CIAIC

Comisión de Investigación
de Accidentes e Incidentes
de Aviación Civil

TECHNICAL REPORT

A-035/1998

Accident of aircraft Fairchild SA-227-AC "Metro III", registration number EC-FXD, in the municipal area of El Prat de Llobregat (Barcelona), on 28th July, 1998
(Issue 2)

MINISTERIO
DE FOMENTO

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COMISIÓN DE INVESTIGACIÓN
DE ACCIDENTES E INCIDENTES
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WARNING

This Report is a technical document which reflects the point of view of the Air Accidents and Incidents Investigation Commission (CIAIAC) regarding the circumstances in which the event being investigated happened, with the relevant causes and consequences.

In accordance with Annex 13 to the International Civil Aviation Convention and with Royal Decree 389/1998, of 13th March, which regulates the investigation of civil aviation accidents and incidents, the investigation is of an exclusively technical nature, without having been targeted at the declaration or limits of personal or financial rights or liabilities. The investigation has been carried out without having necessarily performed legal evidence procedures and with no other basic aim than preventing future accidents. The results of the investigation do not determine or prejudge any disciplinary proceedings that, concerning the event, may be brought by the "Ley de Navegación Aérea" (Air Navigation Law).

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Abbreviations

00 ºC	Degrees centigrade
00º 00' 00"	Degrees, minutes and seconds
Ac	Altocumulus
ACC	Area Control Centre
ADF	NDB signal receiver
AIP	International Aeronautical Publications
APP	Approach Control Office
ATC	Air Transit Control
CAT I	OACI Category I
Ci	Cirrus
CRM	Crew Resource Management
CTE	Captain
CTR	Control Zone
Cu	Cumulus
CVFR	Controlled Visual Flying Rules
CVR	Cockpit Voice Recorder
DH	Decision Height
DME	Distance Measuring Equipment
E	East
EPR	Engine Pressure Ratio
FAP	Final Approach Point
FDR	Flight Data Recorder
ft	Feet
g	Gravity acceleration
GPWS	Ground Proximity Warning System
h. min: seg	Hours, minutes and seconds
hPa	Hectopascal
IAS	Indicated Air Speed
IFR	Instrument Flying Rules
ILS	Instrument Landing System
IMC	Instrumental Meteorological Conditions
INTA	National Airspace Technology Institute
Kms	Kilometres
Kt	Knots
Kw	Kilowatts
Ibs	Pounds
m	Metres
MAC	Mean Aerodynamic Chord of the aircraft
mb	Millibars
METAR	Ordinary Metereological Report
MHz	Megahertz
N	North
N/A	Not Applicable
NDB	Non-Directional Radio Beacon
NM	Nautical Mile
NTS	Negative Torque System
OM	ILS exterior marker beacon
P/N	Part Number
PF	Pilot Flying
PNF	Pilot Not Flying
PSI	Pounds per square inch
QNH	Adjustment of the pressure scale so that the altimeter marks the airport's height above sea level on takeoff and landing
S/N	Serial Number
SAS	Stall Avoidance System
Sc	Stratocumulus
Shp	Shaft horse power
SVFR	Special Visual Flying Rules
TWR	Control Tower
U T C	Co-ordinated Universal Time
VIP	Very Important Passenger
VMC	Visual Metereological Conditions
VOR	VHF Omnidirectional Radiobeacon
W	West

1. FACTUAL INFORMATION

1.1 History of the flight

Flight SWT704 took off from Palma de Mallorca Airport at 22:11 h[1] (00:11 h local time on 28th July, 1998) on a cargo transport flight to Barcelona. The cargo consisted of 95 packets of printed press, with a total weight of 1,102 kg. Before takeoff, 200 litres of JET A-1 fuel had been supplied to the aircraft.

The only persons on board were the two pilots. The left-hand seat was occupied by a pilot flying as “First officer under supervision” (who will be referred to in this report as the “second” or “co-pilot”) and the right-hand seat was occupied by the aircraft’s captain, also acting as instructor (who is referred to in this report as the “captain” or “instructor”), as it had been planned that the pilot in the left-hand seat would use the flight to Barcelona as a recurrent training flight.

Throughout the 27th July, the aircraft, with the same crew, had carried out three cargo flights, between Madrid-Palma de Mallorca, Palma de Mallorca-Ibiza and Ibiza-Palma de Mallorca, where it landed at 19.25 h UTC.

The flight proceeded normally. At 22:31:37 h, the crew contacted the Barcelona APP (Approach Control Office). The crew’s conversation, as recorded by the CVR, indicated that, as part of the training, it was their intention to carry out a single engine missed approach. However, when they were directed to runway 25, the copilot stated: “…it is a missed approach a little bit [difficult] to do it with a single engine…” because they had anticipated they would be cleared to runway 07, so the instructor decided not to carry out the exercise and to postpone it for a subsequent date and to carry out a low approach instead, leaving the glide path slightly above and to do an “engine stop” (“hacemos parada de motor”). Then they would raise the landing gear and then the flaps by increments. The captain added: “As soon as we’re without control, we’ll restore it” (the engine).

However, the copilot carried out a reminder briefing of the published missed approach manoeuvre, just in case it was really necessary to carry it out.

At 22:41:33 they called their operations department on the company’s frequency indicating that they estimated that they would arrive in 15 minutes and that they would require fuel for another flight to Madrid.

The approach to runway 25 was also normal. At 22:47:10 h they contacted the Barcelona control tower, which indicated that they were number 1, that

[1] All the times given in this report are UTC., except when expressly indicated otherwise. Two hours must be added in order to obtain the official time in the area of the Spanish peninsula on the day of the accident (28th July, 1998).

they should continue and that they should notify “established in final”. Afterwards, they extended the landing gear and flaps.

At 22:49:20 an Airbus A-300 was cleared for a rolling take on runway 25, which was acknowledged by the aircraft 4 sec later.

At 22:49:29 h, the instructor indicated to the copilot that, when they were established, they should leave the glide path one dot above, to make a simulated missed approach, including retraction of the landing gear.

At 22:49:55 h, the captain notified the control tower that they were established in final. The tower indicated that they should continue, that a flight was leaving runway 25 and that it would call them immediately. At that moment, as deduced from the radar trace data, aircraft EC-FXD was at a height of some 1400 ft, at some 6 NM (about 3 minutes at 120 kt) from the runway threshold and was moving at a speed of some 140 kt with respect to the ground.

At 22:50:05 h, there was a hot line communication between ATC tower and APP to indicate that control of the departing A-300 was being transferred to the latter. At 22:50:05, the tower said to that aircraft: “LFA 606 contact radar 124.7, bye”, which was acknowledged by the crew 3 sec later.

At 22:50:03 h, with gear and flaps down, the instructor said “Well, engine stop” to which the copilot replied: “Come on, landing gear up”.

At 22:50:15 h, in response to an exclamation of strong displeasure from the co-pilot, the captain said “What’s up? I am putting the engine for you” and, seven seconds later, added: “You’ve done it the wrong way round”. The cockpit communications suggest that the copilot had carried out an action contrary to what was required by the procedure, because he himself admitted: “I was doing it wrong. I had the impression that I was putting it in right.”

Some 15 seconds later, the captain said: “Well, we’ll continue”. Then, at 22:50:34 h, the control tower transmitted: "SWT-704, clear to land runway 25. Wind calm", that was acknowledged by the captain.

Two seconds after this last communication, the captain said: “Well, I am taking out the engine again for you. I’ve raised the flap for you. Now flap by increments…”. A few moments later the copilot asked “I continue with the approach, don’t I?”, to which the captain replied in the affirmative and added that they had been authorized to land and that they were going to land with one engine.

At 22:51:09 he again confirmed "Well, just continue with one engine" and appeared to give general instructions on how to carry out a missed approach or what to do when near the runway, because he said: “Anyway, when you have, when you have a missed or something and you are close to the runway, do it with the foot...and with anything of...(...)...because if you land what happens?...”, although he left some sentences unfinished.

At 22:52:01, the captain said "landing gear", the co-pilot said “landing gear now” and the captain then confirmed "coming down", with which the intermittent “landing gear not down and blocked” signal, which had been sounding at different moments after the engine had been stopped, ceased, and at 22:52:07, the copilot confirmed “Seen (“Visto”)”. Almost immediately there was an exclamation of surprise and displeasure from the captain, and a continuous signal started to sound, which was identified as the stall warning. Almost at the same time, the captain added: “The SAS is coming in” at 22:52:11.

Three seconds later the co-pilot asked “What’s happening?” and two seconds later, in a state of great tension, the captain said "Apply foot!" ("Mete pie" in Spanish, meaning: "Step the pedal!" or "Apply rudder!") to which the copilot replied “I am applying!”. One second later the signal ceased but appeared again almost immediately. Seven seconds after he said he was applying rudder, the copilot cried and the CVR recording ended at 22:52:26 h.

The aircraft turned off to the right of the ILS localizer of runway 25 and, according to the statements of witnesses, adopted a position of almost 90º of roll to the left, then a position of 90º of roll to the right whilst continuing to lose height and then again took up a position of 90º of roll to the left.

Finally, the left wing struck the ground and then the aircraft crashed first into the outside barrier of highway B-203 which runs round the edge of the Airport and then the metallic perimetral fence that surrounds the Airport, finally coming to a halt at some 250 m from the threshold of runway 25 and some 100 metres to the right of the runway axis. The wreckage of the aircraft burst into flames. The two pilots died in the act.

The Airport’s emergency services arrived quickly and put out the fire.

1.2 Injuries to persons

INJURIES	FATAL	SERIOUS	MINOR/NONE
CREW	2		
PASSENGERS			
OTHER			

1.3 Damage to aircraft

The aircraft was destroyed as a result of crashing into the ground and subsequent fire.

1.4 Other damage

In its path the aircraft broke a 30 m section of the outside barrier of highway B-203 (known as the El Prat Beach Road) and then another section of barrier and wall which runs round the edge of the Airport. A motorbike, temporarily parked on the shoulder of the highway, was completely burned.

1.5 Personnel information

PILOT IN COMMAND (flying on the right-hand side)

Age / Sex:	28 years / Male
Nationality:	Spanish
Title:	Commercial Aircraft Pilot
Number:	8214
Date obtained:	12/03/1993
Licence:	
- Renewal Date:	16/02/1998
- Expiry Date:	20/02/1999
Ratings:	IFR, ground multiengine, On Board Radio Operator Certificate (International)

Total flying time:	4,500 hours
Time on the type:	4,132 hours
Last year on the type:	385 hours
Last 30 days on the type:	49 hours

The pilot was qualified in his company as flight instructor or supervisor for Metro III aircraft.

CO-PILOT (flying on the left-hand side)

Age / Sex:	28 years / Male
Nationality:	Spanish
Title:	Commercial Aircraft Pilot
Number:	9154
Date obtained:	10/11/1994
Licence:	
- Renewal Date:	01/09/1997
- Expiry Date:	08/09/1998

Ratings:	IFR, ground multiengine, On Board Radio Operator Certificate (International)
Total flying time:	2,000 hours
Time on the type:	1,769 hours
Last year on the type:	118 hours
Last 30 days on the type:	4 hours

The co-pilot had flown as a Metro III captain in the flight operator company during 139 flying hours. However, on the date of the accident, he was flying as the “First Pilot under Supervision”, due to the fact that he had been inactive since 23rd March, 1998 when he took a sick leave as a result of a fracture on his right ankle. His last flight prior to being off sick was on 20th March, 1998.

Consequently, due to his lack of flying experience during the three preceding months, he needed to carry out at least three take-offs and three landings in training flights in order to recover the condition of captain in that type of aircraft, as per the provisions of point 7.1.7.1.1 “Recent Experience” of the "Air Traffic Rules" in force at the moment of the accident. After his medical discharge, he took part in a theoretical refresher course on 22nd, 23rd and 24th July. On the day of the accident, he was carrying out his first flight after his period of inactivity.

No record was found that he passed any aeronautical medical exam after the period he was on sick leave.

1.6 Aircraft information

The SA-227-AC is a pressurized twin turboprop aircraft with capacity for up to 19 passengers. It is also used in cargo transportation. Up to 2,334 kg of cargo can be transported in the cabin. It is certified under the "Federal Aviation Regulations" (FAR) 23.

Serial number AC-651B had a maximum takeoff weight of 7,258 kg (16,000 lb). Since it had more than 7000 kg of MTOW it had a turbulent wake category of “MEDIUM”.

The aircraft’s power plant consisted of 2 Garret TPE 331-11U-612G engines and 2 McCauley 4HFR34C652 four-blade propellers.

It was equipped with a stall avoidance system (SAS) in which an angle of attack vane sensor and a transmitter situated on the tip of the right wing provide a signal to the SAS computer, which, according to the flight manual activates the stall aural warning at 7 kt before the actual stall and provides power to the servo, which applies a forward (pitch down) force on the stick of approximately 60 lb at 1 kt before reaching the stall. The tolerance of the system could trigger the warning when the airspeed is between 5 and 10 kt before the stall speed and actuate the stick pusher when the speed is at less than 5 kt above the stall.

1.6.1 Airframe

Manufacturer:	Fairchild
Model:	SA-227-AC
Serial Number:	AC-651B
Year of Manufacture:	1986
Registration No.:	EC-FXD
M.T.O.W.:	7,248 kg
Owner:	Swiftair, S.A.
Operator:	Swiftair, S.A.

1.6.2 Certificate of Airworthiness

Number:	3679
Type:	Public Passenger Transport (PPT), Public Cargo Transport (PCT), Normal Category. Authorized flight in icing conditions, night VFR, IFR, instrument approach
Issuance Date:	22/06/1994
Renewal Date:	12/05/1998
Expiry Date:	12/08/1998

1.6.3 Airframe Maintenance Record

Total flying time:	14,748 hours
Last 150-hour inspection:	13/7/1998 (14,715 h)
Hours since last 150-hour inspection:	33

1.6.4 Engines

LEFT ENGINE:

Make:	GARRET
Model:	TPE-331-11U-612G
Power:	1,000 shp
Serial Number:	P-44466C
Total hours:	12,903 hours
Hours since last general overhaul:	2,113 hours
Hours to next general overhaul:	3,887 hours

RIGHT ENGINE:

Make:	GARRET
Model:	TPE-331-11U-612G
Power:	1,000 shp
Serial Number:	P-44225C
Total Hours:	18,179 hours
Hours since last general overhaul:	3,467 hours
Hours to next general overhaul:	2,533 hours

The left engine's logbook, initially issued on 22nd June, 1994, indicates in the section entitled "Mandatory Inspections and Maintenance for this Engine" that an overhaul has to be carried out on this model of engine every 6,000 hours.

1.6.5 Propellers

LEFT PROPELLER:

Make:	McCauley
Model:	4HFR34C652-GJ/B-L106LA-0
Serial Number:	932037
Total Hours:	4,468 hours
Hours since last overhaul:	327 hours
Hours to next overhaul:	3,663 hours
Serial Numbers of the blades:	NG008, NG034, NG025, NG067

This model of propeller is subject to a maintenance overhaul every 4,000 hours. A maintenance centre in Portugal carried out this propeller's overhaul on 14-03-1998. It was recorded that the McCauley Manual 860201, rev. Jan-97 had been followed and that several Service Bulletins and Service Letters of the propeller's manufacturer had been completed.

Subsequently, the propeller was fitted to the aircraft on 29-3-1998, with 0 hours since the last overhaul. At that moment the aircraft had a total of 14,421 hours.

RIGHT PROPELLER:

Make:	McCauley
Model:	4HFR34C652-GL/B-L106LA-X
Serial Number:	931784
Total Hours:	5,692 hours
Hours since last overhaul:	1,636 hours
Hours to next overhaul:	2,364 hours
Serial numbers of the blades:	NE025, NE031, NE039, NE034

This propeller was given an overhaul on 2-3-1994, when the aircraft was still registered in the United States. Subsequently, on 28-10-1996 a maintenance centre in Portugal carried out a new overhaul of this propeller. The records indicate that the McCauley Manual 860201, rev. Feb-91 had been followed and that several Service Bulletins and Service Letters of the propeller's manufacturer had been completed. The propeller was fitted to the aircraft on 17-1-1997, with 0 hours since overhaul. At that moment the aircraft had a total of 13,112 hours.

1.6.6 Record of flights prior to the accident

The Flight Logbook showed the following annotations on the days prior to the accident.

On 19-7-98, after a Barcelona-Ibiza flight in which the pilot in command that had the accident acted as the captain, on turning the propeller of the right engine in Ibiza a strong noise was noticed "like bearings". The blades were looked at and appeared to be correct. On that day it was noted down in the logbook "Engine No. 2 replaced due to an internal mechanical problem. Mounted and tested OK". This replacement of the right-hand engine was carried out in Ibiza and was followed by a test flight, although it appears in the Engine Logbook signed in "Barajas, 21-7-1998". Consequently, the right-hand engine, serial number P-44225C, which had been stripped from aircraft EC-FSV on 10-2-1998 when it had 18,153 hours due to the presence of metal particles in the engine oil, was subsequently fitted in position 2 (right) in the EC-FXD on 21-7-1998 (seven days and 16 flying hours before the accident) with the annotation that it had 18,163 hours. See in Section 1.6.7 the description of the repair carried out to that right-hand engine. The right propeller on the EC-FXC was not replaced, continuing to be the propeller with S/N 931784.

On 21-7-98 the aircraft carried out two flights: Ibiza-Ibiza with a 50-minute duration and Ibiza-Madrid with a 1:20-hour duration. It was noted down, as anomalies, that engine no. 2 (right) did not respond either to the propeller speed control or the power control. It was found that the fork of the power lever was out of place. It was reconditioned and fixed. It was also reported that at 100% r.p.m. engine no. 2 did not give its nominal power. The fault could not be reproduced on the ground and was kept "under investigation".

On 22-7-98 the aircraft carried out 3 flights, in which, as anomalies, it was found that the oil pressure of engine 2 fluctuated and reached 0. With the correct oil level, on increasing the r.p.m., the pressure increased and continued to fluctuate. The oil pressure transmitter was replaced and, on being tested, the result was positive.

On 24-7-98 two flights were carried out, without any anomalies being written up in the Flight Report log.

On 25-7-98 two flights were carried out, with the captain that was on board the EC-FXD on the day of the accident, and, as discrepancies, it was noted down that the spring on the right power lever was a bit loose without acting as a stop, meaning that the lever did not reach a stop and moved into reverse. In addition, the green light (OK) on the “FIRE EXT” of the right engine remained lit. It was noted down in the logbook that the power control had been repaired and the correct functioning of the “FIRE EXT” light had been verified.

The aircraft did not fly again until 27-7-98, on which it covered the following legs:

Madrid-Palma de Mallorca:	1 h 35 m flight time
Palma de Mallorca-Ibiza:	0 h 30 m flying time
Ibiza-Palma de Mallorca:	0 h 30 m flying time
Palma de Mallorca-Barcelona:	0 h 42 m of the flight in which the accident occurred

1.6.7 Repair to the right engine after contamination with particles

After stripping engine S/N P-44225C of aircraft EC-FSV on 10-2-1998 after the existence of magnetic particles had been notified and a sample of oil had been sent to the INTA as part of the PAESA (SOAP) programme, the engine was sent to an authorized turbine engine repair centre or FAA Repair Station in Texas, United States of America, where, according to the records, an “Oil System Contamination Inspection/Limited Repair” was carried out in accordance with Maintenance Manual 72-00-25 (R-16). Several new parts were mounted, whilst others were mounted in an "overhauled" condition. These latter parts were the following: Bearing, forward propshaft, 1st idler assy., Fuel/oil heater, Propeller governor and Planetary stop.

The new parts and components that were mounted were: Bearing, aft propshaft, Bearing, turbine roller, Compressor seal kit, Chip detector housing, Aft curvic, Bearing, propeller governor drive, Retainer and Fuel filter housing cap.

In accordance with the documentation provided by the Repair Station, the engine was functionally tested and checked for possible oil leaks and a vibration evaluation was carried out. All the tests were satisfactory and the engine’s return to service was approved on 26th March 1998 by means of an FAA Form 8130-3, with a total of 18,163 hours of operation, which indicated that the engine had been made to operate in the test bench for a total of 10 hours.

The documentation issued by this Repair Station indicated that:

a) A SOAP (Spectrometric Oil Analysis Program) sample was required between 9 and 12 hours and another between 20 and 30 hours after the inspection carried out. There is no record that these samples were taken (the accident occurred 16 hours after the inspection), and

b) The following airframe components (this refers to the aircraft in which there had been contamination, i.e. the EC-FSV, as the propeller fitted to that aircraft was not mounted subsequently in the EC-FXD, as was the case with engine S/N P-44225C) required pressure flushing: propeller piston dome, oil temperature dome valve, engine oil system reservoir and all associated plumbing. It also indicated that the oil cooler ought to be removed for an overhaul, which was eventually accomplished as per the documentation of the Metro EC-FSV.

1.6.8 <u>Estimate of the aircraft's weight and stall speed</u>

Although the documentation of the last flights was burned during the accident, taking into account the following aspects:

- The aircraft had taken in 200 litres of fuel in Palma de Mallorca (160 kg at 0.8 kg/litre for JET-A1)
- In an earlier flight Barcelona-Palma lasting 40 minutes and with cargo weighing 1,811 kg, the aircraft had consumed 450 lb (675 lb/hour)
- In another flight Barcelona-Ibiza lasting 50 minutes and with cargo weighing 1,143 kg, the average fuel flow had been 600 lb/hour
- The maximum weight of fuel the aircraft can load is 1,969 kg (4,342 lb)
- The crew requested "fuel to fly to Madrid" from its Operating Department in Barcelona, without specifying how much was left on board
- The conversations in the cockpit indicate that the pilots were carrying personal luggage of some weight

the aircraft's weight at the moment of the accident can be estimated in the following way:

Empty weight: 4,303 kg (9,488 lb)
Two pilots and luggage: 154 kg (340 lb)
Fuel to fly to Barcelona: 726 kg (1600 lb)
Fuel for taxi: 45 kg (100 lb)
Payload: 1,102 kg (2,429 lb)

Weight at takeoff in Palma: 6,239 kg (13,757 lb) (the aircraft's MTOW is 7,258 kg or 16,000 lb)

Weight at the moment of the accident: 6,035 kg (13,307 lb)

Entering with that weight in the tables in the Airplane Flight Manual, and taking into account that the accident occurred at sea level and at a temperature of some 24ºC (approximately ISA+10), the following speeds for a zero degrees of bank angle, are approximately estimated as follows:

Stall speed with zero thrust (landing gear and flaps up): 93 KCAS

Stall speed with zero thrust (landing gear up, flaps ¼): 90 KCAS

Stall speed with zero thrust (landing gear down, flaps ½): 87 KCAS

Stall speed with zero thrust (landing gear down, landing flaps): 84 KCAS

The indicated speed is approximately one knot higher than calibrated speed in this speed range. A 20º of bank angle represents an increase of about 3 KCAS of those stall speeds.

A value of 91 KIAS is indicated on a placard in the cockpit and is marked on the anemometer at the beginning of the red arc as the minimum control speed.

The AFM indicates that these speeds are based on tests with both propellers feathered, and that during recovery of a stall with single engine power on (as per FAR 23.205), some 390 ft of height are lost and a pitch of up to 10º of nose down is reached.

The flight manual requires an approach speed of 110 kt for the mentioned weight, without anti-ice of the engine and with flaps and landing gear down. This speed is the same in the case of a single engine approach.

The operator used the following table for approach speeds:

Weight	Flaps ¼	Flaps ½	Flaps down
13000 lb	130 KCAS	115 KCAS	109 KCAS
13500 lb	132 KCAS	117 KCAS	111 KCAS

1.6.9 <u>Intentional Engine Inoperative Speed Procedure</u>

Section “VI. Manufacturer’s Data” (Issued May 22/89) of the aircraft’s flight manual, which is a part of the Manual not specifically approved by the F.A.A., includes a section entitled “Intentional One Engine Inoperative Speed (V_{SSE})”, which provides recommendations for the case of the intentional stoppage of an engine for training purposes.

According to the manufacturer, the V_{SSE} speed is 115 KIAS, and above that speed an engine can be intentionally and suddenly stopped so that the pilots can examine the aircraft’s flight characteristics and actions at low speed and with a single engine.

This section warns that several factors must be taken into account before stopping the engine, including proximity to the ground, weight, speed, the pilot’s capacity, etc.

It indicates that by moving the power lever to idle in flight, approximately the same controllability problems will be obtained as when stopping the engine but with the advantage of having power quickly available to be used in the event of difficulties during the manoeuvre. It stresses that Fairchild recommends that rather than stopping the engine during pilot check out and transition, an engine fault be simulated.

Anyway, the manufacturer indicates that if it is considered necessary to stop an engine during the initial climb for training pilots, the limitations listed in the section must be applied. These include: the landing gear must be up, flaps extended not more than ¼ and both engines with takeoff power.

The aircraft's critical engine regarding directional controllability is the right one.

The minimum speed for an air start is 100 KIAS.

A note is also added indicating that additional training experience can be obtained by lowering the landing gear and flaps at speeds close to final approach speed to demonstrate the problem of controllability, which increases significantly in situations of high single engine power in landing configuration. This note appears to be a continuation of and to refer to the case of "stopping an engine during initial climb".

A copy of this procedure is included in Appendix E.

Subsequently, in a revision dated 11th May, 1999, this section of the Flying Manual was changed and the following paragraphs were eliminated:

"Provided that the aircraft is not lower than 1000 ft above the ground and that it is light enough to maintain regulatory terrain clearance and to remain above stall warning speed, it is permissible to slow from V_{SSE} to V_{MCA}. Remember the minimum airspeed for an air start is 100 KIAS."

"If gross weight and performance permit, additional training experience can be gained at speeds close to final approach speed by extending the landing gear and flaps to demonstrate the significantly increased controllability problem when at high single engine power in the landing configuration."

1.6.10 Engine Failure and Engine Airstart Emergency procedures

A copy of both procedures is included in Appendix F. The case of engine failure consists of 7 steps, which include "cleaning" the failed engine and trimming the aircraft. Airstart consists of 9 steps. There is no indication of who should carry out each step when there are two pilots on board. There is a note that states that the airstart could occur automatically under certain conditions: "Engine relight should be expected to occur automatically if the Auto/Cont Ignition Switch is in AUTO, and fuel is available to the igniters."

1.6.11 <u>Procedure for single engine landing</u>

A copy of this procedure is included in Appendix G. The difference in weight of fuel in each wing must be checked and transferred if necessary and neither the landing gear nor the flaps must be extended beyond ¼ until landing is assured.

1.6.12 <u>Description of the propeller control system</u>

The constant speed, reversible, and manually feathered propellers of the aircraft are oil operated. The governing system consists of engine oil pressure, a feathering spring and blade counterweights. The engine oil is pressurized by the propeller governor and directed into the propeller dome through a passageway called the "beta tube".

The oil pressure acts agains one side of the piston located inside the dome to move the blades from high toward low pitch and, when needed, into reverse. Forces of the spring and counterweights act in the opposite direction to move the blades from low pitch to high pitch. The opposing forces are balanced to keep the engine and the propeller rotating at the constant speed selected with the RPM or speed lever in the cockpit.

The propellers do not have an autofeather system in the event of an engine failure but, when a negative torque is detected, the negative torque system (NTS) sends oil from the governor to the gearcase, the pitch of the blades move towards feather and reach feather angle (approximately 89º of pitch) if all the oil is dumped through the beta tube alter the stop and feather control located in the cockpit has been manually actuated. Therefore, the NTS automatically reduces the drag produced by the windmilling propeller to provide time to the pilot to manually feather it.

The dumping of oil pressure is achieved in both cases through the feathering valve, which is hydraulically actuated by the NTS valve and can be manually actuated with the stop and feather control.

If the negative torque condition disappears, the NTS is deactivated and the blades return to the pitch corresponding to the RPM selected in the cockpit.

The engines have autoignition systems with the operation modes automatic (AUTO), continuous (CONT) and off (OFF):

In the AUTO mode, ignition is automatically provided to the engine when a power failure is detected, for example in the event of an engine shutdown or when the NTS is activated. In this case, it is normal that after an in-flight intencional engine shutdown the autoignition is activated and remains activated for 30 sec alter the propeller has been feathered.

There is an amber light in the cockpit that informs the pilot when the ignition is activated.

1.7 Meteorological information

The METAR Report of 22:00 h provided by Barcelona Airport indicated:

2200 LEBL 27003KT 9999 FEW 030 24/22 Q1015 NOSIG

that is, wind 270º 3 kt, visibility in excess of 10 km, slight cloud at 3,000 feet, temperature 24ºC, dew point 22ºC and adjustment QNH 1015 mb, and no significant changes were expected in the next two hours.

When the aircraft was authorized to land, it was given the datum “wind calm”.

1.8 Aids to navigation

Amongst other air navigation aids, Barcelona Airport has a VOR/DME (QUV, 114.3 MHz), and a localizer (BCA, 109.5 MHz) and an ILS gliding path on runway 25. Runway 07 also has an ILS system (localizer QAA, 110.3 MHz). There is no record that any of the aids were not functioning correctly on the day the accident occurred. The aircraft’s flight path was recorded by the Barcelona approach radar and a copy of the corresponding trace was obtained.

1.9 Communications

The aircraft contacted the Barcelona Approach Control Office (APP, 119.1 MHz) at 22:31:37 h. At 22:47:07 it was transferred to the Barcelona control tower in the 118.1 MHz frequency. The communications equipment of these services and of the aircraft were operative and functioned correctly at all times. A certified copy of the transcription of these communications as recorded by the air transit control services was obtained. This transcription is included in Appendix D.

Communications were normal, without the aircraft declaring any type of problem during the approach. The crew’s last communication, acknowledging the authorization to land on runway 25, took place at 22:50:37 h.

1.10 Aerodrome information.

Barcelona Airport has two runways which cross over each other: 07-25, measuring 3108x45 m, and 02-20, measuring 2720x45 m. Runway 07 has a declared stopway (SWY) measuring 277x45 m and a declared clearway (CWY) measuring 277x150 m.

It operates twenty-four hours a day throughout the year. The emergency and fire extinction service installations are located close to runway 25 threshold.

The approaching aircraft speed adjustments as published in the Spanish AIP (except when the aircraft's cruising speed is lower) are as follows:

- Between 170 and 180 KIAS on receiving the final localizer interception course.
- 160 KIAS on intercepting the gliding path in the FAP; this speed must be maintained up to 4 NM from the threshold.
- If this adjustment cannot be complied with, the ATC must be notified of the speeds that can be maintained.

The AIP also indicates that the radar display system installed in the control tower is authorized to carry out radar assistance functions for aircraft in the final approach, radar assistance for other aircraft in the airport's vicinity and the establishment of radar separation between successive outgoing aircraft.

Runway 25 was separated from the El Prat de Llobregat Beach Road by a metal fence fixed to a concrete wall, which measures 50 cm high by 25 cm wide.

1.10.1 Wake turbulence

The document AIP Spain, issue 4 October 2001, indicates for Barcelona Airport:

"The applicable wake turbulence minima separation are in accordance with what is established in the ICAO Doc. 4444. Pilots in need of additional separation shall notify so to ATC, once the clearance is issued for taxi to the takeoff position and before entering the runway."

1.11 Flight Recorders

1.11.1 Flight Data Recorder (FDR)

The aircraft was equipped with a Fairchild Sundstrand Flight Data Recorder (FDR) model FA-542, P/N 101035-1. This recorder records a total of five flight parameters: barometric height, indicated speed, magnetic course, vertical acceleration and discreet communications signal.

The FDR was sent to a laboratory with the capacity to read it. The FDR’s metal tape had been recorded twice on side 1 and once on side 2. The recording ended just at the end of side 1, although it appeared that both ends of the tape had previously been cut with scissors because the legends "Start Side1/End Side 2" and "End Side 1/Start Side 2" were missing. The recording ended just at the end of side 1. The reading of the parameters was:

- Barometric height: a practically horizontal continuous trace appeared from the beginning of side 1, with hardly any gain in height.

- Indicated speed: also a continuous trace, almost horizontal, from the same point.

- Magnetic course: not clearly located.

- Vertical acceleration: it seemed to be correct, although superimposed on the first recording. It showed a large stain due to the superimposing of points in the final detention point, which indicated that the aircraft had continued flying for some time after the end of the tape in its second run on side 1.

- The discrete communications signal was not located.

- The dater did not function correctly, not even in the first recording on side 1.

In the light of the foregoing, it can be concluded that:

1. As there was no dater and the altitude and course traces were not usable, it was not possible to identify the recording’s detention point or even to establish whether it was related to air or ground.

2. The fact that the end of the recording coincided exactly with the end (cut off) of the tape and with a large mass of superimposed vertical acceleration points made it possible to assume that the tape had come to an end and had stopped before the last flight or flights, without being possible to establish how long before.

Consequently, the FDR did not provide reliable data on the aircraft’s parameters in the moments prior to the accident.

1.11.2 Cockpit Voice Recorder (CVR)

The aircraft was equipped with a Fairchild Cockpit Voice Recorder (CVR) model A-100.

It was partially damaged by the fire and was sent to the U.S. National Transportation Safety Board (NTSB), which has laboratories for adequately processing these recordings and which had appointed an official representative in the investigation. The NTSB was asked about the possibility of carrying out a sound frequency analysis to determine the r.p.m. regime of the engines and propellers during a 75-second period prior to the accident.

The NTSB laboratory achieved a clear reading of the voices in the cockpit and sent to the Commission a copy recorded on a commercial tape. The Commission carried out the corresponding transcription of the conversations in the cockpit.

However, it was not possible to carry out an analysis of the environmental sound frequency spectrum due to the fact that, apparently, the microphone in the aircraft's cockpit area was inoperative during the moments prior to the accident and as a result sounds of the engines and propellers could not be detected on the tape.

1.12 Wreckage and impact information

When the investigation team arrived at the site of the accident, the remains of the aircraft were scattered over a distance of some 200 m from the point of the first impact with the outside barrier of the El Prat Beach Road (see diagram of the wreckage trail in Appendix A). Most pieces of wreckage remained inside the airport premises.

The fuselage was caught up against the airport perimetral fence, on the inside, and with a course of some 20º, that is, about 130º to the right of the course of runway 25 (248º). The front part of the fuselage, in a length of approximately one-third of the aircraft's total length, was completely wrecked and burnt. The fuselage was rolled to the left and supported on the remains of part of the left wing, which did not come off after the first crash into the outside fence of the highway. The right wing was intact, although it had come away from the fuselage and was twisted around its longitudinal axis.

The engine mounting with the right engine had been ripped out of its attachment with the wing and turned downwards and outwards with respect to its normal position.

The right propeller appeared complete, with the four blades joined to the hub which, in turn, was found covered by the dome. It was close to the outside of the airport barrier, some 8 m in front and some 6 m to the left of the right engine mounting wreckage. The four blades had suffered heavy torsion and bending stresses.

The four blades of the left propeller came out of the hub, which remained joined to the body of the left engine and were scattered in different places. One appeared inside the airport enclosure, at some 117 m distance from the main wreckage and between this and runway 25. Another blade appeared at some 45 m from the wreckage but on the opposite side.

The exterior of the rear part of the fuselage was intact, with the horizontal and vertical stabilizers not having suffered much damage, including the elevator and rudder, and still joined to it. Due to the rolled position in which the fuselage was found, the left horizontal stabilizer was touching the ground.

The right leg of the main undercarriage appeared joined to its housing in the right nacelle and in what appeared to be an extended and locked position. The left leg had come loose from its fastening to the left half-wing and was resting some 3 m behind it. The nose landing gear was completely destroyed and burnt.

There were signs of a first contact with the ground at some 45 m from where the fuselage was found, on the other side of the highway, where remains of the left navigation light were found. Then, at some 13 m, there were signs of what appeared to be the first impact of the left propeller. The aircraft continued to go forward, dragging the left wing along the ground, where there were marks including signs of fire right from that first moment. In its path the aircraft broke a section some 30 m wide of the outside barrier of the highway, probably crossed it in a level position, until it broke the airport enclosing barrier and concrete wall and turned round on itself to end up in the position indicated above, facing the highway.

The following indications were observed on the aircraft's instruments:

Vertical speed indicator: 300 ft/min (climbing)

Altimeter: 600 ft

Airspeed indicator: 130 kt

Clock: 12:57 h

Aircraft course: 210º (the magnetic course of runway 25 is 248º)

1.13 Medical and Pathological Information

The aircraft's two occupants died instantly as a result of the crash into the ground and subsequent fire.

The co-pilot had been off on sick leave from 23-3-1998 to 21-7-1998 due to a fracture on his right ankle. There was no record that he passed any aeronautical medical test after that period. The day of the accident, he was flying for the first time after his period of inactivity.

1.14 Fire

A violent fire broke out, which completely burned the front part of the aircraft. A witness declared that "… it touched the ground with the left wing, falling and exploding … dragged along the first barrier, passing straight over the highway in flames …"

According to the Cargo Loadsheet, the aircraft was carrying 1,102 kg of printed press material. The fire extinguishing services arrived at the site of the accident with great speed, as they had seen it from their installations close to the header of runway 25 and they had started out even before the tower declared the alarm. The extinction took place at great speed, with the fire affecting mainly the front part of the fuselage.

1.15 Survival

The aircraft crashed into the ground very violently and, according to the declarations of witnesses, with a bank of some 90º to the left. The front part was completely crushed as a result of crashing into the two fences and the wall. In addition, the aircraft, which was carrying a large quantity of newspaper, burst into flames almost immediately. The probabilities of the crew surviving were almost non-existent.

The existence of the concrete wall meant that the final crash was so violent that the aircraft turned nearly 180º with respect to its path and this was a factor that had a very negative influence on the accident's survival conditions.

Fortunately, the aircraft neither crashed into any of the vehicles that can normally be found on the highway nor into the two people that were standing on the shoulder very close to the point in the barrier that was ripped through during the accident.

1.16 Tests and research

1.16.1 Inspection of the engine-propeller units wreckage

It was decided to send the wreckage of both powerplants to the National Airspace Technology Institute (INTA) for a detailed inspection.

The INTA was requested to carry out the necessary tests on the engine and propeller wreckage of the damaged aircraft in order to establish the causes of the breakages and deformations in these elements. To this end, the wreckage was sent to the installations of its Structures and Materials Division in Torrejon de Ardoz.

As a result of their inspections and tests, the INTA issued Report No. FS1/RPT/4310/097/INTA/98 (Issue 2) "Study of the Causes of the Breakage of Engines and Propellers of the Fairchild SA-227-AC Aircraft, Registration Number EC-FXD". After the approval of the final report of the accident, INTA issued Issue 4 of their report.

The text of the conclusions of the above-mentioned Report at Issue 4 is quoted below.

1.16.1.1 Conclusions on the right engine-propeller assembly

The study conclusions were as follows (translated from the original in Spanish): “When the propeller hit the ground, the propeller no longer rotated and, therefore, the engine was already stopped. The propeller’s first contact with the ground took place simultaneously on two of the blades and the important force that acted on them, deforming them, was the reaction of the ground causing the aircraft’s rate of descent to be arrested. This reaction gave rise to a bending moment which caused the failure of the bushing-engine plate connecting stud bolts, resulting in the propeller being thrown away. Once separated from the engine, the propeller suffered a second impact with the ground which caused damages to the dome, deformation in the cap of the pitch change system spring and the deformation of the propeller’s other two blades (3 and 4).

As reflected in the pitch varying mechanism due to the anomalies it shows, the propeller passed through the following sequential circumstances before touching the ground for the first time [see Figures of the INTA’s report]:

1) A movement of the piston towards feather, in a voluntary or involuntary manner, from a blade pitch angle that cannot be determined. In a situation close to the final feather position, seizing took place between the rod that connects the piston and the crosshead where the actuating links are articulated, and the rod guide bushing. As a result of this seizing, the aforementioned rod dragged the bushing in its movement towards the feather position, shearing its upper flange or lip, and displacing it from its housing, with the result that, when the piston reached the feather stops, it was left out of its housing but with its upper part, already without the flange, pointing into the housing.

2) A movement of the piston from the feather to the zero pitch position. During the piston’s displacement from the feather position to the zero degrees pitch position (approximately 0º of blade pitch angle), the dragging effect of piston connecting rod over the bushing kept the bushing stuck in the hub cap, allowing the pressure of the oil supplied by the auxiliary pump to be maintained and the piston to be displaced towards the approximate zero pitch position. At the end of this phase, the bushing was left firmly seated by its lower face in the connection rod crosshead.

3) A movement, which resulted uncontrolled, of the piston from zero pitch position again to the feather positon.

This lack of control came about as a result of the fact that, on initiating the piston’s displacement towards positive pitch, the bushing supported on the crosshead moved together with the piston from the position it had at the end of the previous phase (zero pitch), permitting oil to leak through the bushing housing into the hub.

Consequently, the **primary failure** of the mechanical device of the pitch control system located inside the propeller was the seizing between the connection rod of the pitch varying mechanism's piston and that rod's guiding bushing, with the direct consequence of the shearing of the bushing's upper flange and the displacement of the bushing from its housing in the hub cap. This failure occurred in a phase of the in-flight feathering, voluntary or unvoluntary, and can be considered as the primary failure of the entire system if there were no other previous failures of the pitch control system that could have produced the movement of the propeller towards feather in and unintentional way.

The determining factors of the incorrect behaviour of sliding between the rod and the bushing could be mechanical in origin (basically inadequate play or tolerances) or defective lubrication. In order to evaluate the first type factors, it is needed the verification of the involved elements and is comparison with the technical data of the corresponding documentation.

The second type factors (lubrication) can be due to a problem or circumstance that could have caused difficulties in the engine's lubrication, either of a general type or directly related to the supply of oil to the propeller control system. To determine whether or not those factors had an influence, and giving the discrepancies found in the engine (oil overpressure valve open, low quantity of oil in the tank and no oil in the filter and its housing) it is recommended that the technical service of the manufacturer disassemble and inspects the crankcase of the reduction gearbox of the propeller of this engine, focusing on the oil circuits of every element related to the propeller pitch control system and the elements themselves (including the regulator, feathering valve, NTS, etc.)"

1.16.1.2 Conclusions on the left engine-propeller assembly

Despite the high degree of destruction of the left engine, due to both the impact into the ground and the subsequent fire, when the manual emergency feathering valve, which is directly actuated by the pilot from the cockpit to feather the propeller in the event of an emergency, was inspected "it was observed that the positon of that valve was that corresponding to the manual feathering and it was not in its normal flight position". The fuel cutoff valve was also actuated, which also seemed logical because both valves are mechanically linked, in such a way that when the pilot actuates the feathering control, the fuel is first cutoff and the the propeller is feathered.

The study concluded that "The only conclusion that can be established, given the fact that only the propeller's four blades were recovered separately, is drawn from their condition and leads to think that very probably the propeller was turning when it hit the ground but the engine was delivering little or no power. "

"This conclusion, together with the fact that the manual feathering valve, as observed in the engine, was activated, makes it possible to establish, as a possible hypothesis and so that both circumstances are congruent, that this control was activated a few seconds (in the region of 3 to 6 seconds) before the aircraft crashed into the ground."

1.16.2 Inspection of the right engine

Following the recommendation made by the INTA after inspecting the wreckage of the right power plant unit, the right engine was sent to a maintenance centre where it was stripped and inspected in an effort to find a fault or malfunction prior to crashing into the ground.

As a result of this inspection, no clear evidence was found that could be related to anomalies during the flight in which the accident occurred.

1.16.3 Inspection of other components of the right propeller control system.

Following the recommendations of Issue 4 of the INTA report, a maintenance center carried out the inspection and functional test of the feathering valve and the pressure regulating valve of the NTS, including the NTS valve and the autoignition switch of the right engine.

The results were as follows.

1.16.3.1 Feathering valve

"Two tests were carried out to check the correct opening:

a) It is a test in which it is measured the oil pressure at which the valve opens and closes (normal operating mode). The test consists of applying oil pressure and slowly increasing that pressure: the valve opens at 94 PSI (nominal value is between 78 and 112 PSI). Then the oil pressure is lowered and it is observed that the valve closes at 70 PSI. The difference between opening and closing pressures should not be above 10 PSI; in this case, the difference is 24 PSI, and therefore the valve is out of tolerante. This Fac. does not preclude the correct functioning of the engine, but it caused certain delay in the closing of the valve alter its activation (because of a negative torque detection). It is difficult to know whether this valve worked correctly before the accident."

b) It consists of checking whether it opens correctly when the emergency control is manually pulled. The outcome of this check was negative, i.e. it was not posible to manually open the valve. It is supposed to open when a manual force between 10 and 16 lb is applied. No obvious damage was observed to explain this fact. The cause could be the dirt of the valve after the accident (it had quite a lot of soot). It cannot be stated that the valve did not function correctly before the accident."

1.16.3.2 Autoignition switch

"The test carried out on this device is a check of the continuity between the pins. The device has three pins: A, B y C. When oil pressure is applied [...], there must be a change of continuity between pins. Initially, the pins between which there is continuity are B and C. When pressure is applied (30 PSI as a maximum) the internal switch must change the continuity to be between pins A and B. This change does NOT occur, i.e., the device does not work correctly. Additionally, there is a leak of oil between cavities due to the damage it has. Due ot the aspecto of the device (heavy deformation) it is highly probable that this failure was a consequence of the accident."

1.16.3.3 NTS valve

"A visual inspection is carried out on this element. When negative torque appears in the engine, the lever causes a movement of the piston incide the valve, which produces an increase of pressure in the circuit and causes the opening of the feathering valve. The piston shows usual wear due to operation. This device is in good condition."

1.16.4 Radar track of the same flight carried out by another aircraft

A copy on paper of the flight's radar trace carried out by a Metro III of the same operator, with the same flight number SWT704, recorded on 19th August 1998, was obtained from the Barcelona ACC for comparison with the trace of the EC-FXD aircraft which suffered the accident 23 days earlier.

The Airport's METAR of 23:00 h on 19-8-98 was:

2300 LEBL 01004KT CAVOK 24/18 Q1017 NOSIG

that is, conditions similar to those of the time of the accident, with the exception of a 10º and 4 kt wind (there was a 3 kt wind from 240º at the moment of the accident on 28th July 1998).

This flight's radar trace showed that there had been a slight deviation to the right of the localizer when the aircraft was at an altitude of 800 ft and flying at a ground speed of 110 kt. The radar indication of ground speed never fell below 11 (110 kt) until the landing (0 ft of altitude in the radar track).

1.16.5 <u>Aircraft's flight path</u>

1.16.5.1 Trajectory of the accident aircraft

The aircraft's flight path, as obtained on processing the data provided by its radar trace, was normal for an approach to runway 25 of Barcelona Airport, although during the localized capture the aircraft remained slightly on the right (see Appendix C).

To prepare this trajectory, it was taken into account that the tower and radar track were not exactly timed (the radar time is around 20 sec advanced with respect to the tower time).

After the captain said: "Well, engine stop" ("Bueno, parada de motor"), a strong deviation to the right was noted, that was later corrected after the captain said "What happens?...I am going to put the engine for you" ("¿Qué pasa?...ahora te meto el motor") and the aircraft remained established in final, on the glide path and localizer and already cleared to land. Later on, it was cleared to land and the captain said: "Well, I am retiring [removing, putting out…] the engine for you again. I have raised the flap. Now flap by increments" ("Bueno, te quito el motor de nuevo. Te he subido el flap. Ahora flap por incrementos"). In these conditions, at 22:51:43 h, at an altitude of some 500 ft and at 1.6 NM from the runway threshold, the aircraft was centered on the localizer, some 50 ft below the gliding path and at a speed of 130 kt with respect to the ground. The speed resolution provided by the radar trace is 10 kt.

As from that moment, the aircraft again captured the gliding path when it was at an altitude of 400 ft and at 1.1 NM and there were slight fluctuations around the path, with a speed of 120 kt.

At an altitude of 300 ft and at 0.9 NM from the threshold, the aircraft was 40 ft beneath the path and established in the localizer, with a ground speed of 110 kt at 22:52:11 h. When at 0.4 NM and an altitude of 100 ft the aircraft was already 100 ft below the path, displaced some 100 m to the right of the localizer and at a speed of 100 kt, at 22:52:25 h; it kept this altitude for approximately 180 m, although it continued its shift to the right of the localizer at 22:52:32, until it dived into the ground at 360 m (0.2 NM) from the header, a point at which the gliding plane is at an altitude of some 75 ft. In this last leg, the aircraft continued increasing its shift towards the right of the localizer. Those last points are not very precise with respect to the distance.

As a summary, it could be estimated that the aircraft begun to lose control when it was at around 200 ft of height and at around 850 m from the final point where it came to a stop (beside the fence) and, therefore, at around 1100 m from runway 25 threshold. According to recorded conversations in the cockpit, the crew realized they had problems with the aircraft (presumably aircraft's control problems) around 17 sec from the final of the recording. At around 100 kt (50 m/s) the aircraft would have covered 850 m during that period of time, and at a vertical speed of roughly 540 ft/min (9 ft/sec) to keep a 3º glide path, it would have descended around 150 ft in that period of time. Those figures, although approximate, are generally coherent with the evidences found and the radar track.

As previously stated, it is important to take into account the speed data given by the radar track could not be completely exact in the final part of the recording. In addition to the inherent resolution of the radar track (around 10 kt), at low height and close to the runway the error could increase. The latest values given by the track are calculated or extrapolated by the system (the position is indicated by a diamond without lines inside it).

The speeds given by that radar track, taken as advisory at those latest points, must be combined with other evidence available during the investigation, like the fact that the stall warning sounded and that the crew noticed that the SAS ("Stall Avoidance System") was activating.

Once the first impact of the left wing against the ground had occurred, the aircraft described a rectilinear path with a course of some 210º, leaving numerous marks in the ground, crossing the Beach Road barrier, the highway itself and the airport barrier, to then turn on its yaw axis and to be left facing the point where the first impact occurred, with the cockpit resting on the concrete wall of the enclosing barrier.

1.16.5.2 Trajectory of the Airbus A-300 that took off previously

The ATC communications transcript, in addition with the CVR transcript, lead to the following sequence of events:

TIME ATC (UTC)	STATION	TEXT	COMMENT
22:49:20	TWR	LFA-606 wind calm, cleared for rolling takeoff	Between 3:20 min and 3:06 min before the accident
22:49:24	LFA-606	Rolling takeoff 25	Escuchado en el CVR; Between 3:16 min and 3:02 min before the accident
22:49:55	SWT704	Establecidos en final, SWT704 (Established in final, SWT704)	Between 2:34 min and 2:31 min before the accident
22:50:34	TWR	SWT704, autorizado a aterrizar 25, viento calma (SWT704, cleared to land 25, wind	Between 1:55 min and 1:52 min before the

		calm)	accident
22:50:48	TWR	LFA606 contact radar 124.7, bye	Between 1:41 min and 1:36 min before the accident
22:50:53	LFA-606	124.7, good bye	Between 1:36 min and 1:33 min before the accident
22:52:26	ACCIDENT		End of the CVR recording

Therefore, when the A-300 was cleared to takeoff, the Metro was approximately 3 min and 13 sec (mean time between ATC and CVR) away from the accident place, which was at a distance of around 300 m from the runway threshold. The aircraft would have used around additional 6 sec to cover those 300 m to reach the threshold.

After being cleared, the A-300 had to enter the runway and, without intermediate stop, apply thrust and initiate the takeoff run, because it was a rolling takeoff.

The A-300 was transferred to approach at 22:50:48 h (1 min and 24 sec after it acknowledged “rolling takeoff”), in ATC tower, which would correspond to approximately 22:51:08 h in radar time.

As a summary, it can be assumed that it took 1 min and 24 sec for the LFA-606 to enter the runway and carry out the takeoff run and initial climb, until the moment it was told to contact approach. At the moment, the SWT-704 was approximately at 3.2 NM away from the runway, and at 1 min and 38 sec from the accident.

The radar track shows that at 22:51:43 (35 sec after it was transferred to approach) the LFA-606 had already initiated a left turn, and it was at 3000 ft of altitude and at 4.7 NM in straight line from the runway and at around 200 kt of ground speed. At those moments, the SWT-704 was at 1.6 NM from the runway, at 500 ft of altitude and with around 100 kt (number 10 shown by the radar track).

1.16.6 <u>Statement of witnesses</u>

A witness, who was standing next to his motorbike and other witness very close to the aircraft’s final resting place and who, according to his own testimony, had the habit of watching aircraft land in Barcelona Airport in runway 25, declared that he saw how the aircraft approached and that he did not think twice about it because he heard it coming in OK. Then, on being questioned by the witness if it was normal for the aircraft to move so much before landing, he looked to his left and saw how the aircraft veered to the right and "put the right wing up and the left wing down, with the wings vertical to the ground. Then it lost height and positioned itself above an earth track that was to the right and then it did another pirouette slightly crossing to the left, lifting the nose and carrying out the same pirouette as the first one but in a vertical position with the left wing up and the right wing down. Immediately afterwards, losing height all the time, it straightened its nose and then went into the same position as in the first pirouette, touching the ground with the left wing, falling and exploding. It dragged the first barrier, passed straight over the highway in flames and at the same turned round on itself, in flames, with the tail in the airport enclosure and the cockpit above the barrier."

The witness had observed other times that the wake of aircraft similar to the A-300, that had taken off a few moments before, used to generate vortices strong enough to take away a helmet or even to turn over a motorbike in the position they were, which was around 50 m, certainly not more than 100 m from the point the Airbus started the takeoff.

In this occasion, he remembered that when the A-300 was accelerating the engines for takeoff, the Metro had not yet "faced the runway for landing". When the Airbus was taking off, the other aircraft faced the runway. Since the moment the Airbus was at the runway to the moment the Metro started to lose control, the witness recalled, in a statement made later, that the time elapsed was 30 or 50 sec. The distance between both aircraft when the first was "warming" the engines could not be exactly stated by the witness, but he was sure it was more than 400 m.

The other witness stated that she noticed the wake of the large aircraft that was taking off, y she did not see dust to arise at those moments.

The two witnesses ran away, afraid that the aircraft "might explode again". He also declared that "immediately afterwards the airport firemen came out to put out the fire" and that the aircraft came to rest one metre away from his motorbike, which was also burned by the propagation of the flames from the burning aircraft.

1.16.7 <u>Estimate of the time needed to carry out an engine stop and start of the engine in flight</u>

The result of a ground test carried out by experienced pilots on a Metro III similar to the accident aircraft. In this test, the procedures "intentional engine shutdown", "airstart" and "immediate airstart" were applied.

The result of the times needed to apply tose procedures was as follows:

Procedure of engine shutdown: 1 min and 15 sec
Procedure of airstart: 1 min and 8 sec
Procedure of immediate airstart: 53 sec

1.17 Additional information

1.17.1 Physical characteristics and limiting surfaces of obstacles at Barcelona Airport

The layout of runway 07-25 as regards to physical characteristics and to limiting surfaces of obstacles was compared with what is established (both dispositions and recommendations) in chapters 3 and 4, respectively, of Annex 14 of the OACI, Eighth Edition (effective on 11-24-1983), and also with Second Edition (effective on 11-9-1995) and Third Edition (effective on 11-4-1999) to Volume I of Annex 14 of ICAO, based on the following data:

- For takeoffs initiated from runway 07, there is a clearway measuring 277x150 m and a stopway measuring 277x45 m, which start at the end of runway 07 and reach as far as the barrier that separates the airport from the El Prat Beach Road.

The layout of the concrete wall, barrier and the highway itself (with mobile obstacles, i.e. vehicles, of up to 4 metres in height based on the standard gage) does not comply with the recommendations of Appendix 14 in the sense that, in the case of class 3 and 4 airports, there should be a stripe of the runway that extends 60 metres beyond the end of the stopway (Recommendation 3.3.2) and a runway end safety area (RESA) that should extend at least 90 m beyond the stripe (Recommendation 3.4.2). In accordance with Appendix 14, no fixed objects (non-frangible) would be allowed in neither the runway stripe nor any mobile objects whilst the runway is being used for takeoff or landing. The latest edition of Annex 14 converts those recommendations in regulations (paragraphs 3.3.2 and 3.4.2) and, additionally, includes the new recommendation that the runway end safety area should extend for at least 240 m from the end of the runway stripe.

It should be noted that the non-compliance affects to aircraft taking off from runway 07, not to aircraft landing to runway 25, in which case there are 277 m free of obstacles between the threshold and the fence and wall where the aircraft impacted.

The takeoff climb surface area (Chapter 4 of Annex 14 of ICAO), which must start at the end of the clearway of runway 07 with a 2% gradient, would also seem to be infringed by the presence of the fence and vehicles on the road.

At the same time, it was established that this layout of wall and barrier does not infringe the recommendations of Appendix 14 of the OACI as regards the limiting surface areas for approach to runway 25.

1.17.2 <u>Wake vortex aircraft separation</u>

The “Reglamento de Circulación Aérea”, as amended by Order of 12-3-1997, states in paragraph 4.4.14.2 that when turbulent wake conditions exist and the separations detailed in other paragraph are not applicable, it will be used at least 2 minutes of separation between a light aircraft and a heavy aircraft when they are using the same runway and the light aircraft arrives after the departure of the heavy aircraft IF IT IS ANTICIPATED THAT THEY PATHS WILL CROSS.

The Reglamento did not cover the case of separation between a light or medium aircraft that lands after a heavy aircraft departs in the same direction and without crossing one the patch of the other.

1.17.3 <u>Characteristics of the turbulent wake of an aircraft during takeoff</u>

The turbulent wake of an aircraft appears when it is generating lift, due to the induced drag of the wing tip wake vortices.

The main hazard it means for other aircraft in to induce a roll movement that could make it to lose lateral-directional control, depending on its roll control capability.

During the takeoff run, the wake starts to generate in general from a point very close to the rotation of the aircraft. In the case of the A-300, it could be assumed (there was no nose wind) that the rotation could have been not earlier than when it was at the half of the 25-07 runway length (total length is 3108 m).

The most recent issue of the “Reglamento de Circulación Aérea” (“Real Decreto 57/2002”) states in its Appendix G that “Vortices tend to deviate downwards and, when close to the ground, move laterally with respect to the trajectory of the generating aircraft, jumping upwards some times.

Another reference that could be used is the latest issue of the FAA Advisory Circular (AC) AC-90-32F, “Aircraft Wake Turbulence”, and dated 20-2-2002. It states that in general the vortices generated by a heavy aircraft tend to fall downwards a vertical speed of several hundred of feet per minute. Pilots should be aware to avoid in general flying behind and below the generating aircraft, although a vertical separation of 1000 ft between them is considered a safe distance.

In the event of taking off or landing behind a heavy aircraft that has performed a go-around or a touch and go, at least 2 min of separation must be applied by the trailing aircraft, according to the AC.

The rule that crews of light aircraft apply in practice to avoid being affected by the wake of a heavy departing aircraft, is to land well before the rotation point of the heavy aircraft (see Figure 1.17.3.1, copied from the FAA Advisory Circular 90-23F).

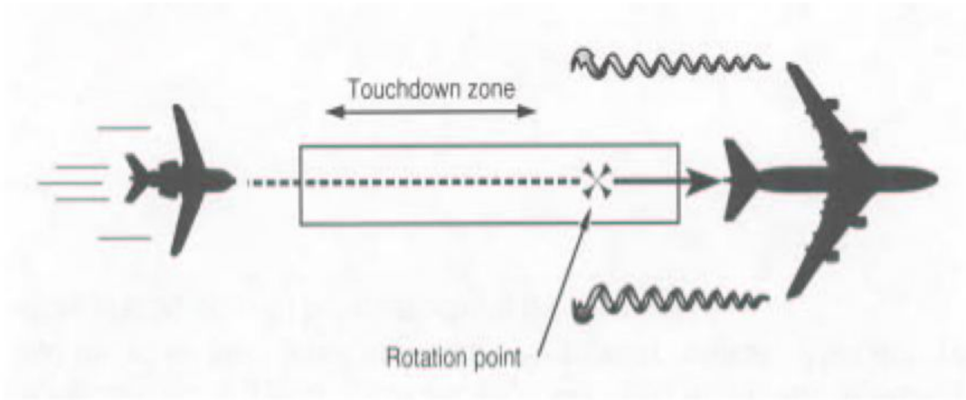

Figure 1.17.3.1 Landing zone to avoid the wake of the aircraft the takes off before

During the approach of two aircraft to the same runway, the practical rule is to be always above the approach path of the first aircraft, because, as previously stated, the wake in general travels downwards.

It can be stated that the wind calm conditions that prevailed in the moments previous to the accident of EC-FXD were negative with respect to the time of permanence of the wake of the preceding aircraft, because there was no wind to promptly dissipate the vortices, but were positive with respect to the possible sweeping of the wake backwards, towards the runway threshold in which the Metro was going to land, as it would have happened in a situation of nose wind during the takeoff of the A-300, and the probability of a possible rebound of the vortices upwards was lower.

Although the generation and movement of the wake of an aircraft are complex phenomena, in general, in a wind calm situation, like the one encountered during the approach of the Metro aircraft, the wake moves downwards and laterally outwards on both sides of the trajectory of the generating aircraft.

In accordance with the mentioned FAA Advisory Circular, *"There is a small segment of the aviation community that have become convinced that wake vortices may "bounce" up to twice their nominal steady state height (with a 200-foot span aircraft the "bounce" height could reach approximately 200 feet above ground level (AGL)). This conviction is based on a single unsubstantiated report of an apparent coherent vortical flow that was seen in the volume scan of a research sensor. No one can say what conditions cause vortex bouncing, how high they bounce, at what angle they bounce, nor how many times a vortex may bounce. On the other hand, no one can say for certain that vortices never "bounce." Test data have shown that vortices can rise with the air mass in which they are embedded.*
Wind shear, particularly, can cause vortex flow field "tilting.""

1.17.4 Jet engine exhaust

The “Reglamento de Circulación Aérea”, as amended by Order 12-3-1997, has the following text in its Appendix G (this part has not changed with the new edition of the “Reglamento”, “Real Decreto 57/2002”):

“The air traffic controllers when issuing clearances or instructions must take into account the hazards that the jet engine exhaust and propeller vortices pose to aircraft during taxi, to aircraft in take off or landing, especially in the case crossing runways are used, and to vehicles and people that move or work in the aerodrome. The jet engine exhaust and the propeller vortices may cause localized winds of speeds high enough to damage other aircraft, vehicles or personnel located in the affected areas.”

Other reference that can be used is the above mentioned FAA Advisory Circular AC 90-32F “Aircraft Wake Turbulence”, dated 20-February-2002, that includes a paragraph on the jet engine exhaust effects that states that “*During ground operations, jet engine blast (thrust stream turbulence) can cause damage and upsets if encountered at close range. Exhaust velocity versus distance studies at various thrust levels have shown a need for light aircraft to maintain an adequate separation during ground operations.”*
It does not provide quantitative values of distances or speeds. It says that it is desirable to align the aircraft to face any possible jet engine blast effects.

For an Airbus A-300, the hazard area of the jet blast covers approximately 579 m behind the rear end of the aircraft. The height of that area is approximately that of the fuselage.

2. ANALYSIS

2.1 Initial progress of the flight

Flight SWT704, scheduled for transporting cargo between Palma de Mallorca and Barcelona on 28th July 1998, was to be used by the crew as an instruction flight. The co-pilot, who that day was flying for the first time since 20th March 1998, and who was sitting in the left-hand seat, would thus carry out a refresher flight as “First officer under supervision”, in accordance with the operator’s procedures.

At first, it had been planned that the aircraft should carry out a missed approach with one engine on its arrival at Barcelona Airport.

However, when the crew was authorized to carry out an approach to runway 25, and on going over the missed approach manoeuvre to that runway, the co-pilot commented that the approach was a bit complicated to be carried out with only one engine, because it was necessary to ascend with the course set for the runway up to 600 ft and then carry out an upwards change of direction to the left until radial 239 of the VOR QVD was intercepted and then to continue climbing up to 4000 ft.

From the conversations in the cockpit it can be deduced that the co-pilot, who was flying on the left-hand side, had the flight controls throughout the approach to Barcelona (PF), whilst the aircraft’s captain and instructor, seated on the right-hand side, acted as the auxiliary pilot in this phase (PNF).

The captain indicated that he had expected the aircraft to be cleared to land on runway 07 and, when air traffic control directed them to runway 25, he decided not to carry out the balked landing on that runway. He added that that missed approach manoeuvre would be postponed for two days later.

The conversations in the cockpit indicate that, after that decision, the captain was considering several possibilities on the type of training to carry out once the missed approach with one engine on runway 25 had been ruled out. He commented the possibility of landing without steering and finally decided to carry out a standard approach leaving the glide path a little above and then stopping the engine. They would then raise the landing gear and flaps by increments.

In the conversations between the two pilots that followed, as the captain used phrases such as “we’ll do a simulation”...“we’ll do something like a small missed approach…” and ”I raise the landing gear for you and it’s as though you were going to carry out a missed approach”.

At that moment the co-pilot did not ask for any clarifications on the type of manoeuvre that was going to be carried out.

During the investigation of the accident, taking into account that the RH propeller was no longer rotating when it hit the ground, and also the damage and marks observed in the pitch control mechanism of this propeller (with the sequence of propeller towards feather, then towards low pitch at around 0º and finally back to a position close to feather in which it impacted against the ground, in addition to the fact that the bushing of the guiding rod appeared broken) two hypotheses were established to explain the sequence of events since the moment the phrase “Engine stop” was pronounced:

Hyphotesis 1: The crew intentionally stopped the RH engine using the corresponding procedure and pulling the stop and feather control.

Hyphotesis 2: The crew simulated that failure of the RH engine by moving the power lever to flight idle position.

Those hypotheses are discussed below. In view of the available findings, the possibility that the training exercise was carried out on the LH engine was discarded, because the deviation of the trajectory was towards the right of the localizer.

2.2 Hypothesis of intentional shut down of the right engine

The hypothesis that the crew stopped completely the right engine by pulling the stop and feather control as a part of a training exercise once stablished in final and in a night flight was considered very improbable from an operational point of view due to obvious reasons. The two stop and feather control levers were found in normal flight position after the accident. On the contrary, after the accident the feathering valve of the right engine was found closed (in normal flight position) and that of the left engine was found actuated (the feather control had been activated).

The aircraft’s Flight Manual, in section “VI. Manufacturer’s Data”, i.e. not explicitly approved by the F.A.A., includes indications on speed for the case of the intentional stopping of an engine in training situations, maintenance adjustments, etc. It is recommended not to make real stoppages but to use simulation consisting of taking the control lever to idle. This section only contemplates the case of carrying out a complete shutoff during the initial ascent after takeoff, when at less than 100 ft above ground level. The Flight Manual recognizes that there are important controllability problems in landing configuration at approach speed and with one engine inoperative. In the date of the accident, the AFM also stated “Provided that the aircraft is not lower than 1,000 ft above the ground and that it is light enough to maintain regulatory terrain clearance and to remain above stall warning speed, it is permissible to slow from Vsse to Vmca. Remember the minimum airspeed for an airstart is 100 KIAS.”

“If gross weight and performance permit, additional training experience can be gained at speeds close to final approach speed by extending the landing gear and flaps to demonstrate the significantly increased controllability problem when at high single engine power in the landing configuration.”

In the conversations recorded in the CVR it can be noted that the flight crew did not read any checklist.

After the captain said “Well, engine stop” (“Bueno, parada de motor”), 2 minutes and 23 seconds before crashing into the ground, the co-pilot answered “Come on, landing gear up”, the acoustic signal of “landing gear not down and locked” could be heard on having moved backwards one of the control levers, and, after a strong displeasure expression by the co-pilot, both crew members realized that the co-pilot had carried out an action contrary to what was required by the procedure.

The captain immediately indicated: “What's up? I’m putting the engine for you” (“Qué pasa? Ahora te meto motor”) and then added “You’ve done it the wrong way round”. However, from the cockpit conversations that were recorded in the CVR it does not seem that the crew members had the sensation of having carried out an irreversible action or that the aircraft was in immediate danger.

In fact, after the co-pilot acknowledged that “I was doing it the wrong way round… I had the impression that I was putting it in right”, ("Lo estaba haciendo al revés. Me daba la sensación de que lo estaba metiendo bien") the captain added: “Well, we’ll continue”. Four seconds later, the tower authorized them to land and the captain collated this instruction without stating any type of problem in the aircraft.

Although there is no evidence as to what actually was the wrong action carried out by the co-pilot, his sentence “I had the impression that I was putting it in right” could be interpreted as having pushed the wrong pedal (i.e. he put his foot down against the “dead” engine, the right one in this case). It may also have had something to do with the aircraft’s trimming. One of the steps required by the engine stop procedure is “Trim: as required”.

The radar tracking data indicate that in the moments subsequent to the right engine stop exercise there was an important deviation to the right of the localizer. The captain’s immediate reaction was to try to put the engine back in, saying “What’s up? I´m putting the engine for you” ("¿Qué pasa? Ahora te meto motor") and seconds later “You’ve done it the wrong way round”.

With a literal interpretation, the phrase “I am putting the engine for you” (“Ahora te meto el motor”) could only mean that the engine was just at flight idle and not completely stopped.

On the other hand, if it is assumed that the engine was completely stopped, it could be argued that the application of the engine stop procedure was interrupted and the crew, facing and unexpected situation, tried to start the engine by the most expeditious means. This could explain, in the frame of this hypothesis, that the time elapsed since the beginning of the stop exercise to the airstart attempt was very short.

The witness marks in the pitch change mechanism (see section 1.16.1.1) showed that, after the propeller went to feather angles, it returned back to low pitch, around 0º. However, during an airstart of the engine, the pitch does not reach to 0º, which corresponds to ground idle, but remains at around 15º corresponding to flight idle. If the propeller rotates at high r.p.m. with 0º of pitch, a high drag will appear in a windmilling condition.

Therefore, the available information led to the conclusion that it was improbable that there was an actual engine stop.

2.3 Hypothesis of simulated RH engine stop

This hypothesis was logical from an operational point of view, because it allowed to train the reactions of the copilot while having readily available the power of the right engine when needed.

According with this hypothesis, when the captain ordered "Engine stop", 2 minutes and 23 seconds before the impact against the terrain, the RH engine power lever was retarded to flight idle. The copilot answered: "Come on, gear up" ("Venga, tren arriba") and some sounds of "gear not down and locked" were heard because one of the levers was retarded, and both crew members realized that the copilot had carried out an accion contrary to the requirement of the procedure. As previously stated in this report that action could have been to push the wrong pedal, that is, to apply right rudder, thus producing the sudden displacement of the aircraft to the right of the localizer.

The captain immediately stated: "What happens? I am going to put the engine for you" ("¿Qué pasa? ... Ahora te meto el motor"), which would just mean to advance the RH power lever and then added "You made it the wrong way" ("Lo has hecho al revés").

Following with this hypothesis of simulated engine stop, in view of the evidences noted on the propeller, there must have been some failure that took, in a way not commanded by the pilot, the pitch towards feather. This failure could have been a malfunction of the NTS, in a way that interpreted there was negative torque and actuated to open the feathering valve to take the propeller to high pitch without an actual power failure.

During that movement of the propeller towards feather, the seizing of the bushing that was observed in the inspection after the accident could have happened.

However, according to the aircraft documentation, the NTS does not take the propeller to a full feather positon (89º), but it increases the pitch to reduce drag until the moment the pilot pulls the stop and feather control. Therefore, the hypothesis of malfunctioning of the NTS alone would not explain why marks of pitch reaching full feather except in the case some transient effect would have caused it, maybe the delay in the closing of the feathering valve that was noted in the inspection of this component (see section 1.16.3.1).

The marks in the pitch change mechanism (see section 1.16.1.1) showed that after the propeller went to feather, it returned back to low pitch, at around 0º.

It could be initially assumed that this fact was due to the normal operation of the governor, after the malfunction of the NTS disappeard and the feathering valve closed again, to reduce the pitch again after the power demand when the right lever was advanced. Even though the flange of the bushing broke, the system allowed this movement because the broken bushing remained seated at its positon in a way that made oil pressure available for pitch change.

However, this process would not explain why the marks found showed that the pitch reached 0º, corresponding to 0º. As stated in the previous section, the high speed rotation of the propeller at 0º would produce high drag due to the windmilling regime, unless it is assumed again a transient effect that made the pitch change rod to momentarily go to 0º and then back to the normal pitch corresponding to the power and r.p.m. demand from the cockpit.

At 22:50:38 h, the captain said “Well, I am taking out again the engine for you. I’ve raised the flap for you. Now flap by increments…one and I have left it for you, ...I am leaving it in the middle for you”. The flap positions are: up, ¼, ½ and full flap.

This phrase would indicate that the captain again retarded the RH engine power lever to flight idle, to continue with the training. At that moment there was no noticeable displacement in the trajectory of the aircraft, according to the radar track.

There are no signs in the CVR that the crew noticed any problem or malfunction of the engine.

It was considered the possibility that in the second case the LH power lever was retarded to “take by surprise” the copilot having in mind that the first simulation had involved the RH engine. This possibility was discarded because the conversation of the CVR indicates that it was intended to continue with the previous exercise (“Well, I am taking out the engine again for you”, suggests “the same engine”). In addition, the final sequence of deviation of the aircraft towards the right is coherent with thrust on the left side of the aircraft.

This hypothesis of simulation of RH engine stop would be in accordance with the fact that the feathering valve of that engine was found in its normal flight position, as it happened with the fuel shutoff valve (both valves are mechanically connected).

According to this hypothesis, when the copilot asked: “I continue with the approach, don’t I?” (“Sigo la aproximación, ¿no?”) the aircraft would be with the RH engine at flight idle, at 110 kt of airspeed, with the landing gear up and with an intermediate position of flap (1/2). The LH engine would be providing the thrust necessary to keep the desired glide path.

After the affirmative answer of the captain: “Yes. We are cleared to land. We are going to land with an engine, OK?” (“Sí. Estamos autorizados a aterrizar. Vamos a tomar con un motor ¿vale?”), the aircraft continued the approach. The flight manual indicates that, in the event of a single engine landing, neither landing gear down nor flaps extension beyond ¼ are selected until the landing is assured.

The crew selected landing gear down 62 sec after the captain confirmed they would land with an engine, that is, the impact happened 23 sec after “Landing gear” was called for in the cockpit.

El CVR shows that before that selection they took action to avoid the ignition activating, when the captain said “Let’s put a little to avoid the ignition bouncing” (“Vamos a poner un poco para que no salte la ignición”) (23 sec after the phrase " Well, I am taking out the engine again for you”), and that he also made general remarks with instructions on how to carry out a missed approach or to face other eventualities close to the runway. He used the phrase: “Anyway, when you have, when you may have a go around or something very close to the runway, you make it with the foot...and without anything of...because if you touchdown what happens...” (“De todas maneras, cuando tienes, cuando tengas una frustrada o algo estés muy cerca de la pista, lo haces con el pie…y con nada de…porque si tomas qué pasa…")

At this point, the captain added: “Then you have to go with nothing of...Well, I am thus removing it for you, OK?” (“Entonces tienes que ir con nada de…Bueno, pues te lo quito ¿eh?”).

The normal action after lowering the landing gear would be to increase the power of the live engine (the left engine) to keep the glide path.

The conversations in the cockpit confirm that there was positive indication of landing gear down and locked at 22:52:07 and, almost coincident, an interjection of surprise of the captain. Then the continuous beep of the stall warning and the captain said “The SAS is coming in”. Two seconds afterwards (seven seconds after the confirmation of gear down and locked) the copilot said “What’s happening?” followed by the statement of the captain: “Apply foot!” (¡“Mete pie!”) and the answer of the copilot “I am applying!” (“¡Estoy metiendo!”). Seven seconds after this latest statement, there was a screm of the copilot and the impact against the terrain happened at 22:52:26 h.

There was no sign that flaps down were selected after there were put “in the middle” (likely, selector at 1/2).

It would be logical that, when the stall warning appeared, the power of the LH engine was increased and it is also possible that at that moment or when lateral-directional controllability problems were noted that could not be corrected by rudder application because of the low speed ("Apply foot!", “I am applying!") it was decided to increase also the power of the RH engine that was at flight idle. This power increase would have caused the governor to increase the pitch but in this case, on the contrary to what happened when the propeller moved towards low pitch, the leak of oil towards the hub due to the breakage of the bushing could have caused it to reach angles close to feather with the engine delivering power, which could have produced its complete stop due to the high rotational drag generated.

This fact would be in accordance with the evidences that the RH propeller was not rotating and had pitch close to feather at the moment of the impact against the terrain.

Between 22:52:11 and 22:52:18 h the spee of the aircraft, as recorded by the radar track, descended from 11 to 10 (from 110 kt to 100 kt because the resolution is 10 kt in the radar system). The subsequent four radar readings always show 10 (100 kt) although they are calculated or extrapolated values by the radar system (the position of the aircraft in the radar track is marked by a diamond without a horizontal line in its interior).

The stall speed of the aircraft, with a weight of around 13300 lb, with flap ½ and landing gear down, and with zero thrust, may be estimated from the flight manual data in around 87 KIAS. The indicated airspeed is around 1 kt above the calibrated airspeed for those values of speed. The SAS provides an aural warning at around 7 kt before the aerodynamic stall. A roll angle of 20º makes the stall speed to increasy by 3 KCAS.

According to the flight manual, the minimum control speed is of around 91 KIAS.

The activation of the SAS, which was noted by the captain 15 sec before the impact against the terrain, would imply the automatic application of a force of 65 lb pitch down over the control column. The flight manual states that during the recoverý of a single engine power on stall around 390 ft of altitude are lost and 10º of pitch down attitude may be achieved.

The sequence of the facts, with a stall warning, activation of the SAS, and subsequent succesive roll movements of 90º, according to the statements of witnesses, to the left and to the right, suggests that there was a loss of lateral-directional control due to a decrease of the speed below the minimum control speed at low altitude, in a situation of asymmetrical thrust.

2.4 Comparison between the hypothesis of intentional shutdown and simulated engine stop

The hypothesis of simulation of engine stop contained in the previous section is the most logical from an operational point of view, to the point were the actual shutdown mentioned in section 2.2 is considered highly improbable, especially taking into account that for its explanantion it is necessary that before the completion of the engine stop procedure, there has been an airstart attempt in which the pitch has reached 0º.

If it is assumed that the engine stop was just simulated, there should have been two independent consecutive failures (malfunction of the NTS and seizing of the bushing) and another transient malfunction to take the pitch to 0º to explain the evidences observed in the propeller. The NTS components inspected and tested (NTS valve and autoignition switch, see 1.16.3) and the feathering valve showed certain malfunctions, although it was not possible to categorically conclude that they had important failures before the accident. The most relevant fact observed could be the delay in the closure of the feathering valve after being activated (because of a detection of negative torque). This malfunction could explain that the operation of the NTS took momentarily the propeller pitch to feather (89º) but not the opposite effect of taking it to 0º.

In any case, the analysis of the available information leads to the conclusion that it is probable that they were carrying out an exercise of simulated engine stop by retarding the corresponding power lever to flight idle, and during which some transient failures happened combined with the mentioned seizing of the bushing.

2.5 Seizing of the bushing that exists between the piston rod and the hub cap

The maintenance record of the engines and propellers were checked, in an effort to find a reason for the seizing and breakage of bushing B, referred to in section 1.16.1.1.2, which is located in the right propeller pitch varying mechanism.

In February 1998 a chip detector warning had been noted in the right engine due to the presence of metal particles when it was fitted to a different aircraft. It has been recorded that the corresponding inspection-repair was carried out to the engine in an authorized maintenance centre in the United States. However, the bushing that failed was found in the right propeller, S/N 931784, which is the same one that had been fitted to aircraft EC-FXD since before 1993. This propeller had a total of 5,692 hours and 1,636 hours since the last general overhaul (to be repeated every 4,000 hours), which had been carried out in a specialized and authorized centre in Portugal.

No metal particles were found in the particle detector or the right engine oil filter in sufficient quantities to have produced a cockpit warning.

Nevertheless, a fault occurred when both the right engine and the right propeller had a potential of thousands of hours until the next general overhaul. This may have been due to mechanical causes (basically, inadequate play or tolerances) or defective lubrication. It would be advisable that the aircraft's manufacturer, in conjunction with the propeller's manufacturer, would carry out an in-depth study of the design characteristics as regards to play and pitch varying mechanism maintenance, in order to avoid a repetition of this failure.

2.6 Possible influence of the wake or the jet engine exhaust of aircraft flight number LFA-606

As discussed in paragraph 1.6.4.2, the A-300 that took off from runway 25 before the accident, was cleared for a rolling takeoff more than 3 min before the moment at which the SWT-704 reached a point located around 250 m from the threshold of that runway.

It is considered that this separation did not include risks with respect to turbulent wake effects for a light or medium aircraft landing in the same runway in which a heavy aircraft had taken off.

The "Reglamento de Circulación Aérea" indicated (paragraph 4.4.14.2.1) that in the case of a displaced threshold the minimum separation should be 2 min between a light or medium aircraft (Metro) and a heavy aircraft (A-300) if it is anticipated that their trajectories are going to cross. In this case, even allowing 50 sec for the A-300 to enter the runway and initiate the takeoff from its holding position, it can be estimated that those 2 min were complied with, and, additionally, the trajectories were not going to cross in any case.

As previously discussed, the wake of the A-300 probably started at or beyond the mid length point of runway 25 (at 1550 m from the threshold), and from that point the natural tendency would be to move laterally towards both sides of the runway and downwards, and that is why there is little probability that it could have affected the Metro, that started losing control at a estimated height of 200 ft AGL and approximately at 2650 m from that mid point of runway 25.

As regards to the jet engine exhaust of the A-300, although its influence could be noticed to some extent by one of the witnesses that were close to the fence of the airport when the A-300 was accelerating (although she did not remember seeing dust arising), her perception that a few moments later, maybe 50 sec, the Metro arrived, can be considered not very exact, because according to the radar track and the communications transcript, the separation between both aircraft should have been more that 2 min, and that even considering that the A-300 needed 50 sec to enter the runway and start the takeoff.

Under these conditions, even if the influence of the jet engine exhaust at the moment of maximum thrust reached 579 m backwards, and around 17 m (56 ft) upwards, being 17 the total height of an A-300 from the gear to the vertical stabilizer, it is considered very unlikely that the blast affected the Metro for the following reasons:

- The Metro arrived at least 2 min after the acceleration of the engines of the A-300 took place. That time is considered long enough for any appreciable effect of the blast on the wind local speed or temperature to dissipate.

- The Metro started losing control, deviating to the right of the localizer, when it was at around 200 ft (61 m) of height, well above the possible height of influence of the jet blast.

- The Metro started losing control, deviating to the right of the localizer at around 1100 m from the threshold of runway 25.

3. CONCLUSIONS

3.1 Findings

The aircraft had been maintained in accordance with the established Maintenance Plan and had a valid Certificate of Airworthiness.

During the flight the crew intended to carry out a simulated missed approach to Barcelona Airport on a single engine, for the purpose of training the co-pilot.

Once established in the approach, the crew decided to change the manoeuvre to an approach with a single engine leaving the gliding path above.

The left propeller was very probably turning at the moment it touched the ground, but with the engine providing little or no power.

The right propeller was stopped and with pitch close to the feather position when the aircraft crashed into the ground.

It is probable that the training exercise the crew were carrying out included to retard the right engine power lever to flight idle to simulate an engine failure.

During the movement of the right hand propeller towards low pitch, it is probable that some transient malfunction of the negative torque sensor system took the blades to high pitch.

At some moment of the movement of the blades of the right hand propeller towards high pitch, seizing occurred between the rod that connects the piston and the crosshead where the actuating links are articulated, and the rod guide bushing on the right propeller.

In the pitch change system on the right propeller, the bushing that exists between the sliding piston rod and the hub cover was not in its original position, on having been dragged towards the interior of the hub by the sliding piston’s rod. Its upper flange was completely sheared off and the rest of the sleeve had been moved until it rested on the crosshead.

Approach with a single engine was carried out right from the beginning with flaps extended to ½.

The stall aural warning started to sound 17 seconds prior to the crash and the crew noted that the SAS was activating.

3.2 Causes

It is considered that the probable cause of the accident was the loss of control of the aircraft due to an excessive reduction of speed at low height, after having extended the landing gear, with an intermediate flap position, and in a situation in which the right hand engine was not providing thrust during the training exercise.

It is considered that the mechanical problems of the pitch change system of the right hand propeller were a contributing factor to the accident.

4. SAFETY RECOMMENDATIONS

REC 08/03. It is recommended that the Civil Aviation General Directorate (DGAC) should establish guidelines and limitations on training manoeuvres involving intentional engine inoperative procedures, whether real or simulated, particularly as regards to the flight type, visibility conditons, minimum altitude and phase of the flight in which it is permitted.

REC 09/03. It is recommended that the aircraft's manufacturer, in coordination with the propeller's manufacturer, review the design conditions, referred to plays and tolerances, and the maintenance conditions of the bushing that exists between the sliding piston rod and the hub cover, in order to minimise the possibility of seizing and breakage during propeller operation.

REC 10/03. It is recommended that the Civil Aviation General Directorate, in coordination with "Spanish Airports and Air Navigation" (AENA), evaluate the possibility of carrying out the necessary modifications to runway 07-25 of Barcelona Airport in order to ensure compliance with the recommendations of Appendix 14 of the OACI, last edition, relating to its physical characteristics and the restriction and elimination of obstacles.

5. APPENDICES

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APPENDIX B

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Photograph 2 Aerial view from the left

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Figure 4 Sketch of bushing B

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Horizontal path of the aircraft deduced from the radar data

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APPENDIX F

Engine Failure during flight Emergency Procedure

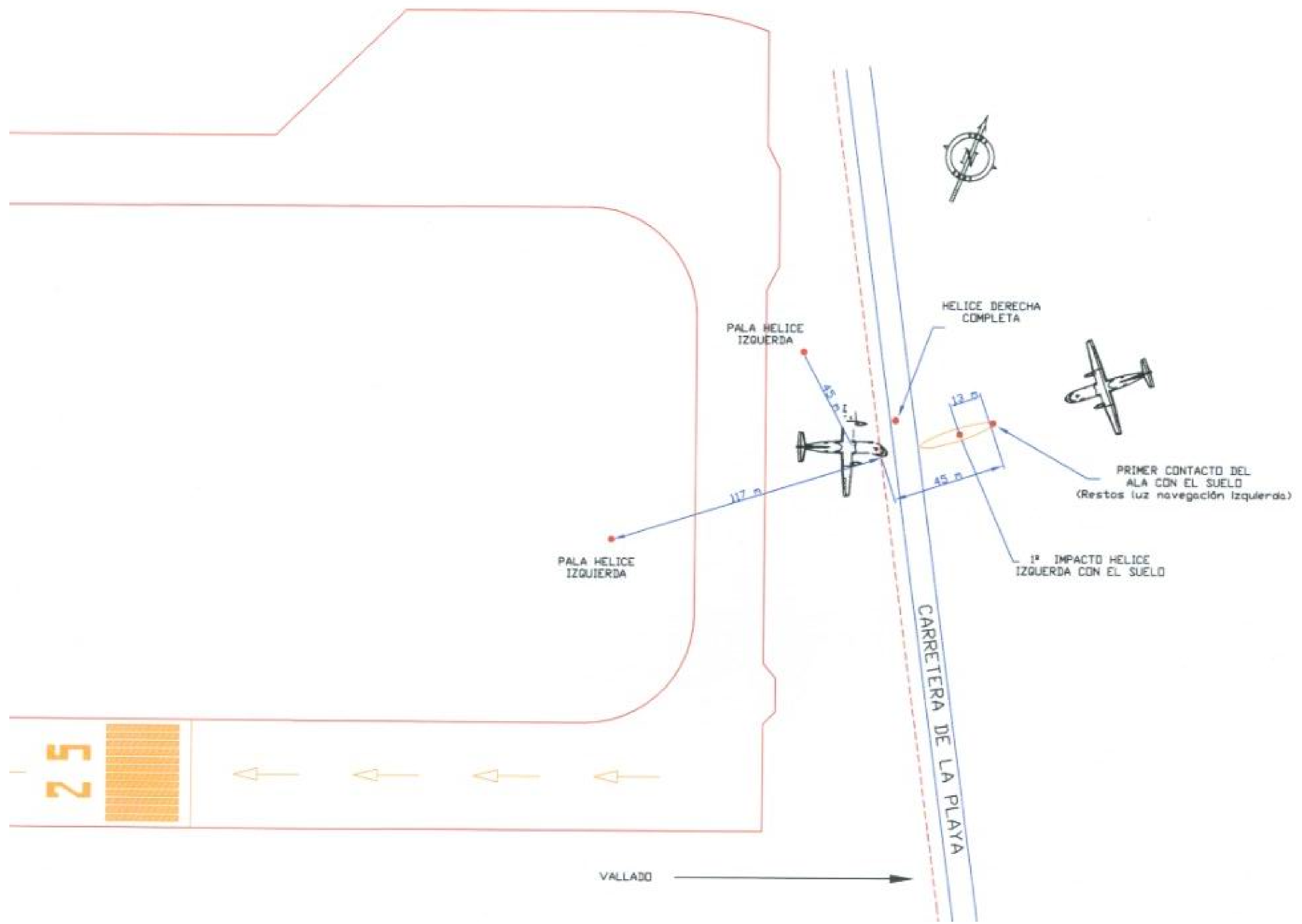
Engine In-flight Relight Emergency Procedure

APPENDIX G

Single Engine Landing Emergency Procedure

APPENDIX A

DIAGRAM OF WRECKAGE


PALA HELICE IZQUIERDA
HELICE DERECHA COMPLETA
13 m
45 m
45 m
117 m
PRIMER CONTACTO DEL ALA CON EL SUELO (Restos luz navegación Izquierda)
PALA HELICE IZQUIERDA
1ª IMPACTO HELICE IZQUIERDA CON EL SUELO
CARRETERA DE LA PLAYA
25
VALLADO

APPENDIX B

PHOTOGRAPHS AND FIGURES

Photo 1.- Aerial view of the accident from the right

Photo 2. Aerial view from the left

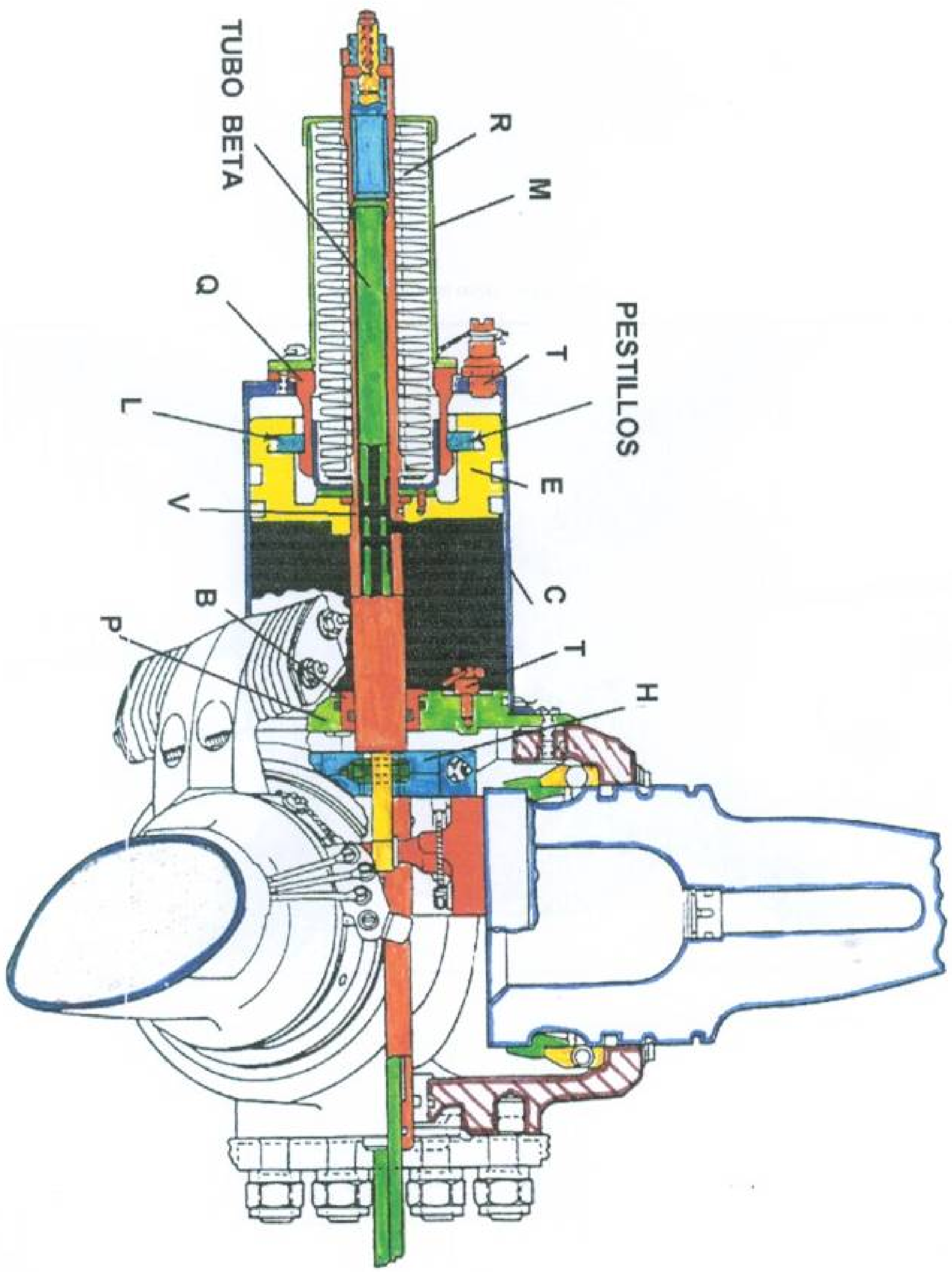


Figure 3. Description of the pitch change mechanism

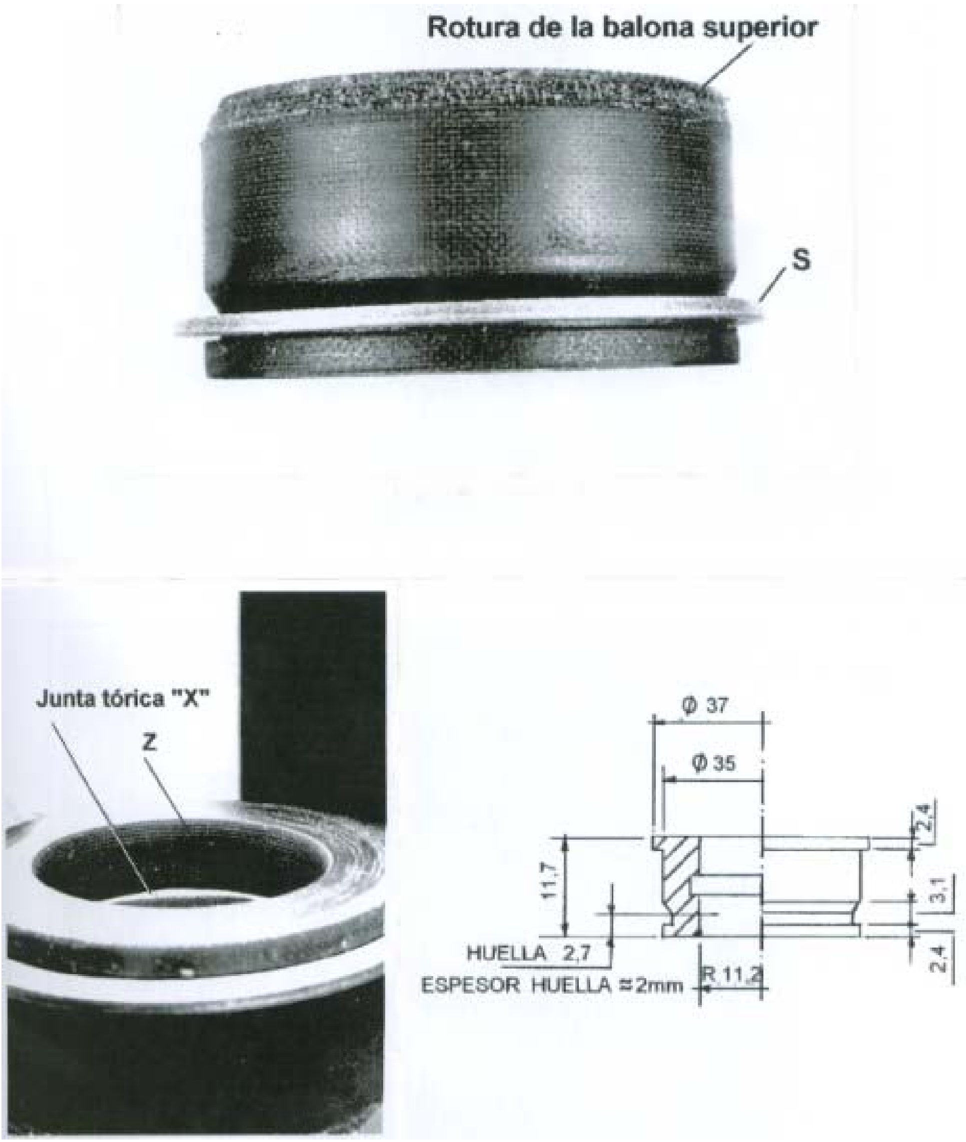
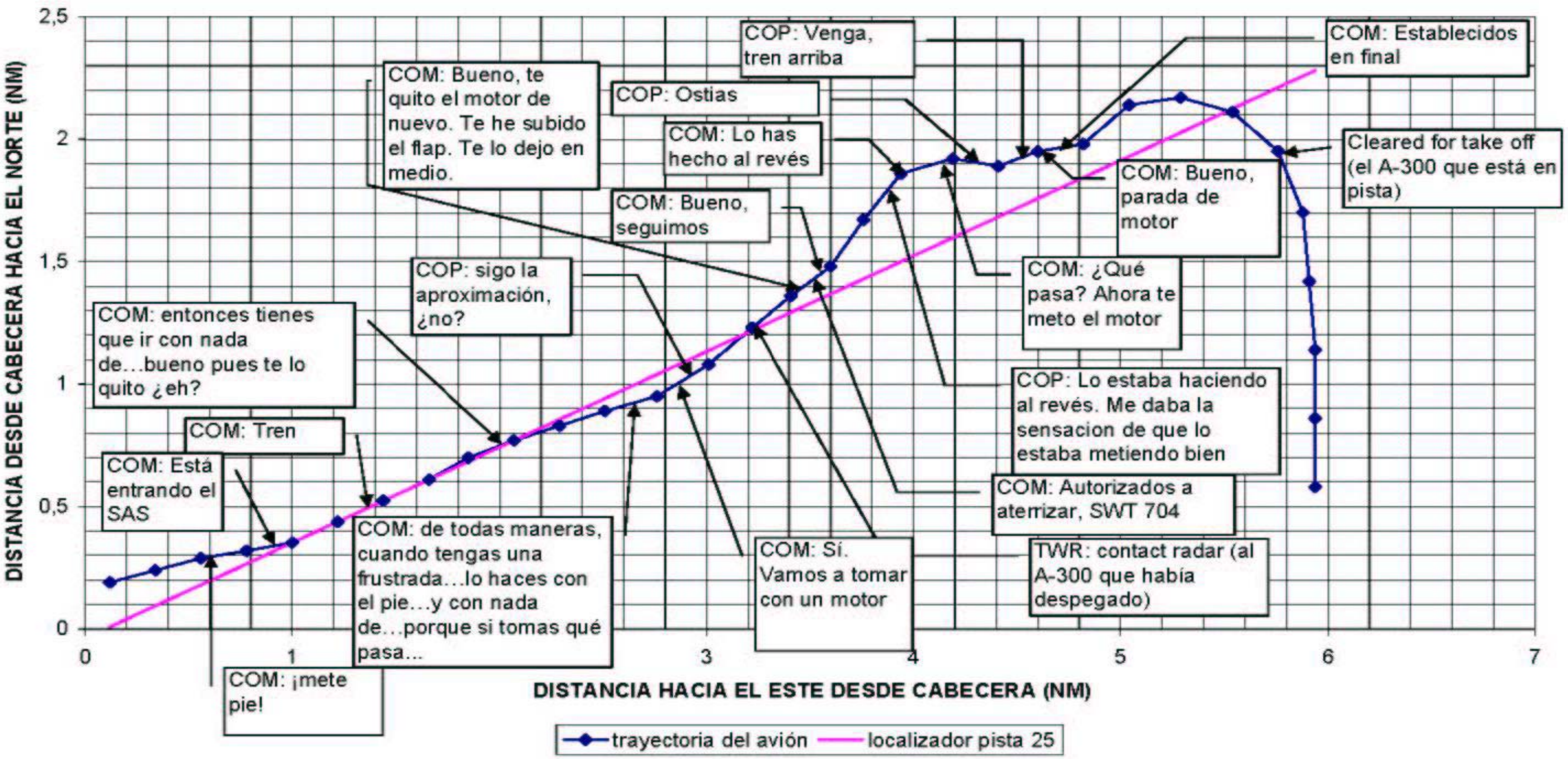


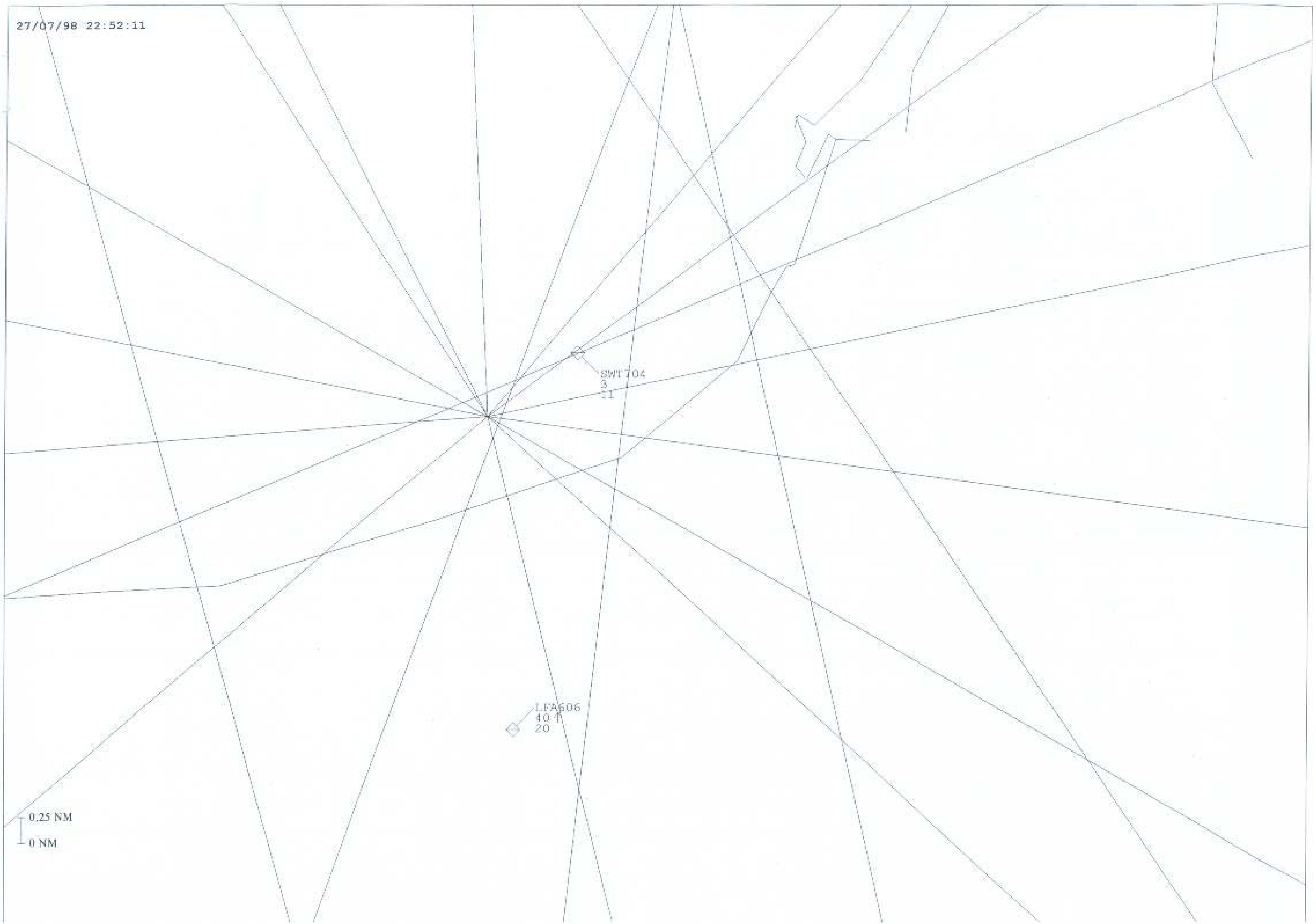
Figure 4. Photo and sketch of bushing B

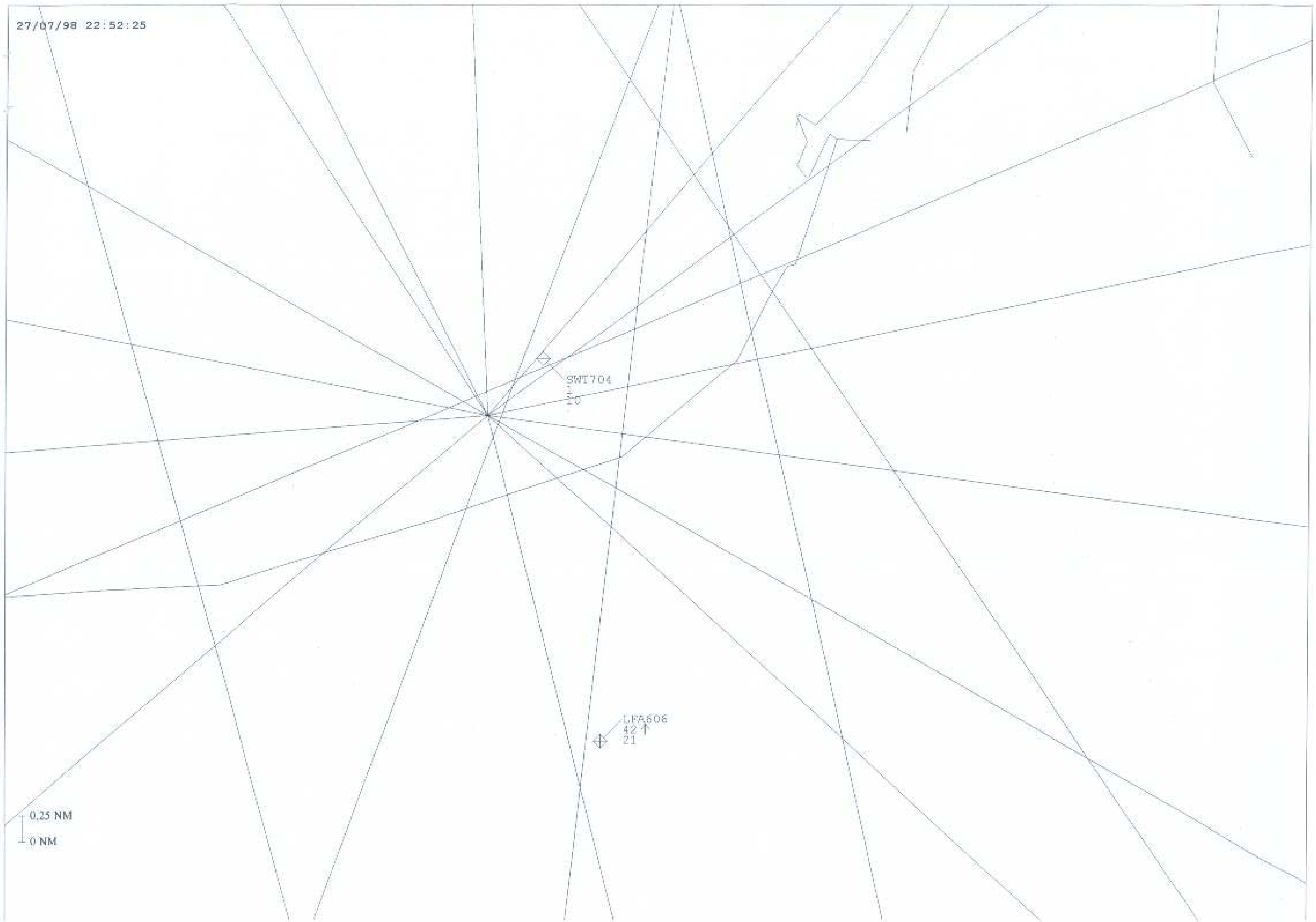
APPENDIX C

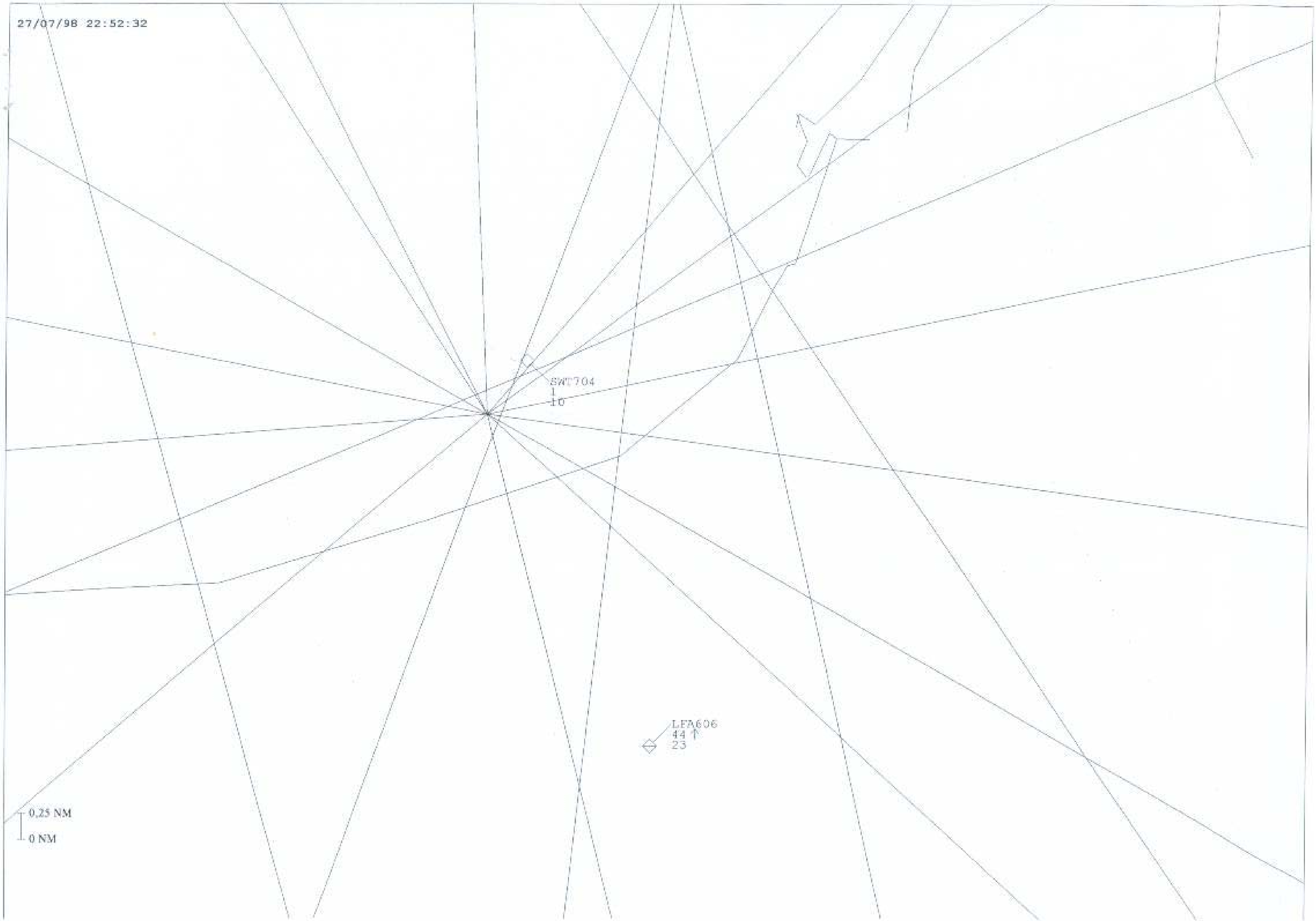
HORIZONTAL PATH OF THE AIRCRAFT DEDUCED FROM THE RADAR DATA

TRAYECTORIA DE EC-FXD
COM: comandante (lado dcho.); COP: copiloto (lado izq.)




27/07/98 22:52:11
SWT704
3
11
LFA606
40 ↑
20
0.25 NM
0 NM


27/07/98 22:52:25
SWT704
LFA606
42
21
0,25 NM
0 NM


27/07/98 22:52:32
SWT704
1
10
LFA606
44
23
0,25 NM
0 NM

APPENDIX D

TRANSCRIPTION OF THE COMMUNICATIONS WITH AIR TRAFFIC CONTROL

COMUNICACIONES ENTRE SECTOR APP Y SWT 704

HORA	CANAL	ESTACIÓN	TEXTO
22:31:37	52	SWT 704	Barcelona muy buenas noches, SWIFTAIR SIETE CERO CUATRO.
22:31:42	50	APP	SWIFTAIR SIETE CERO CUATRO Buenas noches, en contacto radar, pueden ir poniendo rumbo al VOR, pista veinticinco, ... notifiquen listos descenso.
22:31:51	52	SWT 704	Sí, al VOR, esperando la veinticinco, ... SWIFTAIR SIETE CERO CUATRO.
22:31:54	50	APP	
22:32:00	50	APP	
22:32:03	50	APP	
22:32:07	51	TORRE BCN	
22:32:10	50	APP	
22:33:27	51	TORRE BCN	
22:33:29	50	APP	
22:35:01	52	AYC 8552	
22:35:05	50	APP	
22:35:10	51	TORRE BCN	
22:35:15	52	AYC 8552	
22:35:17	50	APP	
22:35:18	50	APP	
22:35:31	50	APP	SWIFTAIR SIETE CERO CUATRO pongan rumbo cero uno cinco
22:35:36	52	SWT 704	Cero uno cinco, SIETE CERO CUATRO
22:37:04	52	TDC 401	
22:37:08	50	APP	
22:37:16	52	TDC 401	
22:37:18	50	APP	
22:37:20	52	AYC 8552	
22:37:24	50	APP	
22:37:28	52	TDC 401	
22:40:23	52	SWT 704	Barcelona, SWIFTAIR SIETE CERO CUATRO, requerimos descenso.
22:40:26	50	APP	SWIFTAIR SIETE CERO CUATRO, descenso para cuatro mil pies con mil dieciséis.
22:40:32	52	SWT 704	Cuatro mil, mil dieciséis, SWIFTAIR SIETE CERO CUATRO.
22:40:59	50	APP	
22:41:04	52	AYC 8522	

22:41:20	51	TORRE BCN	
22:41:24	50	APP	
22:42:57	52	SYB 060	
22:43:04	50	APP	
22:43:11	52	SYB 060	
22:43:15	50	APP	
22:43:19	52	SYB 060	
22:43:22	50	APP	
22:43:26	52	SYB 060	
22:44:00	50	APP	SWIFTAIR SIETE CERO CUATRO continúen descenso para dos mil quinientos pies y pueden poner rumbo Norte.
22:44:06	52	SWT 704	Dos mil quinientos, rumbo Norte, SWIFTAIR SIETE CERO CUATRO.
22:44:13	50	APP	
22:44:18	52	SYB 060	
22:45:06	50	APP	SWIFTAIR SIETE CERO CUATRO, notifiquen si tuvieran el campo a la vista.
22:45:11	52	SWT 704	Sí, lo tenemos a la vista, SIETE CERO CUATRO.
22:45:13	50	APP	Recibido, pues pueden completar aproximación visual izquierda a la pista veinticinco.
22:45:19	52	SWT 704	Visual izquierda, a la veinticinco, SWIFTAIR SIETE CERO CUATRO. Gracias.
22:45:45	50	APP	El SWIFTAIR completa en visual.
22:45:50	51	TORRE BCN	Vale
22:46:22	50	APP	
22:46:28	52	TDC 401	
22:47:07	50	APP	SWIFTAIR SIETE CERO CUATRO torre en veintiuno ocho, hasta luego
22:47:11	52	SWT 704	Veintiuno ocho, adiós buenas noches. Gracias.
22:47:14	50	APP	Contigo el SWIFTAIR.
22:47:17	51	TORRE BCN	Vale. Fin de la transcripción.

COMUNICACIONES ENTRE TORRE DE BARCELONA Y SWT 704

HORA	FRECUENCIA	ESTACION	TEXTO
22:47:00	HOT LINE	APP	Contigo el SWT
22:47:10	121,8	SWT 704	Torre Barcelona, buenas noches SWT 704.
22:47:13	121,8	TWR LCL	SWT 704, muy buenas es el número uno, ahora, viento en calma continúe notifique establecido en final.
22:47:22	121,8	SWT 704	Llamaré en final, SWT 704.
22:48:59	121,8	LFA 606	Ready for departure.
22:49:02	121,8	TWR LCL	LFA 606, ready for rolling.
22:49:12	121,8	LFA 606	Affirmative.
22:49:20	121,8	TWR LCL	LFA 606, wind calm, cleared for rolling take off 25
22:49:55	121,8	SWT 704	Establecidos en final SWT 704
22:49:56	121,8	TWR LCL	SWT 704, continúe, tráfico saliendo ahora pista 25, le llamo enseguida.
22:50:01	121,8	SWT 704	SWT 704.
22:50:05	HOT LINE	TWR LCL	LFA 606 (Transferencia).
22:50:07	HOT LINE	APP	Vale
22:50:34	121,8	TWR LCL	SWT 704, autorizado a aterrizar 25, viento calma
22:50:37	121,8	SWT 704	Autorizados a aterrizar, 704
22:50:50	121,8	LFA 606	Contact radar 124,7, bye
22:50:53	121,8	TWR LCL	124,7, good bye
22:51:32	121,8	IST 682	Delivery, IST 692, good evening
22:51:37	121,8	TWR LCL	IST 682, go ahead.
22:51:41	121,8	TWR LCL	Gate number D3 information PAPA destination Istambul, ready for start

22:51:50	121,8	TWR LCL	IST 682, start approved on D3, you are cleared to Istambul, via F.P.R., expect RWY 25, SARGO 1D departure climb to and maintain 4000FT and squawk 5550
22:52:06	121,8	IST 682	Cleared to dest. Istambul via F.P.R. initially 4000 FT SARGO 1D DEP 5550.
22:52:20	121,8	TWR LCL	IST 682, clearance is correct when ready for push back in this freq.
22:52:21	121,8	IST 682	Maintain this freq.
22:52:45	121,8	TWR LCL	SWT 704
22:52:49	121,8	TWR LCL	SWT 704 (Torre activa la alarma)
22:52:57	HOT LINE	CECOPS	Torre, puedes.
22:52:58	HOT LINE	TWR LCL	Si.
22:52:59	HOR LINE	CECOPS	Oye, ha sonado la alarma.

FIN DE LA TRANSCRIPCIÓN

Abreviaturas usadas en la transcripción de las comunicaciones entre la aeronave EC-FXD y el Control de Tránsito Aéreo entre las 22:31 h UTC y las 22:48 h UTC del día 27 de Julio de 1998:

<u>ESTACIONES</u>	<u>ABREVIATURAS</u>
Controlador APP final:	APP
Vuelo Swiftair 704	SWT 704
Controlador de torre de Barcelona	TORRE BCN

APPENDIX E

“INTENTIONAL ONE ENGINE INOPERATIVE SPEED” SECTION OF THE AIRPLANE FLIGHT MANUAL

PILOT'S OPERATING TIPS (continued)

INTENTIONAL ONE ENGINE INOPERATIVE SPEED (V_{SSE})

The intentional one engine inoperative speed (V_{SSE}) is the speed above which an engine may be intentionally and suddenly flamed out for pilot training purposes and must not be confused with the demonstrated minimum control speed (V_{MCA}). V_{SSE} is to be used as the starting speed when training pilots to recognize the low speed, single engine, handling qualities and performance of the METRO III. After ensuring proficiency in controlling the airplane at V_{SSE}, it is permissible to slow down with one engine inoperative toward V_{MCA} to further increase the trainee's awareness, proficiency, and confidence.

Several factors must be considered prior to intentionally rendering an engine inoperative in flight by either depressing the stop button, pulling the engine stop and feather control part way out, or stopping fuel flow by shutting it off at the firewall with the fuel shutoff switch. Pertinent factors are terrain proximity, gross weight, airspeed, gear and flap configuration, pilot proficiency, and the necessity for flaming out the engine.

NOTE

Retarding a power lever to the flight idle stop to simulate a failed engine at low airspeed will provide approximately the same control and performance problems as will rendering an engine inoperative intentionally. Power lever chops do not adversely affect the engine. With the failed engine at flight idle power, it is readily available to be used to recover from excessive loss of airspeed, altitude, control, or possible difficulties with the operating engine.

WARNING

FAIRCHILD AIRCRAFT CORPORATION RECOMMENDS THAT THE INHERENT SAFETY MARGINS OF SIMULATING ENGINE FAILURE, RATHER THAN ACTUALLY RENDERING IT INOPERATIVE, BE USED DURING PILOT TRANSITION AND CHECK OUT.

PILOT'S OPERATING TIPS (continued)

INTENTIONAL ONE ENGINE INOPERATIVE SPEED (V_{SSE}) (continued)

If it is deemed necessary to intentionally render an engine inoperative during initial climbout for pilot training or check out, the following conditions define the circumstances under which the chosen V_{SSE} is valid. Check Takeoff Weight Limitation Charts in Section 4 for conditions more critical than those shown.

Prior To Intentional Engine Failure

Airport Density Altitude	5,000 FEET MAXIMUM
Minimum Altitude	100 FEET ABOVE GROUND
Both Engines	TAKEOFF POWER (ENGINE ANTI-ICE OFF)
Landing Gear	RETRACTING OR RETRACTED
Wing Flaps	NO MORE THAN 1/4
Gross Weight	14,000 POUNDS MAXIMUM
Bleed Air	ON OR OFF
Airspeed (V_{SSE})	115 KIAS MINIMUM

NOTE

- **The right engine is the critical engine and will create the more challenging directional control problem if it is rendered inoperative.**
- **If the yaw damper is on, the yaw damper will assist the pilot in directional control. (If yaw damper installed.)**
- **Commanding high propeller blade angle by keeping the power lever of the failed engine well forward will reduce windmilling propeller drag in the event that NTS failure accompanies intentional engine failure.**

PILOT'S OPERATING TIPS (continued)

INTENTIONAL ONE ENGINE INOPERATIVE SPEED (V_{SSE}) (continued)

After Intentional Engine Failure

Operating Engine .... TAKEOFF POWER
Landing Gear .... RETRACTED
Wing Flaps .... RETRACTED
Engine Stop and Feather Control (Failed Engine) .... PULLED
Bleed Air .... OFF
Airspeed .... V_{YSE}

WARNING

AT HIGH GROSS WEIGHT AND AT HIGH DENSITY ALTITUDES, ALTITUDE MUST BE SACRIFICED TO ACCELERATE FROM V_{MCA} to V_{YSE}.

CAUTION

- REPEATED INTENTIONAL FLAMEOUTS WHEN OPERATING AT HIGH ENGINE POWER WILL EXPOSE THE ENGINE TO UNNECESSARY AND EXCESSIVE THERMAL SHOCKS AND WILL LIKELY REDUCE ENGINE LIFE.
- DO NOT ALLOW THE ENGINE TO WINDMILL IN THE 18% TO 28% RPM RESTRICTED RANGE.

NOTE

- Provided that the aircraft is not lower than 1,000 feet above the ground and that it is light enough to maintain regulatory terrain clearance and to remain above stall warning speed, it is permissible to slow from V_{SSE} to V_{MCA}. Remember the minimum airspeed for an airstart is 100 KIAS.
- If gross weight and performance permit, additional training experience can be gained at speeds close to final approach speed by extending the landing gear and flaps to demonstrate the significantly increased controllability problem when at high single engine power in the landing configuration.

INTENTIONAL ONE ENGINE INOPERATIVE SPEED IS

115 KIAS

APPENDIX F

ENGINE FAILURE DURING FLIGHT AND INFLIGHT RELIGHT EMERGENCY PROCEDURES

ENGINE FAILURE DURING FLIGHT

1. **ENGINE STOP AND FEATHER CONTROL (failed engine)** .... **PULL**
2. Engine Clean Up Procedure (failed engine)
   a. Fuel shutoff switch .... CLOSED
   b. Hydraulic shutoff switch .... CLOSED
   c. Fuel boost pump switch .... OFF
   d. Generator switch .... OFF
   *e. Bleed air switch .... OFF
   f. Auto/cont ignition switch .... OFF
3. Power Lever (operating engine) .... AS REQUIRED
*4. Bleed Air (operating engine) .... AS REQUIRED

NOTE

If the 100% torque limit is not being developed and bleed air is on, increased power may be obtained by selecting bleed air off.

5. Trim .... AS REQUIRED
6. Generator (operating engine) .... 200 AMPS MAXIMUM (SOME AIRPLANES - SEE LIMITATIONS)
*7. Propeller Synchrophaser Switch (if installed) .... TAKEOFF & LANDING

AIRSTART

CAUTION

IF AN ENGINE HAS BEEN SHUT DOWN BECAUSE OF AN OBVIOUS FAILURE, AS INDICATED BY THE ENGINE INSTRUMENTS OR EXCESSIVE VIBRATION, AN AIRSTART SHOULD NOT BE ATTEMPTED. AIRSTART FOLLOWING INTENTIONAL ENGINE SHUTDOWN IS COVERED IN SECTION 3A, ABNORMAL PROCEDURES.

INFLIGHT RELIGHT

CAUTION

- THIS PROCEDURE IS INTENDED FOR USE DURING FLIGHT ONLY.
- ATTEMPTED USE OF THIS PROCEDURE WHILE ON THE GROUND WITH LIMITED AIRFLOW THROUGH THE ENGINE COULD RESULT IN ENGINE OVER-TEMPERATURES.
- THIS PROCEDURE IS INTENDED FOR USE ONLY WHEN THE REASON FOR THE INADVERTENT FLAMEOUT IS KNOWN WITH CERTAINTY AND WHEN THE PILOT IS CERTAIN THAT A RELIGHT WILL NOT AGGRAVATE THE CONDITION.

1. Power Lever .... APPROXIMATELY 1/4 INCH (6 mm) FORWARD OF FLIGHT IDLE (UNTIL LANDING GEAR WARNING HORN IS SILENCED)
2. Speed Lever .... APPROXIMATELY 97% RPM
3. Airspeed .... BETWEEN 180 AND 100 KIAS
4. RPM .... BETWEEN 60% AND 10%
5. Engine Start Button .... PRESS MOMENTARILY

NOTE

- Press the start button in only long enough to obtain ignition and fuel flow and subsequent light-off.
- If RPM has decayed below 10%, the start button will have to be held in while the unfeathering pump drives the propeller blades to finer pitch and RPM increases to above 10%. Ignition, fuel flow, and light-off should then occur.
- Engine relight will not occur if the SRL computer speed switch function has failed or if the SRL- Δ P/P switch is in the OFF position.

6. EGT .... MONITOR (770°C MAXIMUM FOR ONE SECOND)
7. RPM .... STABILIZED
8. SRL OFF Light .... CHECK OFF
9. Power .... RESET AS REQUIRED

NOTE

Engine relight should be expected to occur automatically if the Auto/ Cont Ignition Switch is in AUTO, and fuel is available at the igniters.

APPENDIX G

SINGLE ENGINE LANDING EMERGENCY PROCEDURE

SINGLE ENGINE LANDING

NOTE

- Compute single engine landing distance by adding 72% to the two engine landing distance shown in Figure 4G-5 if Goodyear dual rotor brakes are installed. Use the single engine landing distance from Figure 4G-4 if B.F. Goodrich single rotor brakes are installed.

- Use the approach speeds shown in Figure 4G-4 or 4G-5.

*1. No Smoking - Fasten Seat Belt Sign .... ON
2. Fuel Balance .... CHECK

NOTE

If excess fuel imbalance is indicated on fuel quantity gauge and/or aileron trim position, balance fuel by utilizing the fuel crossflow.

3. Fuel Crossflow Switch .... OPEN IF REQUIRED TO BALANCE, THEN CLOSED
4. Cabin Differential Pressure .... ZERO
5. Electrical Load .... TURN OFF NONESSENTIAL ITEMS
6. Speed Lever (operating engine) .... HIGH RPM
7. Flaps .... DO NOT EXTEND BEYOND 1/4 UNTIL LANDING IS ASSURED
8. Landing Gear .... EXTEND WHEN LANDING IS ASSURED
9. Nose Wheel Steering .... ARMED
10 *Auto/Cont Ignition Switch (operating engine)* .... AUTO OR CONT

AFTER TOUCHDOWN

1. Brakes .... AS REQUIRED
2. Nose Wheel Steering .... AS REQUIRED
3. Power Levers .... GROUND IDLE

NOTE

- Retard power levers to ground idle as directional control permits. Retarding the power lever of the operating engine from flight idle to ground idle will cause the airplane to yaw toward the operating engine.