DATA SUMMARY

LOCATION

Date and time	**Monday, 9 January 2006; 09:00 h UTC**
Site	**Barcelona-El Prat Airport**

AIRCRAFT

Registration	**EC-GAT**
Type and model	**MD-83**
Operator	**Spanair**

Engines

Type and model	**JT8D-219**
Number	**2**

CREW

	Captain	First Officer
Age	**40 years old**	**40 years old**
Licence	**ATPL**	**ATPL**
Total flight hours	**6,012 h**	**3,400 h**
Flight hours on the type	**4,612 h**	**2,926 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**6**
Passengers			**90**
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**None**

FLIGHT DATA

Operation	**Commercial air transport – Scheduled – Domestic – Passenger**
Phase of flight	**Landing**

REPORT

Date of approval	**9 June 2011**

1. FACTUAL INFORMATION

1.1. History of the flight

On 9 January 2006, shortly before 09:00 UTC[1], an MD-83 aircraft, registration EC-GAT, operated by Spanair, was making an approach to runway 07R at Barcelona Airport. The aircraft was making scheduled flight JKK-6513, and onboard were 90 passengers and a crew of 6. The flight had taken off from Bilbao some 40 minutes earlier.

The Captain was the PF and the first officer was the PNF.

The weather conditions featured good visibility, with no cloud ceiling and an 11-kt left crosswind. The runway was dry.

The flight had been uneventful until shortly before the start of the initial approach on a heading of 150° with the airplane at a relatively high altitude. ATC reminded the crew of the restriction not to descend below 5,000 ft before crossing the coastline. This restriction, imposed due to environmental concerns, had gone into effect a few months earlier.

The aircraft was cutting short the turn to intercept the ILS localizer at the final approach fix (FAF), located at a distance of 8.91 NM. It was flying at an altitude of 3,700 ft and an indicated airspeed of 260 kt.

Since the aircraft was above the glideslope, the final descent was very steep, on the order of 2,500 ft/min. On short final, the aircraft established on the ILS glideslope (GS) but at a high airspeed and while changing to a flaps 40° landing configuration, meaning the approach was not stabilized.

The aircraft flew over the runway threshold at a correct altitude of 50 ft but at 200 kt. The reference (Vref) [2] and target (Vtarget)[3] speeds were 124 kt and 129 kt, respectively. The tire tracks revealed that the aircraft's main landing gear did not make contact with the ground until it was past the halfway point of the available runway

[1] All times in this report are UTC. To obtain local time, add one hour to UTC.

[2] Vref is the landing reference speed. Its minimum values should be:

- 1,30 times x the loss speed for the weight and configuration of the aircraft.
- MCS (Minimum control speed during approach and landing)
- The speed given by the maneuver capacity as specified in FAR.243

[3] Vtarget is the desired landing speed and is determined by adding an amount to Vref, with basis in the reported wind. Such increase won't be less than 5 kt nor more than 20 kt and will be calculated as follows:

5 kt, plus the value of the wind gusts exceeding the average speed of the wind, plus half of the wind average speed value exceeding 20 kt

length (1,600 m from the RWY THR). During the braking maneuver, the four main gear wheels locked and started to skid before blowing out.

The aircraft came to a stop on the runway centerline about one hundred and forty meters before the end. When the crew tried unsuccessfully to start taxiing to exit the runway, they noticed that the wheels were locked. A controller in the Tower saw and reported that the left leg wheels were on fire, as a result of which the crew ordered the immediate evacuation of the airplane.

The firefighting services quickly responded to the scene and extinguished the flames. Passenger busses reported to the aircraft to pick up the passengers about 25 minutes after the incident.

Some passengers were slightly injured during the evacuation of the aircraft.

1.2. Damage to aircraft

The aircraft suffered damage to both wings and to the tail assembly.

- Both main gear legs were damaged by the high-energy braking maneuver.
- The tires, rims and brakes on both legs evidenced friction damage from being in contact with the runway. Those on the left leg had also been affected by the fire.
- Friction and impact damage caused hydraulic lines in the left main gear leg to rupture.
- Also damaged by the fire were the inboard flap, some skin panels and the gear doors on the left wing.
- The lower part of the tail cone was damaged and cracked as a result of impacting against the runway pavement after being ejected to deploy the rear slide.

Inspections of the aircraft did not reveal any apparent damage to its primary structure. Such damage would have resulted had high vertical acceleration values been reached during the landing.

1.3. Personnel information

Captain

Age:	40
Nationality:	Spanish
License:	Airline Transport Pilot License

Flying experience:	• Total flight hours:	6,012 h
	• Hours on the type:	4,612 h
Activity:	• Last 90 days:	192:13 h
	• Last 30 days:	64:29 h
	• Last 24 hours:	2:06 h

First officer

Age:	40
Nationality:	Spanish
License:	Airline Transport Pilot License
Flying experience:	• Total flight hours: 3,400 h • Hours on the type: 2,926 h
Activity:	• Last 90 days: No data available • Last 30 days: No data available • Last 24 hours: No data available

In addition to the cockpit crew, there were three flight attendants and a purser in the passenger cabin.

1.4. Aircraft information

The MD-83 is a medium-range twin-engine passenger aircraft with a capacity for 150 passengers, depending on the seating configuration. Its minimum flight crew complement is two pilots.

1.4.1. *Airframe*

Manufacturer:	McDonnell Douglas
Model:	MD-83
Production number:	49709
Year of manufacture:	1988
Registration:	EC-GAT
Operator:	Spanair

Airworthiness certificate: Valid until 14/02/2006

Total hours on aircraft: 41,627.49 h

Total cycles on aircraft: 27,472

1.4.2. *Maintenance record*

In the ten previous flights there had been no maintenance activities involving the antiskid or autobrake systems.

The wheels mounted on the airplane had passed through the workshop in previous months, specifically on 31/10/05, 04/11/05, 09/12/05 and 29/12/05.

The total number of landings on the installed wheels and brakes were as follows:

	#1	#2	#3	#4
Wheel cycles	151	89	25	14
Brake cycles	25	14	265	520

1.4.3. *Landing weight*

The landing weight is estimated to have been 114,000 lb, versus a maximum allowed landing weight of 140,000 lb.

1.4.4. *Landing performance and airplane geometric data*

For an aircraft landing weight of 114,000 lb, the procedures in the flight manual indicate the following operational values:

Vref = 124 kt
Vtarget = 129 kt
Landing Distance (dry runway) = 2,625 ft = 800 m

The speeds and operating times for the landing gear and the flap surfaces are:

Max. landing gear extension speed = 300 kt
Time to lower gear = 12 s
Time to retract gear = 9 s

Max. speed for lowering 15° flaps = 240 kt
Max. speed for lowering 28° flaps = 205 kt
15° to 28° flap lowering time = 11 s
Max. speed for lowering 28° flaps = 200 kt
Max. tire speed = 195 kt
Distance between nose and main gear wheels = 72 ft

1.4.5. *Wheel braking system*

The aircraft employs a disk braking system for the main wheels.

The pressure exerted by the hydraulic fluid in the actuating pistons mounted on the stators squeezes the stators against the brake rotors or disks.

An additional automatic braking system, autobrake, allows for a constant rate of deceleration to be applied and maintained.

1.4.6. *Antiskid system*

The antiskid system is an automatic, electronically controlled system whose aim is to keep the brakes from locking the main gear wheels, thus preventing them from skidding when the brakes are applied. Each wheel is controlled independently. The system includes, among other components, a system arming switch, a control box, four speed transducers and four dual servovalves.

A transducer mounted on each wheel's axle detects its speed. When the wheel's speed is below a reference speed that is constantly being determined by the system, the brake fluid pressure is released in this wheel until it starts to turn again. If the pressure commanded by the pilot is less than that required to make the wheels skid, the system takes no action. If the antiskid system is not armed, the pressure that reaches the pistons in the brake assemblies depends only on the pilot's input to the pedals and is independent of whether the wheels skid or not.

When the wheels first contact the ground on touching down, they spin rapidly. To keep them from being locked during those moments, there is a "wheel locked and touchdown" interlock in effect when the airplane is in the air. In this situation, the pressure is released in the no. 2 and 3 brake assemblies. These wheels are paired off with the outboard wheels on the opposite wing so that a pressure release signal is available in case the wheels are locked. This interlock is canceled between 1.5 and 5 seconds after the nose wheel contacts the ground.

Another “wheel not spinning” interlock is in effect if the ground speed is in excess of 40 kt.

The first individuals to access the aircraft cockpit after the incident verified that the antiskid switch was ON.

1.4.7. *Spoilers*

On this airplane, there are panels on the top surface of the wings that can be raised in a perpendicular plane to the airflow so as to reduce the lift of the wing and increase its drag in one of the following three scenarios:

- In flight, to reduce the aircraft’s speed.
- In flight, asymmetrically on the dipping wing only to aid in the lateral control of the airplane during a turn.
- On landing, to increase the drag, thus helping to slow the airplane, and to spoil the lift, thus allowing the full weight of the aircraft to rest on the wheels to aid in the braking action.

The spoilers are deployed and retracted hydraulically. The inboard panels on each wing can only be used on the ground during landing (or on an aborted takeoff).

When landing, the spoilers deploy automatically, if the system is armed, when the main wheels start spinning after touchdown, or when the nose wheel leg contacts the ground.

The spoilers can also be deployed manually on the ground if the above ground signals are present, or if any of the main gear struts is compressed (WOW – weight on wheels – signal). In flight they can only be extended as airbrakes if the flap angle is below 8°.

1.5. Meteorological information

The 09:00 METAR for the airport was as follows:

METAR LEBL 090900Z 35011KT 9999 FEW025 08/04 Q1026 NOSIG=

That is, the wind was from 350° at 11 kt. Visibility was in excess of 10 km. There were few clouds, with a base at 2500 ft. The temperature was 8° C and the dewpoint 4° C. QNH was 1026 hPa.

It had not rained and the runway was dry.

The Barcelona Airport is practically at sea level, and even though the temperature was below and the pressure slightly above standard, the true airspeed (TAS) can be estimated to have been practically equivalent to the calibrated airspeed (CAS) [4].

The controller reported a wind from 350 at 10 kt to the pilot of flight JKK-6513.

1.6. Communications

The communications maintained by the aircraft with ATC stations, in particular with approach control and with the airport tower, were reviewed during the investigation. The most notable portions thereof are shown below.

Additionally, prior to the crew's establishing contact with approach control, specifically at 08:50:29, they received a communication from the route controller instructing them to fly direct to PERUK.

Approach Control

08:53:37 Flight JKK-6513 establishes contact while en route to the initial fix (IF), PERUK, which is 12 NM from the runway along its extended centerline. They report flying toward PERUK for 5,000 ft and that their speed is high.
08:53:43 Controls replies that they are cleared for ILS 07 right on their present course.
08:53:49 The crew acknowledges the above information.
08:54:14 The crew of flight JKK-6513 requests to fly directly to the FAF, 9 NM away from the runway.
08:54:19 APP authorizes them to proceed at their discretion, maintaining an altitude of 5,000 ft above ground until past the coastline.
08:54:29 The crew acknowledges "cleared ILS 07 right approach flying to fix at mile 9 and 5,000 ft until past the coastline".
08:56:34 The crew asks control if they can descend at their discretion past the coastline.
08:56:37 Control replies that they can proceed at their discretion when past the coastline.
08:58:13 The controller tells the crew to change the communications frequency to 118.1 (Barcelona control tower, local).
08:58:16 The crew acknowledges the information, eighteen one, and signs off.

[4] If greater precision is required, it can be assumed that TAS = 98% CAS.

Control tower

08:58:17	JKK-6513 establishes contact with Barcelona tower – ground, and reports being on final on 07R.
08:58:18	The controller instructs them to continue and that they are cleared to land on runway 25, which he immediately corrects to 07 right. He provides wind information: 350° at 10 kt.
08:58:20	JKK-6513 acknowledges "cleared to land 07R".
09:00:54	JKK-6513 reports they have had a brake problem and that they will exit the runway in one minute.
09:00:54	The controller acknowledges and indicates that he understands everything to be relatively under control.
09:00:54	The crew reports that the airplane is fine but that they have a brake problem, and that they will exit the runway as soon as possible.
09:00:59	TWR informs the aircraft that they can see the left leg of the aircraft on fire from the tower; JKK-6513 requests the firefighting service.
09:02:12	JKK-6513 informs that they are evacuating the airplane.
09:02:12	The controller requests the crew to repeat the message.
09:02:14	The crew confirms its intention to evacuate the airplane.
09:02:42	The controller asks the crew once again to repeat the message and to state their intentions.
09:03:12	The controller calls JKK-6513 again.
09:03:12	JKK-6513 replies, "go ahead".
09:03:12	TWR informs that emergency services are on the way and will be at their position in a few seconds, and requests that they repeat their previous message, which they did not hear.
09:03:15	JKK-6513 asks the controller how he copies.
09:03:15	The controller replies "loud and clear now".
09:03:25	JKK-6513 informs that they are evacuating the airplane through the right side, which they repeat.
09:03:30	The controller asks if they need ambulances.
09:03:42	JKK-6513 replies that "not for the time being, but we might if a passenger is injured when jumping out".
09:03:45	The controller informs the crew that ambulances are also on the way to the airplane.
09:03:50	JKK-6513 replies "very well, thank you".
09:04:54	In an exchange with another facility, the TWR confirms that the firefighters are on the scene.

1.7. Aerodrome information

The airport of Barcelona El Prat is at an elevation of 4 m (14 ft) and, at that time, had three runways available for aircraft landing and takeoff operations.

The runway used by the incident aircraft was 07R-25L, which is 2,660 m long and 60 m wide. The elevation of the 07R threshold is 2.5 m (8 ft). The runway surface has a convex profile, with a slight upward slope for the first 247 m, no slope during the next 2,175 m, and gradual downslopes of 0.25% in the next 138 m and 0.5% in the final 100 m.

Runway 07R has a PAPI visual aid for the glideslope and an ILS CAT III instrument landing system. Both the visual slope and the ILS glideslope are at a 3° angle.

Appendix B shows the AIP-Spain Instrument Approach Plate for runway 07R.

The AIP flight procedures specify the following speed limits:

"— ATC shall require that speed be reduced to 170 kt/180 kt when commencing the turn to intercept the ILS/LLZ.

— IAS 160 kt when crossing 8 DME ILS on final approach; this IAS must be maintained until 4 NM from the threshold."

The noise abatement procedures in effect at the time of the incident stated that "while vectoring to intercept the final approach, the minimum altitude shall not be below 5,000 ft while aircraft are flying above land".

These procedures were later modified to remove the express limitation to descend below 5,000 ft while the aircraft was above land, which was replaced by the following instruction: "plan the descent to leave the IAF or equivalent position at FL70 or above in order to make a continuous descent to the runway using a low drag/thrust procedure".

1.8. Radar trace

The aircraft was equipped with the required transponder to facilitate tracking by ATC radar systems. Information from the Control Center was received concerning the aircraft's various positions and speeds as displayed in real time on ATC screens. This information is shown graphically in the two figures below.

1.9. Flight recorders

The aircraft had a digital flight data recorder (DFDR) and a cockpit voice recorder (CVR), located in the aft section of the fuselage. Both components were recovered undamaged.

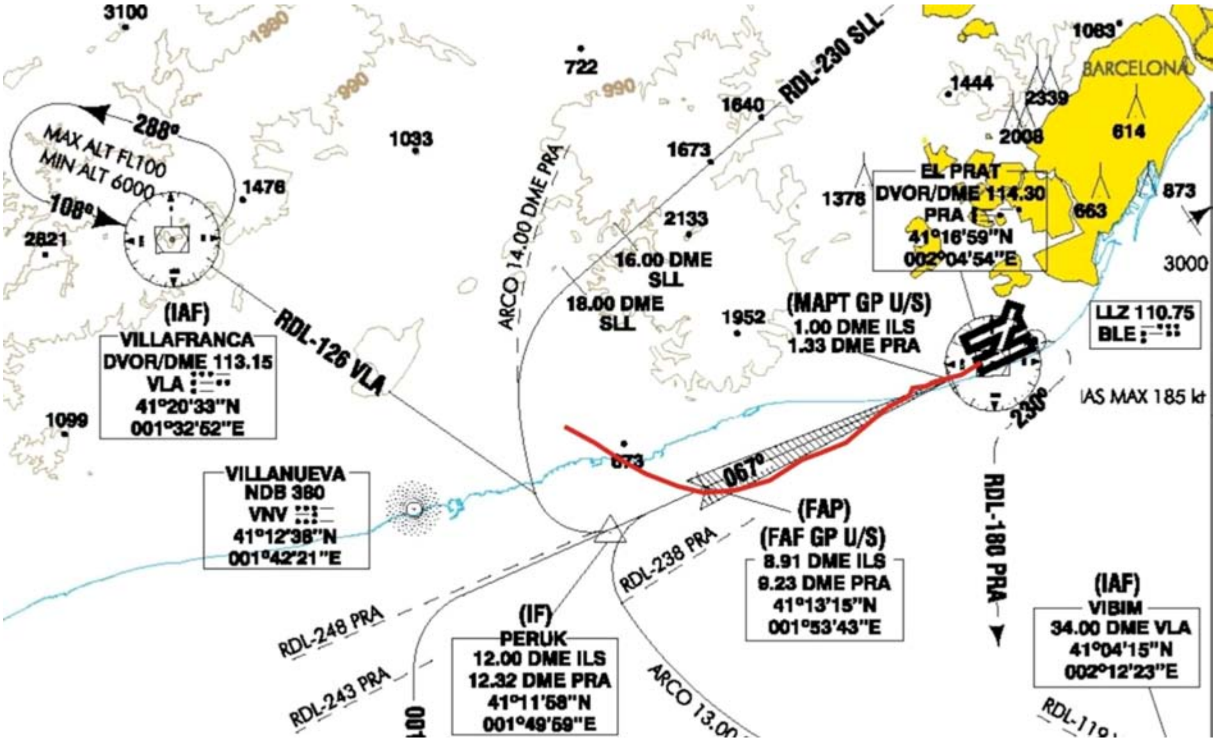


Figure 1. Radar track followed by the aircraft

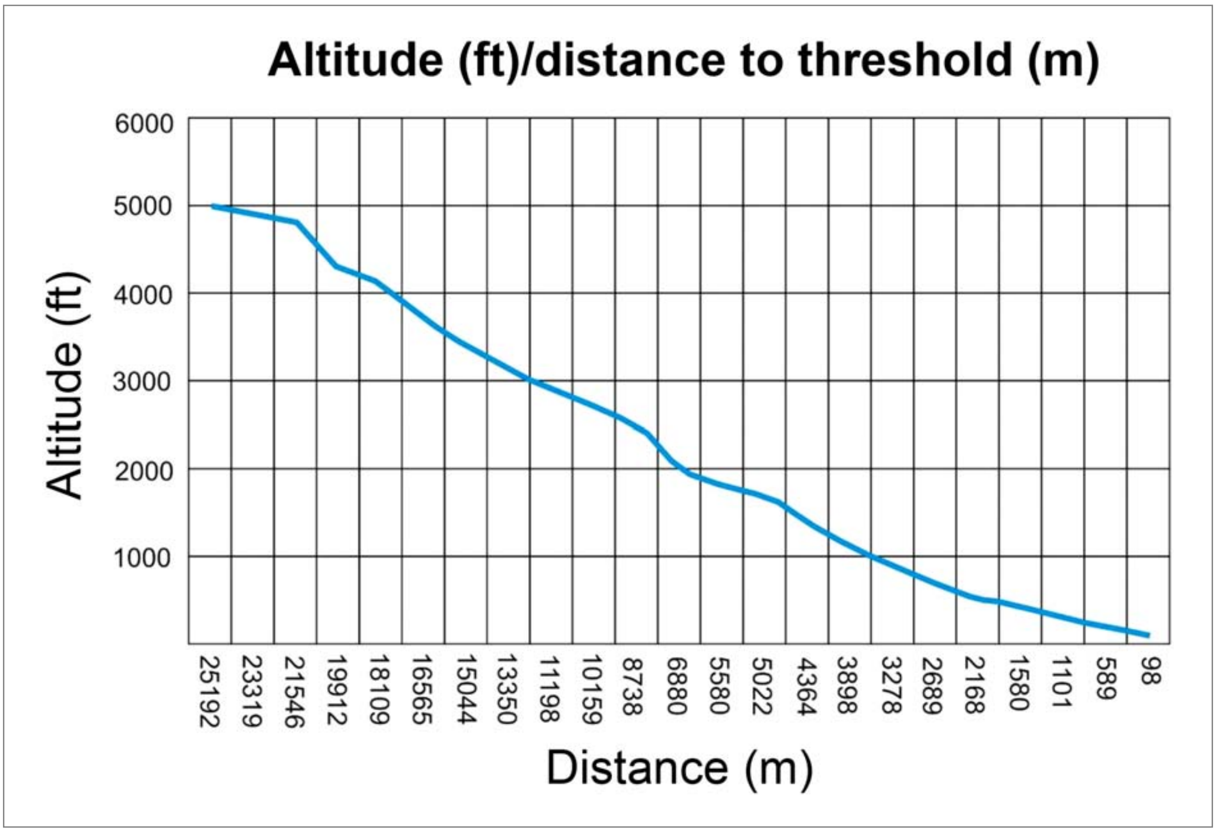


Figure 2. Graph of altitude-distance to threshold on approach

1.9.1. *Digital flight data recorder (DFDR)*

The aircraft was equipped with an ALLIED SIGNAL digital flight data recorder, P/N 980-4100 DXUN and S/N 8925.

The information recorded on it was verified to be mostly correct. At the time corresponding to the landing, however, second zero (t = 0 s), a lack of synchronization was noted along with erratic readings for various parameters, such as high vertical accelerations and strange or impossible values for other parameters, such as CAS = 284 kt and RA = 63 ft.

The recording logs data from various parameters in sets of 64 words every second. The vertical acceleration occupies 8 words each second, while the lateral and vertical accelerations are recorded 4 times a second. Other parameters of interest to the investigation have a sample periodicity of once per second.

The trend for these parameters was studied over two time periods, a broad period that encompassed the 200 seconds prior to touchdown and included the initial and final approaches, and a shorter, 45-second period corresponding to the landing proper.

During the initial moments following touchdown, vertical acceleration was recorded in three consecutive words spaced an eighth of a second apart and whose values were very high, possibly spurious, since the same time instant showed impossible values recorded for several other parameters. The second in which those high values were recorded is shown as time reference 0 in the discussion of the graphs that follow.

Trend of parameters on approach

Figure 3 shows the trend for the speed on the right axis. The values are generally high, with a spurious 284-kt value at the instant of touchdown. The other three lines represent the flight altitude, the radio altitude, with an impossible value of 63 ft at t = 0 s, and the ILS glideslope for reference. The aircraft was above the slope throughout the approach until the short final phase, on which it descended at the established rate at a speed of over 200 kt, which was 71 kt above Vtarget.

The aircraft adopted a landing configuration a few seconds before touchdown and while flying over the runway.

The engine thrust was set to idle during the entire approach. There was no thrust demanded until the braking maneuver on the landing run, during which the reversers were deployed. The deviation of up to three dots with respect to the glideslope indicates that the airplane was flying well above the slope.

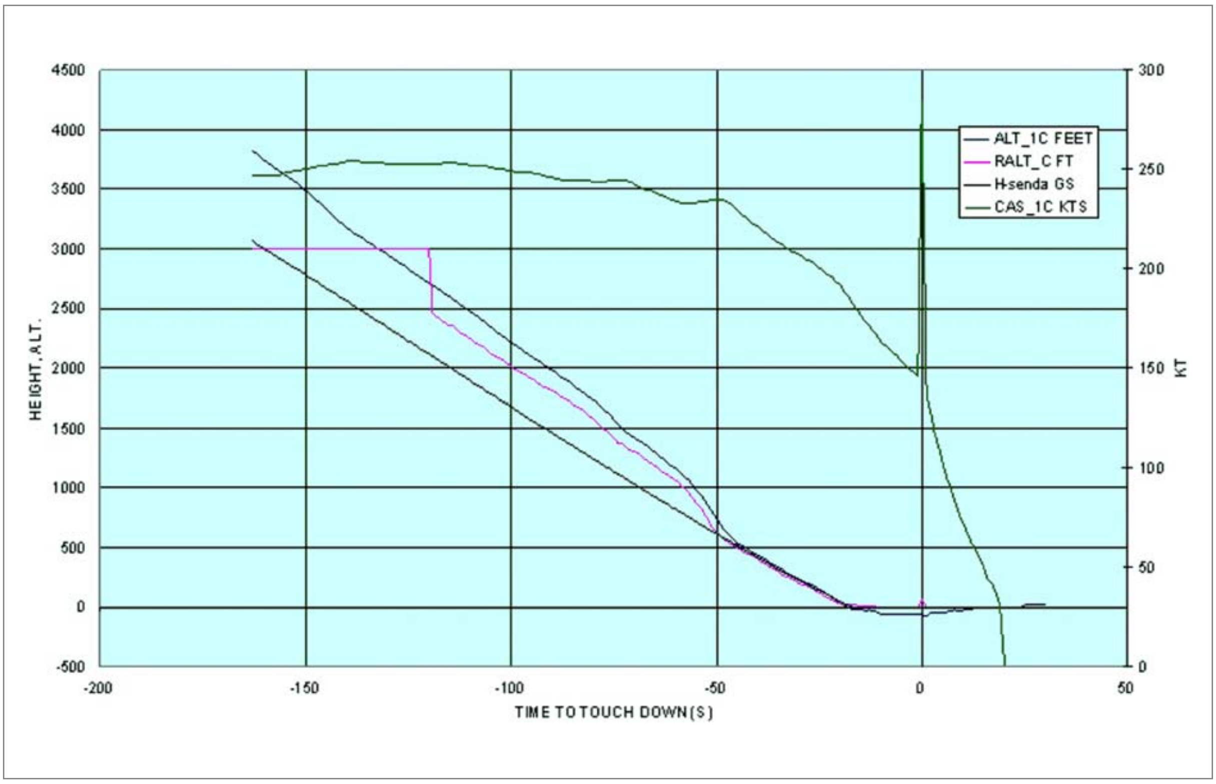


Figure 3. Speed and altitude during approach

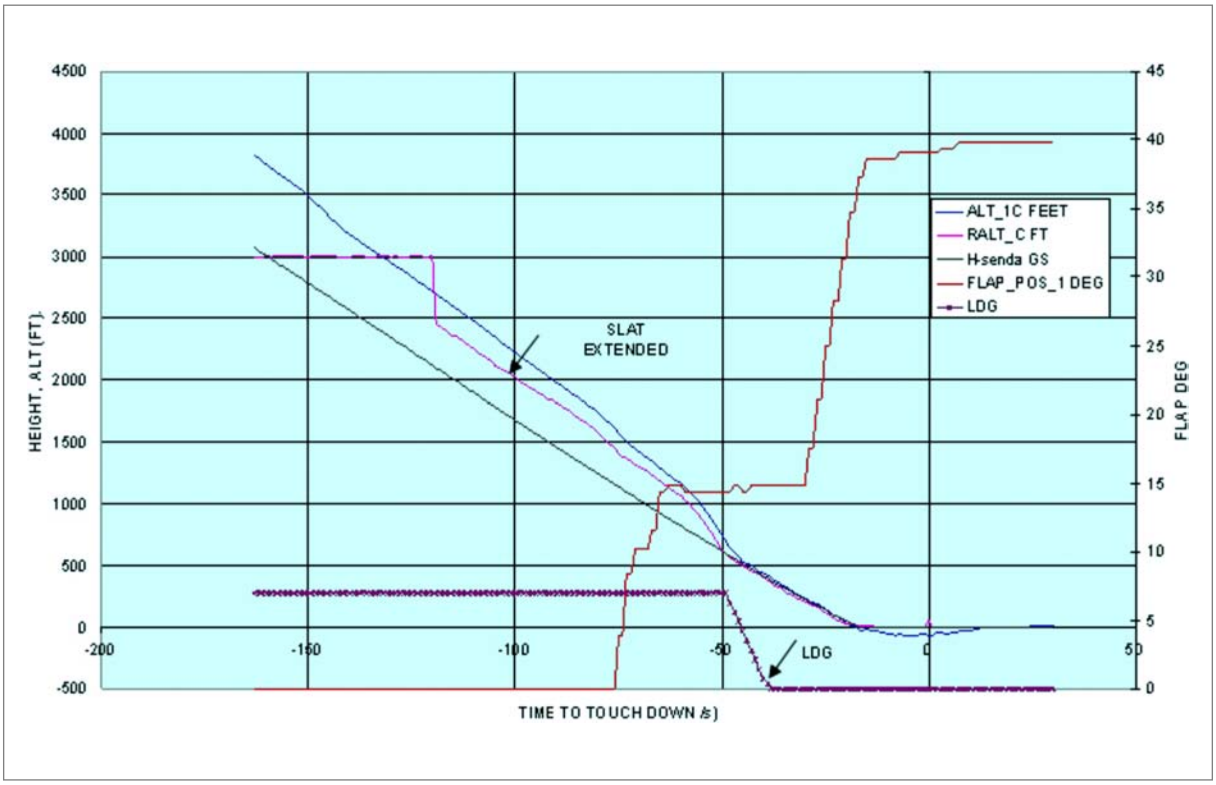


Figure 4. Configuration during landing

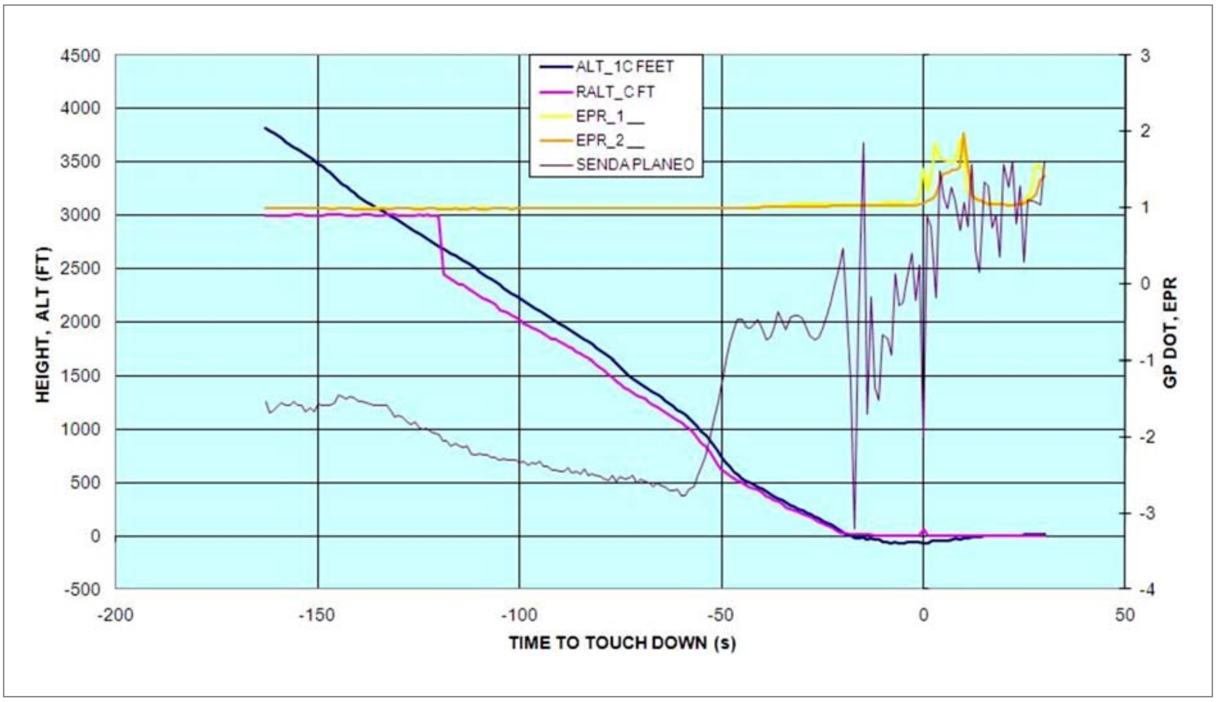


Figure 5. Deviations from glideslope and EPR

The aircraft's descent rate for the segment between the FAF and its reaching 500 ft AGL was high, with an average of 1,648 ft/min, a minimum value of 1,345 ft/min and a maximum of 2,900 ft/min. The final part of the approach saw the descent rate drop to an average of 385 ft/min, with a minimum of 11 ft/min and a maximum of 2,396 ft/min.

Trend of parameters on landing

At t = 0 s, as shown in the previous graphs, both the speed and radio altitude exhibited exaggerated values.

The altitude of the nose wheel was calculated, given that the slope in the touchdown zone was zero, by considering the airplane's altitude, the tangent of the pitch angle and the distance between the main and nose wheels.

Said altitude was practically zero during the 10 seconds prior to the contact made by the main gear at t = 0 s. This implies that the nose wheel contacted the runway some 790 m before the main gear legs did.

The recording of the discrete datapoint for the compression of the nose wheel shows a value corresponding to an AIR position throughout the recording until the end of the landing run. This was due to a problem that affected this parameter's recording only, but not the parameter itself.

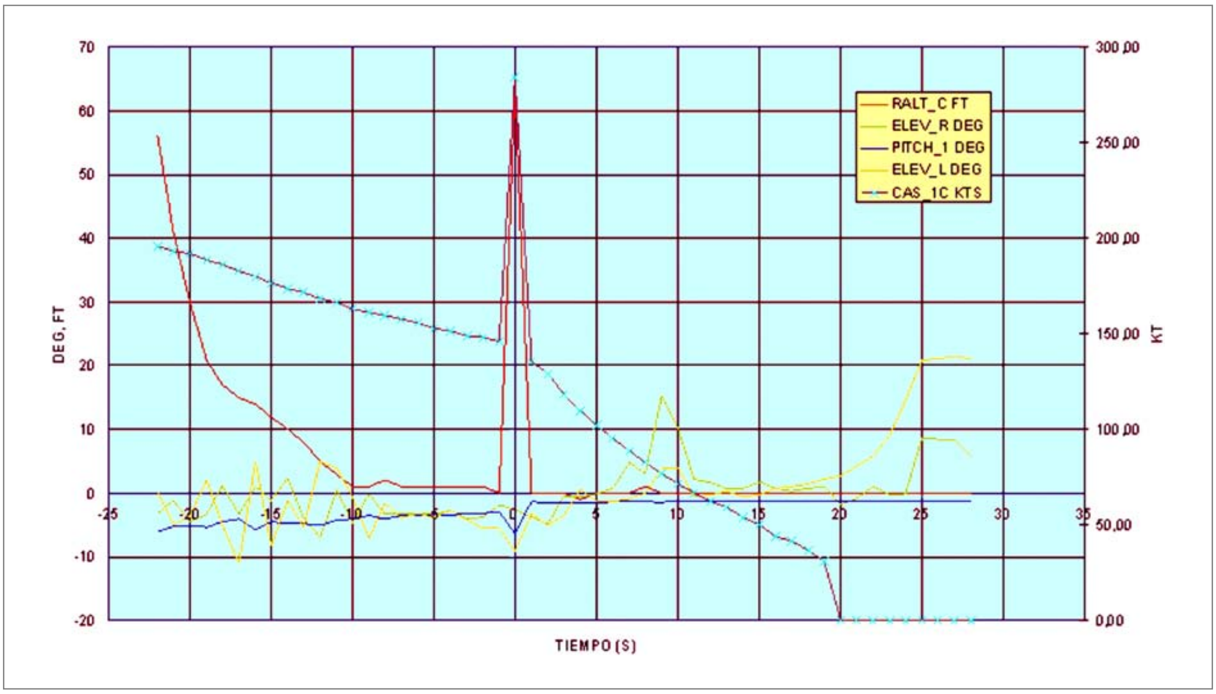


Figure 6. Trend for various parameters during touchdown

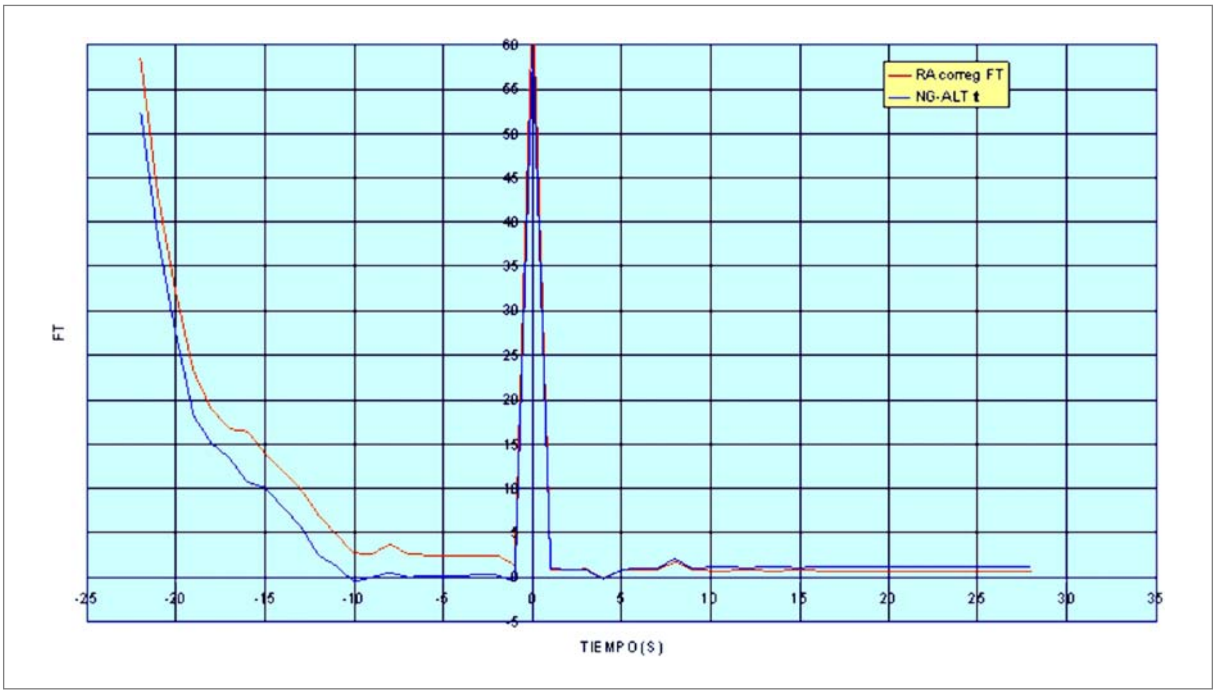


Figure 7. Corrected radio altitude and altitude of nose wheel

The DFDR recording shows that the airplane was flying on short final with a slight left yaw. Four or five seconds prior to touchdown, the left yaw increased sharply, which the pilot corrected with hard right pedal. He then corrected the airplane's tendency to continue yawing left by applying right rudder.

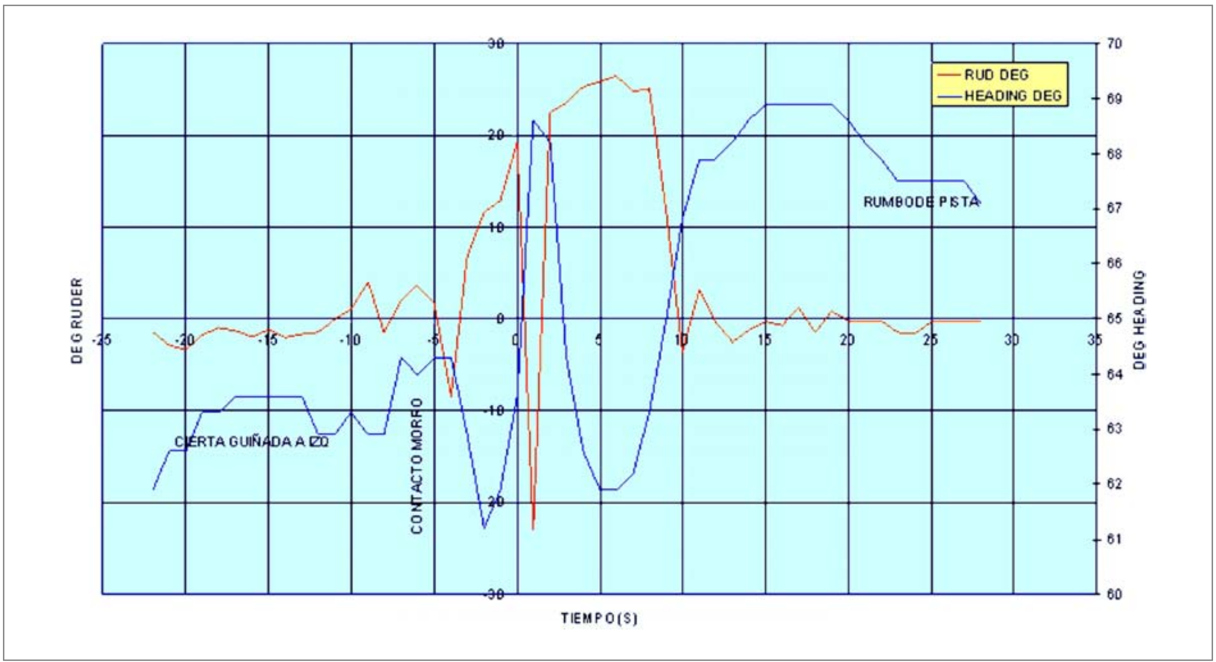


Figure 8. Trend of rudder and course parameters

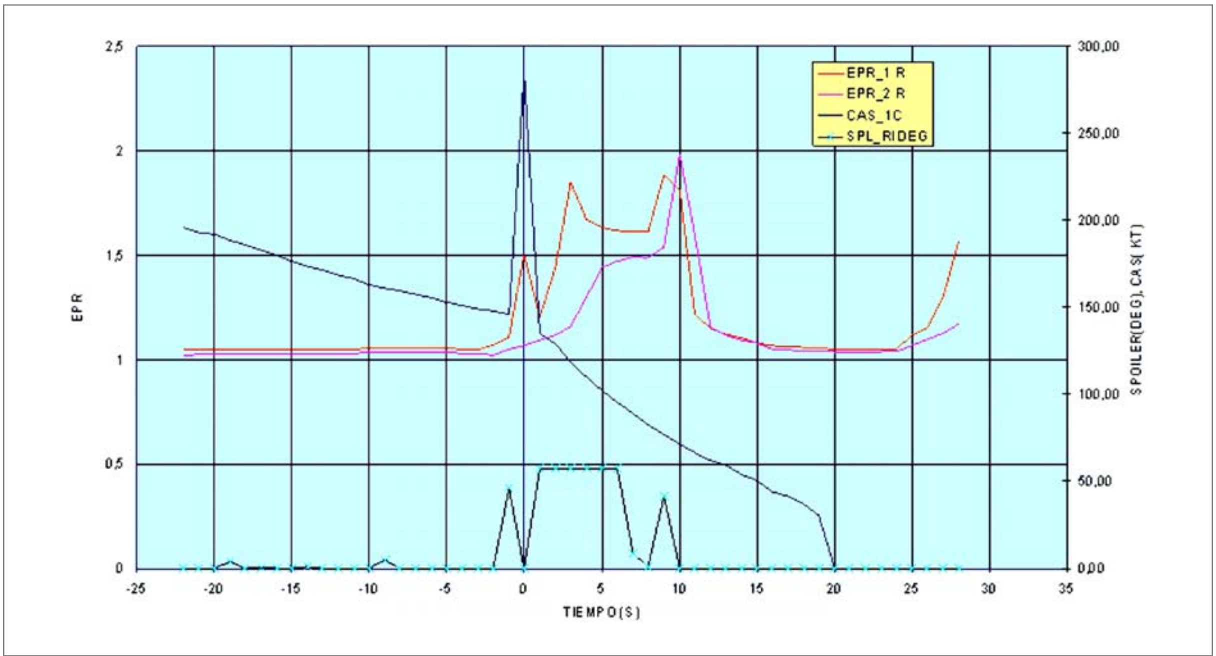


Figure 9. CAS, reverse thrust and spoilers

Although not shown, the airplane's lateral inclination was 2° to the left three seconds before touchdown.

The airplane glided the last few seconds with no engine thrust. The spoilers were deployed one second before the time designated as t = 0, coincident with a possibly spurious recording of 4.89 g's.

At t = 0 s, the recording for the right spoiler shows it as deployed.

The reversers were deployed during the landing run, with EPR reaching a value of up to 1.9.

Additionally, and though not shown here, four seconds before touchdown, the brake pedals were depressed and the system pressurized. At t=0 s, the parameters for hydraulic pressure and the position of the right pedal also exhibit anomalous values that are regarded as spurious.

The following two graphs show, after a rearranging of the data, the variation in the longitudinal and lateral accelerations, which are taken and logged by the DFDR four times per second.

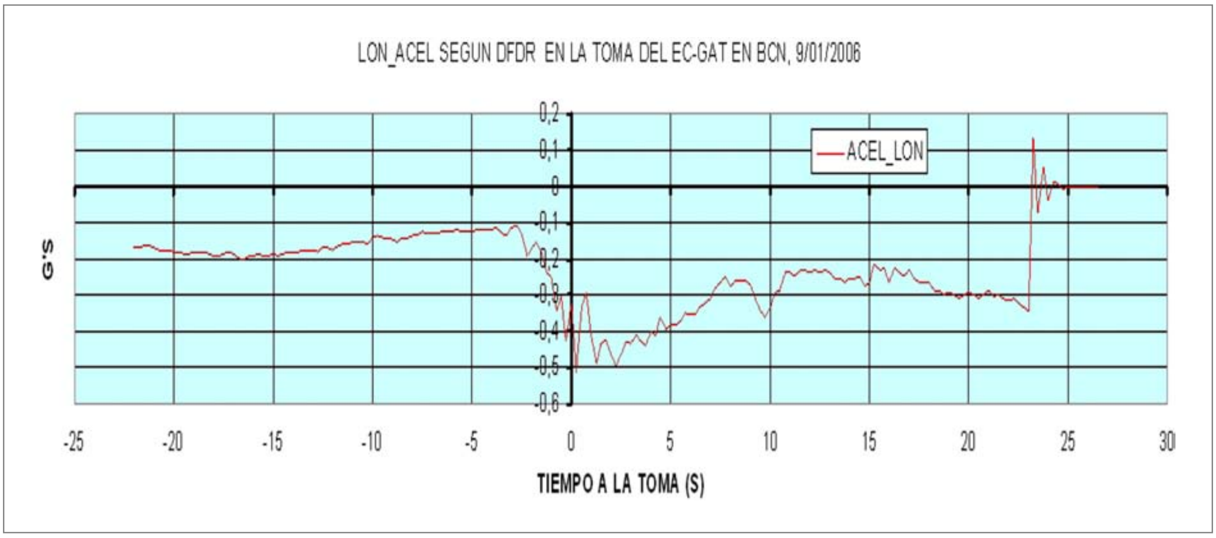


Figure 10. Longitudinal acceleration

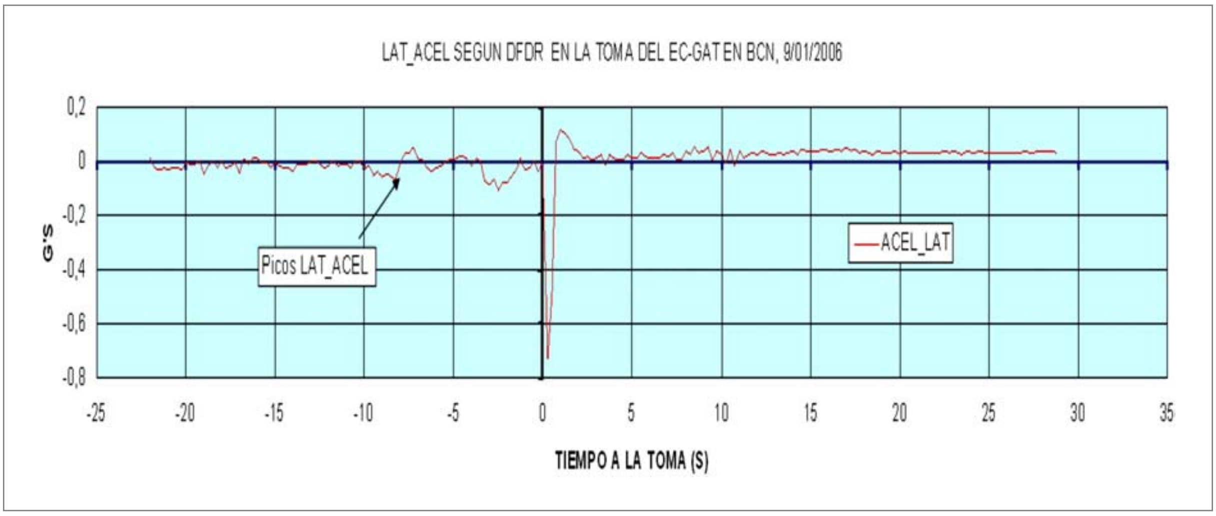


Figure 11. Lateral acceleration

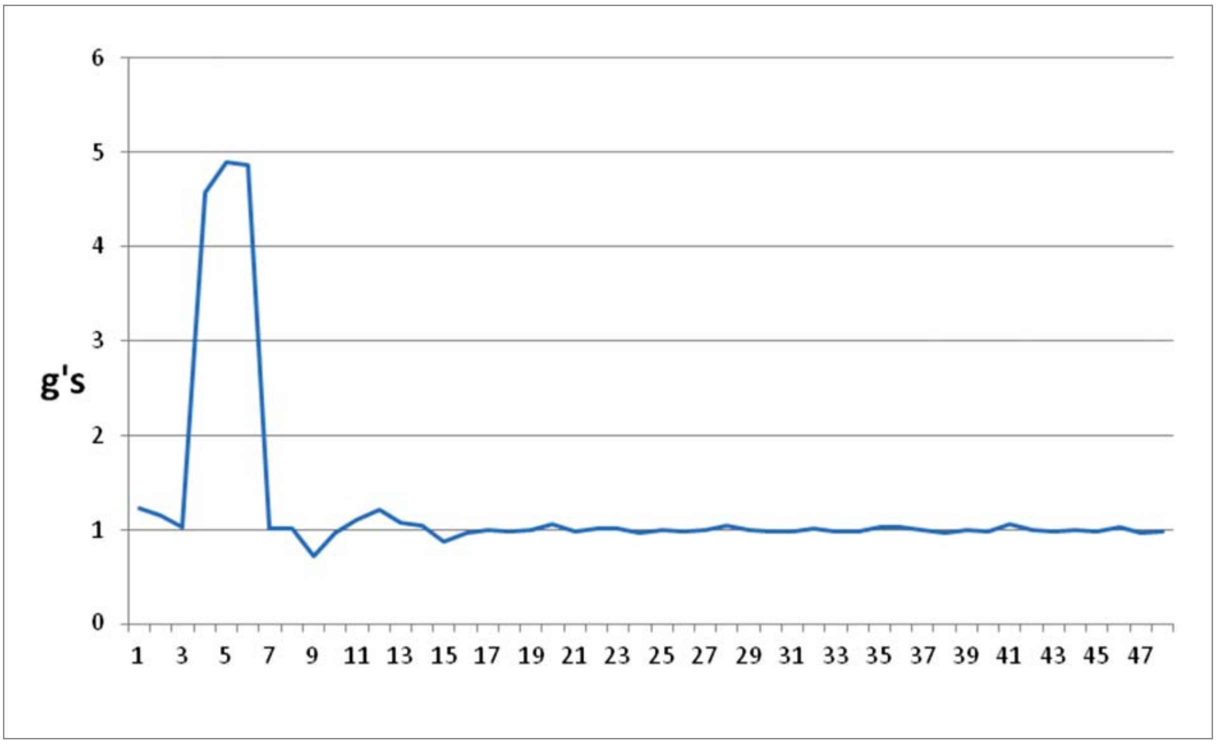


Figure 12. Vertical acceleration

The trend in the parameters for the lateral and vertical accelerations is shown in numerical table form in Appendix A, along with the values for aerodynamic speed, magnetic direction, pitch angle, engine rpm's and fuel flow, among others.

1.9.2. *Cockpit voice recorder (CVR)*

The aircraft was equipped with a HONEYWELL AV557C cockpit voice recorder (CVR), P/N 980-6005-079.

Good information from all four channels was obtained and downloaded.

The voices recorded confirm the transcriptions of the communications with the tower. These recordings were synchronized with those of the DFDR using the VHF communication activation times, and reveal the following information:

- After being instructed by the route controller to proceed directly to PERUK, the Captain said that they were not going to let them descend until they were past the coastline.
- The first officer replied "if they send us through Villafranca...", to which the pilot replied no, that they had been routed through PERUK and sent via the coastline, which according to the AIP...

- The pilot commented that PERUK was at the end, which the Captain acknowledged, but that if they arrived at the coastline before PERUK, they would have 5,000 (ft).
- At 08:53:38, they were cleared by the controller to runway 07R, at which time the Captain told the first officer "let's see if we can go the fix for 7".
- Twelve seconds later the first officer replied "there's one there, at eight, nine, which must be this one". The Captain responded "seven, eight, fix for nine", adding seconds later, "tell him, let's see what he says".
- Three seconds later the first officer requested clearance from ATC to fly direct to the mile-nine fix.
- The controller instructed them to proceed at their discretion but to maintain 5,000 above land and to descend past the coastline.
- The Captain said "this is serious now...", to which the first officer replied that if they went to the coastline and had to maintain 5,000, that they would be high, that they should be at 3,000.
- The Captain acknowledged, but said they would deal with it, to which the first officer replied "or not".
- The Captain added "my plan is... let's see if a little speedbrake".
- Some 342 seconds before touchdown, the crew recognized being relatively high.
- At t = –134 s, they reported being on the 07R final
- At t = –114 s, the GPWS announced 2,500 ft.
- At t = –103 s, the CPT said "about to do a power-off landing".
- At t = –65 s they disengaged the autopilot.
- At t = –56 s, the GPWS warned of passing through 1,000 ft.
- From t = –51 to –28 s, there were repeated GPWS 'SINK RATE', 'PULL UP' and 'TOO LOW TERRAIN' warnings.
- At t=–26 s, the GPWS announced "MINIMUMS" and two seconds later issued four "SINK RATE" warnings.
- At t = –15 s, the GPWS 10-ft altitude announcement is heard.
- At t = –8 s, the first officer said "What's wrong man?", and two seconds later "Brake, brake".
- At t = –4 s, the CPT cried out "It's not braking, it's not braking".
- At t = –3 s, the first officer said "what's wrong man?"
- At t = –2 s, the spoilers are heard deploying.
- At t = –1 s, the CPT insisted that the aircraft is not braking. This assertion was repeated in the seconds that follow.
- At t = +2 s, the sound of the engines with the reversers deployed is heard.
- At t = +18 s, the CPT cried out "Stop, stop!"
- At t = +26 s, the first officer informed the tower that they were attempting to exit the runway.

At no time during the recording is the crew heard doing the "Before landing" checklist, nor reading the descent speeds or rates, nor alluding to a potential go-around maneuver, nor making the callouts at the established altitudes.

1.10. Tracks and marks on the runway

An inspection of runway 07R after the incident did not reveal any identifiable nose wheel tracks. The main gear wheels, on the other hand, left very noticeable tracks starting at a point some 1,600 m away from the 07R threshold. There were also bits of rubber and tire casings.

The initial tracks corresponded to the no. 1 tire, followed by the 61 m long track for the no. 2 tire. The wheels are numbered from left to right as seen from above in the direction of motion. The no. 1 wheel, then, is the outboard wheel on the left leg, while the no. 4 wheel is the outboard wheel on the right leg.

The tracks for the left leg wheels disappeared and reappeared some 20 m later. The tracks for wheels 3 and 4 on the right leg were visible some 35 m further ahead, and were continuous from that point until the end of the landing run.

The distance from the first track until the end of the landing run was 930 m.

From the airplane's final position until the end of the runway there were about 140 m.

Figure 13. Photographs of tracks on the runway

The tracks left by the tires were mostly made by rubber. The rim on the number 1 wheel made contact and left metallic marks shortly after the second appearance of its tracks; the number 2 wheel left metallic marks for the final 415 m of the landing run.

The photograph of the tracks shows how the aircraft made a slight turn to the left shortly after the two main gear legs made contact.

The aircraft stopped on the runway and was unable to move under its own power. It remained in that position until well into the afternoon of that same day. It was not until nine hours later that the four tires were replaced on the aircraft, allowing it to be towed off the runway. The maintenance work at the airport continued throughout the night, leaving runway 07R-25L inoperative until 07:00 on the next day.

1.11. Fire

A fire broke out in the vicinity of the left leg that was extinguished by the airport's firefighting services, which reported promptly to the scene, though after the evacuation of the airplane had commenced.

1.12. Survival aspects

Five passengers were slightly injured during the evacuation, one of whom had to be taken to a hospital.

The Captain ordered the cabin crew to evacuate the aircraft using only the right-side doors.

1.13. Tests and research

Along with the wheels and brake assemblies, the switch for the antiskid system and various other components in this system were disassembled for analysis and inspection in the workshop. The results of these analyses and tests are described below.

1.13.1. *Inspections of wheels and brakes*

The inspection of the wheels and brakes removed from the aircraft after the incident revealed that the wheels had no damage other than that resulting from the skid and blow-out.

The thermal fuses had not tripped and there were no signs of overheating.

The bearings on the wheel did not show any abnormal wear, corrosion or discoloration.

In general, the brake assemblies were in good condition. They were within acceptable limits in terms of wear and the only damage found had resulted from the friction with the runway. They were subjected to pressure tests, which revealed that the pistons pressed the stators against the rotors normally, and then separated normally when the hydraulic pressure was released.

The only damage evident to the antiskid system was to the wiring and resulted from the fire to which it had been subjected.

1.13.2. *Tests of antiskid switch*

The antiskid switch was removed and checked at the airplane manufacturer's facilities to ascertain whether it contributed to the incident in any way. The switch was subjected to X-ray, electrical continuity and resistance checks before being disassembled to check the appearance and wear of its contacts.

The results of these tests were satisfactory in that all of the switch's functions were normal and the wear was as expected for a component that had been in service for several years.

In short, no malfunctions or anomalies were detected in the switch.

1.13.3. *Checks of antiskid and autobrake components*

The four wheel speed transducers or sensors, P/N 40-62575, the antiskid control box, P/N 42-607-1, the autobrake control, P/N 42-809-3 and the four antiskid servovalves were removed from the airplane and sent to the facilities of the manufacturer, CRANE HYDRO-AIRE, INC.

The general conclusion was that all of the components had worked correctly when installed on airplane EC-GAT on the day of the incident.

1.13.4. *Integration of longitudinal acceleration*

In order to be able to relate the different times in the DFDR recording during the landing run to the airplane's position on the runway, the longitudinal acceleration, the values for which were available in quarter-second intervals, was integrated. The first integration yielded the ground speed, and the second gave the distance with respect to the airplane's final position.

The results of the first integration were checked against the values recorded directly for CAS corrected to TAS, and found to be slightly higher. This resulted in changes being made to correct for temporary accelerometer errors. One was a -0.0005 g positional error, determined by the value of the airplane at rest. A second error, proportional to the magnitude of the acceleration, was found to be 2.34%, which minimized the sum of the square differences of the speeds recorded and calculated during the braking run.

With these errors accounted for, the second estimate revealed that:

- The aircraft flew over the runway threshold (2,520 m before the stopping point) at t = –19.5 s before positive contact was made, which is defined as t = 0.
- The aircraft's main landing gear left its first mark (930 m before the stopping point) at t = –1.75 s.
- The aircraft touched down a second time with the left leg at t = –0.75 s.
- Both aircraft legs touched down for good at t = 0 s at a spot that was 810 m away from the final stopping point.
- Based on this integration, the maximum vertical acceleration was recorded a few tenths of a second later, at some 763 m away from the final stopping point.

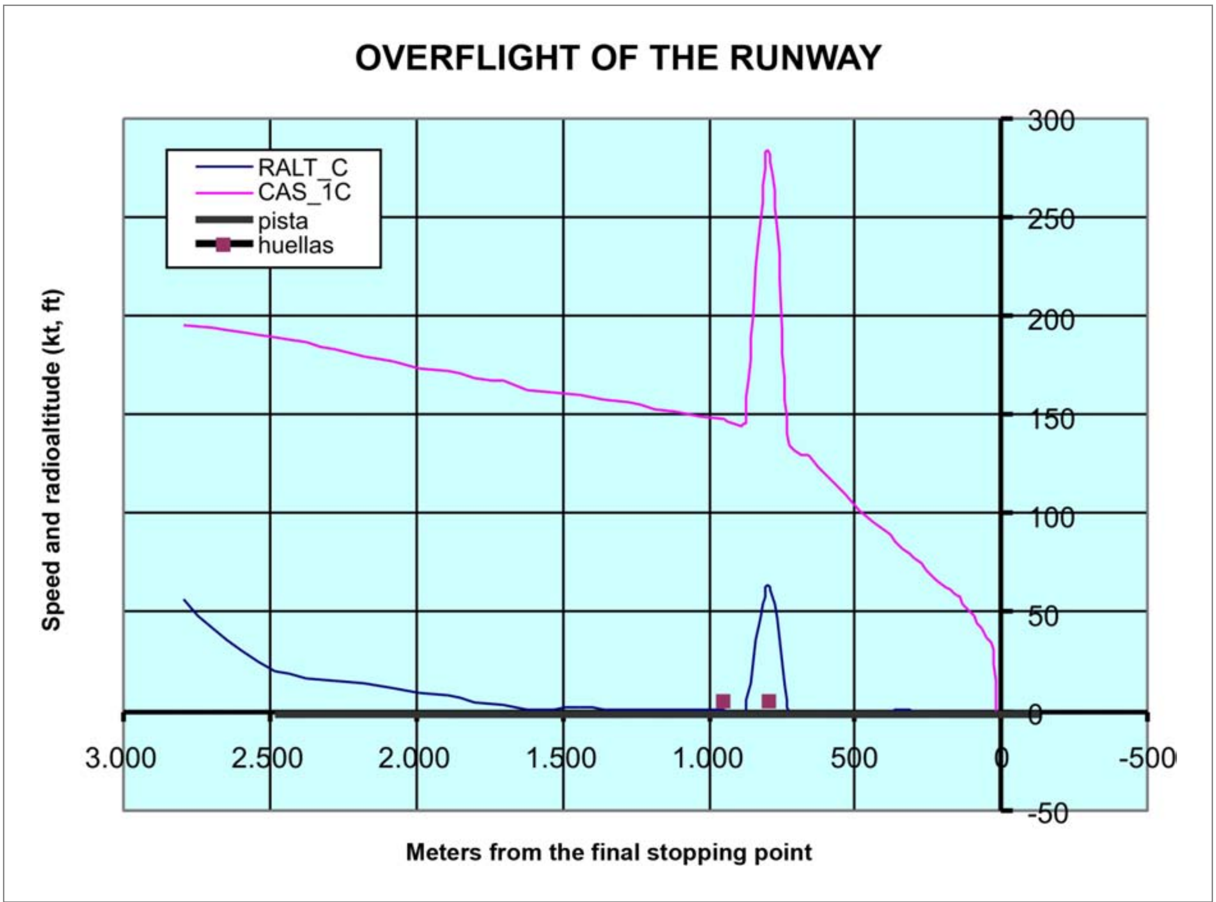


Figure 14. CAS, radio altitude during overflight of runway (meters from final stopping point)

1.14. Organizational and management information

1.14.1. *Company procedures*

Checklists

Spanair's Operations Manual has different checklists which detail the checks and actions to be performed during certain phases of flight, including the Descent, Approach and Landing checklists.

Among the items on the Landing Checklist is to check the position of the landing flaps and to arm the spoiler autobrake system. In the Descent Checklist one of the items is a "Landing Briefing".

Normal landing procedures

The section on Normal Procedures states that "If the approach is not stabilized when passing through a radio altitude (RA) of 500 ft, or if it becomes unstable on an instrument approach near the minimums, a go-around must be performed".

"During the approach phase, a clean configuration is strongly advised prior to selecting flaps and, if conditions allow, prior to the IAF".

"If landing flaps are selected before stabilizing on the extended runway centerline while on a circuit approach, limit the bank angle to a maximum of 30° and the speed to a minimum of 15 kt above the reference speed...".

"The final approach speed is obtained by adding a certain increment, depending on the wind reported, to Vref. The speed increment must not be less than 5 kt or greater than 20 kt".

"The corrected final approach speed is to be maintained until the start of the flare".

Two landing flaps positions are defined, 28° and 40°. It recommends not arming the spoilers below 500 ft.

According to the company's procedures, a visual approach is considered stabilized if the desired slope is attained with wings level prior to reaching a radio altitude of 500 ft, the gear is down and landing flaps are selected. In addition, the speed must be between +20 kt and –5 kt with respect to the final corrected approach speed, the descent rate below 1,500 ft/min and the throttle in the LOW LIM position, or 1.10 EPR if the AT (Autothrottle) is not engaged. The operations manual also states that if the approach is not stabilized when passing through a RA of 500 ft, the landing must be aborted and a go-around performed.

Callouts that must be made by the pilots on an ILS/VOR/NDB approach are also defined. These callouts include "Flaps 28° or 40° selected" requested by the pilot, and the "Speed...", made by the pilot when the flaps are down so as to confirm the new configuration. These callouts are defined in greater detail for an ILS approach, as shown below:

FLIGHT PROCEDURES - Approach

8.4.2 ILS Standard Callouts and Checks.

FLIGHT PHASE	PF		PNF	
	Duty	Call-out	Duty	Call-out
Approaching 1000 ft to level off	Check ALT/FL cleared and selected in FGS	"1000 to level off"	Check ALT/FL cleared and selected in FGS	
Passing 2500 ft R/A	Check R/A and QNH		Check R/A and QNH	"R/A 2500 ft"
On final intercept heading	Check FMA	"ARM VOR"	Check FMA	"VOR ARM"
LOC moving	Check PFD/ADI	"LOC ALIVE"	Check PFD/ADI	"LOC ALIVE"
LOC capture	Check FMA	"LOC CAPTURE"	Check FMA	"LOC CAPTURE"
LOC track	Check FMA	"LOC TRACK"	Check FMA	"LOC TRACK"
G/S moving	Check PFD/ADI	"G/S ALIVE"	Check PFD/ADI	"G/S ALIVE"
G/S capture	Check FMA	"G/S CAPTURE"	Check FMA	"G/S CAPTURE"
G/S track	Check FMA	"G/S TRACK"	Check FMA	"G/S TRACK"
OM or EQUIVALENT POSITION (if marginal)	Check altitude	"ALT CHKD"	Check altitude	"OUTER MARKER ALT CHKD STABILIZED"
1000 AAL	Approach stabilized		Approach stabilized	"1000 ft stabilized" or "1000 ft not stabilized".
AT DH + 100	Look out for VIS REF			"PLUS HUNDRED"
Speed deviations (-5/+10 kts)			Check speed	"TARGET PLUS/MINUS"
Rate of descent. (More than 1000 ft below 2500 ft R/A			Check VSI	"SINK RATE"
AT DH	Confirms ACFT is correctly positioned on the RWY	If visual reference is established "CONTACT"	Monitors primary instruments and FMA	"MINIMUM" (If "CONTACT" is not announced by PF "GO ARND")
Glide slope deviations (more than half DOT). Localizer (1/3 dot or full expanded)			Check PFD/ADI	"GLIDEPATH/ LOCALIZER" "GO AROUND"
Approach lights or runway in sight			If PF has not given visual contact	"LIGHTS or RUNWAYS"
Visual reference		"VISUAL CONTACT"		
If not visual reference al DA/DH or MDA/DH/DP			Check DA/DH or MDA/DH/DP	"MINIMUMS GO-AROUND"
GO-AROUND	Beginning go-around	"GO-AROUND"	Perform	
At Main Gear Spin up			Check spoilers extended	"Spoilers" If not "NO SPOILERS"
50, 30, 20, 10 R/A			Check R/A	Autocallout "R/A 50, 30, 20, 10"

Part B of the Operations Manual, Normal Procedures, 2.7/7 Item 7, presents the criteria established by the company for defining a stable approach as follows:

Flight path	Precision Approach	Maximum deviation from localizar an glidepath one dot.
	Visual Approach	Along the desired flightpath. Wings must be level at or before 500 ft RH.
	Non-precision and circling Approach	Along the desired flight path. Wings must be level at or before 300 ft RH.
Configuration	Landing gear	Down.
	FLAPS/SLAT position	28 or 40/LAND.
Speed		Maximum deviations plus 20 kts and minus 5 kts from corrected final approach speed
Rate of descent		Maximum 1,500 ft per min.
Power setting		Throttles at minimum LOW LIM position or minimum 1.10 EPR if AT is not engaged.

CDA – Continuous Descent Approach

Among the normal procedures found in the Operations Manual is the CDA procedure, which recommends a descent profile like the one shown in the following figure when

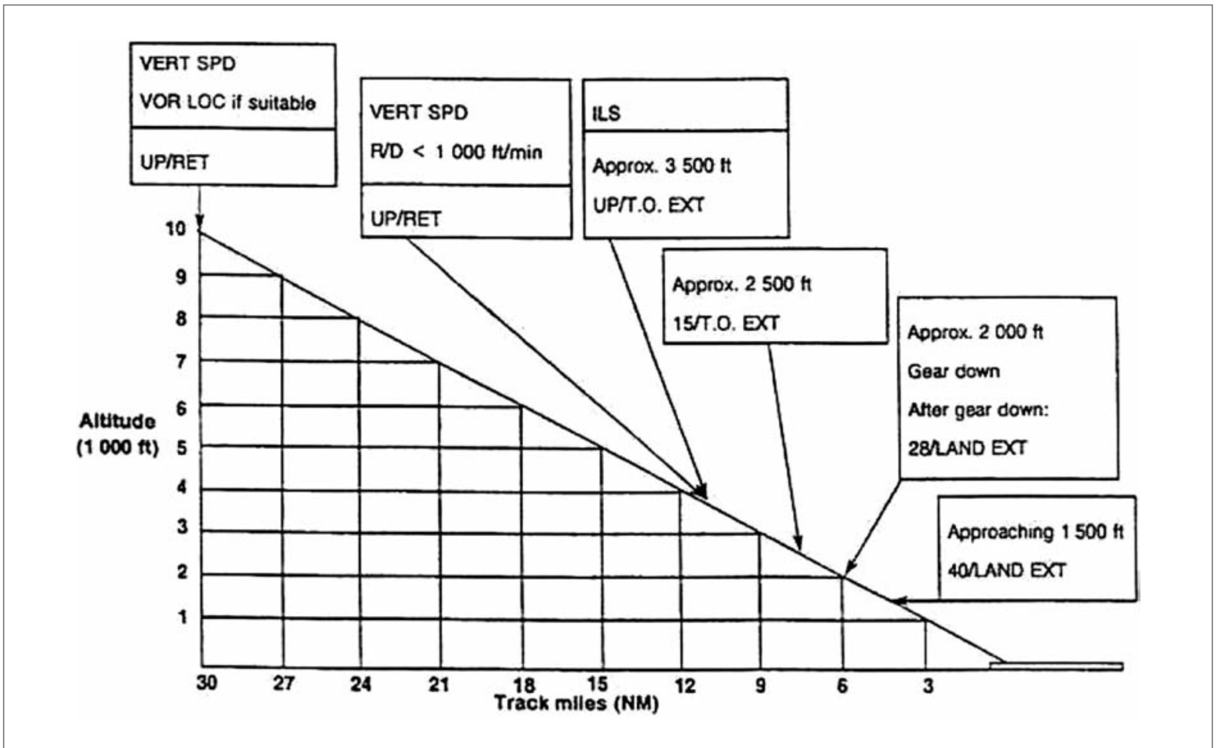


Figure 15. CDA descent profile

there are no ATC restrictions at the airport and weather conditions call for a straight-in approach. The profile is based on selecting idle power until the landing configuration is selected and a descent rate of 1,000 ft every 3 NM. The desired vertical speed is given by the formula V/S = (ground speed/2 × 10).

1.15. Additional information

1.15.1. *Statements and interviews with flight crew*

During an interview with investigators, the crew and Spanair operations personnel stated that:

In the previous flight the autobrake had been used to land in Bilbao. The spoilers deployed properly and they left the runway via the first exit.

The incident flight from Bilbao to Barcelona was uneventful. No anomalies were noted in the brakes during the taxi out.

Asked if they had noticed the position of the antiskid switch, they replied that it is checked prior to each flight, as was done in this case.

Their landing weight was 114,000 lb. The calculated approach speeds were 124 kt for Vref and 130 kt for Vtarget.

It was their first time doing the approach from the south since the change to the Terminal Manoeuvring Area (TMA) two months earlier.

They requested to go directly to the 8.9 NM fix without going through PERUK, which is at 12 NM.

They attempted to do a CDA (Continuous Descent Approach). They were cleared to the 8.9 NM fix and then told to remain above 5,000 ft until past the coastline.

In their opinion they flew the glideslope well but had excess speed.

Nine miles away from the THR the PF disengaged the autopilot. They did not use the autobrake.

At 200 kt they went to flaps 28, and to flaps 40 below 190 kt.

They could not state whether or not they were destabilized.

They touched down smoothly with the main gear after a considerable flare. On reaching the touchdown zone (TDZ) they felt as if they were floating.

They touched down shortly before G7, applied the brakes and felt them to be unresponsive. Both pilots exerted pressure on the brake pedals.

They did not feel the airplane go anywhere. The spoilers did not deploy, although they were not sure if they were armed. The pilot flying deployed them manually without remembering whether he did so before or after applying the brakes. They did not release the brakes after stepping on them.

The reduction in speed was not consistent with the amount of brake being applied.

The PF applied high thrust to the reversers.

Once the airplane stopped, they advanced the throttles to exit the runway but the airplane did not move.

They thought the antiskid had malfunctioned and that had there not been enough runway, they would have departed it because they skidded.

After stopping, when TWR informed them of the fire in the left leg, he ordered the evacuation using the right-side doors.

The flight attendants told them they had noticed two explosions at the end of the landing.

Although the firefighters responded quickly, by the time they arrived and started spraying foam on the downwind side, the 90 passengers had already disembarked.

They seem to recall that the first officer tried but could not set the parking brake. The pedals were locked. They did not look at the brake temperature.

They stated that the antiskid system switch was engaged throughout the landing sequence and that they did not use the autobrake.

Both pilots felt that “there was a mechanical problem with the airplane’s braking system”. “Some fault with the antiskid”.

1.15.2. *Statement from controller in the airport’s control tower*

The controller stated that a few seconds after EC-GAT touched down, white smoke started issuing from the aircraft. The alarm was activated while the aircraft was still moving.

He also added that the next aircraft in the landing sequence, which was some 6 NM behind, was given instructions to go around.

1.16. Mistakes revealed in this operator's landing operations

On 23 January 2005, a DC-9-83 aircraft operated by Spanair made a hard landing at Asturias Airport, which resulted in damage to the aircraft's fuselage and in the loss of a deflector from the right main gear.

The investigation into this event highlighted the existence of certain shortcomings in the approach procedures in place at the operator and led to the issuance of several recommendations, of which two, 14/2009 and 15/2009, hold some relevance to the events of this incident.

REC 14/2009. It is recommended that SPANAIR:

Complete the definition of the callouts on approach, to include the correction criteria that must be followed for both manual and automatic approaches when any deviation from the conditions defined for the callouts is detected.
Add to its MD fleet Operations Manual the landing callouts necessary to prevent the tail, engine nacelles and wingtips from striking the ground.

REC 15/2009. It is recommended that SPANAIR review its Operations Manual, and in general all of the documentation that lists the criteria for issuing callouts on approach, so as to ensure consistency in the definition of the criteria used to issue callouts on approach.

2. ANALYSIS

The fact that the Ground/Air parameter, which indicates when the nose wheel contacted the ground, was not recorded on the DFDR, suggests that the aircraft's operation should be analyzed in reverse, starting from the point at which it came to a stop and rewinding back to the start of the approach taking into account the facts and evidence discovered.

2.1. Braking maneuver during landing run

It is clear that the wheels locked and skidded. The wheels did not turn and the brake assemblies did not dissipate energy, as evidenced by the fact that the thermal fuses did not trip on any of the four wheels.

The focus of attention from the start was the antiskid system, whose intended purpose is to keep the wheels from locking during braking. That the system was engaged is not in question, both as a result of the statements of the pilots and of the first individuals to go into the cockpit following the evacuation and who saw the antiskid switch in the ON position. On the other hand, all of the reports and results from the tests conducted on the system, which included a check of its installation, confirmed that it was functioning properly and that the airplane's antiskid system should have worked normally.

The system is designed to allow for heavy braking of all the wheels while providing for the immediate release of hydraulic braking pressure in a wheel that is rotating slower than the rest, a sign of impending wheel lock. When the wheels first contact the ground during a landing, however, the wheels must be allowed to rotate quickly. That is the reason behind the "landing interlock", which keeps the brakes from taking effect until some time after the touchdown. In a normal landing, the airplane's nose is lifted during the flare and the main wheels descend until they touch the ground and start rotating. The ground spoilers then deploy, causing a loss of lift and allowing the full weight of the airplane to rest on the wheels. In the meantime, the nose descends such that the nose wheels touch the ground, which compresses the nose strut. This completes a circuit that provides an electronic signal to indicate that the nose is on the ground. The antiskid uses this signal to inhibit braking for a period of time calibrated to last between 1.5 and 5 s, even if the brake pedals are pressed.

The DFDR recordings log the AIR/GROUND signal from the nose wheel sensor, which should point to the exact moment of touchdown. In this case, however, from the taxi phase and takeoff in Bilbao until the end of the landing, the recorded value was "AIR", a value that did not change. Since this signal affects many other airplane systems, the failure of the air/ground microswitch in the nose wheel would have been evident to the crew. As a result, the constant presence of the AIR value in the recording is believe to be a DFDR anomaly. There are numerous indications, however, that show that the aircraft contacted the ground with the nose wheels several seconds before the main gear made contact.

The zero time reference, $t = 0$ s, is that second during which the highest vertical acceleration was recorded and which marked the instant of the positive landing. The integration of the longitudinal acceleration and the location of the tire tracks on the runway allowed investigators to determine that the aircraft scraped the runway with the left leg and bounced up slightly at $t = -1.75$ s. At $t = 0$ s, the right wheel touched down. A few tenths of a second later the maximum, though probably spurious, vertical acceleration value was reached.

Given these circumstances, the following reasons could explain the long period of contact between the nose wheel and the runway before the main wheels made contact:

1. The DFDR data (see Figure 6) show that at the moment of touchdown, the aircraft was at a 3° down angle. Taking the airplane's radio altitude and its pitch angle, the

height of the nose wheel can be calculated. The result shows that the nose wheel could have touched the ground stating at t = –10 s and some 8.5 s before the initial contact of wheel number 1.

2. Figure 8 shows a sudden yaw to the left that took place before t = –4 s, that is, 2.25 s before the left gear first scraped the runway. This yaw motion probably occurred as a result of contact by the nose wheel as the airplane was descending at a certain yaw angle due to the crosswind from the left.
3. The oscillations in lateral acceleration (see Figure 10) during the approach became more pronounced at t = –8 s. This can be attributed to forces in the nose gear while the main gear was still not on the ground.
4. The synchronization of the CVR recordings shows that from t = –7.75 s, the pilots noted something strange, with each urging the other to brake, "BRAKE, BRAKE". The most likely explanation is that though the main gear wheels were not on the ground, the rolling motion of the front wheel made them think they had landed.
5. The crew's statements indicate that they made contact as they passed exit taxiway G-7, though the first tracks left by the main gear do not appear until taxiway G-6, some 600 m further forward. The aircraft, which was going at around 160 kt, would have taken 7 or 8 seconds to travel that distance, during which time only the nose wheels were in contact with the runway.

The brake pedals were depressed and the system had been pressurized for 4 or 5 seconds prior to the touchdown by the main landing gear. By the time the main gear contacted the ground, the nose wheels had already been in contact for several seconds and the "landing interlock" would have been nullified. Under these conditions, the main gear wheels would have been locked and remained so for the duration of the landing run. It is believed, then, that the main gear locked, skidded and blew out because of the abnormal pitch angle of the airplane, which resulted in a nose wheel landing that kept the nose wheel in contact with the runway for several seconds before the main wheels touched down.

The aircraft's systems are believed to have worked properly during the landing, as suggested by the satisfactory results of the tests and inspections carried out on the aircraft and its components.

The recording for the lateral acceleration (Figure 10) shows a high value to the left of 0.727 g's instants before touchdown, at t = 0.25 s, which corresponds to the turn in the trajectory seen in the photograph of Figure 1.9.1.

The aircraft was steered without any difficulty since both aerodynamic and front steering wheel controls were available, which allowed the pilot to keep the airplane centered in the runway despite the blow outs. The aircraft skidded to a stop without wheel braking control, as noted by the crew.

The reduced friction of the skidding tires was offset by high reverse thrusters.

At the end, after the airplane stopped, the blown out tires and abraded rims prevented the wheels from turning, thus keeping the airplane on the runway.

2.2. Overflight of runway threshold and landing

According to the DFDR data and the integration of the longitudinal acceleration, the aircraft flew over the runway 07R threshold at an altitude of 30 ft and 190 kt with the engines at idle. It was in a gear down configuration and the flaps, which were extending at the time, were passing through 33°. The 60-kt speed excess over the corrected, or target, reference speed explains the aircraft's long 1520-m long glide, in keeping with the calculations presented in 1.12.4.

Under flight conditions, an MD-83 needs a lift coefficient $C_L = 1.00$ to fly at 180 kt. The (fuselage) angle of attack necessary to achieve that C_L is 0° in open air and –3° with ground effect.

By the end of the glide the speed had dropped to 148 kt. The airplane was also partially resting on the nose wheel, which was on the runway, with the tail in the air pitching it down.

While traveling over the runway, with zero vertical speed, the airplane was moving with the nose wheel rolling on the ground and a high center of gravity. The main gear was off the runway surface.

The PF manually deployed the spoilers at t = -1 s. Since at that point the main gear was still in the air, the airplane dropped abruptly, an impact that was recorded one second later.

Even if the main wheels had not spun up, since the nose wheel was already in contact with the ground, the safeguard that prevents the spoilers from being deployed in flight was already defeated. It can also be confirmed that the ground spoilers were not armed, as recommended for a power-off landing, since in that case they would have deployed automatically when the nose wheel touched down, generating a "ground" signal.

As the crew stated, the landing was smooth, but done with the nose wheel. The airplane then dropped suddenly which, from an airplane braking standpoint, was fortunate because otherwise, the airplane would very likely have gone off the end of the runway.

The abrupt fall may have resulted in significant vertical acceleration values, which led to the errors in the reading and/or recording of some of the parameters recorded by the DFDR. As Table 1.8.1 shows, the parameters that exhibited anomalous values at that instant were those that were recorded around the time of the high acceleration. The spoiler signal itself at t = 0, in which these surfaces are recorded as momentarily deployed, might be spurious. (SPL-RH is word 25 and the first high recording, VERT-D, is the next word, 26.)

2.3. Short final approach

This section provides an analysis of how the airplane was flying in the critical last 500 ft of the descent.

As shown in Figures 3, 4 and 5, on passing through a radio altitude of 500 ft, at t = –45 s before touchdown, its speed was 229 kt, the flaps were at 15°, the engines were at idle and the gear was transiting down. The pilots waited for speed to drop below 205 kt before commanding more flaps. High flap values, of 38.7°, were not reached until t = –15 s, by which time the airplane was flying over the runway. The DFDR shows that the flaps continued extending to 39.1°, a position they reached shortly before the wheels first contacted the ground.

From 100 ft above the decision altitude, the PNF should have focused on monitoring for and detecting any significant deviation in the flight path and/or instruments, and warning the PF of said deviations using the required callouts.

In this case, despite the presence of the requisite conditions, the PNF was not heard making any callouts on the CVR.

Likewise, during this approach phase the GPWS issued several “sink rate”, “pull up” and “too low – terrain” warnings to which the crew should have reacted by taking the appropriate corrective measures.

When passing through a radio altitude of 500 ft, the aircraft did not meet the requirements for a stabilized approach, since even though it was flying on the correct glide slope, its speed was too high and the airplane’s gear and flap configuration was still changing. As a result, the crew should have aborted the maneuver and executed a go-around.

Since the “before landing” checklist was not performed, the pilot could have forgotten to arm the ground spoilers.

2.4. Final approach

When the aircraft intercepted the FAF 8.9 NM (16.5 km) away from the runway, it was at an altitude of 3,700 ft, 800 ft above the approach path at that point, and going at 250 kt, which was 121 kt above the reference landing speed, and which was also in excess of the maximum flap extend speed. Under these conditions, the aircraft had excessive potential and kinetic energy. The crew needed to reduce that excess in order to have the speed at the decision point be within 10 kt of the reference speed, and to be at a proper altitude.

The only way to dissipate that energy was to increase the aircraft's drag, that is, to use "dirty" configurations. Given the aircraft's excess speed and altitude, these actions had to be taken as quickly as possible.

The aircraft's speed when it intercepted the FAF permitted the extension of the landing gear. The crew, however, did not perform this action until 91 s later. They also did not make use of the air brakes.

As a result, the aircraft was slow to decelerate. The slats started to be lowered 111 s before touchdown, that is, 29 s after the FAF was reached. The flaps started to extend 36 s after the slats, reaching a 15° deflection 30 s later. In brief, in the 95 s after passing through the FAF, the crew only commanded the flaps and slats to deflect to their 15° and MID positions, respectively. During this time the speed was only reduced by 25 kt, to 229 kt, which was still far above Vref, though the 503-ft radio altitude was correct. According to the company's procedures, a stabilized approach should not have a descent rate in excess of 1,500 ft/min. During this phase of the approach, the average descent rate was 1,648 ft/min, and the maximum was 2,900 ft/min.

The procedures also state that at a radio altitude of 1,000 ft, the PNF must check the aircraft's conditions and give the appropriate callout: "1,000 ft stabilized" or "1,000 ft not stabilized".

The corresponding callout is not heard on the CVR.

In the interview, the PF said that his intention was to make a CDA (Continuous Descent Approach). This procedure, as described in the company's Operations Manual, is not a procedure for that final approach phase of the flight, but rather a standard procedure for linking the descent from the cruise phase to the initial approach such that normal landing procedures can be resumed when on final.

The CDA procedure specifies a gear down and 28° flap configuration when passing through 2000 ft at a point 6 NM away from the landing zone. The aircraft in this flight did not satisfy these criteria (see Figure 14).

2.5. Initial approach

The flight had proceeded normally prior to nearing Barcelona and starting the initial approach.

In one of the last communications with route control, the controller instructed them to fly directly to PERUK and cleared them to descend to 5,000 ft. The CVR reveals that the crew was aware of the limitation to remain above 5,000 ft until past the coastline, and that under those conditions they would be too high when they reached PERUK.

And yet, before they arrived at the initial approach fix, PERUK, which is 12 NM away from the runway and on its extended centerline, they told Control that their speed was high and requested to fly direct to the FAF, which is 9 NM away from the runway. This request in fact worsened their condition, since it decreased the room available to reduce their speed.

When they started their descent from 5,000 ft, their speed was 260 kt. They had the chance to descend at a vertical speed slightly above normal, or widen the turn so as to increase their gliding distance; they chose the former, but took no actions to lose the excess speed and altitude they were carrying, such as "dirtying" the airplane aerodynamically. The CVR reveals that the crew mentioned a desire to deploy the airbrakes, but did not do so early enough to ensure a more comfortable final approach.

2.6. Fire and evacuation

The crew did not notice the brake temperature, but it is not thought that they overheated because they were not used. The tires were shredded by the contact with the runway but their thermal links did not trip. This means that the heat generated was localized to those areas that were scraping the asphalt. After tires 1 and 2 blew out, the rims were in direct contact with the runway surface, which produced their abrasion and also placed the brake assemblies in direct contact with the runway, possibly rupturing the hydraulic lines.

The heat from the friction, the melted rubber, the hydraulic fluid leaks and the sparks resulting from the friction are believed to have started the fire that broke out when the aircraft stopped at the end of the runway. The evacuation proceeded fairly normally and the fire was quickly extinguished by the firefighting services.

2.7. Operator's flight procedures

In the flight in question, there were significant deviations from established procedures. The improvisation forced on the crew by their excess altitude resulted in the most basic points being overlooked:

- Although the GPWS issued repeated warnings, there is no mention on the CVR of excessive speeds, of deviations from the ILS path, of the high descent rate, of the airplane's configuration, etc.

- There was no "Landing" checklist.
- The non stabilized approach went undetected.

The MD-80 is certified to be piloted by two crewmembers, who must work as a team. Each crewmember has certain tasks assigned intended to support or complement those of the other. In this sense, the callouts are essential, since they represent either the confirmation of a proper maneuver or, on the contrary, warn of its inadequacy so that corrective steps can be taken.

In the case at hand, there was little coordination on the flight deck and an unjustified acquiescence by the first officer to the Captain's decisions, as well as lax adherence to operating procedures, in particular as regards the callouts.

This incident, as well as previous occurrences at this same operator (see 1.15), suggest that the operator should review its procedures for assigning crewmember tasks and that it require strict adherence by its crews to said procedures.

3. CONCLUSION

3.1. Findings

- The crew of the aircraft was properly qualified and their licenses were valid and in force.
- The aircraft had been maintained in accordance with the specified Maintenance Program and had valid airworthiness and registration certificates.
- The aircraft's altitude at the start of the approach was higher than normal.
- On the final approach, the aircraft was going too fast and was too far above the runway in relation to the distance to the runway threshold.
- The "1,000 ft stabilized" or "1,000 ft not stabilized" callout, which should have been made by the PNF in accordance with procedures, was not heard on the CVR.
- When passing through a RA of 500 ft, the aircraft did not meet the requirements for a stabilized approach, since, even though it was flying the correct glide slope, its speed was too high and the airplane, gear and flap configurations were still changing. As a result, the crew should have aborted the landing and gone around. No callouts in this regard were heard on the CVR.
- The initial contact with the ground took place 700 m beyond the TDZ (touchdown zone).
- The aircraft travelled over 60% of the runway's available length, which is 2,660 m, with the nose down before the main gear wheels touched the ground.
- The nose down attitude resulted in the nose gear touching down first, which inhibited the normal operation of the antiskid and ground spoiler systems.
- The normal deployment of the spoilers, with the nose gear wheels on the ground and the main wheels not contacting the ground, along with the inertia of the non-stabilized aircraft, caused the aircraft to drop sharply.

- The nullification of the protective locks of the antiskid system due to the ground signal from the nose gear allowed the four wheels to skid and blow out.
- The sparks, frictional heat, melted rubber and hydraulic fluid leaks started a fire in the left leg when the aircraft stopped at the end of the runway.
- The Captain ordered an evacuation, which proceeded relatively normally, without panic or injuries of any significance.

3.2. Causes

The incident is believed to have been caused by starting the approach at an excessive altitude and speed, and which the crew did not manage to correct using a "dirtier" airplane configuration or a longer final approach. It was also decided not to go around when the excess speed and altitude of the non-stabilized approach made it impossible to land normally.

The specific cause of the main tires blowing out and igniting on landing was the abnormal pitch of the airplane during the landing. The nose wheel contacted the ground several seconds before the main gear wheels did, which nullified the protective interlocks of the antiskid system.

4. SAFETY RECOMMENDATIONS

REC 10/11. It is recommended that Spanair establish a monitoring program specifically intended to check the real extent of compliance by its crews with the MD-80 operating procedures, with specific focus on evaluating the approach and landing phases.

REC 11/11. It is recommended that Spanair provide additional training to its crews to reinforce the concepts of:

- Stabilized approach.
- Standard operating procedures (SOPs).
- Crew resource management.

REC 12/11. It is recommended that Spain's Aviation Safety Agency (AESA) reinforce its supervision program for Spanair in the following:

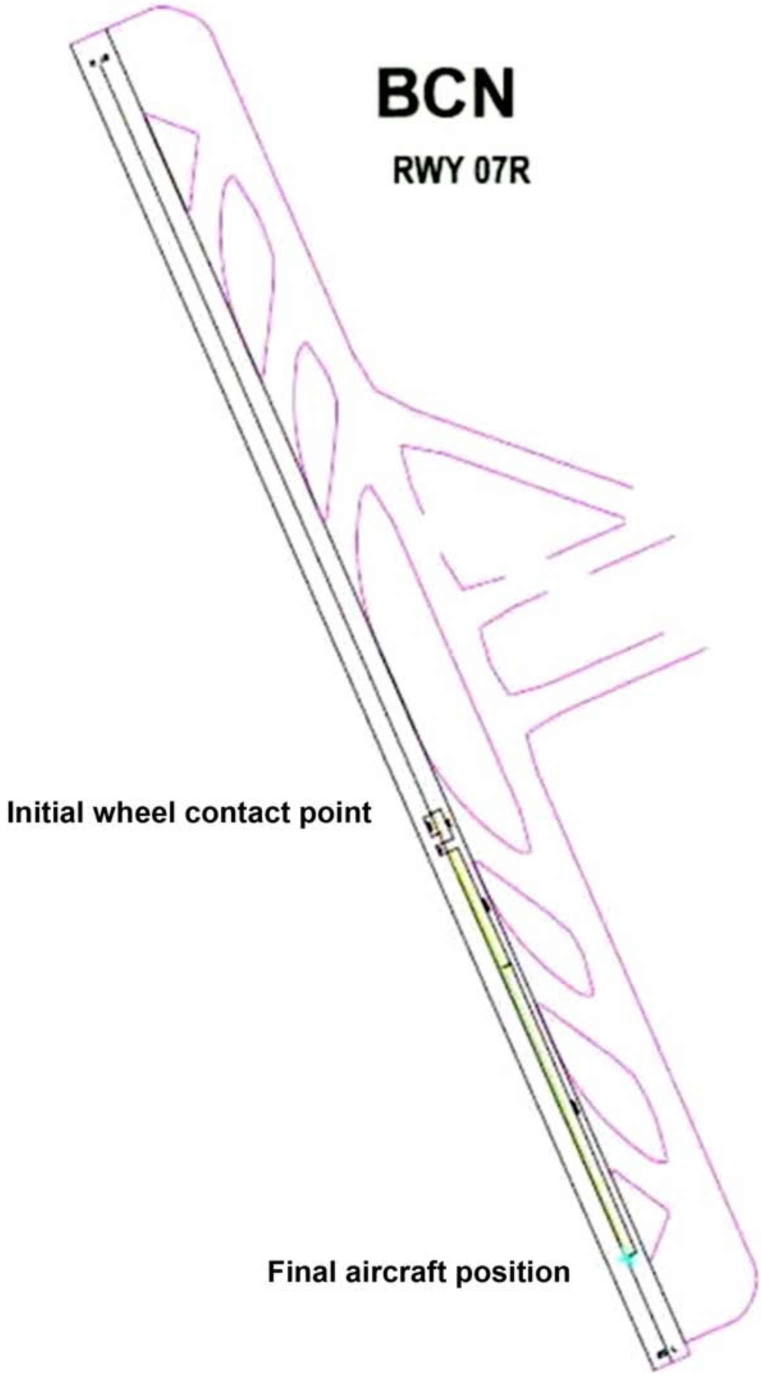
1. Aspects concerning the real extent of compliance by its crews with the MD-80 operating procedures, with specific focus on evaluating the approach and landing phases.
2. The training provided by the company in concepts such as stabilized approach, standard operating procedures (SOPs) and Crew Resource Management.

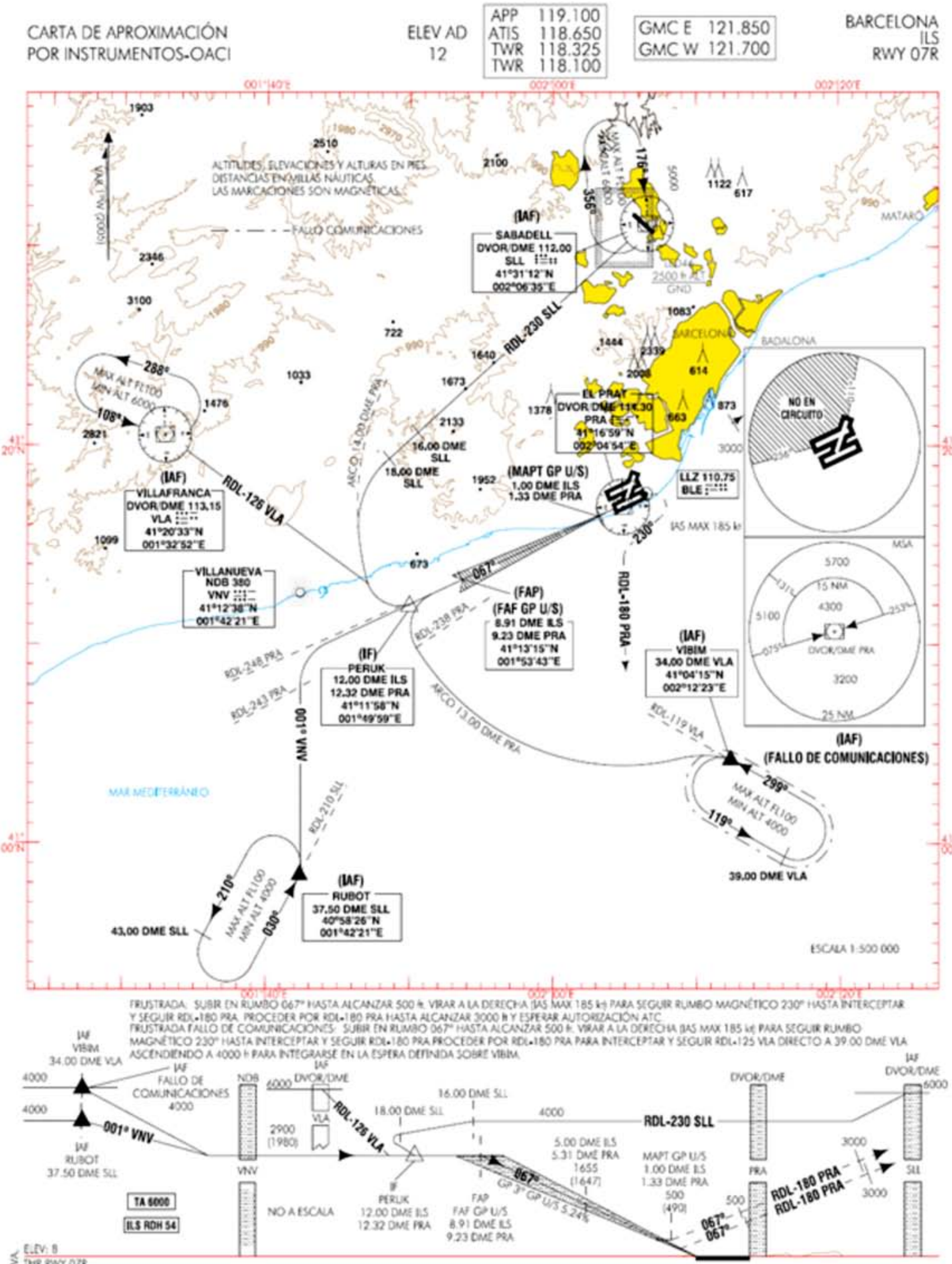
APPENDICES

APPENDIX A
DFDR parameters

TIEMPO SEC	ROLL_2 DEG	RALT_C FT	I/V FT/MIN	CAS_1C KTS	ELEV_L DEG	ELEV_R DEG	PITCH_1 DEG	BRK_POS_1 DEG	BRK_POS_2 DEG	BRK_PRES_ PSI	BRK_PRES_ PSI	FLAP_POS_ DEG	EPR_1 R	EPR_2 R	HEADING DEG	EGT_2C DEG C	N1_1C %RPM	N1_2C %RPM	N2_1 %RPM	N2_1C %RPM	N2_2 %RPM	N2_2C %RPM	NG-ALT ft	RUD DEG	SPL_RI DEG
-22	0,9	56	-1144	196,00	0,1	-3,2	-6,1		29,6	48,9	0		1,044	1,022	61,9	373	39,2	36,5		54	1098	98	50,74	-1,5	0
-21	-1,1	41	-1202	193,25	-4,9	-1,1	-5,2	30,3		48,9	0	31,3	1,044	1,024	62,6	374	39	36,5	1060	60		98	36,89	-2,8	0
-20	-1,6	30	-1256	192,00	-3,6	-4,4	-5		29,5	48,9	0		1,044	1,024	62,6	373	39	36,4		60	1098	98	26,15	-3,3	0
-19	-0,5	21	-1277	188,50	2	-3,3	-5,3	30,1		44	0	34,8	1,046	1,024	63,3	375	38,9	36,4	1058	58		98	16,77	-1,8	4,1
-18	-0,2	17	-1276	186,25	-4,9	1,2	-4,4		29,4	48,9	0		1,046	1,024	63,3	375	38,9	36,2		58	1101	101	13,92	-1	0
-17	0,6	15	-1251	183,00	-11	-3,3	-4,1	30,1		48,9	0	37,3	1,048	1,026	63,6	374	38,8	36,2	1057	57		101	12,31	-1,3	0,4
-16	0,4	14	-1140	180,00	4,9	1	-5,8		29,4	48,9	0		1,05	1,026	63,6	375	38,8	36		57	1104	104	9,13	-2	0
-15	-0,5	12	-912	176,75	-8,3	-1,2	-4,4	30,3		48,9	0	38,7	1,05	1,026	63,6	374	38,6	36	1054	54		104	8,92	-1,2	0
-14	-1,7	10	-765	173,75	-1,2	2,3	-4,7		29,6	48,9	0		1,05	1,028	63,6	376	38,6	35,8		54	1106	106	6,54	-2,1	1,1
-13	-0,3	8	-547	171,75	-5,4	-3,9	-4,7	30,2		48,9	0	38,7	1,05	1,028	63,6	376	38,5	35,8	1057	57		106	4,54	-1,7	0
-12	-0,4	5	-396	168,50	4,9	-7	-5		29,5	53,8	0		1,052	1,03	62,9	376	38,5	35,7		57	1108	108	1,15	-1,5	0
-11	0	3	-394	166,50	3,9	0,5	-4,2	30,2		48,9	0	38,7	1,052	1,031	62,9	377	38,4	35,7	1066	66		108	0,18	0	0
-10	-1,3	1	-408	163,00	-0,5	-4,6	-4		29,6	53,8	0		1,054	1,033	63,3	377	38,4	35,6		66	1109	109	-1,57	1	0
-9	-0,8	1	-436	161,00	-7,1	-0,1	-3,5	30,2		53,8	0	38,7	1,054	1,033	62,9	379	38,3	35,6	1063	63		109	-0,92	4	4,8
-8	4	2	-466	159,50	-1,5	-3,3	-4		29,3	53,8	0		1,054	1,033	62,9	379	38,3	35,4		63	1115	115	-0,57	-1,5	0
-7	-0,5	1	-381	157,50	-3,9	-3,3	-3,5	30		48,9	0	39,1	1,055	1,033	64,3	381	38,2	35,4	1061	61		115	-0,92	2	0
-6	-0,5	1	-290	156,75	-3,2	-3,1	-3,4		21,3	185,8	181,9		1,055	1,033	64	381	38,2	35,3		61	1114	114	-0,80	3,6	0
-5	1,5	1	-214	153,00	-3,8	-3,3	-3,3	9,8		1912	1844,5	39,1	1,054	1,033	64,3	381	38,2	35,3	1064	64		114	-0,67	1,7	0
-4	2,3	1	-129	151,25	-2,7	-2,7	-3,4		10,4	3066	3027,3		1,05	1,031	64,3	376	38,2	34,7		64	1136	136	-0,80	-8,4	0
-3	-2,4	1	-136	149,25	-4,2	-4,1	-3,1	9,7		3051,4	3033,4	39,1	1,046	1,028	62,9	368	36,3	34,7	1101	101		136	-0,41	6,8	0
-2	-3,9	1	-61	148,00	-5,5	-3,7	-3,2		10,4	3036,7	2970		1,072	1,022	61,2	367	36,3	32,5		101	1167	167	-0,54	11,6	0
-1	-1,3	0	-11	146,25	-5,5	-1,8	-2,8	9,3		3022	2948	39,1	1,109	1,052	61,9	386	39,4	32,5	1006	6		167	-1,03	12,9	46,1
0	-5,4	63	-22	284,00	-9,1	-2,6	-6,3		-27,7	2039,1	1583,2		1,506	1,068	63,6	414	39,4	9,5		6	1070	70	57,48	19,2	0
1	-1,9	0	-69	135,25	-3,2	-3,7	-1,3	9,5		3002,5	3039,5	39,1	1,205	1,093	68,6	427	49	9,5	914	914		70	0,90	-23	57,4
2	-2,7	0	13	129,00	-5	-4,7	-1,5		10,3	3007,3	3010,2		1,446	1,117	68,2	433	49	43,1		914	973	973	0,64	22,5	57,5
3	-2,8	0	73	118,75	-3,4	-0,4	-1,6	9,5		3026,9	3044,4	39,4	1,848	1,159	64,3	441	76,4	43,1	775	775		973	0,51	23,5	57,5
4	-2,7	-1	123	110,00	0,6	-0,6	-1,6		10,3	3046,5	3026,1		1,67	1,3	62,6	466	76,4	59,6		775	844	844	-0,49	25,3	57,6
5	-2,9	0	206	102,00	-1,3	-0,1	-1,5	9,5		3031,8	3039,5	39,4	1,635	1,441	61,9	435	77,9	59,6	806	806		844	0,64	25,9	57,7
6	-3	0	168	95,50	-1,3	0,8	-1,3		10,4	3046,5	3028,6		1,615	1,47	61,9	418	77,9	72,2		806	831	831	0,90	26,4	57,7
7	-3,3	0	172	89,00	-0,8	4,8	-1,3	9,4		2982,9	2983,4	39,8	1,613	1,493	62,2	418	77,2	72,2	801	801		831	0,90	24,8	8,7
8	-3,3	1	234	82,50	0,1	3,1	-1,3		10,1	3061,1	3038,3		1,613	1,489	63,3	415	77,2	73,3		801	828	828	1,90	25,1	1,2
9	-2,7	0	256	77,00	4	15,3	-1,4	9,2		2987,8	2998	39,8	1,885	1,537	65	427	77,5	73,3	773	773		828	0,77	11,6	41,4
10	-2,6	0	246	71,75	3,8	10,1	-1,2		9,8	3007,3	3089,6		1,809	1,985	66,8	491	77,5	89,3		773	776	776	1,03	-3,6	0
11	-2,7	0	224	66,75	-0,5	2,2	-1,2	9,2		3051,4	3061,5	39,8	1,217	1,596	67,9	410	69,2	89,3	901	901		776	1,03	3,1	0
12	-2,5	0	224	62,25	-0,2	1,7	-1,3		9,7	3051,4	3031		1,148	1,155	67,9	377	69,2	50,4		901	980	980	0,90	-0,3	0
13	-2,5	0	269	59,75	0,3	0,8	-1,2	9,3		3046,5	3049,3	39,8	1,122	1,117	68,2	372	46,4	50,4	997	997		980	1,03	-2,6	0
14	-2,5	0	284	54,25	-0,5	0,8	-1,2		9,7	3051,4	3021,2		1,105	1,093	68,6	372	46,4	39,3		997	1066	66	1,03	-1,3	0
15	-2,4	0	284	50,50	-0,2	1,8	-1,3	9,4		3046,5	2889,4	39,8	1,08	1,078	68,9	376	39,4	39,3	1052	52		66	0,90	-0,3	0
16	-2,5	0	246	44,25	0,8	0,7	-1,1		10,1	2992,7	2650,1		1,068	1,052	68,9	370	39,4	34		52	1154	154	1,15	-0,7	0
17	-2,5	0	204	41,75	1	0,3	-1,2	9,8		2694,4	2451,2	39,8	1,063	1,046	68,9	370	34,4	34	1132	132		154	1,03	1,2	0
18	-2,3	0	166	37,00	1,5	0,7	-1,2		15,1	2890	2847,9		1,057	1,042	68,9	375	34,4	30,3		132	1219	219	1,03	-1,5	0
19	-2,3	0	131	30,75	2,2	1,1	-1,2	15,4		2586,8	719	39,8	1,056	1,039	68,9	381	31,5	30,3	1189	189		219	1,03	0,8	0
20	-2,3	0	103	0,00	2,8	-1,7	-1,2		24,1	1432,8	156,2		1,052	1,039	68,6	386	31,5	28,6		189	1257	257	1,03	-0,2	0
21	-2,2	0	59	0,00	4,3	-0,8	-1,2	18,3		1183,4	3,7	39,8	1,052	1,035	68,2	390	30	28,6	1214	214		257	1,03	-0,2	0
22	-2,3	0	39	0,00	5,8	1	-1,2		26,8	1051,3	0		1,05	1,035	67,9	396	30	27,6		214	1275	275	1,03	-0,2	0
23	-2,3	0	26	0,00	9,2	-0,3	-1,2	19,5		757,9	0	39,8	1,05	1,037	67,5	401	29,3	27,6	1228	228		275	1,03	-1,5	0
24	-2,3	0	23	0,00	14,5	-0,1	-1,2		29,3	88	0		1,05	1,039	67,5	405	29,3	27,3		228	1280	280	1,03	-1,7	0
25	-2,2	0	89	0,00	20,9	8,7	-1,2	20,7		48,9	0	39,8	1,117	1,068	67,5	461	40,2	27,3	996	996		280	1,03	-0,3	0
26	-2,1	0	124	0,00	21,1	8,4	-1,1		29,3	48,9	0		1,152	1,094	67,5	465	40,2	39,3		996	1012	12	1,15	-0,3	0
27	-2,3	0	148	0,00	21,5	8,5	-1,1	30,3		53,8	0	39,8	1,296	1,124	67,5	463	51,9	39,3	878	878		12	1,15	-0,3	0
28	-2,2	0	168	0,00	21,1	5,9	-1,2		29,3	53,8	0		1,565	1,172	67,1	470	51,9	50,2		878	900	900	1,03	-0,3	0

APPENDIX B
Aerodrome map with tracks, and approach plate for Barcelona ILS RWY 07R


BCN
RWY 07R
Initial wheel contact point
Final aircraft position



HGT REF ELEV THR RWY 07R

OCA/H		A	B	C	D
STA	CAT I	252 (244)	264 (256)	272 (264)	282 (274)
	CAT II	(93)	(110)	(121)	(136)
	CAT III	APPROVED			
	GP U/S	500 (490)			
En circuito (H) sobre 12		580 (570)	690 (680)	890 (880)	1300 (1290)

GS	kt	80	100	120	140	160	180
FAP-THR: 8.91 NM	min:s	6:41	5:21	4:27	3:49	3:20	2:58
FAF-MAPT: 7.91 NM	min:s	5:56	4:45	3:57	3:23	2:58	2:38
ROD: 5.24 %	ft/min	425	531	637	743	849	955

ALT/HGT DME (ILS) FNA GP U/S

13 DME	12 DME	11 DME	10 DME	9 DME	8 DME	7 DME	6 DME	5 DME	4 DME	3 DME	2 DME	1 DME
					2610 (2600)	2300 (2290)	1980 (1970)	1660 (1650)	1340 (1330)	1020 (1010)	700 (690)	

WEF 27-OCT-05 (AIRAC AMDT 13/05) AIP-ESPAÑA AD 2-LEBL IAC/7