter and the main fuel control and pump were also selected for shipment to NADEP Jacksonville.

Based on all evidence examined on-scene and at NADEP Jacksonville, the right engine was operating at or near the maximum afterburner power setting at ground impact. The rotating core exhibited evidence of high rotational energy at ground impact. The engine control components examined all exhibited impact marks indicative of a high (nearly maximum afterburner) power setting. The VEN components all consistently indicated a maximum afterburner nozzle area position. Charred wood pressed into the aft end of the right engine and the soft deformation of the exhaust centerbody indicated combustion heat was present in the turbine section during the impact sequence. The physical evidence exhibited by the right engine and its components supported the pre-impact operational data downloaded from the airplane's data recording system.

Initial inspection revealed little evidence of high rotational energy in the left engine; however, a close inspection of the left engine did reveal signs of high rotational energy at some point during the accident sequence. There was evidence of rubbing between rotors and stators, stator cases and static seals to indicate that the engine was rotating at initial impact. The left engine control components examined all exhibited impact marks indicative of a high (nearly maximum afterburner) power setting and VEN components all consistently indicated a maximum afterburner nozzle area position at impact. Charred wood found in the combustion case indicated that heat was present in the combustor when the debris was ingested. Based on the evidence found during the detailed disassembly, and the correlation between the left and the right VEN positions at impact, it was concluded that the left engine was operating at or near maximum afterburner power at impact. Examination of the right and left engine indicated normal operation throughout the flight. For further information see Propulsion Group Chairman report enclosed with this report.

Maintenance records revealed significant maintenance conducted on the airplane prior to the accident. Fuel tank number 1 was disassembled to inspect for suspect cracked clips on the left and right fuselage structure. The clips were replaced and tank 1 was reassembled. Fuel tank number 4 was disassembled to look for the cause of a re-occurring cavity drain leak. No obvious leak source was discovered, so the bladder tank was removed and replaced. The left and right generators were removed and reinstalled to facilitate the troubleshooting of the fuel tank number 4. The fuel tank number 1 fuel quantity probe was removed and replaced for a fuel quantity indication problem. The right motive flow fuel "T" in door 53R was disassembled for motive flow fuel leak. An O-ring was replaced and the fuel coupling was reassembled. A complete functional check of the fuel system was satisfactorily completed during a post maintenance ground engine run. This work was done by non-union MDA personnel due to a strike of the International Association of Machinists on the property of MDA. Examination of the fuel system indicated normal fuel system operation and no anomalies were discovered. For further information see Maintenance Records Group Chairman's report enclosed with the report.

The aircrew ejection seat components recovered indicated partial/incomplete firing of pyrotechnic items. Most items appeared to have been expended as a result of exposure to extreme heat and/or post crash fire. The ejection seat catapult did not activate. The ejection seat did not leave the cockpit. The Seat Firing Handle was withdrawn from the position it would be installed in during normal flight operations. The handle was in a position forward of and below its normal position when installed in the seat bucket forward beam. The interface link between the handle assembly and the seat initiator firing handle sear assemble was bent approximately 110 degrees from the vertical position over the forward edge of the handle receiver block. A witness mark was noted on the upper forward surface of the handle receptacle in the receiver block which matches the physical characteristics of the handle interface link. The Mechanically Activated Initiator, which provides manual canopy jettison capability, was recovered from the airplane wreckage. The output Shielded Mild Detonating Cord (SMDC) line has been expended and appeared to have functional normally. Visual examination of the inner diameter of the SMDC line, which was sheared off at the surface of the line installation nut, contained evidence the explosive core sear rod was withdrawn fully from the upper end of the unit and was not recovered. The metal guard which normally surrounds the area occupied by the sear rod was mechanically damaged. The actuation sear rod is absent from the unit with no witness marks or damage in the opening where the sear rod is normally installed. For further information see Engineering Investigation of Ejection and Aircrew Escape System Report enclosed with this report.

The IIC calculated, based on ejection seat performance data from Naval Air Training and Operating Procedures (NATOPS), and the accident airplane performance parameters as recorded on DFIRS, the pilot's lowest altitude to safely eject would have been approximately 320 feet agl or two seconds before impact.

The video tape recording system (VTRS) tape of the right DDI Flight Control system (FCS) page was recovered. The FCS page recording contained useful data until approximately 4 seconds before electrical power was lost at impact. The Head Up Display (HUD) VTRS was recovered but the tape was destroyed by the post-crash fire. No faults or flight control cautions were observed in reviewing the VTRS recording of the flight control page (FCP) in the right DDI.

Laboratory X-ray, wire ring-out, and functional tests of the flight control actuators (stabilator, aileron and rudder) indicated no anomalies. Examination of the leading edge flap (LEF) overtravel stops indicated the right wing LEF was 13 degrees down and the left wing LEF was 34 degrees down. Deployable Flight Incident Recorder Set (DFIRS) data indicated both left and right wing (inboard and outboard) LEF were fully extended at 32.5 degrees down. The video recording of the FCS page also indicated near max LEF extension (33 degrees) on both left and right LEF's.

The DFIRS did not deploy from the airplane and subsequently received extensive burn damage. The damage was too extensive to allow normal readout of the data at the MDA facilities. The DFIRS data was recovered by sending the damaged unit to the manufacturer for removal of memory chips and then returning the memory chips to MDA for readout. The airplane's data storage unit (DSU) was recovered and returned to the MDA facility for data recovery. Data was successfully read out from the airplane DFIRS and DSU. DFIRS data were recorded to within .5 to 1.5 seconds of electrical power loss at impact. The electronic data from the DFIRS, DSU and DDI FCP showed normal flight control operation with no faults or failures detected. For further information see Systems Group Chairman's report enclosed with this report.

The Defense Logistics Agency Contractor's Flight and Ground Operations manual specifies MDA Pilot minimum currency requirements of 35 hours flight time in the previous six months, and allows that fifty percent of the flight time required can be simulation time.

The pilot last flew an F/A-18, 19 days prior to the accident date. The pilot also flew five civilian airshows in a Pitts Special, within the last year, with the last airshow on June 8, 1996, 11 days before the accident date. For further information see Operations report enclosed with this report.

ADDITIONAL DATA

Parties to the investigation were the Federal Aviation Administration; MDA; Naval Safety Center; International Association of Machinists; and General Electric.

Following the on-scene portion of the investigation, the wreckage was released to a MDA representative on July 30, 1996.

*Due to limitations within the computer system the last digit of the aircraft Buno number could not be added to the Registration Number under Aircraft Information.

Use your browsers 'back' function to return to synopsis
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NTSB Identification: **CHI96FA211** . The docket is stored in the (offline) NTSB Imaging System.

Accident occurred Wednesday, June 19, 1996 at BETHALTO, IL
Aircraft:McDonnell Douglas F/A-18C, registration: N16518
Injuries: 1 Fatal.

A McDonnell Douglas Aerospace (MDA) pilot was flying a leased Navy F/A-18C and conducting an airshow practice at St. Louis Regional Airport when the airplane impacted the ground at the bottom of a reverse one-half Cuban eight aerobatic maneuver. The briefed altitude at the top of the maneuver was to be 3,500 feet above ground level (agl), which gave the pilot a base line of 1,000 feet agl. Recorded data showed that the actual altitude at the top of the maneuver was 2,280 feet agl. Using a group of F/A-18 pilots in a F/A-18 simulator, the lowest altitude at the top of the reverse one-half Cuban eight required to successfully complete the maneuver was 2,500 feet agl. The pilot had been trained as a Naval Aviator, and was a graduate of the Navy's test pilot school. He joined MDA Flight Operations 3/4/96. The pilot had accrued 16 hours in the F/A-18 in the last year, of which 11 hours were in the last 90 days. MDA did not have a formal training plan for their pilots who perform airshow demonstration flights. The pilot had flown 5 civilian airshows within the last year; the most recent was 11 days prior to the accident. All the airshows were flown in a Pitts Special.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.

the pilot's failure to follow the preflight crew briefing and attain a proper altitude during an aerobatic maneuver. Factors in the accident were: the pilot's previous experience of flying similar airshow routines in a different airplane with substantially different performance characteristics, and the company's failure to have a formal training plan for pilots performing airshow demonstration flights.

Full narrative available

Index for Jun1996 | Index of months

6/19/96

Scab plane crashes on test flight, kills pilot

by Fred Gaboury

This article was reprinted from the ***June 29, 1996*** *issue of the* ***People's Weekly World****. For subscription information see below.*

The effort by McDonnell Douglas to produce high-performance military aircraft behind Machinist union picket lines at its St. Louis facility resulted in the crash of a multi-million-dollar high performance Navy fighter plane and the death of its pilot on June 19. The plane, an F-18, costs between $38 and 63 million each, depending on equipment. The crash was but the latest in a series of setbacks suffered by the nation's fifth largest aerospace manufacturer in less than a week.

Earlier the City of St. Louis adopted a resolution calling upon MD to cease its practice of outsourcing jobs and the Missouri AFL-CIO launched a "Smack Mac Back" campaign to raise $2.5 million to support the families of MD strikers.

The strike began June 5 after 87 percent of the members of Machinists District 837 voted down a proposal allowing the company to continue the practice of outsourcing work to non-union plants and imposing additional costs of health insurance on union members.

Bates, a spokesperson for District 837 called MD's effort to continue production "insane and reckless. They have chosen a path that is fraught with peril," he told the *World*.

"You can't expect a foot doctor to do brain surgery," he said, "and there is no way McDonnell Douglas can produce these aircraft with unskilled workers, be they strike breakers from out-of-state or engineers and other salaried employees."

MD claimed that the F-18 involved in the fatal crash was built in February. But Bates said the plane underwent "complex modifications after it was built and that work was completed by supervisory personnel." He added that MD had attempted to cover up details of the crash and had assumed the lead role in the investigation until removed by the National Transportation Safety Board. "It was a classic example of the fox watching the chicken coop," he told the *World*.

Newspaper accounts of the strike report that MD had an inventory of nearly complete aircraft when the strike began and that the company planned a dozen test flights during the week beginning June 17.

Bates said strikers at the sprawling St. Louis facility were "high" over the decision of the Missouri AFL-CIO to organize a campaign to collect $5 each from the state's half-million members. "It shows the community of workers in action," he said.

Don Owens, Missouri AFL-CIO secretary treasurer, described the Smack Mac Back campaign as the way to "show our capability to win strikes - to show that strikers can prevail. We have to come together in order to keep a strike from going on forever," he said when interviewed in his office in Jefferson City.

Pointing out that MD, ranked second on the list of military contractors, is "dependent on tax dollars which belong to the American people," a June 14 resolution adopted by the St. Louis Board of Aldermen said that more than 5,000 machinists have lost their jobs at MD because "work once done here has moved to Finland and Switzerland; to Georgia and Arizona."

The resolution, introduced by Alderman Kenneth Jones, calls on MD "to stop its practice of outsourcing our workers' jobs" and upon President Bill Clinton "to use the power invested in his office to support the striking workers and their families."

08/20/1996

08/20/96

REQUEST 074/98, REPORT 58

PRELIMINARY REPORT	BELL HELICOPTER-214	ACCIDENT
EVENTS¦PHASES	FUEL SYSTEM FAILURE-MANOEUVRING	
	POWER LOSS-FIRST ENGINE-MANOEUVRING	
	COLLISION WITH TREE-EMERGENCY/UNCONTROLLED DESCENT	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 96/2702-0
FROM STATE : CANADA

DATE, TIME AND METEOROLOGICAL DATA

DATE : 96-07-28
TIME : 14:15
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY : 5701 - 27 000 KG
STATE OF REGISTRY : CANADA
REGISTRATION : C-FXNE

LOCATION

LOCATION : SALMON ARM,4 NM ENE
STATE/AREA : CANADA
DEPARTED : SALMON ARM
DESTINATION : SALMON ARM

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : SUBSTANTIAL

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	2	0	2
PAX :	0	0	0	0	0	0

NARRATIVE

THIS WAS THE SECOND TEST FLIGHT AFTER AN ENGINE CHANGE. ON THE FIRST FLIGHT THE PILOT COULD NOT GET THE DESIRED N2 SETTING, HOWEVER, THE LOW-FUEL WARNING LIGHT CAME ON, EVEN THOUGH THE GAUGE INDICATED 500 LB OF FUEL ON BOARD. THE PILOT RETURNED TO BASE FOR INVESTIGATION BUT NO FAULTS WERE FOUND. ON THIS FLIGHT THE N2 CHECK WAS SATISFACTORY. SHORTLY AFTER THE N2 TESTS, THE LEFT BOOST PUMP FAILED, FOLLOWED BY THE LOW-FUEL WARNING LIGHT ILLUMINATING. THE PILOT HAD JUST TURNED BACK TO THE LANDING AREA WHEN THE RIGHT BOOST PUMP ALSO FAILED. 30 SEC LATER THE ENGINE STOPPED. THE PILOT ENTERED AUTOROTATION AND TRIED TO LAND IN A SMALL CLEARING, BUT STRUCK TREES AND LANDED HARD.

REQUEST 074/98, REPORT 59

UNOFFICIAL REPORT	EH INDUSTRIES-EH 101 HELILINER	ACCIDENT
EVENTS¦PHASES	FLIGHT CONTROL SYSTEM FAILURE-CRUISE	
	HARD LANDING-LANDING	
	NOSE DOWN/OVERTURNED-LANDING	

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 96/0372-0
FROM STATE :

DATE, TIME AND METEOROLOGICAL DATA

DATE : 96-08-20
TIME : 00:00
LIGHT :
GEN WEATHER :

AIRCRAFT DATA

MASS CATEGORY :
STATE OF REGISTRY :
REGISTRATION :

LOCATION

LOCATION : MILAN MALPENSA
STATE/AREA : ITALY
DEPARTED :
DESTINATION :

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : SUBSTANTIAL

INJURY :	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW :	0	0	0	5	0	5
PAX :	0	0	0	0	0	0

NARRATIVE

AN EH-101 UNDERGOING TESTING WITH AGUSTA SUSTAINED SUBSTANTIAL DAMAGE. THE HELICOPTER WAS CHECKING PILOT AIRSPEED READINGS OVER LAKE MAGGIORE WHEN "CONTROL DIFFICULTIES" FORCED A DIVERSION TO MILAN MALPENSA WHERE IT TOUCHED DOWN HARD AND ROLLED ONTO ITS SIDE.

8/20/96

Northern Light

Defense Daily

Title: EH-101 flight operations suspended following mishap. *(EH-101 helicopter)*

Summary: A preproduction Westland/Agusta EH-101 helicopter, suffering from yaw control problems during performance trials, sustained serious damage during a precautionary landing at Malpensa International Airport in northern Italy August 20. 1996

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New Search

Source: Defense Daily
Date: Sept 3 1996
Price: $2.95
Document Size: Short (up to 2 pages)
Document ID: GG19970923010034197
Subject(s): Helicopter industry--Product development; Military helicopters--Testing
Citation Information: (v192 Start Page: p357(1) ISSN: 0889-0404
Author(s):
Document Type: Article

09/10/1996

FTW96LA380

On September 10, 1996, approximately 0850 mountain daylight time, a Bell UH-1H, N23Y, was destroyed during an intentional autorotation at Leadville, Colorado. The commercial pilot in command received minor injuries, and the airline transport rated-designated engineering representative (DER) sustained serious injuries. Visual meteorological conditions prevailed, and no flight plan was filed for the test flight that originated at Leadville on September 10, approximately 0830.

According to an FAA inspector, the crew was conducting high altitude flight tests pursuant to obtaining two STCs (Supplemental Type Certificates): SR000267, for the T53-L-703 engine installation, and SR00266SE, for the installation of a tractor tail rotor system from a Bell 205.

According to the Pilot/Operator Aircraft Accident Report, the pilot entered an autorotation from an altitude of 200 feet agl (above ground level) and at 8,000 pounds maximum gross weight. The maneuver was entered at 42 kias (knots indicated airspeed) with a one second delay before lowering the collective control. The pilot said he was unable to arrest the descent rate as the helicopter approached the runway at 40 knots. The helicopter struck the ground tail first.

A video camera was used to record the flight tests and showed impact occurring on the centerline of runway 34. The tail boom and both skids separated on impact, and the helicopter skidded on its fuselage for 370 feet before coming to a rest on the left side of the runway. The helicopter was equipped with a self sealing fuel system. There was no fire and minimal fuel spillage.

Further examination of the tape revealed the tail boom stinger struck the ground on at least two previous autorotations. According to one FAA helicopter operations inspector, this was indicative that the pilot was "outside the low end of the height-velocity curve." He said that "either there was insufficient airspeed for the altitude used, or there was insufficient altitude for the airspeed used."

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NTSB Identification: **FTW96LA380**. The docket is stored in the (offline) NTSB Imaging System.

Accident occurred SEP-10-96 at LEADVILLE, CO
Aircraft: Bell UH-1H, registration: N23Y
Injuries: 1 Serious, 1 Minor.

The helicopter crew was conducting high altitude flight tests pursuant to obtaining two Supplemental Type Certificates. From an altitude of 200 feet, and at 8,000 pounds gross weight, the pilot initiated an intentional autorotation at 42 knots with a one second delay before lowering the collective control. The pilot said he was unable to arrest the descent rate as the helicopter approached the runway at 40 knots. The helicopter was destroyed when it impacted the runway. A video camera was used to record the flight tests. A review of the tape disclosed that on at least two previous autorotations, the tail boom stinger struck the ground first. According to an FAA helicopter operations inspector, this was indicative that the pilot was "outside the low end of the height-velocity curve." He said that "either there was insufficient airspeed for the altitude used, or there was insufficient altitude for the airspeed used."

Probable Cause

The pilot's improper inflight planning/decision in that he used an inadequate airspeed or an inadequate altitude, or both, for the intentional autorotation.

~~GEAR~~

"FARM DEVELOPMENT CORP; BOISE MONT
REGISTERED OWNER

Full narrative available

+ cuer

Index for Sep 1996 | Index of Months □□□□□□□□□□□□

REQUEST 074/98, REPORT 60

DATA REPORT — BELL HELICOPTER-205A-1 — ACCIDENT

EVENTS¦PHASES — COLLISION WITH TERRAIN-LEVEL OFF/TOUCHDOWN

OPERATION

TYPE : MISCELLANEOUS - TEST/EXPERIMENTAL

FINAL REP

FILE DATA

ICAO FILE : 96/1064-0
FROM STATE : UNITED STATES

DATE, TIME AND METEOROLOGICAL DATA

DATE : 96-09-10
TIME : 08:50
LIGHT : DAYLIGHT
GEN WEATHER : VMC

AIRCRAFT DATA

MASS CATEGORY : 2250 - 5700 KG
STATE OF REGISTRY : UNITED STATES
REGISTRATION : N23Y

LOCATION

LOCATION : LEADVILLE,CO
STATE/AREA : UNITED STATES
DEPARTED : LEADVILLE,CO
DESTINATION : LEADVILLE,CO

DAMAGE, INJURY AND TOTAL ON BOARD

A/C DAMAGE : SUBSTANTIAL

INJURY	FATAL	SERIOUS	MINOR	NONE	UNKNOWN	TOTAL
CREW	0	1	1	0	0	2
PAX	0	0	0	0	0	0

NARRATIVE

THE CREW WAS CONDUCTING FLIGHT TESTS TO OBTAIN TWO SUPPLEMENTAL TYPE CERTIFICATES. FROM 200 FT AND AT 8,000 LBS GROSS WEIGHT, THE PILOT INITIATED AN INTENTIONAL AUTOROTATION AT 42 KT WITH A 1 SEC DELAY BEFORE LOWERING THE COLLECTIVE CONTROL. HE COULD NOT ARREST THE DESCENT RATE AS THE HELICOPTER APPROACHED THE RWY AT 40 KT. THE HELICOPTER WAS DESTROYED WHEN IT STRUCK THE RWY. A VIDEO CAMERA HAD BEEN USED TO RECORD THE FLIGHT TESTS AND IT SHOWED THAT ON AT LEAST TWO PREVIOUS AUTOROTATIONS, THE TAIL BOOM SKID STRUCK THE GROUND FIRST. THIS INDICATES THAT THE PILOT WAS OUTSIDE THE LOW END OF THE HEIGHT-VELOCITY ENVELOPE.

SEQUENCE OF EVENTS

EVENT 1 COLLISION WITH TERRAIN - LEVEL OFF/TOUCHDOWN
1.AUTOROTATION - INTENTIONAL
2.FLIGHT CREW DECISIONS - IMPROPER
3.AIRSPEED - INADEQUATE
4.ALTITUDE - INADEQUATE

NTSB AVIATION ACCIDENT/INCIDENT DATABASE REPORT
Report Number: FTW96LA380

General Information

Local Date:Time	09/10/1996:08:50 MDT
City/State	LEADVILLE, CO
Airport Name/ID	LAKE COUNTY/LXV
Event Type:	ACCIDENT
Injury Severity:	SERIOUS

Operations Information

Category of Operation:	GENERAL AVIATION
Aircraft Type:	HELICOPTER
Aircraft Damage:	SUBSTANTIAL
Phase of Flight:	570 LANDING
Aircraft Make/Model:	
Operator Doing Business As:	
Operator Name:	IDAHO HELICOPTERS, INC.
Operator Code:	GAKA
Operator:	IDAHO HELICOPTERS INC - GAKA
Owner Name:	FARM DEVELOPMENT CORP.

Narrative

THE HELICOPTER CREW WAS CONDUCTING HIGH ALTITUDE FLIGHT TEST S PURSUANT TO OBTAINING TWO SUPPLEMENTAL TYPE CERTIFICATES. FROM AN ALTITUDE OF 200 FEET, AND AT 8,000 POUNDS GROSS WEIGHT, THE PILOT INITIATED AN INTENTIONAL AUTOROTATION AT 42 KNOTS WITH A ONE SECOND DELAY BEFORE LOWERING THE COLLECTIVE CONTROL. THE PILOT SAID HE WAS UNABLE TO ARREST THE DESCENT RATE AS THE HELICOPTER APPROACHED THE RUNWAY AT 40 KNOTS. THE HELICOPTER WAS DESTROYED WHEN IT IMPACTED THE RUNWAY. A VIDEO CAMERA WAS USED TO RECORD THE FLIGHT TESTS. A REVIEW OF THE TAPE DISCLOSED THAT ON AT LEAST TWO PREVIOUS AUTOROTATIONS, THE TAIL BOOM STINGER STRUCK THE GRO UND FIRST. ACCORDING TO AN FAA HELICOPTER OPERATIONS INSPECTOR, THIS WAS INDICATIVE THAT THE PILOT WAS "OUTSIDE THE LOW END OF THE HEIGHT-VELOCITY CURVE." HE SAID THAT "EITHER THERE WAS INSUFFICIENT AIRSPEED FOR THE ALTITUDE USED, OR THERE WAS INSUFFICIENT ALTITUDE FOR THE AIRSPEED USED."

Probable Cause

THE PILOT'S IMPROPER INFLIGHT PLANNING/DECISION IN THAT HE USED AN INADEQUATE AIRSPEED OR AN INADEQUATE ALTITUDE, OR BOTH, FOR THE INTENTIONAL AUTOROTATION.

Aircraft Information

Number of Seats:	2
Aircraft Use:	
Type of Operation:	14 CFR 91
Registration Number:	23Y
Air Carrier Operating Certificates:	ON-DEMAND AIR TAXI

Aircraft Fire: NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	1	1	0
Pass	0	0	0	0
Other	0	0	0	0

Landing Gear: SKID
Certificated Maximum Gross Weight: 8500
Engine Make/Model: LYCOMING:T53-L-703
Number of Engines: 1
Engine Type: TURBO SHAFT

Environment/Operations Information
Basic Weather Conditions: VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg)/Speed (knots): 340/4
Visibility (sm): 30
Visibility RVR (ft): 0
Visibility RVV (sm): 0
Cloud Height Above Ground Level (ft): 0
Visibility Restrictions: NONE
Precipitation Type: NONE
Light Condition: DAYLIGHT
Departure Airport Id: LXV
Flight Plan Filed: COMPANY (VFR)
ATC Clearance: NONE
VFR Approach/Landing: SIMULATED FORCED LANDING
Event Location: ON AIRPORT

Pilot-in-Command
Certificates: COMMERCIAL
Ratings:
Plane: SINGLE ENGINE LAND, MULTIENGINE LAND
Non-Plane: HELICOPTER
Instrument: AIRPLANE, HELICOPTER
Had Current BFR:
Months Since Last BFR: 0
Medical Certificate: CLASS 2
Medical Certificate Validity: VALID MEDICAL-NO
WAIVERS/LIMITATIONS

Flight Time (Hours)

Total :	5032	Last 24 Hrs :	5
Make/Model :	1473	Last 30 Days:	21
Instrument :	214	Last 90 Days:	0
Multi-Engine:	310	Rotorcraft :	0

10/04/1996

10/4/96 ✓

SEA97FA001

HISTORY OF FLIGHT

On October 4, 1996, approximately 1215 hours Pacific daylight time, a Boeing Vertol BV-107 II, 196CH, registered to and operated by Columbia Helicopters, Inc., was destroyed when it collided with terrain following a loss of control in flight during cruise. The crash site was three miles east of the southern boundary of the Aurora airport (refer to CHART I). A post crash fire confined to the engine area was extinguished following the crash. Both pilots and the onboard mechanic were fatally injured. Visual meteorological conditions existed and no flight plan had been filed. The flight, which was a conformity maintenance check flight, was to have been operated under 14CFR91, and originated from the Aurora airport, Aurora, Oregon, at 1138.

Witnesses, many of whom were initially attracted by the unusual sounds from the rotorcraft, reported observing it maneuvering erratically in the vicinity of the accident site, and then tumbling out of control to ground impact. Specifically, one witness reported observing the rotorcraft's rotor blades impact one another. Another witness described the sound as like "metal hitting" and described the maneuvers as "flipping." Another witness reported seeing the rotorcraft flying "straight and level for three or four seconds before it went vertical." Several other witnesses observed the rotorcraft flying away from the Aurora airport approximately 30 minutes before the accident and then return during which they observed it "tumble" (refer to witness statements and attached FAA witness statement transcriptions).

A flight instructor on an instructional flight, who was taxiing out to runway 17 at the Aurora airport, reported that he "heard a helicopter make a position report" (this radio transmission occurred approximately 12:10). He could not recall what was said during the radio transmission but reported that "about 10-15 seconds later (he) heard a stuck mike on the radio with the same helicopter noise. This lasted about 10-15 seconds. Then the mike was un-keyed" (refer to attached statement).

PERSONNEL INFORMATION

PILOT-IN-COMMAND:

The pilot-in-command, who occupied the right seat in the cockpit, held an airline transport pilot certificate as well as a flight instructor's certificate. According to the operator, he had accrued a total of 14,778 hours of flight experience of which 11,841 were as pilot-in-command (PIC), and 14,668 hours were logged in rotorcraft. Additionally, he was reported to have logged 8,880 hours in the Boeing Vertol BV-107 rotorcraft of which 8,269 hours were as PIC. The PIC held a type rating in both the BV-107 and the BV-234 rotorcraft.

CO-PILOT:

The co-pilot, who occupied the left seat in the cockpit, held a commercial pilot certificate. According to the operator, he had accrued a total of 4,112 hours of flight experience of which more than 2,500 hours were as pilot-in-command (PIC) and 4,036 hours was logged in rotorcraft. Additionally, he was reported to have logged 2,449 hours in the Boeing Vertol BV-107 rotorcraft of which 1,809 hours were PIC. The co-pilot held a type rating in the BV-107 rotorcraft.

CREWMAN:

The crewman, whose location in the rotorcraft could not be determined, held an FAA airframe and powerplant mechanic certificate. According to the operator, he had been engaged in maintenance on the rotorcraft during its preparation for flight testing and, as was customary for the operator, was assigned to assist during the accident test flight.

AIRCRAFT INFORMATION

N196CH, serial number 407, was a Boeing manufactured derivative of the model 107 rotorcraft built for Sweden as a model HKP-4, and which had been acquired by Columbia Helicopters, Inc., to be converted to a civil model BV-107-II in accordance with FAA Project Number TDO639NY-R. The rotorcraft had a total of 7,073.0 hours of airframe time at the time its "experimental" certification was approved on August 5, 1996. And, on October 2, 1996, the rotorcraft was issued a maintenance release for its first conformity test flight.

On October 3, 1996, N196CH, was flown for 1.4 hours, including four landing, from the operator's base at the Aurora airport.

1715

On October 4, 1996, N196CH, departed the Aurora airport at 1138 hours on its second test flight (refer to photograph 1 which shows the accident aircraft departing on the accident flight). The aircraft had departed with 1,800 pounds of Jet A fuel.

WRECKAGE AND IMPACT INFORMATION

The aircraft crashed in an open, plowed, agricultural field. The latitude and longitude of the crash site (point A on DIAGRAM I) was 45 degrees 13.52 minutes North and 122 degrees 42.73 minutes West, respectively. The elevation of the site was approximately 175 feet above mean sea level (MSL) (refer to CHART II). The majority of the airframe came to rest in four major sections (refer to SCHEMATIC I, DIAGRAM I and photograph 2). The forward fuselage (including the cockpit) and forward pylon/rotor head assembly (section A) was observed to be furthest west. This section came to rest with its longitudinal axis oriented along a 223/043 degree magnetic bearing line (nose towards the southwest)(refer to photograph 3). The center cabin area (section B) was located slightly east and adjacent to the aft lower fuselage section containing both engines (section C)(refer to photograph 4). The aft pylon and rotor head assembly (section D), which came to rest furthest to the east lay approximately 75 feet from the forward cabin area (refer to photograph 5). These four major sections of the rotorcraft lay along an approximate 270/090 degree magnetic bearing line.

The forward rotor head assembly remained attached to the forward airframe (section A) at its pylon. All three fiberglass rotor blades (red, yellow and green) remained attached to the rotor hub (refer to photographs 6 and 7). However, the blades displayed shattering damage towards their outboard sections and tips. The aft rotor head assembly remained attached to the aft pylon (section D). The aft pylon separated from the fuselage. Again, all three fiberglass rotor blades (red, yellow and green) remained attached to the rotor hub (refer to photograph 5). Again, the blades displayed shattering damage towards their outboard sections and tips.

The synchronization drive shaft, which consists of five successive tubes connecting the forward and aft transmission units, was examined at the site. Shaft numbers four and five (aluminum and steel respectively) were found connected together with the aft end of shaft five attached to the aft transmission unit (refer to photograph 8). Shaft numbers one and two (aluminum) were found connected together with the forward end of shaft one attached to the forward transmission unit. The number two synchronization shaft was observed to be broken at its midpoint and the aft end of this shaft as well as the entire shaft number three were not found within the main wreckage (refer to photograph 9). The entire number three synchronization shaft (aluminum) was located lying in the field approximately 90 feet and 159 degrees magnetic from the forward cabin (section A)(refer to DIAGRAM I and photograph 4). The coupling at each end was absent and the rivets, some of which remained in the shaft, exhibited flush smearing consistent with rotational or longitudinal overload. Additionally, a diagonal impact near the forward end of shaft number three was observed. The impact was consistent with a rotor blade outboard leading edge impact (refer to photograph 10). The aft 40% of the number two shaft was located lying in an adjacent field (refer to photograph 11) bearing approximately 133 feet and 87 degrees magnetic from the number three shaft (refer to DIAGRAM I). A number of smaller aluminum fragments of drive shaft were recovered from the site and these, along with the aft number two shaft section and number three shaft were reassembled at the reconstruction site. The separation at the approximate midpoint of the number two drive shaft was consistent with a rotor blade strike and there was no evidence of any disconnect of the drive shaft prior to the blade strike.

Numerous small fragments of rotor blades, fuselage skin, and fiberglass were observed to be distributed over an area extending 1,400 feet. The general distribution (magnetic track) of the fragments was found to lie along an approximate 004 degree bearing line with many of the smaller fragments having fallen into a filbert orchard north and east of the crash site (refer to CHART II). The size and weight of fragments gradually increased approaching the crash site, with the lightest fragments most distant.

Both the forward and aft pylon and rotor head controls, as well as the control cables and rods within the tunnel connecting the rotor heads, were examined at the site. No evidence of any pre-impact disconnect was found. The engines were observed to have remained within the aft fuselage (section C) which had sustained a post crash fire.

The wreckage was recovered and transported to an indoor facility several miles away for partial reconstruction. During the recovery process it was noted that the right side of the forward cabin/cockpit area, including the main cabin entry and the flight control closet area, which houses much of the rotorcraft's control linkages, was substantially crushed inward (refer to photograph 12).

MEDICAL AND PATHOLOGICAL INFORMATION

Post mortem examination of the pilot-in-command, co-pilot, and crewman, was conducted by Clifford C. Nelson, M.D., at the Offices of the Oregon State Medical Examiner, 301 NE Knot Street, Portland, Oregon, on October 5, 1996. Toxicological evaluation of samples from all three crewmen was conducted by the FAA's Toxicology and Accident Research Laboratory, Mike Monroney Aeronautical Center, P.O. Box 25082, Oklahoma City, Oklahoma. The resultant tests were found to be negative in all three crewmen (refer to attached Toxicology reports).

OFF SITE EXAMINATION AND RECONSTRUCTION

During the off-site wreckage reconstruction phase, the rotorcraft's two General Electric CT58-140-1 turboshaft engines were examined. Examination of the power turbine rotor blades of both left and right engines revealed uniform tip curl opposite to the direction of rotation. Additionally, there was no evidence of any uncontained ejection of engine components from either engine casing.

The forward and aft rotor blades, which had been removed from their respective rotor heads at the site, were reassembled with their associated fragments at the reconstruction site. There was no evidence of any pre-accident inflight loss of components/sections of any of the six rotor blades.

The flight control continuity check of the forward cabin/cockpit area, including the flight control closet area, was continued at the reconstruction site. It was necessary to cut away the external airframe skin in order to access this area. Once accomplished, many of the flight control rods were observed to display evidence of bending deformation, separations characteristic of impact overload, and scratching and paint abrasions (refer to photograph 13).

During the examination and disassembly of the flight control closet, a disconnect was noted at the point where the lower bearing end of the "aft directional and lateral" output pushrod connects to the inboard clevis of the bellcrank within the forward section of the mixing unit (refer DIAGRAM II and photographs 14 and 15). The bolt specified for this installation, a AN (Air Force - Navy aeronautical standard) 464, was absent, as was the nut, washers and cotter key.

The mixing unit was removed from the flight control closet as was the disconnected "aft directional and lateral" output pushrod, and both components were examined more closely (refer to photographs 16 and 17). The pushrod displayed some minor bending deformation and longitudinal scratches of its painted surface. Additionally, there was no evidence of any significant mechanical damage in the pushrod's inner bushing end characteristic of impact deformation against a threaded bolt. However, the opposing "forward directional and lateral" output pushrod, as well as the "aft collective pitch and longitudinal" output pushrod, both of whose lower bearing ends remained attached to the mixing unit, were broken (refer to photographs 16 and 17 and DIAGRAM II). The "forward collective pitch and longitudinal" output pushrod, which remained attached at both ends, to both the mixing unit and the collective pitch and longitudinal input bellcrank, was unbroken but exhibited extensive scratching and bending deformation (refer to photographs 16 and 17 and DIAGRAM VI).

The forward mixing unit section, including the disconnected bellcrank was separated from the entire mixing unit assembly, cleaned with solvent, and examined, as was the pushrod, (refer to photograph 18). It was determined that this bellcrank, P/N 107C2606-8 (refer to photograph 19), was in fact, a collective bellcrank which had been installed in the forward (lateral portion) of the mixing unit, and not the lateral bellcrank, P/N 107C2606-9, called for in Boeing Drawing 107C2606 (refer to DIAGRAMS III, IV, V). A correctly installed collective bellcrank, P/N 107C2606-8, was found to be installed in the aft (collective portion) of the mixing unit, as called for in Boeing Drawing. Note: P/N 107C2606-8 (aluminum) is equivalent dimensionally to P/N 107C2606-1 (magnesium) as detailed in both the Illustrated Parts Catalogue and Boeing Drawing 107C2606. The same applies to P/N 107C2606-9 (aluminum) and P/N 107C2606-2 (magnesium).

The forward cabin/cockpit area, including the flight control closet, was subsequently re-examined for any loose hardware (bolts or nuts) which might have been the disconnected AN464 bolt. A bolt matching the type used to attach the remaining three output pushrods was discovered loose in the flight control closet area. No matching nut was found.

Discussions with the operator and Boeing Vertol indicated that a disconnect of the aft directional and lateral pushrod at the mixing unit would render the aft rotor head incapable of receiving cockpit issued lateral and directional control inputs. The forward rotor head would continue to receive such control inputs thereby creating a control force differential between the two rotor heads (refer to DIAGRAM VI).

TESTS AND RESEARCH

The bellcrank (P/N 107C2606-8) removed from the forward mixing unit, along with both the connected forward and disconnected aft lateral pushrods, and the loose bolt, were hand carried to the Safety Board's Materials Laboratory Division for further examination (refer to photograph 19). Examination of the components was conducted on February 27, 1997 (refer to attached Metallurgist's factual report).

The lower ends of both the (disconnected) aft directional and lateral pushrod, P/N 107C2551-13, and the (connected) forward directional and lateral pushrod, P/N 107C2551-11, control rods during normal assembly are fastened to the forward mixing unit bellcrank, P/N 107C2606-9 by bolts through the clevis tangs and the rod end bearings on each control rod. These bolts are shown in the illustrated parts catalog and assembly drawing as being inserted from the forward (cockpit) side of the bellcrank and secured with a castellated nut and cotter pin on the aft (tail) side. The required fastening hardware includes a NAS 464-4-17 bolt, three AN1 960 washers, (two thick -416, one thin -416L), an AN 320-4 or MS2 17826-4 castellated nut and an AN 381 cotter pin. The bolt passes through a NAS 75-4-010 sliding bushing installed in the forward tang of the clevis and an NAS 77-4-23 flanged bushing inserted into the aft tang. The flanged bushing is shown installed with the flange on the inside of the clevis. The required buildup of exemplar fastening components is shown in figure 2 (metallurgist's factual report). The bushings were found in place in the bellcrank at the accident reconstruction site (refer to photographs 20 and 21) but removed prior to the metallurgy examination.

The bolt suspected of having come from the left clevis connection had head markings identifying it as a NAS 464 close tolerance shank bolt. It had a shank diameter of approximately 0.25 inches, a grip length of 1.06 inches and an overall shank length of 1.41 inches. The bolt was plated with what appeared to be conversion coated cadmium except on the shank and washer flat surface. The dimensions and surface finish were consistent with a NAS 464-4-17 bolt. The bolt had a nearly identical appearance and dimensions to the NAS 464 bolt removed from the right clevis of the bellcrank. The bolt suspected of coming from the left clevis connection along with the right clevis bolt and the exemplar buildup are displayed in figure 3 (metallurgist's factual report).

The right clevis bolt was received with two thin "-416L" washers installed (see arrow, figure 3 metallurgist's factual report). The measured overall width of the clevis (P/N 107C2606-8) between the outer surfaces of the tangs (including the paint layer) was 1.075 inches. The specified overall width of this examined clevis (P/N 107C2606-8) between the outer surfaces of the tangs (excluding the paint layer) was 1.062 inches whereas the specified overall width of the clevis called for in the illustrated parts catalogue (P/N 107C2606-9) between the outer surfaces of the tangs (excluding the paint layer) was 0.960 inches (refer to DIAGRAMS II, IV, and V).

Based on calculations using measurements from the exemplar parts, the bolt suspected of coming from the left clevis would not be long enough to allow the cotter pin to be properly inserted through the nut and bolt using the required arrangement of washers (as shown in figure 3, metallurgist's factual report). However, when only two thin washers are used, like that found for the right clevis assembly, the cotter pin can be inserted. To verify the calculations, trial assemblies were performed using the required arrangement of washers and one using only two thin washers. Figure 4 (metallurgist's factual report) shows the two assembly configurations assembled on the right clevis. As can be seen, the cotter pin hole is only exposed when two thin washers were used. With the thick washer assembly the cotter pin hole was not exposed (hidden by the unslotted portion of the nut) and a cotter pin could not be inserted to safety the nut.

The shank of the bolt suspected of coming from the left clevis connection showed a fine circumferential grinding pattern typical of original manufacture. In addition, three narrow circumferential contact marks were noted on one side of the shank at positions approximately 0.1, 0.69 and 0.88 inches from the underside of the head. The opposite side of the shank was marked by a small band of shallow longitudinal scratches. Both the contact patterns and longitudinal scratches were characteristic of a bolt which had been used in an assembly.

Examination of the bolt threads with a stereo microscope found light circumferential scoring on both the pressure and non pressure flanks of the threads in the area of bracket "A", figure 5 (metallurgist's factual report). A few areas of intermittent light scratching were noted on the threads between the cotter pin hole and the shank in the area of bracket "B" in figure 5 (metallurgist's factual report), but none extended completely around the bolt. A few thread crowns adjacent to the shank were mechanically damaged and deformed on the pressure flanks. The cotter pin hole had an as manufactured appearance with no scratches, gouges or scoring characteristic of contact with a cotter pin.

In comparison, the bolt removed from the right bellcrank clevis showed a continuous scoring pattern of both the thread flanks between the cotter pin hole and the bolt end, in the area of bracket "C", figure 5 (metallurgist's factual report). The threads between the cotter pin hole and the shank, bracket "D" in figure 5 (metallurgist's factual report), were heavily marked on the pressure flanks consistent with contact by nut threads. The cotter pin hole for this bolt showed two prominent score marks for the full length of the bore surface. The unmarked arrow in figure 5 (metallurgist's factual report) denotes the location of one of the score marks. The scores were at diametrically opposed locations in the bore, aligned perpendicular with the longitudinal axis of the bolt and consistent with insertion or removal of a cotter pin.

The surfaces of the tangs for both the right and left clevises were optically compared in the area of the bushings and holes. Figures 6 and 7 (metallurgist's factual report) show the forward and aft faces of the bellcrank, respectively, with the bolts removed. The paint around the bushing on the forward face of the right clevis was cracked and disturbed in a circular pattern consistent with contact by a circular object, see arrow "A" in figure 6 (metallurgist's factual report). The circle of disturbed paint was about 0.5 inches in diameter. The AN 960 washers used in the assembly have an approximately 0.5 inch outer diameter. On the forward face of the left clevis the paint was cracked and appeared to have been lifted from the surface around the hole (bushing had been removed) in a circular area, see arrow "B" in figure 6 (metallurgist's factual report). The damaged paint was not tightly attached to the bellcrank surface and could be easily removed.

Circular impression ridges of paint were visible encircling both clevis holes on the aft surfaces of the bellcrank. Light scratch patterns in the paint within each impression were consistent with contact with a circular object. The aft face of the bellcrank is shown in figure 7 (metallurgist's factual report) with arrows denoting the circular paint impressions.

The inside faces of the left clevis were mostly devoid of surface marking except for a small raised paint ridge on the face of the flanged bushing. In contrast, the inside faces of the right clevis showed a prominent circular contact area on the face of the flanged bushing and cracked paint on the surface of the sliding bushing. A comparison of the markings on the flanged side of the bushings from the left and right clevis is shown in figure 8 (metallurgist's factual report).

During examinations it was noted that the inner diameter of the sliding bushing from the left clevis was greater than the sliding bushing in the right clevis and the exemplar bushing, see figure 9 (metallurgist's factual report). NAS 75-4 bushings have a 0.25 inch nominal inner diameter (ID). The left sliding bushing ID measured 0.27 inches. All other bushings had a nominal 0.25 inch ID. The right clevis and exemplar bushings were also chamfered at the ID, as indicated by arrow in figure 9 (metallurgist's factual report), and the left bushing was not.

Optical examination of the left control arm lower rod end bearing uncovered a dent in the bearing shield. The dent, shown in figure 10 (metallurgist's factual report), was consistent with over travel contact with the bearing ball.

ADDITIONAL INFORMATION

On-site examination and investigation commenced on the evening of October 4 and continued through October 12,1996, after which the wreckage was released to the owner/operator. A number of components were retained for further metallurgical examination and returned June 26, 1997, as documented on the attached "receipt of aircraft parts" (NTSB Form 6120.15).

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NTSB Identification: SEA97FA001 . The docket is stored in the (offline) NTSB Imaging System.

Accident occurred Friday, October 04, 1996 at CANBY, OR
Aircraft:BOEING VERTOL BV-107 II, registration: N196CH
Injuries: 3 Fatal.

The Boeing Model BV-107-II departed on a maintenance check flight with 1.4 hrs total flight time after conversion from a Model HKP-4 per FAA Project #TDO639NY-R. About 37 min later, witnesses saw the rotorcraft moving erratically & tumbling out of control. Postcrash exam of the rotorcraft's flight control system revealed a disconnect between the lower bearing end of the aft directional and lateral control pushrod & the inboard clevis of the forward mixing unit section bellcrank. A bolt, consistent with hardware for that connection, was found in the control closet area. An improper part (collective bellcrank, PN 107C2606-8) was found in place of the required lateral bellcrank (PN 107C2606-9). Clevis width of the -8 part was slightly larger than the -9 part; thus, the clevis bolt was not long enough to allow a cotter pin to be properly installed through the nut & bolt with the required washers (2 thick & 1 thin) installed. To compensate (allow for installation of the cotter pin), 2 thin washers were used in place of the 2 thick and 1 thin washers. Metallurgical exam of the bolt revealed evidence that a nut had been applied to the threaded end, but there was no evidence that a cotter pin had been inserted. No pre-accident engine malfunction or crew impairment was evident.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.

failure of maintenance personnel to install a cotter pin in a clevis bolt in the flight control system, which resulted in the aft directional and lateral control output pushrod to become disconnected from a bellcrank in the forward portion of the first stage mixing unit. A factor relating to the accident was the use of an improper bellcrank, which was wider in the clevis area.

Full narrative available

Index for Oct1996 | Index of months

09/21/1996

FTW96LA395

On September 21, 1996, at 1425 central daylight time, a Bell 407 helicopter, N1114S, registered to and operated by Bell Helicopter Textron Inc., as a Title 14 CFR Part 91 maintenance test flight, was substantially damaged during a forced landing near Kerrville, Texas. Visual meteorological conditions prevailed, and a flight plan was not filed for the local flight. The commercial pilot and one passenger were seriously injured, and the other passenger was not injured. The flight departed Kerrville on a local test flight, about 20 minutes prior to the accident.

According to the operator, the helicopter departed the Bell Helicopter plant in Fort Worth, Texas, the day prior to the accident. The helicopter was being ferried to South America, and was en route to Kerrville, Texas, for it's first fueling stop. When the flight was 20 minutes from Kerrville, after flying through a light rain, the RESTART FAULT light illuminated on the caution and warning light panel. The flight continued to Kerrville, and landed without further incident.

The pilot reported that he elected to troubleshoot the discrepancy prior to engine shut down. He increased and decreased the throttle from idle to 100% Nr in the Full Authority Digital Electronic Control (FADEC) AUTO mode with no anomalies noted. The FADEC was switched from the AUTO mode to MANUAL mode, and all engine indications were normal. He then increased the throttle from idle to 75% Nr and back to idle with no anomalies noted. He repeated this procedure, going to 85% Nr the second time and then back to idle. With the throttle at idle, the FADEC was switched from the MANUAL mode to the AUTO mode. The FADEC warning horn sounded, and the engine began to accelerate at a rate he did not feel comfortable with so the FADEC was switched back to the MANUAL mode. This procedure was repeated with the same results, so he shut the engine down. Maintenance was performed on the helicopter to correct moisture in the Hydromechanical Unit (HMU) P4 connector, and the HMU and Electronic Control Unit (ECU) J1 and J2 connectors that were found loose at the engine firewall.

The pilot further reported that the day of the accident he "motored the engine and parked the piston." The helicopter's engine was started and ground run two times with all systems normal. A 10 minute test flight was performed and no discrepancies were noted. While returning from the test flight, during the approach to Kerrville Airport, at 300 feet AGL, in a right turn, approximately 60 knots, he noted the FADEC FAIL (red) light and warning horn. He did not hear the Engine Out or Low Rotor warning horns. The AUTO RELIGHT, FADEC FAULT and ENGINE OUT caution lights were noted. The rotor RPM was between 90% and 95% and the Np was decreasing through 60%. During the autorotation, to avoid trees and houses, he extended the glide by increasing collective pitch. After clearing the obstacles, he leveled the helicopter and "used all remaining collective for landing." The helicopter "landed hard and remained upright."

According to the Bell 407 Rotorcraft Flight Manual, when the FADEC FAIL warning light illuminates in flight, the pilot should accomplish the FADEC FAILURE procedure as prescribed in paragraph 3-3-K. The procedure is, immediately retard the throttle and hold it to the 90% throttle bezel position; maintain Nr (rotor) with collective only; depress the FADEC MODE switch one time regardless of switch indication, FADEC will switch to MANUAL mode 2 to 7 seconds after this action if it is not already in manual mode; maintain Nr 95% to 100% with throttle and collective; land as soon as possible, and perform a normal shutdown if possible. There is a warning that 2 to 7 seconds after the FADEC FAIL warnings, FADEC may be in MANUAL mode without any pilot action. Nr may increase very rapidly and overspeed to 110% which will result in an engine flameout unless the pilot takes immediate manual control of the FADEC with the throttle. See the enclosed excerpts from the flight manual.

Examination of the helicopter by the FAA inspector at the accident site revealed that, the left skid was buckled, and the right skid was partially separated. The lower right forward portion of the fuselage was damaged, and the fuselage at the tailboom attaching point was buckled. One main rotor blade sustained damaged in the area of the trim tab. The battery was connected and it was verified that the "auto light" was on. The throttle position in the cockpit was found open approximately 80 degrees.

An examination of the FADEC system was completed on September 26, 1996, under the supervision of the investigator-in-charge at the Bell Textron plant in Fort Worth, Texas. With a notebook computer connected to the FADEC download port, the wiring harness from the ECU to the HMU was flexed by hand. It was found that when the aft portion of the harness from the forward firewall to the HMU was flexed by hand near the HMU connector, the voltage from the HMU metering valve position sending pot became erratic. The harness was disconnected from the ECU; the FADEC warning horn sounded and the FADEC FAIL warning light illuminated. The harness was removed and an insulation resistance check was performed using a high voltage tester (Megger). The test revealed that the pin N on the HMU end of the harness indicated a low resistance to the connector back shell (approximately 10,000 Ohms). This aft HMU harness, P/N 23062796, S/N NX0020 was sent to Simmonds Precision for a detailed examination. The HMU and ECU were removed and sent to Chandler Evans Corporation for further examination. The engine was removed and sent to Allison Engine Company for examination. See the enclosed report from Bell Helicopter and the excerpts from the Allison report for further details of the aircraft examination.

The examination of the engine, HMU, and ECU revealed that they performed within the manufacturer's specifications. The examination of the aft HMU harness revealed a manufacturing defect. See the detailed reports of these examinations which are in the enclosed excerpts from the Allison Engine Company report.

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9/21/96

NTSB AVIATION ACCIDENT/INCIDENT DATABASE REPORT
Report Number: FTW96LA395

General Information

Local Date:	09/21/1996
Local Time:	14:25 CDT
City:State	KERRVILLE:TX
Airport Name:ID	
Event Type:	ACCIDENT
Injury Severity:	SERIOUS
Report Status:	FINAL

Operations Information

Category of Operation:	GENERAL AVIATION
Aircraft Type:	HELICOPTER
Aircraft Damage:	SUBSTANTIAL
Phase of Flight:	000 NOT REPORTED
Aircraft Make/Model:	BELL BHT-407-XXX
Operator Doing Business As:	
Operator Name:Code	
Operator:	
Owner Name:	BELL HELICOPTER TEXTRON INC.

Narrative

DURING THE DAY PRIOR TO THE ACCIDENT, WHEN THE FLIGHT WAS 20 MINUTES FROM KERRVILLE AFTER FLYING THROUGH A LIGHT RAIN, THE RESTART FAULT LIGHT ILLUMINATED ON THE CAUTION AND WARNI NG LIGHT PANEL. THE FLIGHT CONTINUED TO KERRVILLE AND LANDED WITHOUT FURTHER INCIDENT. MAINTENANCE WAS PERFORMED TO CORRECT THE DEFICIENCIES. ON THE DAY OF THE ACCIDENT, THE HELICOPTER'S ENGINE WAS STARTED AND GROUND RUN TWO TIMES WITH ALL SYSTEMS NORMAL. A 10 MINUTE TEST FLIGHT WAS PERFORMED AND NO DISCREPANCIES WERE NOTED. DURING THE APPRO ACH TO KERRVILLE AIRPORT, AT 300 FEET AGL, IN A RIGHT TURN, APPROXIMATELY 60 KNOTS, THE PILOT NOTED THE FADEC FAIL LIGHT AND WARNING HORN. DURING THE AUTOROTATION, TO AVOID TREES AND HOUSES, HE EXTENDED THE GLIDE BY INCREASING COLLECTIVE P ITCH. AFTER CLEARING THE OBSTACLES, HE LEVELED THE HELICOPTER AND "USED ALL REMAINING COLLECTIVE FOR LANDING." THE HELICOPTER "LANDED HARD AND REMAINED UPRIGHT." THE PILOT DID NOT PERFORM THE EMERGENCY PROCEDURE FOR A FADEC FA IL WARNING LIGHT AS PRESCRIBED BY THE BELL 407 ROTORCRAFT FLIGHT MANUAL. AN EXAMINATION OF THE HMU HARNESS REVEALED A MANUFACTURING DEFECT.

Sequence of Events

Probable Cause

THE LOSS OF POWER DUE TO THE PILOT'S FAILURE TO COMPLY WITH ESTABLISHED PROCEDURES. FACTORS WERE A SHORT IN THE FADEC WIRING HARNESS DUE TO A MANUFACTURING DEFECT, AND THE LACK OF SUITABLE TERRAIN FOR THE FORCED LANDING.

Aircraft Information

Number of Seats:	7
Aircraft Use:	
Type of Operation:	14 CFR 91
Domestic/International:	
Passenger/Cargo:	
Registration Number:	1114S
Air Carrier Operating Certificates:	
Aircraft Fire:	NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	1	0	0
Pass	0	1	0	1
Other	0	0	0	0

Landing Gear:	SKID
Certificated Maximum Gross Weight:	5000
Engine Make:	ALLISON
Engine Model:	250C47B
Number of Engines:	1
Engine Type:	TURBO SHAFT

Environment/Operations Information

Basic Weather Conditions:	VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg):Speed (knots)	0:5
Visibility (sm):	5
Visibility RVR (ft):	0
Visibility RVV (sm):	0
Cloud Height Above Ground Level (ft):	1500
Visibility Restrictions:	NONE
Precipitation Type:	NONE
Light Condition:	DAYLIGHT
Departure Airport Id:	ERV
Departure City:State	
Destination Airport Id:	
Destination City:State	
Flight Plan Filed:	NONE
ATC Clearance:	NONE
VFR Approach/Landing:	FORCED LANDING
Event Location:	OFF AIRPORT/AIRSTRIP

11/04/1996

11/4/96

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 19961104034519G

General Information

Local Date:	11/04/1996
Local Time:	08:23
City:	FLAGSTAFF
State:	AZ
Airport Name:	
Airport Id:	

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight:	ROLL-OUT (FIXED WING)
Aircraft Make/Model:	HUGHES HU-369-FF
Airframe Hours:	
Operator Code:	
Operator:	
Owner Name:	

Narrative

NARRATIVE: WHILE PERFORMING FLIGHT TESTS ON A PROTO-TYPE MD630N AT FLAGSTAFF AIRPORT, FLAGSTAFF, ARIZONA, THE PILOT ENTERED THE NINTH (9TH) AUTO-ROTATION OF THE DAY AND MADE AN AUTO-ROTATION RUNNING TOUCH-DOWN ON A PAVED SURFACE. AS THE HELICOPTER'S MAIN ROTOR RPM DECAYED WITH THE VEHICLE STILL SLIDING. (200 FT. APPROX.) AND HAVING FORWARD GROUND SPEED, THE MAIN ROTOR BLADES DIVERTED AFT AND CONTACTED THE NOTAM TAIL CONE SEVERING IT FROM THE FUSELAGE APPROX. SIXTY PERCENT AFT OF FUSELAGE ATTACHING POINTS. THE HELICOPTER CONTINUED SLIDING FORWARD SLOWING DOWN DRAGGING THE SEVERED TAIL SECTION AND MAKING A 180 DEGREE TURN COMING TO REST ON THE RUNWAY. THE SOLE OCCUPANT, THE TEST PILOT, WAS NOT INJURED AND THE HELICOPTER SUSTAINED MINOR DAMAGE. THIS REPORT IS CLOSED. THIS REPORT DOES NOT INVOLVE AN NMAC REPORT. FAA FORM 8020-11 NOT RECEIVED FROM AT. THIS DOES NOT INVOLVE A PILOT DEVIATION REPORT BY AT.

Detail

Primary Flight Type:	OTHER
Secondary Flight Type:	TEST FLIGHT
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	630N
Total Aboard:	1
Fatalities:	0

Injuries:	0
Landing Gear:	
Aircraft Weight Class:	UNDER 12501 LBS
Engine Make:	
Engine Model:	
Engine Group:	
Number of Engines:	1
Engine Type:	

Environmental/Operations Information

Primary Flight Conditions:	VISUAL FLIGHT RULES
Secondary Flight Conditions:	WEATHER NOT A FACTOR
Wind Direction (deg):	
Wind Speed (mph):	
Visibility (mi):	10
Visibility Restrictions:	
Light Condition:	DAY
Flight Plan Filed:	NONE
Approach Type:	

Pilot-in-Command

Pilot Certificates:	AIRLINE TRANSPORT
Pilot Rating:	AIRPLANE SINGLE, MULTI-ENGINE LAND
Pilot Qualification:	QUALIFIED

Flight Time (Hours)
Total Hours:
Total in Make/Model:
Total Last 90 Days:
Total Last 90 Days Make/Model:

LAX97LA034

On November 4, 1996, at 0823 hours mountain standard time, the pilot of a McDonnell Douglas MD-600 (NOTAR) experimental helicopter, N630N, experienced a tail boom separation during a landing at Flagstaff, Arizona. Visual meteorological conditions existed at the time and no flight plan was filed for the local test flight. The aircraft was substantially damaged and the pilot was not injured. The aircraft is owned and operated by McDonnell Douglas Helicopter in Mesa, Arizona, and was being operated under an experimental certificate. The six-bladed main rotor helicopter can seat six to seven persons and is equipped with a 600-shaft horsepower engine.

This was a recertification flight test and the pilot was performing a series of height velocity landings. The helicopter was being flown at 4,100 pounds maximum gross weight and was being monitored by onboard instrumentation and telemetry. The pilot indicated this was the 10th landing in the test profile. With a target data entry point of 60 knots indicated airspeed and an altitude of 15 feet, the aircraft touched down at 30 knots. During the 3.5 second and 200-foot slide on the skids, he felt the aircraft shudder, followed by a separation of the tail boom from contact with the main rotor blades. The winds were from 210 degrees at 2 knots and the runway was dry. The pilot reported no mechanical malfunctions or problems with the aircraft prior to the accident.

A videotape of the accident sequence was taken by McDonnell Douglas (MD) ground personnel. The tape indicated a normal autorotative approach and touchdown. During the slide down the runway, the main rotor blades contacted the tail boom and severed it. The aircraft came to a full stop and the pilot exited the aircraft.

Recorded engineering test data indicated the aircraft touched down at 1.5 g's with a 2.6 foot per second rate of descent. The position of the collective control during the landing and the ground slide was at near the 100 percent up position at touchdown and during the ground slide.

In a discussion with MD test engineers, they described the main rotor blade contact with the tail boom as to have been a result of forward velocity and low/decaying main rotor rpm (advanced ratio) due to a full up collective position during the ground run out phase following the autorotative touchdown. In the condition of a high advance ratio, due to the low/decaying main rotor rpm and forward speed, a "blowback" of the main rotor disk occurs. They described this condition as the forward portion of the main rotor disk being displaced upward, while the rear portion of the disk displaces downward. This "blowback" condition is compounded by the high angle pitch setting which causes blade stall over a large portion of the rotor disk. This resulted in an excessive "blowback" that quickly allows tail boom contact by the main rotor blades.

In a further discussion with the MD engineers, they explained that this "blowback" condition exists in all helicopters, but is more apparent in this model due a greater gross weight, reduced flare/deceleration capabilities because of tail boom length and installation angle, and the increased surface of the additional main rotor blade resulting in a more rapid decay of main rotor rpm. McDonnell Douglas Helicopter Company has claimed an exemption from public disclosure of the engineering test data and the video associated with this accident as proprietary and confidential information.

Use your browsers 'back' function to return to synopsis
Return to Query Page

NTSB Identification: **LAX97LA034** . The docket is stored in the (offline) NTSB Imaging System.

Accident occurred Monday, November 04, 1996 at FLAGSTAFF, AZ
Aircraft:McDonnell Douglas MD-600, registration: N630N
Injuries: 1 Uninjured.

The test pilot made a successful preplanned autorotation to a runway in the test helicopter for certification purposes. The aircraft was operated at a designed maximum gross weight to establish a height velocity curve for future operations in high density altitudes. During the ground slide, the main rotor blades contacted and severed the tail boom. Various combinations of engineering design and the 'blowback' phenomena allowed the retreating main rotor blades to tilt downward and contact the tail boom.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.

An uncommanded main rotor blade to tail boom contact due to a 'blowback' phenomena after a successful preplanned autorotation by the pilot to a high density altitude airport with a test aircraft designed at a maximum gross weight.

Full narrative available

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11/21/1996

11/21/96 ✓
[handwritten initials]

NTSB AVIATION ACCIDENT/INCIDENT DATABASE
Report Number: LAX97LA061

General Information

Local Date:Time:	11/21/1996:09:01 MST
City/State:	FLAGSTAFF, AZ
Airport Name:ID	FLAGSTAFF PULLIAM:FLG
Event Type:	ACCIDENT
Injury Severity:	NONE

Operations Information

Category of Operation:	GENERAL AVIATION
Aircraft Type:	HELICOPTER
Aircraft Damage:	SUBSTANTIAL
Phase of Flight:	OTHER
Aircraft Make/Model:	MDDH HU-600-N
Operator Doing Business As:	
Operator Name/Code:	
Owner Name:	MCDONNELL DOUGLAS

Narrative

THE HELICOPTER WAS BEING FLIGHT TESTED TO VALIDATE CERTIFICATION CRITERIA FOR HEIGHT VELOCITY CURVES AT A MAXIMUM GROSS WEIGHT AND ZERO AIRSPEED AT A HIGH DENSITY ALTITUDE AIRPORT. ON THE FOURTH TEST PROFILE, THE PILOT ALLOWED THE AIRCRAFT TO DESCEND BELOW THE TARGET ALTITUDE OF 800 FEET AGL BY ALMOST 70 FEET. THE GROUND TEST ENGINEERS OBSERVED THE DRIFT DOWN AND DIDN'T ADVISE THE PILOT BECAUSE THEY ASSUMED HE HAD ALREADY BEGUN THE AUTOROTATION AFTER HE HAD MADE THE 3 SECOND CALL, AND ALSO THEY BELIEVED THEIR GROUND EQUIPMENT WAS INACCURATE. THE PILOT DELAYED THE AUTOROTATION FOR ABOUT 8 TO 12 SECONDS AND THEN LOWERED THE COLLECTIVE. THE AIRCRAFT LANDED HARD EXCEEDING THE MAXIMUM LOAD FOR THE LANDING GEAR SYSTEM. THE HORIZONTAL SPEED AT TOUCHDOWN WAS 52 KNOTS INSTEAD OF THE TARGET SPEED OF 65 KNOTS. THE TEST HELICOPTER WAS EQUIPPED WITH STANDARD ANALOG ALTIMETERS WITH POINTERS THAT HAVE A LAG TIME INSTEAD OF THE MORE ACCURATE REAL TIME DIGITAL ALTIMETERS.

Probable Cause

THE PILOT'S INATTENTION TO THE ALTITUDE AND INADVERTENT LATE ENTRY INTO AN AUTOROTATION MANEUVER BELOW THE ESTABLISHED MINIMUM TEST ALTITUDE WITH A HELICOPTER OPERATING AT MAXIMUMGROSS WEIGHT IN A HIGH DENSITY ALTITUDE ENVIRONMENT THAT LED TO A SUBSEQUENT HARD LANDING. CONTRIBUTING WERE THE LACK OF POSITIVE COMMUNICATIONS BETWEEN GROUND TEST PERSONNEL AND THE PILOT REGARDING THE LOW ALTITUDE, AND THE LACK OF ACCURATE IN-FLIGHT AND GROUND ALTIMETER EQUIPMENT.

Aircraft Information

Number of Seats:	2
Aircraft Use:	

Type of Operation: 14 CFR 91
Registration Number: 630N
Aircraft Fire: NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	0
Other	0	0	0	0

Landing Gear: SKID
Certificated Maximum Gross Weight: 4100
Engine Make/Model: ALLISON/250-C47M
Number of Engines: 1
Engine Type: TURBO SHAFT

Environment/Operations Information
Basic Weather Conditions:VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg)?Speed (knots): 0/0
Visibility (sm): 50
Visibility RVR (ft): 0
Visibility RVV (sm): 0
Cloud Height Above Ground Level (ft): 0
Visibility Restrictions: NONE
Precipitation Type: NONE
Light Condition: DAYLIGHT
Departure Airport Id: FLG
Flight Plan Filed: NONE
ATC Clearance: NONE
VFR Approach/Landing: TRAFFIC PATTERN, SIMULATED FORCED LANDING
Event Location: ON AIRPORT

Pilot-in-Command
Certificates: COMMERCIAL, AIRLINE TRANSPORT
Ratings:
Plane: SINGLE ENGINE LAND, MULTIENGINE LAND
Non-Plane: HELICOPTER, GLIDER
Instrument: AIRPLANE, HELICOPTER
Had Current BFR: YES
Months Since Last BFR: 12
Medical Certificate: CLASS 2
Medical Certificate Validity: VALID MEDICAL-WITH
WAIVERS/LIMITATIONS

Flight Time (Hours)

Total :	10342	Last 24 Hrs :	1
Make/Model :	1194	Last 30 Days:	56
Instrument :	0	Last 90 Days:	113
Multi-Engine:	2018	Rotorcraft :	7525

LAX97LA061

On November 21, 1996, at 0901 hours mountain standard time, a McDonnell Douglas (MD) prototype experimental helicopter, MD-600N (NOTAR), N630N, landed hard during a local test flight at the airport in Flagstaff, Arizona. Visual meteorological conditions existed at the time. The aircraft sustained substantial damage and the pilot was not injured. This aircraft was involved in a similar accident with the same pilot at the same location during flight tests on 11/04/96 (LAX-97-L-A034).

According to the operator, the test pilot was performing a series of height velocity curve autorotations at maximum gross weight (4,100 pounds) at various altitudes and at zero airspeeds between 800 to 1,000 feet above the ground (agl). During touchdown on the fourth autorotation, the helicopter contacted the runway and displaced both skids with the right skid separating from the aircraft at the brace assembly connecting bolt hole. The fuselage was buckled and cracked along the right side and the bottom of the fuselage.

The investigation revealed that the three previous test point autorotations were conducted at: 1,000 feet agl at 40 knots airspeed; 1,000 feet, 0 airspeed; and at 850 feet, 0 airspeed. There were no reported problems with these tests. According to MD engineers, the first two test points had "mild touchdown rates" (less than 1.5 g's and less than 5 feet per second). The touchdown rate for the third data point indicated a 1.75 g or 5.2 feet per second. It was discovered (after the accident) that the actual entry for this test was begun at 810 feet, instead of the 850 foot intended altitude.

On the fourth test point autorotation, the test pilot was to be at an entry altitude of 800 feet agl and zero airspeed. Prior to entry, the pilot radioed a standard 3 second call to the ground crew that he was about to begin the test run. According to MD ground test data personnel reviewing the instrumentation plots, the entry did not occur until 8 to 12 seconds after the pilot's initial call. During this time, the aircraft had drifted down approximately 70 to 730 feet agl. A review of the video recording indicated the helicopter contacted the runway with the aft portion of the skids. The touchdown rate was about 4.0 g's or 13.5 feet per second. The design limit for this landing gear (skid) system was 6.5 feet per second.

According to the pilot, the autorotation looked very similar to the previous data point until touchdown. At touchdown, the right gear collapsed and the helicopter dropped onto its right side. He stated the touchdown speed was approximately 45 knots. According to the test data, the horizontal speed did not get above 60 knots indicated airspeed, whereas, the other previous data points had horizontal speeds over 64 knots. The test data for this autorotation indicated a speed of 52 knots at touchdown.

The investigation revealed the helicopter was equipped with a standard barometric pressure altimeter and a radar altimeter that was recently calibrated to a + or - 10 feet. Neither of these altimeters provide a digital readout and the altitude seen by the pilot is the needle position (analog) on the gauge. According to MD, there were no other precision instruments available to assist the pilot with altitude readout. Ground personnel monitoring the altimeter strip chart, which they had known to be inaccurate, noticed the aircraft "drift down" about 50 feet and assumed the pilot had already lowered the collective to begin the test after he had made the 3 second call. They did not inform the pilot of their observations.

As a result of this accident and others, MD reduced the maximum operating gross weight to 3,650 pounds and installed a digital altimeter in the cockpit.

The McDonnell Douglas Helicopter Company has claimed an exemption from public disclosure of the information contained in their accident report as privileged and confidential.

NTSB Identification: LAX97LA061 . The docket is stored in the (offline) NTSB Imaging System.

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Accident occurred Thursday, November 21, 1996 at FLAGSTAFF, AZ
Aircraft:McDonnell Douglas MD-600N, registration: N630N
Injuries: 1 Uninjured.

The helicopter was being flight tested to validate certification criteria for height velocity curves at a maximum gross weight and zero airspeed at a high density altitude airport. On the fourth test profile, the pilot allowed the aircraft to descend below the target altitude of 800 feet agl by almost 70 feet. The ground test engineers observed the drift down and didn't advise the pilot because they assumed he had already begun the autorotation after he had made the 3 second call, and also they believed their ground equipment was inaccurate. The pilot delayed the autorotation for about 8 to 12 seconds and then lowered the collective. The aircraft landed hard exceeding the maximum load for the landing gear system. The horizontal speed at touchdown was 52 knots instead of the target speed of 65 knots. The test helicopter was equipped with standard analog altimeters with pointers that have a lag time instead of the more accurate real time digital altimeters.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.

The pilot's inattention to the altitude and inadvertent late entry into an autorotation maneuver below the established minimum test altitude with a helicopter operating at maximum gross weight in a high density altitude environment that led to a subsequent hard landing. Contributing were the lack of positive communications between ground test personnel and the pilot regarding the low altitude, and the lack of accurate in-flight and ground altimeter equipment.

Full narrative available

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01/18/1997

1/15/97

NTSB AVIATION ACCIDENT/INCIDENT DATABASE REPORT
Report Number: LAX97FA091

General Information

Local Date:Time	01/18/1997:12;20MST
City:State	FLAGSTAFF,AZ
Airport Name:Id	FLAGSTAFF PULLIAM:FLG
Event Type:	ACCIDENT
Injury Severity:	NONE

Operations Information

Category of Operation:	GENERAL AVIATION
Aircraft Type:	HELICOPTER
Aircraft Damage:	DESTROYED
Phase of Flight:	LANDING
Aircraft Make/Model:	
Operator Doing Business As:	MCDONNELL DOUGLAS HELICOPTER
Operator Name/Code:	
Operator:	
Owner Name:	MCDONNELL DOUGLAS

Narrative

DURING A CERTIFICATION TEST FLIGHT, THE PILOT WAS FOLLOWING TEST CARD PROCEDURES TO ESTABLISH PARAMETERS FOR A HEIGHT-VELOCITY DIAGRAM. HE BEGAN AN AUTOROTATION, USING A 1-SECOND DELAY (TO SIMULATE PILOT REACTION TIME) BEFORE LOWERING THE COLLECTIVE. AS THE AUTOROTATION PROGRESSED, THE HELICOPTER DEVELOPED A RATE OF DESCENT THAT THE PILOT WAS UNABLE TO CHECK. SUBSEQUENTLY, THE HELICOPTER TOUCHED DOWN HARD, THE SKIDS COLLAPSED, AND THE TAILBOOM WAS SEVERED BY THE MAIN ROTOR BLADES. THE HELICOPTER SLID OFF THE RUNWAY IN TO SNOW AND ROLLED ONTO ITS RIGHT SIDE. CIRCUMSTANCES IDENTIFIED IN THIS ACCIDENT HAD BEEN IDENTIFIED DURING PREVIOUS INVESTIGATIONS OF FLIGHT TEST ACCIDENTS WITH THIS HELICOPTER, BUT THAT INFORMATION HAD NOT BEEN PROVIDED TO THIS TEST PILOT AND FLIGHT ENGINEER.

Probable Cause

FAILURE OF THE MANUFACTURER TO FOLLOW ITS DIRECTIVE TO DEVELOP CORRECTIVE MEASURES IN RESPONSE TO KNOWN ACCIDENT DATA, AND THEIR FAILURE TO ENSURE THAT PERTINENT INFORMATION (IN ENGINEERING DEPARTMENT) WAS COMMUNICATED TO THE TEST PILOT AND ENGINEER (IN FLIGHT TEST).

Aircraft Information

Number of Seats:	1
Aircraft Use:	
Type of Operation:	14 CFR 91
Registration Number:	9202L
Air Carrier Operating Certificates:	

Aircraft Fire: NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	0
Other	0	0	0	0

Landing Gear: SKID
Certificated Maximum Gross Weight: 4100
Engine Make: ALLISON
Engine Model: 250-C47M
Number of Engines: 1
Engine Type: TURBO SHAFT

Environment/Operations Information

Basic Weather Conditions: VISUAL METEOROLOGICAL CONDITIONS (VMC)
Wind Direction (deg): 50
Wind Speed (knots): 5
Visibility (sm): 10
Visibility RVR (ft): 0
Visibility RVV (sm): 0
Cloud Height Above Ground Level (ft): 0
Visibility Restrictions: NONE
Precipitation Type: NONE
Light Condition: DAYLIGHT
Departure Airport Id: FLG
Flight Plan Filed: NONE
ATC Clearance: VFR
VFR Approach/Landing: TRAFFIC PATTERN, SIMULATED FORCED LANDING
Event Location: ON AIRPORT

Pilot-in-Command

Certificates: COMMERCIAL, AIRLINE TRANSPORT, FLIGHT INSTRUCTOR
Ratings:
Plane: SINGLE ENGINE LAND, MULTIENGINE LAND
Non-Plane: HELICOPTER, GLIDER
Instrument: AIRPLANE, HELICOPTER
Had Current BFR: YES
Months Since Last BFR: 8
Medical Certificate: CLASS 2
Medical Certificate Validity: VALID MEDICAL-WITH WAIVERS/LIMITATIONS

Flight Time (Hours)

Total :	10379	Last 24 Hrs :	1
Make/Model :	1213	Last 30 Days:	15
Instrument :	0	Last 90 Days:	133
Multi-Engine:	2018	Rotorcraft :	7556

LAX97FA091

HISTORY OF FLIGHT

On January 18, 1997, at 1220 hours mountain standard time, a McDonnell Douglas MD600N, N9202L, crashed at Flagstaff, Arizona. The aircraft was destroyed; however, the test pilot, the sole occupant, was not injured. The aircraft was being operated by the McDonnell Douglas Helicopter Company on a certification test flight when the accident occurred. The local flight originated at the Flagstaff Pulliam Airport at 1146. Visual meteorological conditions prevailed at the time and no flight plan had been filed.

The operator reported that the pilot had completed four autorotations (height/velocity test data points) from closed traffic on runway 03 without incident. On the next maneuver, the pilot entered an autorotation from 150 feet agl and 85 kias with a 1-second delay in collective reduction. As the maneuver progressed, the aircraft developed a rate of descent the pilot was unable to check. According to onboard telemetry, the aircraft impacted the runway at a vertical velocity above the landing gear's structural limits.

PILOT INFORMATION

The pilot is a graduate of the U.S. Naval Test Pilot School and is employed as a flight test pilot by the aircraft manufacturer. He was formerly a U.S. Air Force test pilot.

AIRCRAFT INFORMATION

The aircraft was a preproduction experimental model pending the issuance of a normal category airworthiness certificate upon successful completion of the flight test certification program (FAR 27.79). The purpose of this flight test was to establish the parameters of the height-velocity diagram. The aircraft gross weight was 4,100 pounds with a forward center of gravity.

WRECKAGE AND IMPACT INFORMATION

A video recording of the accident revealed that as the aircraft touched down, the skids collapsed and the tailboom was severed by contact with the main rotor blades. The tailboom separation resulted in loss of directional control and the aircraft began yawing left during the accompanying ground run. As the ground run progressed, the aircraft veered off the left side of the runway and onto snow covered sod. The main rotor blades struck the ground as the aircraft rolled onto its right side and came to rest.

SURVIVAL ASPECTS

The pilot shut down the aircraft and exited the cockpit through the fractured forward canopy with the aid of crash rescue personnel.

TESTS AND RESEARCH

Detailed discussions were conducted with a representative of the manufacturer, and, the Safety Board examined proprietary company reports. After reviewing the telemetry data, the manufacturer found that conditions in two previous flight test accident investigations were similar to the conditions of this accident. The internal company recommendations that arose from those two accidents had not been complied with when the latest accident occurred. The first recommendation was "to study/define Nr to airspeed to power off rotor dynamics," the second was to "Further investigate and define the 'blowback' phenomena and the conditions that cause it to occur." Also, the findings of the two previous investigations had not been made available to the program test pilot or the flight test engineer.

The data collected from the previous investigations revealed that the difference between a previously successful autorotation and the autorotation that preceded the accident was the position of the aft longitudinal control. In the accident sequence it remained at a position higher than the previous autorotation for about 1.0 seconds. The manufacturer concluded that this put the main rotor in, at least, a partial, and probably increasing stall condition. This conclusion was supported by corresponding increases in mast bending loads and control forces.

According to the manufacturer, the data indicated that the stall peaked approximately 3.0 seconds after the initial collective reduction with the aircraft now about 40 feet radar altitude. The resulting loss of main rotor lift would cause an increase in the rate of descent. The data further shows that a continued increase in collective control would only increase the rotor stall, and the attempt to use airspeed reduction (flare) to help reduce the rate of descent would also be ineffective.

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04/25/1997

4/25/97

```
+---------------------------------------------- REQUEST 074/98, REPORT  67 ------------------------------------------+
+ PRELIMINARY REPORT                            CANADAIR-BD700                                              ACCIDENT +
+ EVENTS¦PHASES                  WHEELS-UP LANDING-UNINTENTIONAL-LEVEL OFF/TOUCHDOWN                                 +
+--------------------------------------------------------------------------------------------------------------------+
                                                             ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL         ++ ICAO FILE          :  97/2369-0
                                                           ++ FROM STATE         :  CANADA
FINAL REP                                                  ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE          :  97-04-25                                  ++ MASS CATEGORY      :  5701 - 27 000 KG
TIME          :  19:50                                     ++ STATE OF REGISTRY  :  CANADA
LIGHT         :  UNKNOWN                                   ++ REGISTRATION       :  C-FJGX
GEN WEATHER   :  UNKNOWN                                   ++
                                                           ++
<---------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  TORONTO/DOWNSVIEW                         ++ A/C DAMAGE        :  SUBSTANTIAL
STATE/AREA    :  CANADA                                    ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  TORONTO/DOWNSVIEW                         ++ CREW   :      0      0      0     2     0      2
DESTINATION   :  TORONTO/DOWNSVIEW                         ++ PAX    :      0      0      0     3     0      3
                                                           ++

                                   ---------------- NARRATIVE ----------------
THE EXPERIMENTAL A/C LANDED WITH THE GEAR RETRACTED. FOR THE PURPOSES OF THE TESTS TO BE PERFORMED DURING THE FLIGHT, THE
GPWS HAD BEEN DISABLED. UNDER NORMAL CIRCUMSTANCES, WITH THE GPWS FUNCTIONING AND DESPITE THE AUDIBLE WARNING SYSTEM BEING
DISABLED, THE CREW WOULD HAVE RECEIVED A "TOO LOW GEAR" WARNING FROM THE GPWS WHEN THE A/C DESCENDED BELOW 900 FT AGL. THE
LANDING GEAR WAS NOT SELECTED DOWN. THE CREW SAID THAT THEY WERE NOT FOLLOWING THE PRE-LANDING CHECKLIST.
```

```
+---------------------------------------------- REQUEST 074/98, REPORT  68 ------------------------------------------+
+ DATA REPORT                                 MISCELLANEOUS-MICROLIGHT                                      ACCIDENT +
+ EVENTS¦PHASES                  UNSPECIFIED FAILURE-FIRST ENGINE-CIRCUIT PATTERN/FINAL                              +
+                                           UNDERSHOOT-LEVEL OFF/TOUCHDOWN                                           +
+--------------------------------------------------------------------------------------------------------------------+
                                                             ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          :  MISCELLANEOUS - TEST/EXPERIMENTAL         ++ ICAO FILE          :  97/0179-0
                                                           ++ FROM STATE         :  BURKINA FASO
FINAL REP                                                  ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE          :  97-05-15                                  ++ MASS CATEGORY      :  BELOW 2250 KG
TIME          :  09:52                                     ++ STATE OF REGISTRY  :  BURKINA FASO
LIGHT         :  DAYLIGHT                                  ++ REGISTRATION       :  XT-ADA
GEN WEATHER   :  VMC                                       ++
                                                           ++
<---------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      :  OUAGADOUGOU                               ++ A/C DAMAGE        :  SUBSTANTIAL
STATE/AREA    :  BURKINA FASO                              ++ INJURY :    FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :  OUAGADOUGOU                               ++ CREW   :      0      0      0     1     0      1
DESTINATION   :  OUAGADOUGOU                               ++ PAX    :      0      0      0     0     0      0
                                                           ++

                                   ---------------- NARRATIVE ----------------
DURING THE DOWNWIND LEG THE ENGINE FAILED. THE PILOT TRIED TO REACH THE RWY BY SHORTENING THE BASE LEG, BUT IMPACT OCCURRED
A FEW HUNDRED METRES FROM THE RWY THRESHOLD.
ICAO NOTE: FACTORS NOT REPORTED.

                               ------------ SEQUENCE OF EVENTS ------------

EVENT  1   UNSPECIFIED FAILURE-FIRST ENGINE - CIRCUIT PATTERN/FINAL
EVENT  2   UNDERSHOOT - LEVEL OFF/TOUCHDOWN
```

05/22/1997

IPTN/CN-250

"LAPES"
Test

5/22/97

```
+--------------------------------------------- REQUEST 074/98, REPORT  69 ------------------------------------------+
+ UNOFFICIAL REPORT                              IPTN-N-250                                                ACCIDENT +
+ EVENTS|PHASES                               OTHER-MANOEUVRING                                                     +
+                                        LOSS OF CONTROL-MANOEUVRING                                                +
+-------------------------------------------------------------------------------------------------------------------+
                                                        ++
<---------------------- OPERATION ----------------------> ++ <---------------------- FILE DATA ---------------------->
TYPE          : MISCELLANEOUS - TEST/EXPERIMENTAL       ++ ICAO FILE        : 97/0153-0
                                                        ++ FROM STATE       :
FINAL REP                                               ++
<----------- DATE, TIME AND METEOROLOGICAL DATA ----------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE          : 97-05-22                                ++ MASS CATEGORY    : 5701 - 27 000 KG
TIME          : 00:00                                   ++ STATE OF REGISTRY : INDONESIA
LIGHT         :                                         ++ REGISTRATION     : PK-XNT
GEN WEATHER   :                                         ++
                                                        ++
<---------------------- LOCATION -----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION      : SERANG                                  ++ A/C DAMAGE       : DESTROYED
STATE/AREA    : INDONESIA                               ++ INJURY :  FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED      :                                         ++ CREW   :    6     0      0     0     0      6
DESTINATION   :                                         ++ PAX    :    0     0      0     0     0      0
                                                        ++
```

---------------- NARRATIVE ----------------

AIRCLAIMS: DURING A LOW ALTITUDE PARACHUTE EXTRACTION (LAPES) TEST IN WHICH A 4 TONNE LOAD OF SAND WAS TO HAVE BEEN DROPPED FROM A HEIGHT OF 1,100FT., PART OF THE PARACHUTE HARNESS APPARENTLY BROKE AWAY BEFORE THE LOAD HAD BEEN FULLY EXTRACTED. ATTEMPTS WERE MADE TO MANUALLY JETTISON THE LOAD BY PUSHING IT OFF THE RAMP BUT THIS WAS NOT POSSIBLE AS A METAL CLEVIS, WHICH HAD FORMED PART OF THE HARNESS SHACKLE, HAD BECOME JAMMED BENEATH THE PALLET. MEANWHILE, THE REAWARD MOVEMENT OF THE LOAD HAD CAUSED CONSIDERABLE CONTROL PROBLEMS. IT WOULD SEEM THAT THE PILOT ATTEMPTED TO MAKE A FORCED LANDING BUT CONTROL WAS LOST AND THE AIRCRAFT CRASHED AND BURNED. FOLLOWING THE ACCIDENT IT WAS STATED THAT AN EMPLOYEE OF METRIX SYSTEM INC., THE MANUFACTURER OF THE EXTRACTION SYSTEM, HAD APPARENTLY USED A CABLE WITH TOO LOW A LOAD CAPIBILITY TO RIG THE HARNESS. THE WEAKER CABLE APPARENTLY APPEARED IDENTICAL TO THE CORRECT ONE.

```
+-------------------------------------------- REQUEST 074/98, REPORT  33 --------------------------------------------+
+ DATA REPORT                                          SNOW-S2R                                              ACCIDENT +
+ EVENTS|PHASES                 NON-MECHANICAL FAILURE-FIRST ENGINE-NORMAL DESCENT                                     +
+                                            COLLISION WITH OBJECT-LANDING                                             +
+------------------------------------------------------------------------------------------------------------------------+
                                                        ++
<---------------------- OPERATION ---------------------> ++ <---------------------- FILE DATA --------------------->
TYPE           :  MISCELLANEOUS - TEST/EXPERIMENTAL     ++ ICAO FILE          :  94/1093-0
                                                        ++ FROM STATE         :  UNITED STATES
FINAL REP                                               ++
<----------- DATE, TIME AND METEOROLOGICAL DATA -------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE           :  94-05-25                              ++ MASS CATEGORY      :  2250 - 5700 KG
TIME           :  12:00                                 ++ STATE OF REGISTRY  :  UNITED STATES
LIGHT          :  DAYLIGHT                              ++ REGISTRATION       :  N1659S
GEN WEATHER    :  VMC                                   ++
                                                        ++
<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION       :  BANCROFT,WI                           ++ A/C DAMAGE         :  SUBSTANTIAL
STATE/AREA     :  UNITED STATES                         ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED       :  BANCROFT,WI                           ++ CREW   :       0      0      0     1      0      1
DESTINATION    :  BANCROFT,WI                           ++ PAX    :       0      0      0     0      0      0
                                                        ++
```

----------------- NARRATIVE ----------------

DURING APP THE PILOT ENTERED A LONG GLIDE TO THE A/P. THE CONDITIONS WERE FAVOURABLE FOR CARBURETTOR ICING AT GLIDE POWER (ACCORDING TO THE TRANSPORT CANADA CARBURETTOR ICING CHART). WHEN THE THROTTLE WAS ADVANCED, THE ENGINE DID NOT PRODUCE POWER. DURING THE FORCED LANDING SHORT OF THE RWY THE A/C STRUCK A DITCH. NO PRE-ACCIDENT MECHANICAL FAILURES WERE FOUND.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   NON-MECHANICAL FAILURE-FIRST ENGINE - NORMAL DESCENT
           1.ICING - PRESENT
           2.CARBURETTOR - ICE IN
           3.OPERATION OF CARBURETTOR HEAT - NOT SELECTED
           4.FORCED LANDING - PERFORMED
EVENT  2   COLLISION WITH OBJECT - LANDING
```

```
+-------------------------------------------- REQUEST 074/98, REPORT  34 --------------------------------------------+
+ DATA REPORT                                   FOUGA-POTEZ-CM170 MAGISTER                                   ACCIDENT +
+ EVENTS|PHASES                         SCRAPED WINGTIP/COWLING/FLOAT-TAKE-OFF RUN                                     +
+                                       MAIN GEAR COLLAPSED/RETRACTED-ABORTED TAKE-OFF                                 +
+------------------------------------------------------------------------------------------------------------------------+
                                                        ++
<---------------------- OPERATION ---------------------> ++ <---------------------- FILE DATA --------------------->
TYPE           :  MISCELLANEOUS - TEST/EXPERIMENTAL     ++ ICAO FILE          :  94/0241-0
                                                        ++ FROM STATE         :  GERMANY
FINAL REP                                               ++
<----------- DATE, TIME AND METEOROLOGICAL DATA -------> ++ <-------------------- AIRCRAFT DATA -------------------->
DATE           :  94-07-02                              ++ MASS CATEGORY      :  2250 - 5700 KG
TIME           :  17:36                                 ++ STATE OF REGISTRY  :  GERMANY
LIGHT          :  DAYLIGHT                              ++ REGISTRATION       :  D-IFCC
GEN WEATHER    :  VMC                                   ++
                                                        ++
<---------------------- LOCATION ----------------------> ++ <----------- DAMAGE, INJURY AND TOTAL ON BOARD ----------->
LOCATION       :  NUERNBERG                             ++ A/C DAMAGE         :  SUBSTANTIAL
STATE/AREA     :  GERMANY                               ++ INJURY :     FATAL SERIOUS MINOR NONE UNKNOWN TOTAL
DEPARTED       :  NUERNBERG                             ++ CREW   :       0      0      0     1      0      1
DESTINATION    :  NUERNBERG                             ++ PAX    :       0      0      0     1      0      1
                                                        ++
```

----------------- NARRATIVE ----------------

DURING TAKE-OFF A TIP TANK SCRAPED THE RWY.
DRN: THE PILOT HAD LOWERED THE TAIL TO DIMINISH THE SHOCKS TO THE NOSEGEAR COMING FROM THE CENTRELINE LIGHTS ON THE RWY. THERE WAS INSUFFICENT SPEED FOR THE TAKE-OFF AND THE A/C STALLED. THE TAKE-OFF WAS ABORTED AND THE RIGHT GEAR COLLAPSED.

------------ SEQUENCE OF EVENTS ------------

```
EVENT  1   SCRAPED WINGTIP/COWLING/FLOAT - TAKE-OFF RUN
           1.LIFT-OFF - POOR
             1.PILOT-EXPERIENCE ON A/C TYPE-LOW
EVENT  2   MAIN GEAR COLLAPSED/RETRACTED - ABORTED TAKE-OFF
```

Flight Test NEWS

PUBLISHED BY THE SOCIETY OF FLIGHT TEST ENGINEERS June 1997
POST OFFICE BOX 4047, LANCASTER, CA 93539-4047 USA VOLUME 28, NUMBER 6

IPTN Airplane Accident

On Thursday May 22, 1997 at 13:28 P.M. IPTN (Nusantara, SFTE Corporate Member) lost 5 of its best flight test members in an CN235 aircraft accident. The accident occurred while the aircraft was performing LAPES test (Low Altitude Parachute Extraction System) in Gorda, Serand - West Java. Initial reports indicate the extraction line broke before the load had exited the aircraft and a low altitude stall resulted. The five casualties were: 1. Capt. Pilot/Vice President Chief Test Pilot, Dipl. Ing. Erwin Danoewinata, Graduated from Aeronautic Engineering, Department of Stuttgard University and the National Test Pilot School, Mojave, CA. Award winner of the 1969 Ivan C. Kinchloe Award. 2. Capt. Pilot Stanley F.H. Halim MFTT. Graduate from Aeronautic Engineering Department of Technical University Delft, Netherlands and the National Test Pilot School in Mojave, CA. 3. Flight Test Engineer, Ing. Didik Permadi, Graduated from Aeronautic Engineering, Department of University de Paris Paris, France and the National Test Pilot School in Mojave, —A. 4. Flight Test Mechanic, Prihatno Sutodrwiryo, Graduated from LPPU/PLP Curug in Tanggerang. 5. Flight Test Mechanic, Bamband Budi Prasetyo, Graduated from LPPU/PLP Curug in Tanggerang.

SFTE extends our sincere sympathy to the families of the fallen airmen and to Nusantara.

Corporate Member Highlight
Aydin Telemetry

During the latter part of 1996, the AYDIN Corporation made significant changes to realign their business structure. In line with the Company's new market driven focus, AYDIN product divisions were grouped to maximize the synergy of their people, products, systems and technical expertise. The airborne telemetry (AYDIN Vector) and ground telemetry product lines (AYDIN Monitor) were combined to form AYDIN Telemetry.

Lockheed Martin Skunk Works, (LMSW) Palmdale, CA recently selected AYDIN Corporation to provide Flight Test Instrumentation for the Joint Strike Fighter Concept monstration Program. The contract, valued at approximately million, requires AYDIN to manufacture a majority of the equipment and to integrate other major subcontractor's equipment for these aircraft for delivery through 1998.

The Data Acquisition System specified by the US DOD and LMSW is based upon the Common Airborne Instrumentation System (CAIS) currently under development for the Department of Defense by the US Navy. The F-22 and the F-18 E/F Programs are the first major aircraft development programs to utilize a CAIS Compatible Data Acquisition System.

The system will consist of standard AYDIN Micro-Miniature Model MMSC-800 Narrow Band and Wide Band Data Acquisition units used on the F-22 aircraft Program. The system will be compatible with the CAIS BUS and integrated with other major CAIS equipment.

Additional AYDIN Vector equipment to be integrated includes the High Speed Data Interleaver Mini Armor 700, RF Transmitters, Programmable BUS Controllers, Data Interface Modules, and Cockpit Displays.

AYDIN is a recognized world leader in the design, manufacture, and systems integration of flight test and flight certification instrumentation systems for both commercial and military applications. Other major Lockheed Martin programs with which AYDIN is involved include F-22, C-130J, F-16MLU, F-117 and Dark Star Tier III Minus UAV.

AYDIN Telemetry has released its latest full line Vector products Selection Guide. If you have not received the Guide and would like a free copy, contact AYDIN Telemetry, P.O. Box 328, Newtown, PA/USA, 18940-0328. You can also request a copy by calling (215) 968-4271, fax (215) 968-3214 or email aydin@aydinvector.com.

Scholarship Applications Requested

Applications for SFTE undergraduate must be received in the Society Headquarters Office by July 8, 1997 along with a current transcript. Applications can be requested from the Society Office.

Applicants shall be the son or daughter of a Society Member in good standing or a Student Member in good standing. Applicants shall have completed his or her college freshman year and be majoring in engineering, computer sciences, mathematics, physics or other technical discipline. The Board of Directors will determine the winner(s) of the scholarship. Scholarship, as opposed to need, shall be a primary consideration for the award. The award shall be for one school year. Previous winners, as well as those who applied in previous years, are eligible to compete again.

Houle, David

From: **Delaney, Michael**
To: Houle. David
Subfect FW: IPTN Flight Test Tragedy in Serang, West Java, Indonesia
Date: Friday, May 23, 1997 2:58PM
Priority: High

Dave
Received this from Neil who is on the AIAA FT Tech Comm. with me.
MikeD

From: NEIL DOH

Subject: IPTN Flight Test Tragedy in Serang, West Java. Indonesia Date:
Friday, **May 23,** 1997 1 :OSPM

Dear Friends and Colleagues:

An experimental CN-235 military transport crashed and bu med at 13:1 S on = Thursday. 22 June 1997 (06:15 GMT) at Gorda Airbase. All six flight= crews were killed and bumed beyond recognition They were frve = Indonesians and one American. They were executing a Low Altitude = Parachute Extraction System (IAPES) test of **a 4,000** kg payload. = According to Dr. 8.J. Habibie, CEO of f PTN in the aftermath news = conference, the airplane was about 200m above the ground when the = parachute lanyards broke causing the payload to become unstable and = shifted to the rear of the ac. The resulting extreme aft CG caused the • ac to stall and Impacted tail first. The names of the deceased are:

1.Pilot Capt. Erwin Danoewinata • Chief Project Pilot
2.Co-pilot HaJim
3. Project FTE: Didik Permadi
4.Mechanic: Prihatno
5.Mechanic: Bambang Budi
6.Consultant William Denton (American) Cargo Dropping System = specialist of Metrix Inc.

This tragic accident is expected to create a major setback for IPTN .. Flight Test Division and the certification of the N2SO project, as we m are embarking on the early stages of its flight test program of 2 :s prototype aircraft PA·1 and PA-2. Erwin was the PIC on the first ffight = of both aircraft and has been involved in every test ffight thereafter. = He is survived by his wife, Christiana. and 12-year~td son, Jan Wilbur.= The Indonesians funeral ceremony is scheduled to be officiated by Dr. =

Habibie today at the Cikutra Heroes Cemetery in Bandung.

Aespectfu1ty1

NE!LOOH

09/09/1997

9/9/97

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 19970909034819G

General Information

Local Date:	09/09/1997
Local Time:	15:05
City:	SALINA
State:	KS
Airport Name:	SALINA MUNI
Airport Id:	SLN
Event Type:	INCIDENT - GENERAL AVIATION

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight:	FCD/PREC LDG FROM CRUISE
Aircraft Make/Model:	BEECH BE-95-B55 (T42A)
Airframe Hours:	
Operator Code:	MANUFACTURER
Operator:	BEECH ?
Owner Name:	SKYMASTERS, INC

Narrative

NARRATIVE: AIRCRAFT WAS ON EXPERIMENTAL FLIGHT TEST IN LOCAL AREA AT WICHITA, KANSAS FOR SPIN RECOVERY. DURING RETRACTION OF LANDING GEAR UNDER HIGH G LOADS, THE LEFT MAIN WOULD NOT RETRACT. WHEN THE GEAR WAS THEN EXTENDED, IT WOULD NOT LOCK DOWN. AIRCRAFT DIVERTED TO SALINA, KANSAS WHERE AN EMERGENCY LANDING WAS PERFORMED WITH MINOR DAMAGE TO LEFT GEAR DOOR, LEFT FLAP AND LEFT AILERON. INVESTIGATION REVEALED THE LEFT LANDING GEAR RETRACT ROD HAD FAILED.

Detail

Primary Flight Type:	OTHER
Secondary Flight Type:	TEST FLIGHT
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	93T
Total Aboard:	1
Fatalities:	0
Injuries:	0
Landing Gear:	RETRACT TRICYCLE
Aircraft Weight Class:	UNDER 12501 LBS
Engine Make:	CONT
Engine Model:	IO-470 SER

Engine Group:
Number of Engines: 2
Engine Type:

Environmental/Operations Information

Primary Flight Conditions: UNKNOWN
Secondary Flight Conditions: WEATHER NOT A FACTOR
Wind Direction (deg):
Wind Speed (mph):
Visibility (mi):
Visibility Restrictions:
Light Condition: DAY
Flight Plan Filed: NONE
Approach Type:

Pilot-in-Command

Pilot Certificates: AIRLINE TRANSPORT
Pilot Rating: AIRPLANE SINGLE, MULTI-ENGINE
LAND
Pilot Qualification: QUALIFIED
Flight Time (Hours)
Total Hours:
Total in Make/Model:
Total Last 90 Days:
Total Last 90 Days Make/Model:

04/16/1998

4/16/98

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 19980416028059G

General Information

Local Date:	04/16/1998
Local Time:	10:15
City:	BOONEVILLE
State:	AR
Airport Name:	
Airport Id:	

Aircraft Information

Aircraft Damage:	NONE
Phase of Flight:	NORMAL CRUISE
Aircraft Make/Model:	
Airframe Hours:	140
Operator Code:	
Operator:	
Owner Name:	

Narrative "SHEKARI"

A AMATEUR BUILT AIRCRAFT, N8072U, MODEL RANS-160F16, OPERATED BY RANDY J. SCHLITTER, LOST EXPERIMENTAL WOOD PROPELLER, DURING CRUISE, AT 5000 FEET MSL. THE COMMERCIAL PILOT MADE AN EMERGENCY LANDING IN FIELD IN CLOSE PROXIMITY TO THE BOONEVILLE MUNICIPAL AIRPORT, THE AIRCRAFT LANDING WITHOUT INCIDENT. NO INJURIES, NO PASSENGERS ON BOARD. THE PROBABLE CAUSE WAS HARMONIC VIBRATION BETWEEEN PROPELLER AND CRANKCASE FLANGE. THIS EXPERIMENTAL PROPELLER WAS UNDER FLIGHT TESTING WHEN THE FAILURE OCCURRED AND REPLACED WITH DIFFERENT TYPE WOOD PROPELLER.

Detail

Primary Flight Type:	PERSONAL	CREW TRAINING
Secondary Flight Type:	PLEASURE	MARKET SURVEY
Type of Operation:	GENERAL OPERATING RULES	
Registration Number:	8072U	
Total Aboard:	1	
Fatalities:	0	
Injuries:	0	
Landing Gear:	NONRETRACT CONVENTIONAL	
Aircraft Weight Class:	UNDER 12501 LBS	
Engine Make:		
Engine Model:		
Engine Group:		
Number of Engines:	1 RECIP	
Engine Type:		

Environmental/Operations Information

Primary Flight Conditions:	UNKNOWN
Secondary Flight Conditions:	UNKNOWN
Wind Direction (deg):	
Wind Speed (mph):	
Visibility (mi):	
Visibility Restrictions:	
Light Condition:	DAY
Flight Plan Filed:	NONE
Approach Type:	

Pilot-in-Command

Pilot Certificates:	COMMERCIAL PILOT
Pilot Rating:	AIRPLANE SINGLE ENGINE LAND
Pilot Qualification:	QUALIFIED

Flight Time (Hours)

Total Hours:	5000
Total in Make/Model:	140
Total Last 90 Days:	100
Total Last 90 Days Make/Model:	

06/22/1998

A U.S. MARINE PILOT AND NAVIGATOR will have to wait at least another "week or two" to learn if they will be court-martialed on charges that they flew their EA-6B electronic warfare aircraft into a ski-lift cable in Italy, said Marine Corps officials at Camp Lejeune, N.C. The Feb. 3 accident killed 20 people.

The judge in last week's two-day hearing is considering what the crew knew about height restrictions for EA-6B Prowler flights. Elements of the USMC aviation community were operating under at least two altitude standards in the accident area: a minimum of 1,000 ft. for aircraft without head-up displays and an Italian rule requiring a minimum of 2,000 ft.

The severed cable was strung down a mountainside at a height of 370 ft. However, Marine Col. Thomas Blickensderfer, who investigated the accident, said that when he flew an Air Force simulator in recreating the fatal mission, he inadvertently dropped to 300-500 ft. The phenomenon was attributed to an optical illusion caused by flying out of a narrow valley into a wider one that can make aircrews think they

are highe
visual rec
signed to
instrume
hatting, e
board rep
The h
Richard
tialed. A
EA-6B's
Seagrave
Lt. Co
squadron
flights be
officers' r
Cherry P
subject tc
operation

nine passengers. The passengers were General Electric Co. engineers involved in the hydroelectric turbine business. A fire broke out after the twin turboprop departed Dorval airport in Montreal and an emergency landing was made at Mirabel, but the aircraft exploded and veered off the runway, coming to a stop 150 ft. away.

A KAMOV KA-50 BLACK SHARK attack helicopter crashed during a daytime test flight near Torzhok, 140 mi. northwest of Moscow. The pilot, Maj. Gen. Boris Vorobiyov, chief of the Army aviation's combat training center, was killed. A special commission is investigating the cause. A Defense Ministry official said eyewitnesses reported seeing a rotor blade section fly off the Ka-50 during an aerobatic maneuver involving a high-speed turn 50-100 meters (164-328 ft.) above ground.

Av Week
6/22/98

PHILIPPINE AND JAPANESE a
are examining cockpit and fl
recorders from a Japan Airline
that left Runway 24 during a n
ing in Manila on June 14 in h
Capt. Takayoshi Minami repor
water coverage on the runway a
ed the trijet aircraft, which wa
248 passengers and 11 crewm
a flight from Tokyo. Twenty-
sengers were injured during an
evacuation.

NEGOTIATORS FOR NORTHWE
and the International Assn. of
and Aerospace Workers have
tentative agreement on a four-
contract. The agreement offers
raise over the contract term, ret
the amendable date. The pensio
was improved.

DENMARK WANTS TO ACQUIRE a lethal suppression of enemy air defense (SEAD) capability for its F-16s through the purchase of the Raytheon-built AGM-88 High-Speed Anti-Radiation Missile (Harm). [illegible]

The Scandinavian nation has designated funds starting next year for new F-16 weapons acquisitions. How that money is going to be spent has not been determined, but Kai E. Poulsen,

07/09/1998

[redacted]

7/9/98

Peter H Donath Jr
07/21198 08:45 AM

To:

cc:
Subject:

Here's an interesting story from AVWeb (http://www.avweb.com'newswire/news9829.html#2) about dual flameout in a T-tailed twinjet. Another reason I try to stay current in multi-engine land, single-engine land AND GLIDER aircraft.

-Pete Donath
Flight Test/Ffight Sciences

Cessna's CitationJet Prototype Buys The Shoulder

Double Flameout Results In Little Damage ...

Somebody's living right - maybe all three Cessna engineering test pilots who were aboard the company's original Model 525 CitationJet prototype, N525CJ. Their Experimental ride suffered a complete loss of power on both engines Thursday, July 9 during a test flight from Wichita's Mid-Continent Airport The crfNI successfuRy landed their newfound glider in the eastbound lanes of Kansas state route 96, a four-lane highway, east of 119th street some frve miles northwest of ICT, at about 2:00 p.m. Central time. The crew - pilot Scott Simpson, copilot Mark Chavez, and flight engineer Trenton Shepherd - was unhurt .

. .. But An Exciting Landing ...

AVweb sources tell us that In setting down the CJ, the crew managed to avoid hitting an automobile on K-96 - which the CJ was rapidly overtaking until its driver finally noticed the jet and accelerated out of the way - touching down with the left main and nose gear on the pavement, but with the right main gear on the dirt shoulder of the highway. They narrowly missed a drainage ditch in the process, finally coming to rest on the right shoulder of the highway. What little damage was sustained involved the dirt and mud thrown up by the right main wheel and ingested into the windmilling right engine, plus minor dents in the right wing leading edge, a result of contact with roadside reflector posts. The reluctance of the motorist to make way for the gfidin' Citation led one wag to suggest the CJ's option list might be fattened a bit by adding an extra-loud ham. Even so, the crew clearly did a great jt putting the plane down safely under difficult circumstances. Nice work, gentlemen.

...As The Investigation Begins

But they might still need some help with the post-flight paperwork. Investigators from the NTSB, FAA and Cessna quickly converged on the scene but it didn't take them long to determine the cause of the flame-out: fuel exhaustion -- the tanks were dry as a bone. Sources close to the investigation tell AVweb that the cockpit fuel gauge erroneously indicated a substantial quantity of fuel remaining (about 500 pounds), although the low fuel warning light reportedly was illuminated. Initial indications are that the fuel quantity indicating system aboard N525CJ may not be the same as installed in Cessna's production versions of the CitationJet. Another possibility is the installation of presumably thirstier engines. Although Cessna declined to discuss the purpose of the test flight, speculation is that N525CJ may have been fitted with two new, 2300 lb. thrust copies of the Williams FJ44 engine, replacing the 1900 lb. thrust version currently installed on production CJs.

The regulatory fate of the Cessna flight crew was uncertain as AVweb's deadline approached. Had it been a private pilk Skylane who ran out of gas five miles from an intended destination, there's little doubt that fuel gauges reading 1/4 full not prevent the FAA from giving the pilot his or her very own "609 ride." Some remedial training in preflight planning, at very least, might also be prescribed. Whether the experimental airworthiness certificate -- coupled with the possibly non-standard engines and instrumentation -- will be considered by the FAA as sufficient mitigation to get the Cessna te off the hook enforcement-wise remains to be seen. At least the FAA "traffic ticket" enforcement scheme is on hold.

Service With A Smile?

In the end, the unplanned landing brought out even more than NTSB and FAA investigators. Cessna's support operation swung into action and quickly dispatched a pumper truck and washed down the contaminated right engine. A Cessna fuel truck then refueled the aircraft. After a careful inspection, the aircraft was permitted to take off from K-96 and fly to Mid-Continent. The highway was reopened to automobile traffic shortly before 5 p.m. We look forward to that kind of service the next time we set down in the Wichita area.

n525cjmap_sm.gi

c525.jpg

7/9/98

FAA INCIDENT DATA SYSTEM REPORT

Report Number: 19980709023479G

General Information

Local Date:	07/09/1998
Local Time:	14:20
City:	WICHITA
State:	KS
Airport Name:	WICHITA MID-CONTINENT
Airport Id:	ICT
Event Type:	INCIDENT - GENERAL AVIATION

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight:	FCD/PREC LDG FROM CRUISE
Aircraft Make/Model:	CESSNA CE-525-XXX
Airframe Hours:	
Operator Code:	
Operator:	
Owner Name:	

Narrative

DURING FACTORY FLIGHT TEST LOW FUEL LIGHT. BOTH ENGINES OUIT. LANDED HIWAY. FUELED. RETURNED TO ICT.

Detail

Primary Flight Type:	OTHER
Secondary Flight Type:	TEST FLIGHT
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	525CJ
Total Aboard:	3
Fatalities:	0
Injuries:	0
Landing Gear:	RETRACT TRICYCLE
Aircraft Weight Class:	UNDER 12501 LBS
Engine Make:	
Engine Model:	
Engine Group:	
Number of Engines:	2
Engine Type:	

Environmental/Operations Information

Primary Flight Conditions: VISUAL FLIGHT RULES
Secondary Flight Conditions: WEATHER NOT A FACTOR
Wind Direction (deg):
Wind Speed (mph):
Visibility (mi):
Visibility Restrictions:
Light Condition: DAY
Flight Plan Filed: NONE
Approach Type:

Pilot-in-Command

Pilot Certificates: AIRLINE TRANSPORT
Pilot Rating: AIRPLANE SINGLE, MULTI-ENGINE
LAND
Pilot Qualification: UNKNOWN, FOREIGN PILOT
Flight Time (Hours)
Total Hours:
Total in Make/Model:
Total Last 90 Days:
Total Last 90 Days Make/Model:

~~FO~~
October 27, 1998

IAD99FA008 10/27/98

HISTORY OF FLIGHT

On October 27, 1998, at 1456 eastern standard time, a Learjet 45 registered in the experimental category, N454LJ, was destroyed after a loss of control during landing roll and collision with a ground vehicle at the NASA Wallops Flight Facility (WAL), Wallops Island, Virginia. The certificated airline transport pilot (ATP) was not injured. The ATP rated copilot and the flight test engineer received minor injuries. There were no injuries on the ground. Visual meteorological conditions prevailed for the local test flight that originated at WAL, at 1449. No flight plan had been filed for the flight conducted under 14 CFR Part 91.

According to the pilot, the airplane and crew were involved in flight test certification for a new nose wheel tire. For the test, the airplane was passed through a "pool" or "trough" of water on the runway at different speeds. Then data was collected using video, still photography, and on-board diagnostic equipment. The airplane was loaded, configured, and operated inside and outside the weight-and-balance and performance envelopes of a Learjet 45 registered in the normal category. The pool was 30 feet wide, 200 feet long, formed with flexible rubber dikes, and contained 3/4 of an inch of standing water. Beginning the day prior to the accident, the crew had successfully completed 10 passes through the test pool.

In a written statement, the pilot described the flight prior to the accident. He further described adjustments made on final approach to reach the intended touchdown point; 1,000 feet beyond the approach end of runway 22. The pilot said:

"Initial alignment during rollout was uneventful. [Thrust reversers] were selected to, and maintained at, idle reverse until a point where I thought we needed to select maximum reverse to get full reverse thrust and enter the pool at target speed of 80 knots. As soon as the [thrust reversers] reached full reverse, the aircraft pulled to the right. Left rudder was input to realign the fuselage.

"At pool arrival, the aircraft had almost re-aligned and I left left rudder and nose wheel steering in to attempt to drift the aircraft left a couple of feet, since it appeared the right mains were on the edge of the pool. The aircraft began a fishtail to the right (nose left) and I immediately input right rudder and stowed the [thrust reversers]. I believe this arrested the fishtail, but a runway [left] side departure was evident."

The pilot described the maneuvers necessary to avoid striking test participants, vehicles, and equipment along the left side of the runway after the airplane departed the pool. However, he was unable to prevent the right wing from striking an unmanned pickup truck parked on an intersecting runway. After collision with the truck, the wings separated from the airplane, the fuselage rolled inverted, and spilled fuel ignited.

In a written statement, the co-pilot said:

"The aircraft entered the trough with maximum thrust reversers selected. [I] gave a "mark" to specify trough entry. My impression was that the aircraft had a slight right drift at water entry. Immediately after entering the trough, the aircraft yawed left. While this yaw was apparent, [I] felt the aircraft was controllable. The aircraft corrected back to the right slightly then yawed hard left. At this point, [I] felt the aircraft was in an uncontrollable hydroplaning condition and that the aircraft was going to depart the runway."

A review of videotape revealed that left rudder inputs and movement of the airplane's nose to the left were evident just prior to pool entry. The nose wheel and rudder remained deflected as the airplane entered the pool. The airplane continued to yaw left as the tail "fishtailed" to the right. The airplane departed the left side of the runway, struck the pickup truck, and came to rest inverted and on fire.

When questioned about the airworthiness of the airplane, both pilots stated there were no deficiencies with the airplane or its performance.

The accident occurred during the hours of daylight approximately 37 degrees, 56 minutes north latitude, and 75 degrees, 27 minutes west longitude.

PILOT INFORMATION

The pilot held an Airline Transport pilot certificate with ratings for airplane single engine land, multi-engine land, and instrument airplane. He also held a flight instructor certificate for airplane single engine land, multi-engine land, and instrument airplane.

His most recent Federal Aviation Administration (FAA) First Class Medical Certificate was issued on November 17, 1997.

The pilot reported 13,073 hours of flight experience, 767 hours of which were in make and model.

The co-pilot held an Airline Transport pilot certificate with ratings for airplane multi-engine land, and instrument airplane. He also held a commercial pilot certificate with ratings for airplane single engine land, rotorcraft-helicopter, and instrument helicopter.

His most recent Federal Aviation Administration (FAA) First Class Medical Certificate was issued on June 22, 1998.

The co-pilot reported 4,202 hours of flight experience, 93 hours of which were in make and model.

AIRCRAFT INFORMATION

The airplane was a 1996 Learjet 45, registered in the experimental category to Learjet, Inc., for the purposes of research and development.

The airplane was on an annual inspection program with the most recent inspection completed on October 12, 1998. The airplane had accrued approximately 5 hours of flight time since that date and had a total of 339.4 hours at the time of the accident.

METEOROLOGICAL INFORMATION

The weather reported at Wallops Island was scattered clouds at 1,800 feet with winds from 070 degrees at 12 knots.

AERODROME INFORMATION

According to the statement:

"In the summer of 1998, prior to the accident, [the] Chief... arranged for the Virginia Department of Fire Programs to bring their Mobile Aircraft Fire Trainer to WFF in June 1999. All WFF fire fighters that are authorized to operate ARFF vehicles have completed a NFPA 1003 certification program sponsored by the Virginia Department of Fire Programs. This training included daytime, nighttime, and backup system operation of the ARFF vehicles. It also included wheel/brake fires, engine fires, and crew rescue. The next training session is scheduled for one week starting March 2, 2000. We intend to conduct this training annually."

The equipment problem with the Amertek C-4000 germane to this accident was stuck turret valves. The United States Navy identified this problem and published a solution. The Wallops Fire Department reviewed the Navy's solution but rejected it in favor of their own fix. According to the statement:

"The Navy fix was rejected in favor of replacing the actuator with a larger diameter actuator rather than slaving another cylinder into the linkage. Additionally, we sent the mechanics to the Army Vehicle Maintenance facility for two weeks of ARFF training."

SURVIVAL ASPECTS

The crew of the airplane was secured in their seats by 5-point harnesses and was uninjured during the accident sequence. The occupants were suspended inverted in their harnesses when the airplane came to rest. Release of the harnesses resulted in the crew falling to the roof of the aircraft and 2 of 3 crewmembers sustaining minor injuries.

The crewmembers stated the emergency and crew coordination training each received from the United States Military, NASA, and Learjet, along with the coordinated efforts of the crew, resulted in a successful egress from the burning wreckage

In a written statement, the pilot explained the crew was unable to open the main exit, so he and the flight-test engineer moved to the emergency exit to attempt egress. While the pilot and engineer worked unsuccessfully on the emergency exit, the co-pilot was able to open the main door and all three crewmembers exited that door. According to the pilot:

"I estimate that almost any more delay and we would not have made it, due to flames and the cabin filling up with smoke. My crew's crew coordination during the egress sequence was superb, and they were directly responsible for our successful exit from the burning wreckage."

ADDITIONAL INFORMATION

An Operations and Safety Directive (OSD) was prepared for the water ingestion tests on October 15, 1998. Members of the Operations and Safety staffs of the Wallops Flight Facility approved the test as outlined in the OSD.

Examination of the OSD, the accident site, and interviews with the crews revealed that formal risk management had not been employed. Hazard identification, risk assessment, control measure development, implementation of controls, and control evaluation was not performed.

Objects beyond the departure end of the trough (vehicles, generators, cameras, and personnel) were not

The National Aeronautics and Space Administration operated the Wallops Flight Facility, of the Goddard Space Flight Center for the purposes of flight testing. NASA, the military, various branches of the federal government, and private industry use the facility.

At the airport were three intersecting runways oriented 10-28, 17-35, and 04-22 degrees. The runways were 8,000, 4,820, and 8,750 feet respectively. All three runways were 150 feet wide and constructed of asphalt and concrete. Runway 04-22 was equipped with a water ingestion trough for water ingestion testing.

WRECKAGE INFORMATION

The wreckage was examined at the scene on October 28, 1998, and all major components were accounted for at the scene. Examination of the runway and the test pool revealed the tire tracks from the accident run were still visible. The tire tracks revealed that upon pool entry, the left main gear and the nose gear tires tracked through the pool, while the right main gear tires tracked outside the pool.

The wreckage path was approximately 300 feet long and oriented approximately 180 degrees. The wreckage path was measured from the point of collision with the truck and the final resting point of the fuselage. The truck was originally parked on the left side of runway 22 at the intersection of runway 17-35.

The truck was completely destroyed by frontal collision and post crash fire and came to rest approximately 150 feet down the wreckage path. The airplane came to rest inverted, oriented approximately 240 degrees, and was also consumed by post crash fire. Fire destroyed the airplane's exterior on the north side of the wreckage and consumed the interior. The south side of the wreckage was unmarked by fire damage.

The emergency exit door on the south side of the fuselage was undamaged and unopened.

AIRCRAFT RESCUE FIRE FIGHTING (ARFF)

A review of videotapes revealed ARFF units arrived at the accident site approximately 40 seconds after the accident. Water was dispensed from the first unit approximately 1 minute after its arrival. However, the unit, an Amertek C-4000 pumper truck, was unable to dispense water onto the fire. The turret mounted nozzle sprayed water between the truck and the fire, and then the flow of water was stopped.

The driver/firefighter egressed the cab of his truck, without his full complement of Personal Protective Equipment (PPE), and attempted to deploy the hand-held hose from his truck. The flow of water started and stopped intermittently, and the firefighter appeared to struggle with the equipment. The first response vehicle performed no effective fire fighting.

In a telephone conference, the Wallops Installation Safety Officer, Aviation Safety Officer, and Fire Chief said that their internal investigation revealed deficiencies in ARFF equipment and training.

According to the Fire Chief, the failure of the first vehicle to effectively fight the fire was the result of incomplete training and equipment malfunction. The Chief then described the equipment modifications that were performed and the subsequent training of all ARFF personnel at Wallops Island.

A written statement from the Wallops Safety Office outlined the equipment and training upgrades.

identified as hazards, nor were the personnel positioned there identified as being at risk. Several test personnel on the ground reported they abandoned their stations to avoid being struck by the accident airplane. Further, the runway was not marked with alignment cues or a go/no go point to assist the aircrew.

On scene, the Wallops Flight Facility Aviation Safety Officer (ASO) asked how future tests could be accomplished more safely. In response, formal written hazard identification, risk assessment, and risk management procedures were suggested by the Safety Board Investigator. Specific control measures offered to mitigate risk in further water ingestion tests were offered in a letter to the ASO. They were:

1. Improved alignment cues:

Temporary Highway Department grade marking tape line approximately 1,000 feet in length prior to and centered on target area.

2. Determination and marking of Go/No Go point along alignment tape:

Tape line placed over and perpendicular to alignment tape. This line would be used to determine if alignment for test run is suitable, or if test run should be abandoned in favor of aircraft control issues only.

3. Unmanned remote mounted cameras for recording event.

The Wallops Flight Facility convened a Mission Operation Review Team in response to the accident. A report of their findings and recommendations was published April 27, 1999.

Among the suggestions for water ingestion test planning were:

1. Conduct a hazard analysis and document the mitigating features. Define specific limitations on personnel locations and details on the acceptability of project equipment within the hazard area.

2. Establish aircraft alignment cues.

3. Develop and implement abort/contingency procedures.

4. Investigate the ability to satisfy mission requirements through the use of remotely operated cameras and/or longer length optics (operated from a farther distance).

5. Update the OSD to provide a map showing personnel location..."

According to FAA Advisory Circular 150/5300-13 Table 3-1, the design standard for the Runway Safety Area Width and the Runway Object Free Area Width were 500 feet and 800 feet respectively. These distances were measured from the runway centerline. Examination of diagrams provided by NASA and a review of videotape revealed that the accident pickup truck, a step van, and a trailed generator were all parked approximately 150 feet from the runway centerline.

The airplane wreckage was released to the owner on October 28, 1998.

Use your browsers 'back' function to return to synopsis
Return to Query Page

10/27/98

NTSB Identification: **IAD99FA008**

Accident occurred OCT-27-98 at WALLOPS ISLAND, VA
Aircraft: Learjet 45, registration: N454LJ
Injuries: 2 Minor, 1 Uninjured.

This is preliminary information, subject to change, and may contain errors. Any errors in this report will be corrected when the final report has been completed.

On October 27, 1998, at 1456 eastern standard time, a Learjet 45 registered in the experimental category, N454LJ, was destroyed after a loss of control during landing roll and collision with a ground vehicle at the NASA Wallops Flight Facility (WAL), Wallops Island, Virginia. The certificated airline transport pilot (ATP) was not injured. The ATP rated copilot and the flight test engineer received minor injuries. There were no injuries on the ground. Visual meteorological conditions prevailed for the local test flight that originated at WAL, at 1449. No flight plan had been filed for the flight conducted under 14 CFR Part 91. According to the pilot, the airplane and crew were involved in flight test certification for a new nose wheel tire. For the test, the airplane was passed through a "pool" or "trough" of water on the runway at different speeds. Then data was collected using video, still photography, and on-board diagnostic equipment. The airplane was loaded, configured, and operated inside and outside the weight-and-balance and performance envelopes of a Learjet 45 registered in the normal category. The pool was 30 feet wide, 200 feet long, formed with flexible rubber dikes, and contained 3/4 of an inch of standing water. Beginning the day prior to the accident, the crew had successfully completed 10 passes through the test pool. In a written statement, the pilot described the flight prior to the accident. He further described adjustments made on final approach to reach the intended touchdown point; 1,000 feet beyond the approach end of runway 22. The pilot said: "Initial alignment during rollout was uneventful. [Thrust reversers] were selected to, and maintained at, idle reverse until a point where I thought we needed to select maximum reverse to get full reverse thrust and enter the pool at target speed of 80 knots. As soon as the [thrust reversers] reached full reverse, the aircraft pulled to the right. Left rudder was input to realign the fuselage. "At pool arrival, the aircraft had almost re-aligned and I left left rudder and nose wheel steering in to attempt to drift the aircraft left a couple of feet, since it appeared the right mains were on the edge of the pool. The aircraft began a fishtail to the right (nose left) and I immediately input right rudder and stowed the [thrust reversers]. I believe this arrested the fishtail, but a runway [left] side departure was evident." The pilot described the maneuvers necessary to avoid striking test participants, vehicles, and equipment along the left side of the runway after the airplane departed the pool. However, he was unable to prevent the right wing from striking an unmanned pickup truck parked on an intersecting runway. After collision with the truck, the wings separated from the airplane, the fuselage rolled inverted, and spilled fuel ignited. In a written statement, the co-pilot said: "The aircraft entered the trough with maximum thrust reversers selected. [I] gave a "mark" to specify trough entry. My impression was that the aircraft had a slight right drift at water entry. Immediately after entering the trough, the aircraft yawed left. While this yaw was apparent, [I] felt the aircraft was controllable. The aircraft corrected back to the right slightly then yawed hard left. At this point, [I] felt the aircraft was in an uncontrollable hydroplaning condition and that the aircraft was going to depart the runway." A review of videotape revealed that nose-left steering and left rudder inputs were evident just prior to pool entry. The nose wheel and rudder remained deflected as the airplane entered the pool. The airplane continued to yaw left as the tail "fishtailed" to the right. The airplane departed the left side of the runway, struck the vehicle, and came to rest inverted and on fire. The wreckage was examined at the scene on October 28, 1998, and all major components were accounted for at the scene.

Examination of the runway and the test pool revealed the tire tracks from the accident run were still visible. The tire tracks revealed that upon pool entry, the left main gear and the nose gear tires tracked through the pool, while the right main gear tires tracked outside the pool. When questioned about the airworthiness of the airplane, both pilots stated there were no deficiencies with the airplane or its performance. The pilots further stated the emergency and crew coordination training each received from the United States military, NASA, and Learjet, along with the coordinated efforts of the crew, resulted in a successful egress from the burning wreckage.

Index for Oct 1998 | Index of Months

Learjet 45 destroyed during ponding tests

by Paul Lowe

A Bombardier Learjet 45 undergoing post-certification testing at NASA's Wallops Flight Facility (WAL) in Wallops Island, Va., was destroyed on October 27 when it ran off the runway and struck an unoccupied NASA vehicle. Two of the three crewmen were taken to a nearby hospital for treatment of minor injuries, while the captain refused treatment at the scene.

He told the National Transportation Safety Board that the tests involved rolling out the Model 45 at different speeds through a "pool" or "trough" of standing water after landing to certify a new nosewheel tire. On the accident landing, the aircraft slid off the left side of Runway 22, struck the vehicle and came to rest inverted and on fire at 1456 EST. The flight was conducted under Part 91 in VMC, and originated at WAL at 1449.

The tire tracks revealed that upon entering the purposely ponded water, the left main gear and the nose gear tires tracked through the 30-ft-wide by 200-ft-long pool, while the right main gear tires tracked outside of it. The 3/4 in. of surface water was held by flexible rubber dikes.

The day before the accident, the Wichita-based crew had successfully completed ten passes through the test pool, with data collected using video, still photography and onboard diagnostic equipment. The test aircraft, N454LJ (S/N 45-004), was registered in the experimental category but was loaded, configured and operated both inside and outside the weight-and-balance and performance envelopes of a Learjet 45 registered in the normal category.

In his written statement, the ATP-rated captain described the adjustments he made while on final to reach the intended touchdown point 1,000 ft beyond the approach end of Runway 22. He then described the landing: "Initial alignment during rollout was uneventful. [Thrust reversers] were selected to, and maintained at, idle reverse until a point where I thought we needed to select maximum reverse to get full reverse thrust and enter the pool at the target speed of 80 knots."

As soon as the thrust reversers reached full reverse, he wrote, the twin turbofan pulled to the right and he added left rudder to realign the fuselage. "At pool arrival, the aircraft had almost realigned and I left both left rudder and nosewheel steering in to attempt to drift the aircraft left a couple of feet, since it appeared the right mains were on the edge of the pool," he recalled. "The aircraft began a fishtail to the right [nose left] and I immediately input right rudder and stowed the [thrust reversers]. I believe this arrested the fishtail, but a runway [left] side departure was evident."

He maneuvered to avoid hitting equipment along the left side of the runway after the Learjet skidded through the test pool, but was unable to prevent the right wing from striking a pickup truck parked on an intersecting runway. After the collision, the wings separated from the airplane, the fuselage rolled inverted, and spilled fuel ignited.

The ATP-rated copilot recalled that the Model 45 had maximum thrust reversers selected when it entered the trough. "[I] gave a 'mark' to specify trough entry," he wrote. "My impression was that the aircraft had a slight right drift at water entry. Immediately after entering the trough, the aircraft yawed left. While this yaw was apparent, [I] felt the aircraft was controllable. The aircraft corrected back to the right slightly, then yawed hard left. At this point, [I] felt the aircraft was in an uncontrollable hydroplaning condition and that the aircraft was going to depart the runway."

NTSB said a review of the videotape revealed that nose-left steering and left rudder inputs were evident just before pool entry, and the nosewheel and rudder remained deflected as the Learjet entered the pool. It continued to yaw left while the empennage "fishtailed" to the right as control was lost.

The Board said the wreckage was examined on October 28, and all major components were accounted for at the scene. When questioned about the airworthiness of the airplane, both pilots said there were no deficiencies with the airplane or its performance.

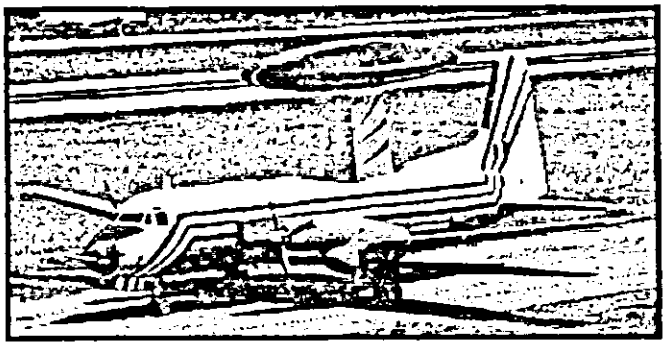
According to NASA, the aircraft was conducting tests to demonstrate that water thrown up by the nosewheel and mainwheels during takeoff and landing is not directed into the engines in hazardous quantities. A Learjet spokesman described it as "post-certification testing outside the envelope...things you wouldn't cover normally."

S/N 45-004 was one of the aircraft used in the original certification of the Model 45, which was awarded its airworthiness certificate by FAA last spring. The Learjet spokesman said the company often continues "support testing," and, in fact, still does flight trials with an older Model 31, introduced in 1987. The loss of N454LJ is not expected to affect additional Model 45 testing. □

Jan 11, 1999

#4748 Modified to "AWACS" Config

Crash n Burn: The Flying Chapatti story



The HS-748 Avro based Flying Chapatti

When a HS-748 Avro aircraft crashed into the dense forests near Arakkonam in Tamil Nadu on January 11th 1999, it not only killed eight people but also caused a severe setback to one of India's most ambitious defence research projects. The Avro, which belonged to the Defence Research and Development Organisation's(DRDO's) Centre for Airborne Systems(CABS), was a test platform for developing a sophisticated indigenous Airborne Early Warning(AEW) system--India's answer to the AWACS (Airborne Warning and Control System) developed by the US.

Theres no doubt that India needs an AWACS. After Pakistan failed in acquiring the AWACS in the mid-'80s, India decided to try its hand at building a system. Studies and analyses on an indigenous ASP(airborne surveillance platform) began in July 1985 under project "Guardian", later renamed "Airawat". According to DRDO, 43 lead-in-schemes were initiated to prove various concepts and technologies, outlining specifications, building a technical data base, and developing prototype hardware.

Essentially, an "eye in the sky" with a very wide sweep, the ASP was meant to provide advance warning about hostile activity across the border. The goal was to achieve long-range surveillance capability. "The concept was not confined to India's tactical air battlefield. When we built one, we wanted it to be as good as the best in the world, better than the Hawkeye," said a DRDO scientist.

Some aircraft of this type are capable of identifying upto 600 targets even 200 miles away, it is said. The utility of ASP also lies in its ability to act as an air-based command and control centre, overcoming the limitation of directing air operations from the ground. Early warning by such a plane was seen as the key to pre-positioning planes, giving them a big advantage in combat. Essentially a "force multiplier" for greatly enhancing the capability of all the fighter jets, especially the high performance planes of the IAF like the MiG-29's, Mirage-2000's and SU-30's.

The "technology demonstrator" ASP was configured around a platform of an Avro plane on which a revolving rotordome was to be mounted. On May 24, 1989, the Avro fitted with the pylons(without the dome) first flew at the Kanpur facility of Hindustan Aeronautics Limited (HAL). It was then ferried to Bangalore, where CABS fitted it with a 24 ft x 5 ft composite rotodome. It took to the air on November 5, 1990.

CABS, which had been set up under Dr K. Ramchand, acted as a system house and integration agency using all the expertise and infrastructure available in India. All through the 90s, scientists at CABS and the Electronics and Radar Development Establishment(LRDE), worked on the turning rotodome, on the high-power transmitter, the antenna, the signal processor, the post-processor and the radar data-processor.

The challenge was to rotate the dome for all-round coverage. System Controls, a Bangalore-based private enterprise, developed the hydraulic controller which provided dynamic speed selection through touch-screen user interface. The rotodome is driven by a hydraulic servo system using aircraft hydraulic power. The dome was fabricated with the help of Hindustan Aeronautics(HAL). Static analysis of the rotodomed-aircraft was done at the National Aerospace Laboratories(NAL) as also the ground tests and computational studies on its dynamics.

Flying Chapatti at the Aero India show in 1998

The ASP had been in test flight with the CABS for some years now and had been flown during the Aero India shows in 1996 and 1998. The DRDO had spent a little over Rs 200 crore to develop this early warning system, similar to the American E-2C Hawkeye. However DRDO officials said that to get the capabilities of even the E-2C, India would have to spend at least Rs 2,000 crore.

The programme had achieved stellar success in most aspects, including airborne radar analysis, "target against clutter" characterisation and measurement and developing a hybrid navigation system. The main challenge left was, to quote a CABS brochure, "evolving the radar and support mission system avionics into a flying surveillance platform". There had been reports of using active phased array radars in which the direction of radar signals could be swivelled electronically, thus negating the need for a rotating dome. Educated guesses were made that the ill-fated mission was testing the new radar system. But CABS officials denied this. "We had finalised the former," they said.

The ASP had flown several sorties during the last week where it was undergoing trials and operating from the naval airbase 'INS Rajali' at Arakkonam near Chennai. It was on a test flight between Vellore and Tambaram when it crashed. "The aircraft did two somersaults, then swerved to avoid electricity lines and the villagers," said S. Ezhamalai, the village head of Attur village which is about 5 km from INS Rajali. "What would have happened had he not done so."

The debris of the Avro HS-748 in Attur village

Stunned personnel of the CABS were tight-lipped about the crash as top officials, including centre Director Dr K. Ramchand and Additional Director K. Tamil Mani, were away at Vellore. DRDO chief and Scientific Advisor to Defence Minister Dr A.P.J. Abdul Kalam also rushed to Vellore and later arrived in Bangalore with the bodies.

Speculation was rife about possible causes of the crash. One theory based on eyewitness accounts suggested that the rotodome may have collapsed, causing the pilot to lose rudder control. CABS scientists however found it hard to believe the rotodome collapsed on the plane. The indigenous fabrication of the rotodome mounting had won the team the DRDO's "outstanding contribution award" in 1992, and no problem had been reported in nine years.

Some reports questioned the DRDO's wisdom of developing this technology on an "unreliable" HS-748 Avro. However officials said it was only an experimental platform. "The platform would finally have to be decided by the user, the IAF," they added. DRDO chief Dr Abdul Kalam had pointed out at the Bangalore air show(1998) that after having configured the radar, the project had moved to the search for the next platform. "If the user wants a longer range, we can have a bigger platform," he had said. DRDO was believed to have been looking at either an Ilyushin-76 or a Boeing.

Indian Air Force(IAF) pilots pointed out that though old, the Avro's were not unsafe. The IAF was in fact still flying a couple of dozen of these aircraft. The IAF which lost four of its men in the accident commissioned a four-member team to look into it. The blackbox, containing critical records of the last hour of the flight were recovered and studied. Meanwhile the ASP programme was grounded until the real reason of the crash could be determined. Investigations into the crash later revealed that the rotodome fitted on the Avro had indeed broken off, hit the aircraft's tail and resulted in the accident.

Scientists I. Jayakumar(LRDE) and K.P. Shaju(CABS) were among the eight killed

Officials at CABS were concerned more with the loss of the scientists and the air force officers than the experimental platform. "We can build another one, but four of the key men have gone," said an official. Not a mere elegiac statement. CABS has attracted some of the smartest young scientists, their average age, 32, is among the lowest in the world. Among those killed were four test pilots with the Aircraft Systems and Training Establishment, two scientists of LRDE and two from CABS. Mr P. Elango and K.P. Shaju of CABS were working with D. Narasimha Sharma and Immanuel Jayakumar of the Bangalore-based LRDE and interfacing with squadron leaders P. Venkataraman, N.V. Seshu, S. Bhatnagar and B. Ravi of the IAF Systems Training Establishment when the crash took place. They had not only designed and fabricated the large rotodome but also validated the concept by frequent flight trials. The aircraft had already logged over 225 hours of test flight with the rotordome.

In the wake of the Avro crash, the question before CABS director K. Ramchand and DRDO director Dr A.P.J. Abdul Kalam was whether to start again on another platform. "We had completed about 90 per cent of the project," said a DRDO scientist. "It would take us back at least by three years." Even CABS director K. Ramchand, who in 1996 spoke of how the modified Avro could detect an object flying at supersonic speed 10 minutes in advance, was cautious. "We will try to restart the project," he said. CABS was prepared to build another rotodome and fit it on a spare Avro, on which some structural modifications had already been carried out. But the Ministry of Defence(MoD) refused it clearance and asked CABS to go slow on the project. "The crash will set back the programme and the system will have to be imported," said Roddam Narasimha, director of the National Institute of Advanced Studies (NIAS) and a noted aerospace scientist.

Dr V.K. Atre

In January 2000, the Indian government decided to scrap the AEW project and buy a system from either Israel or Russia. "It has been put in the cold storage for now," admitted Dr V.K. Atre, Scientific Advisor to the Defence Minister. "The pros and cons have been considered. The progress has been slow, and after the crash, the project has been reviewed and we have decided to put it on hold." "But for the crash, we would have got it operational by now," said another official attached to the project.

The IAF was set to acquire the Russian A-50 AEW system based on an Ilyushin-76 aircraft, however after extensive trials it was found to be unsatisfactory. Later, Israel entered the scene offering Phalcon systems. However the US put enormous pressure on Israel to scrap the deal, citing the post-Pokhran sanctions. "Israel has been restrained by the US from selling it to India," admitted an IAF official. Union Home Minister Lal Krishna Advani, visited Israel and tried to persuade them to go ahead with the deal. Defence Minister George Fernandes also had discussions with Israeli authorities on this issue.

The US EP-3 spy plane's crew detained by China

Following the election of Republican George Bush as President of the US in December 2000, things began to change positively in India's favour. The anti-China mood in the US senate following the detaining of a US spy plane by the Chinese in April 2001 and the subsequent diplomatic tussle, caused the US to view India as a suitable counter-weight to an increasingly aggressive and belligerant China. The US gave Israel an informal nod, allowing it to go ahead with its AWACS deal with India. There are also talks of the post-Pokhran sanctions being dropped.

In August 2001, reports at the Le Bourget airshow indicated a successful tie-up between Israel Aircraft Industries(IAI) and Beriev of Russia to build an Indian Awacs. The new aircraft, dubbed the A-50EhI, will build on electronics Israeli companies developed for China's AEW requirement, a program that was dropped after strident US opposition. A final agreement was said to have been reached and 3 aircraft will be produced for the Indian Air Force in a deal worth about $1 billion. According to Beriev, the aircraft will be the brand-new Il-76TD with P-90A engines. Delivery is expected in 2005, with Russian aircraft, Israeli radar and Indian software programming.

11/01/99

AviationSafetyNetwork

Accident Description

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Accident description

Date:	**11.01.1999**
Time:	15.45
Type:	Hindustan Aeronautics Ltd. HAL-748-219 Srs. 2
Operator:	Defence Research and Development Org.
Registration:	H-2175
C/n:	569
Year built:	1978
Crew:	4 fatalities / 4 on board
Passengers:	4 fatalities / 4 on board
Total:	8 fatalities / 8 on board
Location:	Athur (India)
Phase:	
Nature:	Military
Flight:	- (Flightnumber)

Remarks:
The HAL-748 plane crashed 2,5km from the Arakkonam NAS. The aircraft crashed in a dense forest. The HAL-748 was converted to carry a rotordome, which would ultimately house the in-built radar, on top. Prelminary reports suggest the dome collapsed on top of the aircraft, since the dome was found 2km from the runway.

Source:

- The Hindu
- The Hindustan Times

[disclaimer]

1/11/99

Indian crash victims worked on key defence project

RTw 1/12/99 8:45 AM

NEW DELHI, Jan 12 (Reuters) - Four Indian defence scientists who died in a plane crash this week were involved in a key project to build the country's first airborne early-warning control and command system, officials said on Tuesday.

Eight people, including the four scientists from the Defence Research and Development Organisation (DRDO), died when an Indian Air Force Avro aircraft crashed in southern India on Monday.

"All the eight were on board an Avro 748 modified to carry out a DRDO project," the defence ministry said in a statement. Four other victims belonged to the Indian Air Force.

The statement did not give a cause for the crash. The plane came down near Athur in Tamil Nadu state.

The plane, which carried a saucer-shaped radar dome, was exhibited at an airshow in southern Bangalore city this month.

Work on the airborne early-warning project began more than a decade ago, experts said.

Airport Tax

APn 1/12/99 2:04 AM

WASHINGTON (AP) -- A bill to renew the Federal Aviation Administration may include a proposal to raise an airport ticket tax from $3 to $5, The Associated Press has learned.

The passenger facility charge, or PFC, is a tax requested by local governments and earmarked for improvements at their airports. It must be approved by the Transportation Department.

PFCs are capped at $12 a ticket -- equal to four $3 charges per round trip -- but would rise to a maximum of $20 a ticket under the administration proposal.

The federal government also levies its own airline ticket tax: 8 percent of a passenger's airfare, plus $2 for each leg of a trip. The combination of taxes and PFCs can add substantially to the price of an airplane ticket.

For example, the cost of a round trip from Washington to Orange County, Calif., via O'Hare airport in Chicago climbs by a total of $35 when the tax, segment charges and PFCs are added. The airports in Washington and Chicago both charge $3 facility fees each way.

Last year the Clinton administration tried to raise the fee from $3 to $4 per airport, but Congress rejected the change.

The administration has yet to announce its latest intentions, but the fee increase is one of the final elements being drafted into legislation that would reauthorize the FAA, according to a Transportation Department source, who spoke on the condition of anonymity.

In an interview in December, Transportation Secretary Rodney Slater said the nation's aviation system needs widespread investment, including money to modernize the air traffic control system, improve personnel training and rebuild airports.

Last year's administration proposal to raise the PFC was supported by the Airports Council International-North America, which represents airport operators. It said airports will not be able to handle an expected surge in travel without significant capital investment.

April 07, 1999

G-164-B
Grumann

Turbine Engine
STC Conversion

4/7/99

FAA INCIDENT DATA SYSTEM REPORT
Report Number: 19990407019289G

General Information

Local Date:	04/07/1999
Local Time:	13:30
City:State	NUNICA:MI
Airport Name:ID	JABLONSKI:33C

Aircraft Information

Aircraft Damage:	MINOR
Phase of Flight:	ROLL-OUT (FIXED WING)
Aircraft Make/Model:	GRUMAN G-164-B
Airframe Hours:	8478
Operator/Operator Code:	
Owner Name:	

Narrative

AIRCRAFT MADE A NORMAL LANDING ON RUNWAY 26. AFTER THE TAIL WHEEL CONTACTED THE GROUND THE PILOT SELECTED THE "BATA RANGE" AND THE TAIL WHEEL STARTED TO RISE AND CONTINUED TO COME UP UNTIL THE PROPELLER HIT THE GROUND AND FLIPPED THE AIRCRAFT OVER. (NOTE AIRCRAFT WAS BEING TEST FLOWN FOR AN STC TURBINE ENGINE CONVERSION) PILOT TO RECEIVE 4040.90 FLIGHT CHECK.

Detail

Primary Flight Type:	OTHER
Secondary Flight Type:	TEST FLIGHT
Type of Operation:	GENERAL OPERATING RULES
Registration Number:	48417
Total Aboard:	1
Fatalities:Injuries:	
Landing Gear:	
Aircraft Weight Class:	UNDER 12501 LBS
Engine Make:Model	WALTER:M601E11
Engine Group:	M601
Number of Engines:	1
Engine Type:	TURBOPROP

Environmental/Operations Information

Primary Flight Conditions:	VISUAL FLIGHT RULES
Secondary Flight Conditions:	WEATHER NOT A FACTOR
Wind Direction (deg):Wind Speed (mph):	
Visibility (mi):	
Visibility Restrictions:	

Light Condition: DAY
Flight Plan Filed: NONE
Approach Type:

Pilot-in-Command

Pilot Certificates:	AIRLINE TRANSPORT
Pilot Rating:	AIRPLANE SINGLE, MULTI-ENGINE LAND
Pilot Qualification:	UNKNOWN, FOREIGN PILOT
Flight Time (Hours)	
Total Hours:	6100
Total in Make/Model:	20
Total Last 90 Days:	
Total Last 90 Days Make/Model:	

08/24/1999

ERJ-135

8/24/97

NTSB Identification: **SEA99IA148** . The docket is stored in the (offline) NTSB Imaging System.

Incident occurred Tuesday, August 24, 1999 at MOSES LAKE, WA
Aircraft:Embraer ERJ-135, registration: PTZJA
Injuries: 3 Uninjured.

The pilot reported that during a minimum unstick speed determination test flight, the aircraft lifted off to about five feet and, just prior to achieving aileron effectiveness, the aircraft rolled to the left. The left wing dropped and contacted the runway surface, resulting in minor damage to the wingtip and outboard trailing edge of the aileron. The pilot continued the takeoff and returned for landing without further incident.

The National Transportation Safety Board determines the probable cause(s) of this accident was:

Minimum aircraft control exceeded during takeoff test flight, which resulted in dragging a wing on the runway surface.

Full narrative available

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SEA99IA148

On August 24, 1999, at 1110 Pacific daylight time, an Embraer ERJ-135, PTZJA, registered to and operated by Embraer as a 14 CFR Part 91 test flight, dragged a wing tip on the runway and damaged runway lights during a minimum unstick speed flight test at the Grant County Airport, Moses Lake, Washington. Visual meteorological conditions prevailed at the time and no flight plan was filed for the local flight. The airplane received minor damage and the two airline transport pilots and flight engineer, were not injured.

In a written statement, the pilot reported that the test maneuver was a minimum unstick speed determination. The pilot stated that during the eighth takeoff the aircraft lifted off to about five feet and, just prior to achieving aileron effectiveness, the aircraft rolled to the left. The left wing dropped and contacted the runway surface, resulting in minor damage to the wingtip and outboard trailing edge of the aileron. The pilot continued the takeoff and returned for landing without further incident.

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