LE GOUVERNEMENT
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REVISED FINAL REPORT

Accident on 6 November 2002 in Luxembourg to the Luxair Fokker 27 Mk050 registered LX-LGB

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Accident on 6 November 2002
in Luxembourg
to the Luxair Fokker 27 Mk050
registered LX-LGB

AET – Administration des Enquêtes Techniques

B.P. 1388 L-1013 Luxembourg

Tel: +352 247 84404
Fax: +352 26 47 89 75
Email: info@aet.etat.lu
Web : www.mt.public.lu/transports/AET

FOREWORD

In accordance with Annex 13 to the Convention relative to the International Civil Aviation Organization, Directive 94/56/CE of the Commission and to the Luxembourg law dated 30 April 2008[1] on technical investigations in relation to accidents and severe incidents which happened in the domains of civil aviation, maritime transport and railways, it is not the purpose of the aircraft accident investigation to apportion blame or liability.

The sole objective of the investigation and its final report is the prevention of future accidents.

Consequently, the use of this report for purposes other than prevention may lead to wrong interpretations.

This report is a translation from the official report published in French.

ADDENDUM

The original report into the Luxair accident was published in December 2003. Since then developments have taken place which led the investigation commission to issue a revised report.

[1] Replacing the initial law dated 8 march 2002 on technical investigations and creating the independent Administration des Enquêtes Techniques

CONTENTS

ABBREVIATIONS

AFM	Aircraft flight manual
AOM	All Operator Message / Aircraft Operating Manual
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot Licence
BECMG	Becoming (TAF message)
BITE	Built in test equipment
BKN	Broken (TAF message)
BR	Mist (TAF message)
CAT II	All weather operations category (low visibility operations)
CPL	Commercial Pilot Licence
CRM	Crew resource management
CVR	Cockpit voice recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EMI	Electromagnetic interference
FAA	Federal Aviation Agency
FAF	Final Approach Fix
FDR	Flight Data Recorder
FG	Fog (METAR message)
FL	Flight level
FSK	Frequency Shift Keying
ft	Feet
GA	Go Around
GPWS	Ground Proximity Warning System
HDG	Heading
HP	High pressure
hPa	Hectopascal
IAF	Initial Approach Fix
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IR	Instrument Rating
JAA	Joint Aviation Authority
JAR	Joint Aviation Regulations
kHz	Kilo Hertz

KT	Knots (METAR)
kts	Knots
lb	Pound
LH	Left Hand
LP	Low Pressure
LVP	Low visibility procedures
M ETAR	Meteorological aviation report
MHz	Mega Hertz
mph	Miles per hour
ms	Millisecond
NDB	Non-Directional Radio Beacon
NM	Nautical Mile
NOSIG	No significant change (METAR message)
NSW	No Significant Weather (TAF message)
OVC	Overcast (METAR message)
PCU	Propeller Control Unit
PEC	Propeller Electronic Control
PF	Pilot Flying
PNF	Pilot Not Flying
PPL	Private Pilot Licence
QFU	Runway magnetic direction
QNH	Pressure setting to indicate elevation above mean sea level
RVR	Runway visual range (Horizontal visibility on the runway)
RN	National road
RH	Right Hand
RPM	Rotations per Minute
RMI	Radio Magnetic Indicator
RWY	Runway
SB	Service Bulletin
SCT	Scattered (TAF message)
SOP	Standard operating procedures
TAF	Terminal aerodrome forecast
TDZ	Touch Down Zone
TEMPO	Temporary (METAR)
TR	Aircraft type rating
TRTO	Type Rating Training Organisation
UTC	Universal Time Coordinated
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range

SYNOPSIS

Date of accident
Wednesday 6 November 2002 at 09h 06min[(2)]

Accident site
Niederanven, three point five kilometres to the east of threshold runway 24 of Luxembourg Airport

Aircraft
Fokker F27 Mk050 registered LX-LGB

Owner
LUXAIR

Operator
LUXAIR

Type of flight
Public transport of passengers
Flight LG9642/LH2420 Berlin - Luxembourg

Persons on board: 22
2 cockpit crew, 1 cabin crew, 19 passengers

Summary

During an ILS approach to runway 24, whilst established on the centreline, the aircraft disappears from the radar screens. It is located again at three point five kilometres to the east of threshold runway 24, seven hundred metres north of the centreline.

Persons on board	Persons			Aircraft	Load	Third parties
	Fatal	Injured	Not injured	Destroyed	Destroyed	-
Crew	2	1	-			
Passengers	18	1	-			

[2] Unless otherwise specified, times mentioned in this report are UTC times.

ORGANISATION OF THE INVESTIGATION

According to Luxembourg legislation and to article 26 of the Chicago convention of the ICAO and its annex 13, the Grand-Duchy of Luxembourg, country of occurrence, started a technical investigation. An investigation commission was created by ministerial decree. The French bureau of investigation for the safety of civil aviation (BEA) was asked for assistance.

Investigators assisted by experts from the Dutch Type Certificate Holder Fokker Services B.V. and by technical and operational experts from Luxair have examined the site of the accident to secure material evidence. At the same time, the flight data recorders have been taken to the BEA for reading and analyses.

A representative from the engine manufacturer Pratt & Whitney and from the propeller manufacturer Dowty joined the investigators and work continued on the first findings of the recorders and on the aircraft wreckage that had been transported into a hangar at Luxembourg airport.

The Netherlands participated in the investigation as State of manufacture of the aircraft. Germany, having suffered many victims, also sent experts.

The technical investigation and the judicial investigation were closely coordinated during the first phase of the collection of technical information and of the examination of the components removed from the wreckage, with mutual respect to their individual procedures and objectives.

Investigative work on the airframe, engines, propellers and different aircraft equipments was started immediately.

The first factual findings of the investigation were published in a preliminary report issued in January 2003.

After additional investigations and analysis by the experts of the BEA, all CVR and FDR read outs were validated and finalised.

A number of aircraft components and equipments, removed from the wreckage were sent to the manufacturers and other specialised laboratories for examination and additional testing. These activities were done in the presence of the investigation team.

Additionally, the investigation team went to a Fokker 27 Mk050 flight simulator with the aim to reproduce the last minutes of the accident flight.

1. FACTUAL INFORMATION

1.1. History of the flight

The Fokker 27 Mk050 registered LX-LGB and operated by Luxair left Berlin on 6 November 2002 at 07h 40min on flight LG 9642/LH 2420 with destination Luxembourg.

Cruising level was at FL 180. At 08h 50min, Frankfurt Control asked the crew to stop descent at FL 90, direct to Diekirch and at 08h 52min the flight was transferred to Luxembourg Approach. They were instructed to enter the Diekirch hold at FL 90, to expect later on vectors for an ILS 24 and were given the latest RVR readings.

At 08h 59min, well before reaching the Diekirch hold, the aircraft was recleared to 3000ft QNH and to turn left heading one three zero. At this time the aircraft flew in the clear sky above a fog layer. RVR was two hundred seventy five meters. The crew evoked a go-around if the RVR was not three hundred meters whilst passing ELU (it's minima for a category II approach).

At 09h 04min 36s, the aircraft passed overhead ELU maintaining 3000ft QNH.

At 09h 04min 57s, the ATC controller transmitted an RVR of three hundred meters. Power was further reduced, flaps 10 were selected and the landing gear was lowered.

Immediately after the landing gear was lowered, the pitch angle of the two propellers simultaneously reached a value that is lower than the minimum values for flight. This propeller pitch setting involves a rapid decrease of speed and altitude.

During the following seconds, the left engine stopped and then the right engine stopped. The flight data recorders, no longer powered ceased functioning. At 09h 05min 42s (radar time base), the aircraft disappeared from the radar screen. It was immediately found in a field seven hundred meters to the north of runway centreline 24 and three point five kilometres to the east of the threshold.

1.2. Injuries to persons

Injuries	Crew	Passengers	Other persons
Fatal	2	18	-
Serious	1	1	-
Minor / None	-	-	-
Total	3	19	-

1.3. Damage to the aircraft

The aircraft was destroyed

1.4. Other damage

There was no damage to third parties

1.5. Personnel information

1.5.1. Captain

Male, 26 years, airline transport pilot licence

Total flight hours: 4242
Hours on type: 2864
Last 3 days: 0
Last 28 days: 54
Last 30 days: 57
Day of the accident: 1 hour and 36 minutes before the last flight.

The captain resumed flying on 6 November 2002, after a rest period of 91 hours (standby).

Last checks:
Proficiency check: 1 June 2002 (date provided by Luxair, documentation not on file)
Line check: 12 June 2002
Medical check: 19 June 2002, valid until 5 July 2003.

1.5.1.1. Licenses

- FAA CPL license N°2501396 issued 16.11.1994, Luxembourg validation N° 3488 dated 05.04.1995
- Swiss theoretical ATPL passed on 06.06.1995
- Swiss CPL license N° 36314 issued 07.11.1995 with Fokker 27 Mk050 co-pilot type rating, Luxembourg validation N° 3721 on 20.02.1996
- Swiss ATPL captain Fokker 27 Mk050 issued 16.03.1999

1.5.1.2 Qualifications

- TR captain Fokker 27 Mk050 valid until 14.12.2002
- IR/CATII captain Fokker 27 Mk050 valid until 14.12.2002

1.5.1.3 Aeronautical career

- Contract with Luxair Commuter as of 1 April 1995 with total flying of about 236 hours on glider, single and multi engine aircraft.
- Type rating co-pilot Fokker 27 Mk050, July 1995
- Contract with Luxair as of 10 February 1996
- Type rating co-pilot B737, July 1997
- Conversion and type rating to captain Fokker 27 Mk050 started beginning of 1999.

1.5.2. Co-pilot

Male, 32 years, airline transport pilot licence

Total flight hours: 1156
Hours on type: 443
Last 3 days: 0
Last 28 days: 50
Last 30 days: 54
Day of the accident: 1 hour and 36 minutes before the last flight.
Last flight before the accident: 1 November 2002

Last checks:
Proficiency check: 22 June 2002 (date provided by Luxair, documentation not in file)
Line check: 13 June 2002
Medical check: 30 November 2001, valid until 14 January 2003

1.5.2.1 Licenses

- FAA CPL license N° 2511212 issued 28.04.1995

- Luxembourg PPL license N°865, issued 30.08.1996 with aerobatics and instrument flight qualifications.
- German ATPL license N° 11500 issued on 19.06.2000 with 700 flying hours. Luxembourg validation N° 4971 dated 12.12.2000.

1.5.2.2 Qualifications

- IR/CAT II valid until 14 January 2003

1.5.2.3 Aeronautical career

- Freelance pilot, flying on Short Skyvan and Britten Islander, with around 300 hours.
- ATPL training between 1998-2000
- Luxair recruitment process (interview on 10.07.2000, psychological test on 13.07.2000, flight test on 26.07.2000 and recommendation on 28.11.2000.)
- Contract with Luxair dated 04.12.2000
- Fokker 27 Mk050 ground course finished in December 2000
- Fokker 27 Mk050 co-pilot conversion and type rating carried out Dec 2000/Jan 2001.
- Type rating F27 Mk050: June 2001

1.5.3. Cabin crew

Female:	32 years.
Entry date at Luxair:	16 February 1995.
Last checks:	18 May 2002.

1.5.4. Air traffic control

Approach control, taking over traffic from foreign centres for integration into the approach sequence, was performed in a dedicated radar room. Staff present at the moment of the accident was:

- One qualified approach controller working on the radar position
- One qualified approach controller working in the assistant/coordinator position

Aerodrome control takes over traffic from approach control for landing. Staff present at the moment of the accident was:

- One qualified aerodrome controller working on the aerodrome position
- One qualified aerodrome controller working in the assistant/coordinator position
- One trainee with no duties assigned.

1.6. Aircraft informations

1.6.1. Airframe

- Manufacturer: Fokker Aircraft BV (Netherlands)
- Type: F27 Mk050
- Serial N°: 20221
- Airworthiness certificate:
  - Delivered on 26 June 1991
  - Valid until 19 June 2003
- Flight hours up to 6 November 2002: 21 836
- Cycles up to 6 November 2002: 24 068

1.6.2. Engines

Manufacturer: Pratt & Whitney Canada

Engine	Type	Serial Number	Operating hours	Cycles
Left	PW 125B	124315	20 372	22 060
Right	PW 125B	125004	18 454	20 077

1.6.3. Propellers

Manufacturer: Dowty Propellers

Propeller	Type	Serial Number	Operating hours	Cycles
Left	R352/6-123-F/1	DRG8487/89	18 008	16 958
Right	R352/6-123-F/1	DRG11867/89	17 923	19 470

1.6.4. Mass and balance

The aircraft was within the weight and balance envelope as determined by the manufacturer.

1.6.5. Maintenance and airworthiness

The evening before the accident a «230 flight hours inspection» was performed with a satisfying result. Upon completion of the inspection, the aircraft was released to service by the issuance of a Certificate of release to Service (N°3769).

The hold item list (HIL) mentioned an inoperative antiskid system on the right hand landing gear up to the 5 November 2002 (date of the inspection). This anomaly was first detected on 27 September 2002 and the RH antiskid harness had been replaced. On 24 October 2002, the same system was inoperative again. Despite changing the outboard wheel speed sensor, the system remained inoperative. The problem was resolved on 5 November 2002 by replacing the RH inboard wheel speed sensor. This was listed on the HIL N°00321 as item D, which was by that action cleared on 5 November 2002.

1.6.6. Aircraft type certification

The Fokker F27 Mk 050 is an aircraft derived from the F27. A lot of modifications were introduced, mainly very advanced cockpit equipment with monitors for flight data, different engines and propellers. The first flight of the prototype was on December 28, 1985.

The type certificate was issued on May 15th, 1987 by the Dutch authorities. The production ran from 1987 until May 1997. 208 aircraft were built including 2 prototypes.

The FAA Type Certificate was issued on 8 February 1989 and the aircraft is in service with 30 operators on all 5 continents.

1.7. Meteorological informations

1.7.1. General situation

Luxembourg was under the influence of high pressures, with a low pressure system centred over Iceland and a low-pressure system moving slowly to the east.

This generated persistent fog, which only cleared during the early afternoon hours.

1.7.2. Situation at the aerodrome

Meteorological information recorded at the airport is integrated into the ATIS message. For this period of time, the meteorological values were as follows:

METAR from 07h 50min:	00000KT 0100 R24/250N FG OVC001 04/04 Q1024 NOSIG
METAR from 08h 20min:	00000KT 0100 R24/250N FG OVC001 04/04 Q1024 NOSIG
METAR from 08h 50min:	00000KT 0100 R24/250N FG OVC001 04/04 Q1023 NOSIG
METAR from 09h 20min:	00000KT 0100 R24/250N FG OVC001 04/04 Q1023 NOSIG

Recorded RVR values as shown in appendix 14 are minute averages. The RVR given by ATC is the actual measured value which is updated every 15 seconds. RVR values are not recorded by second intervals.

The forecast established for this period was as follows:

TAF from 06h 00min:	060600 060716 18003KT 2000 BR BKN003 TEMPO 0710 0100 FG BKN001 BECMG 1113 18007KT 5000 NSW SCT015 BKN030 BECMG 1215 18012 KT 9999 SCT020 BKN035=
TAF from 09h 00min:	060900 061019 18002KT 0100 FG BKN001 BECMG 1114 2000 BR BKN009 BECMG 1416 20010KT 9999 SCT015 BKN040=

1.7.3. Situation at the diversion aerodrome

During the flight, the crew listened to the ATIS message of Saarbrücken (Germany) aerodrome. The captured information was:

Wind 1104 knots, visibility 2000 meters- few 200- broken 600 feet- temperature 2.6- QNH 1024- trend becoming visibility 3000 meters- broken 800 feet- expect ILS approach RWY 27- transition level 60- Wind 1104 knots- visibility 2000.

1.7.4. Meteorological information available to the crew in Berlin

A trip file for the return flight was delivered to the crew by the handling agent. No proof could be obtained from the handling agent if this file contained any type of meteorological data. This type of detailed information is not saved nor stored by the handling agent.

This information could not be secured on the accident site. Anyhow, a new forecast would only have been available after 09h 00min, which was about the estimated time of arrival of the flight in Luxembourg.

1.8. Aids to navigation

The approach procedure for the CAT II ILS DME for runway 24 is based on the following means (see Jeppesen chart appendix 1):

- a VOR/DME DIK 114,400 MHz materialising the IAF and collocated with an NDB 307 kHz
- an ILS/DME ILW 110,700 MHz
- an NDB ELU 368,5 kHz at 5,5 NM from the threshold.

All these equipments were operating normally at the time of the accident.

1.9. Communications

During the last minutes of the flight, LGL9642 was in contact with the Frankfurt en-route Centre, the Luxembourg Approach Control and the Luxembourg Control Tower.

The aerodrome operates following radio communications frequencies:

- Approach Control frequency 118.900 MHz
- Control Tower frequency 118.100 MHz

These equipments were operating normally at the time of the accident.

Excerpts from the communications with the different organisations are given below with the CVR time base (Appendix 4 shows the radio communications transcription).

Communications with Frankfurt Centre:
At 08h 44min 25s, Luxair 9642, at FL 140, contacted Frankfurt who asked to route directly to ELU and to maintain the flight level. At 08h 46min 43s, the flight was authorised to descend to FL100, then to FL60 at 08h 49min 06s.

At 08h 50min 39s, the controller transmitted: « Luxair 9642 by request of Luxembourg stop your descent level 90 set course to Diekirch ». The crew acknowledged.

At 08h 52min 15s, the controller transferred the aircraft to Luxembourg Approach Control: « Luxair 9642 for lower and radar vectors contact Luxembourg 118.900 good bye ».

Communications with Luxembourg Approach Control
At 09h 01min 25s, the approach controller asked «9642 turn right heading 220 to intercept cleared for approach, report established on the localizer ».

At 09h 02min 32s, the crew announced « The Lux euh 9642 is now established on the localizer ». The flight was then transferred to Control Tower frequency, which was contacted at 09h 02min 51s.

Communications with Luxembourg Control Tower
At 09h 02min 57s, the tower controller replied « Luxair 9642 good morning, continue approach. The wind is calm RVR beginning 250 meters, mid section 250 meters, stop end 225 meters ».

At 09h 03min 08s, the crew replied « … that's copied Luxair 9642… but we need 300 meters for the approach ».

At 09h 03min 18s, the tower controller transmitted «9642 copied… uh so continue approach and I'll keep you advised we didn't have 300 uh… uh during the last time ».

At 09h 03min 28s, the crew announced «Euh Roger 9642, we keep you advised we're proceeding to ELU now and … uh standing by 9642».

At 09h 04min 36s, the tower controller informs MK123 «We have now on the three positions 275 meters». This message is heard by the crew.

At 09h 04min 42s, the captain repeats «275 meters».

At 09h 04min 46s, he says «Yes, well we do a go-around, missed approach».

At 09h 04min 57s, the tower controller transmitted an RVR of 300 m to the crew: «Luxair 9642 RVR 300 meters 275 meters stop end 275 meters».

At 09h 05min 05s, the crew announced «9642 Roger so we continue».

At 09h 05min 08s, the tower controller replied «9642 you are cleared to land wind 180°….knots».

The co-pilot acknowledged this message at 09h 05min 13s. It was the last communication with ATC.

1.10. Aerodrome information

The airport has a single runway oriented 241°/061° of a length of 4000 meters. Altitude of threshold runway 24 is 1214 feet.

The two runway orientations are each equipped with an ILS;

- for runway 06, an ILS category I,
- for runway 24, an ILS category III.

The airport is equipped with a primary and secondary approach radar, used by Approach Control for i.e. radar vectoring on initial and intermediate approach and for separating incoming and outgoing IFR traffic.

The fire protection category of the airport is category 8, in accordance with ICAO Annex 14.

All technical equipments of the airport worked normally.

1.11. Flight recorders

The Fokker 27 Mk050 was equipped with two flight recorders:

	DFDR	**CVR**
Model	Fairchild F800	Fairchild A100A
Reference (P/N)	17M-800-251	93-A100-80
Serial number (S/N)	3672	56866

The recorders have been taken to the BEA in the afternoon of 7 November 2002. Extractions and readings of the tapes have been done right away.

Final validated data of the CVR and DFDR are shown in the appendices 2 and 3.

1.11.1. Read out operations

1.11.1.1. DFDR

The recorder, still fixed to its support structure, was in good shape. Inside of the protected box, the tape was in place and in an apparent perfect condition. The reel on which the magnetic tape is rolled inside the recorder has been extracted and placed on an appropriate reading device. This device produces files that faithfully render the analogue signals registered on the magnetic tape, but these files have to be decoded and synchronized by appropriate software.

1.11.1.2. CVR

The cockpit voice recorder was still fixed to its support structure. Not much damaged, its state nonetheless required the box to be cut apart. After extraction, the tape has been transferred onto a new standard reel.
The magnetic tape of the CVR Fairchild A-100 comprises four channels, which correspond to the four channels recorded during thirty minutes.

The reading of the tape has been done on an adapted REVOX reading device, after adjusting the tape speed thanks to the 400 Hz signal corresponding to the onboard power supply. Furthermore, the CVR included on channel 2 an FSK signal (Frequency Shift Keying). This signal is composed of acoustic bips spaced exactly by 4000 ms permitting to fine tune the tape speed. In addition, these bips code UTC time that can be read by a specialised decoding device.

1.11.2. Read out results

1.11.2.1. DFDR

Hereafter are listed some significant parameters of the last 30 seconds of the recording.

At 09h 05min 00s: reduction of engine power

- Heading: 239°
- Indicated airspeed: 165 kts
- Pressure altitude: 2 742 ft
- Propeller torque (left and right): 17% and 15%
- Propeller speed (left and right): 85% and 85%
- Fuel flows (left and right): 493 lb/h and 447 lb/h
- Flaps position: 0

At 09h 05min 09s: start lowering flaps

- Heading: 240°
- Indicated airspeed: 152 kts
- Pressure altitude: 2 712 ft
- Propeller torque (left and right): 0% and 0%
- Propeller speed (left and right): 85% and 85%
- Fuel flows (left and right): 208 lb/h and 182 lb/h
- Flaps position: 1

At 09h 05min 16s: start lowering landing gear

- Heading: 238°
- Indicated airspeed: 145 kts
- Pressure altitude: 2 635 ft

- Propeller torque (left and right): 0% and 0 %
- Propeller speed (left and right): 85% and 85%
- Fuel flow (left and right): 214 lb/h and 188 lb/h
- Flaps position: 12

At 09h 05min 17s, the left propeller «blade angle» parameter switches from «normal» to «low pitch» [3] signalling a propeller blade angle setting less than 10°.

- Heading: 236°
- Indicated airspeed: 144 kts
- Pressure altitude: 2 617 ft
- Propeller torque (left and right): 0% and 0%
- Propeller speed (left and right): 86% and 86%
- Fuel flows (left and right): 202 lb/h and 174 lb/h
- Flaps position: 12

The right hand propeller[4] «blade angle» parameter switches from «normal»to «low pitch» a second later.

At 09h 05min 20s: start of flaps retraction

- Heading: 237°
- Indicated airspeed: 131 kts
- Pressure altitude: 2 512 ft
- Propeller torque (left and right): 3% and 0%
- Propeller speed (left and right): 86% and 95%
- Fuel flows (left and right) : 352 lb/h and 334 lb/h
- Flaps position: 12

At 09h 05min 26s: last recorded values

- Heading: 244°
- Indicated airspeed: 125 kts
- Pressure altitude: 2 145 ft
- Propeller torque (left and right): 0% and 0%
- Propeller speed (left and right): 6% and 98%
- Fuel flows (left and right): 7 lb/h and 352 lb/h
- Flaps position: 0

1.11.2.2. CVR

A complete transcription of the recording has been performed, showing a start at time 08h 33min 49s and ending at time 09h 05min 44s. The valid CVR data for the event sequence ends at time 09h 05min 28s, followed by brief interruptions and restarts. Duration of the valid data recording is 31min 39s.

Communications between the pilots and ATC are in English.

Communications between the crewmembers and their company are in the Luxembourg language. These dialogues have then been translated into French and English (see appendix 2).

[3] This is a binary parameter, meaning there are only two possibilities: « normal » or « low pitch ».
[4] The sample rate of the low pitch parameter is one time per second. Due to the sample rate, the time difference can be anywhere between a little bit more than zero seconds and just less than two seconds.

During the last 30 minutes of the recording, following relevant communications between the pilots are noted:

At 08h 35min 15s, the crew gets the following information from ATIS: Visibility 100 meters, RVR 250 meters, no change, fog.

At 08h 41min 08s, in contact with Frankfurt radar, they are requested to proceed direct Kirn and descend to FL140.

At 08h 44min 53s, the copilot checks again on the latest weather: ATIS – 0820 wind calm, visibility 100, RVR 250 meters no change, overcast 100, temperature 4, dew point 4 no change.

At 08h 45min 08s, the copilot remarks that it looks bad with the weather and the captain replies “Dad still works with all the tricks” and evokes the possibility of a holding pattern and a RVR evolution.

At 08h 46min 21s, the captain asks the copilot if he has already spoken to the passengers. His reply is no. There is an uncertainty about who should do it, the pilot flying or the pilot not flying. Since the copilot is handling the radio, the captain tells him to make the announcement to the passengers, but nobody is sure of what to say.

At 08h 47min 32s, the captain decides to call Luxair Dispatch to find out the latest status of the RVR.

At 08h 47min 57s, Dispatch reports that the RVR is 250 for the moment and adds that it has not been 300 for some time, and that if it wouldn’t improve, they would be diverted to Saarbrücken.

At 08h 48min 35s, the captain asks Dispatch if there is a Cargolux taking off in the near future.

At 08h 49min 25s, the crew expresses their discontent to be diverted to Saarbrücken and the captain listens to the Saarbrücken ATIS.

At 08h 50min 41s, Frankfurt Control requests them to stop descend at FL90 and to set course to Diekirch.

At 08h 51min 42s, the copilot asks again what to tell the passengers.

At 08h 52min 49s, on initial contact with Luxembourg approach, they are told to enter the Diekirch hold at FL90, and to expect radar vectors later on for an ILS Cat II on 24. Are also transmitted QNH 1023, current RVR beginning 250 meters, mid 275 meters and stop end 225 meters.

At 08h 53min 36s, the copilot starts his announcement first in Luxembourg language, then German and finally in English by letting the passengers know that they will join the holding pattern and wait for weather improvement.

At 08h 54min 43s, the captain tells Luxembourg radar that he is reducing speed to 160 kts.

At 08h 56min 44s, the copilot asks the cabin attendant if his announcement did make sense.

At 08h 58min 12s, the crew talks about the fuel on board and on how much they will need for the holding and the diversion.

At 08h 58min 50s, Approach control requests them to descend to 3000 feet on QNH1023 and to turn left heading 130°.

At 08h 59min 35s, the captain asks the copilot about the latest RVR. The copilot answers that he doesn't know.

At 09h 00min 22s, the captain calls Dispatch again for the latest RVR, which is 275 meters. Upon this he asked the copilot: "what are we going to do now", who replied: "I don't know".

At 09h 00min 50s, the crew hears a message from ATC given to LGL 8362 about the RVR status of 275 / 275 / 255 meters.

At 09h 01min 06s, the copilot questions: "what will they do with us then, Holding or Approach", upon which, the captain replies: "that it is for an approach".

At 09h 01min 15s, the copilot mentions that Cargolux should make a go-around in order to clear up the fog, so they could land.

At 09 h 01 min 25 s, ATC tells the crew: "turn right heading 220 to intercept, cleared for approach, report established on the localizer".

At 09h 01min 42s, after having been cleared for approach, the copilot remarks that the controller takes them in ahead of other aircraft (then in the Diekirch hold).

At 09h 02min 09s, the captain announces: "LOC is alive and captured".

At 09h 02min 12s, the captain instructs the copilot: "tell him …. that if at Echo we don't have 300 meters, that we then do a go-around and proceed to Diekirch".

At 09h 03min 04s, after the transmission of the last RVR information from tower, the captain says twice "Oh, this doesn't bring a thing", and at 09h 03min 16s, he adds "Tell them, we continue to ELU, if we have nothing, then ehhh".

From 09h 04min 30s to 09h 04min 53s, the crew performs the BEFORE APPROACH checklist.

At 09h 04min 46s, the captain announces to the copilot: "Yes, well we do a go-around, missed approach".

At 09h 04min 57s, tower transmits an RVR of 300 meters for the beginning of the runway.

At 09h 05min 00s, rotation speed of the turbines varies. A sound corresponding to the lifting of the ground range selectors is heard. Consequently and during an interval of sixteen seconds, flaps are extended and the landing gear lowered.

At 09h 05min 02s, the copilot says: “will not be enough”.

At 09h 05min 08s, the crew is cleared to land.

At 09h 05min 17s, one second after the landing gear starts to come down, an increase of rotational speed of at least one propeller is perceived, and then numerous noises of selections and power variations are heard.

At 09h 05min 19s, the captain says: “What’s that?”.

At 09h 05min 27s, the beginning of a GPWS alarm appears, one second later the CVR stops.

Two portions of recording are then noted, one of 0,9 second duration, the other of 0,7 second duration and separated by 11,2 seconds and representing recorded portions from the beginning of the CVR and not newly overwritten.
At no moment of the flight, the crew mentions any failure of aircraft systems.

1.11.3. Correlation with radar recordings

The recordings from the Luxembourg radar were available in the usual Asterix format. A conversion of this file into an exploitable Rho / Theta format has been performed, which can easily been analysed by standard tabulation software.

Vertical and horizontal plots of the aircraft’s trajectory during the last minutes have been drawn and are shown in appendices 16 and 17.

1.12. Wreckage and impact information

1.12.1. Site description

The aircraft touched down approximately on a heading of 295°, as indicated by the general direction of the debris. The first impact marks are found on the south edge of the road RN1. They represent the two main landing gears and the fuselage tail cone.

Scraping marks on the road, notably from the left wing tip show that the aircraft scratched across the road before hitting an embankment at the north side of the road RN1.

Aerial view of RN1 and the site

The major part of the damage results from this impact during which the aircraft lost three blades from the right propeller and two from the left propeller, wheels from the left and right landing gear.

Furthermore, the aft portion of the fuselage was disrupted at the trailing edge of the wings by this shock.

After this bounce, the empennage and part of the right outboard wing broke away, the aft portion of the fuselage turned around to the right and the aircraft came to rest 25 meters further away in a field.

Aerial view of the right hand side of the aircraft

Aerial view of the left hand side of the aircraft

1.12.2. Wreckage examination

Note: After the rescue operations, the investigators have done the observations listed below. It is possible that certain observations do not correspond to the situation at impact as through the shock or through some rescue operations, lever positions may have been affected.

Exterior:
The fuselage and the wings remained attached. The aft portion of the fuselage, including the rudder and the horizontal stabiliser, were detached from the aircraft. The flight data recorders were ejected by impact and found close to the detached aft portion of the fuselage. On the fuselage a more important deformation was noted on the right hand side as compared to the left side. The central part of the fuselage was burnt.

The flaps (left and right wing) were retracted. The landing gears were ripped out.

The engines suffered light damage, except for the lower parts that were in contact with the ground. On the left hand side, all propeller blades are broken at their root. On the right hand side, three propeller blades out of six remain attached to the hub. All blades, of composite construction, are damaged. Some are delaminated and others are totally destroyed.
Blade pitch angle of the LH propeller is close to feather. Blade pitch of the RH propeller is in the beta range.

No damage were detected neither on the parts exposed to the relative wind nor in the engine intakes, which may be attributed to bird impact.

Cockpit:
Power lever positions are not relevant, as all cables have been stretched and rescue services were active in this area to retrieve the pilots. Left and right fuel levers are in OPEN position.

Elevator trim position is incoherent with the trim tab position. As for the power levers, its position may have been affected by traction or rupture of the cables and by the rescue operations.

Rudder trim position is five units to the left. Flaps selector is in the OFF position.
The Ground Idle Stop selector is in the OFF position.

- Left instrument panel
  Altimeter indicates 998 feet, and is set to 1023 hPa. The stand-by altimeter shows 690 feet and is set to 1037 hPa.
  The speed indicator shows 110 kts, the speed bug is positioned at 101 kts. The stand-by speed indicator shows zero kts.

- Central instrument panel
  The parameters of the two engines (propeller speed, HP turbine RPM and turbine temperatures) are close to zero. The RPM indicator of the LP turbine shows 92% for the two engines.

  Brake pressure indicator and fuel totaliser show zero.
  The two engine torque indicators show 25% (minimum reading of the indicators and powered down position). The OFF flag is apparent.
  The temperature and oil pressure indicators show zero.
  Landing gear selector is in the DOWN position.

- Left instrument panel
  The speed indicator shows 125 kts, with the speed bug positioned at 91 kts.
  The altimeter indicates 380 feet and is set to 1023 hPa.
  The RMI indicates 295°, the single needle shows 080°and the double needle shows 295°.

- Glare shield panel
  The left and right EFIS are switched to mode NAV.

- Overhead panel
  Landing lights, taxi lights, anti-collision lights, navigation lights, strobes, non-smoking sign and fasten seat belt sign are «ON».

  The handles of the engine fire extinguishers are not pulled. The fire loop push buttons are in the normal position.

  The ignition switches LH and RH of the Engine Control Panel are in the «ON» position.

  The PEC switches are in position «NORMAL» (PEC's are operational).
  Fuel pump switches are «ON».
  Hydraulic pump switches are «ON».
  Cockpit windshields and pitot heating switches are «ON».
  Engine anti-icing is «ON»; wing anti-icing is «OFF».

1.13. Medical and pathological informations

The results of the analysis performed on the blood samples taken from the pilots did not show any evidence that could have affected their ability to control the aircraft.

1.14. Fire

When the aircraft came to a halt, a fire started and destroyed the central part of the fuselage.

1.15. Survival aspects

The layout shown hereafter represents the seating as known from the check-in. It does not necessarily reflect the actual seating. Considering the number of passengers, the possibility exists

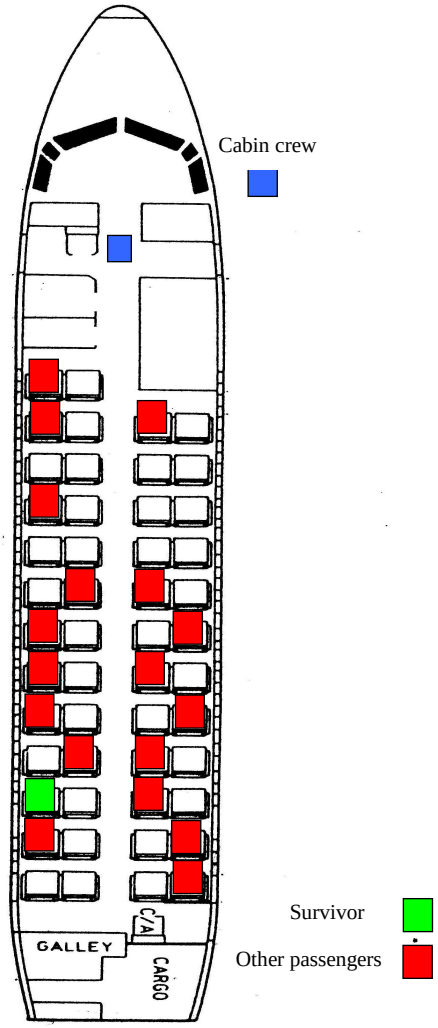
that one or the other passenger may have been seated on a different seat as shown by the boarding cards.

The aircraft hit the embankment with the aft portion of the fuselage (behind the trailing edge of the wing), this part being partially disrupted and turned over 90° to the right (in flight direction)

At 09h 06min a witness notified the accident to the national emergency centre. On site intervention of the airport fire brigade started at 09h 18min after positioning of the fire engines.

Rescue services found passengers, ejected from the fuselage, behind the left wing. Some passengers were still attached to their seat and others were not. The cabin crewmember was found in the corridor next to the fuselage front entrance. The captain wore his full harness, the copilot only his ventral belt.

The cockpit did not burn and a hole was cut in the fuselage to retrieve the captain who survived. Only one of the ejected passengers survived.



Cabin seating as per check-in

1.16. Tests and research

1.16.1. Complementary flight recorder analyses

1.16.1.1. DFDR

In order to validate initial findings, further detailed analyses have been performed by the BEA.

It has been confirmed that from the 6 DFDR channels, one channel could not be completely exploited. However this did not concern the accident flight, which is entirely available on the recorder. The end of exploitable information was confirmed to be time 09h 05min 26s (this last second included).

It has to be noted that the power lever position (power lever angle) is not a recorded item.

1.16.1.2. CVR

1.16.1.2.1. Noise identification

It was concluded from the initial CVR readout report that additional tests were necessary. These tests were conducted by the CVR experts from BEA with the aim to validate the hypotheses based upon the transcriptions of the noises and alarms recorded on the CVR.

In order to reproduce similar conditions to those during the accident, several tests were performed:

- The same type of CVR (a magnetic tape A100-A) was used on every aircraft used to perform the tests. This was also the type of CVR installed on the accident aircraft.
- A Luxair Fokker 27 Mk050 registered LX-LGC flew from Paris to Luxembourg with a BEA safety investigator present in the cockpit.
- Following this flight, the CVR was removed from the aircraft for read out and analysis of noises and alarms.
- The same aircraft was used for a ground recording.
- Finally, the same tests were recorded in the Fokker 27 Mk050 LX-LGD in order to compare the results with a wider range of aircraft.
- During the tests, the air conditioning was turned on to recreate the main background noise generally heard on CVRs.
- Tests were performed several times on each aircraft in order to compare the transcribed noises with several samples.

Identification and analysis of the relevant noises are found in appendix 18 to this report. The main conclusions are as follows:

- The tests, performed on two Luxair Fokker 27 Mk050, were used to compile a large number of noises in order to compare them to those recorded on LX-LGB. The tools available to identify them showed some characteristics of these noises, such as their duration, their rate and the main distribution of the frequencies. During analysis, it is important to note that the tests were recorded on the same type of aircraft, though different from the accident aircraft. Background noises may vary with the aircraft's speed, its engine parameters, and flight configuration (flaps, propeller pitch and landing gear). Moreover, each switch or lever on an aircraft can have its own characteristics, different from those of the same part on another aircraft.

- This analysis nevertheless gives the following results:

Time of transcript	Hypothesis	Result
09h 04min 58s	Ground Idle Stop movement	Probable
09h 05min 00s	Lift of the Ground Range selector	Positive
09h 05min 09s	Flaps control	Positive (towards 10°)
09h 05min 11s	Taxi Lights switching on	Positive
09h 05min 19s	-	Noise of the ground idle position (positive)
09h 05min 21s	Flaps control	No identification possible
09h 05min 27s	-	No identification possible

To conclude, it must be pointed out, that as far as the movement of the ground idle stop is concerned, the result of the noise analysis is strengthened by the fact, that at time 09h 04min 53s, the copilot says “ground idle stop off”, this being the last item of the BEFORE APPROACH checklist.

1.16.1.2.2. CVR and radar trajectory synchronisation

The recordings contain dating information from different sources.

- The time basis of the CVR recording is the FSK signal (recorded every 4 seconds) which source comes from the onboard clock. The DFDR records the “hour”, “minute” and “seconds” parameters that also come from the onboard clock.
- Time information registered on the radar recordings comes from the standard airport GPS clock.

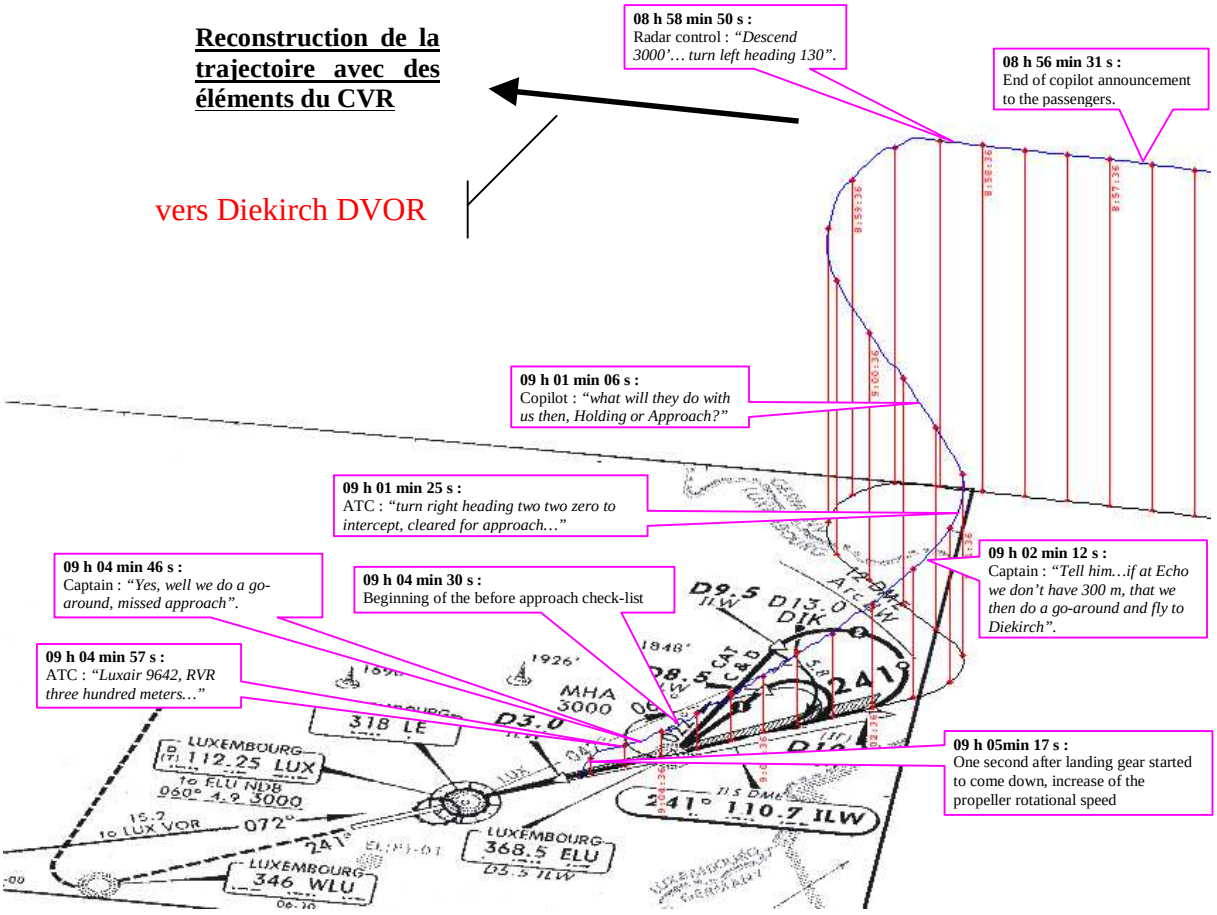
The altitude information allowed a time correlation between the radar recording and the DFDR recording. In fact, the pressure altitude taken into account by the aircraft calculators is recorded on the DFDR every second. It is simultaneously transmitted by the transponder under flight level format (altitude rounded up at 100 ft) and registered by the radar station, roughly every 4 seconds.

Since the radar record and the DFDR record have the same source for the pressure altitude, one can correlate their base time by relating the vertical approach profile obtained by these recordings. (Appendix 17 – vertical plot of the trajectory)

The precision of these correlations is estimated at a few seconds, because of the flight level resolution of 100 ft and the sampling of the radar period of about 4 seconds.

The good correlation between the DFDR recording and the CVR recording has been verified by the binary parameter “transient ident” which is active during the communications of the cockpit crew and the ATC. This parameter is recorded every second and the precision of this correlation can be estimated by one second.

From the CVR recordings and elements from the radar trajectory, a flight path showing the last phase of the flight has been made up.



This three dimensional trajectory has been made up on the basis of Luxembourg radar data. Synchronisation precision between DFDR and CVR is one second.

The vertical profile of the trajectory shown in appendix 17 represents radar data illustrating that the final descent of the aircraft started markedly after the ELU beacon.

1.16.2. Propeller regulation systems

1.16.2.1. General

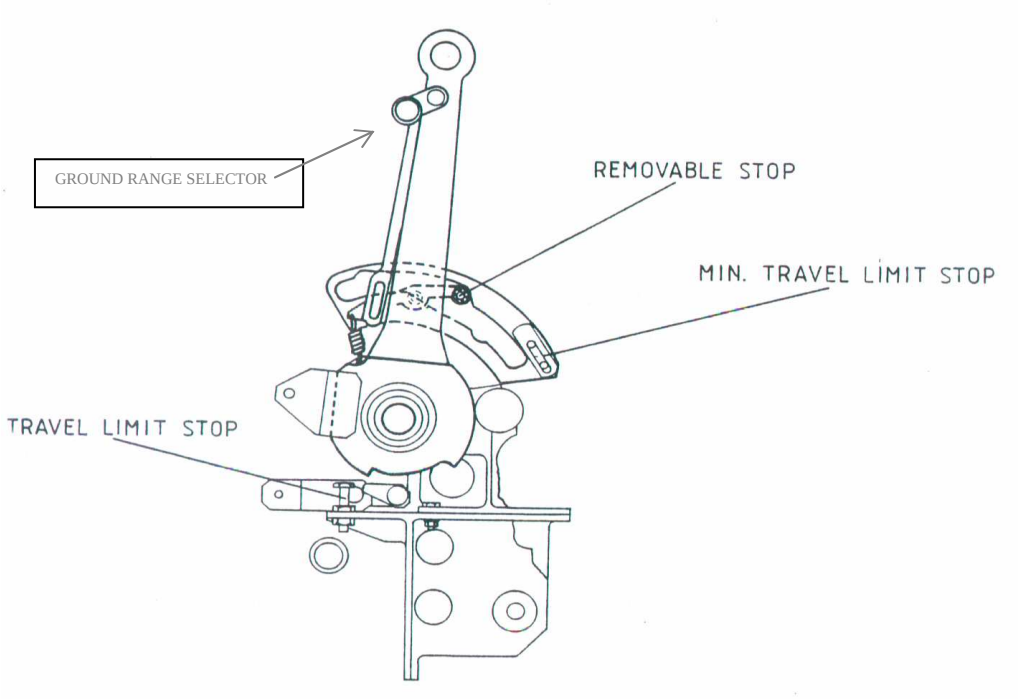
The engines each drive a variable-pitch, constant-speed six blades propeller. A propeller speed indicator is located at the centre main instrument panel. Two possibilities exist to control the propeller:

- Above flight idle, constant speed control is regulated automatically in flight.
- On the ground, below flight idle and in the beta mode range, propeller pitch is directly controlled by the power lever position.

The actual blade angle at which the propeller produces zero thrust (torque) depends on the rotational speed of the propeller and the forward speed. At a blade angle of approximately 26°, the aerodynamic force tends towards zero and starts acting backwards if propeller pitch is further reduced.

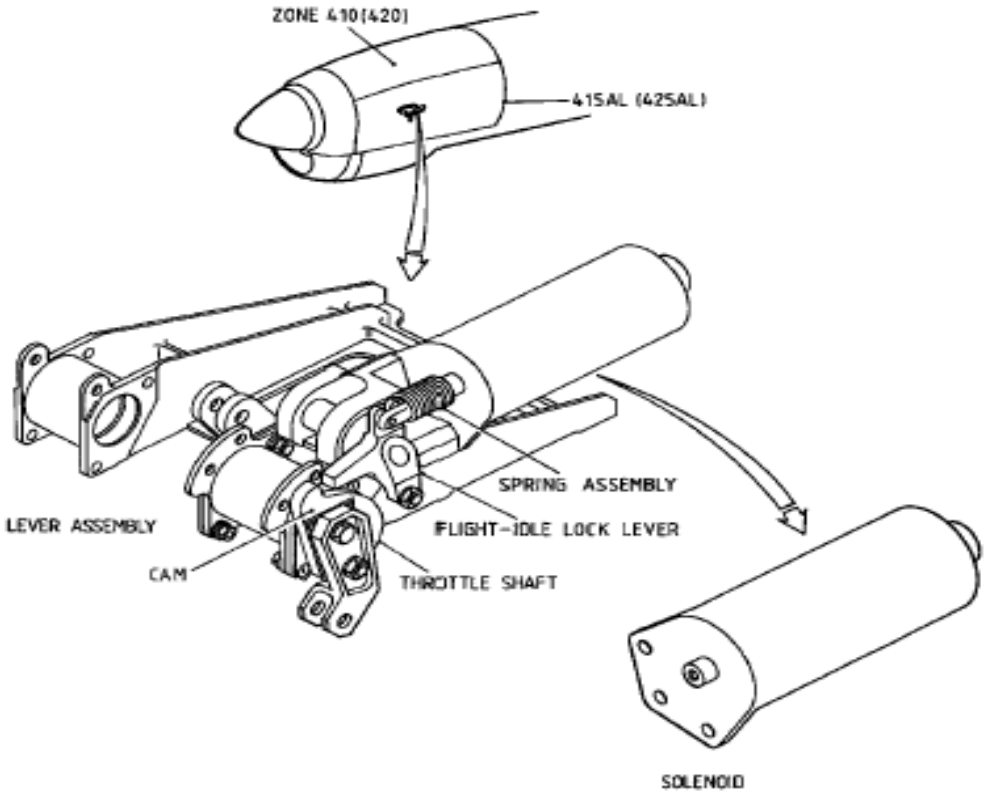
In flight, power lever positions below flight idle are prevented by two means:

- a mechanical primary stop (ground range selector) on the power levers. This primary stop requires a positive, distinct and separate pilot action, as required by certification regulations



Power levers and ground range selector

- an electrical secondary stop (flight idle stop solenoid) on each engine.



To select the beta mode after landing, with the power levers in the flight idle position one has to grab and lift the ground idle selectors fixed to the power levers and move the levers backward. This first mechanical stop on the power levers is doubled by a flight idle stop fixed to each engine and activated by solenoids.

Once the solenoids are powered up, the flight idle stops are released and power levers may be moved backwards below the lever range for flight.

Power supply to the solenoids is assured when:

- one of the sensors mounted on the shock absorbers of the left and right main landing gear detects a compression of the shock absorber during landing, or

- the two wheel speed sensors, each one mounted in the wheel axle on one main landing gear detect a wheel speed in excess of 17 kts.

1.16.2.2. Constant speed control

Above flight idle, the Propeller Electronic Control (PEC) unit controls propeller speed by varying the blade angle.

Speed is controlled to 100% during take-off, maximum continuous and go-around power settings. Propeller speed is controlled to 85% during climb and cruise.

Propeller synchronizing is totally automatic.

1.16.2.3. Propeller pitch

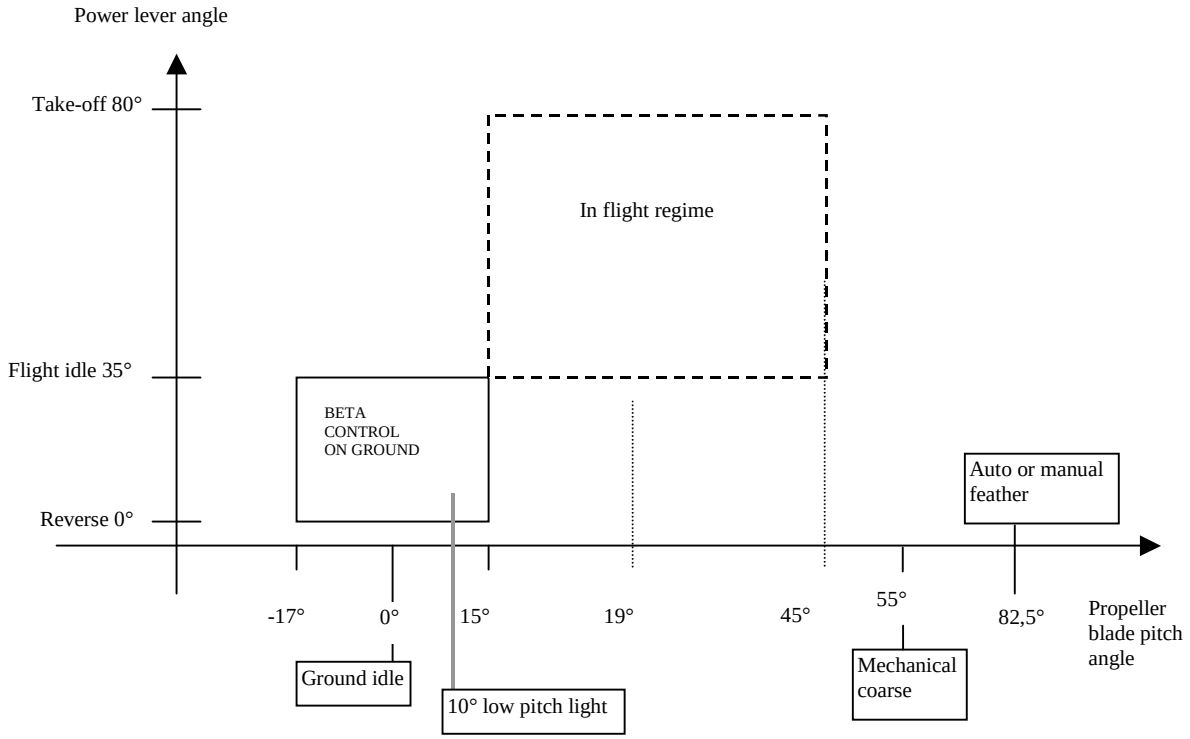
Propeller pitch angle varies in flight from + 15° to approximately + 45°. Propeller pitch is controlled by balancing oil pressure against the coarse seeking force that results from the counterweights, which are attached to the roots of the blades.

A high-pressure pump, driven by the propeller gear box and being part of the overspeed regulation and supplied with engine oil, provides the required oil pressure. In the event of an oil pressure loss, the counterweights will move the blades to an angle of + 55°, thus eliminating propeller overspeed and minimising the drag created by the wind milling propeller. The dedicated drive of the high-pressure pump assures control as long as the propeller is wind milling.

In case of an in flight engine failure, the propeller regulating mechanism initially tries to maintain a constant speed of the propeller in relation to the indicated airspeed until it is feathered either automatically or manually.

1.16.2.4. Control in mode beta

Below flight idle, the power lever controls propeller pitch directly from about a blade angle of + 15° to -17° (full reverse).



In the beta mode, the commands of the propeller electronic controls are inhibited. Propeller blade angles are then solely controlled by the movement of the power levers (power lever angle).

A blue low pitch light, located on the central instrument panel, comes on when the blade angle drops below 10°.

During the investigation it was found that, with the power levers in flight idle, it is possible to lift the ground range selectors (primary lock) and move the power levers a small distance further aft until blocked by the secondary lock. This is a deliberate action by the pilot.

1.16.2.5. Overspeed protection

In flight, a propeller overspeed governor comes into operation when propeller speed reaches 104%.
The gearbox-driven governor reduces the oil flow to the pitch changing mechanism.
If there is no propeller speed reduction, the propeller speed reaches 108% and the overspeed governor intervenes directly in reducing fuel flow. On the ground, with the propeller in mode beta, overspeed protection is accomplished at 108% by reducing the fuel flow.

1.16.2.6. Feathering system

The propeller can be feathered automatically or manually. The propeller is feathered manually when the fuel lever is set to SHUT or START. The feathering pump is activated when:

- the autofeathering system is activated when the aircraft is on the ground or in flight, or
- when the fuel lever is set to SHUT or START when the aircraft is in the air.

The feathering pump brings the blade pitch angle to a position of 82°, minimizing thereby aerodynamic drag (feathered propeller).

1.16.3. Antiskid control system

The antiskid system gives optimum brake operation for all runway conditions and operates on the normal brake system only. The system's main components are:

- An antiskid control unit
- Four wheel speed sensors
- Two antiskid control valves

The system also uses:

- The integrated alerting unit (IAU)
- The flight compartment test panel
- The GND/FLT relays
- The towing switch relays
- The main landing gear up-lock switches

The dual electric power supply to the skid control unit is via both main gear uplock switches in the landing gear down sequence as soon as the uplocks are released.

The antiskid control unit receives input signals from the wheel speed sensors and gives outputs to the antiskid control valves to control the main wheel brake pressures. The antiskid control unit has three operational modes, anti-skid, locked wheel protection and touch down protection.

a) antiskid mode is activated at wheel speeds above 10 kts (12mph). The antiskid control unit will detect a deceleration of one or more wheels. The relevant antiskid control valves will reduce the brake pressure in relation with the rate of deceleration.

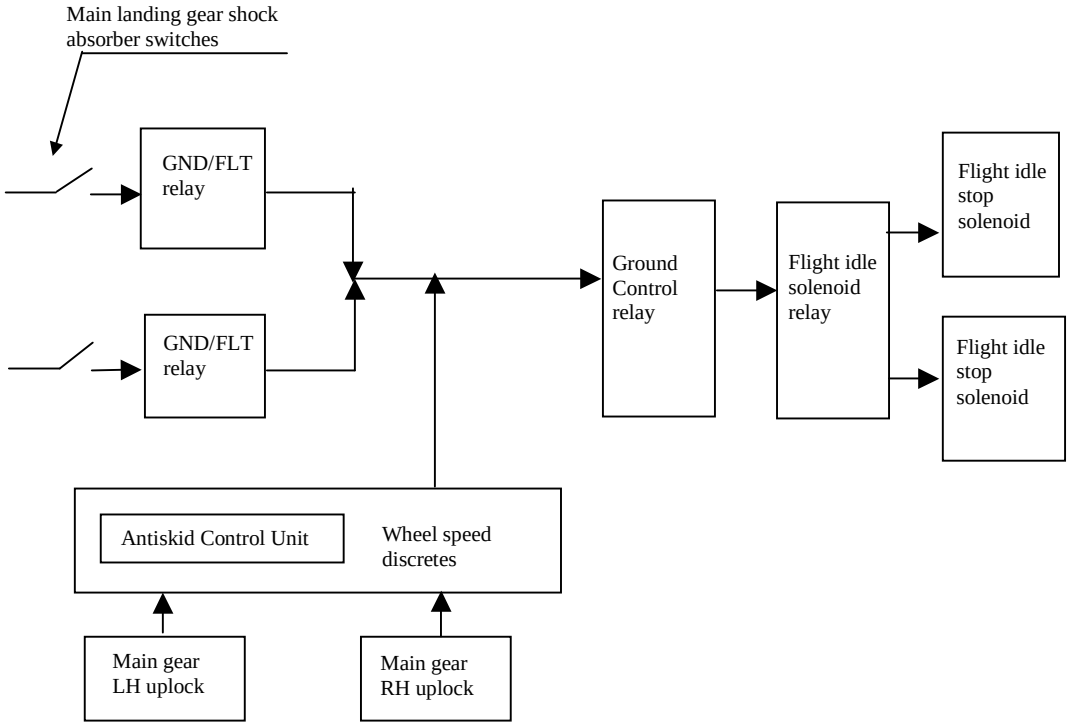
b) locked wheel protection mode is active at speeds above 17 kts (20mph). When the speed of a wheel decelerates to a point where it may lock, brake pressure is fully released to allow the wheel to spin up again.

c) touch down protection mode releases all pressure from the brakes in flight with the landing gear down and for a period of seven seconds after touch down in case of no wheel spin-up (e.g. due to hydroplaning). When a wheel speed is above 30 kts, the full dump current to the relevant valve is stopped. From this moment antiskid control is in operation for that wheel.

The antiskid control unit monitors the dual electric power supply inputs and the ground/flight relay inputs. When a difference in a pair of inputs occurs for more than 15 seconds, a signal is sent to the integrated alerting unit (IAU). The related magnetic indicator on the antiskid control unit identifies the failure.

The wheel spin-up signals or the GND/FLT relays switches energise the flight idle stop solenoids through the ground control relay. The antiskid control unit senses the wheel spin-up signals. The main gear switches initiate the transmission of GND/FLT signals.

The following illustration shows, how these signals are carried to the flight idle stop solenoids.



Power up of the skid control unit is via the main gear uplocks switches.

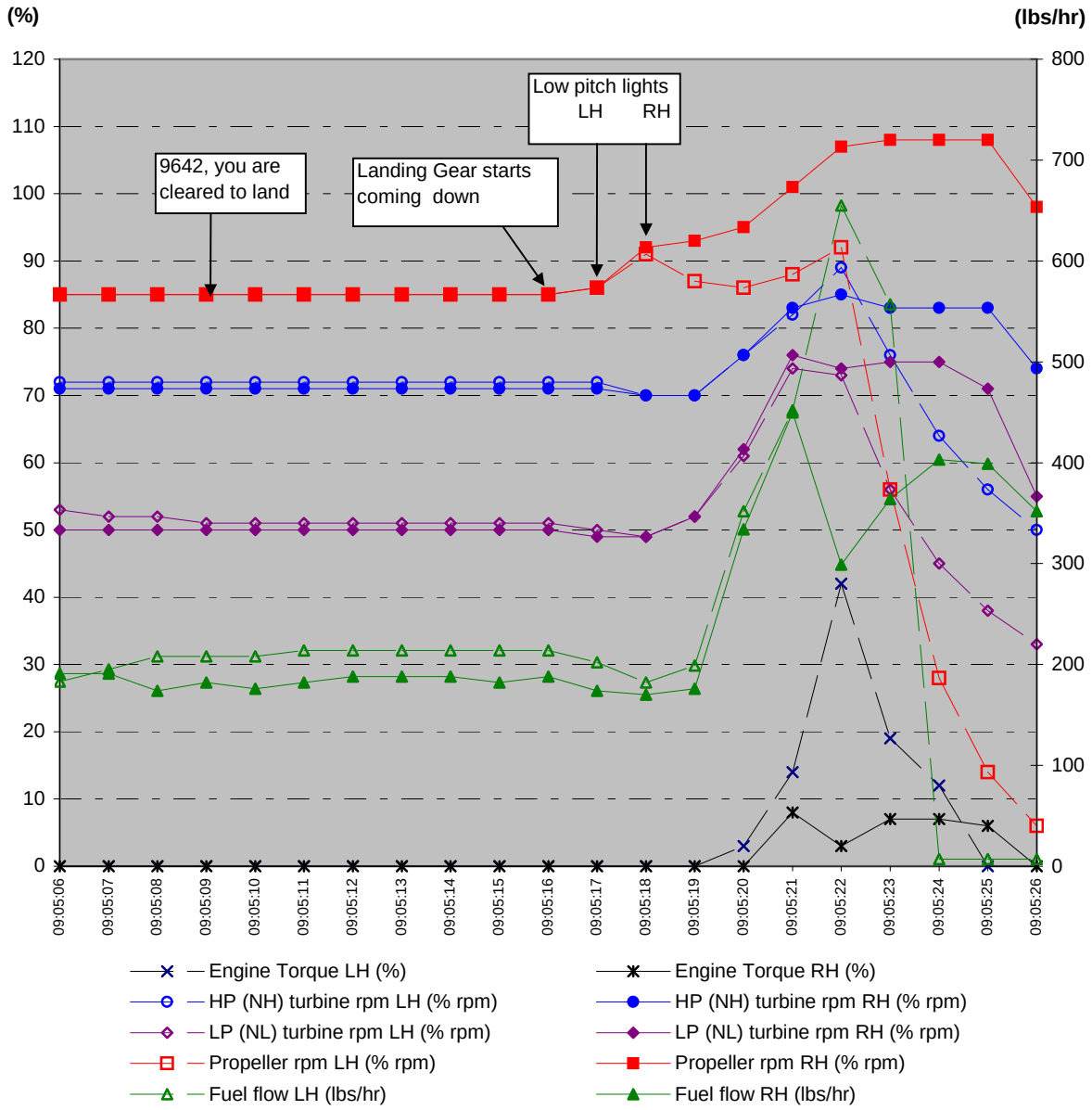
1.16.4. Interpretation of recorded engine parameters

For the last 20 recorded seconds, from time 09h 05min 06s to time 09h 05min 26s the relevant engine parameters are shown in following table.

LGB	Engine		Fuel		HP (NH)		LP (NL)		Propeller	
	Torque LH (%)	Torque RH (%)	flow LH (lbs/hr)	flow RH (lbs/hr)	turbine rpm LH (% rpm)	turbine rpm RH (% rpm)	turbine rpm LH (% rpm)	turbine rpm RH (% rpm)	rpm LH (% rpm)	rpm RH (% rpm)
09:05:01	4	4	283	261	81	80	66	66	85	85
09:05:02	0	0	207	202	77	77	61	61	85	85
09:05:03	0	0	183	179	75	74	58	57	85	85
09:05:04	0	0	160	191	73	72	55	53	85	85
09:05:05	0	0	177	173	72	71	54	51	85	85
09:05:06	0	0	183	191	72	71	53	50	85	85
09:05:07	0	0	195	191	72	71	52	50	85	85
09:05:08	0	0	208	174	72	71	52	50	85	85
09:05:09	0	0	208	182	72	71	51	50	85	85
09:05:10	0	0	208	176	72	71	51	50	85	85
09:05:11	0	0	214	182	72	71	51	50	85	85
09:05:12	0	0	214	188	72	71	51	50	85	85
09:05:13	0	0	214	188	72	71	51	50	85	85
09:05:14	0	0	214	188	72	71	51	50	85	85
09:05:15	0	0	214	182	72	71	51	50	85	85
09:05:16	0	0	214	188	72	71	51	50	85	85
09:05:17	0	0	202	174	72	71	50	49	86	86
09:05:18	0	0	182	170	70	70	49	49	91	92
09:05:19	0	0	199	176	70	70	52	52	87	93
09:05:20	3	0	352	334	76	76	61	62	86	95
09:05:21	14	8	452	450	82	83	74	76	88	101
09:05:22	42	3	655	299	89	85	73	74	92	107
09:05:23	19	7	557	364	76	83	56	75	56	108
09:05:24	12	7	7	403	64	83	45	75	28	108
09:05:25	0	6	7	399	56	83	38	71	14	108
09:05:26	0	0	7	352	50	74	33	55	6	98

Time 09h 05min 26s is the last valid record of the DFDR.

These values are transposed into the following diagram, allowing subsequent analysis.



According to the engine manufacturer's information, the HP (NH) values for Flight Idle in flight are 74%. Flight Idle corresponds to zero torque, which is easily recognized for the recorded engine parameters. It can be noted that the engines never stabilised on this setting.

Analysing all the data recorded (19 approaches available) on the DFDR, this HP value of 74% can be found for all flights where the engines are on flight idle with a zero torque value.

Up to 09h 05min 00s, the power settings are consistent for the horizontal flight portion at 3000 ft QNH whilst passing ELU.

At 09h 05min 02s, propeller torque is zero and HP indicating 77%, which during the next seconds drops to 72% for the LH engine and 71% for the right hand engine, values recorded at time 09h 05min 17s.

With these engine speed readings, the propeller blade angles were between 15° and 10°; this coincides with a power lever position below flight idle, 15° being the minimum setting for flight idle and 10° being the limit for the low pitch light.

At 09h 05min 17s, the low pitch parameter of the LH propeller switched to low pitch.
A second later, at 09h 05min 18s, the low pitch parameter of the RH propeller switches to low pitch. At this time both HP values had dropped to a minimum reading of 70%.

The low pitch light only comes on, when the propeller blade angle is below 10°. Until they came on, the propeller RPM where stable at 85%, which is the normal setting for cruise and climb sectors.

At 09h 05min 19s, reverse power was applied to both engines, which is documented by a rapid increase of all engine parameters.

Some time after this moment, the power levers were set beyond the flight idle position back into the flight range. On the CVR, no related noise can be identified. Such a lever movement noise is most probably submerged within the intense level of noise in the cockpit at that moment (see appendix 22 for a detailed description of this phase).

At 09h 05min 22s, whilst the LH and RH propeller speeds had further increased, the LH engine was shut down by putting the fuel lever in the SHUT position.

At 09h 05min 23,4s the LH propeller RPM drops below 50% and the LH generator is taken off-line by the generator control unit (GCU). The RH generator now powers all electrical buses. This is consistent with the fact that at that moment the CVR records a noise similar to an electric transfer.

At 09h 05min 25s, the LH engine HP drops below 60%. No alert level 3 triple chime was recorded on the CVR, confirming that the engine was shut down manually.

This can be reasonably said, as in order for the propeller to go to feather in flight, three conditions must exist, namely:

- the power lever is in the flight range,
- the GND/FLT signal is FLT mode,
- and the fuel lever not in OPEN position.

(see appendix 22)

The left hand propeller was found to be in the full feathered position.

With the left hand propeller going into feather, the brake effect of this propeller started to decrease.

At 09h 05min 25s, the RH propeller speed had reached 108% RPM. This represents the maximum value allowed by the overspeed governor of the propeller. At this time, the RH engine was shut down, by putting the fuel lever in the SHUT position.

At time 09h 05min 26s, the last valid record, both fuel levers are in the SHUT position.

However, with all three preceding conditions still existing, the right hand propeller did not feather, possibly because of the following reasons:

- The right hand propeller was too far in the reverse range,
  In this particular case and with the power lever repositioned in the flight idle range, the beta tube was hydraulically isolated and the delivered pressure was not available to reposition the propeller into a positive blade angle.

- The propeller manufacturer stated that if the propeller blade angle was below – 4°, the resultant force acting on the propeller blades would put the propeller in full reverse. With the power lever in ground idle position (beta range), the blade angle is approximately 0°. In view of all registered parameters and considering that the blade angle is –17° for full reverse, it can be said that the propeller blade angle was below –4° when the engine was shut down.

The right hand propeller was found in the full reverse position (see appendix 22).

1.16.5. Examination of components removed from the wreckage

Following components and equipments have been removed from the wreckage for close examinations. All examinations and tests have been done in the presence of the investigation team.

1.16.5.1. Engines

Before removal of the engines from the wreckage, the totality of the engine command rods and bellcranks were checked with appropriate rigging pins. All riggings were found to be conforming to specifications.

Furthermore, as no deviations of the engine parameters during normal flight operation have been observed, the possibility of misrigging of the engine controls can be ruled out.

Before dispatching the PW125B engines to the manufacturer, following components have been removed to be tested at the propeller manufacturer facility: the PCUs, the feathering pumps, the beta tubes and the de-icer brush assemblies.
All steps of the investigation were documented and photographed.

The evaluation of the accessories from both engines revealed only minor deviations, which were not considered to have prevented the proper operation of the engines. Both engines displayed contact signatures to their internal components consistent with engine producing little or no power at the time of impact. There were no indications of any pre-impact anomalies or distress that would have precluded normal engine operation prior to impact.

The engines producing little or no power at the time of impact is consistent with the data recovered from the DFDR, which shows a sharp fuel flow decrease down to zero on the LH engine at time 09h 05min 23s. The last valid recording also shows that both fuel cut-off levers were in the SHUT position suggesting that both engines were shut down prior to impact. This is also consistent with the fact that the debris found within the combustion section of both engines did not show any evidence of charring or burning, indicating that no combustion was taking place at the time of impact. The ingestion of those debris was most likely caused by the fact that, although the engines were shut down, the LP compressors were most likely still rotating at the time of impact. This is the result of the run down time of the LP compressor (minimum of 180 sec required) being longer than the time between the fuel cut-off and the time of the impact (approximately 20 seconds for the LH engine and 15 seconds for the RH engine, considering approximately 15 seconds of missing data between the end of the valid recording and the time of impact).

1.16.5.1.1. Left Hand Engine Examination

This engine had received a hot section inspection at 15,787 total hours on 13 June 2000. Hours since overhaul were 9,099 and cycles since overhaul were 9,794.

The left hand engine showed no structural damage. Light circumferential scoring was noted on the Low Pressure (LP) impeller. No scoring or rubbing was noted on the hot section components that would indicate damage beyond expected normal deterioration. All rotors were free to turn and all examined bearings were in good condition. Some ingested dirt, wood chips and airframe debris were found throughout the compressor and combustion sections of the engine. None of this debris however, showed evidence or burning or charring.

1.16.5.1.2. Right Hand Engine Examination

This engine had received a hot section inspection at 16,640 total hours on 13 June 2000. Hours since overhaul were 8,038 and cycles since overhaul were 8,247.

Structural damage to the right hand engine was limited to an impact fracture of the oil tank. Light circumferential scoring was noted on the power turbines and LP impeller. All rotors were free to rotate and all examined bearings were in good condition. No damage was noted on the hot section components beyond expected operational wear. As on the left hand engine, ingested dirt, wood chips and airframe debris were found throughout the compressor and combustion sections of the engine. None of this debris however, showed evidence of burning or charring.

1.16.5.1.3. Electronic Engine Control (EEC)

An engine electronic control unit controls each engine. Both units were taken to their manufacturer for testing. The EEC is a single channel digital Electronic Engine Control in conjunction with a mechanical fuel control (MFC). It monitors and adjusts the power of the engine.

Both units passed their functional tests and no malfunctions were identified.

1.16.5.2. Antiskid Control System

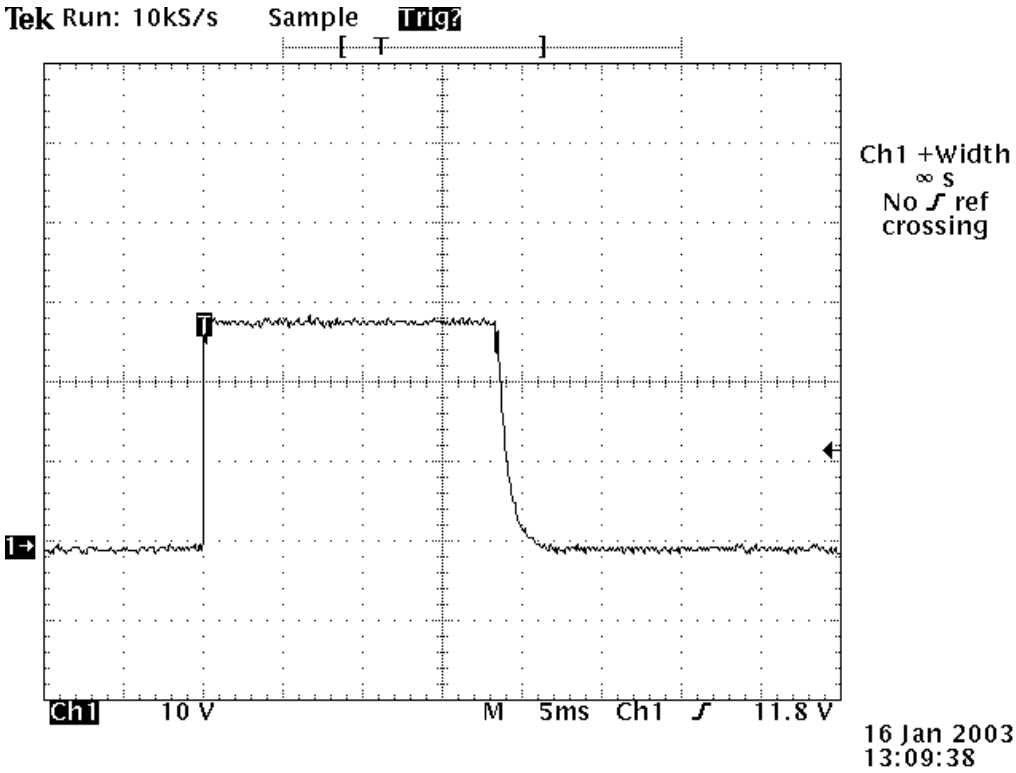
The antiskid control unit (Part number 6004125/ Serial number AUG89-084) and the four wheel speed sensors (part number 6004123-1) were shipped to their manufacturer ABSC and tested in the presence of the investigation commission. This antiskid control unit is an original equipment not modified by Service Bulletin N° F050-32-4.

Since the antiskid control unit was installed on shelf N°1 of the avionics rack behind the cockpit, it suffered some fire damage and the box case was distorted by impact. The technicians were able to open the box cover by cutting in and peeling back the two planes so that the chassis could slide out. All the printed circuit boards on the chassis were undamaged and the unit could be tested satisfactory according to manufacturer specifications.

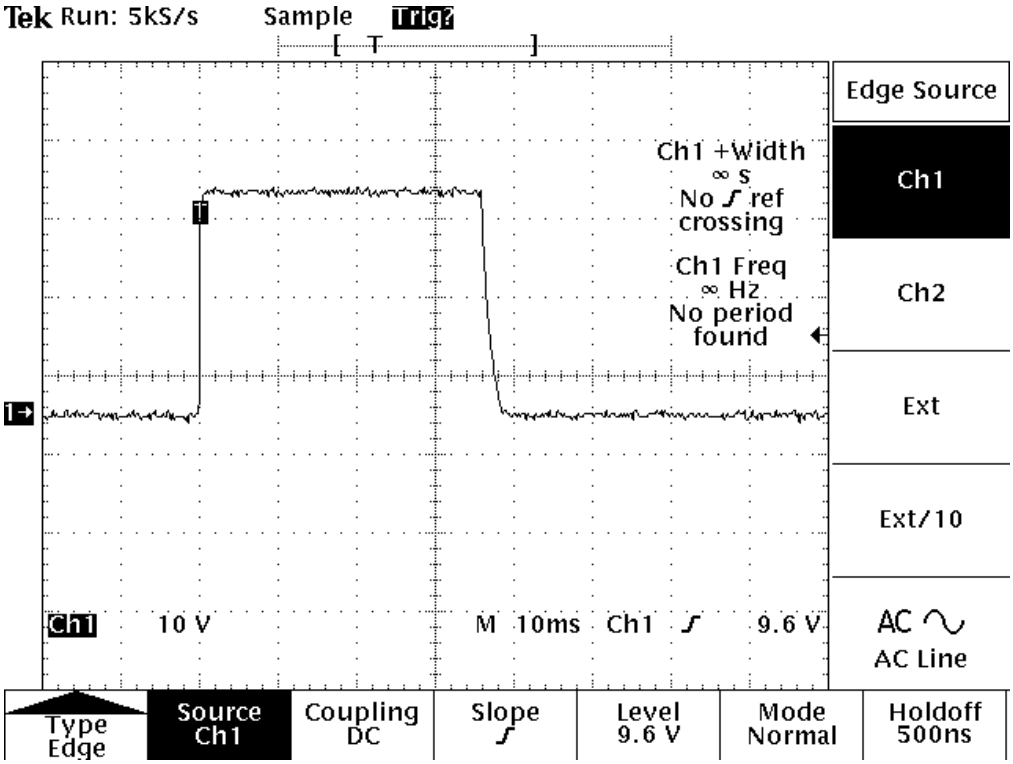
The speed sensors of the four wheels were tested and all passed the manufacturers specifications.

The four wheel speed discrete relays were tested separately in the modes FLT and GND in order to verify their power up behaviour. In mode FLT, the duration of the power up signal was found to be in the range from 13 ms to 20 ms for the four relays. In mode GND, the signal duration was slightly less in the range from 11 ms to 19ms. All signals looked identical,

only the duration varied and the same repeated tests produced always the same results. The following illustration shows the signal from the right hand outboard relay.



In order to reproduce the aircraft installation, where two relays are connected in series for the left and right hand gear legs, the test set up was reconfigured to observe the power up behaviour, this time only in mode FLT in order to duplicate the aircraft configuration. The duration of the power up signal is found to be 36 ms for both the right and the left hand side. The signal from the RH side is illustrated below.
All signals resemble each other and repetitive tests produce each time the same results.



These tests show the working characteristics of the installation associated with the antiskid control unit, part number 6004125 as installed on the accident aircraft.

Modifications to the antiskid control unit published in August 1992 through Service Bulletin N° Fo50-32-4 issued by ABSC, led to a change of the unit part number to 6004125-1 after the modifications.

In June 1994, a revision N°1 of Service Bulletin N° F050-32-4, was issued. The recommended modifications were still the same and revision concerned only the reason of the service bulletin which was now indicated as preventing a condition during power up of the skid control box whereby a signal pulse is inadvertently sent to the ground control relay thus affecting the flight idle stop solenoid (secondary stop). The unit's part number remained 6004125-1.

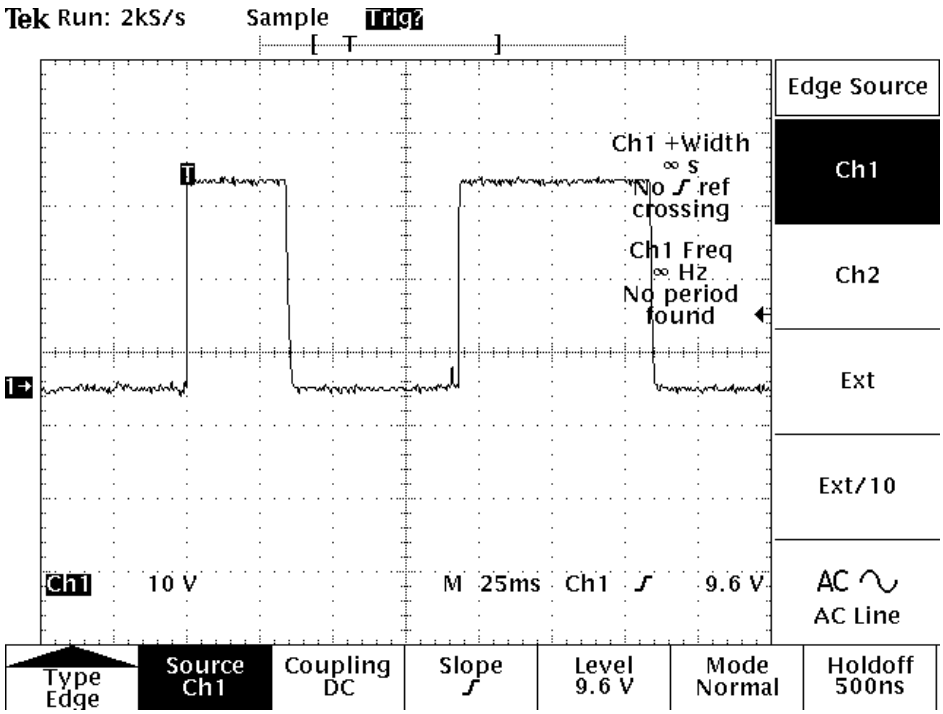
After having performed the tests of the aircraft's unmodified unit, a modified unit available at the factory underwent the same tests, which demonstrated that the power up signal pulse was totally suppressed.

1.16.5.2.1. Electromagnetic interference (EMI)

On final to runway 24, aircraft pass nearby a satellite relay station to the right of extended runway centreline and the question can be raised as to the possibilities of the solenoids being energised through electromagnetic interferences of this relay station or eventually through cell phones as some have been found on the accident site.

Additional tests were performed on the antiskid control unit in order to analyse the performance of the unit by inducing electromagnetic interferences (EMI).

An electrical signal introduced on the TEST button of the antiskid control unit simulated an EMI signal during power up. These tests were executed in mode FLT. It is noted that a new signal is generated repeatedly on power up, showing a duration of around 65 ms. The tests were performed on the unmodified and the modified control unit. The following picture illustrates the signal output of the LH outboard and LH inboard discrete relays for the unmodified control unit.



The result was that the first impulse (~35 ms) was due to the power up of the unit through the release of the main gear up-locks and the second impulse (~65 ms) was triggered by the EMI signal.

The same tests were carried out on the modified unit (modified by ABSC SB F50-32-4) and it became apparent that the first impulse due to the power up of the system was suppressed leaving only the EMI induced impulse.

The question remained, if the duration of the first signal (~35 ms) would be long enough to energise the flight idle stop solenoids.

The duration of the second pulse (EMI) was long enough to energize the flight idle solenoid under all circumstances, thus removing the secondary stop.

It was later demonstrated by Fokker Services B.V. (see 1.16.5.4.) that the duration of the first pulse, when both antiskid control box channels were powered at the same moment, was long enough to energize the flight idle solenoids, this being an aircraft equipment induced phenomena.

There was no reason to suspect that EMI interference was a condition of the accident, as on the other hand, this final approach path is regularly used and flight checked without any reports from the operators on this type of conflict.

Finally, the same tests were performed on a new engineering prototype of the antiskid control unit. It is noteworthy that during these tests, the two pulses were totally suppressed by the built in modifications of this prototype.

1.16.5.3. Propellers

The propeller assemblies, blades and other components were sent to their manufacturer. Among those components were the PCU's (Propeller Control Unit), Feathering pumps, Brush packs and Beta tubes.

The two propeller assemblies were dismantled. All the observed damages are consistent with impact or post impact damage. Impact marks on various components, when realigned, gave equivalent impact blade angles of –17° for the right hand propeller and +84° for the left hand propeller, which equated to full reverse and full feather angles respectively.

The PCU's were examined and satisfactorily passed their specified functional tests. The small amounts of damage or distortion were consistent with impact and did not hamper their correct functioning.

The left brush pack showed a partially severed speed sensor fixation due to the impact. Electrical properties of this sensor were beyond tolerances. It has been determined that this was due to the heat damaged cable insulation resulting from the post crash fire.

The other components passed their functional tests satisfactory.

1.16.5.3.1. Propeller Electronic Control (PEC)

The two control boxes (one per propeller) were shipped to and tested by the manufacturer. There was extensive fire damage to the outside casings of both units. Parts of the aluminium casings had burned and melted away. The connectors were also damaged by the fire and it was not possible to test the functionality of the whole units.

The individual circuit boards of both units were however in remarkably good condition regarding the external fire damage of the units. Testing the individual circuit boards as such was however discarded, as there was heat damage observed in small adjacent areas on each on the boards that might bear a risk of corrupting the memory chips and /or changing their status. It was therefore decided to remove the memory chips and have their information secured.

Considering the fact that propeller electronic control is only effective with the power levers in the flight regime (above flight idle), that events of the flight started to go wrong when the power levers were below flight idle in the beta mode, that up to this moment the crew did not mention any equipment failure, it was concluded to terminate this particular component testing.

1.16.5.4. Various components tested by Fokker Services B.V.

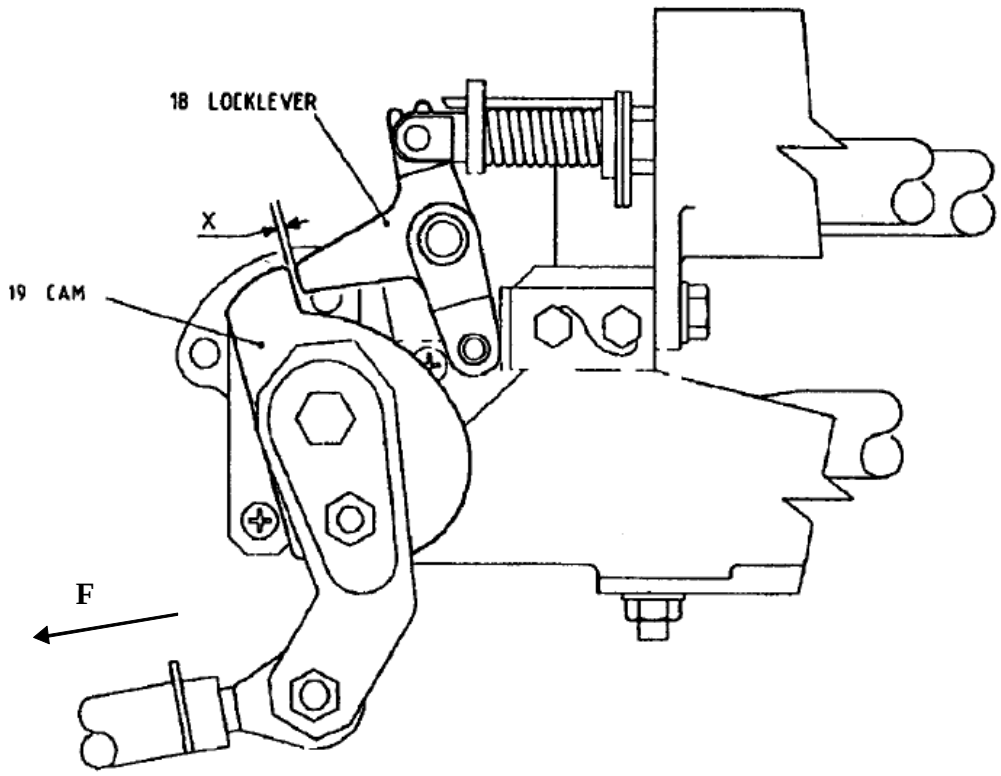
Below mentioned components were shipped to Fokker Services for testing.

- LH GND/FLT switch - equipment N° W0892B; this switch provides the GND/FLT signal of the LH gear to the ground control relay. All functionality tests were satisfactory. The determination of the operating force produced a value that was slightly out of limits; however this should not have any effect on the operation of the ground flight switching.
- RH GND/FLT switch - equipment N° W0892B; this switch provides the GND/FLT signal of the RH gear to the ground control relay. All functionality tests were satisfactory. This switch had suffered from impact. The plunger of the ground switch was bent holding the switch in the in-flight position (pushed in position). To restore the normal operation of the switch, the switch was removed from its bracket and the sleeve surrounding the plunger was cut open on a length of one centimetre. After this the plunger could be moved. No abnormalities were noted.
- Relay - equipment N° K2046A; this is the LH GND/FLT relay which receives the GND/FLT signal. It is carried into the ground control relay. The electrical resistance measured on some of the switch contacts of the relay was slightly high. However the measured values should not create any aircraft abnormalities.
- Relay - equipment N° K0260A; this is the RH GND/FLT relay which receives the GND/FLT signal. It is carried into the ground control relay. No abnormalities were noted during the tests.
- Relay - equipment N° K0887A; this is the ground control relay which receives the signal from the GND/FLT relays and from the four wheel speed discretes. These are carried into the flight idle solenoid relay. No abnormalities were noted during the tests.
- Relay - equipment N° K2999A; this is the flight idle solenoid relay that triggers both LH and RH flight idle stop solenoids. No abnormalities were noted during the tests.
- Resistors - equipment N° R3001A and R3002A; these resistors are tied in parallel to the flight idle solenoid relay, one per flight idle solenoid. No abnormalities were noted during the tests.
- LH Flight idle stop solenoid – equipment N° L2723A and its associated brackets, linkages and push-pull rods; this solenoid frees the movement of the flight idle lock lever on the LH engine, thus permitting the LH power lever to be moved into the Beta range. No abnormalities were noted during the tests.
- RH Flight idle stop solenoid – equipment N° L2723A and its associated brackets, linkages and push-pull rods; this solenoid frees the movement of the flight idle lock lever on the RH engine, thus permitting the RH power lever to be moved into the Beta range. The plunger of the solenoid was corroded. This may explain why the forces measured were out of tolerance on the test bank. However, the higher forces did not prevent the flight idle solenoid to function on the accident flight.

- Propeller Control Panel – equipment N° PL0011A; this panel provides switching and visual indications of the propeller electronic control systems and feathering pumps. No abnormalities were noted during the tests.
- Engine Control Panel – equipment N° PL0010A; this panel provides visual indications of engine and fuel system faults and performs switching operations relevant to engine starting and control. The background light of the lighting panel was inoperative. Beside this problem, the unit functioned properly.
- Engine Rating Panel – equipment N° AC1608A; on this panel, engine power selections are made i.e. for climb mode, cruise mode etc. The J2 connector was sheared off. However the panel could be normally tested. During the test, the lights of the switches worked intermittently. No other abnormalities were noted.

After these tests had been performed, an additional test was performed on relay - equipment N° K0887A in order to determine the minimum required pulse duration to activate the relay. Results were consistent with the relay data sheet that states that the relay must respond to a pulse duration of 20 ms.

A final test was set up for the determination of the force required to prevent disengagement of the flight idle locklever and cam (see illustration below).



When the flight idle cam is pulled against the flight idle lock lever and the flight idle solenoid is energised, than the amount of force applied, determines whether the flight idle lock can disengage.

With a force (F) applied to the push-pull rod lower than 44.5 N, the flight idle stop disengaged when the flight idle solenoid was energised. When higher forces were applied the flight idle stop remained engaged. The same value was found on both flight idle solenoid assemblies. It was thus demonstrated, that by pulling hard enough back on the power levers against the secondary stop and with the solenoids energised, the flight idle lock lever was prevented from disengaging.

1.16.5.5. Pedestal and bulbs

The central pedestal and 196 light bulbs were removed from the wreckage and shipped to a French State approved laboratory for examination. The results are as follows.

- Concerning the pedestal, no conclusions on power lever position on impact were possible. Functionally, no deficiencies have been found. All lever mechanisms including the ground range selectors worked as specified. Electric continuity tests and the operation of the micro switches showed that these components were all in good operational condition.

- Concerning the analyses of the bulbs, the impact has not been hard enough to conclude on electrical circuits under tension at that moment.

1.16.6. Fokker 27 Mk050 simulator

Accompanied by Luxair pilots, the investigation team had a flight session in the simulator actually used by the company in Maastricht. The aim was to reproduce the last minutes of the flight based on data recorded on the two flight recorders.

The simulator being configured to duplicate manoeuvres within the normal flight envelope, it has been demonstrated that it was not possible to reproduce the last minute of the flight, especially the conditions leading to the rapid descent.

Indeed, the data package did not include the flight conditions enabling the reproduction of selecting beta mode in flight.

1.16.7. Time synchronisation

Time stamped information gathered in ground based systems (radar and radio communications) and the aircraft recorders, although referring always to UTC, differ slightly as their individual time bases are independent. It is however possible to match the individual sequences as ATC communications are recorded on the ground and on the CVR of the aircraft. Comparing those two recordings, it has been established that the average time difference is about 2 seconds.

1.16.8. Power supply to the CVR and DFDR

The CVR and DFDR are both connected to the same electrical bus, 115 VAC bus 1. This bus is powered as long as one of the generators is providing electrical power.
The DFDR receives to be recorded data from the Digital Flight Data Acquisition Unit (DFDAU). This unit is powered by DC Dual Bus and receives inputs from various aircraft systems. The DC Dual Bus is powered as long as one of the generators is providing electrical power. The DFDAU collects all information and generates data to the DFDR. After power up, the DFDAU requires some time to perform self testing and the collection of information before any (valid) data is sent to the DFDR. This is the so-called “warm up time”. Basically the DFDAU requires a maximum of 4 seconds to become fully operational.

The generators go off-line when the propeller RPM (NP) drops below 50%, which was the case for the LH generator at time 09h 05min 23,2s. With the LH generator off-line, only the RH generator provided the electrical supply to the recorders.

Time 09h 05min 26s is the last valid DFDR recording and time 09h 05min 28s is the last valid recording of the CVR for the event sequence. However, at time 09h 05min 41s the CVR records

a valid ATC message to another airplane meaning that at that moment the CVR was under power through its electrical bus.

1.17. Information on organisations and management

1.17.1. Luxair

Luxair was created in 1962 and started flights on a Fokker 27 from Luxembourg to Paris. Regular routes to the major European capitals and to the Mediterranean holiday destinations were added along the years.

The Airline Operator Certificate was valid on the date of the accident. Therein are listed, three Boeing 737/500, two Boeing 737/400, four Fokker 27 Mk050 and eight Embraer 145.

The JAR 145 maintenance approval was valid at the date of the accident.

Luxair received the JAR-FCL1 TRTO approval from the Belgium CAA for the Type Training on Fokker 27 MK050, Boeing B737 300-800 and Embraer 145 on 09 April 2001. Prior to this JAR-FCL1 approval, no other approval procedure existed for training.

The Luxembourg civil aviation directorate approved the Training Manual, part D of the Luxair OPS Manual on 15 October 2001 (revision 9 concerning the whole manual)

Luxair received its first JAR-OPS1 Air Operator Certificate 18 February 1999. Prior to the JAR-OPS1 regulation, Luxair operated under a Certificate of Competency according to ICAO Annex 6.

1.17.1.1. Pilot training

As Luxembourg is not issuing any professional licences, Luxair pilots detain professional licences from nine different countries. Their initial training, their type rating, or their conversion training may have been accomplished in different training centres in different countries, depending on availability or other factors.

No training program had been approved by the authority. However, two possibilities were detailed in a Luxair syllabus explaining how to become a Luxair pilot, namely:

1- Either the candidate could follow an ab-initio training program through the Belgium Aviation School, or another selected school. Then the candidate had to pass a written examination, a psycho test, a medical test and a physical aptitude test before engaging an apprentice contract with the company. Then the candidate followed the training school to obtain the necessary licenses in order to conclude a working contract with Luxair.
2- Or the candidate had already a CPL IFR with the theoretical ATPL. Before being selected, the candidate had to follow interviews, a psychological test and a practical test before being able to conclude a working contract with the company.

As both pilots were, prior to their employment with Luxair, in possession of a CPL associated with multi-engine and instrument ratings, they went through the standard Luxair conversion course to obtain a co-pilot type rating on Fokker 27 Mk050, associated with a CAT II qualification.

It is noteworthy that the selection file, as described above in point 2, for the co-pilot was available to the investigation commission. No such file concerning the captain could be obtained.

Nowadays, pilot training is done in accordance with the provisions and programs as detailed in their Operations Manual part D – Training manual. All theoretical courses are accomplished by Luxair ground instructors in their flight training centre in Luxembourg. Simulator trainings (Fokker 27 Mk050) are basically performed nowadays in Maastricht, by Luxair or approved flight instructors. This has not always been the case, as in the past simulator training has also been done with SAS in Stockholm. It is noteworthy that the captain's conversion simulator training has been done with MAS in Kuala Lumpur with local instructors, although based on the Luxair syllabus. A Luxair examiner and a CAA Examiner, if provided, take the simulator checks. In this case, the captain having a Swiss licence, a Swiss examiner took the check.

The copilot had his ground courses in Luxembourg and his simulator training in Maastricht.

1.17.1.2. Audits

Prior to the implementation of JAR-OPS1, an audit conducted on 26 and 27 January 1998, by the authority was initiated in order to assess the compliance of the company's structure and documentation. Salient results of this audit were:

- Adaptations to the manuals needed to be done,
- Adaptations of the company structure to be made to the JAR-OPS1 requirements, namely the implementation of a quality assurance structure headed by a qualified post holder and the designation of an accountable manager.

Following their JAR-OPS1 approval, regular audits have been conducted.

1.17.1.3. Flight analysis

In November 2000, Luxair took the decision to equip the jet fleet (B735, B734 and E145) with a flight analysis system. First tests on a B735 did not conclude on a viable system. In September 2002, two B734 and two E145 were equipped to start new test series in order to validate the hardware and the software of the system. This was finally achieved in February 2003 and Luxair decided to upgrade all the remaining jet aircraft with this system. Since August 2003, the flight analysis system is operational on their jet fleet.

Retrofitting the Fokker 27 Mk050 aircraft with such a system could not be considered at that time, as no system had been certified by the manufacturer.

1.17.2. Authority (Directorate of Civil Aviation – DAC)

1.17.2.1. JAR-OPS1 introduction

By grand-ducal regulation dated 23 March 1998, the JAR-OPS1 (adopted version from 22 May 1995) became applicable in Luxembourg.

1.17.2.2. JAR 145 introduction

The JAR 145 was introduced by EU directive 3922/91, dated 16 December 1991.
Luxair received its first JAR-145 approval on 21 December 1993.

1.17.2.3. Licensing

Since Luxembourg does not issue yet any professional licenses, it refers to the method of rendering valid the foreign licenses by applying the recommendations of the ICAO Annex 1, and the grand-ducal regulation dated 17 August 1994 by applying the EU directive N°91/670/CEE, dated 16 December 1991 on the mutual recognition of personnel licenses between EU member States.

Presently Luxair employs a total of 154 pilots for the three types of aircraft that they operate (51 on the B734/B735, 70 on the EMB145 and 33 on the Fokker 27 MK050). Their professional licenses are spread over 9 different issuing countries.

1.17.2.4. Technical supervision

By ministerial decree dated 7 November 1952, the control for the issuance and revalidation of certificates of airworthiness of Luxembourg registered aircraft has been delegated to the French Bureau Veritas.

1.17.2.5. Operational supervision

By ministerial decree dated 24 January 1967, the same Bureau Veritas has been appointed to perform amongst other duties, the operational supervision of ground and flight operations for all international commercial air transport activities.

1.17.2.6. ICAO audit

From 7 to 12 March 2001, ICAO performed a safety oversight audit of the Directorate of Civil Aviation on annex 1 (Licensing), annex 6 (Operations) and annex 8 (Airworthiness).

1.18. Additional information

1.18.1. Previous occurrences

1.18.1.1. General considerations

The technical possibility to use reverse thrust (mode Beta) on propeller driven aircraft is a distinctive feature of all turboprop aircraft. An analysis of the accident records of propeller driven aircraft in general shows that some accidents occurred whilst the mode Beta was used in flight, despite the mechanical primary stop provided to avoid such a situation. It is documented that the pilot can easily remove this primary stop and select reverse thrust in flight.

Aircraft certification requirements stipulate that this mode Beta selection may only be possible by a positive, distinct and separate action by the pilot. The provided mechanical stop to be removed by the pilot satisfies this requirement. No certification requirements existed for the provision of a secondary stop on the Fokker 27 Mk050 aircraft.

Due to repeated incidents and accidents of this nature, many recommendations have been made to certification authorities, ranging from the installation of placards in the cockpit to the installation of automatic flight idle stops.

From the onset of the Fokker 27 Mk050 production, the aircraft was certified with a secondary flight idle stop, although this was not mandated by certification requirements.

1.18.1.2. Fokker 27 Mk050

Since the early days of the aircraft's line operation, the functioning of the antiskid control unit has been source for troubles. During aircraft maintenance, some operators discovered inadvertent activation of the flight idle solenoid due to the power up behaviour of the antiskid control unit. Adding to the complexity of the system, the unit also provides signals for other aircraft systems, namely the propeller regulations through the flight idle stop solenoids and thus, the problems surfaced also on the propeller regulation system.

In 1988 a report from an operator showed that the power lever settings below flight idle were possible in flight after reset of towing switch. This problem was identified during maintenance activities. The system was reviewed by Fokker Aircraft B.V. who confirmed the anomaly, which was caused by the power-up effect of the skid control unit. Fokker Aircraft B.V. determined that no immediate action was required in view of the low probability of the failure.

This conclusion was reached because several conditions must be met simultaneously before any operational effect will appear. The conditions identified by Fokker Aircraft B.V. were

- Gear must be lowered,
- Main gear unlocking must be such that the inboard and outboard antiskid control channels which are powered by the LH and RH main landing gear uplock switches respectively must be powered within approximately 20 ms from each other. Only if this condition occurs, the secondary lock is removed for 16 seconds.
- The power levers must be below the flight idle position (crew has to lift the ground range selectors). This is not a normal power lever position. Normally the approach is flown with approximately 15% to 18% torque (in GA power rating). The power levers are at such a torque setting above the flight idle position.

- The crew must continue to pull the power levers backwards within the 16 seconds time frame (after landing gear down).

In 1990, ABSC was requested by Fokker Aircraft B.V. to define a modification for the skid control unit to correct the power-up anomaly.

On 1 August 1992, the company ABSC issued service bulletin Fo50-32-4. A modification to the antiskid control box was introduced by adding to each wheel board one capacitor and one diode. This modification permitted that wheel speed sensor disconnect would be properly detected. The modifications being done would change the unit's part number to 6004125-1.
This service bulletin was not issued as an Airworthiness Directive, but it was incorporated into the production as a standard from skid control unit serial AUG92-117 onwards.

In 1993, an incident report was received by Fokker Services B.V. concerning power lever selection below flight idle during approach. Also verbal confirmation from several airlines was received, that ground range selector levers have been operated occasionally during flight, primarily in turbulence conditions.

On 29 June 1994, the company ABSC issued a revision N°1 of the service bulletin F50-32-4. It was a text modification of the service bulletin from 1992, saying that the added components prevent a condition during power up of the skid control box whereby a signal pulse is inadvertently sent to the ground control relay thus affecting the flight idle stop solenoids.

This service bulletin was not issued as an Airworthiness Directive , but the accomplishment of the service bulletin was recommended when the control unit would be removed or repaired for another reason. This however, is only done upon explicit request from the operator. Although the unit was returned a couple of times for repair, the operator never expressed such a request.

On 20 December 1994, Fokker Aircraft B.V. published a service letter N° 137 informing operators about the possibility of inadvertent release during flight of the mode beta locks. Fokker Aircraft B.V. identified there a working characteristic leading to a release of the flight idle stop.

In 1998, a complaint from an operator was received complaining about pulsating brake behaviour and loss of braking at low speeds in the normal braking mode.

On 2 August 1999, Fokker Services B.V. published a service bulletin F50-32-035 proposing a change of the grounding connections of the Anti-skid box. This change has been proposed because cases have been experienced of intermittent or no braking action from the normal braking system caused by EMI disturbance signals in the wiring from the wheel speed sensors to the antiskid box.
This service bulletin was not mandated.
Although the reasons for this Service Bulletin are not directly linked to the accident, its application would have covered the application of ABSC service bulletin Fo50-32-4.

1.18.1.3. Fokker Service letter N° 137 and its dissemination within Luxair

Fokker Aircraft B.V. identified the potential deactivation of the secondary stop as of 1988. A solution was proposed by a modification of the anti skid box through a Service Bulletin in 1992. A complete explanation of the failure was distributed to the operators maintenance departments in December 1994 by the Service Letter n°137, dated 20 December 1994. Luxair received this service letter early by fax on 13 December 1994.

Two remarks can be made about this: as it was a technical note containing also some operational information, Luxair maintenance department received it. It could be established that this Service Letter had reached the operations department. However, it could not exactly be determined at what date. No indications could be obtained that the information contained in this document was at that time incorporated into the operational documentation and/or used for crew briefings, which may have contributed that this important information was lost over time.

However it is clear that existing AFM content specified already propeller operating limits to the effect that selection of ground idle in flight, in case of failure of the flight idle stop would lead to loss of control from which recovery may not be possible (Appendix 19).

1.18.2. Operator's All Weather operations

The procedures for flight conduct are laid down in the Aircraft Operations Manual (AOM). Part A describing general basics and part B pertaining to the Fokker 27 Mk050 operation.

Most salient excerpts pertaining to the conduct of the accident flight are given below.

In AOM part A, it is stipulated in section 8.4.3 paragraph 100 "Commencement and continuation of the approach", that:

The captain or the pilot to whom conduct of the flight has been delegated may commence an instrument approach regardless of the reported RVR/visibility, but the approach shall not be continued beyond:

- *The outer marker or equivalent position for precision approaches*
- *1000 ft above aerodrome level for non precision approaches*

if the reported RVR/visibility is less than the applicable minima.

In the same section paragraph 200 "Applicability of aerodrome operating minima" it is stipulated that:

When RVR assessments are actually available, the TDZ RVR is the deciding value for all approaches, except circle to land approaches, which require a minimum meteorological visibility.

In AOM part A, it is stipulated in section 8.4.4 under paragraph 100 "Definitions and principles" that:

As opposed to a conventional approach where either the captain or the co-pilot may perform an approach and land at the captain's discretion, in the monitored approach procedure, the aircraft is flown by the co-pilot (through the autopilot as applicable) down to the applicable MDA/DA/DH for all type of approaches followed by a straight-in manual landing.

The landing, after the monitored approach, shall always be made by the captain.

In the same section under paragraph 200 "Work distribution", it is stipulated that:

The co-pilot normally takes over controls at the top of descent, but at the latest when leaving the IAF or equivalent position when being radar vectored, till the captain announces << Landing>> and takes over the controls for landing.

In AOM part B, it is stipulated in section 2.3.18 (Monitored Approach Procedure) under paragraph 100 ”General Philosophy” that:

> *CAT II approaches are always flown using the monitored approach procedure. The autopilot is a requirement for CAT II approaches.*

Further more, it is marked in section 2.3.20 (Low visibility operations), under paragraph 100 ”General” that:

> *The approach briefing is performed by the PF. However, before any low visibility approach, the Commander shall perform an operational review of the procedures, callouts and aircraft handling in case of missed approach.*

In the same section under paragraph 300 “Task distribution for CAT II approaches”, it is stipulated that:

> *For CAT II (or monitored approaches in general), the F/O flies the aircraft through the autopilot and the captain lands the aircraft, if sufficient visual references are available at minima.*

The whole section 2.3.20 (Low visibility operations) is shown as appendix 15 to this report.

1.18.3. Propeller operating limitations (AFM of the Fokker 27 Mk050)

In the aircraft flight manual (AFM), section “Power plant limitations” paragraph –Propeller operating limitations- the following sentence is expressly marked in a warning message.

> *Do not attempt to select Ground Idle in flight. In case of failure of the flight idle stop, this would lead to loss of control from which recovery may not be possible.*

A copy of this page is shown as appendix 19 to this report.

1.18.4. Traffic into the airport

During the whole morning, the visibility is much reduced and the RVR varies between 225 and 275 m. LVP procedures are activated early in the morning, which compels approach control to increase separations between arriving aircraft to allow landing aircraft to leave the CAT II-III sensitive area.

Traffic at the time of the accident is typical for CAT II-III operational conditions. The majority of commercial operators are certified for CAT II and/or CAT III operations. There was no VFR traffic to deal with.

During wintertime, the airport is open to air traffic as of 05:00. This day, 24 aircraft departed and 9 aircraft landed before the accident occurred.

In the period preceding the accident, following aircraft are handled by approach control

Initial call [5]	Flight N°	Situation of the flight
08h 35min 00s	LGL 6892	Landed at 08h 47min 44s
08h 38min 09s	LGL 9512	Landed at 08h 52min 12s
08h 43min 03s	LGL 8362	Entering DIK hold, FL80 at 08h 57min 56s
08h 43min 36s	SWR 750	Landed at 08h 59min 22s
08h 45min 47s	LGL 9302	Landed at 08h 55min 35s
08h 49min 36s	LGL 402	Entering DIK hold, FL 60 at 08h 53min 10s, leaving the hold at 09h 00min 24s, 3000' QNH, Heading 090°
08h 51min 07s	LGL 4452	Entering DIK hold, FL 90 at 08h 56min 01s
08h 52min 38s (accident flight)	LGL 9642	FL90 on course to DIK hold, then at 08h 58min 48s cleared 3000' QNH , Heading 130°
09h 01min 38s	LGL 5432	FL100 on course to DIK hold

LGL 6892 and LGL 9512 are in the intermediate approach when, at 08h 43min 03s LGL 8362 and at 08h 43min 36s SWR 750 contact approach control well south of the French-Luxembourg border. About 2 minutes later, LGL 9302 presents itself approximately 15NM northeast of ELU.

While LGL 9302 continues to ELU, LGL 402 and LGL 4452 make their first call on the frequency and receive instructions to join the DIK hold.

At 08h 48min 27s LGL 8362 asks the controller to maintain FL80, join DIK hold and to wait for an RVR improvement above 300m.

At 08h 57min 56s LGL 8362 reaches the DIK hold at FL80. There are now 3 aircraft in the hold.

When LGL 9302 is about 10NM from the threshold, SWR 750 is still well south of ELU, which gives the controller an opportunity to position that flight behind LGL 9302.

At 08h 52min 38s LGL 9642 calls approach control for the first time and the controller decides to maintain him at FL90, direction DIK.

At 08h 53min 10s LGL 402 announces its entry into DIK hold passing from FL100 to FL60. 3 minutes later, LGL 4452 joins also the DIK hold at FL90.

Since the first call from LGL 9642, the controller supplies information of RVR values for runway 24 (250m). At no moment, the pilot informs approach control that the values transmitted are below his minima. For the controller, the flight can therefore be integrated in the normal approach sequence.

There are now 3 aircraft in the hold, LGL402 at FL 60, LGL4452 at FL90, LGL8362 at FL 80 and LGL 9462 is approaching the hold also at FL90.

LGL 9642 will need to be given another flight level for separation purposes (LGL4452). As anyhow the approach controller had to deal with this flight approaching DIK, he had two possibilities; either assign a new flight level in the hold or lead him to an approach. As he notices that he can place this flight behind SWR 750 into the intermediate approach and in front of LGL 402, who is at FL60 in the DIK hold, his choice is towards an approach authorization in order to evacuate traffic rapidly.

[5] Times are from ATC transcript (Appendix 4)

At 08h 58min 48s LGL9642 is about 10NM from the DIK hold when the controller instructs the flight to descend to 3000 feet and turn left on a heading of 130°. This decision is taken because LGL9642 is the flight closest to ELU and would bring lesser delay to the other arriving aircraft. This decision allows him amongst others, to descend LGL 9642 through the flight levels of LGL 402 and LGL 4452, who are north of DIK. Then, LGL 9642 is directed to intercept the ILS and authorized for the approach.

LGL9642 is then handed over to the Tower and upon initial contact, when the controller forwards actual RVR values, only then the crew replies that they need an RVR of 300m.

After the accident, the airport was closed due to non-availability of rescue services. A total of 4 aircraft had to divert.

1.18.5. ATC department

The Manual of Air Traffic Services (MATS) is the basic department documentation for air traffic controllers. Therein, the use of radar in the aerodrome control service in Luxembourg is described in Section 5, Chapter 3.9.1. as follows:

> *Surveillance radar may be used in the provision of aerodrome control service to perform the following functions:*
> *a) radar information of aircraft on final approach;*
> *b) radar information of other aircraft in the vicinity of the aerodrome.*

2. ANALYSIS

2.1. Accident scenario

The following scenario, based on CVR and FDR recordings and on technical facts, analyses the crew's actions when faced with events both inside and outside the cockpit, from the beginning of the approach to Luxemburg until the recorders stopped.

2.1.1. Descent

The CVR recording begins at 08h 33min 49s when the aircraft is still in cruise.
At 08h 35min 15s the first record is noted of the crew checking Luxembourg ATIS. The RVR is below their minima, and it quickly appears that there will be a delay resulting, either in waiting in the holding pattern, or in a diversion.

The crew expresses some impatience and their wish to land as planned in Luxemburg. There is still time for meteorological conditions to improve, and the worry dissipates as the flight continues in a normal way until the descent at 08h 41min 08s.

At 08h 44min 46s the copilot listens again to the ATIS. The RVR has not changed from the previously announced 250 meters, the minimum value needed to start the final approach being 300 meters.
At 08h 45min 10s they start some discussions about various strategies that will give them a chance to land despite the bad weather conditions.

At 08h 45min 45s the copilot picks up on the captain's remark about a CAT III traffic behind them, remark voiced at 08:45:12 and which was interrupted by the ATIS message. The captain continues with his theory at 08h 45min 53s without concluding on a strategy how to proceed. In fact, no decision about how to continue the flight is taken and consequently there is no approach briefing. Simultaneously, as there is little chance for a rapid RVR improvement, the probability that they have to hold is high. This appears in discussions they have about the RVR readings. Consequently they still have time to prepare for the approach.

At 08h 46min 21s starts a long period, which lasts around 10 minutes during which the copilot is busy with the preparation of the public announcements to the passengers. It isolates the copilot from the captain, who on another hand does not help him as no decision has been made at this stage about the approach strategy.

At the same time the captain calls Luxair Dispatch to confirm the visibility and its evolution and to get some information about the take-off of a Cargolux flight, because he expects to get a temporary improvement brought by the thrust of this heavy aircraft on take-off.

At 08h 52min 49s, the crew is instructed to enter the holding pattern at Diekirch DVOR.
Finally at 08h 53min 24s, the copilot issues the passenger announcements in three languages, telling them that they will join the hold to wait for a weather improvement.

Until then however, nothing jeopardises the conduct of the flight, and it is to be noted that it is a routine flight for a crew returning to its home base. At this stage, their plan of action is indeed to wait, as they calculate the fuel available until they have to divert.

Two remarks can however be made at this stage about the crew activity:

- It seems that despite their desire to arrive, they are convinced that they will have to enter the hold. Their exchanges are somehow limited and they both remain isolated in different tasks, as they are guided to the Diekirch hold, waiting for a RVR improvement.

- They use a lot of their resources to gather information and to imagine solutions to improve the situation. But this constitutes a rather distracting element and leads them to deviate ultimately from their SOP's by utilising a less efficient working method (the copilot is assigned an unusual task; the captain tries to find alternative but unrealistic solutions).

At this moment in time, these factors are in no way a deviation from SOP's but favoured the acceptance by the crew of the approach after the controller changed his strategy and instructed them to perform the approach. The sudden change in pace triggered a conduct of the approach in adverse conditions, during which the crew had difficulties to follow the procedures.

Indeed at 08h 58min 50s, ATC instructions to descend to 3000 feet and to change their heading from 270° en route to Diekirch to 130°, surprises the crew. It is a first radar vector that will lead to the interception of the localiser. Their reaction is to check the RVR again with Luxair dispatch and at 09h 01min 06s, the copilot sais: "Yes, what are they doing with us, holding or is it for an approach?". Dispatch gives them 275 meters, confirmed by ATC a few seconds later, which is below their minima.

2.1.2. Intermediate approach

At 09h 01min 25s, they are cleared for the approach as they are descending through 6000 ft at a distance of thirteen NM from the airport. They express some surprise about the fact that they pass before all the aircraft in the hold and they begin to prepare the aircraft for the approach. But, as they are caught off their guard by the priority given to them, they did not have much time to do so. Their actions resemble an initiation of a CAT II approach, but they never mention this. Finally they deviated from Luxair SOPs for this type of approach; for example, there is no announcement of a transfer of the flying task to the copilot, which suggests that the captain remains Pilot Flying in contradiction with the task sharing for a CAT II approach. They put the seatbelt sign on, set the altitude and are then interrupted by the capture of the localizer and the transfer to the control tower some moments later. This underlines the fact that they have no time to perform all of the approach actions and briefing, and moreover that they have no common plan of action as they no longer follow the standard task sharing, perhaps confused by the RVR values.

At 09h 02min 12s, the captain told his co-pilot: "Tell him ….that if we don't have 300 meters at Echo, we are going to perform a go-around". This message which was never delivered to ATC because they were transferred to the tower frequency at this time. The priority given to the flight in the approach sequence and the lack of the required RVR values put some additional pressure upon the crew although, according to their procedures they could continue up to ELU.

At 09h 02min 57s, aerodrome control confirms an RVR reading of 250 m, which was in fact a worsening tendency compared to previous readings, prompting the captain to say to his copilot "Say we continue until ELU and if we have nothing, then ehhh". This hesitation in the captain's instructions confirms the lack of preparedness and shows how the crew's determination had

drifted. At that moment, the crew's attention is still focused on an RVR improvement. This explains why nothing happens until they almost reach ELU. In fact, the beacon frequency was not dialled in, most probably because they did not have the time to reorganise the radio navigation equipment, which triggers a remark made by the copilot. The captain replies that the DME distance could replace the beacon. The tone of these exchanges however indicates that there is a relaxed atmosphere in the cockpit. This happened approximately thirty seconds before they overflew ELU that is to say at around 1.3 NM from it.

At 09h 04min 30s, about six seconds before ELU, the copilot starts the BEFORE APPROACH checklist. He is still performing this checklist as they overfly ELU. There is no announcement made neither in the cockpit nor to ATC about passing ELU.

At 09h 04min 46s, a few seconds after the latest RVR values (3x275m) were passed to MKA123, the captain having heard these values and repeating them, decides to perform the go-around as mentioned at time 09h 02min 12s. ELU was passed ten seconds before. The copilot does not react and continues with the checklist, placing the ground idle stop in the OFF position, this being the last action of this checklist. This misunderstanding most probably results from the lack of preparation and of accuracy resulting from the previous flight phase. Moreover, as the crew never got prepared for a go-around and as the aircraft was not in descent, this go around decision did not imply any significant action. The aircraft is in level flight at 3000 ft, as it had been before and at a constant speed.

At 09h 04min 57s, ten seconds after the captain said that they would perform a "missed approach", the controller transmitted the latest RVR of 300 meters.

From the CVR it is clear that the copilot handles the communications and checklists which are pilot non flying tasks (PNF). In consequence the captain is the pilot flying (PF). Implicitly this is acknowledged at 08h 46min 33s, when the copilot says "You fly" in relation to the public address delegated to him by the captain. No transfer of pilot flying functions is announced during the recorded time frame.

2.1.3. Final approach, attempt to capture the glide path

This RVR value, which corresponded exactly to the required landing minima, triggers a sudden reversal of the captain's decision, who then chooses to resume the approach without announcing it.

However no procedure exists to capture the glide slope from above after having passed the final approach point. The captain, without a word, brought the power levers to flight idle and at the same time pulled the ground range selectors in order to be able to bring the power levers slightly further backwards. This action is deduced from the value of the Left and Right HP turbine RPM parameters, which were below the flight idle minimum and by the identified relevant noises on the CVR. The "secondary stop" installed on the engines maintained the power levers in a position slightly below the flight idle (see paragraph 1.16.5.1.).

In reality, the captain had to achieve two goals, each one being contradictory with the other. Indeed, when he decided to catch up with the glide, the aircraft was 300 ft above it. Due to the growing lack of time and lack of preparation since they had been cleared for the approach, the crew did not have time to slow the aircraft down and configure it for landing. Catching up with the glide from above, meant descending rapidly and consequently increasing the speed, which was still relatively high. Using a power lever position below flight idle to decrease power to the

minimum should help to descend without increasing the speed. The investigation has shown that it actually did not improve the deceleration.

It has not been possible to determine to what extent, if ever, this was common practice or if this manoeuvre was an instinctive isolated reaction to reduce thrust to the minimum.

At 09h 05min 02s, the copilot stated: “will not be enough/sufficient” which could mean that despite this action of the captain, he doubted the obtained sink rate would be sufficient to capture the glide path.

At 09h 05min 05s, the copilot informs the controller that they continue the approach. The crew having noticeably deviated from SOPs, a certain confusion prevails in the cockpit. It can be noted that, although the captain decides to continue the approach, he does not call for the flaps and gear. He waits several seconds before putting the aircraft into descend. However, it is noteworthy that the copilot tried to help by proposing the extension of the flaps (09h 05min 07s), then the landing gear. The aircraft then starts to descend, still being well above the glide path.

On the other hand and although the simulation has not been performed, it seems credible from a technical point of view, considering the initial conditions when the aircraft starts descent to catch up with the glidepath, to continue the approach and land.

2.1.4. From landing gear extension until the impact

The Ground idle stop was removed at 09h 04min 58s as foreseen in the DESCENT AND APPROACH checklist. The Primary lock (ground range selectors) was removed at 09h 05min 00s as positively identified by the CVR analysis.

The investigation has demonstrated that the most probable cause for the removal of the secondary stop, was the extension of the landing gear at 09h 05min 16s, which triggered the energising of the flight idle stop solenoid relay through the antiskid box.

The captain, faced now with a sudden time pressure and all mechanical locks being removed, and with the hand pressure on the power levers, may have unintentionally moved the power levers further backwards without realising that he was now in beta mode, passing through the ground idle position (a double click on the CVR can be attributed to this event), towards full reverse.

Following events happened in a very rapid sequence. The increase in reverse power triggered a propeller overspeed that was heard and noticed by the crew. Feeling a tremendous increase in drag and the consequent deceleration, one of the crewmembers retracted the flaps. The power levers were moved into the flight range but the propellers could not exit the beta range (see paragraph 1.16.4 above and Appendix 22). Faced with the impossibility to recover from this situation, the LH engine had probably been shut down, followed a couple of seconds later by the RH engine, as shown by the positioning of the fuel levers in the SHUT position.

The FDR and CVR readings stopped at this moment. Due to the lack of data, it was not possible to further analyse the subsequent flight phase.

The aircraft glided in the fog layer, and the crew certainly did what they could to flare the aircraft at the last moment when they saw the ground.

2.2. Task sharing and crew performance

A number of standard operational procedures were not applied because of the sudden increase in workload brought by the execution of the direct approach although the crew was set to enter DIK hold. Consequently, there was no approach preparation, nor briefing, which meant amongst other that the crew did not express which type of approach would be performed. In any case, had this RVR of 300 m been available at that moment in time, the only available operational issue would have been to execute a CAT II approach. The task sharing corresponding to CAT II approach was however not applied. This might have influenced the crew performance.

The abovementioned events testify a lack of method and professionalism of the crew in handling this unexpected situation. One obvious reaction could have been to refuse the approach sequence. The combination of routine and the will to arrive at destination ("get home itis") favoured the decision of the crew to accept the approach clearance, although they were not prepared to it. At this precise point the chain of events started to build up which ultimately led to successive uncoordinated decisions and actions by the crewmembers.

The additional pressure which accompanied the priority given to them on the other aircraft, combined with this will to do the approach, may partially explain the interception of the glide from above and the positioning of the power levers below flight idle.

2.3. Training

The variety of trainings do not favour standardized working procedures and methods. It may contribute to the abovementioned deficiencies regarding crew cooperation.

Before the implementation of JAR-OPS1 in March 1998, the training programs had not been submitted by the operator for approval to the authority, as there was no requirement to do so.

However, in ICAO annex 6, part 1, it is detailed in chapter 9.3 – Flight crew member training programs- that <<…an operator shall establish and maintain a ground and flight training program, approved by the State of the Operator…>>. This annex has not been transposed into national legislation.

Subsequent to the JAR-OPS1 introduction in 1998, it can be noted that the Luxair O.M. part D. Training Manual had been approved by the Authority in 2001.

2.4. Organisational aspects and oversight

It appeared during the investigation that the existing control mechanisms from the Authority and the Operator including the recurrent trainings of the Operator did not prevent the crew to drift from standard operating procedures.

It was also discovered that, about an hour before the accident, another F27 Mk050 from Luxair landed without having at any moment received a RVR reading at or above their required minima of 300 meters.

Noted deficiencies during the approach of the accident aircraft, as well as the landing of the other Luxair F27 Mk050 below the minima, indicate that the methods in place to guarantee safe operations are not sufficient.

The ICAO audit of the Authority in March 2001 (ref. 1.17.2.6.) has revealed a number of shortcomings concerning:

- procedures to efficiently supervise the delegated tasks in order to ensure consistency and reliability
- and the lack of a formal air operator supervision system.

Continuous airworthiness issues concerning foreign Authorities and manufacturers have been added in an addendum to this revised report.

2.5. Beta range safety devices

2.5.1. Secondary stop design

The secondary stop was introduced on turboprops to prevent the selection of beta mode in flight. Accident statistical data on turboprops document that, the intentional use of beta mode in flight is sometimes used by pilots to dissipate excessive energy.

The device installed on the F27 Mk050 aircraft was changed in 1988 from a single solenoid installed on the central pedestal, to two separate solenoids installed on each engine. It must be noted that the secondary stop design allows the pilots to lift the ground range selectors (also in flight) and move the power levers through the primary flight idle stop.

This design does not prevent the intentional or unintentional removal of the primary stop, meaning that the safety function of this first device is not guaranteed. The primary and the secondary stop system of the Fokker 27 Mk050 was certified against JAR25.1155 (change 9). According to this regulation, the installation of the secondary stop was not mandatory. It is worth mentioning that the new version of European airworthiness requirement JAR25.1155 (harmonization initiative set up by the FAA and JAA) issued in May 2003 (change 16), introduces this notion of “a means to prevent both inadvertent or intentional selection or activation of propeller pitch setting below the flight regime”. Excerpts of this new regulation are shown in appendix 21.

2.5.2. Secondary stop reliability

By Fokker Aircraft B.V. Service Letter n°137 issued in 1994, the operators were informed about the possible scenarios leading to the deactivation of the secondary stop. Fokker Aircraft B.V. required no corrective action because they considered this occurrence was remote (see paragraph 1.18.1.2); however Fokker Aircraft B.V. indicated in the same letter that it could happen during each flight when the landing gear is selected down. These two statements seem to be incoherent and some questions remain regarding the reliability of the system.

The aim of the secondary device is to be an ultimate backup to avoid a catastrophic situation. The philosophy of this concept implies that the backup must be reliable at all times during flight. Despite the presence of two different safety devices serving one single purpose, their intended design purpose is not fulfilled. The new JAR25.1155 (change 16) requirements also requests “a reliability such as the loss of the safety devices is remote”.

2.6. Functioning of the ATC department

Luxembourg air traffic control has a very limited volume of airspace available to position aircraft for approach. Whilst in normal CAT I conditions operators face very few delays, the situation changes for CAT II/III conditions because separations have to be increased due to airport restrictions. Regularly aircraft have to be directed to the DIK holding either for separation

purposes or because actual weather conditions are below the operators landing minima and the pilots decide to wait for weather improvements.

On first contact with approach control, it is not foreseen that crews announce their operational limitations. When sequenced into the current approach phase, they are nevertheless supposed to inform the controller of their intentions if actual weather conditions are below their minimum, which is done by LGL8362 at 08h 48min 27s and which is not done by the accident crew. Whilst taking control of the preceding flights, the controller announces to each flight his strategy by giving it a sequence number for the approach. This has not been done for the accident flight.

At 08h 43min 08s LGL8362 is sequenced as number 4 and at 08h 48min 27s this crew tells ATC that they want to keep FL 80 until RVR reaches 300m. Consequently they are directed towards DIK hold at this level. This planned sequence now being freed is given to flight SWR750 originally sequenced as number 5.

An opportunity arose to speed up traffic when the pilot of LGL8362 cancelled the approach sequence. The approach controller decided to bring LGL9642 immediately into the current approach sequence, as they were conveniently placed in relation to the ELU beacon.

Following the development of the different flights, the controller notices that regarding the positions of SWR750 and LGL9642 (10 nm to the east of the DIK beacon) he can evolve his strategy by placing LGL9642 in sequence behind SWR750.

The controller was not aware that the crew of flight LGL9642 had an operational constraint. Controllers generally do not know what the operational authorizations are from the various companies and their various types of aircraft, nor the induced limitations for different stages of the flight. Furthermore and considering the type of training received, they only have a limited knowledge of the workload development, which the crews have during their different flight phases. Only individual observation and experience can bring information on the capacities and approach limitations of the different aircraft. It has to be noted that access to this type of information is neither formalized nor harmonized.

Additionally, it is worth mentioning that about an hour before, the same type of aircraft from the same company made an approach and a landing in similar meteorological conditions with RVR values given as 275m / 225m / 225m prior passing ELU.

In fact, whilst the new RVR of 300m is communicated, flight LGL9642 has already passed the ELU beacon, position where the crew should have started their descent. The question can be raised as of the necessity of this information being passed at this stage of the flight? It is evident that air traffic controllers don’t need to know the procedural sequence of events in a cockpit and what elements must be available at what time to trigger specific pilot actions. As a matter of fact, the passing of the ELU beacon is neither announced in the cockpit, nor communicated to ATC.

Tower controllers have a radar display available showing traffic in the airport vicinity. It is mainly used as guidance to facilitate VFR traffic into finals in relation to arriving IFR traffic.

3. CONCLUSIONS

3.1. Findings

1. The crew possessed the necessary licences and qualifications to perform the flight,
2. The aircraft possessed a valid Certificate of airworthiness,
3. The Luxembourg authority did not have to approve the aircraft flight manual, as it was originally approved by the Dutch certifying authority,
4. The aircraft weight and balance were in the approved range,
5. There were no aircraft system malfunctions until the final descent,
6. Radio navigation aids functioned normally,
7. RVR was below approved company minima during the initial and the intermediate approach,
8. During the approach, the crew deviated from the operators SOP's,
9. Despite the fact that the meteorological conditions for a CAT II approach prevailed, none of the required prerequisites, to perform a CAT II approach, were taken by the crew,
10. The captain resumed the final approach after having announced a go-around, without reaction from the copilot,
11. In order to achieve this goal, the crew performed several non-standard actions, amongst which the positioning of the power levers below flight idle. The AFM contained a limitation that prohibits the selection of ground idle in flight,
12. The selection of the landing gear down, triggered the deactivation of the second safety device (solenoid secondary stops) which was a possible malfunction identified by the manufacturer,
13. The aircraft's drag increased significantly and the aircraft's speed dropped as the rate of descent increased,
14. Both engines were shut down by cutting the fuel flow,
15. After engine shut downs, the two flight recorders stopped recording.

3.2. Causes

The initial cause of the accident is the crew's acceptance of the approach clearance although they were not prepared to it, namely the absence of preparation of a go-around. It led the crew to perform a series of improvised actions that ended in the prohibited override of the primary stop on the power levers and leading to an irreversible loss of control.

Contributory factors can be listed as follows:

1. A lack of preparation for the landing, initiated by unnecessary occupations resulting from an obtained RVR value, which was below their company approved minima, created a disorganisation in the cockpit, leading to uncoordinated actions by each crewmember.

2. Some procedures as laid down in the operations manual were not followed at some stage of the approach. All this did not directly cause the accident, but created an environment whereby individual actions were initiated to make a landing possible.

3. Routine and the will to arrive at destination may have put the crew in a psychological state of mind, which could have been the origin of the deviations from standard procedures as noticed.

4. The priority in the approach sequence given to the crew by ATC, which facilitated the traffic handling for the controller who was not aware of the operational consequences.

5. The low reliability of the installed secondary stop safety device that was favoured by the non-application of service bulletin ABSC SB Fo50-32-4. Also the mode of distribution of the safety information (Fokker Aircraft B.V. – Service letter137) to the operator as well as the operator's internal distribution to the crews, that did not guarantee that the crews were aware of the potential loss of secondary stop on propeller pitch control.

6. Latent shortcomings in the Authority and the organisational structure of the operator, in combination with poor application of SOPs by the crew.

4. SAFETY RECOMMENDATIONS

4.1. Safety measures taken since the accident

On 14 November 2002, technical services from Fokker Services B.V. issued an All Operators Message (ref. AOF 50.022) to recall, amongst other, to all operators of Fokker 27 Mk050 aircraft, the characteristics of the security systems of the propellers.

The investigation commission issued following recommendations:

- The first, safety recommendation N°1, dated 15 November 2002, stipulating that:

  In order to avoid the failure of the Flight Idle Stop security, the Investigation Commission recommends that the opportunity should be evaluated to render the modification of the Antiskid Control Box stated in the Service Bulletin be mandatory for all Fokker 50 aircraft.

  Furthermore and without waiting for this modification, the Investigation Commission recommends that the crewmembers should be informed about the potential functioning of the system as mentioned above and about the content of Fokker message to all operators AOF50.022 dated 14 November 2002.

- The second, dated 28 November 2002, recommends the publication of an airworthiness directive stipulating that:
  - Service bulletin N° Fo50-32-4-revision 1 from ABSC and
  - Service bulletin N° F50-32-035 from Fokker Services B.V.,

  be made mandatory for all Luxembourg registered Fokker 50 aircraft.

  This airworthiness directive LUX-2002-001 has been published on 29 November 2002.

  Informed in parallel about this recommendation, Luxair has proceeded with the modifications of their aircraft between 15 November and 8 December.

- The third, safety recommendation N°2, dated 23 January 2003, stipulating that:

  In order to improve the functioning of the secondary safety Flight Idle Stop, the investigation commission recommends, that the announced publication of Service Bulletin Fo50-32-7 be speeded up and that its application be made mandatory for all Fokker F27Mk050 type aircraft.

On 8 May 2003, technical services from Fokker Services B.V. issued an All Operators Message (ref. AOF 50.028) announcing the publication of:

1. Fokker SB F50-32-038
2. ABSC SB Fo50-6004125-32-01

and stipulated that, with these modifications incorporated, abnormal braking, loss of braking at low speeds as well as unintended energizing of the flight idle stop solenoids are considered to be adequately covered.

On 8 May 2003, technical services from Fokker Services B.V. issued a Manual Change Notification/Maintenance Documentation (ref. MCNM-F50-045) incorporating the modifications to perform on the Skid Control Unit.

On 9 May 2003, a fourth safety recommendation was made, recommending the publication of an airworthiness directive stipulating that:

- Service bulletin N° Fo50-6004125-32-01 from ABSC and
- Service bulletin N° F50-32-038 from Fokker Services B.V.,

be made mandatory for all Luxembourg registered Fokker 27 Mk050 aircraft.
This airworthiness directive LUX-2003-001 was published on 12 May 2003 and all aircraft need to be modified by 1 November 2003.

On 31 May 2003, the Dutch authorities issued an airworthiness directive BLA Nr 2003-091, rendering service bulletin N° F50-32-038 from Fokker Services B.V. mandatory.

By 9 August 2003, all Luxembourg registered Fokker 27 Mk050 aircraft had been modified accordingly.

4.2. Improvements in the design of the safety device

Not withstanding the existing recommendations and procedures, it appears that intentional override of the primary flight idle stop on turboprops in flight is not excluded.

The existing design of the Fokker 27 Mk050 does not prevent the selection in flight of the propeller pitch setting below the flight idle regime.

Hence it is recommended to review the existing design in order to examine the possibility of prohibiting in flight, intentional and inadvertent selection of the propeller setting below the flight idle regime.

It is further recommended, considering the number of similar accidents on turboprops in general, that authorities responsible for airworthiness of these types of aircraft, check whether the design of these safety devices as proposed by JAR25-1155 (change 16) should be made applicable to existing designs.

4.3. Organisation and management

4.3.1. Luxair

4.3.1.1. The investigation of the accident brought to light deficiencies in the domain of crew task-sharing. Consequently it is recommended:

- that a review of the airline operational oversight be performed.

4.3.1.2. The investigation pointed out that the variety of training centres used by Luxair could have had an influence on crew cooperation and synergy. It is hence recommended:

- to ensure that recruitment procedures, pilot training, strengthen cockpit resource management (CRM) training and recurrent trainings allow to reach a standard of harmonization.

4.3.1.3. Considering the importance of the information contained in different technical publications issued by a manufacturer and concerning flight operational safety matters as well, it is recommended:

- that Luxair makes sure that their organisation ascertains the diffusion of this type of information to all parties concerned.

4.3.1.4. ICAO Annex 6 recommends "*that from 1 January 2002, operators of aircraft whose takeoff weight exceeds 20,000 kg establish and maintain a flight data analysis programme in the context of their accident prevention and flight safety programme*".

This system enables the operator to constantly monitor the operations and to identify the deviations. Such a system is in place in Luxair for the E145, B734 and B735 types of aircrafts. Hence it is recommended:

- that such a system be implemented also for the Fokker 27 Mk050 type of aircraft.

4.3.2. Authority

4.3.2.1. The investigation of the accident brought to light deficiencies in the domain of crew task-sharing and application of methods. Consequently it is recommended,

- that the authority reviews its oversight methods of the working methods of the airline crews.

4.3.2.2. The variety of training facilities that have been used by Luxair could have had an influence on the lack of application of standard methods that were pointed out in the scenario of the accident. As before the application of JAR-OPS1, there was neither formal follow-up nor oversight of the different trainings and in the light of the accident it is today difficult to evaluate the situation at Luxair regarding this standardization. Furthermore, the oversight of these trainings did not allow highlighting its potential weaknesses. It is therefore recommended that the authority,

- perform a review of the previous trainings in order to establish the measures to put in place to achieve a suitable harmonization;
- review the methods for approval and oversight that would improve the detection of deviations during the training.
- ensures that the training environment of the operator is kept as stable and harmonized as possible.

4.3.2.3. Since a radar display is available for information only in the control tower and no procedures exist in the current department documentation to eventually take maximum advantage of such equipment, it is recommended,

- that the authority identify if the actual set-up of the equipment could be used for surveillance and radar assistance through appropriate procedures paired with methods of utilization and training.

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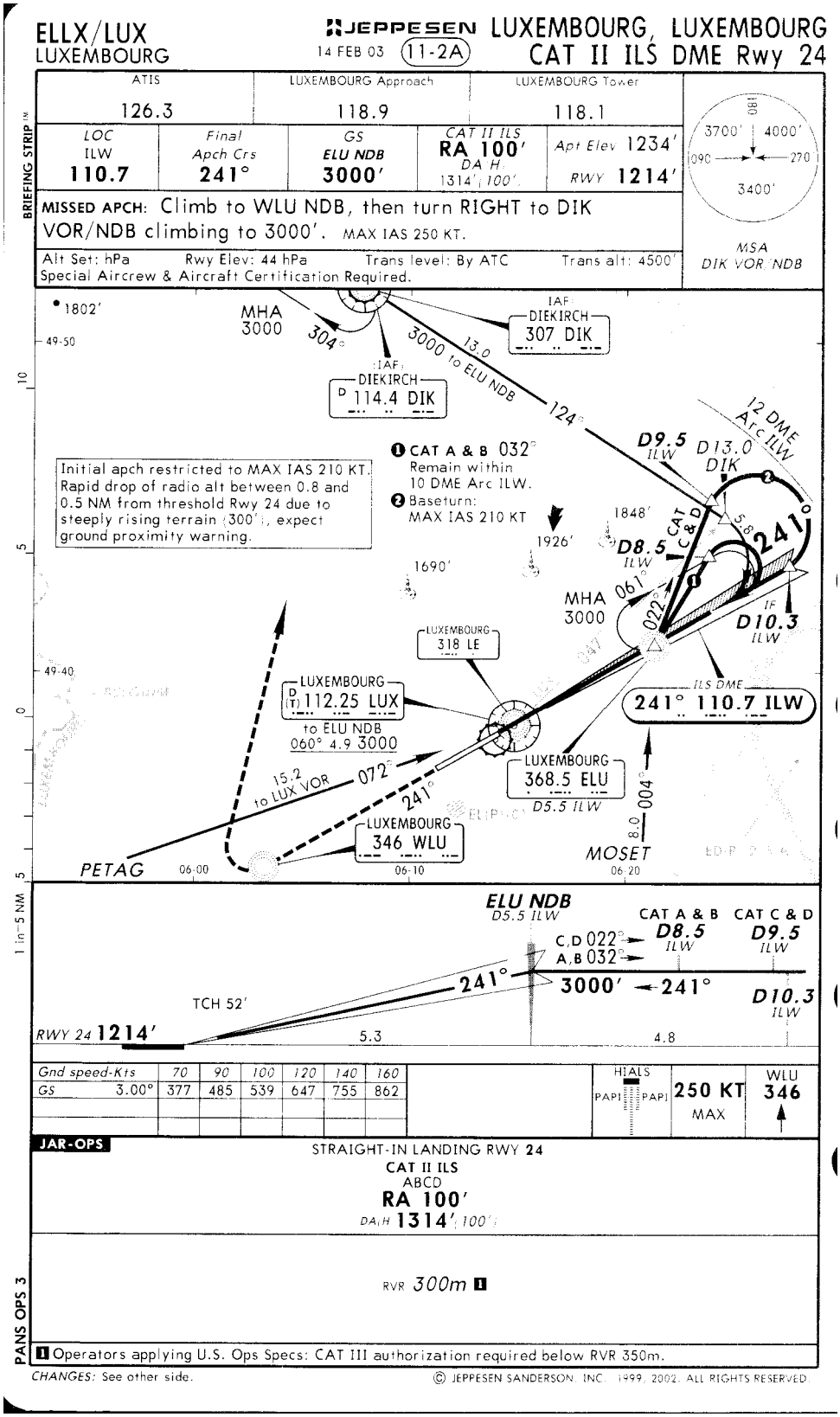
APPENDICES

Appendix 1: CAT II ILS DME RWY 24 (Jeppesen Chart)



Appendix 2: CVR Transcript

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
08 h 33 min 49				START OF RECORDING
till 08 h 35 min 14				Conversation irrelevant to the flight
08 h 35 min 15	I'm OFF Number one		*ATIS:* Visibility one hundred meters, RVR two five zero meters, no change, fog	
08 h 35 min 28		Two five zero meters …ech muss awer hém, kaka mâchen goen et ass net méi fir lang hei ze holden		Two five zero meters…but I have to go home to relief myself *it is not to stay in the holding for long*
08 h 36 min 00		Oh yo		Oh yes
08 h 36 min 01				Conversation irrelevant to the flight
till 08 h 37 min 29				
08 h 37 min 30			Luxair nine six four two contact Radar on one two four decimal four seven, Tschüss	
08 h 37 min 35		One two four point four seven, nine six four two, tschau		
08 h 37 min 46		Frankfurt Radar; Hello; Luxair nine six four two, flight level one eight zero, just overhead Mabob, Pemax next		
08 h 37 min 53			Luxair nine six four two, Frankfurt Radar, hello, identified	
08 h 37 min 57				Conversation irrelevant to the flight
till 08 h 41 min 06				

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
08 h 41 min 07		Hei, esch huelen hei zeréck		Here, I take it back here
08 h 41 min 08			Nine six four two, proceed direct Kirn, and descend flight level one four zero	
08 h 41 min 15		Direct Kirn, and descending flight level one four zero, Luxair nine six four two		
08 h 41 min 25				Conversation irrelevant to the flight
till 08 h 44 min 29				
08 h 43 min 02		Speed		
08 h 44 min 19			Luxair, nine six four two, contact Radar one two five decimal six	
08 h 44 min 22		Two five six, nine six four two, tschau		
08 h 44 min 29		Radar Hallo, Luxair, nine six four two, descending flight level one four zero, on course to Kirn		
08 h 44 min 35			Luxair, nine six four two, Frankfurt Guten Tag, identified, I call you back for further descend, set course direct to Echo Lima Uniform	
08 h 44 min 42		Direct Echo Lima Uniform, and we standby, Luxair, nine six four two		
08 h 44 min 46		Ech huelen nach eng Kéier dât		*I will check one more time the latest*

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
		leschten Wieder, huh, mussen nach a bessen schaffen.		*weather, huh, have still to work a little*
08 h 44 min 53	Scheisse		*Listening to Luxembourg ATIS:* 0820 wind calm visibility 100 RVR 250 meters no change overcast 100 temperature 4 Dew point 4 no change	Shit
		Et ass nach emmer calme		It is still calm
08 h 45 min 04		No change		
08 h 45 min 08		Dât dot geseit schlecht aus, mei Jong		This looks bad, my son
08 h 45 min 10	De Pap schafft nach mat allen Tricken			*Dad still works with all the tricks*
08 h 45 min 12	Waa mir elo den eischten sinn, a wann kén mat CAT drei hannert eis kennt, dann....			*If we are now the first one and if nobody follows us with CAT III, then…*
15		É moment,	*Listening to Luxembourg ATIS*: QNH 1023 transition level 50 Cat two Cat three in operation, latest RVR will be given on the ATC frequency Observation ROMEO…	One moment,
08 h 45 min 40		Gutt, zereck		Good, back
08 h 45 min 45		Du wolls eppes verzielen vun enger CAT zwé, oder wât?		You wanted to tell something about CAT II, or what ?
08 h 45 min 47				C – chord
49		One to go ASEL		

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
51	Yo, Merci			Yes, Thank you
53	Nee, esch wees net wann et zwee honnert fönnef a siventzesch meter sinn, oder irgend eppes esou, froe mir vir an den Holding ze goen ELU drei dousent fouss, so bâl et drei honnert meter get, könne mir direkt...*(unintelligible word)*			*No, I don't know if there are 275 m, or something like that, we will ask to go into the holding ELU 3000 feet, as soon as it goes to 300 m, we can go directly…(unintelligible word)*
	De problem ass, wann et zwé honnert fönnef a siventzech ass an du bass hei am Holding, an hien seet Ok, drei honnert, da fängst du un, an da get et irgenwéi ennerwé zwé honnert fönnef a siventzech, an da bass du schon erem gefullt			*The problem is, if it is 275 m and you are in the holding, and he says OK, 300, then you start and somehow on your way it changes back to 275, then you are screwed again*
08 h 46 min 08		Yo		*Yes*
08 h 46 min 10		Et ass awer zwé honnert foffzech		But it is 250
11	Yo, nén, um ATIS as et zwé honnert foffzech			Yes, no, on the ATIS it is 250
12		Yo, Yo		Yeh, yeh
14	Karayuu !			Exclamation!
18		Fönnef honnert fouss dén ass dann bei siwenzeng honnert zwanzech, hee,		500 feet, he is then at 1720, huh
21	Huess du de Leit schon eppes gesôt?			*Did you say something already to the people?*
22		Wât?		What?

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
	De Leit, hues du denen schon eppes gesôt?			*The people, did you tell them already something?*
23		Né		No
26	Dât muss du awer nach maan			You still have to do that
27		Wéi? Ech muss guer neischt!		What? I have to do nothing!
30	Wât? Muss du neischt?			What? You must nothing?
33		Du flitts		You fly
34	Nén, mé du mechs de Radio			No, but you do the radio
35		Soll ech de Leit eppes zielen, Ok		*Shall I tell something to the people, Ok*
36	Yo, du mechs de Radio			Yes, you do the radio
38		Ok		Ok
39	..Starker Nebel, es wird ne harte Landung..			*.. heavy fog, it will be a hard landing..*
43		Wât, soll ech de Leit da verzielen?		What shall I say to the people ?
45	Ech wéss et net			I don’t know
46			Luxair nine six four two, descend flight level one hundred	
50		Descend flight level one hundred, Luxair, nine six four two		
08 h 47 min 05		Wât soll ech de Leit da verzielen; Et wir Niwel?		*What shall I say then to the people; that it is foggy?*

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
08h 47 min 06	Ma wéi d'Wieder ass, starker Nebel, bla, bla, bla, wann et da schief gét, könne mir soen, sorry, an dann soen ech souwisou eppes, wann et schief gét			*Well what the weather is like, heavy fog, bla, bla, bla, if it turns bad then, we can say, sorry, and then I will say something anyway, if it turns bad*
13		Yo		Yes
17		Soll ech et net elo verzielen datt mir villeicht eventuell e bessen delai kré'en dodurch?		*Shall I not tell them already now that we might get some delay because of that?*
21	Yo, kanns du hinnen soen			Yes, you can tell them that
27	Yo, so hinnen dât			Yes, tell them that
32	Wârt, esch ruffen den Dispatch emol, OFF Number one			*Wait, I call Dispatch again, OFF number one*
34		Yo		Yes
39	Dispatch; moien, neng secks veier zwé,			Dispatch, good morning, 9642
45			*Dispatch:* Neng secks veier zwé, gudde Moien,	Dispatch: 9642, good morning
47	Yo, normaler weis, ann zeng minuten bis eng vierel Stonn			*Yes, normally in 10 minutes to a quarter of an hour*
51			*Dispatch:* Yo, dât wir dann fir de Bravo veier	*Dispatch: Yes, it will be then Bravo four*
54	Bravo veier, wéi geseit et aus mam Wierder momentan?			*Bravo four, how is the weather for the moment ?*
57			*Dispatch*: RVR zwé honnert fofzech am moment	Dispatch: RVR 250 for the moment
08h 48 min 02	Ann, varierert dât dann oder ass et			*And, is that changing or has it been like*

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
	schons lâng esou?			*that for long?*
06			*Dispatch:* Also, ehh, et ass schons eng gutt Zeit datt et net méi drei honnert gewisen huet, an, ehh, bon.	Dispatch: Well, ehh, it has been quite a while that it did not show 300, and, ehh, well
			Komm mir kucken an dann wann wirklech neischt ass, an Saarbrecken ass anderrei, da gess de op Saarbrecken diverteiert.	*Lets see, and if there is really nothing and Saarbrücken is good, then you will be diverted to Saarbrücken*
21	Ok, merci, bis geschwönn			Ok, thank you, until later
25	Yo, esch sinn erem do			Yes, I am back
28	Wârt, ech maan			*Wait, I will*
29	Ah, Dispatch nach eng Ké'er, vum neng secks veier zwé			*Ah, Dispatch once more from 9642*
33			*Dispatch:* Neng secks veier zwé	Dispatch: 9642
35	Dir west net zoufällecher Weis of villeicht eng Cargolux oder esou irgentwann eng kéi'er eraus gét, oder esou?			*You don't know eventually if perhaps a Cargolux, or something like that, will leave any time or so?*
41			*Dispatch:* Wât?	Dispatch: What?
42	Op eng Cargolux takeoff mecht an nächster Zukunft?			*If a Cargolux takes off in the near futur?*
48			*Dispatch:* Yo, elo, elo gét eng eraus, he	*Dispatch: Yes, now, now there is one leaving, he*
52	Elo an a puer Minuten oder elo direkt?			*Now in a few minutes or immediately?*

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
55			*Dispatch:* Elo, si mecht elo takeoff	*Dispatch: Now, they now take off*
57	Ah, Ok			Ah, Ok
08 h 49 min 07	Et ass schon lâng keng drei honnert meter méi			*It is quite a while that there was 300 m*
10		Wivill ass et dann elo?		How much is it now?
13			Nine six four two, descend flight level six zero	
14		Descending flight level six zero, Luxair nine six four two		
25	Oh nén, mir gin zwar, ech gin net op Saarbrecken			*Oh no, we go however, I will not go to Saarbrücken*
31		Ech sinn bei de Leit, he!		I am with the people, he!
33			*Listening to Saarbrücken ATIS* until 08 h 50 min 36: *Wind 1104 knots, visibility 2000 meters- few 200- broken 600 feet- temperature 2.6- QNH 1024- trend becoming visibility 3000 meters- broken 800 feet- expect ILS approach RWY 27- transition level 60- Wind 1104 knots- visibility 2000*	
08 h 50 min 41			Luxair, nine six four two; on request from Luxembourg, stop your descend at flight level nine zero, set course to Diekirch	

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
48		Stop descend nine zero, direct Diekirch, Luxair nine six four two		
08h 51 min 42		Zereck; ech muss mer elo mol, wât ech de Leit soll zielen, dât ass emmer esou schwéier, ech hât dén Fall elo schon lâng net méi		*Back; I have now to, what I should tell the people, it's always so difficult, it has been a long time since I had this situation*
54		Ehh		Ehh
58		Ehh, wéi ass d'Wieder iwerhâpt? Niwelech, déif Wolleken		*Ehh, how is the weather anyway? Foggy, low clouds*
08 h 52 min 15			Luxair, nine six four two, for lower and Radar vectors contact Luxembourg one one eight decimal nine	
21		Ehh, one eight decimal nine, Luxembourg, nine six four two, bye, bye		
26		Kucken wât déi elo soen		Lets see what they now say
41		Luxembourg Radar, gudde Moien, Luxair nine six four two, descending level nine zero, on course to Diekirch		Luxembourg Radar, good morning, Luxair nine six four two,……
49			Luxair, nine six four two, enter Diekirch holding, flight level nine zero, it will be vectors later on for ILS two four Cat two on two four, QNH one zero two three,	

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
			current RVR beginning two five zero meters, mid two seven five meters, stop end two two five meters	
08 h 53 min 06		That's all understood, Luxair nine seven, correction nine six four two		
20	Wéi? One hundred for six zero, dat héscht dé gét elo durch eis Héicht			*What? One hundred for six zero, that means he passes through our height.* [Captain refers to an ATC clearance given to another aircraft]
24		Ech sinn bei de Leit elo, he		I am with the people now, he
36		Ladies and gentlemen, good morning from the cockpit your first officer. Well the latest news from Luxembourg. The weather is for the moment very foggy and the temperature 4°. Unfortunately the fog is so dense that eh, at the moment we cannot land, so we have to wait a little bit for improvement, so that means that we are proceeding to a holding and to wait for weather improvement. Anyway we keep you informed as soon as we have some news and the time it might take for the weather to improve. Thank you for your attention.		[Co-pilot gives passenger info on public address until 08 h 56 min 31. Languages used: Luxembourg, then German and finally English]

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
08 h 54 min 43	Luxair, nine six four two is reducing speed to one six zero			
49			Roger, nine six four two	
08 h 56 min 34	Yo, Yo, dat war awer wirklesch Pech, ehh, Cargolux gét elo reischt eraus, wann se eis direct goen			*Yes, yes, it was really a pity, eh, Cargolux leaves only now, if they had let us directly*
38		Yo		Yes
	goen geloost hätten, da wiren mer elo just richtech gewiercht			let us go directly, then we would have been just right
44		Paula ? hun ech net zevill egal wât geschwart ? Alles OK ? Merci. Et ass alles ok, et ass just wénst dem Niwel. Wann d'Wieder elo besser get, et félt net vill, et félen 25 meter, wann mir déi hunn, dât misst goen, ok, tschau		[Call to cabin crew] *Paula ? Didn't I talk nonsense ? Everything ok ? Thank you. Everything is ok, it is only because of the fog. If the weather gets better now, its not missing a lot, we miss 25 meters, once we have those, it should be ok, bye*
51				[Co-pilot talks to cabin crew until 08 h 57 min 22]
08 h 57 min 31	Verflixt namol!			Damn it !
34	Dât wir wierklech ze vill schéin gewierscht vir eng Kéier mat der Cargolux			*It would have been really too nice to be able for once with Cargolux*
40		Established on the LOC (*)		
44	Swissair ass wierklech optimal elo (*)			*Swissair is really optimal now(*)*
				[The crew refers to another aircraft]

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
55	Se hätten eis sollen do hannen drunn hänken, blöd approche do			*They should have hooked us behind them, silly approach*
08 h 58 min 12	Se hun all net esou vill Spritt wéi mär hunn. Mär hun getankt, mé léiwen Jong, vir den (unintelligible word)			*They all don't have as much fuel as we have. We have filled up, my dear son, for the (unintelligible word)*
20		Mir können holden bis d'Pei		*We can hold until pay day*
23		Bis wéni, bis wivill Auer könne mer iwerhâpt holden, wât brauchen mer iwerhâpt vun Sprit?		*Until when, until what time can we hold anyway, what do we need as fuel anyway?*
26	Ehh, Fönnef honnert fofzech, ehh, sieven..... sieven honnert, né, achthonnert fofzech mussen mer hun nach wa mer den Holding verloosen			*Eh, 550, eh, seven..seven hundred, no, we need 850 when we leave the holding*
38		Wéi? Alternate drei honnert		How? Alternate 300
39	Dât héscht, mer können fönnef honnert fofzech kilo verbrennen hei			*That means, we can burn 550 kilos here*
43		Né, mir brauchen bis op den Alternate plus nach eng kéier zwanzech Minuten Reserve fir eng hallef Stonn erem hei, secks honnert Kilo brauchen mir der nach.		*No, we need until the alternate plus 20 more minutes reserve for half an hour back here, 600 kilos we still need*
48	Yo, mé ech hâlen den Holding awer och gär dofir			*Yes, but I like keep the holding also for that*
50			Luxair, nine six four two,	

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
			descend to three thousand feet on one zero two three, turn left heading one three zero	
57		Ass dat fir eis?		Is that for us?
58	Yo			Yes
59		Descend three thousand feet on QNH one zero two three and say again the heading?		
08 H 59 min 06			One three zero	
08		Left heading one three zero, Luxair, nine six four two		
13		Wât ass dât dann fir a scheiss		*What kind of shit is that*
35	Wéi ass d'RVR dann elo?			What is the RVR now?
37		Ech wéss et net		I don't know
49		Ech hun normal NAV		I am on normal NAV
50	Wât war den QNH? One zero			*What was the QNH? One zero*
51		Two three		Two three
59	Solle mer net elo den Dispatch froen wât d'RVR ass?			*Shouldn't we ask Dispatch now, what the RVR is now?*
09 H 00 min 01		Dach		Yes
02		Mechs du dât elo? Oder soll ech et mâchen?		*Do you do it now? Or, shall I do it?*
04	One two six decimal three sin mer, neen one three one decimal six two			We are 126.3, no 131.62

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
09		Correct		Correct
19	Ech sin nach eng Kéier OFF nummer eent			I am OFF number one again
20		Yo		Yes
22	Dispatch, nine six four two nach eng Keier			Dispatch, 9642 again
	Wéi fill de Moment d'RVR?		Dispatch: 9642 go ahead	
	Ok		Eh, 275	
38	Zwee sieven fönnef meter nach, wât machen mer elo?			*275 meters, what do we do now?*
41		Ech wéss et net		I don't know
50			[ATC transmits RVR] beginning 275, mid section 275, stop end 225 meters to Luxair eight three six two	
09 H 01 min 06		Yo, wât mâchen si dann mat eis, holding oder ass dât do fir eng approche?		*Yes, what do they do with us then, holding or is it for an approach?*
09	Dât ass fir eng approche			It's for an approach
15		So d'Cargolux soll én go-around mâchen zu Letzeburg		*Tell Cargolux to do a go-around in Luxembourg*
16	Wât?			What?
17		Se sollen a go-around mâchen		They should do a go-around

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
19	Né se sinn reischt take-off gemâch			No, they just made a take-off
21		Maja, se sollen eng Schleif mâchen an dann a go-around an dann mâchen se alles frei, an dann sssst		*Yes, they should make a circuit and then a go-around and then they clear up everything, and then sssst*
09 h 01 min 25			Niner six four two turn right heading two two zero to intercept cleared for approach report established on the localizer	
09 h 01 min 31		Right heading two two zero. and euh cleared approach… and we call you established on the localizer nine six four two		
09 h 01 min 42		Oh freck, da ginn mir nach virun all Mensch geholl hei		*Oh gosh, they bring us in before all the others*
09 h 01 min 43	He			
09 h 01 min 44		Mir gi nach virun jidwerengem virgeholl hei		*They bring us in before everybody*
09 h 01 min 58		Solle mer de seat belt umâchen?		*Should we switch on the seat belt?*
09 h 02 min 00	Yo yo dât wier villeicht net schlecht			*Yes Yes this wouldn't be a bad idea*
09 h 02 min 02	Mir mussen hei fir d'approche ehhhh			*We must here for the approach ehhhh*
09 h 02 min 04	100 Fouess			*100 feet*
09 h 02 min 07		Yo, ech hun dât schon dran		*Yes, I already dialled that in*

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
09 h 02 min 09	LOC ass alive an captured			LOC is alive and captured
		Checked		
		Missed approach heading		
09 h 02 min 12	So him, ech geng villeicht beschéd soen färer Weis dass wa mer bei Echo keng 300 meter hun, dass mer dann e go-around machen an op Dikrech fléen			*Tell him, I would rather say as a matter of fairness, that if at Echo we don't have 300 meters, that we then do a go-around and fly to Diekirch*
09 h 02 min 32		The Lux euh nine six four two is now established on the localizer		
09 h 02 min 37			Luxair niner six four two contact tower on one one eight decimal one, äddi	Äddi = goodby
09 h 02 min 41		Eighteen one nine six four two , äddi		Äddi = goodby
09 h 02 min 51		Turm, gudden Moien Luxair nine six four two is established I L S two four		*Tower, good morning……*
09 h 02 min 52				Noise resembling a seat movement
09 h 02 min 57			Luxair nine six four two gudden Moien, continue approach. The wind is calm R V R beginning two five zero meters, mid section two five zero meters, stop end two two five meters	*Gudden Moien = good morning*
09 h 03 min 04	Oh, dat brengt neischt			*Oh, this doesn't bring a thing*
09 h 03 min 07	Oh, dat brengt neischt			*Oh, this doesn't bring a thing*
09 h 03 min 08		Euh… that's copied Luxair nine six four two… but euh		

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
		we need three hundred meters for the approach		
09 h 03 min 16	So, mir gin weider fir bis ELU, wa mir dann neischt hätten, dann ehhhhhhh			*Say, we continue up to ELU, if then we have nothing, then ehhhhh*
09 h 03 min 18		Yo	Nine six four two copied… euh so continue approach and I'll keep you advised we didn't have three hundred euh… euh during the last time	*Yes*
09 h 03 min 26	Oh			
09 h 03 min 28		Euh Roger nine six four two we keep you advised we're proceeding to ELU now and …euh standing by nine six four two		C chord
09 h 03 min 38			Roger… and euh we have ehhh zero degrees wind	
09 h 03 min 42		Roger		
09 h 03 min 43			…schen , zero knots	
09 h 03 min 44		Roger		
09 h 03 min 52	Hä			Exclamation (questioning)
09 h 04 min 09	Sou, si mer de beacon, he nach net grât			Now, are we beacon, hey not yet
	En ass 5,5 DME			It is 5,5 DME
09 h 04 min 16		Da muss é mol e beacon setzen, mei Jong		*Then one must select a beacon first, lad*

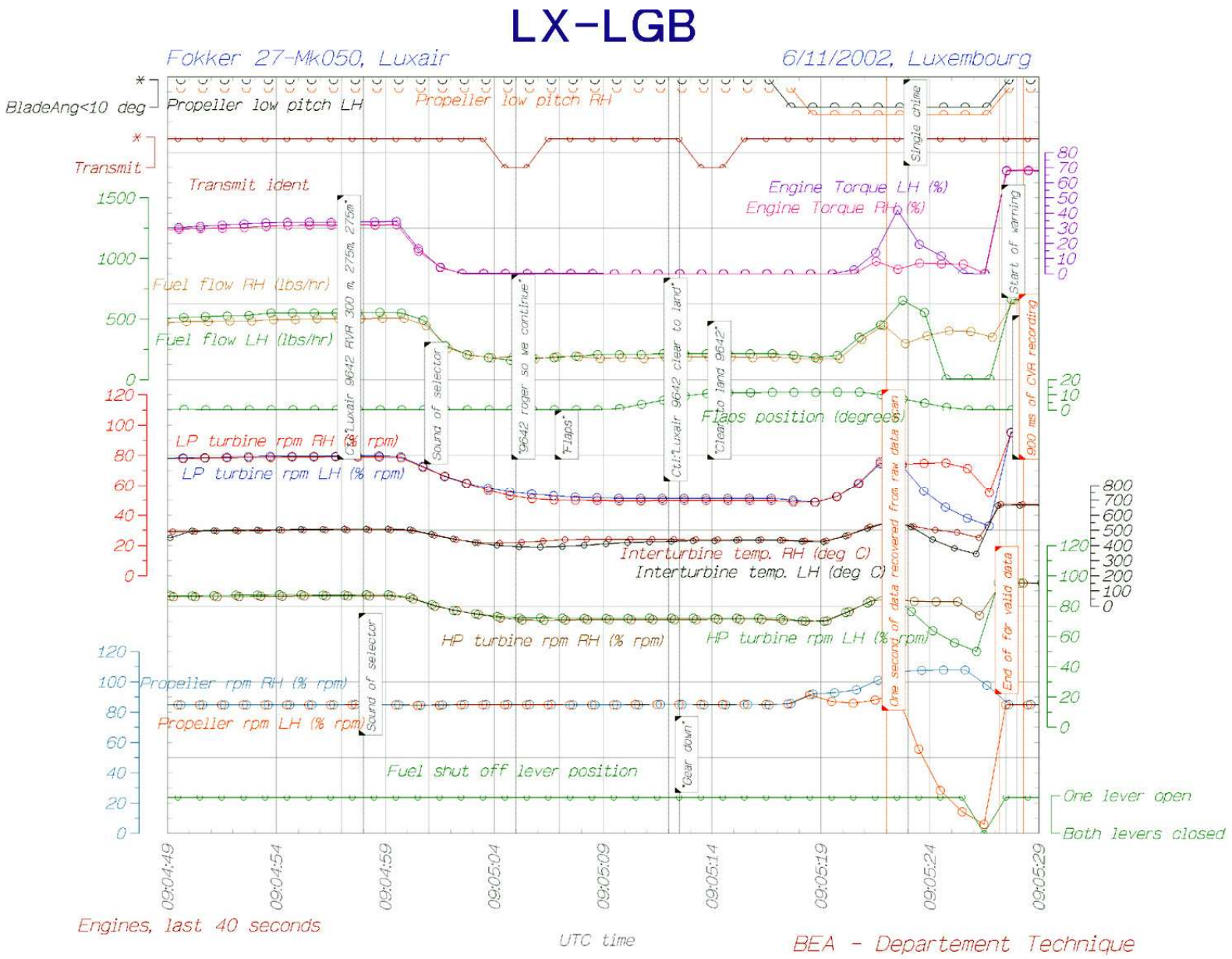
UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
09 h 04 min 18	Yo, mé ech hun jo en DME			Yes, but I do have a DME
09 h 04 min 19		Ye Ye Ye		*Laugh*
09 h 04 min 23		Ye Ye Ye		
09 h 04 min 25	Laugh			
09 h 04 min 30		ASEL		
09 h 04 min 33		Three thousand sixty top		
09 h 04 min 35	Checked			
09 h 04 min 36		Landing altitude and briefing completed, altimeters euh set		
09 h 04 min 40		Speed ninety five one oh five one oh nine Landing altitude		
09 h 04 min 43	Two seven five meters			
09 h 04 min 44		set		
09 h 04 min 46	Yo, bon mir mâchen en go-around, missed approach			*Yes, well we do a go-around, missed approach*
09 h 04 min 53		Ground idle stop off		
09 h 04 min 57			Luxair nine six four two RVR three hundred meters two seven five meters … stop end two seven five meters	
09 h 04 min 58				Noises identified to probably be the displacement of the Ground Idle Stop
09 h 05 min 00				Variation of the turbine rotational speed
05 min 00				Noises identified to be the lifting of the

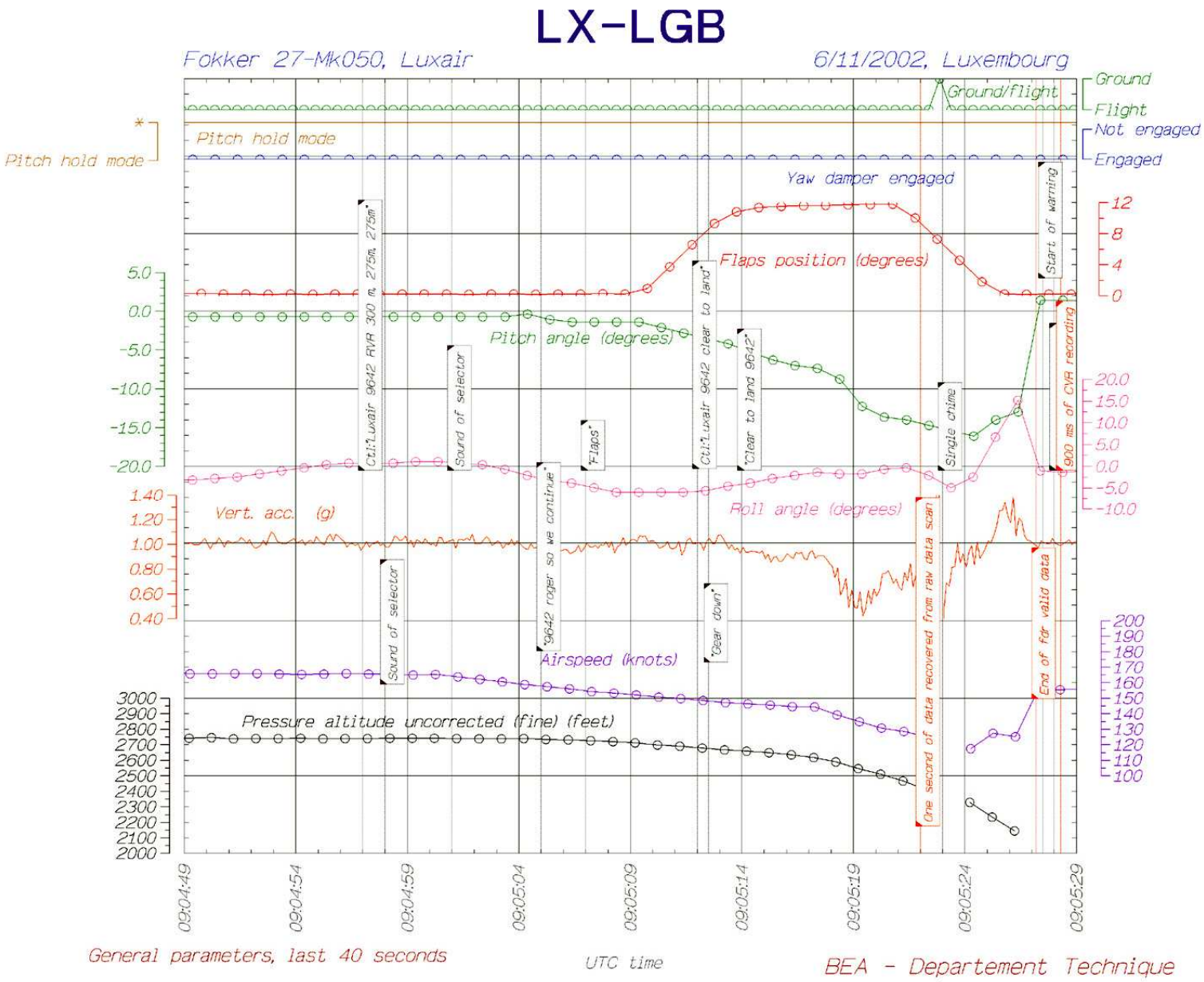
UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
				Ground Range selectors
05 min 02		gét net duer		*will not be enough/sufficient*
05 min 05		Nine six four two roger so we continue		
05 min 07		Flaps?		
05 min 08	Oh mir sin ....flaps ten		Nine six four two you're cleared to land wind one eight zero degrees (unintelligible) knots	Oh we are… flaps ten
05 min 09 s 10				Noise identified to be the moving of the flap selector
05 min 11 s 20				Noise identified to be selecting Taxi Light
05 min 11 s 80		Gear down?		
05 min 12 s 70	Ya			
05 min 13 s 60		Clear to land nine six four two		
05 min 16 s 10				Noise similar to selecting gear down followed by gear extension noises
05 min 16 s 60		Dât do gett zwar….		*This will rather be…….*
05 min 17 s 70				Increase of propeller speed
05 min 19 s 40				Noise identified to be the power levers passing through the ground idle position
	Wât ass dât			What's that ?
05 min 21 s 20				Noise similar to flaps selection (no identification possible)

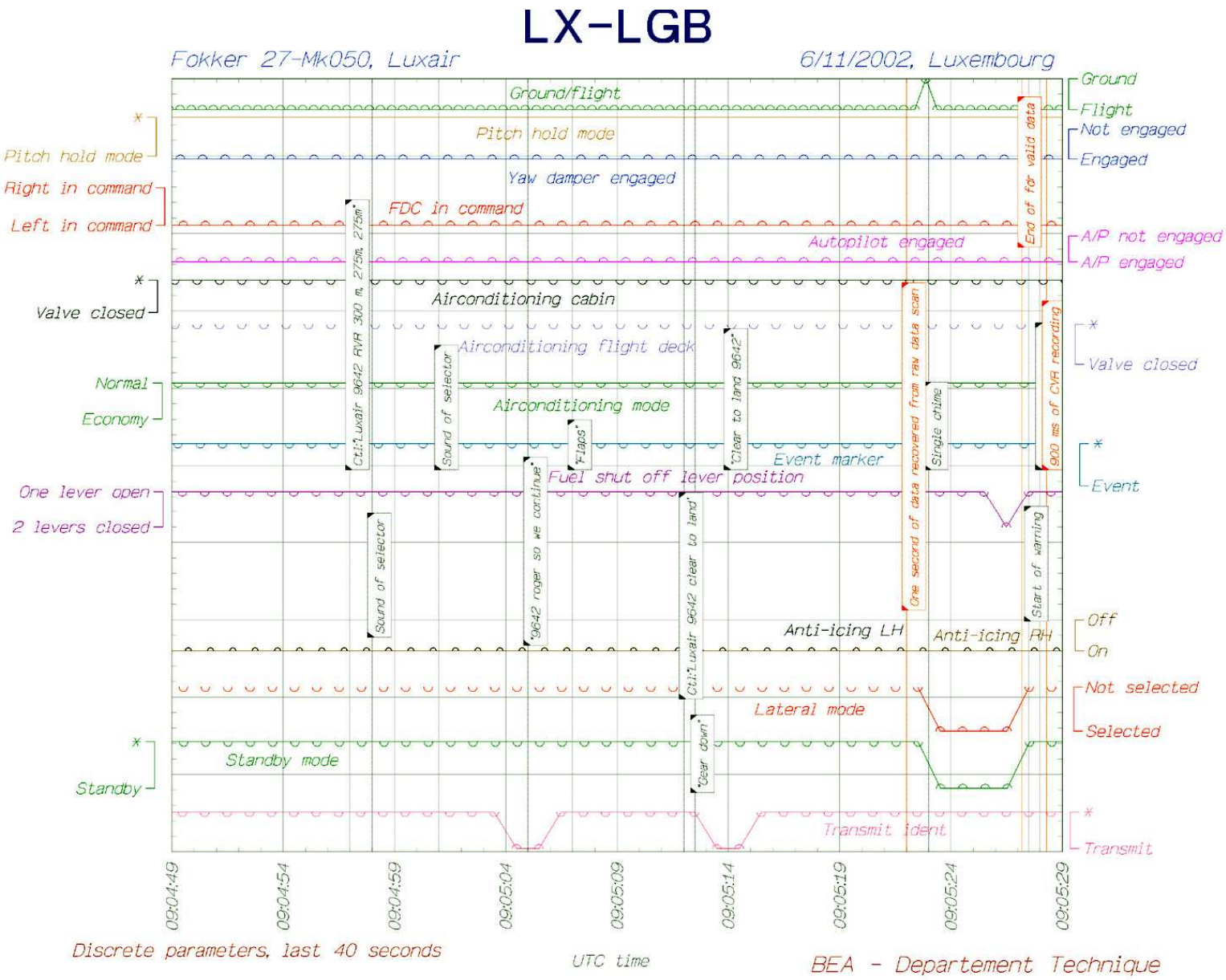
UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
05 min 21 s 60				Noise similar to a propeller speed variation
05 min 22 s 80	Hä			Exclamation (questioning)
05 min 22 s 90	Oh merde			Oh shit
05 min 23 s 40				Noise similar to electric transfer
05 min 23 s 70				Single Chime
05 min 26 s 20				Noise similar to a propeller speed reduction
05 min 27 s 00				Noise (no identification possible)
05 min 27 s 70				Start of GPWS alarm « Terrain »
05 min 28 s 00				Recording stops (1/3 s)
05 min 28 s 30		Bo dât war awer eng lenk		*Wow this was shrewd stuff*
Non validated time				The recorded portion from 05 min 28 s 00 until the noise of electric transfer at 05 min 28 s 90 is a recorded portion from the beginning of the CVR and not newly overwritten
05 min 28 s 90				Noise similar to electric transfer
Non validated time				
05 min 29 s 10	Oh merde	Heavy breathing		Oh shit
Non validated time				
05 min 40 s 10				Restart of recording. The recorded portion from 05 min 40 s 10 until the noise of electric transfer at 05 min 40 s 80 is a recorded portion from the beginning of the CVR and not newly

UTC time	Captain	Co-pilot	ATC	Noises, translation or explanations
				overwritten.
05 min 40 s 80				Noise similar to electric transfer
05 min 41 s 60			Ready for push back next, Mike Kilo Alpha one two three	
05 min 41 s 90				Double Chime (two single Chimes separated by 0.7 seconds)
05 min 44 s 60				End of recording

Appendix 3: FDR Graphics


LX-LGB
Fokker 27-Mk050, Luxair
6/11/2002, Luxembourg
BladeAng<10 deg
Propeller low pitch LH
Propeller low pitch RH
Transmit
Transmit ident
Single chime
Engine Torque LH (%)
Engine Torque RH (%)
Start of warning
Fuel flow RH (lbs/hr)
Fuel flow LH (lbs/hr)
"Luxair 9642 RVR 300 m, 275m, 275m"
Sound of selector
"9642 roger so we continue"
"Flaps"
"Luxair 9642 clear to land"
"Clear to land 9642"
Flaps position (degrees)
900 ms of CVR recording
LP turbine rpm RH (% rpm)
LP turbine rpm LH (% rpm)
Interturbine temp. RH (deg C)
Interturbine temp. LH (deg C)
One second of data recovered from raw data
End of for valid data
HP turbine rpm RH (% rpm)
HP turbine rpm LH (% rpm)
Propeller rpm RH (% rpm)
Propeller rpm LH (% rpm)
"Gear down"
Fuel shut off lever position
One lever open
Both levers closed
09:04:49
09:04:54
09:04:59
09:05:04
09:05:09
09:05:14
09:05:19
09:05:24
09:05:29
Engines, last 40 seconds
UTC time
BEA - Departement Technique


LX-LGB
Fokker 27-Mk050, Luxair
6/11/2002, Luxembourg
Ground/flight
Ground
Flight
Pitch hold mode
Not engaged
Engaged
Yaw damper engaged
Flaps position (degrees)
Pitch angle (degrees)
Roll angle (degrees)
Vert. acc. (g)
Airspeed (knots)
Pressure altitude uncorrected (fine) (feet)
Ctl:"Luxair 9642 RVR 300 m, 275m, 275m"
Sound of selector
"Flaps"
"9642 roger so we continue"
Ctl:"Luxair 9642 clear to land"
"Clear to land 9642"
"Gear down"
Single chime
Start of warning
900 ms of CVR recording
End of fdr valid data
One second of data recovered from raw data scan
09:04:49
09:04:54
09:04:59
09:05:04
09:05:09
09:05:14
09:05:19
09:05:24
09:05:29
General parameters, last 40 seconds
UTC time
BEA - Departement Technique


LX-LGB
Fokker 27-Mk050, Luxair
6/11/2002, Luxembourg
Ground/flight
Ground
Flight
Pitch hold mode
Not engaged
Engaged
Yaw damper engaged
FDC in command
Right in command
Left in command
End of for valid data
Autopilot engaged
A/P not engaged
A/P engaged
Airconditioning cabin
Valve closed
Airconditioning flight deck
Valve closed
Normal
Economy
Airconditioning mode
Event marker
Event
Fuel shut off lever position
One lever open
2 levers closed
Anti-icing LH
Anti-icing RH
Off
On
Lateral mode
Not selected
Selected
Standby mode
Standby
Transmit ident
Transmit
09:04:49
09:04:54
09:04:59
09:05:04
09:05:09
09:05:14
09:05:19
09:05:24
09:05:29
Discrete parameters, last 40 seconds
UTC time
BEA - Departement Technique

Appendix 4: ATC Transcript

Transcript of Original Tape Recording

Approach radar control unit

Frequency 118.900

Time in UTC	From	To	Communications
08:52:38	LGL9642	APP	Luxembourg Radar gudde Muergen Luxair nine six four two, descending flight level nine zero, uh, on course to…, Diekirch.
08:52:47	APP	LGL9642	Luxair niner six four two enter Diekirch holding at flight level niner zero it will be vectors later on for an I_L_S approach category two on two four. Q_N_H is one zero two tree current R_V_R beginning two five zero on mid section two seven five, stop end two two five.
08:53:05	LGL9642	APP	That's all understood, uh, Luxair nine seven, correction nine six four two.
08:53:10	LGL402	APP	Uh, Luxair four zero tree is entering Diekirch hold, passing one hundred for six zero.
08:53:15	APP	LGL402	Roger four zero two.
08:53:26	LGL9302	APP	Luxair nine tree zero two are we cleared to land?
08:53:30	APP	LGL9302	Luxair nine tree zero two is cleared for approach, for landing contact tower one one eight one, bye bye.
08:53:36	LGL9302	APP	One one eight one, Luxair nine tree four two, bye.
08:54:44	LGL9642	APP	And Luxair nine six four two is reducing speed to one sixty.
08:54:47	APP	LGL9642	Roger nine six four two.
08:56:01	LGL4452	APP	Luxair four four five two entering hold Diekirch flight level nine zero.
08:56:05	APP	LGL4452	Roger four four five two.
08:56:15	APP	SWR750	Swiss seven five zero turn left heading tree tree zero base leg.
08:56:20	SWR750	APP	Left heading tree tree zero base leg, Swiss seven five zero.
08:56:45	APP	SWR750	Swiss seven five zero turn left heading two seven zero to intercept the localizer, report established on the loc.
08:56:51	SWR750	APP	Left heading two seven zero to intercept the localizer, we'll report established on the loc, Swiss seven five zero.
08:57:37	SWR750	APP	Established on the loc Swiss seven five zero.
08:57:39	APP	SWR750	Roger, Swiss seven five zero continue your approach, the sensitive area is not clear yet, we have a seven four seven about to depart.
08:57:47	SWR750	APP	Okay, we continue the approach in this case, Swiss seven five zero.
08:57:56	LGL8362	APP	Luxair eight tree six two entering Diekirch holding, flight level eight

			zero time five seven.
08:58:01	APP	LGL8362	Roger, eight tree six two.
08:58:14	LGL4452	APP	And approach, for info, Luxair four four five two we need two hundred meters for the approach.
08:58:28	APP	LGL4452	Four four five two say again, please.
08:58:30	LGL4452	APP	Uh, just for info, we need two hundred meters for the approach.
08:58:33	APP	LGL4452	Okay no problem.
08:58:35	APP	SWR750	Swiss seven five zero is cleared for the I_L_S category tree contact tower one one eight decimal one, bye bye.
08:58:41	SWR750	APP	One one eight one and cleared for the approach cat tree, Swiss seven five zero, bye bye.
08:58:48	APP	LGL9642	Luxair niner six four two descend to tree thousand feet on one zero two tree turn left heading ...one tree zero.
08:58:57	LGL9642	APP	Descending tree thousand feet on Q_N_H, uh, one zero two tree and say again the heading?
08:59:04	APP	LGL9642	One tree zero.
08:59:07	LGL9642	APP	Uh, left heading one tree zero Luxair nine six four two.
08:59:09	CLX778	APP	Cargolux seven seven eight airborne.
08:59:11	APP	CLX778	Cargolux seven seven eight climb flight level seven zero on runway heading.
08:59:17	CLX778	APP	Runway heading, seven zero, Cargolux seven seven eight.
08:59:23	APP	LGL402	Luxair four zero two report speed.
08:59:27	LGL402	APP	Speed two ten four zero two.
08:59:29	APP	LGL402	Roger four zero two bring it back to one eight zero.
08:59:35	LGL402	APP	Uh, for how long, because otherwise we are burning more fuel, four zero two
08:59:39	APP	LGL402	Uh, that's just to slow you down and then I'll take you out of the hold.
08:59:42	LGL402	APP	Okay no problem, so reducing one eighty, four zero two, merci.
09:00:24	APP	LGL402	Luxair four zero two, descend to tree thousand feet one zero two tree, turn right heading zero nine zero.
09:00:30	LGL402	APP	Roger right heading zero nine zero and down to tree thousand one zero two tree, four zero two.
09:00:40	LGL8362	APP	Approach, uh, eight tree six two, could you confirm our latest R_V_R_.
09:00:46	APP	LGL8362	R_V_R beginning two seven five, mid section two seven five, stop end two two five.
09:00:52	LGL8362	APP	Okay.
09:01:09	APP	CLX778	Cargolux seven seven eight turn right heading zero six zero, climb to flight level one two zero.

09:01:17	CLX778	APP	Right heading zero six zero, climb flight level one two zero, Cargolux seven seven fi…seven seven eight.
09:01:21	APP	LGL9642	Luxair niner six four two turn right heading two two zero to intercept. Cleared for approach, report established on the localizer.
09:01:30	LGL9642	APP	Right heading two two zero and, uh, cleared approach and we call you established on the localizer nine six four two.
09:01:38	LGL5432	APP	Luxembourg approach good morning, Luxair five four tree two descending flight level one tree zero to Diekirch, information Sierra.
09:01:44	APP	LGL5432	Luxair five four tree two, uh, gudde Muergen, descend to flight level one hundred enter Diekirch holding, vectoring later on to the I_L_S_ two four, cat two.
09:01:54	LGL5432	APP	Luxair five four tree two descend flight level one hundred enter Diekirch holding for vectors runway two four, uh, how bounds, uh, how much delay do you expect?
09:02:04	APP	LGL5432	Just couple of minutes.
09:02:06	LGL5432	APP	Roger.
09:02:13	APP	CLX778	Cargolux seven seven eight climb to flight level one seven zero.
09:02:18	CLX778	APP	Cleared flight level one seven zero, Cargolux seven seven eight.
09:02:20	APP	CLX778	I have to take you on a, uh, zero six zero heading to get you on top of the Diekirch holding
09:02:27	CLX778	APP	Roger, we are turning right.
09:02:30	LGL9642	APP	Luxair nine six four two is now established on the localizer.
09:02:34	APP	LGL9642	Luxair niner six four two contact tower one one eight decimal one Äddi.
09.02.39	LGL9642	APP	Eighteen one nine six four two. Äddi

Aerodrome control unit

Frequency 118.100

Time in UTC	From	To	Communications
09:02:48	LGL9642	TWR	Tuerm gudde Muergen Luxair nine six four two is, uh, established I_L_S two four
09:02:54	TWR	LGL9642	Luxair nine six four two gudde Muergen, continue approach the wind is calm R_V_R beginning two five zero meters mid section two five zero meters stop end two two five meters.
09:03:07	LGL9642	TWR	Uh, that's copied Luxair nine six four two, but we need tree hundred meters for the approach.
09:03:16	TWR	LGL9642	Nine six four two copied, uh, so continue approach I keep you advised. We didn't have tree hundred, uh, during the last, uh, time.

09:03:25	LGL9642	TWR	Uh, roger nine six four two we keep you advised. We're proceeding to Elu now and, uh, standing by, nine six four two.
09:03:35	TWR	LGL9642	Roger and we have, uh, zero degrees wind, uh.
09.03.40	TWR	LGL9642	Correction zero knots.
09:03:43	LGL9642	TWR	Roger.
09:03:45	TWR	SWR750	Seven five zero report entering parking number one please.
09:03:53	TWR	SWR750	Swiss seven five zero report entering the apron.
09:03:57	SWR750	TWR	We report entering the apron, Swiss seven five zero.
09:04:10	MKA123	TWR	Tower, good morning Mike Kilo Alpha one two tree, stand two with Romeo requesting start up please.
09:04:18	TWR	MKA123	Mike Kilo Alpha one two tree good morning, start up is approved, runway in use two four, Q_N_H one zero two tree, confirm you are parking number seven.
09:04:26	MKA123	TWR	Negative, Sir, parking two and we are cleared for start one zero two tree and could you just give us the position of that lowest value of R_V_R, please.
09:04:38	TWR	MKA123	We have now on the tree positions two seven five meters.
09:04:41	MKA123	TWR	Thank you.
09:04:48	SWR750	TWR	Uh, We are entering the apron behind marshaller (garbled transmission).
09:04:59	TWR	LGL9642	Luxair nine six four two R_V_R tree hundred meters two seven five meters stop-end two seven five meters.
09:05:03	LGL9642	TWR	Nine six four two roger, so we continue.
09:05:07	TWR	LGL9642	Nine six four two you are cleared to land, wind one eight zero degrees five knots.
09:05:11	LGL9642	TWR	Cleared to land, uh, nine six four two
09:05:16	TWR	MKA123	Mike Kilo Alpha one two tree Luxembourg (garbled due to simultaneous transmission).
09:05:16	SWR750	TWR	(Unreadable) … we are at the apron.
09:05:22	MKA123	TWR	Was that for Mike Kilo Alpha one two tree?
09:05:24	TWR	MKA123	That's confirmed, Mike Kilo Alpha one two tree report ready for push back.
09:05:29	MKA123	TWR	Cleared to push, thanks, one two tree.
09:05:31	TWR	MKA123	Mike Kilo Alpha one two tree, I confirm report ready for push back.
09:05:39	MKA123	TWR	Ready for push back next, Mike Kilo Alpha one two tree.
09:05:42	TWR	MKA123	Roger.
09:06:57	TWR	LGL9642	Nine six four two Luxembourg.
09:07:08	TWR	LGL9642	Luxair nine six four two Luxembourg.

09:07:30	TWR	LGL9642	Luxair nine six four two Luxembourg do you read?
09:07:55	TWR	LGL9642	Luxair nine six four two Luxembourg do you read?
09:08:10	TWR	LGL9642	Luxair nine six four two Luxembourg.
09:08:39	TWR	LGL9642	Luxair nine six four two Luxembourg do you read?

The signers certify the completeness and correctness of the present transcript
Luxembourg Airport 13 November 2002

(s)
Head of Air Traffic Control
Luxembourg

(s)
Deputy head of Air Traffic Control
Luxembourg

Appendix 5: Service bulletin ABSC N° Fo50-32-4, revision 1

AIRCRAFT BRAKING SYSTEMS Corporation

SERVICE BULLETIN

TO: HOLDERS OF SERVICE BULLETIN F50-32-4 FOR LANDING GEAR SKID CONTROL SYSTEM - CONTROL UNIT REWORK INSTRUCTIONS

Attached to this transmittal letter is Revision No. 1 of Service Bulletin F50-32-4 (basic issue dated Aug 1/92).

HIGHLIGHTS OF REVISION NO. 1 DATED 29 JUNE 1994

REVISION NO. 1 CONTAINS ALL PAGES OF THE SERVICE BULLETIN. Pages which have been revised are outlined below, together with the Highlights of the revision.

1. SECTION I, Page 1 of 6:

A. Added Revision No. 1 and date.

B. Removed reference to autobrake which was incorrect and added correct statement in the Reason paragraph (paragraph B).

C. Removed blank page.

2. Replace Service Bulletin F50-32-4, pages 1 thru 7 with Service Bulletin F50-32-4, Revision No. 1, pages 1 thru 6, revised Jun 29/94.

Jun 29/94

F50-32-4
Page 1 of 1

AIRCRAFT BRAKING SYSTEMS Corporation

SERVICE BULLETIN

SUBJECT: LANDING GEAR SKID CONTROL SYSTEM - CONTROL UNIT REWORK INSTRUCTIONS

SECTION I - PLANNING INFORMATION

A. EFFECTIVITY: This Service Bulletin is applicable to all Control Unit Assemblies 6004125 used on F27 Mk050 (FOKKER 50) aircraft.

B. REASON: This Service Bulletin is issued to inform operators of the new Control Unit 6004125-1 and provides instructions to modify the 6004125 control unit assembly into the 6004125-1 assembly. The new unit differs from the old only in the addition of one capacitor and one diode, one each per wheel board. These components prevent a condition during power up of the skid control box whereby a signal pulse is inadvertently sent to the ground control relay thus affecting the flight idle stop soleniods.

The modification does not eliminate any existing test functions. It does not affect the antiskid control functions.

C. DESCRIPTION: The Service Bulletin provides rework instructions for:

(1) Addition of one capacitor (C76) and one diode (CR10) on each wheel control board.

(2) Reidentifying reworked boards and control unit and performing testing at unit bench and aircraft levels.

D. COMPLIANCE: Compliance with this Service Bulletin is to be accomplished at the option and expense of the operator. It is recommended this rework be accomplished when the control unit is removed or being repaired for another reason.

E. APPROVAL: Compliance with this Service Bulletin does not alter FAA TSO conformance.

F. MANPOWER: Eight man-hours (estimated) are required to modify, reidentify and test one control unit. This includes six hours allotted for minimum testing. This estimate does not include the time required to remove, install and test the unit in the aircraft.

G. MATERIAL - COST AND AVAILABILITY: Obtain capacitor and diode locally from best source as required.

H. TOOLING: None.

I. WEIGHT AND BALANCE: None.

J. ELECTRICAL LOAD DATA: Not affected.

K. REFERENCE: AP-647 (32-47-56) Component Maintenance Manual for Skid Control Unit Assembly 6004125 (basic issue dated 14 February 1986), Revision No. 2 dated 21 March 1989.

L. OTHER PUBLICATIONS AFFECTED: None.

SECTION II - ACCOMPLISHMENT INSTRUCTIONS

The following instructions detail the steps required to rework the Control Unit Assembly 6004125 to 6004125-1.

CAUTION: PRINTED WIRING BOARDS CONTAIN DEVICES SUSCEPTIBLE TO DAMAGE OR DEGRADATION FROM ELECTROSTATIC DISCHARGE (ESD). HANDLING PRECAUTIONS AND REPAIR PROCEDURES APPLICABLE TO ELECTROSTATIC SENSITIVE DEVICES (ESSD) ARE REQUIRED.

A. Removal of Both Wheel Control Boards

(1) Release turnlock fastener at the rear of the control unit.

(2) Remove screw from the top of the control unit assembly and slide chassis subassembly free of cover. Retain the screw and cover until reassembly.

NOTE: Note location of subassembly serial number relative to "Inboard/Outboard" card slot location.

B. Rework of Wheel Control Boards

CAUTION: POLYURETHANE COATINGS MUST BE THOROUGHLY REMOVED FROM THE AREAS TO BE RESOLDERED OR AN INADEQUATE ELECTRICAL CONTACT WILL RESULT. POSITION COMPONENTS CAREFULLY TO ASSURE ADEQUATE CLEARANCE OF COMPONENT BODIES AND LEADS WITH REGARD TO ADJACENT COMPONENTS.

NOTE: For removal and application of urethane coatings, see Replacing Components on Circuit Boards paragraph in referenced Component Maintenance Manual.

(1) Rework Control Board Subassembly 6004125 into 6004125-1 as follows (See Figure 1):

(a) Install Capacitor M39014/02-1411 (C76) and Diode JANTXIN4148-1 (CR10) on the non-component side of board as shown in Figure 1.

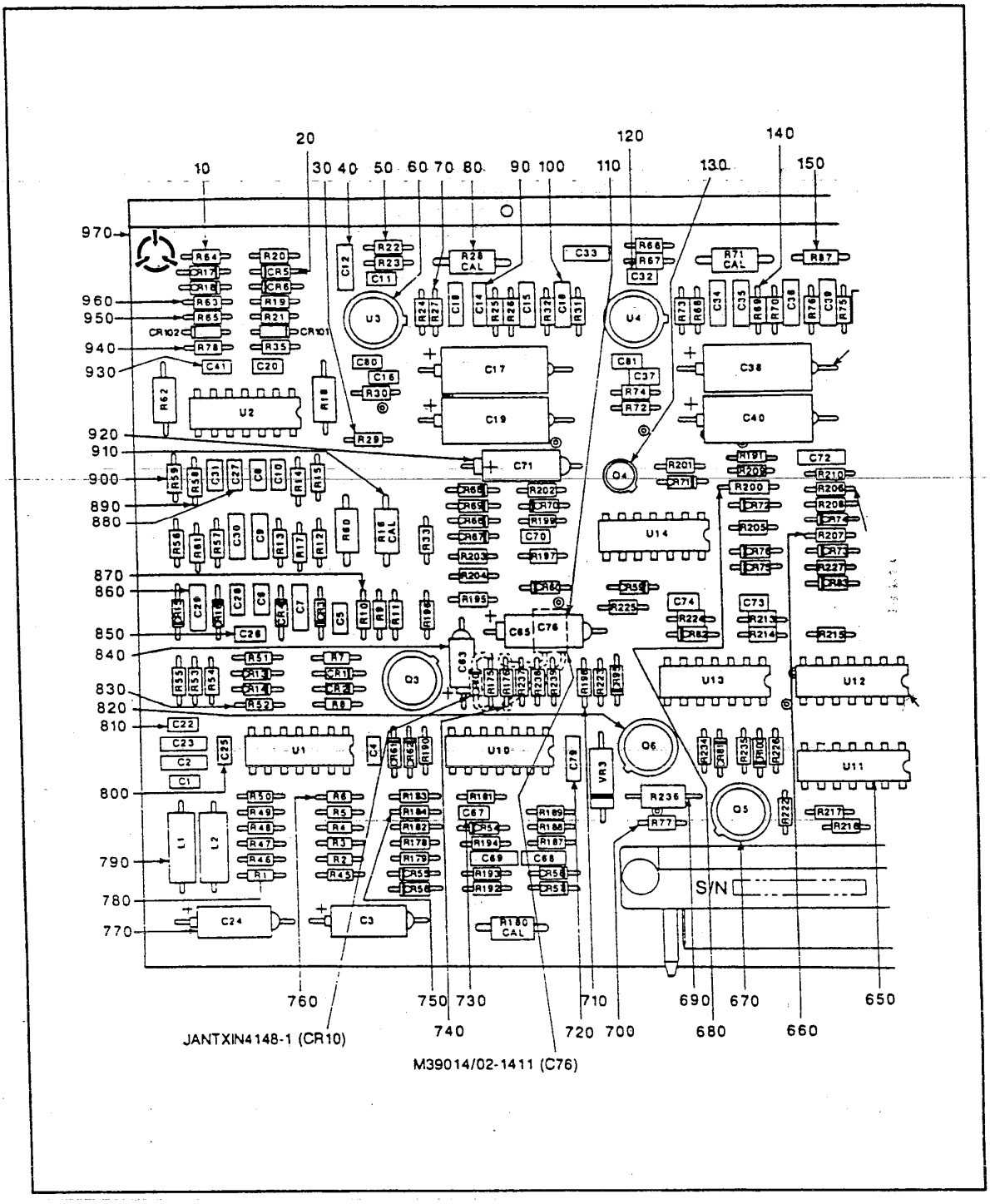
NOTE: Use Insulation Sleeving B7444-3-2-16B and Hysol 0151 Sealant as required.

1 Solder each component to board and trim ends.

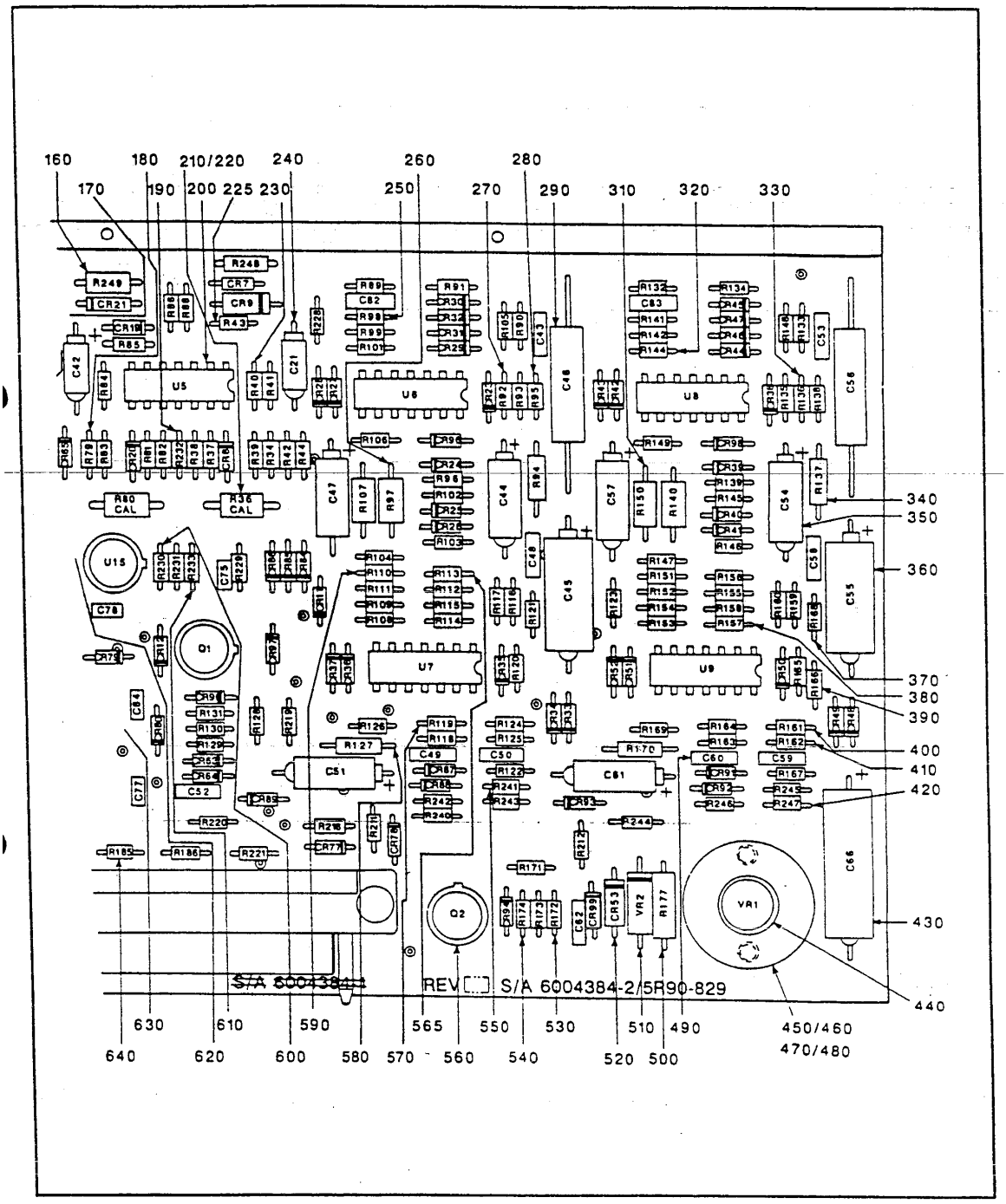
2 When installing a new component, maintain 0.03 inch (0,76 mm) minimum space between the component and the surface of the board.

CAUTION: AVOID CONTAMINATION OF THE BOARD CONNECTOR PINS WITH RESIDUE FROM THE CLEANING AND COATING PROCESSES.

3 Clean components and reworked area with Freon TP-35 and allow to dry thoroughly.



Modification of Wheel Control Board to 6004384–2/5R90–829
Figure 1 (Sheet 1 of 2)



Modification of Wheel Control Board to 6004384–2/5R90–829
Figure 1 (Sheet 2 of 2)

WARNING: USE POLYURETHANE COATING ONLY IN A WELL-VENTILATED AREA. DO NOT INHALE FUMES AND AVOID PHYSICAL CONTACT WITH THE COATING.

4 Apply a protective coating of Hysol PC-29M or Humiseal 1B31 over each component and the repaired area of the board. Apply only a very thin coat, 0.002 inch (0,051 mm) maximum and do not allow a buildup of coating between the other parts of the board.

C. Reidentification of Control Boards

(1) Board identification is located adjacent to the board connector as shown in Figure 1.

(2) On each control board, cross out but do not obliterate existing identification.

(3) Reidentify board as part number S/A 6004384-2/5R90-829 in 0.10 inch (2,54 mm) high characters, using a contrasting color epoxy marking ink, Hysol Wornowink, Series M.

D. Reidentification of Control Unit Assembly 6004125 to 6004125-1

(1) Remove existing Identification Plate 6004357 from control unit and discard.

(2) Using a new Identification Plate 6004357, metal stamp existing control unit serial number on designated pad and "-1" after part number 6004125 in 0.06 inch (1,52 mm) high characters.

(3) Install new Identification Plate 6004357 on the control unit.

E. Control Unit Reassembly

(1) Install each "S/A 6004384-2/5R90-829" Wheel Control Board Subassembly in appropriate card slot.

(2) Slide chassis subassembly into the cover using retained screw. Secure turnlock fastener at rear of control unit.

F. Acceptance Testing of Control Unit Assembly 6004125-1

(1) Perform full control unit assembly test in accordance with TESTING AND FAULT ISOLATION section of referenced Component Maintenance Manual, paragraph 3.

G. On-Board Aircraft BITE Test of Control Unit

(1) An aircraft checkout (BITE test) of the control unit should also be performed with Auto-Brake powered down.

SECTION III - MATERIAL INFORMATION

A. The following parts are required to rework each brake assembly.

New Part Number	Units Per Assembly	Nomenclature	Old Part Number	Disposition
M39014/02-1411	1	CAPACITOR	-	-
JANTXIN4148-1	1	DIODE	-	-
6004357	1	PLATE, Identification	6004357	Discard

B. The following bulk material shall be required.

Bulk Material - As Required	Recommended Source
Cleaning Solvent TP-35 Freon	E.I. DuPont DeNemours & Company, Incorporated Petrochemicals Department Freon Products Division 1007 Market Street Wilmington, DE 19898
Insulation Tubing B7444-3-2-16B	Commercially available
Sealant 0151	Hysol Division The Dexter Corporation 211 Franklin Street Olean, NY 14760
Sealant, Polyurethane Coating Type PC-29M	Hysol Division The Dexter Corporation 1505 East Don Julian Road P.O. Box 1282 Industry, CA 91749-1282
Humiseal Electronic Component Protective Coating IB31	Columbia Chase Corporation Humiseal Division 26-60 Brooklyn-Queens Expressway West P.O. Box 445 Woodside, NY 11377-0445
Trichloroethane Specification MIL-T-81533	Commercially available
Stiff-Bristled Fiberglass Brush	Commercially available
Epoxy Marking Ink Hysol Wornowink Series M Specification MIL-I-43553	Hysol Division The Dexter Corporation 1505 East Don Julian Road P.O. Box 1282 Industry, CA 91749-1282

Appendix 6: Service letter 137, Fokker Aircraft B.V.

Fokker 50
SERVICE LETTER

ATA ch. 76

137

ENGINE CONTROLS

Automatic Flight Idle Stop - Operation of the Flight-Idle Stop Solenoids during Flight.

Effectivity: All F27 Mark 050 and 0502 aircraft.

Introduction

A primary (mandatory) mechanical stop is installed in the flight compartment to prevent inadvertent movement of the power levers into the Ground (or Beta) range during flight. In addition to this, a secondary (back-up) stop is installed on each engine, this is the automatic flight-idle stop.

This Service Letter informs the operators about two issues related to the operation of the automatic flight-idle stop; Firstly the possibility that pilots may lift the ground-range selector-levers and move the power levers through the primary stop during flight. Secondly, the possibility of inadvertent operation during flight of the secondary or so called automatic flight-idle stop.

Background information/Recommendations

Primary stop (Refer to figure 1)

It has been reported that handling of the ground-range selector-levers occurs during flight, e.g. when the hand of the pilot holds the selector levers during turbulent weather conditions. This may result in the situation that the power levers pass the primary stop and now rest against the secondary stop. When the engine controls are incorrectly adjusted this may result in a propeller RPM/drag increase. When the power levers remain against the secondary stop during aircraft landing, it may not be possible to move the power levers into the Ground range due to the imposed friction.

AFM procedures recommend operation of the selector levers only after nose wheel touch-down. For this issue it is considered the operators responsibility to take action where considered appropriate.

Page	1	2	3	4													
Revision	-	-		-													

Secondary stop (Refer to figure 1 and 2)

The secondary or so called automatic flight-idle stop prevents inadvertent entering of the propeller into the Ground range during flight if the ground-range selector-levers are accidentally operated. The location of this secondary stop on the engine also ensures protection after a control cable failure.

When the flight-idle stop solenoids (one on each engine) are energized, the lock-lever is withdrawn from the power levers. This makes it possible to retard the power levers into the Ground range after landing of the aircraft. During normal operation of the system, the solenoids will be energized after landing when one of the following input signals is available:

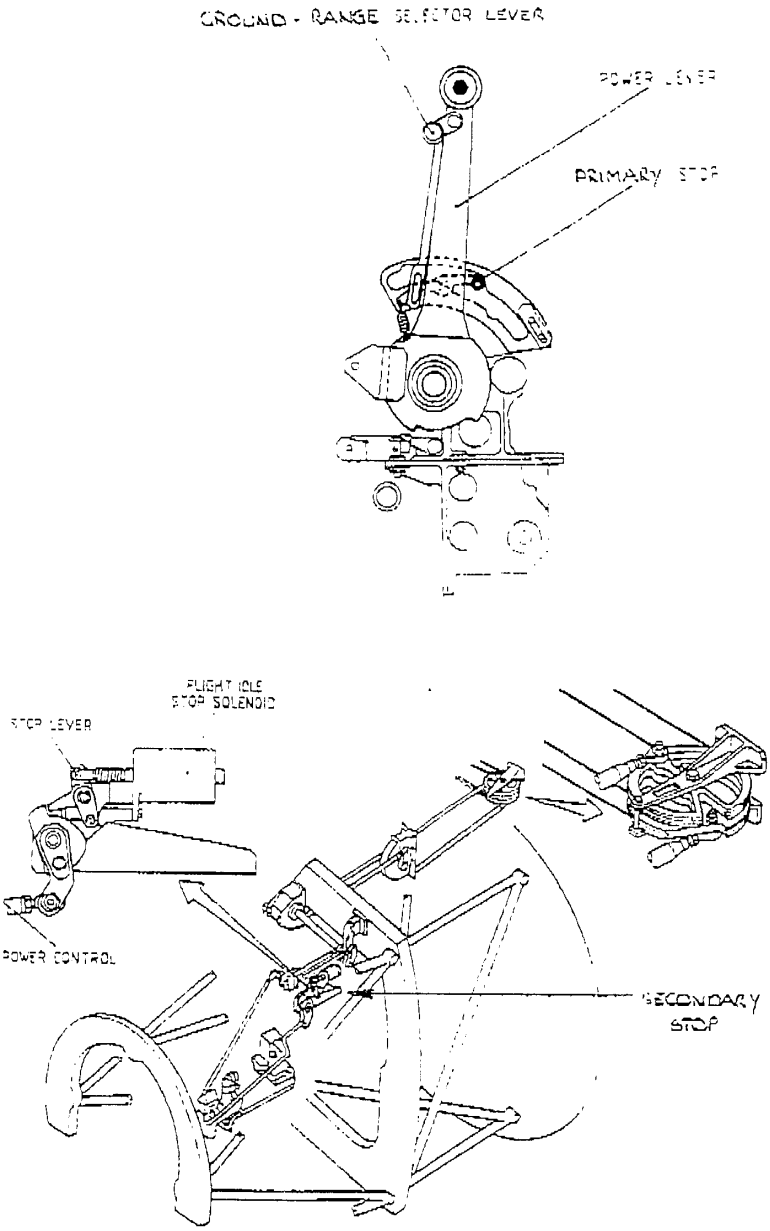
- Wheel speed-up signal (20 MPH) from the anti-skid control system
- Ground signal from the Ground/Flight relays.

However in-service experience revealed that the flight-idle stop solenoids may also be energized, during flight, for a period of 16 seconds under the following circumstances:

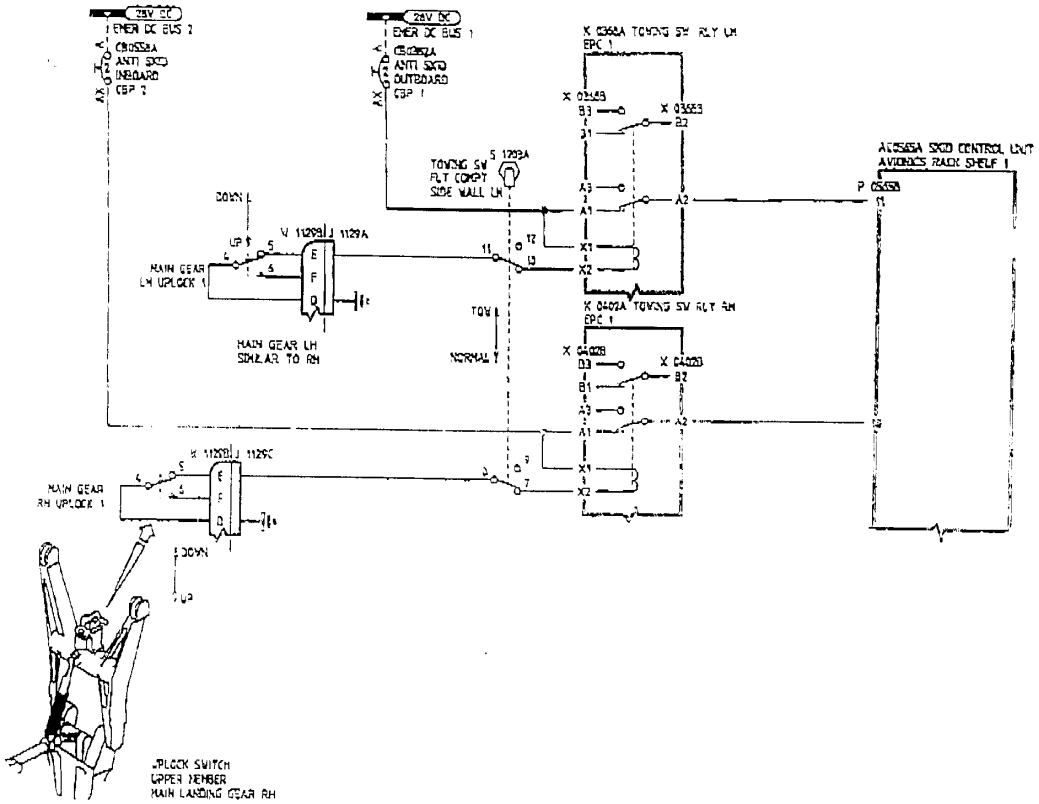
1. When both the LH and RH main landing gear uplock-switches are de-energized at the exactly the same time. Although considered to be remote, this may happen during each flight when the landing gear is selected down.
   The occurrence of this phenomenon can be prevented with a skid control unit modification. This modification, when incorporated, changes the partnumber of the skid control unit from 6004125 into 6004125-1 and is covered by Service Bulletin Fo50-32-4 from the vendor Aircraft Braking Systems. This modification was incorporated into anti-skid unit s/n AUG92-117 and subsequent.

2. During an operational check of the anti-skid system. The AOM recommends to perform this check before the landing when a lightning strike is experienced while the landing gear is down. Besides activation of the automatic flight-idle stop, also the rating on the ERP may change automatically to Go Around when the "Cruise rating in approach" modification is incorporated (refer to SBF50-73-010) into the aircraft. Fokker considers to include a note in the AOM which informs flight crews about this possible rating change.

3. When, during flight, the TOW switch is operated from NORMAL to TOW and back to NORMAL. There is no procedure recommended in the AOM to cycle the TOW switch during flight.



The Automatic Flight Idle Stop
Figure 1



The Anti-Skid Control System
Figure 2

Appendix 7: Service bulletin Fokker Services B.V. N° F50-32-035

LANDING GEAR

Wheels and brakes – Introduction of new ground connections for the Anti-Skid box.

1. Planning Information

A. Effectivity

(1) F27 Mark 050, 0502 and 0604 aircraft serial numbers:

20103 thru 20335.

(2) Production version: Not applicable.

B. Reason

(1) Cases have been experienced of intermittent or no braking action from the normal braking system.
Investigation has learned that this is caused by EMI disturbance signals. The EMI signals cause undesired signals in the wiring from the wheel speed sensors to the anti skid control box, which in turn could cause undesired dump-signals from the anti skid control box. As a result of this hydraulic brake pressure will be dumped resulting in intermittent or no braking action.

This Service Bulletin is issued to inform the operators how to change the "ground" wiring to the anti skid control box.

C. Description

(1) This Service Bulletin tells you how to:
- Remove the avionics shelf that holds the Anti-skid box.
- Do rework on ground connections.
- Install the shelf in the avionics rack.
- Do the test procedures.

Page	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

D. Compliance

(1) Recommended.

E. Approval

(1) The technical information contained in this Service Bulletin has been approved under the authority of the JAA Design Organization Approval no. RLD.JA.001.

F. Manpower

(1) Approximately 8 man-hours are necessary to do this Service Bulletin on 1 aircraft.

This table of manpower will help you to schedule and do this Service Bulletin:

Instructions	Men	Man-hours	Elapsed time (hours)
Inspection	-	-	-
Removal	1	1.5	1.5
Modification Installation	1	3	3
Testing	2	3	1.5
Total		8	6

(2) The estimated hours are for direct labor done by experienced personnel. They are calculated based on the conditions given in the Service Bulletin Introduction, section 2.C., "Manpower".

G. Material - Cost and Availability

(1) You can order the necessary parts as mod kit SBF50-32-035A, SBF50-32-035B or SBF50-32-035C.

H. Tooling - Price and Availability

(1) Not applicable.

J. Weight and Balance

(1) Weight change: none
Index change: none.

K. Electrical Load Data

(1) Not affected.

Appendix 8: Airworthiness directive LUX-2002-001

AIRWORTHINESS DIRECTIVE

AD : LUX-2002-001

Grand-Duché de Luxembourg
Ministère des Transports
Direction de l'Aviation Civile
(DAC)

Applicability : Fokker F.27 Mk.050 and 0502 series airplanes: certificated in any category.

Note 1 : This AD appplies to each airplane identified in the preceding applicability provision, regardless of whether it has been modified, altered, or repaired in the area subject to the requirements of this AD.

Compliance : Required as indicated, unless accomplished previously.
To prevent the selection of a lower pitch than the low pitch for flight.

Corrective actions :

1.
-LANDING GEAR SKID CONTROL SYSTEM – Control unit rework instructions in accordance with Fokker 50 Aircraft Braking Systems Service Bulletin Fo50-32-4 revision 1 dated 29/06/1994.
-WHEELS AND BRAKES – Introduction of new ground connections for the Anti-Skid Box in accordance with Fokker 50 Service Bulletin F50-32-035.
-ENGINE CONTROLS – Automatic Flight Idle Stop – Operation of the Flight-Idle Stop Solenoids during Flight in accordance with Fokker 50 Service Letter N°137/1994

2.
All responsible aircraft pilots have to be explicitly and expressly informed that there are certain conditions where the solenoids can be inadvertently activated in flight. The reference to the corresponding chapters in the Airplane Flight Manual (AFM) has to be noticed to the pilots.

Effective Dates

Corrective action 1 of this amendment becomes effective on January 1st, 2003.

Corrective action 2 of this amendment becomes effective on November 29, 2002.

Issued in Luxembourg, on November 29, 2002.

Airworthiness office, Direction of Civil Aviation

Appendix 9: AOF 50.028, Fokker Services B.V.

Fokker 50/60 All Operators Message

Dated : May 08, 2003

Sequence No. : **AOF50.028**
Ref. No. : TS03.52599
Page : 2 OF 3

Subject: Fokker 50 – Skid control unit modification, up-date #1.

This All Operators Message is to inform you that Service Bulletin SBF50-32-038 has been issued as a cover Service Bulletin for the ABSC SB 6004125-32-01 introducing a new modification of the Skid Control Unit to improve EMI protection and to suppress the 20 mph wheelspeed discretes during Skid Control Unit test (while retaining a previous modification), as already announced in AOF50.024.

Note: In the previous AOF the new ABSC SB was announced as SB Fo50-32-07, however, due to a new numbering system at ABSC, the subject SB got a new number:

ABSC SB 6004125-32-01

In AOF50.024 the background of the previous modification to the Skid Control Unit as well as the reason for the new modification were extensively explained.
The AOF ended with the expectation that the SB's introducing this new modification would be issued at the end of February 2003.
However, at a very late stage a shortcoming in the modification was discovered. The correction of this shortcoming caused a delay in issuing both SB's.

Fokker Services SBF50-32-038:

Fokker Service Bulletin SBF50-32-038 has been issued as a Fokker Services cover Service Bulletin requiring the accomplishment of a number of Service Bulletins to improve the Skid Control Unit.
This Service Bulletin requires the accomplishment of:

- ABSC SB 6004125-32-01
- Fokker Services SBF50-32-035

It is expected that this SB will be mandated by the CAA-NL with a compliance time of 1 year after the issue date of this SB for pre ABSC SB Fo50-32-4 units (identified as 6004125) and 1,5 year for post ABSC SB Fo50-32-4 units (identified as 6004125-1).

ABSC SB 6004125-32-01:

ABSC SB 6004125-32-01 has been issued to modify the Skid Control Unit electronic circuits in order to reduce the EMI susceptibility of the wheelspeed sensor input and test inputs of the Skid Control Unit.
The SB also includes the modification introduced with ABSC SB Fo50-32-04 for those units which are still pre that SB.
Accomplishment of this Service Bulletin on the Skid Control Units p/n 6004125 and 6004125-1 will modify these Units into a Skid Control Unit p/n 6004125-2.

Fokker Services SBF50-32-035:

Fokker Service SBF50-32-035 is an existing SB, which was already issued in Aug 1999. This SB introduces a modification of the aircraft wiring to reduce the levels of EMI on the wheelspeed sensor wiring by relocating the Skid Control Unit Signal grounds from the aircraft structure to the avionics shelf.

In conclusion:

With these modifications incorporated, abnormal braking, loss of braking at low speeds as well as unintended energizing of the flight idle stop solenoids are considered to be adequately covered.

Copies of the subject Service Bulletins are attached and also available at the Fokker Services web-site https://www.myfokkerfleet.com (restricted site for customers only) as an attachment to this All Operator Message.

Sincerely yours,

F.T. van de Pol
Vice President Technical Services
Fokker Services bv

Sequence No. : **AOF50.028**
Ref : TS03.52599

Appendix 10: Service bulletin Fokker Services B.V. N° F50-32-038

LANDING GEAR

Wheels and Brakes - The Modification of the Skid Control Unit.

1. Planning Information

A. Effectivity

(1) F27 Mark 050, 0502 and 0604 aircraft serial numbers:

20103 thru 20335.

(2) Production version of this modification: Not applicable.

B. Reason

(1) The Skid Control Unit has been modified to provide a solution for reported pulsating brake behavior and loss of braking at low speeds in the normal braking mode. Investigation of this behavior has shown that EMI, caused by failed components in other electronic systems and induced on the wheel speed sensor and/or test inputs of the Skid Control Unit was the cause of these problems. The modifications that are introduced provide a significant reduction of its EMI susceptibility.

The modified Skid Control Unit also provides suppression of the 20 mph wheel-speed discretes during the execution of a Skid Control System test in flight, which is recommended by the AOM to be performed after a lightning strike with landing gear down. This suppression was considered necessary because the 20 mph wheel-speed discretes activate the Ground Control Relay and Flight-Idle-Stop solenoid (for 16 sec) of the propeller control system. After modification inadvertent effects on the propeller control are eliminated.

Page	1	2	3	4													
Revision	-	-	-	-													

(2) Aircraft Braking Systems Corporation has issued Service Bulletin 6004125-32-01 to introduce Skid Control Unit 6004125-2 with the modifications mentioned under paragraph (1) implemented.

NOTE: This new part number also includes the modifications that were introduced in Skid Control Unit with part number 6004125-1 to prevent inadvertent generation of 20 mph wheel-speed discretes during power-up at landing gear extension.

(3) To reduce the level of EMI that may be induced on the wheel-speed sensor wiring, the ground connections of the skid control unit must also be adapted, refer to Fokker Services SBF50-32-035.

C. Description

(1) This Service Bulletin tells you how to:
- Remove skid control unit pn 6004125 (all mods) or pn 6004125-1
- Install skid control unit pn 6004125-2.

(2) Before, or and the same time as, you do this SB, you must do:
- SBF50-32-035 - LANDING GEAR - Introduction of new Connections for the Skid Control Unit.

D. Compliance

(1) Fokker Services recommends the accomplishment of this Service Bulletin within 12 months after the date of issue of this Service Bulletin if the Skid Control Unit is in a PRE ABSc Service Bulletin F50-32-4 configuration.

(2) Fokker Services recommends the accomplishment of this Service Bulletin within 18 months after the date of issue of this Service Bulletin if the Skid Control Unit is in a POST ABSc Service Bulletin F50-32-4 configuration.

NOTE: It is expected that the CAA-NL will set the same compliance terms in the Dutch Airworthiness Directive (BLA) that will be issued with respect to this subject.

E. Approval

(1) The technical information contained in this Service Bulletin has been approved under the authority of JAA Design Organization Approval no. RLD.JA.001.

F. Manpower

(1) The normal time for removal/installation of the anti-skid control unit.

(2) For the modification to the Skid Control Unit, refer to Aircraft Braking Systems Service Bulletin 6004125-32-01.

G. Material - Cost and Availability

(1) Refer to the Aircraft Braking Systems Service Bulletin 6004125-32-01.

H. Tooling - Price and Availability

(1) Not applicable.

I. Weight and Balance

(1) Weight change: None
Index change: None.

J. Electrical Load Data

(1) Not affected.

K. References

(1) Fokker 50/60 Aircraft Maintenance Manual (AMM)
Fokker 50/60 Service Bulletin (SB):
- SBF50-32-035

Aircraft Braking Systems SB:
- F50-32-4
- 6004125-32-01

Fokker internal reference(s):
- ECR 52588.

L. Publications Affected

(1) This SB affects the publications listed below:

(a) Maintenance Documentation

- Fokker 50/60 Wiring Manual (WM) - chapter 32-45
- Fokker 50/60 Illustrated Parts Catalog (IPC) - chapter 32-45.

NOTE: See attached Manual Change Notification MCNM F50-045.

(b) Maintenance Programs

Not affected.

(c) Operational Documentation

Not affected.

(2) For incorporation of this Service Bulletin in your documentation refer to the Service Bulletin Introduction, section 4 "Incorporation of Service Bulletins in Documentation of Fokker Services".

2. Accomplishment Instructions

A. Remove skid control unit pn 6004125 (all mods) or pn 6004125-1 (Refer to the AMM, chapter 32-45-01).

B. Send the removed unit to an approved workshop for modification (Refer to Aircraft Braking Systems Service Bulletin 6004125-32-01).

C. Install the modified skid control unit (Refer to the AMM, chapter 32-45-01). Use:
- 1 Skid Control Unit pn 6004125-2.

D. Do the Operational Test of the Anti-Skid System (Refer to the AMM, chapter 32-45-00).

3. Material Information

This part is necessary to do this Service Bulletin on 1 aircraft:

New Part Number	Qty	Keyword	Old Part Number	Instructions/ Disposition
6004125-2	1	Unit, skid control	6004125 (all mods) or 6004125-1	Modification *

NOTE*: Send the unit to an approved workshop for modification (Refer to the Aircraft Braking Systems Service Bulletin 6004125-32-01).

Appendix 11: Service bulletin ABSC N° Fo50-6004125-32-01

AIRCRAFT BRAKING SYSTEMS Corporation

SERVICE BULLETIN

Subject: LANDING GEAR - SKID CONTROL SYSTEM

INTRODUCTION OF SKID CONTROL UNIT ASSEMBLY 6004125-2

SECTION I - PLANNING INFORMATION

1. EFFECTIVITY: This Service Bulletin is applicable to Skid Control Unit Assemblies 6004125 and 6004125-1 used on the F27 MK050 (Fokker 50) Aircraft.

2. CONCURRENT REQUIREMENTS: Incorporation of Service Bulletin Fo50-32-4, Revision 1, dated 29 June 1994, to modify 6004125 Skid Control Unit to 6004125-1 Skid Control Unit.

3. REASON: This Service Bulletin is issued to inform operators of the new Skid Control Unit 6004125-2. It provides instructions to return existing control units to Aircraft Braking Systems Europe Limited (ABSEL) for modification of the 6004125 and the 6004125-1 control unit assembly into Skid Control Unit 6004125-2.

   ABSC has received reports of degraded braking caused by too much antiskid activity. The cause is electromagnetic interference (EMI) from other avionics systems. EMI is conducted into the skid control unit through the aircraft wiring. This may cause incorrect antiskid activity, resulting in degraded braking. While the skid control unit is designed to reject a limited amount of EMI, aging effects on some aircraft have increased EMI radiation to the extent that normal antiskid operation can be affected.

   In addition to the EMI hardening of Skid Control Units 6004125 and 6004125-1, the unit will be modified to disable the Wheel Speed Discrete circuit relays during manual application of the "Built-In-Test (BIT)" push button. "BIT" can be applied from the front panel test button or remotely from the cockpit if a Skid Control Unit is installed on the aircraft.

4. DESCRIPTION: This Service Bulletin notifies operators of the availability of the new Skid Control Unit 6004125-2 for use on the Fokker 50 aircraft.

   One difference between Skid Control Unit Assemblies 6004125-1 and 6004125-2 is a hardware change to the wheel speed and built-in-test (BIT) circuits on the two (2) Control Board Subassemblies 6004384-2. The modified control board subassemblies will have the new part number 6004384-3.

   A second difference is that the Auxiliary Printed Wiring Board (AUX Board) is also modified to disable the relays that control the Wheel Speed Discrete Circuit during manual application of the "Built-In-Test (BIT)". Additional hardware components from the BIT initiate switch will disable the discrete circuit when the BIT test switch is closed.

   Inclusion of additional hardware will harden the noted modifications to EMI. Pins are added to the AUX Board connectors in the Control Unit Chassis. Two wires are added to the chassis wire harness to connect the new AUX Board connector pins to the BIT switch on the front panel of the chassis. The AUX Board will have the new part number 6004386-2.

AIRCRAFT BRAKING SYSTEMS
Corporation

5. COMPLIANCE: Refer to Fokker Services SBF50-32-038 for compliance instructions. This SB can be accomplished by returning the units to ABSEL to incorporate the necessary changes. To schedule the return of your units, please contact Customer Support after 14 March 2003 at the following address:

   Aircraft Braking Systems Europe Limited
   683-685 Stirling Road
   Slough, Berkshire, England SL1 4ST
   Phone: 44-1-753-696-006
   Fax: 44-1-753-696-012
   Telex: 846695-ABSEL-G
   Sita: LHRLLCR
   Reference ABSC Service Bulletin 6004125-32-01

6. APPROVAL: Compliance with this Service Bulletin does not alter FAA Parts Manufacture Approval (PMA) conformance. Fokker Services has approved this Service Bulletin.

7. MANPOWER: None.

8. WEIGHT AND BALANCE: No Effect.

9. ELECTRICAL LOAD DATA: No Effect.

10. SOFTWARE ACCOMPLISHMENT SUMMARY: Does not apply.

11. REFERENCE(S):

   A. AP-647 (32-47-52) Component Maintenance Manual for Skid Control Unit Assembly Part Numbers 6004125 and 6004125-1 (basic issue dated 14 February 1986), Revision No. 5 dated 28 June 1995.

   B. Fokker 50 Service Bulletin Fo50-32-4, Revision 1, dated 29 June 1994.

12. OTHER PUBLICATIONS AFFECTED: Does not apply.

13. INTERCHANGEABILITY AND INTERMIXABILITY: Does not apply.

SECTION II - MATERIAL INFORMATION

1. MATERIAL - Price and Availability: The cost to modify to Skid Control Unit Assembly 6004125-2 is $3,750.00 each for units modified through 31 December 2003. See COMPLIANCE on this page for returning antiskid control units.

2. MATERIAL - Necessary Materials:

A. The parts necessary to do the changes given in this Service Bulletin are as follows:

New Part Number	Nomenclature	Old Part Number	Quantity	Disposition
6004125-2	SKID CONTROL UNIT ASSEMBLY	6004125 or 6004125-1	1	Return to manufacturer for modification

3. TOOLING - Price and Availability: Does not apply.

SECTION III - ACCOMPLISHMENT INSTRUCTIONS

A. The modifications specified by this Service Bulletin cannot not be done by the operators. Return all skid control units to Aircraft Braking Systems Corporation for modification as told in COMPLIANCE in SECTION I - PLANNING INFORMATION.

Appendix 12: Fokker Services B.V. MCNM-50-045

MCNM-F50-045

Subject : The Modification of the Skid Control Unit .

Reason : This MCN is issued to provide you with the changes on the content(s) of the affected manual(s), due to the introduction of SBF50-32-038.

Effectivity : F27 Mark 50 , 0502 and 0604 aircraft serial numbers: 20103 thru 20335.

Compliance : Once you have determined the applicability of this MCN for one or more of your aircraft, incorporate this information into the applicable manual(s).

Publications Affected : The Illustrated Parts Catalog (IPC)
The Wiring Manual (WM)

Change Note : **IPC**
Chapter 32-45-00 Fig. 01 ANTI-SKID SYSTEM
To be updated to show the new part number 6004125-2 of the modified Skid Control Unit (Refer to ABS SB6004125-32-01).

Change Note : **WM**
Part 1, Equipment List, series PL
To be updated to show the new part number 6004125-2 of the modified Skid Control Unit (Refer to ABS SB6004125-32-01).

NOTE : If you have a Documentation Revision Service (DRS) with Fokker Services, this information will be included into your manuals at the earliest opportunity.

Appendix 13: Airworthiness Directive LUX-2003-001

AIRWORTHINESS DIRECTIVE

AD : LUX-2003-001

Grand-Duché de Luxembourg
Ministère des Transports
Direction de l'Aviation Civile
(DAC)

Applicability : Fokker F.27 Mk.050 and 0502 series airplanes; certificated in any category.

Note 1 : This AD applies to each airplane identified in the preceding applicability provision, regardless of whether it has been modified, altered, or repaired in the area subject to the requirements of this AD.

Compliance : Required as indicated, unless accomplished previously.

Corrective action

-LANDING GEAR - SKID CONTROL SYSTEM – Control unit rework instructions in accordance with Aircraft Braking Systems Corp. Fokker 50 Service Bulletin ABSC SB 6004125-32-01 dated 07/05/2003.

-WHEELS AND BRAKES – THE MODIFICATION OF THE SKID CONTROL UNIT – Skid Control Unit modification to reduce the EMI susceptibility of the windspeed sensor input and test inputs of the Skid Control Unit and suppression of the 20 mph wheelspeed discretes in accordance with Fokker 50 Service Bulletin SBF50-32-038 dated 08/05/2003.

Reference

-Fokker All Operators Message AOF50.028 - Fokker 50 – Skid Control Unit modification, up-date #1 dated 08/05/2003.
-Fokker Manual Change Notification MCNM F50-045 – New part number 6004125-2 of the modified Skid Control Unit dated 08/05/2003.

Effective Dates

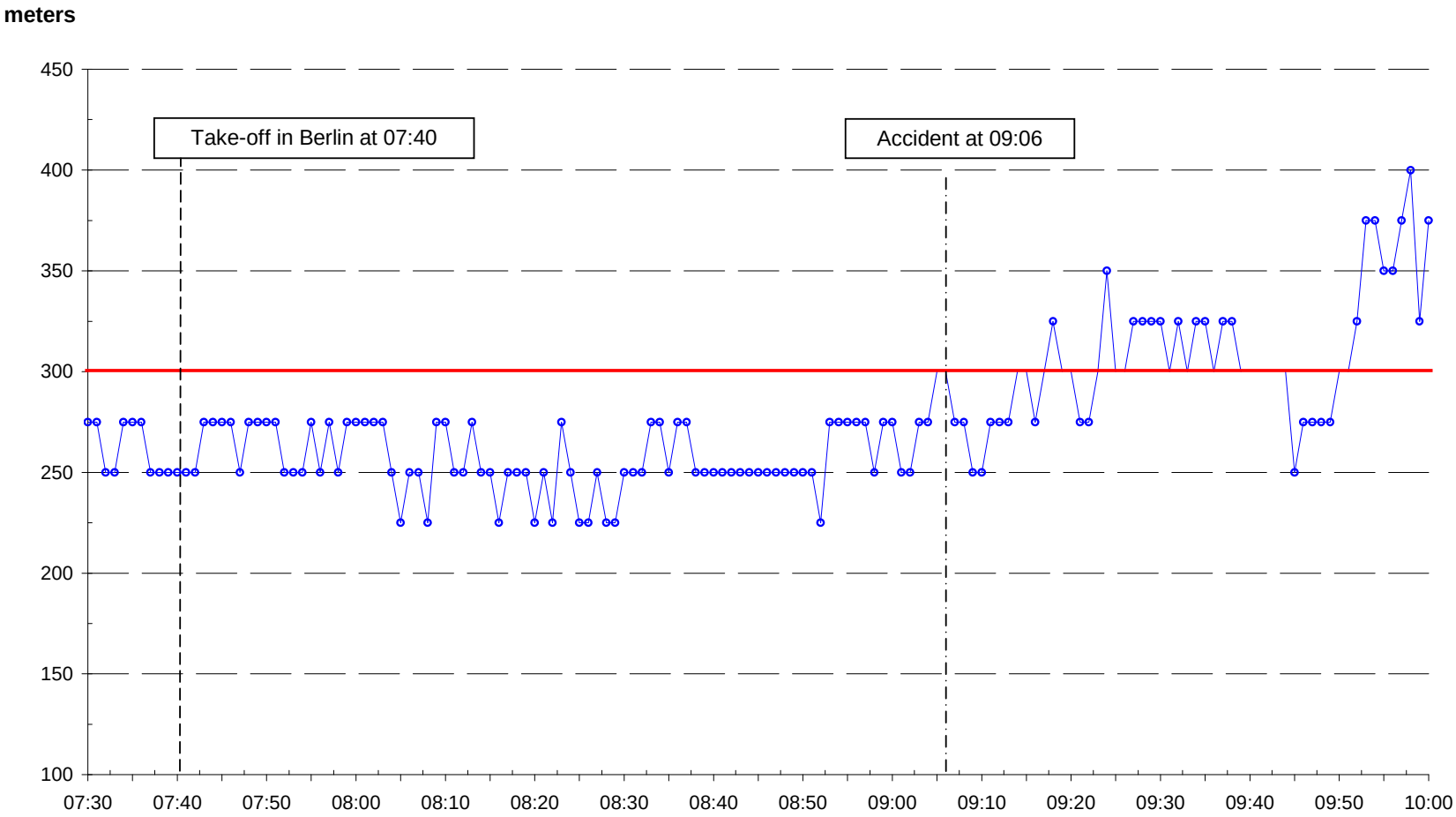
This amendment becomes effective on November 1st, 2003.

Issued in Luxembourg, on May 12, 2003.

Airworthiness office, Civil Aviation Authority.

Appendix 14: RVR values (revised)

RVR (position A) recordings at the airport



Appendix 15: Excerpts from Luxair AOM – Low visibility operations

2.3.20 LOW VISIBILITY OPERATIONS

100 GENERAL

Special aircraft and ground equipment are required as well as specific crew qualification.

Training for low visibility take-off and Cat II approaches will be performed in accordance with the Operations Manual Part D. Crew qualifications required and basic procedures are detailed in the Operations Manual Part A, General Basics, chapter 5 and chapter 8.4 respectively.

The approach briefing is performed by the PF. However, before any low visibility approach, the Commander shall perform an operational review of the procedures, callouts and aircraft handling in case of missed approach.

Because the barometric altimeter is not used for the determination of the landing minimum, there is no requirement to perform an altimeter check for Cat II approaches. The outer marker check must however be made.

Below 500 ft, the radio altimeter becomes the primary instrument to measure the height of the aircraft in relation to the ground.

Early detection of pilot incapacitation during low visibility approaches is utmost important.

The pressure altimeter bug shall be set to 500 ft above TDZ elevation rounded up to the nearest 20 ft.

The periodic practice of real or simulated low visibility approaches is a requirement.

NOTE: Due to the steep rising terrain in Luxembourg RWY 24, the barometric altimeter has to be used down to an altitude of 300 ft AAL. The altimeter bug will nevertheless be set to 1720 ft, **but** the "+200 – no flag" call shall be made passing 1520 ft on the barometric altimeter. Only now the radio altimeter becomes the primary altitude readout instrument.

200 OPERATIONAL REVIEW

To conduct actual Cat II approaches, both pilots must be qualified.

Prior to starting the approach (preferably before top of descent), check the Notams, airport status and Company minima.

Check the aircraft maintenance status.

For Cat II, the wind limits are:
- Total wind: 20 kts
- Crosswind component: 15 kts
- Tailwind component: 10 kts
- No gust, no shear

300 TASK DISTRIBUTION FOR CAT II APPROACHES

For Cat II (or monitored approaches in general), the F/O flies the aircraft trough the A/P and the Commander lands the aircraft, if sufficient visual references are available at minima.

400 CALLOUTS DURING A CAT II APPROACH

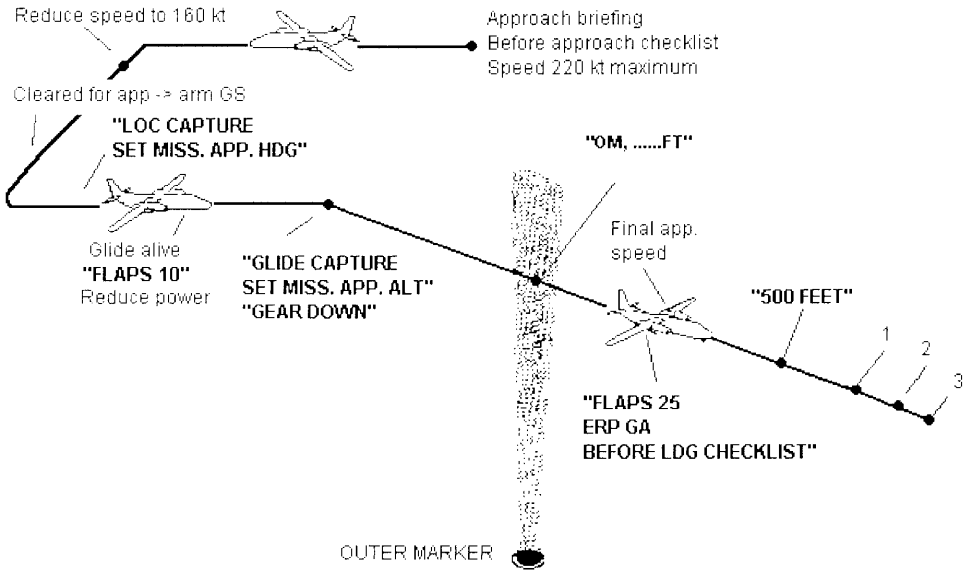
The basic operational callouts described above for Cat 1 ILS approaches remain valid for Cat II, with the following exceptions:

- No altimeter check
- Additional callout performed at 500 feet above TDZ.

The F/O is acting as PF during approach till minimum, where the Commander takes over control of the aircraft if visual references are sufficient.

PF (F/O)	PNF
	Ann.: « **LOC ALIVE** »
Ann.: « **CHECKED** »	
At Loc capture, ann.: « **LOCALIZER CATURE, SET MISSED APP. HEADING** »	Sets and ann.: « **CHECKED - MISSED APP. HEADING SET** »
	Ann.: « **GLIDE ALIVE** »
Ann.: « **CHECKED** »	
At glide capture, ann.: « **GLIDE CAPTURE, SET MISSED APP. ALTITUDE** »	Sets and ann.: « **CHECKED - MISSED APP. ALTITUDE SET** »
Passing the OM or equivalent, ann.: « **OUTER MARKER, (VALUE READ) FEET** »	If satisfied, ann.: « **CHECKED** »
When passing 500 ft AAL call: « **500 FEET** »	Call: « **CHECKED** »
200 ft above DA, call out: « **+ 200, NO FLAGS** »	Confirms, ann.: « **CHECKED** »
100 ft above DA: « **APPROACHING MIMIMUM** »	Call out: « **CHECKED** »
At DA, call out: « **MINIMUM** »	
If the required visual references have been established, the Commander takes over control of the aircraft and announces: « **LANDING** ». The F/O answers « **MONITORING** », keeps "head down", monitors the flight path on instruments and calls out any deviations. At 50 ft RA, callout « **50 FEET** ». The Commander disconnects the A/P and announces: « **DISCONNECTED** ».	
If no visual references at DH, the Commander calls out: « **GO AROUND** », the F/O answers « **GO-AROUND, FLAPS 10** » and performs the missed approach procedure.	

500 CAT II ILS PROFILE



1: " +200, NO FLAG"
2: "APPROACHING MINIMUM"
3: "MINIMUM"
FOLLOWED BY EITHER: **"LANDING or GO AROUND"**

Appendix 16: Horizontal plot of the trajectory

Excerpts from Original Tape Recording

Approach radar control unit

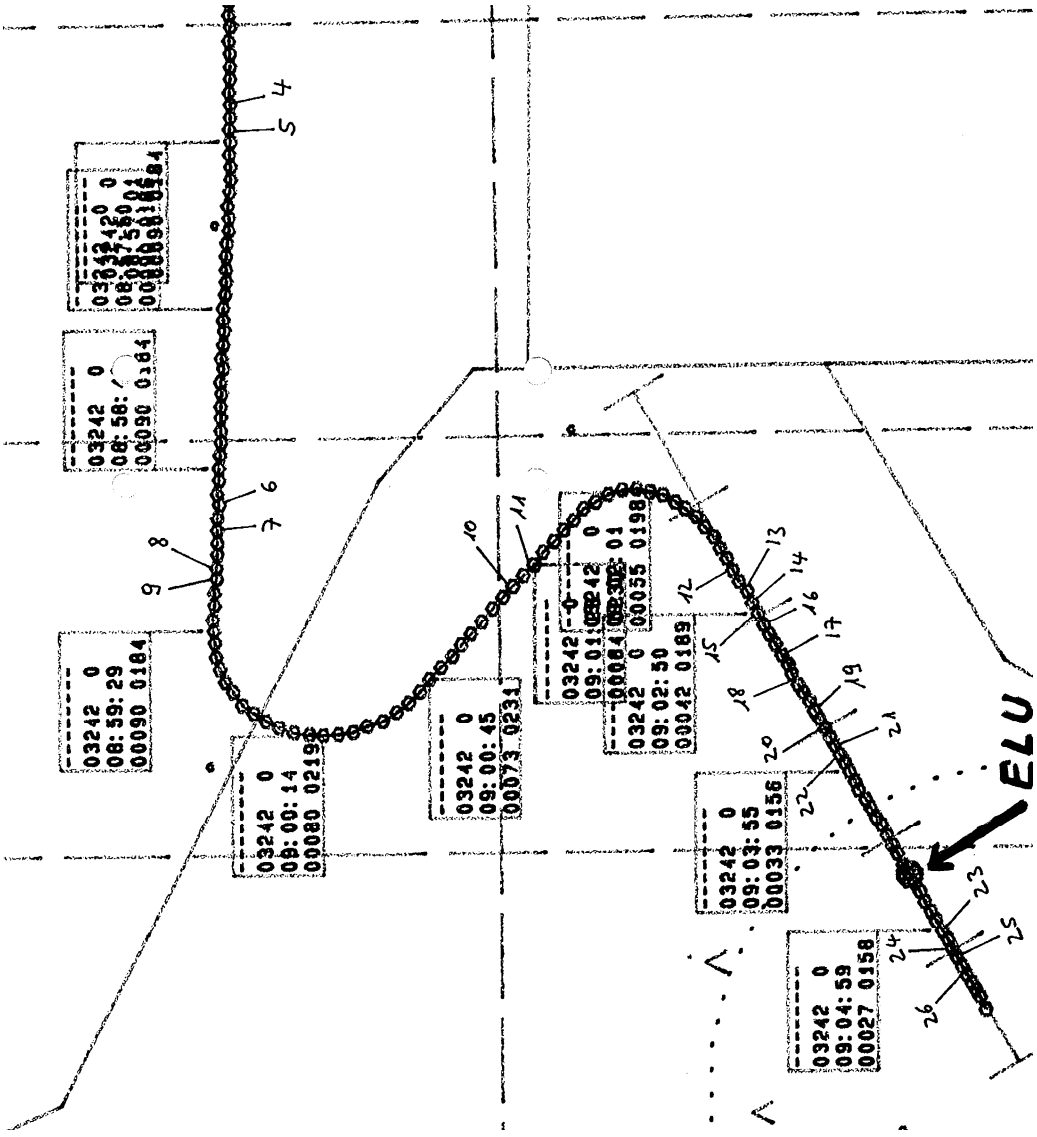
Frequency 118.900

Points	Time in UTC	From	To	Communications
1	08:52:38	LGL9642	APP	Luxembourg Radar gudde Muergen Luxair nine six four two, descending flight level nine zero, uh, on course to…, Diekirch.
2	08:52:47	APP	LGL9642	Luxair niner six four two enter Diekirch holding at flight level niner zero it will be vectors later on for an I_L_S approach category two on two four. Q_N_H is one zero two tree current R_V_R beginning two five zero on mid section two seven five, stop end two two five.
3	08:53:05	LGL9642	APP	That's all understood, uh, Luxair nine seven, correction nine six four two.
4	08:54:44	LGL9642	APP	And Luxair nine six four two is reducing speed to one sixty.
5	08:54:47	APP	LGL9642	Roger nine six four two.
6	08:58:48	APP	LGL9642	Luxair niner six four two descend to tree thousand feet on one zero two tree turn left heading ...one tree zero.
7	08:58:57	LGL9642	APP	Descending tree thousand feet on Q_N_H, uh, one zero two tree and say again the heading?
8	08:59:04	APP	LGL9642	One tree zero.
9	08:59:07	LGL9642	APP	Uh, left heading one tree zero Luxair nine six four two.
10	09:01:21	APP	LGL9642	Luxair niner six four two turn right heading two two zero to intercept. Cleared for approach, report established on the localizer.
11	09:01:30	LGL9642	APP	Right heading two two zero and, uh, cleared approach and we call you established on the localizer nine six four two.
12	09:02:30	LGL9642	APP	Luxair nine six four two is now established on the localizer.
13	09:02:34	APP	LGL9642	Luxair niner six four two contact tower one one eight decimal one Äddi.
14	09.02.39	LGL9642	APP	Eighteen one nine six four two. Äddi

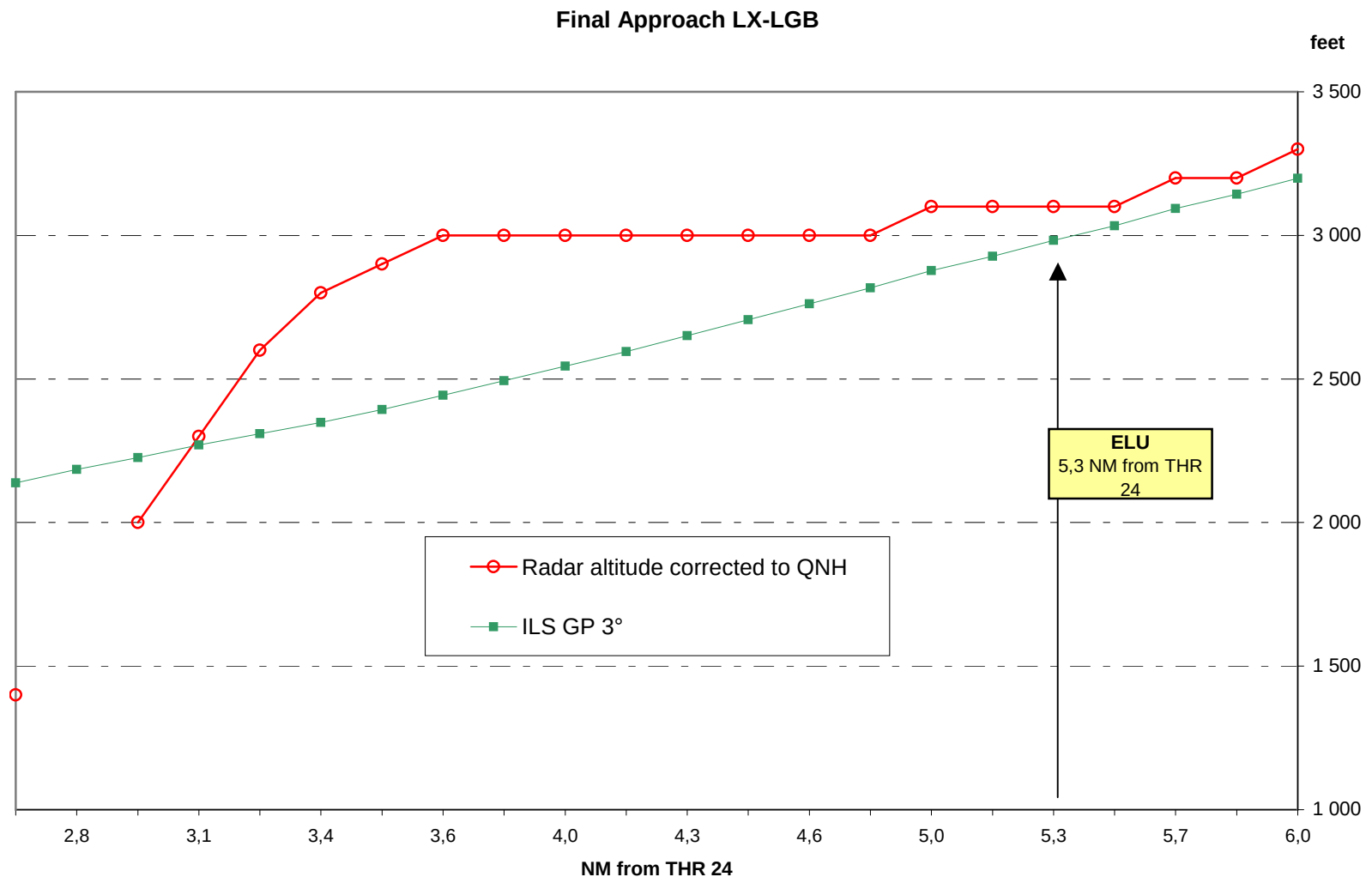
Aerodrome control unit

Frequency 118.100

Points	Time in UTC	From	To	Communications
15	09:02:48	LGL9642	TWR	Tuerm gudde Muergen Luxair nine six four two is, uh, established I_L_S two four
16	09:02:54	TWR	LGL9642	Luxair nine six four two gudde Muergen, continue approach the wind is calm R_V_R beginning two five zero meters mid section two five zero meters stop end two two five meters.
17	09:03:07	LGL9642	TWR	Uh, that's copied Luxair nine six four two, but we need tree hundred meters for the approach.
18	09:03:16	TWR	LGL9642	Nine six four two copied, uh, so continue approach I keep you advised. We didn't have tree hundred, uh, during the last, uh, time.
19	09:03:25	LGL9642	TWR	Uh, roger nine six four two we keep you advised. We're proceeding to Elu now and, uh, standing by, nine six four two.
20	09:03:35	TWR	LGL9642	Roger and we have, uh, zero degrees wind, uh.
21	09.03.40	TWR	LGL9642	Correction zero knots.
22	09:03:43	LGL9642	TWR	Roger.
23	09:04:59	TWR	LGL9642	Luxair nine six four two R_V_R tree hundred meters two seven five meters stop-end two seven five meters.
24	09:05:03	LGL9642	TWR	Nine six four two roger, so we continue.
25	09:05:07	TWR	LGL9642	Nine six four two you are cleared to land, wind one eight zero degrees five knots.
26	09:05:11	LGL9642	TWR	Cleared to land, uh, nine six four two


03242 0
08:59:29
00090 0184
03242 0
08:00:14
00080 0219
03242 0
09:00:45
00073 0231
03242 0
09:02:50
00042 0189
03242 0
09:03:55
00033 0156
03242 0
09:04:59
00027 0158
ELU

Appendix 17: Vertical plot of the trajectory


Final Approach LX-LGB
feet
3 500
3 000
2 500
2 000
1 500
1 000
ELU
5,3 NM from THR 24
Radar altitude corrected to QNH
ILS GP 3°
2,8
3,1
3,4
3,6
4,0
4,3
4,6
5,0
5,3
5,7
6,0
NM from THR 24

Appendix 18: CVR supplementary analysis

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 survenu le 6 novembre 2002 en approche de l'aéroport de Luxembourg au Fokker 50 immatriculé LX-LGB exploité par Luxair

Accident occurred on November 6, 2002, on approach to Luxembourg Airport to the Fokker 50 registered LX-LGB operated by Luxair

RAPPORT D'EXPLOITATION DU CVR Essais complémentaires

Cockpit Voice Recorder REPORT: Additional tests

CVR - 2002 - BVD - 03

1 CIRCONSTANCES / *CIRCUMSTANCES*

Le 6 novembre 2002 à 9h05 UTC, un Fokker 50 exploité par Luxair immatriculé LX-LGB s'écrase lors de son approche sur l'aéroport de Luxembourg peu après s'être établi en finale ILS 24.

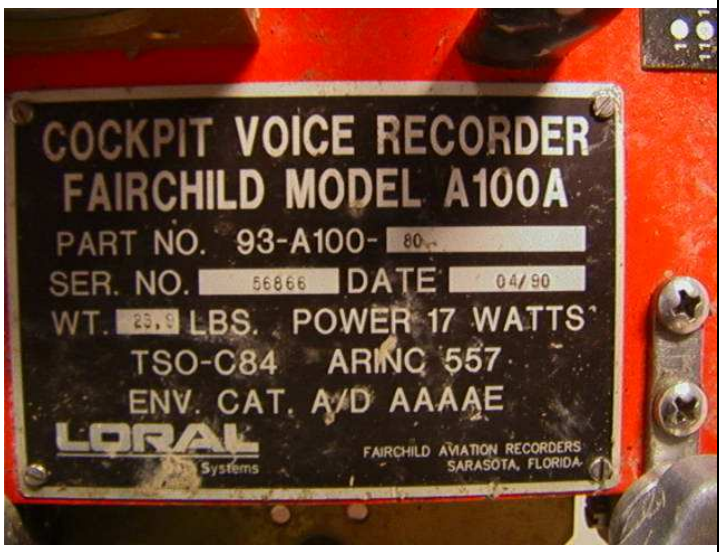
On November 6, 2002 at 9.05 UTC time, a Fokker 50 operated by Luxair and registered LX-LGB crashes during the approach to Luxembourg just after establishing on ILS 24.

2 ENREGISTREURS / *RECORDERS*.

Le Fokker 50 était équipé de deux enregistreurs de vol :

The aircraft was equipped with two flight recorders:

	FDR	CVR
Model	Fairchild F800	Fairchild A100A
Part number (P/N)	17M-800-251	93-A100-80
Serial number (S/N)	3672	56866



Les enregistreurs ont été lus le 7 novembre 2002 par un enquêteur technique du BEA (CF Rapport d'Exploitation des Enregistreurs).

The Flight recorders were read out on November 7, 2002, at the BEA (See Flight Recorders Report).

3 ESSAIS COMPLEMENTAIRES / *ADDITIONAL TESTS*

Le rapport d'exploitation des enregistreurs concluait sur la nécessité de réaliser des essais complémentaires avec l'aide de la compagnie. Ces essais ont été effectués entre le 31 mars et

le 1er avril 2003 à Luxembourg avec des membres de la commission d'enquête, assistés par un pilote de Fokker 50.

Leur but est de pouvoir valider les hypothèses émises lors de la transcription des bruits et alarmes présents sur le CVR de l'avion accidenté.

The flight recorders report concluded there was a need to proceed with additional tests with the assistance of the Airline. These tests were performed between March 31st and April 1st, 2003, in Luxembourg with members of the investigation commission, assisted by a Fokker 50 pilot.

The aim was to validate the hypotheses based on the transcription of the noises and alarms recorded on the CVR.

Protocole / *Protocol*

Afin de pouvoir recréer des conditions similaires au vol de l'accident, plusieurs séries d'essais ont été réalisées :

- Le même type d'enregistreur (un A100-A à bande magnétique) était utilisé sur tous les avions ayant servis aux tests. C'est également ce type d'enregistreur qui équipait l'avion accidenté.

- Un vol a été fait sur le Fokker 50 immatriculé LX-LGC de la compagnie Luxair entre Paris et Luxembourg avec un enquêteur technique du BEA présent en poste

- A l'issue de ce vol, le CVR a été prélevé pour lecture des données et analyse des bruits et alarmes.

- Le même appareil a été utilisé pour un enregistrement des essais au sol.

- Enfin, les mêmes essais ont été enregistrés dans le Fokker 50 LX-LGD au sol afin de comparer les résultats avec un panel plus large d'appareils.

- Lors des essais en poste, le conditionnement d'air était opérant pour recréer le principal bruit de fond entendu généralement sur un CVR.

- Les manipulations ont été réalisées plusieurs fois sur chaque appareil afin de bénéficier d'un plus grand nombre d'éléments de comparaison.

In order to reproduce similar conditions to those during the accident, several tests were performed:

- *The same type of CVR (a magnetic tape A100-A) was used on every aircraft used to perform the tests. This was also the type of CVR installed on the crashed aircraft.*

- *A Luxair Fokker 50 registered LX-LGC flew from Paris to Luxembourg with a safety investigator present in the cockpit.*

- *Following this flight, the CVR was removed from the aircraft for read out and analysis of noises and alarms.*

- *The same aircraft was used for a ground recording of the tests.*

- *Finally, the same tests were recorded in the Fokker 50 LX-LGD on the ground in order to compare the results with a wider range of aircraft.*

- *During the tests, the air conditioning was turned on to recreate the main background noise generally heard on CVRs.*

- *Tests were performed several times on each aircraft in order to compare the transcribed noises with several samples.*

Environnement sonore / *Acoustic environment*

Les essais ayant été réalisés au sol, il n'y a aucun bruit aérodynamique ni de bruit de moteur. Cette différence n'entame cependant en rien la validité des résultats car les bruits aérodynamiques sont des bruits large bande que l'on retrouve sur tout le spectre. Ils ne modifient pas la signature spectrale du bruit étudié. Les moteurs de l'avion quant à eux ont une signature spectrale connue que l'on peut donc discriminer par rapport au bruit analysé.

Since the tests were carried out on the ground, there were neither aerodynamic noises nor engine noises. This difference, though, does not affect the validity of the results in so far as aerodynamic noises have a broad-band signature visible on the whole analysed spectrum. Thus, they do not modify the spectral signature of the analysed noise. Regarding the aircraft's engines, their signature was known and could thus be discriminated from the targeted noise.

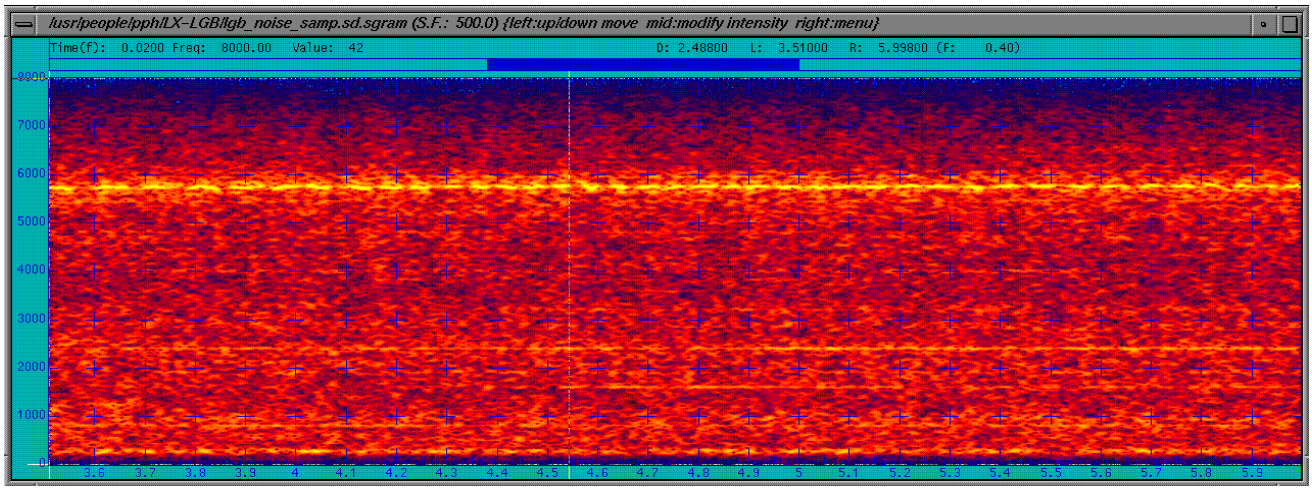


Fig. 1**: Représentation Temps – Fréquence du bruit de fond du LX-LGB en vol. **Time – Frequency representation of the background noise on LX-LGB in flight.

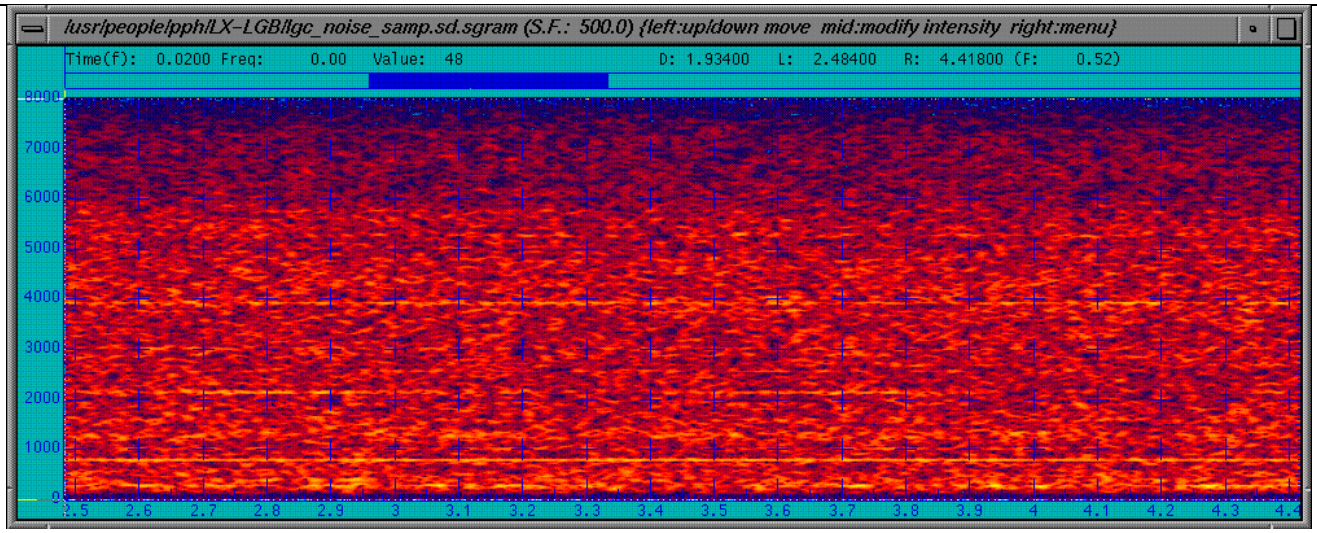


Fig. 2: *Représentation Temps – Fréquence du bruit de fond du LX-LGC au sol.* ***Time – Frequency representation of the background noise on LX-LGC on the ground.***

Comme l'illustrent les deux figures précédentes, le LX-LGB (fig. 1) présente un signal plus bruité que celui du LX-LGC (fig. 2). Les hautes fréquences (autour de 5700 Hz) correspondent au bruit de la turbine de l'avion. Le bruit de fond est globalement plus élevé en raison du bruit aérodynamique caractérisé par un spectre large bande.

As shown in the previous figures, LX-LGB in flight (Fig.1) shows a signal with more noise than on LX-LGC on the ground (fig.2). Higher frequencies (around 5,700 Hz) match with the turbine noise whereas the global background noise has a wide range spectrum, consistent with aerodynamic noise.

Échantillons enregistrés / *Recorded Samples*

La liste suivante recense une sélection de bruits générés dans le poste de pilotage du Fokker 50. Cette sélection a été faite en concertation avec les membres de la commission d'enquête.

The following list summarizes a selection of noises and alarms generated in the cockpit of the Fokker 50. This selection has been done with the members of the investigation commission.

- Manœuvre de la commande des volets / *Flap selector operation,*
- Manœuvre de la manette des gaz / *Throttle operation,*
- Déplacement du siège dans 3 directions / *Seat motion in 3 directions,*
- Utilisation des accoudoirs / *Use of armrest,*
- (Dés)-activation des Taxi lights */ Taxi lights switching,*
- (Dés)-activation des Landing lights */ Landing lights switching,*
- (Dés)-activation de la Compass light / *Compass light switching,*
- (Dés)-activation du voyant cabine "Seat Belts On" / *"Seat Belts On" light switching,*
- Génération de l'alarme GPWS / *GPWS alarm generation,*
- Génération du *Double* et *Triple Chime / Double and Triple Chime generation,*
- Mouvements d'objets en poste */ Objects moving in the cockpit,*
- Ouverture et fermeture de la porte / *Door opening and closing.*

Identifications et analyses / *Identification and analyses*

Les paragraphes suivants rapportent les résultats des essais et les analyses de comparaison des signaux entre l'enregistrement du CVR accidenté et les enregistrements des essais. La méthodologie employée sera décrite en détail dans l'exemple suivant, les autres identifications reprenant le même principe. Ces identifications suivront l'ordre dans lesquels les bruits ont été transcrits, i.e. chronologiquement.

The following paragraphs report the results of the tests and comparison analyses between the recording of the accident CVR and the tests recording. A first example will be thoroughly explained, the other identifications following the same principle. The noises and alarms identification will follow the order in which they were transcribed, i.e. chronologically.

Exemple de l'identification de l'activation des *Taxi Lights* / Taxi Lights *Identification example:*

Afin de valider le bruit transcrit, l'analyse spectrale de ce dernier est comparée avec celles des différents essais enregistrés dans les autres avions. Pour accroître les probabilités et la fiabilité des identifications, il convient d'en comparer plusieurs aspects.

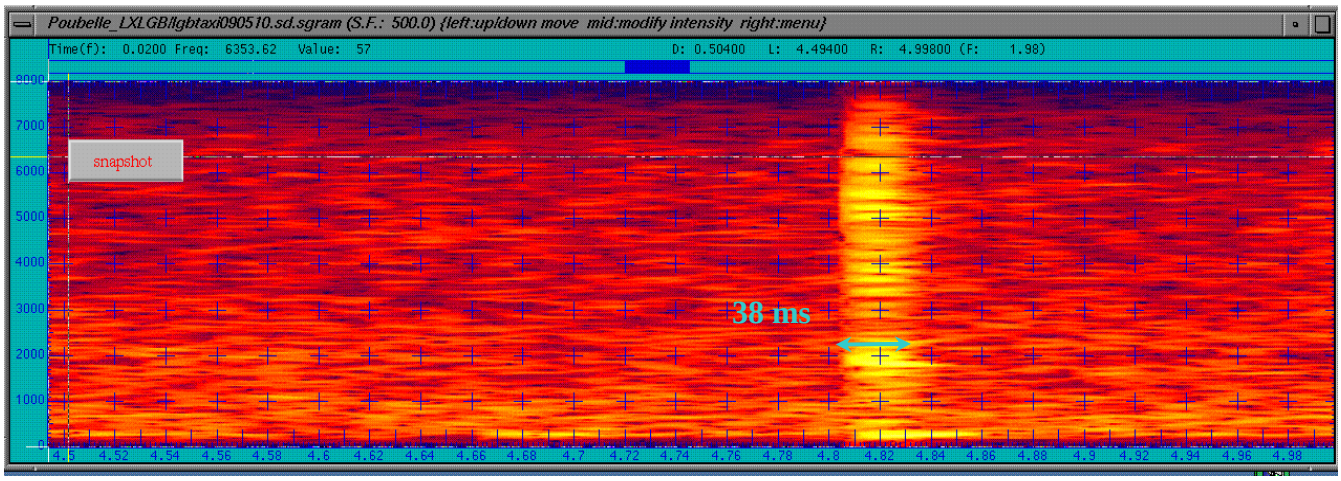


Fig. 3: *Représentation Temps – Fréquence du bruit transcrit.* ***Time – Frequency representation of the transcribed noise.***

La figure ci-dessus représente le bruit enregistré sur le CVR de l'accident et transcrit comme l'activation des taxi lights. La figure suivante représente un enregistrement du bruit généré par l'activation des taxi lights lors des essais au sol.

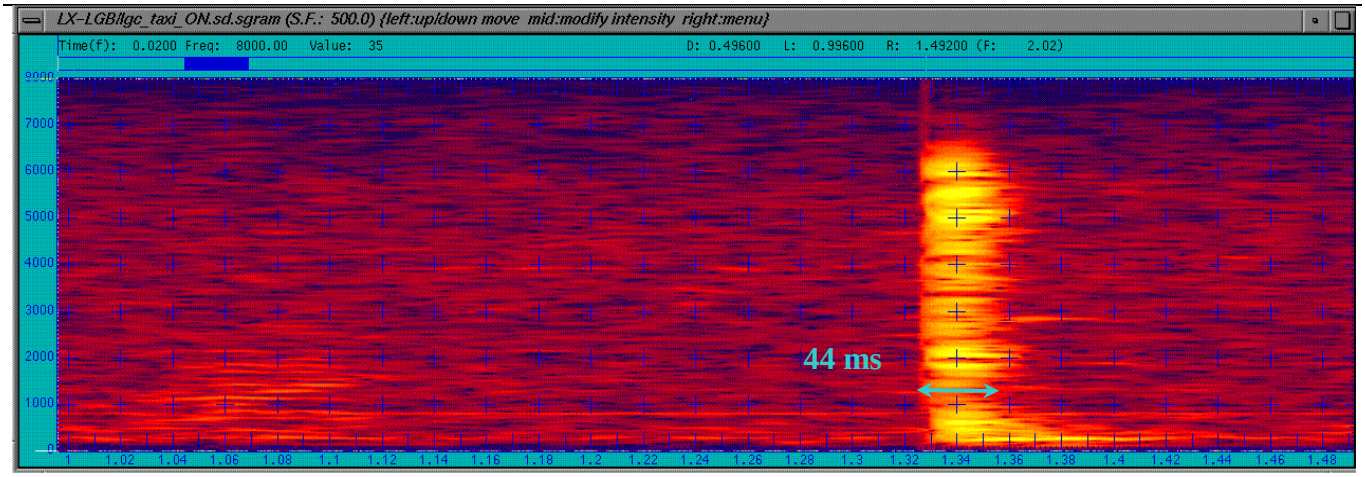


Fig. 4: *Représentation Temps-Fréquence du bruit generé.* ***Time – Frequency representation of the generated noise.***

Le domaine temporel : / ***The time domain:***

L'analyse du signal dans ce domaine consiste à mesurer la durée du signal global et sa cadence si le bruit se décompose en plusieurs parties.

The signal analysis consists in measuring the global signal duration and its cadence if the noise can decomposed in several parts.

Dans cet exemple on a : / *In this example, we have:*

Durée du bruit transcrit / *Duration of the transcribed noise*: **38 ms**
Durée du bruit generé / *Duration of the generated noise*: **44 ms**

Le domaine fréquentiel : / ***The frequency domain*****:**

L'analyse se fait ici sur la répartition des pics d'énergie selon la gamme de fréquence étudiée et sur la forme du signal. Cette dernière est définie par les durées respectives de chaque fréquence caractéristique du bruit étudié. Ainsi dans l'exemple étudié, on retrouve dans les deux représentations une composante basse fréquence plus longue que les autres fréquences. Cela est dû au montage de l'interrupteur sur le panneau supérieur du cockpit. A cet emplacement, une cavité existe sous le panneau supérieur et l'air qu'elle contient entre en vibration, expliquant cette composante basse fréquence.

The analysis is here done on the energy distribution over the range of frequencies studied and the shape of the signal. The latter is defined by the respective duration of each specific frequency of the analysed noise. Thus, in this example, both representations feature a low frequency peak longer than the other frequencies. This is due to the position of the switch on the over-head panel. At this location, a cavity exists below the panel and the air contained starts to vibrate, explaining this low frequency peak.

Les courbes ci-après constituent une coupe verticale de la représentation temps - fréquence décrite plus haut. On peut y voir à un instant donné (pris au milieu du bruit) les fréquences qui caractérisent le bruit analysé. On s'attache ici à la **répartition** des pics d'énergie pour identifier le bruit.

The graphs here-after are a vertical view of the time – frequency representation described above. They show, at a given time (taken in the middle of the noise), the frequencies that define the analysed noise. The distribution of these energy peaks is significant in identifying the noise.

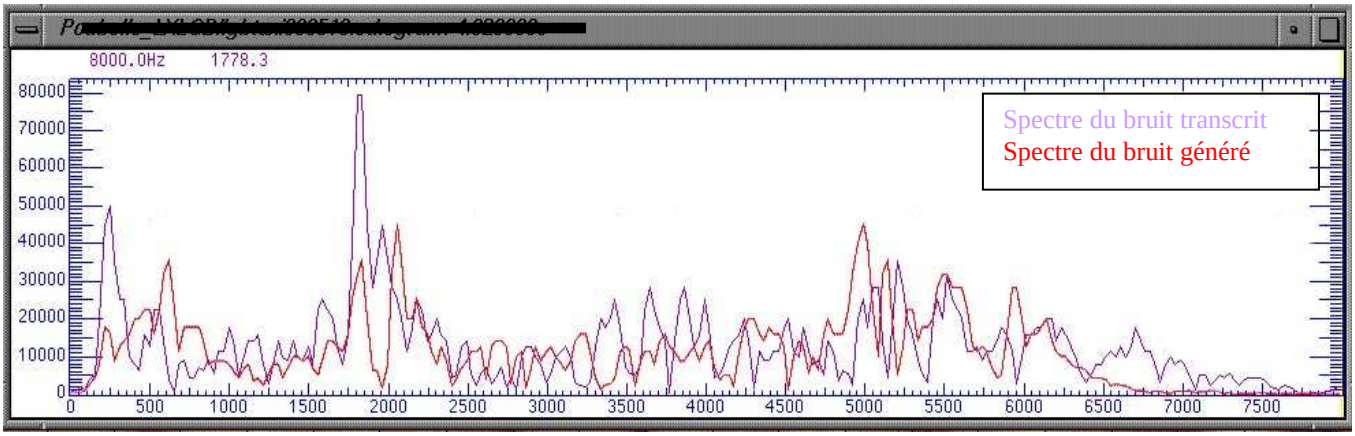


Fig. 5: *Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et généré (en rouge**). Spectrum comparison between the transcribed noise (in mauve) and the generated noise (in red)***

On retrouve les mêmes composantes fréquentielles, notamment aux basses fréquences et autour de **2000** et **5000** Hz.

*As seen in figure 14, the same frequencies are visible, especially for low frequencies and around **2000** and **5000** Hz.*

On conclut donc ici à l'identification positive de **l'allumage des *Taxi Lights***.
*We can thus draw a positive conclusion on the identification of the **Taxi Lights turned On.***

Par ailleurs, ces résultats sont à rapprocher de la phase de vol au cours de laquelle ces bruits interviennent et des procédures de vol qui prévoient, tous dysfonctionnements mis à part, les actions sur les instruments et manettes de l'aéronef.

Moreover, those results have to be compared with the period of the flight during which they occur and with expected flight procedures, assuming no malfunction occurred.

Enfin, il convient de prendre en compte dans ces analyses la perception de l'oreille humaine, assimilable à un puissant analyseur permettant de compiler tous les aspects précédemment développés et de reconnaître, par expérience et par simple écoute, le bruit d'un interrupteur. Ce facteur a une place importante dans l'analyse.

Finally, it should be taken into account the human perception of the hear, comparable to a powerful analyser which can compile all the previously described aspects and can recognize, by experience and through a single listening, the noise of a switch. This factor has an important part in the analysis.

Il est important de noter que dans ces analyses, il ne peut être tenu compte des intensités respectives des signaux transcrit et généré. En effet, les fonctions de contrôle automatique du gain atténuent le signal lorsque le bruit de fond est plus important afin d'éviter une saturation du signal. On ne peut donc pas raisonner sur les valeurs absolues de ces intensités.

It is important to note in these analyses that the respective intensities of the transcribed and the generated noises cannot be taken into account. Indeed, the automatic gain control functions attenuate the signal when the background noise is important in order to prevent the signal overload. We thus cannot analyse the absolute values of those intensities.

NB : Ce rapport présente les comparaisons entre un enregistrement du CVR accidenté et un enregistrement d'essai. Il convient de noter que ces analyses ont été faites pour les deux avions ayant servis aux test et permettent de confirmer que les manœuvres d'une même commande produisent sur les deux avions différents des résultats similaires

N.B.: This report present the comparison between a recording of the accident CVR and one recording of the tests. It should be noted that these analyses were performed for both aircrafts and showed that the same command on the two different aircraft produced similar results.

09 h 04 min 58 s : "Bruit de sélecteur similaire au déplacement du Ground Idle Stop" / *"Sound similar to the operation of the Ground Idle Stop Selector"*

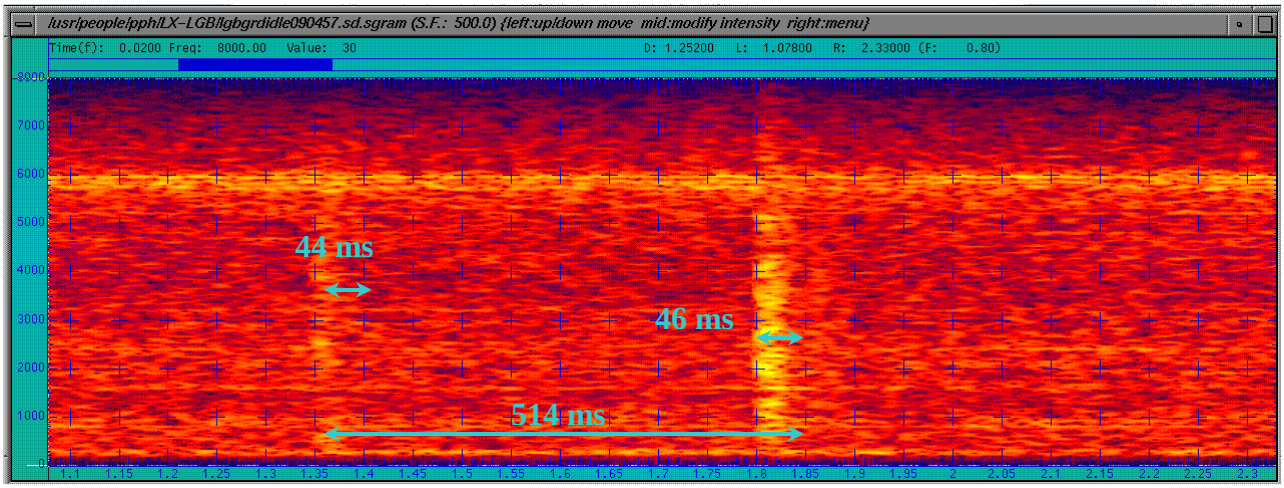


Fig. 6: *Représentation Temps – Fréquence du bruit transcrit.* ***Time – Frequency representation of the transcribed noise.***

La figure précédente représente le bruit à analyser dans le domaine temps-fréquence. L'axe horizontal y représente le temps, l'axe vertical les fréquences, et un code de couleur l'énergie du signal (le bleu représentant les faibles énergies, le jaune ou blanc les plus fortes).

The previous figure represents the noise to be analysed in the time-frequency domain. The horizontal axis represents the time, the vertical axis the frequencies, and a colour code the energy of the signal (blue being the lowest energies, yellow or white the highest).

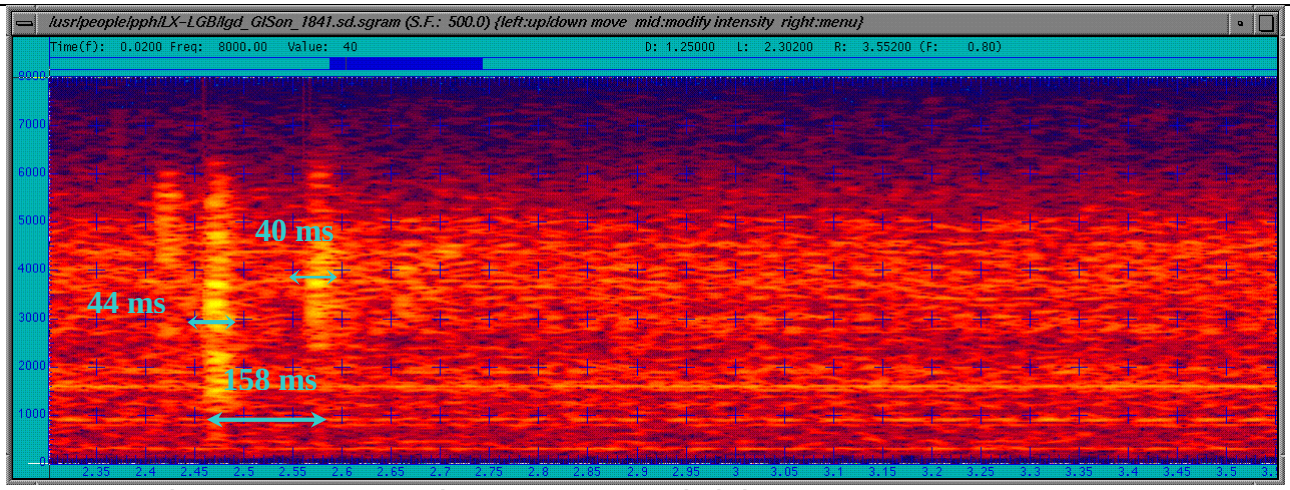


Fig. 7: *Représentation Temps-Fréquence du bruit généré****. Time – Frequency representation of the generated noise.***

La figure précédente représente le bruit du déplacement du Ground Idle Stop vers la position OFF, dans le domaine temps- fréquence.

The previous figure represents the noise of the Ground Idle Stop selector set to OFF, in the time-frequency domain.

Dans le cas présent, les deux bruits ont une forme similaire et peuvent se décomposer en 2 parties. **Cette forme est a priori cohérente avec l'hypothèse de la manœuvre du sélecteur en question** (le *Ground Idle Stop*). En effet, manipuler ce sélecteur suppose sa levée d'une butée, sa translation puis son ré-enclenchement dans sa nouvelle position, d'où le double bruit. Cette cinématique est la seule à produire ce double bruit, à l'exception de la manœuvre des commandes de gaz, des volets et du train d'atterrissage. Ces deux dernières commandes cependant ont une signature spectrale bien différente que l'on ne peut confondre avec le bruit analysé ici.

In the present case, both noises have a similar shape and can be defined as the conjunction of two shorter noises. ***This shape is consistent with the hypothesis of an action on the selector in question*** *(Ground Idle Stop). In fact, moving this selector requires lifting it from its initial position, transferring it and then dropping it into its new position, which explains the double noise. This sequence of operations is the only one which produces this double noise, apart from the throttle, the flaps selector and landing gear levers. However, the two latter controls have quite different spectral signatures that cannot be confused with the noise analyzed here.*

Analyse temporelle / ***Time analysis :***

La durée de ces bruits est du même ordre de grandeur : 44 et 46 ms pour le LX-LGB, et 44 et 40 ms pour le LX-LGD. A noter que la durée entre ces deux clics peut être facilement modifiée par la cinématique décrite ci-dessus.

The duration of these noises is about the same: 44 and 46 ms for the LX-LGB, and 44 and 40 ms for the LX-LGD. It should be noted that the duration between the two clicks can be easily modified due to the particular sequence of operations previously described.

Analyse fréquentielle / *Frequency analysis :*

Les courbes ci-après constituent une coupe verticale de la représentation temps - fréquence décrite plus haut. On peut y voir à un instant donné (choisi au milieu du bruit) les fréquences qui caractérisent le bruit analysé. On s'attache ici à la **répartition** des pics d'énergie pour identifier le bruit.

The graphs here-after are a vertical view of the time – frequency representation described above. They show, at a given time (taken in the middle of the noise), the frequencies that define the analysed noise. The distribution of these energy peaks is significant in identifying the noise.

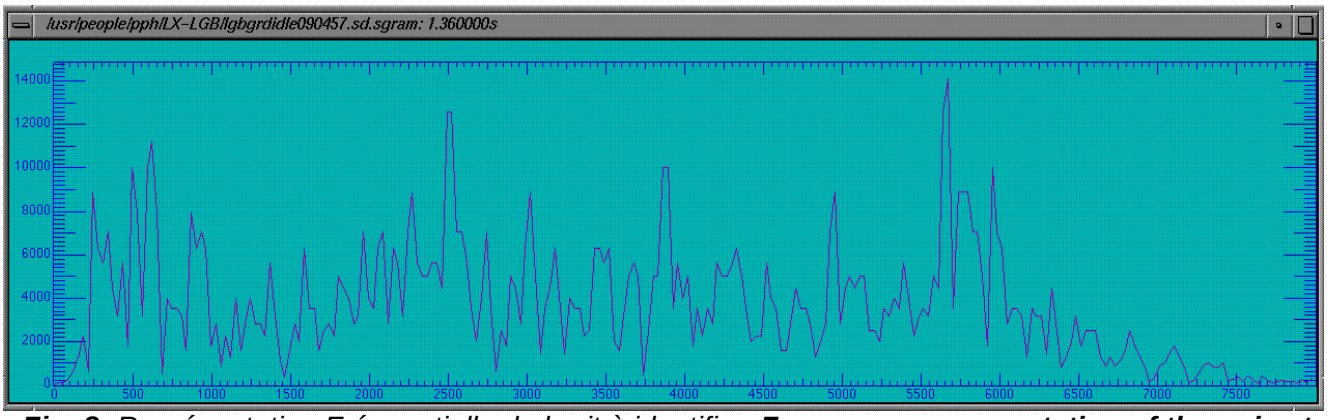


Fig. 8: *Représentation Fréquentielle du bruit à identifier****. Frequency representation of the noise to be identified.***

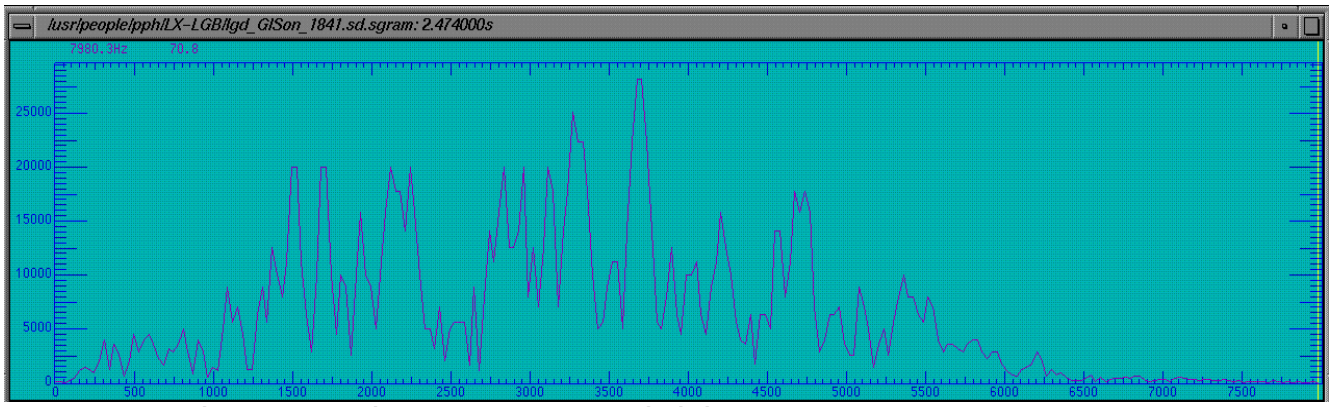


Fig. 9: *Représentation Fréquentielle du bruit généré****. Frequency representation of the generated noise.***

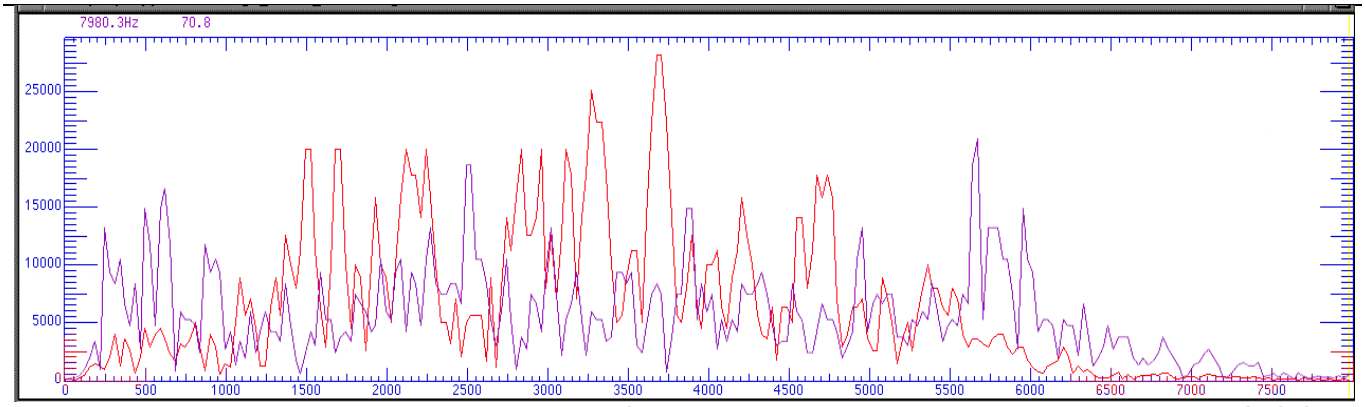


Fig. 9bis : *Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et généré (en rouge).* ***Spectrum comparison between the transcribed noise (in mauve) and the generated noise (in red)***

Comme expliqué précédemment, les figures 5 et 6 illustrent les différences de bruit de fond entre les deux CVR. Dans le cas du LX-LGB, le spectre est plus large en raison des bruits aérodynamique et des moteurs.
Cependant, on reconnaît des correspondances entre les deux spectres, notamment de **1500** à **2500** Hz et entre **4500** et **5000** Hz.

As explained above, figures 5 and 6 show the difference in the background noise between the two CVRs. In the case of LX-LGB, the spectrum is wider due to aerodynamic and engine noises.
However, some frequencies match between the two spectrums, especially from ***1,500*** *to* ***2,500*** *Hz, and between* ***4,500*** *and* ***5,000*** *Hz.*

Au vu des éléments décrits ci-dessus, il apparaît donc ***probable*** que la commande actionnée soit celle du Ground Idle Stop mis sur Off.

Given the data described above, it seems likely that the selector that was selected was the Ground Idle Stop command set to Off.

09 h 05 min 00 s : "Bruit similaire au soulèvement des Ground Range Selector" / *"Sound similar to the lifting of the Ground Range Selector"*

Ce bruit est généré lorsque, à partir de la position *Flight Idle* des deux manettes de puissance, le pilote soulève les deux leviers du *Ground Range Selector*, permettant le passage du cran amenant ces deux manettes en plage "Béta". Un bruit se fait entendre pour chaque levier, gauche et droit. Cependant, lorsque la manœuvre est faite pour les deux côtés en même temps, ces deux bruits sont alors confondus en un seul.

This noise is generated when, from the Flight Idle *position of the throttles the pilot has to lift two levers called Ground Range Selector permitting the movement of the throttles into the Beat range. A noise can be heard for each lever, left and right. However, when the operation is done simultaneously for both sides, the two noises appear to be one.*

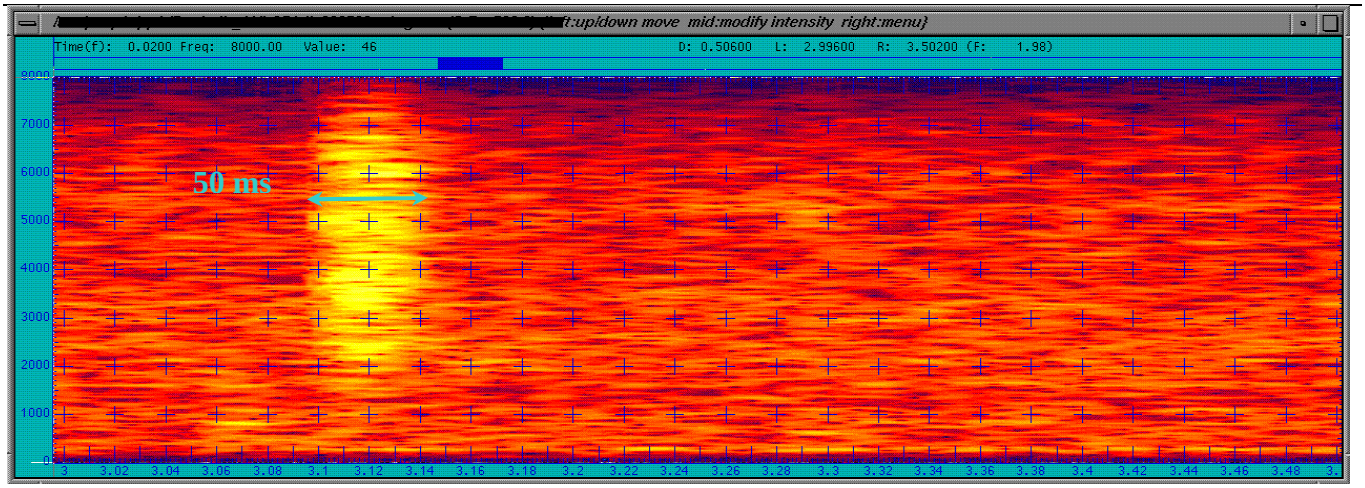


Fig. 10: *Représentation Temps – Fréquence du bruit transcrit.* ***Time – Frequency representation of the transcribed noise.***

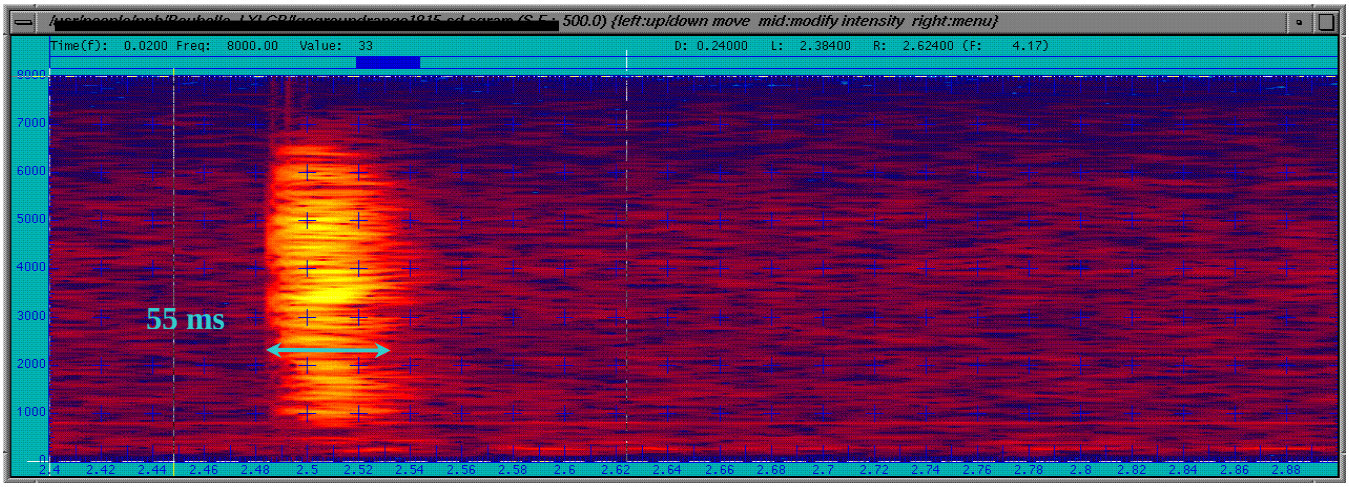


Fig. 11: *Représentation Temps-Fréquence du bruit généré.* ***Time – Frequency representation of the generated noise.***

La figure ci-dessus représente le bruit du déplacement des *Ground Range Selector* dans le domaine temps - fréquence dans le cas où les deux leviers sont soulevés simultanément afin de retrouver une forme semblable à celle obtenue avec le bruit transcrit.

The above figure represents the noise made by the operation of the Ground Range Selector when the two levers are lifted at the same time in order to obtain a shape similar to the transcribed noise.

Analyse temporelle / *Time analysis* :

Durée du bruit transcrit / *Duration of the transcribed noise*: **50 ms**
Durée du bruit generé / *Duration of the generated noise*: **55 ms**

Analyse fréquentielle / *Frequency analysis :*

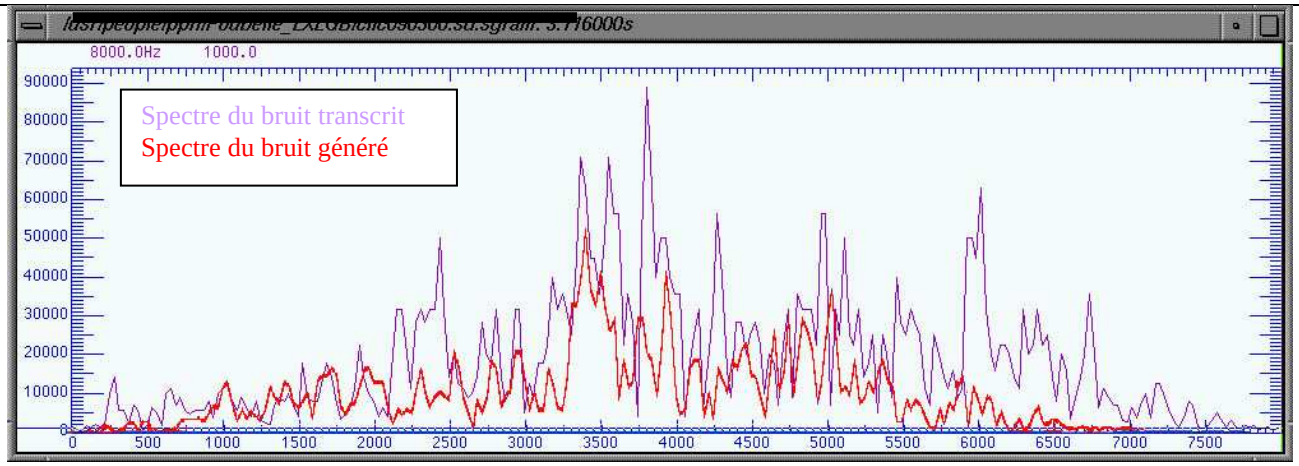


Fig. 12: *Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et generé (en rouge).* ***Spectrum comparison between the transcribed noise (in mauve) and the generated noise (in red)***

La figure ci-dessus est une superposition des représentations fréquentielles du bruit transcrit et du bruit généré. Les intensités du spectre du bruit transcrit apparaissent logiquement supérieures à celles du bruit généré (voir paragraphe **3.2 *Environnement sonore / Acoustic environment***).
On constate ainsi que les deux spectres sont très proches. On rappelle que les pics entre 5500 et 6000 Hz proviennent du fonctionnement du turbopropulseur.

*The above figure is a superimposition of 2 spectra from the transcribed noise and the generated noise. The spectrum intensity for the transcribed noise is logically higher than for the generated noise (See paragraph **3.2 Environnement sonore / Acoustic environment**).*
Thus, both spectra are very similar. As a reminder, the peaks between 5,500 and 6,000 Hz come from the operation of the turboprop.

On peut donc conclure, en raison de la meilleure concordance des spectres de fréquences, que bruits transcrit et généré sont identiques : il s'agit du **soulèvement deux leviers du *Ground Range Selector***.

*We can thus conclude, based on better matching between the frequency spectra, that the transcribed and the generated noises are the same: it is the **lifting of the two Ground Range Selector levers***.

09 h 05 min 09 s : "Bruit similaire à la manoeuvre de la commande des flaps" / *"Sound similar to the operation of flaps control"*

Ce bruit intervient alors que l'équipage vient de mentionner la position des volets. A la suite de cette annonce et de ce bruit, les données du FDR indiquent un déploiement des volets vers la position dix degrés.

This noise occurs as the crew members talk about the flaps position. After this communication and this noise, the FDR data show that the flaps extended to ten degrees.

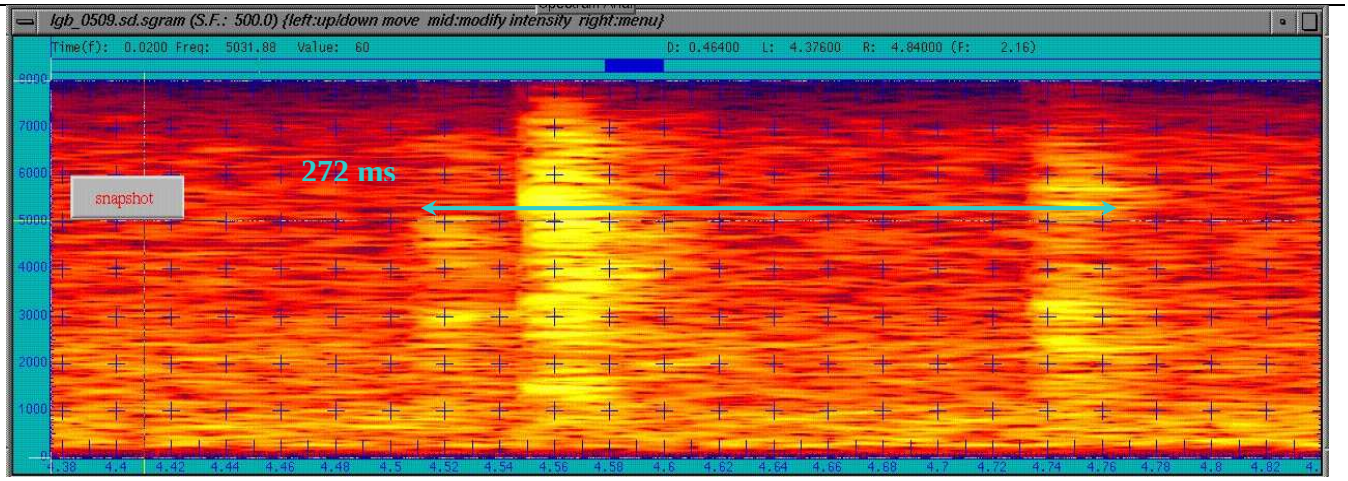


Fig. 13: *Représentation Temps – Fréquence du bruit transcrit.* ***Time – Frequency representation of the transcribed noise.***

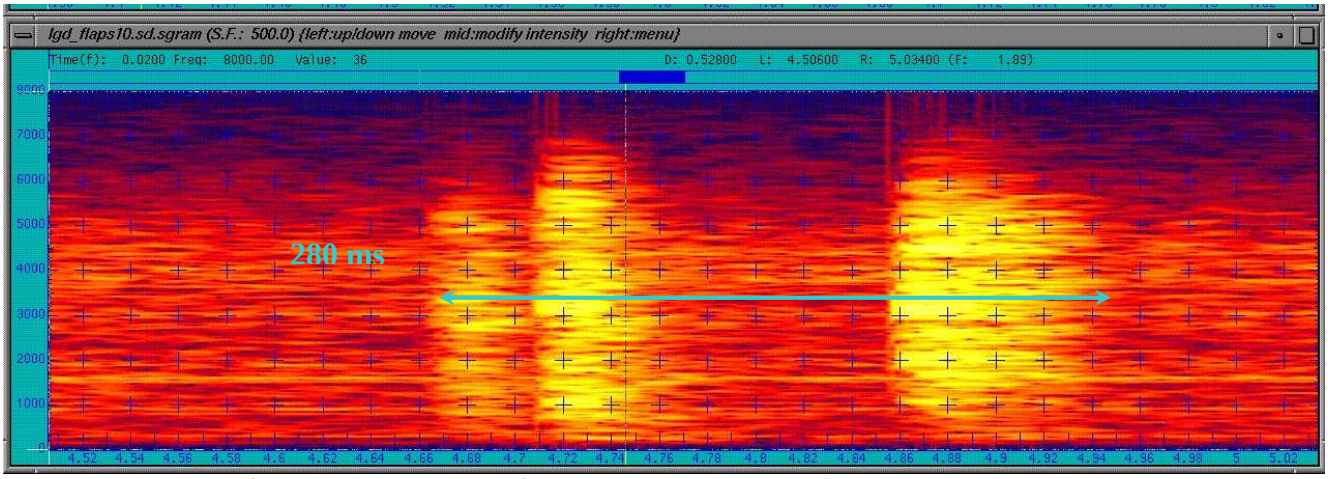


Fig. 14: *Représentation Temps-Fréquence du bruit generé.* ***Time – Frequency representation of the generated noise.***

Analyse temporelle / *Time analysis :*

Durée du bruit transcrit / *Duration of the transcribed noise*: **272 ms**
Durée du bruit generé / *Duration of the generated noise*: **280 ms**

Les figures précédentes illustrent les similitudes existant entre les deux bruits, où l'on retrouve la même forme de signature, les mêmes cadences.

The preceding figures illustrate the similarities between the two noises, where the same signature shape and rates are found.

Analyse fréquentielle / *Frequency analysis* :

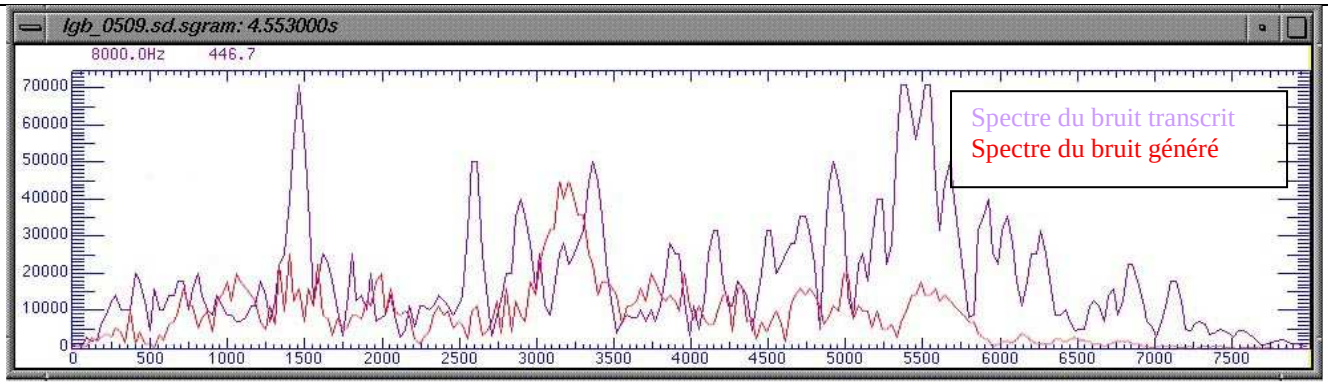


Fig. 15: *Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et generé (en rouge)**. Spectrum comparison between the transcribed noise (in mauve) and the generated noise (in red)***

Bien que moins évidents, les résultats de la figure ci-dessus permettent de retrouver les points communs entre les deux bruits, notamment autour de **3250**, **3800**, **5000** et **5500** Hz.

Though not as clearly as in previous examples, the above figure shows the similarities between the two noises, especially around **3250**, **3800**, **5000** and **5500** Hz.

Tous les éléments précédents (durée, cadence, faciès, répartition des fréquences) permettent donc de conclure à **l'identification positive du bruit : le déplacement de la commande des volets.** Les données du FDR confirme un **déplacement vers la position dix degrés**

All the previous elements (duration, rate, shape, distribution of frequencies) allow us to reach a conclusion about the ***positive identification of the noise: the setting of the flaps control.*** *The FDR data confirm a* ***movement towards ten degrees****.*

09 h 05 min 11 s : "Bruit similaire à l'activation des Taxi Lights" / *"Sound similar to Taxi Lights being switched on"*

Voir l'exemple donné dans le paragraphe **3.4 Identifications et analyses** / ***Identification and analyses***

See the example given in paragraph ***3.4 Identifications et analyses / Identification and analyses***

09 h 05 min 19 s : "Bruit" / *"Noise"*

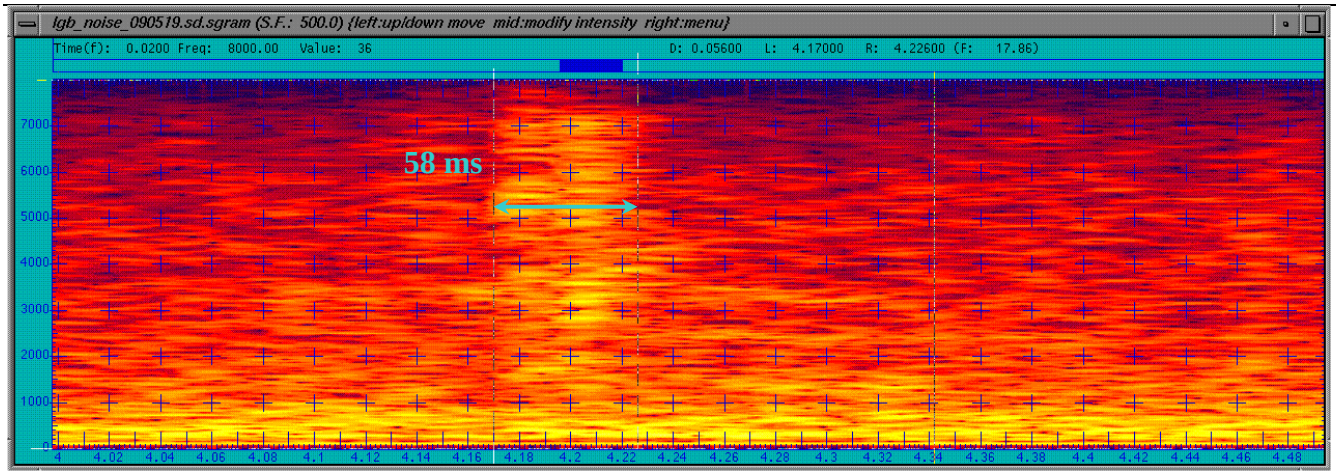


Fig. 16: *Représentation Temps - Fréquence du bruit à identifie****). Time Frequency representation of the noise to be identified.***

Ce bruit peut se décomposer temporellement en deux parties correspondant à deux « clics » distincts mais très rapprochés. Sa durée totale est de **58 ms**.

This noise can be decomposed temporally in two parts corresponding with two separate but adjacent noises. Its total duration is ***58 ms****.*

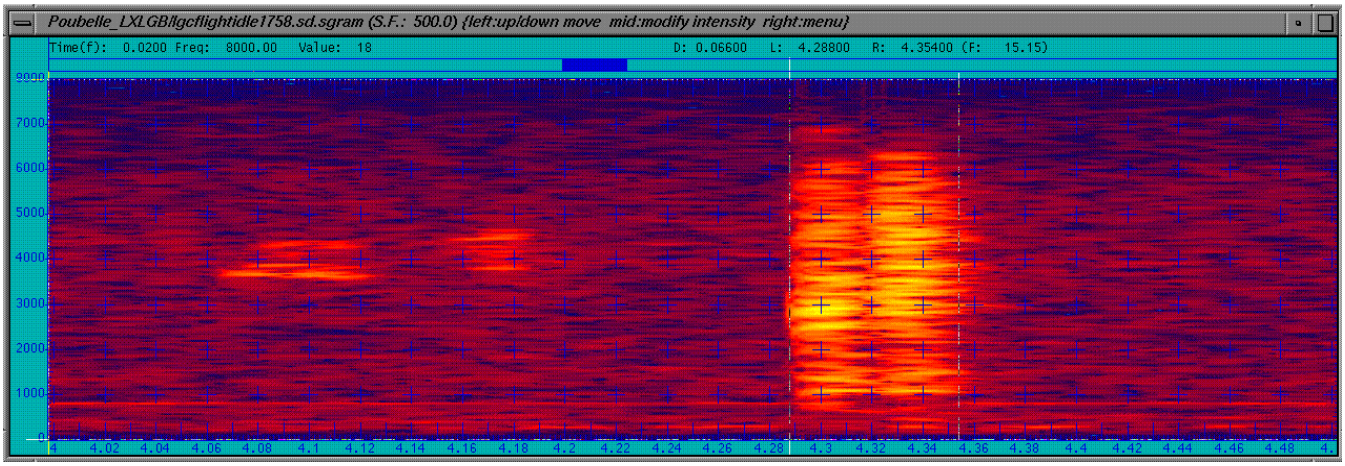


Fig. 17: *Représentation Temps - Fréquence du mouvement de la manette des gaz mise en position « Flight Idle ».*
Time Frequency representation of the operation of the throttle moved to « Flight Idle » position.

La figure ci-dessus correspond à la manipulation des manettes des gaz sur le Fokker 50 immatriculé LX-LGC. Ces manettes étant en position *Ground Idle*, elles sont ramenées en position *Flight Idle*. On retrouve ici cette décomposition en deux clics distincts. La durée totale de ce bruit est de **70 ms**.

The above figure corresponds to the movement of the thrust levers on the Fokker 50 registered LX-LGC. The thrust levers were moved to the Flight Idle *position from the* Ground Idle *position. The same two separate clicks can be seen. The total duration of this noise was* ***70 ms****.*

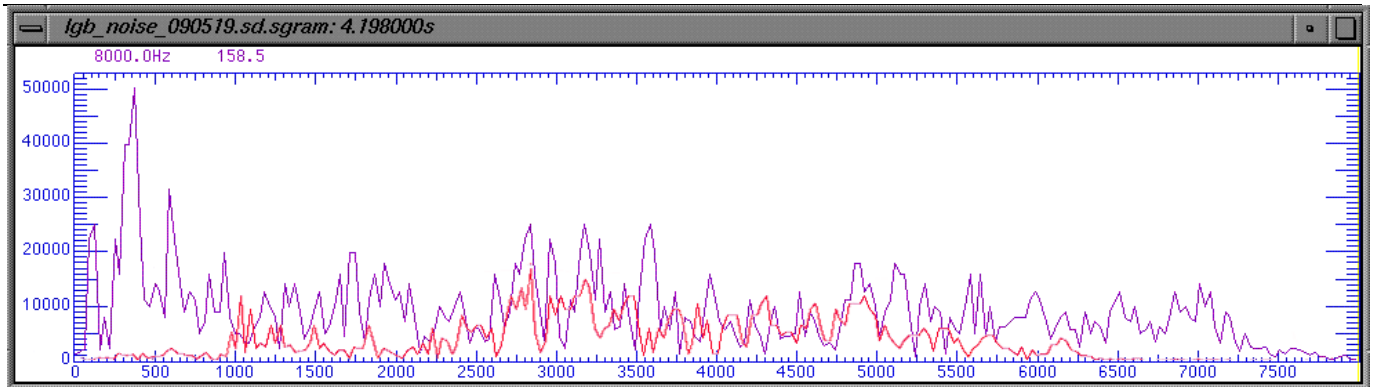


Fig. 18: Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et généré (en rouge).
Spectrum comparison between the transcribed noise (in mauve) and the generated noise (in red)

Le bruit à identifier est rapproché de celui de mouvement de la manette des gaz dans la mesure où ce dernier est cohérent avec le faciès du signal (deux clics). La figure ci-dessus illustre les fréquences communes à ces deux bruits (**2800**, **3200**, **5000** Hz…). Il s'agit ici du déplacement des manettes des gaz vers la position *Flight Idle*.

*The noise to be identified is compared with that of the movement of the thrust levers in so far as the latter is consistent with the shape of the signal (two clicks). The above figure shows the common frequencies between these two noises (**2800**, **3200**, **5000** Hz…). This represents the movement of the throttle levers to the* Flight Idle *position.*

Une deuxième comparaison du bruit transcrit avec un autre mouvement de manette donne des résultats comparables. En ramenant cette fois les manettes de gaz en position *Reverse*, on obtient les résultats suivants :

A second comparison of the transcribed noise with another lever movement gives comparable results. By moving the throttle levers to the "Reverse" position, the following results are obtained:

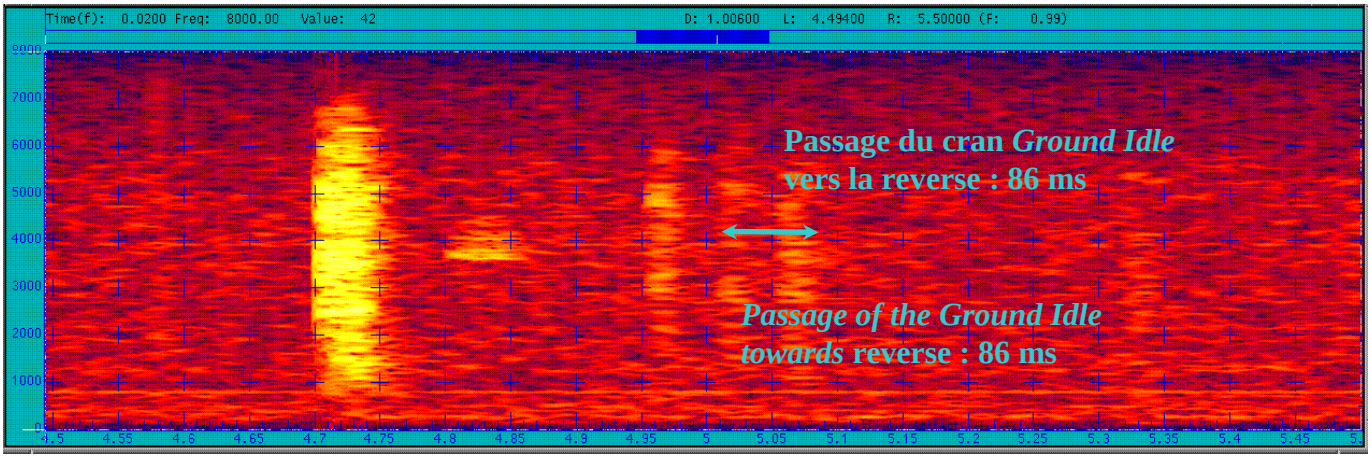


Fig. 19**: Représentation Temps - Fréquence issue du mouvement de la manette des gaz mise en position « Reverse » depuis la position* Flight Idle. ***Time Frequency representation of the movement of the throttle from the* Flight Idle *position to the « Reverse» position.

La figure ci-dessus illustre tout le mouvement des manettes de gaz de la position *Flight Idle* à la position *Reverse*. Les flèches indiquent le passage du cran *Ground Idle*.

The previous figure shows the complete displacement of the thrust levers from the Flight Idle *position to the* Reverse *position. The arrows indicate the passage of the* Ground Idle *position.*

S'agissant d'un mouvement de manette, on retrouve encore la même décomposition du bruit. Dans le cas présent, ce bruit est plus long que celui transcrit, avec les causes connues décrites au paragraphe **3.4.2**. Les comparaisons des spectres donnent :

*Since this is a movement of a lever, the same double signature of the noise is obtained. In this case, this noise is longer than the one transcribed, the known causes being as described in section **3.4.2**. The comparison of the spectra shows :*

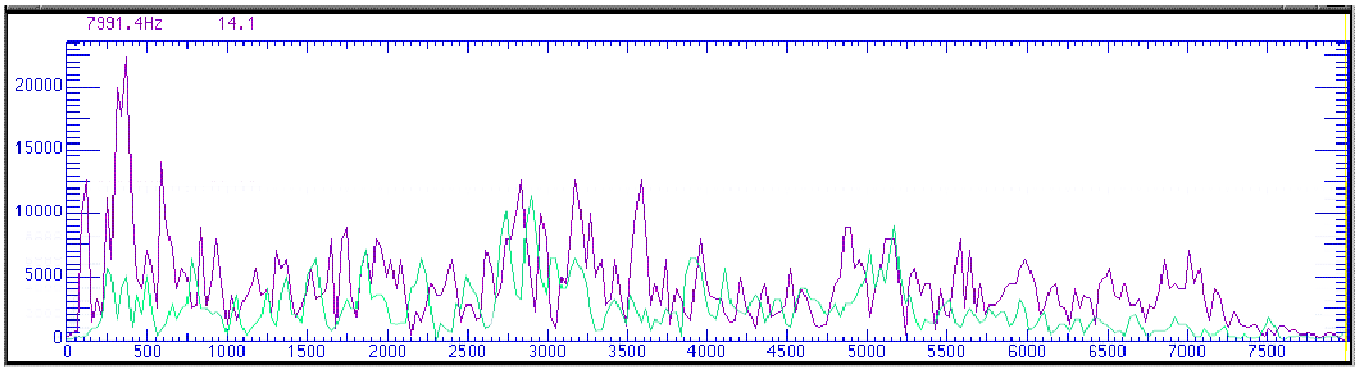


Fig. 20: *Comparaison des composantes fréquentielles des bruits transcrit (en mauve) et generé (en vert).* ***Spectrum comparison between the transcribed (in mauve) and the generated noise (in green)***

Là encore, les spectres présentent des similitudes autour de **700**, **1500**, **3200**, **4000** Hz, … C'est pourquoi les deux précédents bruits testés ont été comparés entre eux afin d'établir une identification différentielle. On obtient alors les résultats de la figure suivante.

*Here again, both spectra show similarities around **700**, **1500**, **3200**, **4000** Hz… This is why the two previous noises tested were compared with each other in order to obtain a differential identification. The results in the figure below were thus obtained.*

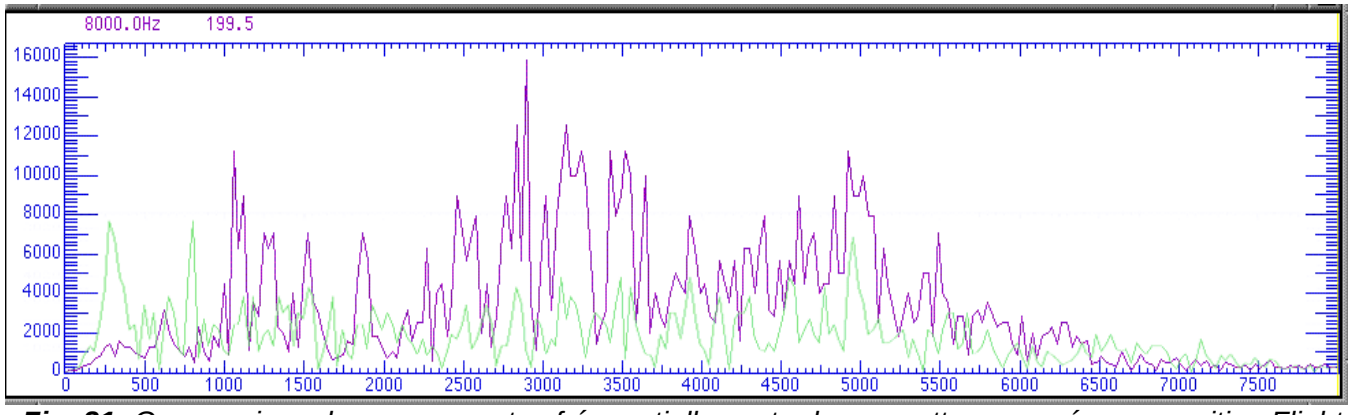


Fig. 21: *Comparaison des composantes fréquentielles entre les manettes poussées en position Flight Idle (en mauve) et en reverse (en vert).* ***Spectrum comparison between the throttle set to Flight Idle position (in mauve) and Reverse position (in green)***

Les deux spectres présentent des caractéristiques générales proches ne permettant pas de distinguer les deux mouvements de manettes entre eux de manière systématique. Il convient donc de conclure que l'identification du bruit transcrit est **probablement celle d'un mouvement de manette, sans que l'on puisse conclure vers quelle position**. L'enregistrement FDR montre une montée en régime des moteurs

consécutive à ce bruit, ainsi que le passage du paramètre enregistrant le calage de l'hélice en « *Low Pitch* ». **Ce dernier point est cohérent avec l'hypothèse du passage en *Reverse*.**

*The two spectra show similar general characteristics, which makes it impossible to make a positive distinction between the two different lever movements in a systematic manner. It can thus be concluded that the identification of the transcribed noise is probably that of a thrust lever movement, though no conclusion can be reached as to which position it was moved to. The FDR recording shows an increase in engine RPM following this noise and the recorded parameter for the propeller pitch switches to "Low Pitch". **This is consistent with the hypothesis of the Reverse mode of the propeller.***

09 h 05 min 21 s : "Bruit similaire à la manoeuvre de la commande des flaps" / *"Sound similar to the operation of flaps control"*

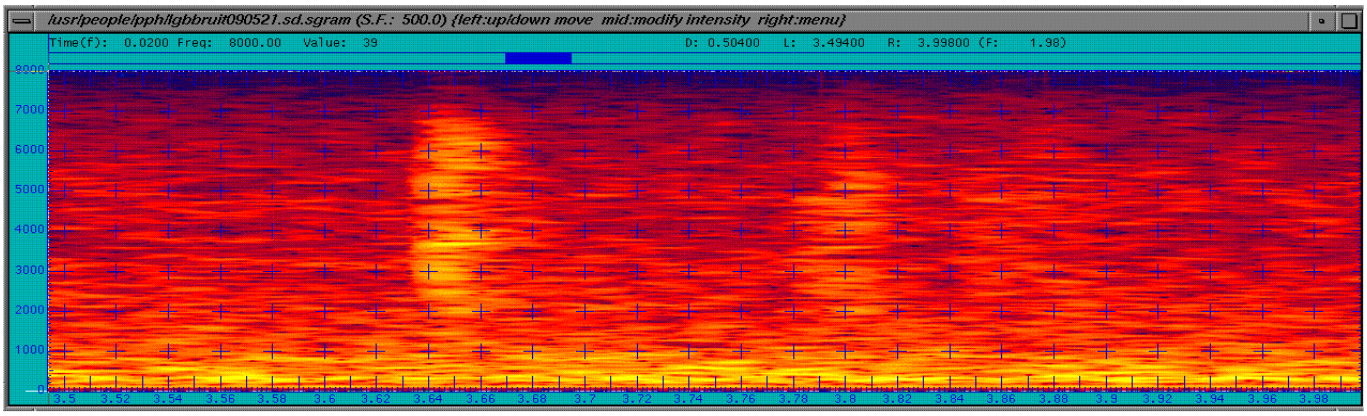


Fig. 22 : *Représentation Temps – Fréquence du bruit.* ***Time – Frequency representation of the noise.***

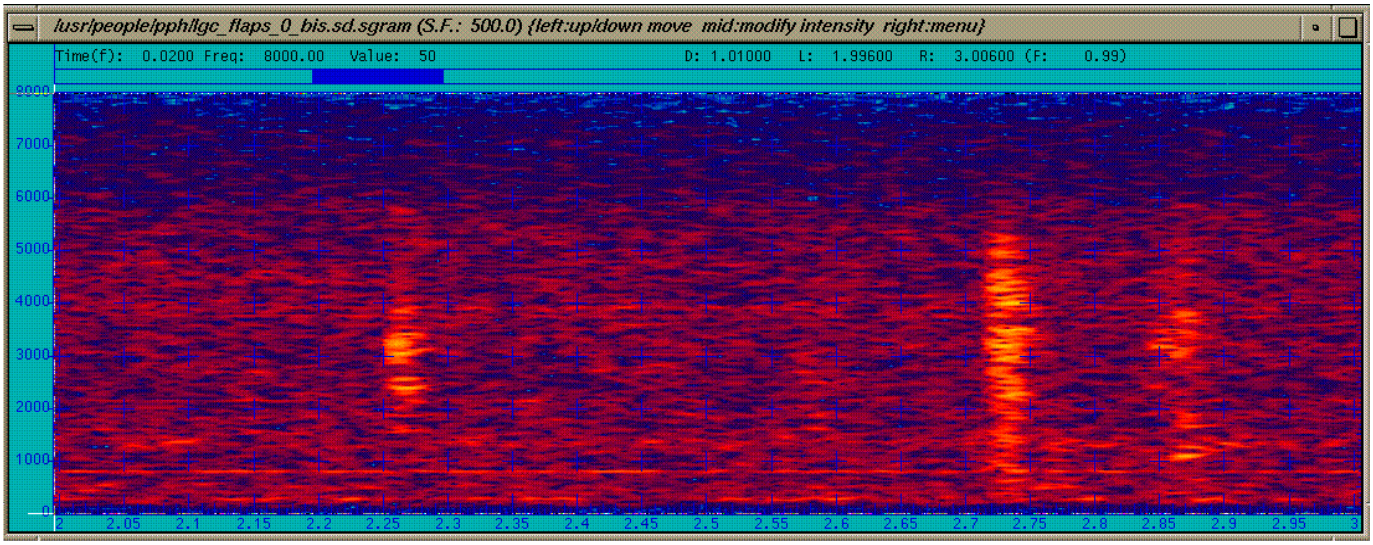


Fig. 23 : *Représentation Temps – Fréquence du bruit de la commande des volets ramenée en position 0°.* ***Time – Frequency representation of the flaps command noise moved to 0°.***

Ce bruit intervient juste avant que les données FDR indiquent un repliement des volets vers la position « rentrés ». A l'écoute, ce bruit est perçu comme proche des bruits de commande des volets. Cependant, les essais effectués ne permettent pas de valider cette identification, les spectres de fréquence (non représentés ici) ne présentant que peu de similarités.

This noise occurs just before the FDR data show that the flaps returned to the retracted position. When listening to this noise, it sounds similar to the noise of the flaps control. However, this could not be validated by the tests preformed due to the small similarities between the frequency spectra (not represented here).

09 h 05 min 27 s : "Bruit" / *"Noise"*

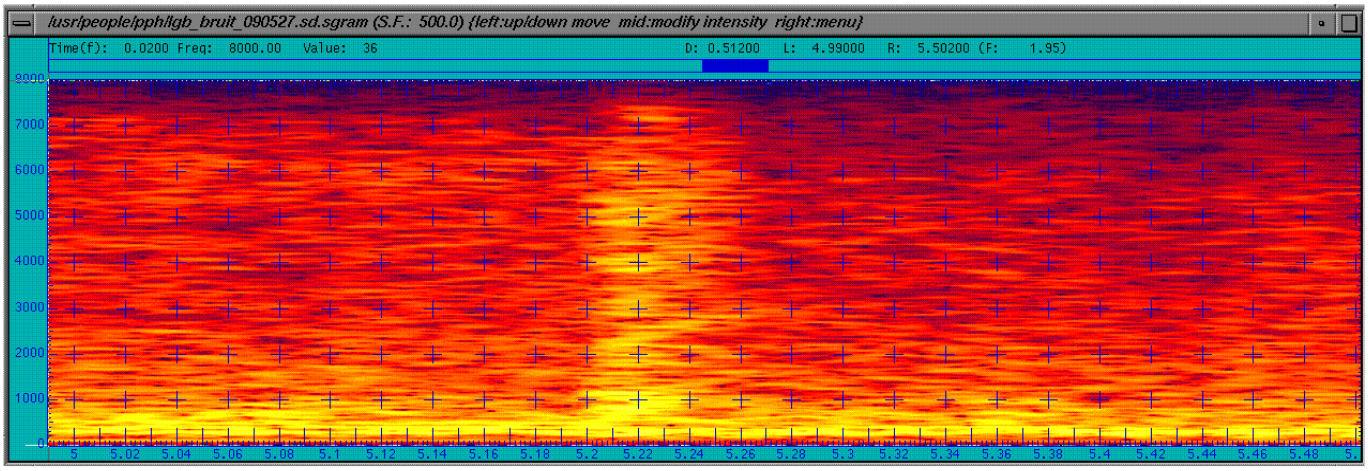


Fig. 23 : *Représentation Temps – Fréquence du bruit.* ***Time – Frequency representation of the noise.***

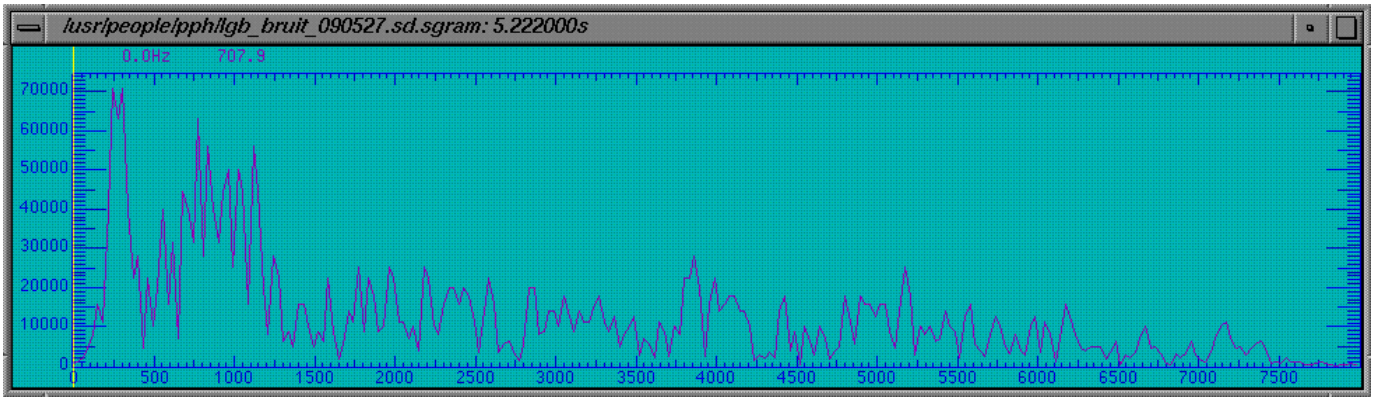


Fig. 24 : *Spectre du bruit inconnu.* ***Spectrum of the unidentified noise.***

Ce bruit, caractérisé par de fortes énergies en basses fréquences, n'a pas pu être identifié par les essais.

This noise, characterized by high levels of energy at low frequencies, could not be identified by the tests.

4 CONCLUSION

Les essais effectués sur deux Fokker 50 de la Luxair ont permis de recenser un grand nombre de bruits afin de les comparer à ceux présents sur le CVR du LX-LGB. Les outils disponibles pour ces identifications permettent de dégager certaines caractéristiques de ces bruits, comme leur durée, leur cadence et la répartition des fréquences majoritaires. Il convient lors de l'analyse de souligner que les essais ont été faits sur un avion de même type, mais différent de celui accidenté. Les bruits de fond peuvent varier avec la vitesse de l'avion, ses paramètres moteurs, sa configuration de vol (volets, pas de l'hélice, train d'atterrissage). De la même façon, chaque interrupteur ou manette d'un appareil peut présenter des caractéristiques propres différentes du même élément d'un autre avion.

Il ressort néanmoins de cette analyse les résultats suivants :

Temps de la Transcription	**Hypothèse**	**Résultat**
09 h 04 min 58s	Déplacement du Ground Idle Stop	Probable
09 h 05 min 00s	Soulèvement du Ground Range Selector	Positif
09 h 05 min 09s	Commande des flaps	Positif (vers 10 °)
09 h 05 min 11s	Activation des Taxi Lights	Positif
09 h 05 min 19s	-	Passage du cran ground idle (positive)
09 h 05 min 21s	Commande des flaps	Pas d'identification possible
09 h 05 min 27s	-	Pas d'identification possible

The tests made on two Luxair Fokker 50's were used to compile a large number of noises in order to compare them to those recorded on LX-LGB. The tools available to identify them showed some characteristics of these noises, such as their duration, their rate and the main distribution of the frequencies. During analysis, it is important to note that the tests were recorded on the same type of aircraft, though different from the accident aircraft. Background noises may vary with the aircraft speed, its engine parameters, and flight configuration (flaps, propeller pitch, landing gear). Moreover, each switch or lever on the aircraft can have its own characteristics, different from those of the same part on another aircraft.

This analysis nevertheless gives the following results:

Time on the Transcription	***Hypothesis***	***Result***
09 h 04 min 58s	*Ground Idle Stop movement*	*Probable*
09 h 05 min 00s	*Lift of the Ground Range selector*	*Positive*
09 h 05 min 09s	*Flaps control*	*Positive (towards 10°)*
09 h 05 min 11s	*Taxi Lights switching on*	*Positive*
09 h 05 min 19s	-	*Noise of the ground idle position (positive)*
09 h 05 min 21s	*Flaps control*	*No identification possible*
09 h 05 min 27s	-	*No identification possible*

Les autres bruits testés et décrits en page six n'ont pas de correspondance avec des bruits transcrits.
The other tested noises described in page six do not have any match with transcribed noises.

Appendix 19: Excerpts from Luxair AFM

FLEXIBLE TAKE-OFF (PROCEDURE)

FLX shall not be used when:
- The runway is contaminated with standing water, slush, snow, or ice.
- The runway is wet unless the increased stopping distance is accounted for.
- Windshear is reported or expected.
- Skid control is inoperative.
- The operator cannot establish a means to verify the availability of max take-off power to ensure that engine deterioration does not exceed authorized limits.

PROPELLER OPERATING LIMITS

WARNING: DO NOT ATTEMPT TO SELECT GROUND IDLE IN FLIGHT. IN CASE OF FAILURE OF THE FLIGHT IDLE STOP, THIS WOULD LEAD TO LOSS OF CONTROL FROM WHICH RECOVERY MAY NOT BE POSSIBLE.

To avoid high propeller stresses, stabilized ground operation in the propeller rpm range of 65 per cent to 90 per cent NP is not permitted with the airplane static.
Excluded from this limitation is the use of reverse during ground maneuvering in engine EC operating mode.

Appendix 20: Airworthiness Directive of the Netherlands BLA nr. 2003-091

Transport and Water Management
Inspectorate
Civil Aviation Authority Netherlands

Airworthiness Directive Of The Netherlands

Bijzondere Luchtwaardigheida Aanwijzing - BLA

Correspondence address
P.O. Box 575, 2130 AN Hoofddorp, The Netherlands

Caution

In accordance with the Aviation Act 2001 (Wet Luchvaart)), Articles 3.22, the following Airworthiness Directive (BLA) is issued by the Minister of Transport, Public Works and Water Management. Airworthiness Directives affect aviation Safety. These are regulations which require immediate attention. You are cautioned that no person may operate an aircraft to which an Airworthiness Directive applies, except in accordance with the requirements of thereof

BLA nr : 2003-091

Date : 31. juli 2003

FOKKER SERVICES B.V.
(Fokker)

F.27 Mk.050, MK.502 AND MK.604

CAA-NL Type Certificate Nr.: T-050-87

LANDING GEAR - SKID CONTROL UNIT – REPLACEMENT

Description :
Several Fokker 50 (F.27 Mk.050) operators have reported pulsating brake behaviour and loss of braking at low speeds in the normal braking mode. Investigation of this phenomenon has shown that electromagnetic interference (EMI), resulting from failed components in other electronic systems and induced on the wheel speed sensor and/or test inputs of the Skid Control Unit, is the cause of these problems. The Aircraft Braking Systems Corporation (ABSC) has now developed a modified Skid Control Unit, Part Number (P/N) 6004125-2 and has issued Service Bulletin (SB) 6004125-32-01 to recommend the replacement of all earlier models (P/N 6004125 and 6004125-1). Concurrently, this modified unit also provides suppression of the 20 mph wheel speed signals during the execution of a Skid Control Unit test in flight, which is recommended by the AOM, to be performed after a lightning strike with landing gear down. Suppression is considered necessary because the aforementioned signals inadvertently activate the Ground Control Relay and Flight-Idle Stop solenoid for about 16 seconds of the Propeller Control System. The modified unit retains the modification of P/N 600425-1 preventing inadvertent generation of the 20 mph wheel speed signals during power-up at landing gear extension. The conditions as described above, if not corrected, could result in continued erratic brake behaviour and propeller control problems. Since an unsafe condition has been identified that may exist or develop on aircraft of this type design, this Airworthiness Directive (BLA) requires the replacement of the affected Skid Control Units.

Applicability: **Fokker Aircraft B.V.,** Model F.27 Mk.050, Mk.0502 and Mk.0604 aircraft, all serial numbers, if equipped with ABSC Skid Control Units P/N 6004125 or 6004125-1.

Effective date : September 1, 2003

Compliance: Required as indicated, unless accomplished previously.

(a) Replace the affected Skid Control Units as follows

(1) For Skid Control Units with P/N 6004125 (pre-ABSC SB F50-32-4), within the next 8 calendar months after the effective date of this directive, in accordance with Part 2 Accomplishment Instructions of Fokker Services SB F50-32-038 dated May 8, 2003 or a later CAA-NL approved revision; or

(2) For Skid Control Units with P/N 6004125-1 (post-ABSC SB F50-32-4), within the next 14 calendar months after the effective date of this directive, in accordance with Part Accomplishment Instructions of Fokker Services SB F50-32-038 dated May 8 , 2003 or a later CAA-NL approved revision;

Note: ABSC SB No.6004125-32-01 dated May 7, 200 also pertains to this subject.

(b) Before or concurrent with the action as required by either paragraph (a)(1) or (a)(2) of this directive, as applicable, modify the Skid Control Unit ground wiring in accordance with Part 2 Accomplishment Instructions of Fokker Services SB F50-32-035 dated August 2,1999 or a later CAA-NL approved revision;

(c) After May 1, 2004, no spare Skid Control Units P/N 6004125 or 6004125-1 may be installed as replacement parts.

Remarks

- Operators of the affected aircraft may obtain copies of the referenced service information upon request directly from Fokker Services B..V., Technical Services Dept., P.O.Box 231, 2150 AE Nieuw-Vennep, The Netherlands; telephone (31) 252-627-350; facsimile (31) 252-627-211; e-mail technicalservices.fokkerservices@stork.com.
- Compliance with this directive must be recorded in the proper Aircraft Log Book(s).

Address inquiries concerning this AD to
Aircraft Division, Section C&D; telephone +31-23-566-3'i55; facsimile +31-23-566-3006; e-mail Info.Register@ ivw.nl

Appendix 21: Excerpts from JAR 25.1155

JAR 25.1141(f) (continued)

(2) In the case of valves controlled from the cockpit other than by mechanical means, where the correct functioning of such a valve is essential for the safe operation of the aeroplane, a valve position indicator operated by a system which senses directly that the valve has attained the position selected, unless other indications in the cockpit give the flight crew a clear indication that the valve has moved to the selected position. (See ACJ 25.1141(f).)

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.1143 Engine controls

(a) There must be a separate power or thrust control for each engine.

(b) Power and thrust controls must be arranged to allow –

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(e) If a power or thrust control incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the shut-off position. The means must –

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shut-off position.

[Ch.12, 10.05.88; Ch.13, 05.10.89]

JAR 25.1145 Ignition switches

(a) Ignition switches must control each engine ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

JAR 25.1145 (continued)

(c) [Each group of ignition switches except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.]

[Amdt. 16, 01.05.03]

JAR 25.1149 Propeller speed and pitch controls

(a) There must be a separate propeller speed and pitch control for each propeller.

(b) The controls must be grouped and arranged to allow –

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(c) The controls must allow synchronisation of all propellers.

(d) The propeller speed and pitch controls must be to the right of, and at least one inch below, the pilot's throttle controls.

JAR 25.1153 Propeller feathering controls

(a) There must be a separate propeller feathering control for each propeller. The control must have means to prevent its inadvertent operation.

(b) If feathering is accomplished by movement of the propeller pitch or speed control lever, there must be means to prevent the inadvertent movement of this lever to the feathering position during normal operation.

JAR 25.1155 Reverse thrust and propeller pitch settings below the flight regime

[Each control for selecting propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) must have the following:

(a) A positive lock or stop which requires a separate and distinct operation by the flight crew to displace the control from the flight regime (forward thrust regime for turbo-jet powered airplanes), and it must only be possible to make this separate and distinct operation once the control has reached the flight idle position.

(b) A means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime (reverse [

JAR 25.1155(b) (continued)

[thrust for turbo-jet powered airplanes) when out of the approved in-flight operating envelope for that function, and override of that means is prohibited.

(c) A reliability, such that the loss of the means required by paragraph (b) above is remote.

(d) A caution provided to the flight crew when the means required by paragraph (b) above is lost.

(e) A caution provided to the flight crew when a cockpit control is displaced from the flight regime (forward thrust regime for turbo-jet powered airplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) outside the approved in-flight operating envelope. This caution need not be provided if the means required by paragraph (b) is a mechanical baulk that prevents movement of the control.]

[Amdt. 16, 01.05.03]

JAR 25.1161 Fuel jettisoning system controls

Each fuel jettisoning system control must have guards to prevent inadvertent operation. No control may be near any fire extinguisher control or other control used to combat fire.

JAR 25.1163 Powerplant accessories

(a) Each engine-mounted accessory must

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or of any remote accessory driven by the engine is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

[Ch.12, 10.05.88]

JAR 25.1165 Engine ignition systems

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw electrical energy from the same source.

(c) The design of the engine ignition system must account for

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) *Not required for JAR 25.*

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit not used for assisting, controlling, or analysing the operation of that system.

(g) There must be means to warn appropriate flight-crew members if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(h) Each engine ignition system of a turbine powered aeroplane must be considered an essential electrical load.

[Ch.9, 30.11.82; Ch.14, 27.05.94]

JAR 25.1167 Accessory gearboxes

For aeroplanes equipped with an accessory gearbox that is not certificated as part of an engine -

(a) The engine with gearbox and connecting transmissions and shafts attached must be subjected to the test specified in JAR–E 160 and JAR E 740, as applicable.

Appendix 22: Fokker Services B.V. comments

One of the observations of the Luxair wreckage was that the right hand propeller blades were found in the maximum reverse pitch position. The internal examination of the right hand engine showed that there was no combustion at the time of impact, indicating that the engine was shutdown prior to that. Shutting-down the engine would normally result in a feathered or partly feathered propeller (depending on the available time) because the fuel lever also moves the feathering valve to the feather position.

Propeller hang-ups in reverse pitch may be explained by a phenomenon observed in the so-called "Cranbrook manoeuvre". The objective of the "Cranbrook manoeuvre" is to demonstrate that if full reverse thrust is selected after landing and the crew decides to take-off again because the runway is obstructed, that full forward thrust can be selected rapidly without exceeding any powerplant limitations. It should be noted that the "Cranbrook manoeuvre" is a special Canadian requirement (ref.: Airworthiness Manual Advisory AMA/525/3) that is not part of the standard JAR/FAR 25. During a recent Fokker 50 Type Validation meeting with Transport Canada it was stated that the Fokker 50 would not be required to meet this requirement because of the original Type Certification date of the Fokker 50 was before the AMA 525 publication date.

From "Cranbrook manoeuvre" type testing it is known that, when slamming a power lever from full reverse to above flight idle, occasionally the propeller may not come out of reverse and may not get into feather either. This behavior requires a real slamming movement and can not be duplicated in case of a more gradual power lever movement. The phenomenon (which may be expected to be common for similar turboprop designs) can be explained as follows.

There are two means to move the propeller blades from the reverse position towards the take-off position (coarse pitch), hydraulically when the propeller is beta controlled or by means of counter weights in the constant speed range. Which of the two means applies depends on the power lever position, i.e. below flight idle this will be hydraulic pressure and above flight idle the counter weights. The counter weights will only force the propeller blade to the correct (coarse) direction from a positive blade angle as starting point.

The reverse pitch hang-up will occur when the power lever is moved out of the full reverse position into a position above the flight idle so quickly that the propeller blade has no time to achieve a positive blade angle. This because, if the blade angle is still negative when the oil pressure is dumped, the counter weights may return the blades to the full reverse position.

In addition with subsequent fuel shutoff, feathering is also not possible when the propeller is in the full reverse position and the power lever in the flight range because the relevant ports in the pitch control unit are blocked.

The Luxair FDR data for the right hand engine has been reviewed to determine if the reverse pitch hang-up could have been caused by an "in flight Cranbrook type manoeuvre". One significant phenomenon that is noticeable on the FDR is that when the propeller has entered beta range both propeller speed (Np) and high pressure rotor speed (Nh) increase. The increase of propeller speed in that case is expected due to the windmilling effect. However, the Engine Electronic Control (EEC) should have reduced the fuel flow to minimum idle in an attempt to lower the propeller speed to the correct Np speed schedule in the EEC. Furthermore, the propeller overspeed appears to be controlled at 108 percent, which indicates that fuel flow is not controlled by the EEC but instead by the overspeed governor (pneumatic setting). Shop testing of the fuel system components afterwards did not show any defects that could explain this uncontrolled fuel flow after beta entry.
If however the power lever is assumed to be in the flight range, i.e. above flight idle, while the propeller pitch is at maximum reverse, the EEC will control engine power regardless of propeller speed. When the propeller speed reaches the set point of the overspeed governor, the overspeed governor will limit the fuel flow. This scenario exactly matches the recorded data.

Assuming that the crew operated both power levers simultaneously, it can be concluded that both power levers were far in the reverse range and that both were slammed forward. The FDR shows that both propellers were below the low pitch switch setting when the FDR stopped. On the ground however the LH propeller was found in the feather position while the RH propeller was found in reverse position. This indicates that the blade angle/beta tube positions on both propellers were marginal with respect to the ability to feather (apparently leading to the situation where the LH pitch control mechanism just received supply of feathering pump oil pressure, and the RH side not).

Had this phenomenon not occurred on the RH engine/propeller, thus assuming RH propeller had feathered after the last recorded sample as well, this would eventually have taken away the asymmetry, but would of course (given the shutdown of both engines) not have restored propulsion.

ADDENDUM

Continuous airworthiness

The original report into the Luxair accident was published in December 2003. Since then, developments have taken place which led the investigation commission to issue a revised report.

1. Major events since the Luxair accident

On 10 February 2004, a Fokker F27 MK.050 operated by Kish Airlines, crashed on approach to Sharjah International airport, 2.6 nm from threshold runway 12.

The final report into this accident was released on 21 April 2005. The investigation concluded that:

> *During the final approach, the power levers were moved by a pilot from the flight idle position into the ground control range, which led to an irreversible loss of flight control.*

One of the contributory causes listed in the report is:

> *The unmodified version of the skid control unit failed to provide adequate protection at the time of the event.*

This was also listed as one of the contributory causes in the Luxair report.

2. Safety recommendations contained in original report

Chapter 4 of this report deals with safety recommendations and in paragraph 4.2 – Improvements in the design of the safety device it was specified amongst other:

> *It is further recommended, considering the number of similar accidents on turboprops in general, the authorities responsible for airworthiness of these types of aircraft, check whether the design of these safety devices as proposed by JAR25-1155 (change 16) should be made applicable to existing designs*

3. New technical developments

On 22 October 2008, Fokker Services B.V. published an All Operator Messages – Fokker 50/60 referenced AOF50.047 dealing with the modification to the Automatic Flight-Idle Stop System to introduce the Flight Idle Stop System Control Unit.

The aim is that this All Operator Message is to inform about the release of mandatory Service Bulletin SBF50-76-017 dated 22 October 2008

It is further detailed therein, that:

> *Two accidents have occurred with Fokker 50 aircraft that were the result of inadvertent ground range selections during flight.*
>
> *Detailed investigations have shown that on both occasions the crew deviated from the standard operating procedures while the protection from the automatic flight-idle stop system was temporarily not available. The latter has been corrected by means of*

Service Bulletin SBF50-32-038, a mandatory modification to the Anti Skid Control Box (ref. All Operators Message AOF50-028, dated May 08, 2003).

Although the F50/F60 in the latest mod status fully complies with the applicable certification requirements, Fokker Services B.V. agreed with CAA-NL that the means of protection to prevent in-flight beta entry (ground regime) will be upgraded to comply with the more recent certification standards as laid down in CS25.1155 amendment 1.

……

After incorporating of service bulletin SBF50-31-023 and SBF50-76-017 the automatic flight-idle stop system will provide the following alerting for the crew:

- *A level 2 alert will be generated to alert the flight crew for reduced protection from the flight idle stop solenoids by means of a fault annunciator on the automatic flight-idle stop control panel.*
- *A level 2 alert will be generated to make the flight crew aware of an attempt to select the power lever into the ground regime while airborne by means of a "GND RANGE SEL" annunciation on the central annunciator panel (CAP).*

……

This AOF50.047 is attached as appendix to this addendum.

4. Conclusions

By the publication of both above mentioned Service Bulletins and the incorporation of associated operational and maintenance documentation changes introduced with MCNO F50-023 and MCNM F50-068 (both attached to SBF50-76-017) in the affected manuals, Chapter 4. Safety recommendations notably chapter 4.2 – Improvements in the design of the safety device, has been totally acknowledged by Fokker Services B.V. and the CAA NL.

It is noteworthy to mention that 6 years passed, before this issue qualified "as possible malfunction (deactivation of secondary stops)" by the manufacturer, was finally addressed.

5. List of appendices

Appendix A: CS25 Amendment 5, EASA (2 relevant pages)
Appendix B: AOF50.047, Fokker Services B.V.
Appendix C: SBF50-76-017, Fokker Services B.V. (first sheet only)
Appendix D: SBF50-31-023, Fokker Services B.V. (first sheet only)
Appendix E: AD2009-0049, EASA
Appendix F: Timeline of published documentation

(b) Each flexible control must be approved or must be shown to be suitable for the particular application.

(c) Each control must have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection.

(d) Each control must be able to maintain any set position without constant attention by flight-crew members and without creep due to control loads or vibration.

(e) The portion of each powerplant control located in a designated fire zone that is required to be operated in the event of fire must be at least fire resistant. (See CS 25.903(c).)

(f) For Powerplant valve controls located in the flight deck there must be a means:

(1) for the flightcrew to select each intended position or function of the valve; and

(2) to indicate to the flightcrew:

(i) the selected position or function of the valve; and

(ii) when the valve has not responded as intended to the selected position or function.

[Amdt. No.:25/1]

CS 25.1143 Engine controls

(a) There must be a separate power or thrust control for each engine.

(b) Power and thrust controls must be arranged to allow –

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the flow of the injection fluid must be adequately controlled.

(e) If a power or thrust control incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the shut-off position. The means must –

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shut-off position.

CS 25.1145 Ignition switches

(a) Ignition switches must control each engine ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

(c) Each group of ignition switches except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

CS 25.1149 Propeller speed and pitch controls

(a) There must be a separate propeller speed and pitch control for each propeller.

(b) The controls must be grouped and arranged to allow –

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(c) The controls must allow synchronisation of all propellers.

(d) The propeller speed and pitch controls must be to the right of, and at least 25 mm (one inch) below, the pilot's throttle controls.

CS 25.1153 Propeller feathering controls

(a) There must be a separate propeller feathering control for each propeller. The control must have means to prevent its inadvertent operation.

(b) If feathering is accomplished by movement of the propeller pitch or speed control lever, there must be means to prevent the inadvertent movement of this lever to the feathering position during normal operation.

CS 25.1155 Reverse thrust and propeller pitch settings below the flight regime

Each control for selecting propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered aeroplanes) must have the following:

(a) A positive lock or stop which requires a separate and distinct operation by the flight crew to displace the control from the flight regime (forward thrust regime for turbo-jet powered aeroplanes), and it must only be possible to make this separate and distinct operation once the control has reached the flight idle position.

(b) A means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered aeroplanes) when out of the approved in-flight operating envelope for that function, and override of that means is prohibited.

(c) A reliability, such that the loss of the means required by sub-paragraph (b) above is remote.

(d) A caution provided to the flight crew when the means required by sub-paragraph (b) above is lost.

(e) A caution provided to the flight crew when a cockpit control is displaced from the flight regime (forward thrust regime for turbo-jet powered aeroplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered aeroplanes) outside the approved in-flight operating envelope. This caution need not be provided if the means required by sub-paragraph (b) is a mechanical baulk that prevents movement of the control.

CS 25.1161 Fuel jettisoning system controls

Each fuel jettisoning system control must have guards to prevent inadvertent operation. No control may be near any fire extinguisher control or other control used to combat fire.

CS 25.1163 Powerplant accessories

(a) Each engine-mounted accessory must –

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or of any remote accessory driven by the engine is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

CS 25.1165 Engine ignition systems

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw electrical energy from the same source.

(c) The design of the engine ignition system must account for –

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) *Reserved.*

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit not used for assisting, controlling, or analysing the operation of that system.

(g) There must be means to warn appropriate flight-crew members if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(h) Each engine ignition system of a turbine powered aeroplane must be considered an essential electrical load.

CS 25.1167 Accessory gearboxes

For aeroplanes equipped with an accessory gearbox that is not certificated as part of an engine –

(a) The engine with gearbox and connecting transmissions and shafts attached must be

Appendix B: AOF50.047, Fokker Services B.V.

All Operator Messages - Fokker 50/60

Fokker 50/60 – Modification to the Automatic Flight-Idle Stop System to introduce the Flight Idle Stop System Control Unit

Dated: October 22, 2008
Sequence No.: AOF50.047
Fokker Ref.:
Subject: Fokker 50/60 – Modification to the Automatic Flight-Idle Stop System to introduce the Flight Idle Stop System Control Unit

This All Operator Message is to inform you about the release of mandatory Service Bulletin SBF50-76-017, dated 22 October 2008.

Applicability

F27 Mark 050, 0502 and 0604 aircraft serial numbers:
All

Required attention

This message contains safety-related information that may concern your whole organization. The recommendations contained herein are of special importance for:

>	flight operations, including flight crew training
>	maintenance, including maintenance training
	ground handling and servicing
>	engineering and modification planning
>	spares and logistics

Please see to it that the following information does reach those who need it, in particular if some activities are outsourced (for instance to an outside maintenance provider, ground handler or training/simulation company).

Background information

Two accidents have occurred with Fokker 50 aircraft that were the result of inadvertent ground range selections during flight.
Detailed investigations have shown that on both occasions the crew deviated from the standard operating procedures while the protection from the automatic flight-idle stop system was temporarily not available. The latter has been corrected by means of Service Bulletin SBF50-32-038, a mandatory modification to the Anti Skid Control Box (ref. All Operators Message AOF50-028, dated May 08, 2003).

Although the F50/F60 in the latest mod status fully complies with the applicable certification requirements, Fokker Services agreed with CAA-NL that the means of protection to prevent in-flight beta entry (ground regime) will be upgraded to comply with the more recent certification standards as laid down in CS25.1155 amendment 1.

According CS25.1155 amendment 1 each control for selecting propeller pitch settings below the flight regime requires the following:
(a) A positive stop, which requires a separate and distinct operation by the flight crew.
(b) A means to prevent both inadvertent and intentional selection of propeller pitch settings below the flight regime.
(c) Reliability, such that the loss of the means required by paragraph (b) is remote.
(d) A caution provided to the flight crew when the means required by paragraph (b) is lost.
(e) A caution provided to the flight crew when a cockpit control is displaced from the flight regime into a position to select propeller pitch settings below the flight regime.

A number of these requirements are already included in the current design but not all.
The following requirements still had to be covered:
· A further improvement of the reliability of the Automatic Flight Idle Stop system.

· The introduction of a caution (level 2 alert) if the Automatic Flight Idle Stop system is inadvertently activated during flight.
· The introduction of a caution (level 2 alert) if the crew removes the primary stop, i.e. lifts the ground range selector levers, during flight.

Actions

A modification to the Automatic Flight-Idle Stop system has been developed to comply with the requirements. To provide the alerting for the modified Automatic Flight-Idle Stop system also a modification to the Integrated Alerting System has been developed.

The changes to the integrated alerting system, which are required to provide the alerting for the flight idle stop system, are described in Service Bulletin SBF50-31-023. This modification is introduced separately from SBF50-76-017 to give the operators the opportunity to upgrade the Integrated Alerting Unit (IAU) and Central Annunciator Panel (CAP) in advance.

Service Bulletin SBF50-76-017 introduces the Modification to the Automatic Flight-Idle Stop System and introduces:
- the Flight-Idle Stop System Control Unit (FISSCU)
- the Automatic Flight-Idle Stop (AFIS) panel
- a switch on each ground range selector lever
- a modification to the Maintenance and Test panel.

After incorporating of Service Bulletin SBF50-31-023 and SBF50-76-017 the Automatic Flight-Idle Stop system will provide the following alerting for the crew:
- a level 2 alert will be generated to alert the flight crew for reduced protection from the flight idle stop solenoids by means of a fault annunciator on the Automatic Flight-Idle Stop control panel.
- a level 2 alert will be generated to make the flight crew aware of an attempt to select the power lever into the ground regime while airborne by means of a "GND RANGE SEL" annunciation on the Central Annunciator Panel (CAP).

Manual Change Notifications MCNM F50-068 (AMM, IPC, WM and TSSM changes) and MCNO F50-023 (AFM, AOM and QRH changes) are attached to Service Bulletin SBF50-76-017.

Copies of subject Service Bulletin(s) and of the AD (once issued) are available at the Fokker Services web-site https://www.myfokkerfleet.com (restricted site for customers only) as an attachment to this All Operator Message.

Compliance

Fokker Services recommends the accomplishment of this Service Bulletin within 2 years after the date of issue of Service Bulletin SBF50-76-017.

It is expected that EASA will issue an Airworthiness Directive (AD) with respect to this subject with the same compliance terms. Refer to the EASA website for the publication of a Proposed Airworthiness Directive for comments.

Fokker Services advises operators to plan the Flight-Idle Stop System modification well in advance of the end of the compliance time as mentioned in the EASA Airworthiness Directive to make sure that the mod kits are available in time and the AD compliance time is respected.

Kind regards,

FOKKER SERVICES BV

Attachments:
MCNM-F50-068_-.pdf (9044KB) | MCNO-F50-023_-.pdf (384KB) | SBF50-76-017_-.pdf (6192KB)

Back Top

Appendix C: SBF50-76-017, Fokker Services B.V. (first sheet only)

STORK Fokker

Service Bulletin
Fokker 50/60

ENGINE CONTROLS

Power Control - Modification to the Automatic Flight-Idle Stop System to introduce the Flight Idle Stop System Control Unit.

1. Planning Information

A. Effectivity

(1) F27 Mark 050, 0502 and 0604 aircraft serial numbers:

20103 thru 20335

NOTE: For aircraft serial number 20327 only Part 3, Activating of the Flight Idle Stop Control Unit is applicable.

(2) Production version of this modification: Not applicable.

Page	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Page	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Page	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Page	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Page	69	70	71	72	73	74	75	76	77	78	79						
Revision	-	-	-	-	-	-	-	-	-	-	-						
Attachments	58 Drawing sheets. For a detailed listing refer to pages 13 thru 16.																

B. Concurrent Requirements.

(1) Before, or at the same time as you do Part 2 or Part 3 of this SB you must do:
- SBF50-31-023 - INDICATING/RECORDING SYSTEMS - Central Warning System - The Introduction of a modified Integrated Alerting Unit and Central Annunciator Panel as a provision for the Automatic Flight-Idle Stop System Modification.

Step (2) is applicable for aircraft serial numbers 20103, 20133, 20141 and 20142.

(2) Before, or at the same time as, you do this SB you must do:
- SBF50-76-010 - ENGINE CONTROLS - Power Control - The Modification of the Electrical Installation of the Automatic Flight-Idle Stop System.

C. Reason

(1) Detailed investigation of two incidents with the Fokker 50 aircraft has shown that the crew deviated from the standard operating procedures while the protection from the automatic flight-idle stop system was temporarily not available. To solve this matter a mandatory modification to the Anti Skid Control Box has been issued by means of SBF50-32-028. (ref. All Operators Message AOF50-028, dated May 08, 2003). Although the flight-idle stop system, after the installation of the modified Anti Skid Control Box, fully complies with the applicable certification requirements, it has been decided that the flight-idle stop system will be modified to comply with the more recent requirements in CS 25.1155 amendment 1. This means that monitoring of the flight-idle stop system and alerting of the crew will be added.

(2) For alerting of the crew the following alerts are introduced:
- a level 2 alert has been added to alert the flight crew for reduced protection from the flight idle stop solenoids by means of a fault annunciator on the Automatic Flight-Idle Stop control panel.
- a level 2 alert has been added to make the flight crew aware of an attempt to select the power lever into the ground regime while airborne by means of a "GND RANGE SEL" annunciation on the Central Annunciator Panel (CAP).

D. Description

(1) This Service Bulletin is divided into two parts as follows:

PART 1: Installation of the Micro Switches and related Wiring in the Pedestal.

This Part tells you how to:
- Install the micro switches on the power levers.
- Install the new wiring in the pedestal.
- Verify the adjustment of the switches.
- Do the after installation testing.

NOTE: It is allowed to do PART 1 separately from PART 2 (First Part 1 and later Part 2).

Appendix D: SBF50-31-023, Fokker Services B.V. (first sheet only)

STORK Fokker

Service Bulletin
Fokker 50/60

INDICATING/RECORDING SYSTEMS

Central Warning System - The Introduction of a modified Integrated Alerting Unit and Central Annunciator Panel as a provision for the Automatic Flight Idle Stop System Modification.

1. Planning Information

A. Effectivity

(1) F27 Mark 050, 0502 and 0604 aircraft serial numbers:

20103 thru 20335

NOTE: For aircraft serial number 20327 only Part 2, Installation of a modified Integrated Alerting Unit and Central Annunciator Panel is applicable.

(2) Production version of this modification: Not applicable.

B. Concurrent Requirements

Step (1) is applicable for aircraft serial numbers 20103 thru 20108, 20110 thru 20116, 20119, 20120, 20129, 20133, 20141 and 20142.

(1) Before, or at the same time as, you do this SB, you must do:
- SBF50-31-005 - INDICATING/RECORDING SYSTEMS – Central Warning System - The Wiring Change of the Integrated-Alerting-System Test-Receptacles.

Page	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Revision	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Page	18	19	20	21	22	23	24	25	26	27							
Revision	-	-	-	-	-	-	-	-	-	-							
Attachments	29 Drawing sheets. For a detailed listing refer to pages 9 and 10.																

C. Reason

(1) A recommended modification to the automatic flight idle stop system will be introduced by SBF50-76-017. The **changes to the integrated alerting system to provide the alerting for the flight idle stop system are described in this SB.**

(2) This modification is introduced separately from SBF50-76-017 to give the operators the opportunity to upgrade the Integrated Alerting Unit (IAU) and Central Annunciator Panel (CAP) in advance.

D. Description

(1) This Service Bulletin tells you how to:
- Remove the present IAU and CAP.
- Install the upgraded IAU and CAP.
- Rework electrical wiring on avionics rack shelf 6.
- Rework aircraft wiring and install dummy load resistor if applicable.
- Install some wiring provisions for the flight idle stop system.
- Perform functional tests for the affected systems.

(2) To enable the installation of the modified units some wiring changes are needed. Also some wiring provisions for the flight idle stop system will be installed.

(3) This SB is divided into 2 parts as follows:

Part 1: Installation of a modified Integrated Alerting Unit and Central Annunciator Panel including Wiring Changes and is applicable to ALL aircraft serial numbers EXCEPT aircraft serial number 20327.

Part 2: Installation of a modified Integrated Alerting Unit and Central Annunciator Panel based on the Installation and Deactivation of Flight Idle Stop system according to Fokker Services report no. FS-N616, and is applicable to aircraft serial number 20327

E. Compliance

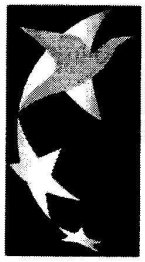
(1) Optional.

F. Approval

(1) The technical content of this document is approved by EASA or under the authority of DOA nr. EASA.21J.059.

Appendix E: AD2009-0049, EASA

EASA AD No : 2009-0049

EASA	AIRWORTHINESS DIRECTIVE
	**AD No.: 2009-0049** **Date: 02 March 2009** Note: This Airworthiness Directive (AD) is issued by EASA, acting in accordance with Regulation (EC) No 216/2008 on behalf of the European Community, its Member States and of the European third countries that participate in the activities of EASA under Article 66 of that Regulation.

This AD is issued in accordance with EC 1702/2003, Part 21A.3B. In accordance with EC 2042/2003 Annex I, Part M.A.301, the continuing airworthiness of an aircraft shall be ensured by accomplishing any applicable ADs. Consequently, no person may operate an aircraft to which an AD applies, except in accordance with the requirements of that AD, unless otherwise specified by the Agency [EC 2042/2003 Annex I, Part M.A.303] or agreed with the Authority of the State of Registry [EC 216/2008, Article 14(4) exemption]..

Type Approval Holder's Name :	**Type/Model designation(s) :**
Fokker Services B.V.	F27 Mark 050, Mark 0502 and Mark 0604 aeroplanes

TCDS Number :	EASA.A.036
Foreign AD :	Not applicable
Supersedure :	None

ATA 76	**Engine Controls – Automatic Flight-Idle Stop Control Unit – Installation**
Manufacturer(s):	Fokker Aircraft B.V.
Applicability:	F27 Mark 050, Mark 0502 and Mark 0604 aeroplanes, all serial numbers.
Reason:	Detailed investigations of two accidents with Fokker 50 (F27 Mark 050) aeroplanes have identified as probable cause that the flight crew selected propeller reverse during flight while the protection from the automatic flight-idle stop system was temporarily not available. This action is not in accordance with approved operating procedures. In addition, it has become clear that in general, flight crews attempt to make power lever selections below flight-idle more frequently than anticipated. This condition, if not corrected, could lead to further events of inadvertent propeller reverse selection during flight, resulting in loss of control of the aeroplane. Even though the potential for this kind of event is primarily driven by operational (human) factors, corrective (AD) action is nevertheless considered justified. A direct cause of possible temporary unavailability of the automatic flight-idle stop protection has been addressed by CAA-Netherlands AD 2003-091. To improve the overall reliability of the flight-idle stop system, making the system less sensitive to intentional and inadvertent power lever selections below flight-idle, Fokker Services has developed a modification that meets the latest requirements. This modification has been published as Service Bulletin (SB) SBF50-76-017,

EASA Form 110 Page 1/2

	which provides instructions to modify the flight-idle stop system and introduces additional monitoring and flight crew alerting which were not required during the original certification of the aeroplane. For the reasons described above, this AD requires the installation of an automatic flight-idle stop control unit and the accomplishment of associated modifications.
Effective Date:	16 March 2009
Required Action(s) and Compliance Time(s):	Required as indicated, unless accomplished previously. Within 24 calendar months after the effective date of this AD, install an automatic flight-idle stop control unit and accomplish the associated modifications in accordance with the Accomplishment Instructions of Fokker Services SBF50-76-017.
Ref. Publications:	Fokker Services SBF50-76-017 dated 30 September 2008. The use of later approved revisions of this document is acceptable for compliance with the requirements of this AD.
Remarks :	1. If requested and appropriately substantiated, EASA can approve Alternative Methods of Compliance for this AD. 2. This AD was published on 23 January 2009 as PAD 09-019 for consultation until 20 February 2009. No comments were received during the consultation period. 3. Enquiries regarding this AD should be referred to the Airworthiness Directives, Safety Management & Research Section, Certification Directorate, EASA; E-mail ADs@easa.europa.eu. 4. For any question concerning the technical content of the requirements in this AD, please contact: Fokker Services B.V., Technical Services Dept., P.O.Box 231, 2150 AE Nieuw-Vennep, The Netherlands. telephone +31 (0)252-627-350; facsimile +31 (0)252-627-211 e-mail: technicalservices.fokkerservices@stork.com. The referenced publication can be downloaded from www.myfokkerfleet.com.

Appendix F: Timeline of published documentation

Timeline of published documentation

Identification	Issue	Manufacturer / Authority	Status of document	Reference
SB F050-32-4	01/08/1992	ABSC	optional	
SB F050-32-4 Rev1	29/06/1994	ABSC	optional	cf. Appendix 5
Service letter 137	20/12/1994	Fokker Aircraft B.V.	information	cf. Appendix 6
1996 FOKKER AIRCRAFT bankruptcy				
SBF50-32-035	02/08/1999	Fokker Services B.V.	recommended	cf. Appendix 7
AD LUX-2002-001	29/11/2002	DAC Luxembourg	mandatory	cf. Appendix 8
Fo50-6004125-32-01	07/05/2003	ABSC	as defined in SBF50-32-038	cf. Appendix 11
AOF50.028	08/05/2003	Fokker Services B.V.	information	cf. Appendix 9
SBF50-32-038	08/05/2003	Fokker Services B.V.	recommended	cf. Appendix 10
AD LUX-2003-001	12/05/2003	DAC Luxembourg	mandatory	cf. Appendix 13
BLA2003-091	31/07/2003	CAA-NL	mandatory	cf. Appendix 20
CS-25 Amendment 5	05/09/2008	EASA	regulation	cf. Addendum - Appendix A
AOF50.047	22/10/2008	Fokker Services B.V.	information	cf. Addendum - Appendix B.
SBF50-76-017	22/10/2008	Fokker Services B.V.	recommended	cf. Addendum - Appendix C.
SBF50-31-023	06/11/2008	Fokker Services B.V.	optional	cf. Addendum - Appendix D.
AD2009-0049	02/03/2009	EASA	mandatory	cf. Addendum - Appendix E.