MINISTERE DE L'EQUIPEMENT, DES TRANSPORTS, DU LOGEMENT, DU TOURISME ET DE LA MER - BUREAU D'ENQUETES ET D'ANALYSES POUR LA SECURITE DE L'AVIATION CIVILE

BEA

Accident on 2 May 2000 at Lyon-Satolas (69) to the Learjet 35A registered G-MURI operated by Northern Executive Aviation Ltd

REPORT

g-ri000502a

F O R E W O R D

This report presents the technical conclusions reached by the BEA on the circumstances and causes of this accident.

In accordance with Annex 13 of the Convention on International Civil Aviation, with EC directive 94/56 and with Law No. 99-243 of 29 March 1999, the analysis of the accident and the conclusions and safety recommendations contained in this report are intended neither to apportion blame, nor to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents or incidents. Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

SPECIAL FOREWORD TO ENGLISH EDITION

This report has been translated and published by the BEA to make its reading easier for English-speaking people. As accurate as the translation may be, the original text in French should be considered as the work of reference.

Contents

Glossary

ADI	Attitude Director Indicator
CAA	Civil Aviation Authority
DGAC	Direction Générale de l'Aviation Civile (General Directorate for Civil Aviation)
FAR	Federal Aviation Regulations
ft	Feet
HSI	Horizontal Situation Indicator
IVSI	Instantaneous Vertical Speed Indicator
JAR	Joint Airworthiness Requirements
kt	Knots
MSW	Control Wheel Master Switch
lb	Pound
NM	Nautical Mile
PF	Pilot Flying
PNF	Pilot Not Flying
QNH	Altimeter setting to obtain aerodrome elevation when on the ground
RMI	Radio Magnetic Indicator
SOAP	Spectrometric Oil Analysis Program
UTC	Universal Time Co-ordinated

SYNOPSIS

Date and Time

Tuesday 2 May 2000 at 12 h 39[1]

Site of accident

Lyon-Satolas Airport (69)

Type of flight

Chartered transport of passengers
Flight NEX 4B from Farnborough (UK) to Nice (France)

Aircraft

Learjet 35A registered G-MURI

Owner

Murray Aviation Ltd.

Operator

Northern Executive Ltd.

Persons on board

2 flight crew, 3 passengers

Summary

The Learjet 35A registered G-MURI was undertaking a flight between Farnborough and Nice. While in cruise at FL 390, it suffered a failure on the left engine. The crew decided to divert to Lyon-Satolas airport. The aircraft was guided on final approach to runway 36L by the ILS. On short final, when just over the runway threshold, the aircraft banked sharply to the left, the wing touched the ground and it crashed and caught fire.

	People			Equipment	Third Parties
	Killed	Injured	Uninjured		
Crew	2	-	-	Destroyed	N/A
Passengers	-	-	3		

[1] All times in this report are UTC except where otherwise specified. Two hours should be added to obtain the legal time applicable in metropolitan France on the day of the accident.

ORGANISATION OF THE INVESTIGATION

The BEA was informed of the accident on 2 May 2000 at around 12 h 45. An investigator-in-charge was appointed to lead the investigation and an investigation group was formed.

In accordance with the provisions of Annexe 13 of the Chicago Convention, the United Kingdom, as State of Registration and State of Operator of the aircraft, and the United States, as State of Manufacture, each appointed an accredited representative, assisted by advisers.

For the purposes of the technical investigation, working groups were formed in order to gather information in the following areas:

- engine,
- structure and systems,
- flight, crew and ATC data (radio and radar).

Subsequently, a variety of work was undertaken:

- teardown of the left engine,
- examination of the left engine bearing No.5,
- examination of the warning panel,
- examination of the fuel transfer and feed valves.

The work was undertaken in co-ordination with the judicial authorities.

The results from this work are contained in this report.

In accordance with Annex 13, the Draft Final Report was sent to the AAIB, for the United Kingdom, and to the NTSB, for the United States, for comments. The NTSB indicated that they had no comments to make. The AAIB made some comments which have been taken into account in the present report. The AAIB also made some general observations which are appended to this report

1 – FACTUAL INFORMATION

1.1 History of the Flight

On 2 May 2000 at 9 h 35, the Learjet 35A registered G-MURI took off from Manchester (United Kingdom) for a positioning flight to Farnborough. The flight took forty minutes. At 11 h 22, it left Farnborough bound for Nice as flight number NEX 4B with five people and a dog on board. The Captain was pilot flying (PF).

The aircraft climbed initially to FL 270, which it reached at 11 h 41.

At 12 h 22, cruising at FL 390, the left engine of the aircraft suffered a failure. The crew shut it down and began to descend. They declared an emergency and asked to fly to the nearest aerodrome with a runway longer than one thousand six hundred metres. Lyon-Satolas airport, located about sixty-two nautical miles away left abeam of the aircraft, was proposed. The descent with one engine shut down towards Lyon-Satolas was undertaken under radar guidance, at a high speed and with a high rate of descent.

At 12 h 35, the pilot stabilised the aircraft at three thousand feet, intercepted the runway 36L ILS and was cleared to land. The final was started at 233 kt according to radar data and the slow down progressive. At 12 h 36 min 45 s, the flaps were extended to 8°. According to the radar data, the aircraft was then at 2,400 ft[2], 4.4 NM from the runway threshold and at a speed of 184 kt. At 12 h 36 min 58 s, the landing gear was extended. At 12 h 37 min 03 s, the flaps were set to 20°. According to the radar data, the aircraft was then at 2,100 ft, 3.5 NM from the runway threshold at a speed of 180 kt. No malfunctions or additional problems were announced to the ATC by the crew during the final approach.

At 12 h 38 min 08 s, the co-pilot told the Captain that the aircraft was a little low. According to the radar data, the aircraft was then at 1,100 ft, 0.9 NM from the runway threshold at a speed of 155 kt. At 12 h 38 min 17 s, he repeated his warning and announced a speed 10 kt above the approach reference speed. At 12 h 38 min 22 s, the co-pilot again stated that the aircraft was a little low on the approach path and immediately afterwards asked the Captain to increase the thrust. According to the radar data, the aircraft was then at 900 ft, 0.1 NM from the runway threshold at a speed of 150 kt. At 12 h 38 min 24 s, the Captain indicated that he was losing control of the aircraft. The aircraft, over the runway threshold, banked sharply to the left, touched the ground with its wing, crashed and caught fire.

[2] Altitude corresponding to the values transmitted by the encoding altimeter. Taking into account the QNH on that day, about 800 feet should be subtracted to estimate the height above the ground.

1.2 Injuries to Persons

	Fatal	Serious	Minor/None
Crew	2	-	-
Passengers	-	-	3
Others	-	-	-

1.3 Damage to Aircraft

The aircraft was destroyed by the impact and the fire.

1.4 Other damage

There was no third party damage.

1.5 Personnel Information

1.5.1 Captain

- Male, aged 46 years, joined the company on 1st June 1995
- Airline Transport Pilot's Licence (ATPL) issued by the United Kingdom on 12 November 1991 valid until 11 November 2001
- Type rating issued on 2 April 1995
- Captain on the Learjet 35A since 1997.
- Last Base Check (P1 H and PH right seat) on type on 19 January 2000, valid until 18 July 2000
- Last Line Check (P1 H and P2 NH) on type on 23 July 1999 valid until 22 August 2000
- Instrument Rating renewal 23 July 1999 valid until 22 August 2000
- Medical certificate Class one issued on 15 December 1999 valid until 1st July 2000. Limitations:
  - valid only while wearing correcting spectacles with second pairs avalaible,
  - holder to fly as or with qualified co-pilot only.

Flying experience:

- Total flying hours 4,954 including 2,113 on type
- In the previous 90 days: 46 all on type

- In the previous 28 days: 14 all on type
- In the previous 24 hours: 4 including the accident flight

The Captain had not performed a landing at Lyon in the previous twelve months, his rest period before the flight was eleven hours.

1.5.2 Co-pilot

- Male, aged 33 years, joined the company on 1st March 1998.
- Commercial Pilot's Licence (CPL) issued by the United Kingdom on 20 June 1997 valid until 19 June 2007
- Type rating obtained on 27 April 1998
- Last Base Check (P1 H) on type 30 November 1999 valid until 29 May 2000
- Last Line Check (P2 H and P2 NH) on type 8 July 1999 valid until 7 August 2000
- Instrument Rating renewal 10 May 1999 valid until 9 June 2000
- Medical certificate Class one issued on 14 January 2000 valid until 1st February 2001. No Limitations.

Flying experience:

- Total flying hours 1,068 including 850 on type
- In the previous 90 days: 103 all on type
- In the previous 28 days: 9 all on type
- In the previous 24 hours: 2 including the accident flight

The co-pilot had not performed a landing at Lyon in the previous twelve months, his rest period before the flight was over twenty-four hours. His previous flight had been performed on 26 April.

1.5.3 Training and checks

Both pilots had completed an approved Learjet 35A initial training course that included simulator training.

All subsequent recurrent training was conducted on the aircraft under the guidance of training pilots approved by the UK CAA.

Note 1: The base checks, conducted every six months, include an engine failure during take off followed by a single engine, radar vectored ILS, which culminates in a "go-around", as well as at least one landing with one engine shut down.

Note 2: In addition, the commander is required to complete a check of his ability to fly from the right hand seat. This check includes the same exercises as for the base check, plus a visual circuit before landing.

Both pilots had completed Cockpit Resource Management (CRM) training in accordance with the requirements of the UK CAA. This specialised training was performed by another airline.

1.6 Aircraft Information

1.6.1 Airframe

- Manufacturer: Gates Learjet Corporation, USA
- Type: Learjet 35A
- Serial number: 35A-646
- Entry into service: 21 December 1988
- UK Registration Certificate issued 19 February 1998
- Airworthiness Certificate issued 19 February 2000, valid to 18 February 2003
- Flying hours since manufacture: 4,291.35
- Flying cycles since manufacture: 3,637

The aircraft, formerly operated in the United States, was issued an Export Certificate of Airworthiness on 18 February 1998. The inspections carried out for this purpose included some anticipated works due at twelve years from date of manufacture and incorporation of the modifications required by the CAA in Engineering Change Request 1793. This included introduction of a gated flap lever, stall warning audio and engine fire bells. A flight test was conducted by Learjet on 13 February 1998. The aircraft was delivered at 3,675.7 Hours and 3,090 Cycles.

On 15 May 1998, a 300 hour inspection was performed at 3,761 hours and 3,167 cycles. On 14 June 1999, a 300 hours inspection and a 600 hours inspection were performed at 4,050.5 hours and 3,433 cycles.

1.6.2 Engines

- Number of engines: 2
- Manufacturer: Honeywell International (Allied Signal/Garrett), USA
- Type: TFE 731-2-2B
- Part Number: 3070300-3564

1.6.2.1 Left Engine

- Serial Number: P-74207
- Total running time: 8,404 hours
- As the engine was operated in the United States, the 150 and 300 hours inspections were conducted on 5 November 1999 at 8,288.4 TSN
- The Spectrometric Oil Analysis Program (SOAP) Check performed on 5 November 1999 showed the following filter results: Carbon and Aluminium traces (less than 10% of net filter weight) but with a major (40% or more of net filter weight) grit content. This result was considered as Normal
- A further analysis was performed on 9 December 1999 after the oil filter bypass indicator popped up. The sample showed the following filter results: Iron 17-4 and Carbon traces, Aluminium minor (10-39% of net filter weight) fine wear and major grit. The Iron 17-4 traces were four small chunks. The laboratory asked for a further analysis after 25 hours
- The engine had been removed from the Learjet 35A-298 on 22 December 1999
- On 27 January 2000, the engine configuration and serviceability were verified in the United-States at 8,373 hours and 5,152 cycles, before its return to service
- The engine was fitted to the aircraft on 24 February 2000 at 8,373 TSN and 5,152 CSN. At the time of departure on the accident flight the engine had 8,402 TSN and 5,178 CSN
- It was installed on G-MURI on 24 February 2000
- The 25 hours (8.5 filter hours) sample was taken on 17 March 2000 and produced a normal result which allowed resumption of taking of samples at the recommended intervals. The filter results indicated: Stainless Steel, Carbon, Copper, Magnesium and Aluminium traces. Major grit was also noted. The laboratory comment highlighted C863 Stainless Steel Flakes and 17-4 PH (Iron)
- The last analysis conducted on 14 April 2000 at 8,396 TSN, 5,172 CSN and 23 filter hours confirmed a normal result
- At departure on the day of the accident, the engine had run for 8,402 hours and 5,176 cycles

1.6.2.2 Right Engine

- Serial Number: P-74263
- Total run time: 6,562 hours
- The engine was removed from the Learjet 35A-002 on 26 November 1999
- On 29 December 1999, the engine configuration and serviceability were verified in the United States at 6,531 hours and 5,625 cycles. At the same time the 150 and 300 hours inspections were conducted
- The SOAP analysis performed on 29 December 1999 showed some carbon and aluminium traces (less than 10% of net filter weight) and major (40% or more of net filter weight) grit content. The result was considered as normal
- The engine was installed on G-MURI on 24 February 2000
- The last SOAP analysis conducted on 14 April 2000 at 6,554 hours, 5,645 cycles and 23 filter hours gave a normal result
- At departure on the day of the accident, the engine had run for 6,560 hours and

5,651 cycles.

1.6.3 Weight and Balance

The takeoff weight was estimated as being 17,186 lb and on landing at around 15,100 lb. The aircraft's weight at the time of the engine failure has been estimated at around 15,300 lb. In all cases, the aircraft was within the accepted balance limits.

1.6.4 Performance

The following characteristic performance figures, in relation to the event, are taken from the aircraft Flight Manual:

- At a weight of 15,300 lb, single engine flight is possible at FL 250.
- The VREF corresponding to a weight of 15,300 lb is 129 kt.
- The VMCa (minimum velocity for control of the aircraft in flight) is 110 kt. This is the minimum speed at which the aircraft can be maintained in level flight after the shut down of the critical engine, the other engine being at maximum takeoff thrust.
- The VsO (stall velocity in landing configuration) at a weight of 15,300 lb is 100 kt.

The normal recommended descent parameters are:

- Above 10,000 ft: indicated airspeed of 350 kt and vertical speed of 3,000 ft/min.
- Below this altitude: indicated airspeed of 250 kt and vertical speed of 3,000 ft/min.

In operation, during final with one engine shut down, with landing gear down and flaps extended to 20°, the N1 corresponding to the first part of the descent is normally about 61%, and it can then be increased to about 70% when the landing is assured and the configuration adapted.

1.7 Meteorological Conditions

Prior to departure from Manchester the crew were issued with their meteorological dossier for both the flight to Farnborough and for the onward flight from Farnborough to Nice. This dossier included the following notable elements:

- Situation at altitude at 12 h 00:

The east of France was influenced by the edge of the trough from the depression centred off Portugal. Light winds from the south were passing east and then north-east of the Paris basin.

- Ground situation at 12 h 00:

The pressure field was disparate, slightly depressive, with stormy activity over high ground. Winds were light, varying from southeast to northeast.

1.7.1 Conditions in the accident region

Over the Lyon region, the weather was unstable and stormy with 1/8 of cumulus at 2,000 ft and 1 to 2/8 of cumulonimbus at 3,000 ft. Visibility was estimated at 10 km. The ground wind was said to be variable, mainly from the north, weak from 5 to 10 kt, with wind in the lower cloud layers (up to 5,000 ft) estimated as mainly north-north-west at lower levels, and north-north-east at higher levels, at 10 to 15 kt. The 0°C isotherm was at about 10,000 ft.

1.7.2 Observation at Lyon-Satolas at 12 h 30

- Wind 360°/6 kt variable from 300° to 030°,
- Visibility over 10 km,
- Cloud: 1/8 Cu at 2,000 ft, 1/8 Cb at 3,000 ft,
- Temperature: 22 °C
- Dewpoint temperature : 15 °C
- Humidity: 67%
- QNH: 1014 hPa, QFE threshold 36L: 985 hPa.

1.8 Aids to Navigation

Lyon-Satolas airport is equipped with a 114.750 MHz frequency LSA VOR-DME installed more or less in the centre of the airport. Runway 36L has a 110.750 MHz frequency SAN ILS whose descent line-up radio is associated with a DME. The final approach track passes directly over the 405 kHz frequency LYS locator located at 7.9 NM from the LSA VOR-DME.

The airport is also equipped with approach radar that was used by G-MURI for the ILS approach to runway 36L.

This equipment was all in working order.

1.9 Telecommunications

1.9.1 Radio communications

Flight NEX 4B was successively in contact with the following Air Traffic Control Units:

- Farnborough Tower,
- Farnborough Approach,
- London Centre,
- Paris Control Centre position UZ on 131.250 MHz from 11 h 37 min 21s to 11 h 43 min 45 s (6 min 24s),
- Brest Control Centre position ZS on 132.830 MHz from 11 h 46 min 02 s to 11 h 53 min 35 s (7 min 33 s),
- Bordeaux Control Centre position V on 133.920 MHz from 11 h 55 min 15 s to 12 h 06 min 21 s (11 min 6 s), position T2 on 127.080 MHz from 12 h 06 min 47 s to 12 h 23 min 16 s (16 min 29 s),
- Marseille Control Centre position W1 on 134.100 MHz from 12 h 23 min 43 s to 12 h 26 min 45 s (3 min 2 s), position LS on 128.320 MHz from 12 h 26 min 52 s to 12 h 29 min 49 s (2 min 57 s),
- Lyon Approach on 127.570 MHz from 12 h 30 min 32 s to 12 h 34 min 51 s (4 min 19 s),
- Lyon Tower on 120.450 MHz from 12 h 35 min 09 s to 12 h 38 min 29 s.

No significant events were reported before 12 h 22 min 15 s, when the engine failure was announced and the declaration of an emergency situation by the crew. Since this phase occurred less than thirty minutes before the accident, all of the radio communications are included in the CVR transcript.

1.9.2 Radar data

The radar data for the whole flight was recorded and read out. They allowed the flight profile to be determined (see appendix 4) and thus establish a balance estimate as close as possible to reality at the time of the event (see § 1.6.3).

The radar data shows that the pilot adopted a high rate of descent (around 6,000 f t/min. for the first three minutes after the engine was shut down (descent from FL 390 to FL 210). This phase was followed by stabilisation and a descent at a lower rate (descent from FL 210 to FL 143 in six minutes). A further increase (around 3,000 ft/min.) was noted for three minutes between FL 143 and FL 44.

Between the engine failure and the time of the accident, the aircraft track in the horizontal plane was also reconstituted (see appendix 3). The data provided ground speed information which should be considered cautiously given the precision of the radar tracking. This speed data was compared with the information available from the CVR tape, though it was indicated airspeed, and that obtained by spectral analysis of the engine speed.

The last minutes of the flight are shown in the following table:

Time	Indicated airspeed on CVR	Radar [1] Ground speed	Mode C	Height	N1 %	Flaps/ Gear	Dist/ threshold [2]
12 h 35 min 07 s		233 kt	3,200 ft	2,414 ft	55%	0°	9.7
12 h 35 min 14 s					74%	0°	
12 h 35 min 32 s		218 kt	2,900 ft	2,114 ft	74%	0°	8.25
12 h 35 min 33 s					78%	0°	
12 h 35 min 56 s		199 kt	2,800 ft	2,014 ft	78%	0°	6.89
12 h 36 min 11 s					79%	0°	
12 h 36 min 17 s		*you are on the glide*			79%	0°	
12 h 36 min 20 s		192 kt	2,600 ft	1,814 ft	79%	0°	5.64
12 h 36 min 30 s					80%	0°	
12 h 36 min 34 s		*just above the glide*			80%	0°	
12 h 36 min 37 s		187 kt	2,500 ft	1,714 ft	80%	0°	4.83
12 h 36 min 40 s					78%	0°	
12 h 36 min 45 s		184 kt	2,400 ft	1,614 ft	78%	8°	4.42
12 h 36 min 46 s					77%	8°	
12 h 36 min 56 s					76%	8°	
12 h 37 min 01 s		181 kt	2,200 ft	1,414 ft	76%	8°/GE[3]	3.63
12 h 37 min 03 s					75%	20°/GE	
12 h 37 min 09 s		180 kt	2,100 ft	1,314 ft	78%	20°/GE	3.23
12 h 37 min 17 s		178 kt	1,900 ft	1,114 ft	78%	20°/GE	2.85
12 h 37 min 18 s	159 kt	*slightly high*			80%	20°/GE	
12 h 37 min 31 s	159 kt				80%	20°/GE	
12 h 37 min 33 s		170 kt	1,600 ft	814 ft	80%	20°/GE	2.13
12 h 37 min 36 s					78%	20°/GE	
12 h 37 min 41 s	154 kt	168 kt	1,500 ft	714 ft	78%	20°/GE	1.78
12 h 37 min 49 s		167 kt	1,400 ft	614 ft	78%	20°/GE	1.43
12 h 38 min 01 s	149 kt				78%	20°/GE	
12 h 38 min 05 s		155 kt	1,100 ft	314 ft	78%	20°/GE	0.76
12 h 38 min 09 s		*a little bit low little bit low*			81%	20°/GE	
12 h 38 min 16 s					82%	20°/GE	
12 h 38 min 18 s	139 kt				82%	20°/GE	
12 h 38 min 19 s					86%	20°/GE	
12 h 38 min 21 s		152 kt	900 ft	114 ft	86%	20°/GE	0.14
12 h 38 min 22 s					86%	20°/GE	
12 h 38 min 23 s			*put the power*		86%	20°/GE	
12 h 38 min 24 s			*I'm losing it*		91%	20°/GE	
12 h 38 min 28 s		146/147 kt	Sound of impact		65%	20°/GE	

(1) The radar data was obtained from the Grenoble-Four Monopulse SSR radar until 12 h 38 min 21 s. The last plot was obtained from the southeast CRNA radar processing system (146 kt) and the Lyon-Satolas primary radar (147kt).

(2) Distance from the runway 36L threshold in nautical miles.

(3) GE = Landing gear extended

1.10 Aerodrome Information

Lyon-Satolas is a controlled aerodrome open to public air transport. It is located twenty kilometres east-southeast of Lyon, at an altitude of two hundred and fifty metres (821 feet at the reference point). It has two parallel runways oriented 18/36 (appendix 2). Runway 18R/36L is 4,000 metres long and 45 metres wide. Runway 18L/36R is 2,670 metres long and 45 metres wide. The 18L, 36R and 36L QFU's are equipped with an ILS/DME. Performance of ILS approaches is possible on all the QFU's.

1.11 Flight Recorders

For this type of aircraft, the regulations require the installation of only one flight recorder. The aircraft was not equipped with a Flight Data Recorder, since the operator decided to equip it with a Cockpit Voice Recorder (CVR).

CVR characteristics:

- Manufacturer: Universal
- Type: 30B
- Part Number: 1603-02-03
- Serial Number: 128

The CVR was extracted from the wreckage on 3 May; it was only brought to the BEA's premises on 9 May.

A transcript of the recording is included in appendix 1. The following points are of note:

- 12 h 20 min 53 s, Captain "does that sound noisy to you",
- 12 h 20 min 58 s, co-pilot "what the radio",
- 12 h 20 min 59 s, Captain "no the engine",
- 12 h 21 min 40 s, Captain "hear that",
- 12 h 21 min 55 s, Captain "what is that",
- 12 h 21 min 57 s, Captain "it's the left engine look and the hyd… "
- 12 h 22 min 09 s, Captain "we have lost it Mayday Mayday", accompanied by a fall in engine speed,
- 12 h 22 min 15 s, co-pilot to Bordeaux Control "Mayday Mayday Mayday Nex Four Bravo we've lost an engine at flight level three nine zero and we're in the descent",
- 12 h 22 min 30 s, Captain "I'm shutting the left down",
- 12 h 23 min 17 s, Captain to Bordeaux Control "Netax Four Bravo we also

smell smoke in the cockpit we need vectors to the nearest airfield",

- 12 h 24 min 02 s, Captain to Marseille Control "we need the nearest airfield with sixteen hundred meters Netax Four Bravo",
- 12 h 30 min 13 s, Captain "I don't like the sound of that other engine that's why I'm worried",
- 12 h 32 min 24 s, Captain, "we should have a discrete frequency on a Mayday",
- 12 h 32 min 51 s, co-pilot "twenty copied Nex Four Bravo",
- 12 h 32 min 52 s, co-pilot "better start bringing the speed back now",
- 12 h 33 min 13 s, Captain "just watch the indications on that good engine",
- 12 h 33 min 15 s, Captain "keep your eyes open for the field",
- 12 h 33 min 34 s, co-pilot "okay three to go high rate of descent",
- 12 h 33 min 39 s, co-pilot "fourteen miles zero one one",
- 12 h 33 min 43 s to 46 s, co-pilot "coming to the nine o'clock", "your speed's still quite high",
- 12 h 34 min 59 s, co-pilot "okay glideslope's alive speed's still a little bit high approaching…",
- 12 h 35 min 10 s, co-pilot "Lyon Tower hello Netax Four Bravo just levelling three thousand ft established on the ILS",
- 12 h 35 min 50 s, co-pilot "er seven point five yeah that check the DME is correct",
- 12 h 36 min 04 s, co-pilot "yeah visual I'm visual with the field little bit…",
- 12 h 36 min 04 s to 09 s, Captain "yeah yeah I got it", there's two runways", "there's two isn't it we're going for the left",
- 12 h 36 min 34 s to 36 s, co-pilot "okay just above the glide a little bit", "eight flap",
- 12 h 36 min 37 s, Captain "er no not yet",
- 12 h 36 min 45 s, Captain "okay I'll take eight now",
- 12 h 36 min 51 s, co-pilot "V ref will be one two nine",
- 12 h 36 min 58 s, Captain "er gear",
- 12 h 37 min 01 s, co-pilot "gear's travelling speed checks",
- 12 h 37 min 03 s, Captain "twenty flaps",
- 12 h 37 min 04 s, co-pilot "speed checks travelling",

- 12 h 37 min 08 s, Captain “and follow me through get rid of your paperwork and follow me through”,
- 12 h 37 min 18 s, co-pilot “plus thirty at the moment slightly high”,
- 12 h 37 min 39 s, Captain “plenty of runway”,
- 12 h 37 min 41 s, co-pilot “plus twenty five”,
- 12 h 37 min 47 s, Captain “on landing I’m going to stop the aeroplane”,
- 12 h 38 min 01 s, co-pilot “okay plus… twenty”,
- 12 h 38 min 02 s, Captain to Lyon Tour “and two Bravo on landing we will exit all the passengers immediately”,
- 12 h 38 min 08,5 s, co-pilot “okay a little bit low little bit low”,
- 12 h 38 min 12,8 s, co-pilot “you want all the flaps”,
- 12 h 38 min 12,8 s, Captain “not yet”,
- 12 h 38 min 17,7 s, co-pilot “plus ten you’re getting a little bit low”,
- 12 h 38 min 20,8 s and 22,8 s, co-pilot “little bit low”,
- 12 h 38 min 23,3 s, co-pilot, “put the power”,
- 12 h 38 min 24 s and 25 s, Captain “I’m losing it”.

Note: at 12 h 22 min 20 s, a 530 Hz signal is heard for one second. On the Learjet 35A, the Malfunction Warning produces an autopilot disconnect sound at 550 Hz ± 10% which lasts for one second. The signal is the same whatever the disconnection method.

1.12 Wreckage and Impact Information

Note: the positions of the flight controls and that indications on the instruments noted on the wreckage may not correspond to those at the time of the impact.

1.12.1 Distribution of wreckage

Many pieces were spread out on the ground from the point of impact up to the main wreckage: debris from the left wingtip tank, windshield fragments, and various parts of the cockpit.

The seats from the cockpit were found to the right of the main wreckage: the left seat was about ten metres away while the right seat, whose back was separated from the seat, was at the base of the main wreckage.

Aerial Photo

1.12.2 The airframe

The wreckage was generally oriented at a heading of 322°. It was resting on its belly and on both wings with a slightly nose-up attitude. Soot marks marked the right side and the right engine. The fuselage was crumpled on the right side, on each side of the emergency exit. It was twisted above the right wing.

The front of the fuselage was destroyed. The fuselage was damaged on its lower side. The ventral fin was torn off the aircraft. The cockpit was completely crushed and was only attached to the fuselage by some pieces of floor and electrical wires. A piece of the cockpit ceiling was hanging off the right side of the airframe.

The left wing was highly deformed. The wing tip tank and approximately fifty centimetres of wing extension were separated. The leading edge and forward portion of the top wing skin were peeled back and bent upwards. The aileron was damaged by impact on both inboard and outboard ends. The outboard flap track attachment was torn from the wing. The outboard trailing edge was bent forward.

The right wing was deformed from the wing root. The wing tip tank and approximately twenty centimetres of wing extension were separated. The aileron showed impact damage on both inboard and outboard ends. The inboard trailing edge was bent forward and a portion was further bent aft.

The right main landing gear is folded outboard, under the wing. The outboard door hinge is torn in a direction from aft to forward. The gear actuator attach pillar bolt is sheared. The inboard door is closed.

The right main landing gear had collapsed outboard, under the wing. The left main landing gear had collapsed inboard into the wheel well.

The nose gear, slightly damaged, had remained attached to the forward part of the airframe via a tangle of electrical bundles and some pieces of floor and of the cockpit.

1.12.3 Engines

The left engine was in position on the airframe but only one external inspection was possible at the site. The cowlings were not opened, at the request of the judicial authorities.

The engine mount pylon and nacelle are displaced downwards, and the nacelle was lying on the wing at the level of the left spoiler panel. There was no evidence of exposure to fire. There was light scoring on the air inlet fan shroud outer airflow surfaces adjacent to the fan blades. The fan-turbine assembly was intact and rotated freely. There was an accumulation of what appeared to be water in the bottom of the inner nacelle surface.

The third stage low-pressure turbine appeared to be undamaged and rotated freely. There was residual oil at the bottom of the engine exhaust nozzle inlet and a trail of oil extending aft. No metallic debris was observed.

On the electrical system, the Electronic Engine Control (EEC) with all electrical and pneumatic connections was found securely mounted. The specific gravity adjustment was set to position 5 and the manual mode switch was in the “Normal” position.

On the oil system, the oil filler door was open. No evidence of oil leakage was observed. When the oil filler tube cap was removed for the purposes of the investigation, a flow of oil was observed; the oil filler tube cap was replaced and the access door was closed.

No other information on the engine could be obtained at the site. No oil or fuel samples were taken from this engine until it was torn down[3] on 18 May 2000.

The right engine was in position on the airframe and it was possible to examine it at the site.

There was evidence of exposure to fire on external surfaces of the engine nacelle. The engine mount pylon and the nacelle were slightly displaced downwards. The air inlet was deformed at four o’clock and soot was observed forward of the fan. There was an outward puncture of the rear nacelle at seven o’clock, although surfaces around this puncture were intact. There is light scoring on the air inlet fan shroud outer airflow surfaces adjacent to the fan blade tips. The acoustic treatment panel seam was separated from the air inlet. The fan-turbine assembly

[3] The wreckage and the engines were moved on 5 May 2000.

was intact and rotated freely. There was soot on all surfaces of the fan and the spinner. There were rotational deposits of dirt adhering to the spinner in a path opposite the direction of rotation of the fan. No oil leakage or debris was observed in the bypass airflow path.

The fuel supply system appeared undamaged. The fuel control power lever was at the maximum position of 120°. The fuel filter appeared to be uncontaminated and the bypass indicator was not extended. A fuel sample was obtained for analysis.

On the electrical system, the Electronic Engine Control (EEC) with all electrical and pneumatic connections was found securely mounted. The specific gravity adjustment was set to position 5 and the manual mode switch was in the “Normal” position.

The whole pneumatic system appeared undamaged.

On the oil system, the oil sight tank gauge indicated overfilling. The oil filler tube cap was removed and a flow of oil was observed. The oil filter bypass indicator was extended. The magnetic chip detector was uncontaminated. The oil filter appeared uncontaminated. Two oil samples were taken for analysis. The other components of the circuit such as the pump, the breather pressurizing valve and the fluid connections appeared undamaged.

1.12.4 Flight controls

Continuity of the control cables for the elevator, rudder and ailerons in the area of the cockpit could not be checked because of the damage suffered by that part of the aircraft. In the wings, the aileron cables appeared correctly mounted. The flap connecting cables were slack. The tail assembly was intact.

The horizontal stabilizer trim position was measured at 14 inches, which equates to - 7.87 degrees stabilizer angle (7.87° on the indicator). The normal operating movement is graduated from 2° to 9° on the indicator, the values for takeoff being between 5° and 7.6°

Rudder trim was measured at 0.21 inches to the right (yaw effect to the left), which corresponds to an angle of about 2.33°, for maximum travel of 15° $\pm$ 1°.

Aileron trim was measured at 0.30 inches up, which corresponds to an angle of about 3.66°, for maximum travel of 8° $\pm$ 1° in the direction of a bank to the left.

The damage on the lower surface of the flaps suggests that they were not extended more than twenty degrees at impact.

When the wreckage was removed, while a crane lifted the aircraft, the flap actuators were measured. Both actuators had remained attached to their respective levers. The left actuator measured 6.32 inches and the right 6.34 inches. These measurements indicate approximately 23 degrees down. The right flap was also measured with an inclinometer, which indicated 22 degrees down.

The gated flap handle was found on the 8 degrees down position. There was no impact damage to this part. A rotation of the gate plate was noted.

Access to the spoiler actuators was not possible because the left engine was lying on the left spoiler panel and the right spoiler was in the ground fire. The spoiler switch on the quadrant was found in the “Extend” (aft) position and the switch guard was broken in an aft direction.

1.12.5 Systems

1.12.5.1 Electrical system

The condition of the electrical system prevented any inspection beyond observing the circuit breaker panels and battery switches. The main batteries were disconnected when the airplane was lifted.

1.12.5.2 Fuel supply

The following fuel system valves were in the following positions:

- Left motive flow: Open
- Right motive flow: Open
- Wing cross-flow: Closed
- Left engine fuel shut off: Closed
- Right engine fuel shut off: Closed
- Fuselage transfer valve: Open
- Fuselage gravity valve: Closed
- Left tip tank jettison valve: Closed
- Right tip tank jettison valve: Closed

The fuel control panel has numerous switches broken off in an aft direction.

1.12.5.3 Hydraulic system

The hydraulic system valves were in the following positions:

- Left hydraulic shut off valve: Closed
- Right hydraulic shut off valve: Open

1.12.5.4 Engine fire extinguishing system

The left and right extinguishers were discharged. The yellow, manual discharge disk was slightly melted, but was still in the retainer. The red thermal discharge disk was missing.

1.12.6 Cockpit

The cockpit was destroyed by impact though the following instruments were recorded.

- Engine instruments:

    - Left engine EGT (P/N 131350-3, S/N 27-1829): digits and needle 028 °C
    - Right engine EGT (P/N 131350-3, S/N 128-829): digits and needle 537 °C
    - Left engine N1 (P/N 131346-3, S/N 46-1806): digits and needle 7.7%
    - Right engine N1 (P/N 131346-3, S/N 66-1814): digits and needle 44.4%

- The N2 indicator positions were not positively identified. Both indicators were separated from the instrument panel and no wiring plug was identifiable. On one, indications were: needle 0%, digits 0.4%, on the other: needle and digits 72.3%.

    - The dual engine fuel flow indicator displayed:
        - 50 lb/h (Left engine)
        - 0 lb/h (Right engine)

    - The dual oil pressure indicator displayed:
        - 45 PSI (Left engine)
        - 0 PSI (Right engine)

    - The engine synchronizer switch was in the SYNC position.

- Left instrument panel readings:

    - Altimeter: glass and needle broken, setting 1014 hPa (29.94 Hg)
    - Airspeed indicator: 278 kt (needle), internal bug 132 kt, bug 148 kt
    - ADI: 110° bank to the left, 22° nose down
    - IVSI: - 6,000 ft/min
    - HSI destroyed, no reading possible
    - RMI 340°

- Right instrument panel readings:

    - Altimeter: 2,400 ft, setting 1014 hPa (29,94 Hg)
    - Airspeed indicator: 68 kt, internal bug 131 kt, three bugs at 120, 220 and 240 kt
    - ADI: 100° bank to the left, 90° nose up
    - IVSI: - 950 ft/min
    - HSI: 330°
    - RMI: 341°
    - altitude warning: 3,000 ft

- Centre pedestal

    - The thrust lever for the left engine was in the shutdown position. The quadrant gate was nicked, which showed that the lever had moved aft on impact
    - The thrust lever for the right engine was about two inches aft of the full thrust stop. Examination of the quadrant cover and the lever showed

that the lever had apparently moved aft on impact. The forward stop on the cover bore a mark which seemed to indicate that the lever was in the forward position on impact
    - The elevator trim switch was in the PRI position and twisted upwards
    - On the elevator trim display, the needle was in the “Takeoff” area and indicated about 5.3°
    - The rudder trim switch was blocked beyond the maximum “Nose Right” position
    - On the rudder trim display, the needle was veering slightly towards the “Right” direction
    - On the aileron trim display, the needle was in the neutral position for the left aileron in a very slightly positive position for the right aileron

- Breaker panels

- Many of the circuit breakers on both panels (Left and Right) were popped but their positions at impact were undetermined because of the break-up of the forward fuselage and wiring.

Other switch positions were noted:

    - Left battery: On
    - Right battery: On
    - Left Starter-Generator: on GEN
    - Right Starter-Generator: on GEN

- The landing gear handle was in the “Down” position.

1.13 Medical and Pathological Information

The investigation did not bring to light any previous medical history, apart from the Captain’s vision limitations noted in paragraph 1.5.1.

Toxicological analyses were performed on various biological samples taken from the pilots. These analyses showed no traces of medicines or listed drugs. The alcohol tests were unusable since the sampling was erroneous, the samples having been kept in dry flasks, that is to say without any sodium fluoride to prevent the production of ethanol in the samples.

The results obtained were thus not used for the purpose of analysing this event.

1.14 Fire

At 12 h 27, the Tower informed the Rescue and Fire Fighting Service of the diversion of an aircraft which had declared an emergency. Details were given at 12 h 28 and the RFFS was in position from 12 h 29.

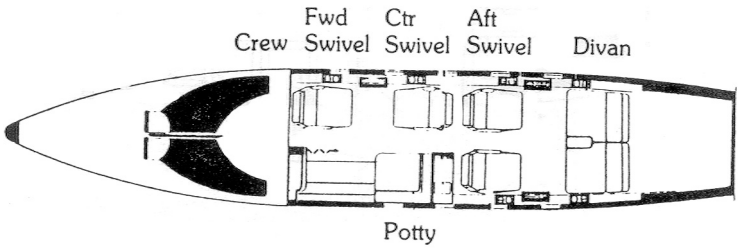
Two large fire-fighting vehicles were positioned on taxiway A6 at about 900 metres

from the threshold of runway 36L. Two others took up position on taxiway A5 at about 1,500 metres from the threshold of runway 36L.

The intervention began at 12 h 38 min 26 s and the two nearest vehicles put out the fire that had broken out on impact. The fire mainly affected the right side of the aircraft: the fuselage, wing and engine nacelle. At 12 h 41 min 48 s, the fire was contained. The fire was put out quickly through the use of around fifteen hundred litres of water and a hundred litres of foam.

1.15 Survival Aspects

G-MURI was configured in “mid-cabin“ version with seven seats. Two passengers were seated in seats at the rear of the cabin, the third in a seat facing them.



The autopsies on the pilots showed that the injuries caused their deaths immediately on impact.

Since the fire broke out on the right side, where the emergency exit was situated, the passengers evacuated through the gap that had appeared at the front caused by the destruction of the cockpit.

1.16 Tests and Research

1.16.1 Analysis of fluids

Analysis of the fuel and oil samples was carried out by the judicial authorities. The aim was to determine the quality of the fluids, any possible pollution and the nature of any elements they contained.

With regard to the oil and fuel from the right engine, no results were available at the time of writing of this report.

For the left engine, investigators were able to obtain the following results on the oil sample alone. The samples were sent to the British laboratory that usually undertook the routine analyses on the aircraft’s engines in the context of the

SOAP programme. The analyses were carried out on 21 June 2000. They showed the presence of quantities described as “traces” (less than 10% of the net weight of the filter) of copper, magnesium and aluminium, but also significant pollution (40% or more of the net weight of the filter) of steel-molybdenum-chrome-vanadium (M50) from the alloy that makes up the engine bearings. The oil also contained higher quantities than normal of various metallic debris.

It should be noted that these results did not satisfy the required depth of analysis in the context of a technical investigation, and in particular the conformity of the fluids to applicable aeronautical standards was not established.

1.16.2 Left engine

The engine was examined in the presence of the BEA at a specialised company approved by the manufacturer, so as to determine the cause of the malfunction that led to its being shut down. After teardown, it was clear that bearing No.5 was damaged, its inner cage destroyed and the remaining nineteen ball bearings inside being damaged. A simple visual inspection showed no signs of overheating on the outer race. Oil was present throughout the area of bearing No.5. The oil spray nozzles were neither clogged nor blocked and the associated parts showed no obvious faults.

All of the HP shaft as well as the turbine inter-stage casing, with associated parts, were preserved for metallurgical analysis.

1.16.3 Left Engine No.5 Bearing

Bearing No.5 was installed on the left engine on 22 October 1998 at the time of a repair carried out on the compressor. Bearings No.1, 2 and 4 were also changed during this operation. The engine then had a total of 8,053.4 hours and 4,898 cycles. Damage to the part therefore occurred after 350.6 hours of operation and 279 cycles. In its statistics, the CAA had not recorded any previous failures on bearing No.5 on this type of engine.

The main damage observed affected the ball bearing. The aft half-race was gouged by the forward axial thrust of the HP body. All of the balls showed identical wear resulting from significant over-stress.

Damage to the bearing originated from progressive fatigue cracking of the bearing cage. The final rupture of the cage cells released the balls, leading to excessive play in the bearing rotary body. Axial thrust from the HP body, induced by the centrifugal compressor, resulted in wear on the inner ball race surface and final damage to the bearing balls.

No evidence was found to explain the progressive and generalised damage to the bearing cage. This type of damage is usually caused by excessive loads on the bearing rotary body, possibly resulting from a failure in tightness or in axial position between the components of the bearing. These hypotheses could not be

developed any further, taking into account the severely damage condition of these parts.

The other damage resulted from the failure of the bearing.

Particles retrieved from the magnetic cap were identified as being fragments of the race and of the bearing cage.

Observations and extra metallurgical checks performed on the various components of the bearing race showed that:

- The outer race and the front inner half-race showed signs of localised superficial overheating;
- The rear half-race showed deep generalised overheating;
- The races are made of bearing steel whose structure and hardness in healthy areas corresponded to those usually found.

1.16.4 Master warning overhead panel

The BEA ordered an examination of the filaments of all of the light bulbs on the warning panel.

Observations with the binocular magnifier and on the electron scan microscope showed that the PITCH TRIM was lit at the time of impact, the L GEN, WSHLD HT, ½ BANK, COMPT RESET lights were difficult to pronounce on and the other lights were off.

Note: Illumination of the amber PITCH TRIM light indicates the pitch trim speed monitor has detected a trim speed fault allowing high trim rates with the flaps up or that the trim monitor has detected a fault that would allow a trim runaway if an additional fault were to occur. The PITCH TRIM light will illuminate whenever either Control Wheel Master Switch (MSW) is depressed. The latter, located on either side of the pilots' wheels allows the autopilot to be temporarily over-ridden. It also temporarily inhibits the yaw damper. As soon as the pressure is released, the PITCH TRIM light goes off and the yaw damper function works again.

The Flight Manual indicates that one yaw damper (the aircraft has two) must be active. The switch was found broken in the PRI position, which leads to the conclusion that the yaw damper was operating during the final approach.

Note: The Flight Manual underlines the precautions to take in case of unavailability of the yaw dumper: it is preferable to avoid flying in a turbulent atmosphere and to land with a minimum of fuel in the wingtip tanks, otherwise the aircraft may be subject to unwanted reduction in lateral stability control (Dutch roll). This stability can be improved by an increase in speed.

1.16.5 Fuel Crossfeed and Transfer Valves

A function test was performed on the Fuel Crossfeed and Transfer Valves on the wreckage in April 2001.

- The valve positions checked at the time of the field investigation were

confirmed: X-feed Closed, Transfer Open.

- The X-feed valve pins were identified and energized as follows: A Open, B Closed, and E Grounded. The X-feed valve was functioning correctly.

- The Transfer valve wires were identified and energized as follows: Red Open, Orange Closed, and Black Grounded. The Transfer valve was functioning correctly.

1.16.6 Fuel distribution

A complete fuel fill having been carried out at the Farnborough stopover, the aircraft had taken off with 6,100 lb of fuel. At 12 h 07 min 46 s, the co-pilot having proposed “It’s gone to one thousand five hundred pounds on the burn, do you want to move the fuel out of the fuselage then”, the reply was “yep can do”. It can thus be supposed that at 12 h 08 a fuel transfer was commenced from the fuselage tank towards the wing tanks. Subsequently, no indications were given by the crew that the transfer had been interrupted.

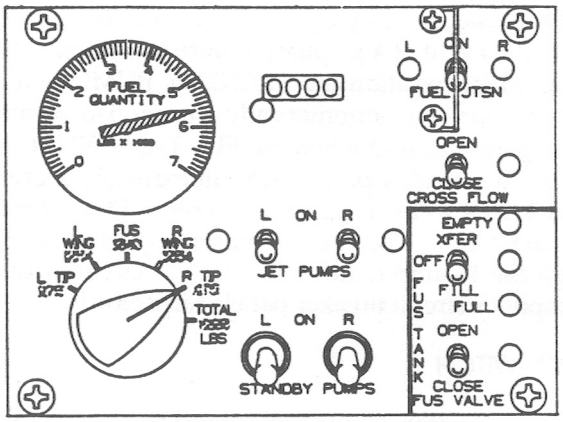


Illustration of the fuel management panel

The Learjet 35A’s fuel system includes two wingtip tanks with a capacity of 1,150 lb each and a fuselage tank of 1,340 lb. Fuel consumption occurs through transfer from the wingtip tanks to the wing tanks. Transfer from the fuselage tank to the wing tanks normally takes place by positioning the TANK XFER-FILL switch on the XFER position. The wing tank crossfeed valve opens and the transfer pump begins to operate. During this activity, temporary illumination of an amber light on the fuel control panel indicates transit to the appropriate operating position. Permanent illumination indicates that the valve is not in the selected position.

The positions noted on the valves, fuselage transfer open and cross-feed closed, allows two hypotheses to be considered to determine the fuel balance. Either these positions resulted from a malfunction leading to incorrect positioning of the cross-feed valve during the transfer procedure, or the incorrect positioning of this valve resulted from the impact.

In the first case, the fuel imbalance can be estimated at 442 lb extra in the left wing and the fuel remaining in the fuselage at 1,030 lb.

In the second case, the fuel imbalance can be estimated at 132 lb extra in the left wing and the fuel remaining in the fuselage at 539 lb.

In both cases the figure obtained remains below the maximum shown on landing of 600 lb, as featured in the Flight Manual procedures.

1.17 Information on Organisations and Management

Northern Executive Aviation Ltd, founded in 1961, is one of the oldest air taxi companies in the United Kingdom. Its Air Transport Certificate was issued on 9 July 1991 to operate several types of aircraft including the Learjet 35A, for public transport of passengers, freight and for air ambulance work. The certificate was valid at the time of the accident.

The operator possesses its own JAR-45 approved maintenance centre and also undertakes the sale of aircraft.

1.18 Additional Information

1.18.1 Procedures described in the Flight Manual

The “Engine Failure – In-Flight Shutdown” procedure is in section III, Emergency Procedures (red), page 3-30 of the Flight Manual approved by the FAA/CAA on July 1st 1987. It includes the following steps:

1. Thrust lever of affected engine on CUTOFF
2. ENG SYNC switch on OFF
3. Yaw Damper on OFF, retrim as required, then engage the Yaw Damper
4. START-GEN switch on OFF
5. Reduce electrical load
6. BLEED AIR switch on OFF
7. Fuel balance: monitor and cross flow if necessary
8. Refer to “Single-engine landing” in section IV

The “Single-engine landing” procedure, described in IV, unusual procedures (Amber), page 4-24, is described in the following way:

- Final approach configuration, gear DN, flaps 20°
- Final approach speed, VREF + 10
- When the landing is assured, flaps DN, VREF

Note: the crew had selected a VREF of 129 kt as recommended in the Flight Manual.

1.18.2 Operations Manual

Volume 1 of the Operations Manual, in section 5 paragraph 12.6 “piloting technique”, indicates that performance with one engine shut down is almost always improved if 5° angle of bank is applied towards the operative engine.

This indication seems to be inspired by the JAR 23 certification regulation that proposes the same method.

1.18.3 Witness testimony

1.18.3.1 Passengers

According to the passengers, the flight was going normally until the left engine start making noise then juddering. The pilot then pulled the left red T handle at the top of the control panel and then shut down the left throttle. There were no unusual smells or smoke in the cabin before or after the engine stopped.

The speed-brakes were used during descent and then stowed when approaching the ground (a few thousand feet). The co-pilot told them that they were going to land in Lyon because of an engine problem.

The approach was normal and, a few metres from the ground, the pilot placed his hand on the right thrust lever. The nose went up a little at the same time as the aircraft turned to the left then the left wing dropped and touched the ground. One passenger stated that he felt the aircraft accelerating a short time before the wing touched the ground. Another stated that the aircraft veered to the left while the right engine was accelerating.

A few seconds later the aircraft stopped; the cockpit was missing and the right side of the aircraft was on fire.

The passengers did not hear any aural alarms before the impact.

1.18.3.2 Observers on the ground

One person was about a thousand metres northwest of the runway 36L threshold and could not hear noise as auxiliary power equipment was in operation. Three others were at about five hundred metres west of the runway 36L threshold (see appendix 2) in front of a hangar whose doors were open.

The presence of fire engines on the taxiways having attracted their attention, they were looking for the aircraft in question on final. The approach seemed rather low, but the attitude was normal without any banking. The speed seemed a little high. At one time the aircraft seemed to stop descending, its nose slightly up. At that moment the roll rate seemed constant to one of the observers. The closest observers heard a reduction in engine power before noticing a very rapid roll. Two heard a thrust increase before the aircraft's left tank touched the ground.

The left wing touched the ground first, then the cockpit. When the aircraft came to a stop, the right side caught fire. The firemen arrived as some people were coming out of the front of the aircraft.

1.18.3.3 Learjet 35A pilots

Several Learjet 35A pilots, despite the qualities they attributed to the aircraft, underlined the vigilance required for a power up with one engine shut down. They stated in particular that the thrust is high on the operative engine and that it is essential to pay great attention to maintaining directional control and the correct speed, otherwise the aircraft can slip out of the pilot's control.

2 - ANALYSIS

2.1 Management of the Engine Failure

The flight proceeded normally until the appearance of noises from the left engine. The Captain suspected a malfunction of the engine even before seeing any indications on the control panel. Thus, at the time of the failure, he reacted immediately by shutting down the malfunctioning engine, asking his co-pilot to declare an emergency and initiating the descent. He also switched to manual control, since the autopilot disconnect aural warning was then recorded on the CVR.

The indications noted on the engine instrument displays confirmed the situation: left engine shut down and right engine providing thrust. Only one inconsistency, which certainly resulted from the impact, was noted on the backup instruments for fuel flow and oil pressure, the values for the right engine being zero.

The engine failure resulted from the failure of the bearing No.5 ball bearing. Excessive strain on the rear half-race of the bearing was identified, without it being possible to identify the cause thereof.

Certification regulations applicable to the Learjet 35A provide that the aircraft should be capable of operating with a failed engine. The principal actions associated with this situation are described in the emergency procedures in the Flight Manual. Examination of the wreckage showed that the procedures were followed, though no crew callouts are heard on the CVR.

The appearance of the smell of smoke in the cockpit is quite consistent with this type of event, which may lead to vaporised lubricant being temporarily carried through the air conditioning system. This would also explain why no subsequent mention was made of it and why the passengers did not notice it. This smell could, however, have created a certain tension for the Captain.

The Captain was subsequently anxious on several occasions about the noise and indications from the operative engine. The co-pilot tried to calm this anxiety through the assistance he provided and by following the navigation. Division of tasks seemed unambiguous between the two crew members. The Captain did, however, make several calls on the radio although the task of communication was attributed to the PNF.

It should also be noted that, though all of the actions to be taken to pursue the flight seem to have been performed correctly, no check-lists were performed aloud. In particular, the check-list for “Engine failure – in-flight shutdown”, mentioned at one point by the Captain, was not performed, the workload increasing significantly on approach to the aerodrome. This check-list would have allowed the crew to check and act on the fuel balance and, presuming that the position noted was that which existed before the impact, to cut the engine synchronizer.

2.2 The Final Approach

The radar data (cf. § 1.9.2 and appendix 4) shows that, at the beginning of the final approach (12 h 35 min 56 s – 6.9 NM), the aircraft was slightly below 3,000 ft QNH, that its speed was above that recommended in the Flight Manual (199 kt rather than 160 kt) and that it was still in a clean configuration. This resulted in an approach that was not stabilised in terms of speed with an approach configuration at about 3.6 NM from the threshold. At that time, the indicated airspeed can be estimated at about 167 kt. The crew saw the runway 6.5 NM from the threshold. From 3.5 NM onwards, the Captain asked the co-pilot to follow him at the controls. Up until about 1.5 NM from the threshold, the approach had been conducted above the glide slope with excess speed compared to the VREF + 10 (139 kt), which was dwindling slowly.

Further notable signs of the Captain's edginess are that he told the co-pilot that he was going to stop the aircraft after the landing, then made a call to the Tower to ask for the wind and to tell them that he was going to evacuate the passengers on landing. This announcement is surprising considering that the failed engine had been made safe and no other malfunctions had been noted by the crew who were monitoring the operative engine closely. Further, the runway is not limited for such a landing and taxiing with a single engine is a normal procedure. This shows that the tension that the Captain had attributed to the noise from the operative engine during the descent had not dissipated.

From this time on, the aircraft went below the glide slope, the speed continued to decrease and the Captain significantly increased the thrust on the operative engine, while hesitating over complete extension of the flaps. The latter was in fact never done.

Note: although the flap selector was found in the 8° position, it is likely that this position resulted from the impact. In fact, measurements taken on the flap actuators show an extension of 20° and correspond to the announcements made by the crew.

2.3 The Loss of Control

The illumination of the PITCH TRIM light leads to the idea that during the attempt to maintain control of the aircraft, one of the pilots pressed the MSW switch, which comes to hand quite naturally when the control wheel is held with both hands. In fact, bearing in mind the position noted on the elevator actuator, the hypothesis of a trim movement during short final can reasonably be excluded. The disconnection of the yaw damper which resulted from pressing the MSW was certainly not significant at that time.

Concerning the fuel balance, it seems logical to accept the hypothesis of correct operation of the fuel transfer procedure which would have led to a slight imbalance and the presence of a reasonable quantity of fuel in the fuselage tank. In any event, in all cases the calculated value remains within the demonstrated limits and its influence is slight.

The high thrust requirement on the right engine, associated with the presence of fuel in the fuselage tank and the angle of the aircraft's elevator, can be considered to correspond to the eyewitnesses' accounts that indicated an increase in nose-up attitude and a slight increase in engine speed.

Rotation around the yaw axis generated by the extra thrust to the right led to an induced roll effect, perhaps accentuated by the slight fuel imbalance.

The speed, though decreasing, was still above the VMCa (110 kt). The witnesses appeared to confirm this since the speed was considered to be high by the observers on the ground. Furthermore, the last radar plot indicated a ground speed of 146 kt, and though this is an extrapolated value, it is significantly above the VMCa. In any case, it never approached stall speed since no stall speed warning was recorded on the CVR and no aural warnings were noticed by the passengers.

The wind announced thirty-seven seconds before the accident was 020°/10 kt. It did not contribute to the accident. Furthermore, the meteorological report showed no turbulent conditions.

Supposing that they were not or were little modified on impact, the trim elements noted on the wreckage show that the aileron trim indicated a right bank whereas the directional trim indicated left yaw. The aileron trim may have resulted from the trim required to maintain a 5° bank towards the operative engine, as recommended in the Operating Manual. As regards the directional trim, it is quite possible that it corresponded to the value displayed during normal cruise, the PF having chosen to maintain lateral control by use of the rudder pedals alone, in as much as the aircraft spent the greater part of the time at a high speed and the operative engine at moderate thrust, requiring little lateral trim. It was only on short final, when the speed dropped significantly, that the PF realised that he was losing control of the aircraft.

None of the factors analysed leads to an explanation for the loss of control, except if we accept that the PF, despite his experience and training, did not pay attention to maintaining directional control at the time of the final increase in thrust. The suddenness of the loss of control at low height made it impossible for the PNF to make any effective control inputs. Several pilots in fact commented upon the aircraft's characteristics in this domain.

This lack of attention to directional control, may be explained by the edginess which seems to have affected the pilot, faced with a real situation of an engine failure with an operational diversion, in conditions that were quite different from those simulated in base checks.

Finally, the suddenness of the loss of control at a low height made it impossible for the co-pilot to intervene effectively through joint control.

2.4 Management of the Situation by the ATC Services

Aside from the accident itself, it should be noted that in the sixteen minutes and thirty seconds of flight after the Mayday call, the crew had to change radio frequency four times, including twice with the same organisations (Southeast CRNA and Lyon-Satolas). This does not appear to have contributed to the accident, the last frequency change occurring before the beginning of the final approach, three minutes and twenty seconds before the accident, the Captain taking it as a surprising procedural point and not as a distraction. Nevertheless, such changes of frequency are not appropriate. In fact, a manual error could cause radio contact to be lost between an aircraft in an emergency situation and the ground at a moment that might be critical. In addition, listening in, reading back, displaying the frequency and calling the new controller are so much available time wasted by the crew when managing an emergency and performing check-lists. This is why it is essential that any aircraft that has declared an emergency be kept on the same frequency, which should also be freed of all other radio traffic.

This is in fact recommended in ICAO Doc 4444 (PANS-ATM), first edition, November 2001, part 44 “Procedures to apply in emergency situations, communication failures and chance situations”. Paragraph 1.1.3 states: *changes in radio frequency and SSR code are to be avoided if possible and should only normally be carried out if an improved service can be provided to the aircraft in question*. The DGAC is studying the transposition of this text whose provisions, for the most part, should be proposed as an amendment to the ATC regulations (RCA) in the course of 2003.

If in-flight engine failure and the continuance of the flight in that configuration are not, in truth, exceptional circumstances, the situation could deteriorate rapidly, more so given the presence of smoke in the cockpit. In addition, considering its workload, the crew is not always in a position to express clearly and concisely the nature of the event with which it is really confronted.

3 - CONCLUSIONS

3.1 Findings

- The crew possessed the certificates, licences and qualifications required to undertake the flight.

- The crew had had sufficient rest time before the flight.

- The aircraft was certificated and maintained in accordance with the regulations.

- While the aircraft was in cruise, the rupture of the No.5 bearing led to the failure of the left engine.

- The left engine was shut down, the crew declared a Mayday and undertook a descent followed by an approach on one engine.

- The approach, including its final phase, was never stabilised.

- Just before the runway threshold, a significant increase in thrust was commanded on the right engine.

- The aircraft banked sharply to the left and touched the ground with its left wing before crashing and catching fire.

3.2 Probable Cause

The accident resulted from a loss of yaw and then roll control which appears to be due to a failure to monitor flight symmetry at the time of the thrust increase on the right engine.

The hastiness exhibited by the Captain, and his difficulty in coping with the stress following the engine failure, contributed to this situation.

AAIB COMMENTS

The accredited Representative of the United Kingdom made the following comments concerning AAIB Participation in the BEA Investigation.

Annex 13 to the Convention on International Civil Aviation (The Chicago Convention) sets out *inter alia* the 'International Standards and Recommended Practices' for the conduct of an aircraft accident investigation. The European Council Directive 94 / 56 / EC, which came into force on 21 November 1994, established the fundamental principles governing the investigation of civil aviation accidents and incidents within the European Union States. This Directive embodied the provisions of Annex 13 into European legislation.

The United Kingdom, as the State of Registry and the State of the Operator, had rights of participation in the investigation laid down in Annex 13 to the Chicago Convention and EU Directive 94 / 56 / EC. The United Kingdom appointed an Accredited Representative and an Advisor from the Air Accidents Investigation Branch (AAIB) to participate in the investigation conducted by the Bureau Enquêtes Accidents (BEA) under the provisions of the 'Convention' and the 'Directive'. Co-operation between the BEA and the AAIB enabled the AAIB to make an effective contribution to the investigation.

The French judicial authorities conducted a separate inquiry into the accident in parallel with the BEA investigation. The manner in which the judicial investigation was conducted presented major impediments to the technical investigation. The difficulties encountered are listed below.

The French judicial authorities did not allow the AAIB Investigators full access to all relevant evidence as soon as possible. (Annex 13 Chapter 5. 25d). For example, the judicial authorities:

a Denied investigators access to the aircraft for the first 60 hours following the accident whilst police carried out their own investigation.

b Delayed examination of the seized engine for 21 days after the accident.

c Delayed for a period of seven weeks a chemical analysis of the engine oil and its associated oil filter. The standard of this examination was inappropriate following an engine failure, as it did not comment on the oil specification, its suitability for purpose, or the conditions under which it had been operating. The delay gave adequate opportunity for the oil samples to deteriorate. Therefore evidence pertinent to the causes of the engine failure was compromised or lost by the Judicial investigation.

These obstructions to the technical investigation were in contravention with the State of Occurrence's obligations under the Chicago Convention (Annex 13). It is also in contravention of the European Council Directive 94 / 56 / EC which states *"investigators should be able to complete their tasks unhindered"*. Furthermore, the restrictions and procedural delays imposed by the judicial authorities subverted the Directive requirement that *"air safety requires investigations to be carried out in the shortest possible time"*.

List of Appendices

FOREWORD

The following is the transcript of the elements which were understood from the work on the CVR recording. This transcript contains conversations between crew members, radiotelephonic messages and various noises corresponding, for example, to the movement of selectors or to alarms.

The reader's attention is drawn to the fact that the recording and transcript of a CVR are only a partial reflection of events and of the atmosphere in a cockpit. Consequently, the utmost care is required in the interpretation of this document.

The voices of crew members are heard via the headset microphone. They are placed in separate columns for reasons of clarity. Another column is reserved for the voices of others, the noises and alarms also heard via the CAM.

GLOSSARY

UTC	UTC time from the ATC system.
Ctl	Voice of Air Traffic Controller on the frequency in use
CAM	Cockpit Area Microphone
(@)	Sounds, alarms
( )	Words or group of words in parentheses are doubtful
(…)	Words or group of words with no bearing on the flight
(*)	Words or group of words not understood

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 07 min 46	It's gone to one thousand five hundred pounds on the burn do you want to err move the fuel out the fuselage then				
50		Err yep can do			
12 h 08 min 15	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
38		It's like yesterday only there's more of them and bigger			
43		Lots lots of little ones yesterday lots of big ones today			
12 h 09 min 29			(Ctl) Netax four Bravo say your mach number?		
33		Seven seven			
33	Accelerating mach decimal seven seven Netax four Bravo		Idem		
37			(Ctl) Roger		
12 h 10 min 22		All alright yeah			
51	(Straight) a left turnish roundabout that sort of direction				
54		Sorry?			
56	(...) about here we got a left turn one three five slightly left towards...				
12 h 11 min 01		Oh my god			
30		Oh the route is the route in there or not			
33	No there is no route in there				
35		Alright it doesn't matter			
39		Just wondered what the distance was on...			
12 h 11 min 59	Err two thirty two at the moment				
12 h 12 min 03		Rog			
11		Hot in here isn't it			
14	Yeah				

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 14 min 17		There's some big bastards there			
19	Certainly are				
12 h 15 min 25		Can't quite see that one in real terms can you I think that's the two outside ones 'cos they are in a row look			
34		There's one almost in front of us which isn't quite so... obvious			
36			(Ctl) November euh Nex four Bravo descend initially flight level three nine zero		
42	Descend initially Flight level three nine zero Netax four Bravo		Idem		
46		Shit I didn't want to do that			
12 h 16 min 24		Oh shit can you turn the heat down a touch			
28		(*)			
29		I don't know if it its 'cos I'm in the sun or what that I am baking over here			
31	Yeah -(...)				
12 h 17 min 24				(@)	Reduction in engine thrust
49			(Ctl) (*) four Bravo maintain flight level three nine zero for the time call call you back for lower level		
56	Maintain for now Netax four Bravo merci		Idem		
12 h 18 min 03	One hundred ninety five to Nice				
10		Ninety five			
11	One nine five				
12		One nine five			
14		I'd like to get past these first before we descend			
27			Piste 2 : ATIS		

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
29				(@)	Noise of selector
12 h 19 min 14	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
12 h 19 min 16	Capturing				
30	The flight plan has us going to err this place LATAN which is twenty left roughly from where we are now				
37	About a minute and a half				
12 h 20 min 08		Just turn that pressurisation down a touch			
26		We're still going to (Louvre) aren't we			
28	Yeah (*) to run				
53		Does that sound noisy to you			
58	What the radio				
59		No the engine			
12 h 21 min 09			(Ctl) Netax four Bravo proceed to LATAN now		
13	Direct LATAN Netax four Bravo merci		Idem		
12 h 21 min 33	'kay it's going up to forty degrees to the left				
36		Forty			
37	Four zero yeah... 'bout one				
40	One two	Hear that			
41	Yeah				
43	About one one five the heading				
47		One five			
48	One one five				
55		What is that			
57		It's the left engine look and the hyd...	(Ctl) (*) four Bravo have you turn left to euh LATAN		

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 22 min 01	Affirm in the left turn this time heading LATAN heading one one five		Idem		
05			(Ctl) (*) because there is a military zone on activity		
09	That's copied thank you		Idem		
12 h 22 min 12		Oh shit (@) we've lost it Mayday Mayday			
13	(@)	(@)			2 thumping sounds
14				(@)	Reduction in engine thrust
15	Mayday Mayday Mayday Nex four Bravo we've lost an engine at flight level three nine zero and we're in the descent				
20	(@)	(@) right		(@)	Alarm (530 Hz 1 s)
21			(Ctl) Netax four Bravo descend flight level three seven zero now		
22				(@)	Reduction in engine thrust
24	(@)	(@)		(@)	Alarm (3000 Hz 0,5 s) similar to Altitude Alert
26	Descending three seven zero this is a Mayday we have lost an engine we are descending further than three seven zero	Mayday	Idem		
30		I'm shutting the left down			
31	Shut left down				
32			(Ctl) Ok roger euh...		
33		Mayday to the nearest airfield	Idem		
35			(Ctl) Sqwak seven seven zero zero (*)		
38		(@)			
39	Seven seven zero zero Netax four Bravo		Idem		
43		We need descent to the nearest airfield emergency	Idem		
45				(@)	Reduction in engine thrust

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
46	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
49		And smoke			
51	(*)				
52		Eh yes			
54				(@)	Noise of selector
12 h 22 min 58	And it's Netax four bravo's requesting vectors to nearest available airfield	(@)	Idem	(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
12 h 23 min 01				(@)	Noise of selector
03			(Ctl) Four euh you may descent at your convenience confirm you have lost an eng... an engine		
05		We need directions to the nearest airfield	Idem		
08	Affirm we have shut down our left engine Netax four Bravo		Idem		
12			(Ctl) Okay squawk seven seven zero zero please		
15	Seven seven zero zero I'm Squawking Netax four Bravo		Idem		
17		Netax four Bravo we also smell smoke in the cockpit we need vectors to the nearest airfield	Idem		
24			(Ctl) You may descent flight level two zero zero Netax four Bravo and contact Marseille on frequency one three four one now Sir	(@)	Noise of undetermined origin
27		(@)			Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
36	One three four one Netax four Bravo au revoir				
40	(@)	(@)			Alarm (700 Hz 0,3 s) similar to a change of VHF frequency
43		We're turning away from this			

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
	Marseille Mayday Mayday Mayday Mayday Netax four Bravo in the descent to flight level two hundred requesting vectors to the nearest available airfield we have shutdown our left hand engine and we have suspected smoke and fumes in the cockpit		Idem		
12 h 23 min 49		(*) (heading the north)			
55			(Ctl) Okay Nex four Bravo descent two zero zero and do you request to land on the closest field or not?		
12 h 24 min 02		Yes yes			
03	The closest airfield please Nex four Bravo		Idem		
05			(Ctl) (*) four Bravo check your transmission you are broken do you want to continue to Nice or euh Marseille or closer than Marseille?		
09		I'll call him			
15		We need the nearest airfield with sixteen hundred meters Netax four Bravo	Idem		
20			(Ctl) Okay the nearest airfield with a runway one six zero zero meters confirm?		
25		Affirm	Idem		
29			(Ctl) November four Bravo fly heading one eight zero if feasible		
36	One eight zero Netax four Bravo		Idem		
37		Eh weather			
43		We need a... is there anywhere to the north?			
48	(*)				

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 25 min 01			(Ctl) Netax four Bravo are you able to fly heading one... do you want to land at Lyon Satolas?		
12 h 25 min 07	Yeah go for Lyon				
08		Affirm Netax four Bravo	Idem		
10			(Ctl) Euh November four Bravo so fly heading one one... euh fly heading zero zero seven zero zero seven zero to Lyon Satolas		
22	Zero seven zero to Lyon Satolas Netax four Bravo		Idem		
25		Netax four Bravo we'll need to steer about zero three zero for weather initialy	Idem		
26	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
27				(@)	Noise of selector
30			(Ctl) Okay zero three zero for weather Netax four Bravo and do you want a lower level?		
36		Yes	Idem		
40	Say one five zero initially and then we'll stabilise at one five that's safety altitude				
41				(@)	Increase in engine thrust
47	Requesting flight level one five zero November four Bravo		Idem		
54		What was that?			
55	(*)				
57				(@)	Increase in engine thrust
12 h 26 min 02	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
03				(@)	Increase in engine thrust
07		How far is Lyon?			
08	(*)				

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 26 min 10			(Ctl) November four Bravo fly to Lima Yankee Sierra beacon fly heading zero seven zero I call you back for the frequency of Lima Yankee Sierra		
25	Zero seven zero requesting descent flight level one five zero err November four Bravo		Idem	(@)	Increase in engine thrust
29			(Ctl) November four Bravo descend initially two zero zero and contact one two eight three two		
33		(@)			Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
36	One three eight one two Nex four Bravo		Idem	(@)	Increase in engine thrust
38			(Ctl) November four Bravo one two eight decimal three two		
42	My apologise one two eight decimal three two Nex four Bravo		Idem		
48		(@)			Alarm (700 Hz 0,3 s) similar to a change of VHF frequency
52	Control bonjour Mayday four Bravo is levelling level two hundred diverting to Lyon with an engine failure		Idem		
12 h 27 min 00		I don't that other one's making funny noises			
01			(Ctl) Netax four Bravo confirm it's an engine failure and continue descent level one two zero		
06		(@)			Alarm (3000 Hz 0,15 s) similar to the Altitude Alert
08	Continue descent to one two zero affirm we had a oil pressure indication and an engine failure and we've shut down the left hand engine		Idem		

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
14		What's the range to them			
15			(Ctl) Roger four Bravo do you need safety euh at the landing?		
12 h 27 min 19		Yes			
20	Affirm Nex four Bravo		Idem		
23	Half a second Dave uhm				
26		Netax four Bravo can you give us our range to you?	Idem		
32				(@)	Increase in engine thrust
38	Okay in the descent one two zero Dave keep it going down	Yes			
41	Speed's good				
42				(@)	Increase in engine thrust
46				(@)	Increase in engine thrust
48				(@)	Reduction in engine thrust
51		Netax four Bravo range to you please?	Idem		
54	It's alright Dave I'll sort that out don't worry about that				
57	Keep just keep it flying				
59			(Ctl) four Bravo from Lyon you are forty miles		
12 h 28 min 04		Understood	Idem		
06			(Ctl) Four Bravo say how many passengers		
09		Three P O B and two pilots five P O B	Idem		
13			(Ctl) Five P O B thank you	(@)	Increase in engine thrust
18	(…) I'm sorry we've lost... we're had an engine problem with our left engine we're going into Lyon and we'll take it on from there Sir sorry for the problem				
40		Where is Lyon have you got it in there oh thanks mate			

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
41	Hold on a sec yeah it's coming up Dave coming up				
12 h 28 min 43		I don't like the sound of... I don't like that other vibration			
46	You're going down so fast there Dave that...				
49		What?			
	The vibration and it's thirty six miles zero five zero				
55		Zero five zero			
56	Yeah				
59				(@)	Noise of selector
12 h 29 min 01		I put what on so fast?			
03	You you hearing with that engine?				
04		Er			
21			(Ctl) Netax four Bravo continue present heading if possible		
25	Heading zero five zero err Nex four Bravo radar heading		idem		
28		And we need the plates for Lyon			
30			(Ctl) Netax four Bravo on heading zero five zero descending level one two zero you contact Lyon approach frequency one two seven decimal five seven		
31		Oh right			
43	One two zero on the heading and one two seven five seven the approach frequency Nex four Bravo merci beaucoup				
50		Did you shut the emergency air off.. the last?			

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
51		(@)			Alarm (700 Hz 0,3 s) similar to a change of VHF frequency
53	Ok				
12 h 29 min 57		Do you want to go through the checklist now the emergency checklist?			
59	Err will do (say err) get the navigation now we'll do the checklist in a second they've got us under control were quite high though need to get it going down	Alright			
12 h 30 min 06		How far are we?			
07	Thirty miles				
08		What's the runway?			
09	Just standby I got that on the on the other (strip)			(@)	Reduction in engine thrust
11			Piste 2 : ATIS commence		
13		I don't like the sound of that other engine that's why I am worried			
15		Yeah			
24				(@)	Reduction in engine thrust
32		Netax four Bravo can you give me the runway direction we are expecting	Idem		
36			(Ctl) Runway three six left for landing three six left and err want radar vectors for three six left?		
43		Affirm this is a full emergency	Idem		
45			(Ctl) Understood so proceed a right turn on heading euh zero eight zero and descend flight level six zero		
52	Zero eight zero descending flight level six zero Netax four Bravo		Idem		
55				(@)	Reduction in engine thrust

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
12 h 31 min 04		How far out now			
06	Okay twenty two miles				
09				(@)	Reduction in engine thrust
13			(Ctl) Nex four Bravo you have the frequency of the I L S?		
12 h 31 min 17	Negative Sir can we have that please		Idem		
18			(Ctl) Okay the frequency one one zero point seven five		
23	One one zero seven five Nex four Bravo		Idem		
26			(Ctl) (Okay)		
45		You've set me up have you			
46	I'm setting you up				
47		(Al right)			
55				(@)	Reduction in engine thrust
59			(Ctl) Nex four Bravo can you right turn heading zero nine zero continue descent flight level euh co... correction five thousand feet and Q N H one zero one four		
12 h 32 min 05				(@)	Reduction in engine thrust
12	Five thousand feet one zero one four Netax four Bravo and radar heading zero nine zero		Idem		
17			(Ctl) That's correct		
18		Netax four Bravo we'd like to keep the approach short	Idem		
24		We should have a discreet frequency on a mayday			
35				(@)	Reduction in engine thrust

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
38		Netax four Bravo we'd like to keep the approach short	Idem		
41			(Ctl) (*) three six left		
44				(@)	Noise of selector
46		Tighten your seat belt			
47	You alright?		(Ctl) Nex four Bravo you understood twenty nautical miles for touch down		
51	Twenty copied Nex four Bravo		Idem	(@)	Reduction in engine thrust
52	Better start bringing the speed back now Dave		(Ctl) It's okay for a (*) approach?		
54		Yeah			
12 h 32 min 55	Say again Nex four Bravo		Idem		
56			(Ctl) Is it okay for a (*) approach?		
59	Affirm Nex four Bravo	Yes	Idem		
12 h 33 min 01			(Ctl) Okay Nex four Bravo continue descent three thousand feet on Q N H one zero one four		
07	Three thousand feet one zero one five set Nex four Bravo				
13		Just watch the indications on that good engine			
15	Yes	Keep your eyes open for the field			
17	Yeah				
34	Okay three to go high rate of descent	Yup seen		(@)	Reduction in engine thrust
39	Fourteen miles zero one one				
	There's (*)				
43	Coming to the nine o'clock				
46	Your speed's still quite high				

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
47			(Ctl) Nex four Bravo turn left heading zero three zero to lock on I L S three six left and report established		
55	Zero three zero to lock on for the I L S for three six left Nex four Bravo		Idem		
12 h 34 min 03	That's copied merci beaucoup Netax four Bravo		Idem		
06	Okay standing by (the flap) two thousand feet to level				
09		Have you set the pressurisation quick?			
19				(@)	Noise of selector
22				(@)	Increase in engine thrust
12 h 34 min 26	Okay				
37	Okay	It's alive			
39	Ok it's starting to come alive Nex four Bravo established three six left localiser		Idem		
43			(Ctl) Roger you are about four nautical miles south of Lima Yankee Sierra beacon clear I L S three six left and call Tower one two zero four five good by	(@)	Reduction in engine thrust
52	One two zero four five position copied Netax four Bravo merci beaucoup		Idem	(@)	Reduction in engine thrust
56	(@)	(@)			Alarm (700 Hz 0,3 s) similar to a change of VHF frequency
59	Okay glide slope's alive speed's still a little bit high approaching...				
03		Yeah		(@)	Reduction in engine thrust
10	Lyon Tower bonjour Netax four Bravo just levelling three thousand feet established on the I L S		Idem		

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
11	(@)	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
14				(@)	Increase in engine thrust
17			(Ctl) Nex four Bravo bonjour clear to land (*) left wind north ten knots		
22	Cleared to land three six left Netax four Bravo		Idem	(@)	Increase in engine thrust
25	Okay (*)				
26				(@)	Noise similar to interference caused by the engine automatic restart system
29		Only the right pump			
30	Yep				
33				(@)	Increase in engine thrust
12 h 35 min 35	Okay a little bit to the right				
37		Get rid of that			
41	(Start) descent ok speed checks my side				
42		Right			
43		Okay I don't want anything yet			
47		That D M E is right is it?			
50	Erh seven point five yeah that checks the D M E's correct				
12 h 36 min 01		See the runway yet			
04	Yeah visual I'm visual with the field little bit...	Yeah yeah I got it			
06		There's two runways			
09		There's two isn't it we're going for the left			
10	(@) There's two yeah going for the left one	(@)		(@)	Alarm (3000 Hz 1,5 s) similar to the Altitude Alert
11				(@)	Increase in engine thrust
12	Slightly left of track at the moment				
14	Coming back in	Okay			

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
17	Okay you're on the a glide				
19		Can you tighten my seat belt			
21	What do you want to do with it?	I think it what... it that one isn't it oh shit no			
23				(@)	Noise of selector
24	Want it just tighten it				
25		Yeah you know you know the lock			
27	There you go				
28		Is it locked that's it thanks and yours			
31	Okay?			(@)	Increase in engine thrust
34	Okay just above the glide a little bit				
12 h 36 min 36	Eight flap				
37		Err no not yet			
41	Little bit fast			(@)	Reduction in engine thrust
43	V ref will be...				
45		Okay i'll take eight now		(@)	Reduction in engine thrust
48		The ref is			
50		Take a... sensible guess			
51	V ref will be one two nine				
53		Right			
56				(@)	Reduction in engine thrust
58		Err gear			
59	Slightly high				
12 h 37 min 01	Gear's travelling speed checks?				
03		Twenty flaps		(@)	Reduction in engine thrust
04	Speed checks travelling			(@)	Noise of selector
08		And follow me through get rid of your paperwork and follow me through		(@)	Increase in engine thrust
11	Yeah sure				

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
14	Oh this will save having to do a base check				
18	Plus thirty at the moment slightly high			(@)	Increase in engine thrust
25	Flaps set clearance you got				
28				(@)	Noise of selector
31	Good visual plus thirty at the moment				
36				(@)	Reduction in engine thrust
39		Plenty of runway			
41	Plus twenty five				
47		On landing I'm going to stop the aeroplane			
51		Wind direction four Bravo	Idem		
54			(Ctl) Wind zero two zero knots ten knots zero two zero degrees ten knots		
58	Yeah				
12 h 38 min 01	Okay plus... twenty				
02		And two Bravo on landing we will exit all the passengers immediately	Idem		
07			(Ctl) Roger		
38 min 08,50	Okay a little bit low little bit low	Full flaps			
38 min 10,20				(@)	Increase in engine thrust
38 min 11,90		No hold on			
38 min 12,80	You want all the flap?				
38 min 13,80		Not yet			
38 min 15,65				(@)	Increase in engine thrust
38 min 17,70	Plus ten you're getting a little bit low				
38 min 19,35				(@)	Increase in engine thrust
38 min 20,80	Little bit low				
38 min 22,20		Oh shit			
38 min 22,80	Little bit low				
38 min 23,30	Put the power				
38 min 23,45		Shit			

UTC time	Track 2	Track 3	Tracks 2 & 3	Track 4	Observations
	Co-pilot	Captain	VHF	CAM	
38 min 23,70				(@)	Increase in engine thrust
38 min 24,00		I'm losing it			
38 min 25,00		(…)		(@)	Noise of selector and reduction in engine thrust
38 min 26,35	(@)				Interference (600 Hz 1,5 s)
38 min 27,00		(…)			
38 min 28,00	(@)	(@)			Noise of impact
38 min 28,60				(@)	Noise of impact
12 h 38 min 29					End of recording

AIP
FRANCE

AD2 - LFLL - OACI
24 FEB 00

CARTE D'AERODROME - OACI
AERODROME CHART - ICAO

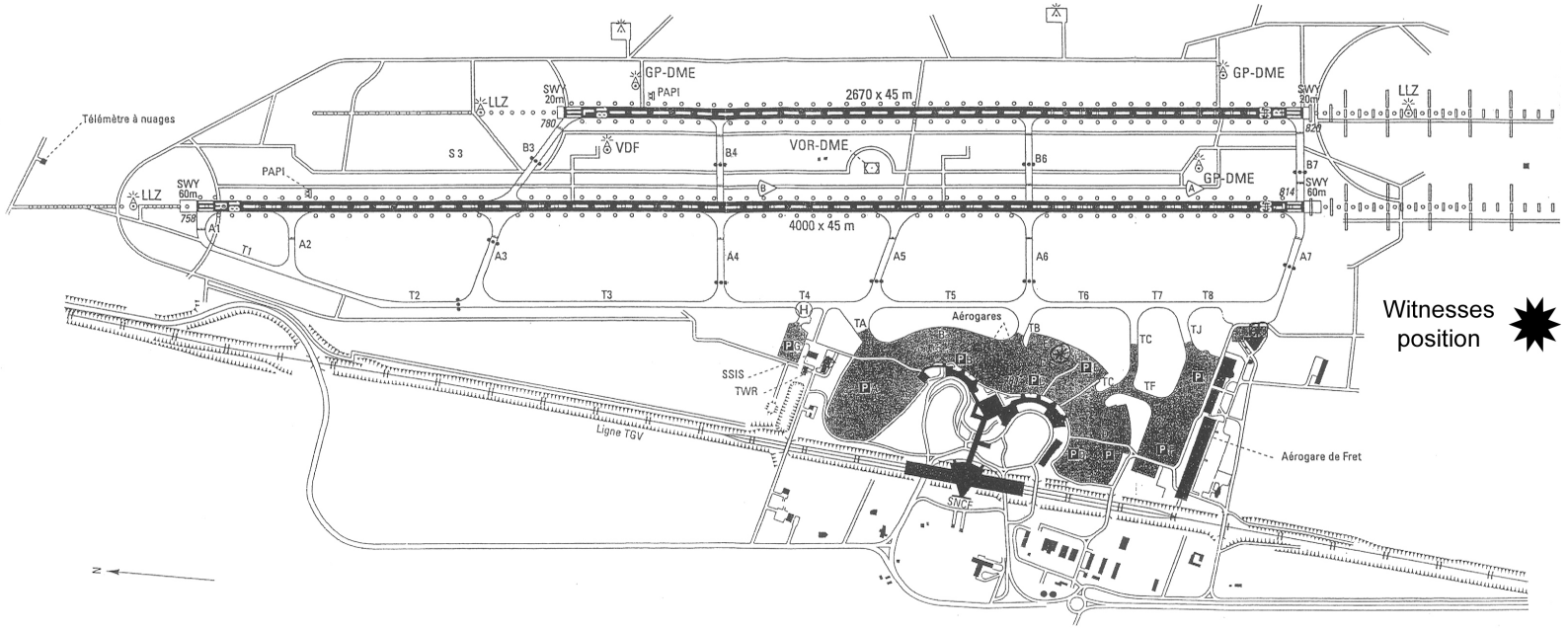
LAT : 45 43 32 N
LONG : 005 04 52 E

ALT
ELEV *821 ft (30 hPa)*

LYON **SATOLAS**

VAR 1°W (95)

GUND = 161 ft



LEGENDE

- Transmissomètre
- Barre d'arrêt *Stop bar*
- Point d'arrêt *Holding point*
- Aire de trafic *Apron*

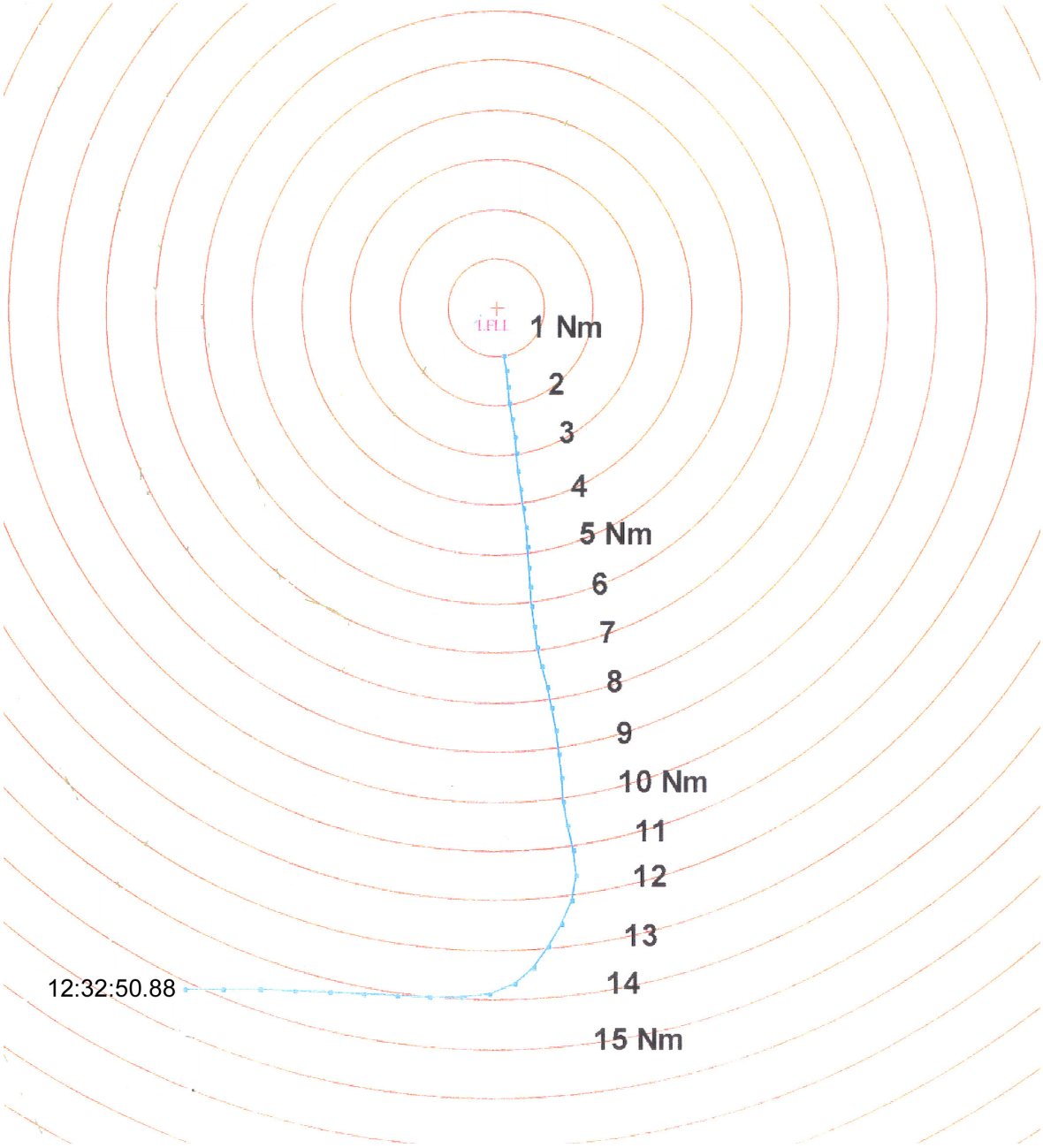
ECHELLE : 1/15 000

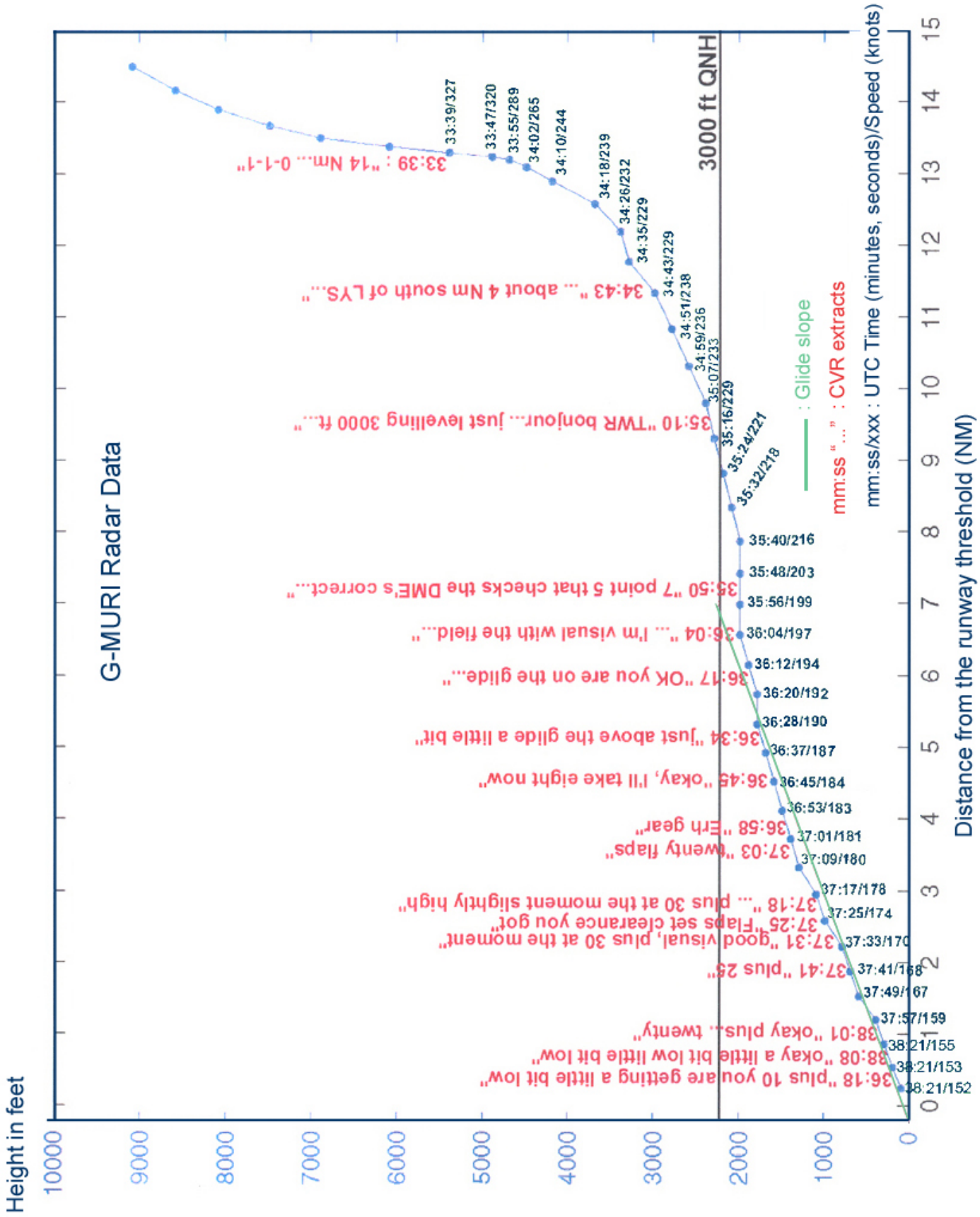
0 50 100 200 300 400 500 m

SERVICE DE L'INFORMATION AERONAUTIQUE

AMDT 02/00 **CHG** : Présentation.

VERSO BLANC


1 Nm
2
3
4
5 Nm
6
7
8
9
10 Nm
11
12
13
14
15 Nm
12:32:50.88


G-MURI Radar Data
3000 ft QNH
Height in feet
Distance from the runway threshold (NM)
mm:ss/xxx : UTC Time (minutes, seconds)/Speed (knots)
mm:ss "..." : CVR extracts
: Glide slope
33:39 : "14 Nm... 0-1-1"
33:39/327
33:47/320
33:55/289
34:02/265
34:10/244
34:18/239
34:26/232
34:35/229
34:43/229
34:51/238
34:59/236
35:07/233
34:43 "... about 4 Nm south of LYS..."
35:10 "TWR bonjour... just levelling 3000 ft..."
35:16/229
35:24/221
35:32/218
35:40/216
35:48/203
35:50 "7 point 5 that checks the DME's correct..."
35:56/199
36:04/197
36:04 "... I'm visual with the field..."
36:12/194
36:17 "OK you are on the glide..."
36:20/192
36:28/190
36:34 "just above the glide a little bit"
36:37/187
36:45/184
36:45 "okay, I'll take eight now"
36:53/183
36:58 "Erh gear"
37:01/181
37:03 "twenty flaps"
37:09/180
37:17/178
37:18 "... plus 30 at the moment slightly high"
37:25/174
37:25 "Flaps set clearance you got"
37:31 "good visual, plus 30 at the moment"
37:33/170
37:41/168
37:41 "plus 25"
37:49/167
37:57/159
38:01 "okay plus... twenty"
38:08 "okay a little bit low little bit low"
38:21/155
38:21/153
36:18 "plus 10 you are getting a little bit low"
38:21/152

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