DATA SUMMARY

LOCATION

Date and time	**Tuesday, 31 May 2005; 10:09 h UTC**
Site	**Tenerife Norte Airport (Santa Cruz de Tenerife)**

AIRCRAFT

Registration	**TF-ATJ**
Type and model	**BOEING B747-400; S/N 24108**
Operator	**Air Atlanta Icelandic**

Engines

Type and model	**CFM CF6-80C2B1**
Number	**4**

Crew

Pilot in command

Age	**44 years**
Licence	**ATPL**
Total flight hours	**9,515 h**
Flight hours on the type	**529 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**12**
Passengers			**403**
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**Several runway lights broken and scratches to the runway surface**

FLIGHT DATA

Operation	**Comm. Air Transport – Scheduled – Domestic-Passenger**
Phase of flight	**Landing – Flare**

REPORT

Date of approval	**27 February 2007**

1. FACTUAL INFORMATION

1.1. History of the flight

The flight departed without incident from Madrid and approached Tenerife Norte Airport (TFN) after an uneventful cruise. It was a flight operated by Air Atlanta for Iberia under a wet leasing agreement. Prior to descent, the crew completed the approach briefing, with particular mention of the minimum sector altitudes and the Vref speed to which they decided to add a wind correction of 10 kt. On the «landing bug card» they had on board, they wrote down «Vref. 142» with flaps 30.

At FL 330 they started their descent to RWY 30 as per ATC instructions. The descent began at 100 NM from the TFN VOR, with ATIS «Y» reported. The crew recorded that information as Y 0940Z, wind 330/22G28 and QNH 1021.

At 9:49 h, they were descending through FL80 on course to Tenerife and the crew informed the ATCO they were travelling at «high speed». At 9:53 h the crew asked whether it was possible to turn left «to a probable heading... to loose a little bit the high». They were cleared to descend at their own discretion «with your own turn» for a straight-in approach because they were number one and they were under no restrictions. The crew answered they were going to a heading of 180 «so we can loose the higher speed» and asked for radar vectors from the ILS. At 9:55 h they asked again for radar vectors. When the ATCO reminded them that they were cleared for a straight-in approach, they answered «we are IMC and this time we would like to take radar heading if you have the radar on». At 9:57 the ATCO asked them to take a «right heading 270 final vector» to the ILS. At 9:59 the crew reported «established on the localizer, we'll descend with the glide». They were at 13 NM from touchdown and were instructed to contact the tower. The crew recalled that the approach checklist was completed and the aircraft remained established at the localizer at an altitude of 4,400 ft as per ATC instructions under radar vectors.

According to the statement of the crew, once established on the glide slope, descent started with autopilot «B» engaged and flaps 20°, a speed equal to Vref plus 20 kt. During the initial approach no significant turbulence or speed or attitude changes were noted. Landing gear was extended at approximately 6 NM inbound and flaps 25° and then 30° were selected. Final Landing Checklist was called for and completed. At approximately 1500 ft AGL visual contact with TFN was established and communications changed to tower frequency.

The approach continued normally but turbulence was noted at this point, and it was decided to disconnect autopilot «B» and to continue manually. The tower cleared the aircraft for landing on runway 30, with reported wind of 320/24. The aircraft

was on the localizer and glide slope with Vref plus 10 kt. When descending through 1,000 ft AGL, a shift in the wind direction was noted producing an estimated increase of 15 kt in indicated airspeed. Immediate action was then taken to rectify conditions and speed was adjusted again to Vref plus 10 kt. No further speed changes were noted. At approximately 10 ft above the runway during the final flare a sudden wind shift occurred that in the opinion of the crew produced more lift on the left wing. The pilot flying (PF), who was the first officer, reacted to correct this condition and the aircraft carried out a «firm landing» in the opinion of the crew. They did not feel that overcontrolling manoeuvres were executed in the pitch or roll axes. They remembered the aircraft touching down on the centre line of the runway.

According to the load sheet, the landing weight was around 261,166 kg (the maximum being 285,752 kg). The centre of gravity (cg) at takeoff had been 23.80% MAC (with a take off weight of 285,717 kg).

A passenger on the flight, who was an employee of the airport, stated that the approach was somewhat turbulent and the aircraft was moving all the time, although nobody noticed anything strange or any impact at touchdown, except that it was a moderately hard landing.

The last wind check provided to the crew when cleared to land was 330/24. At 10:04:47 h the ATCO said: «At your discretion with the marker, adios» and the crew answered «Thank you».

There was no other communication with the ATC during the landing roll and taxi. The aircraft vacated runway 30 normally and proceeded to the assigned gate, where the crew shut down the engines and completed the after landing checks. The passengers disembarked normally.

After a while, the ground personnel came on board and advised the crew that damage to the engine 4 cowling had been observed. The damage consisted of a couple of holes at the bottom of the cowling and several other scratch marks. There also were glass slivers stuck around the scratch area.

The flight crew advised the ATC at 10:27 h and a runway inspection was ordered. Two runway edge lights on the right side of the runway were observed to be completely broken. Two other lights showed broken glass. Between the two broken lights, there was an area of deep grooves and scratches some 2 to 4 cm in width (see Figure 2).

The aircraft was subject to several inspections, including a hard landing inspection, and was ferried back to base several days afterwards.

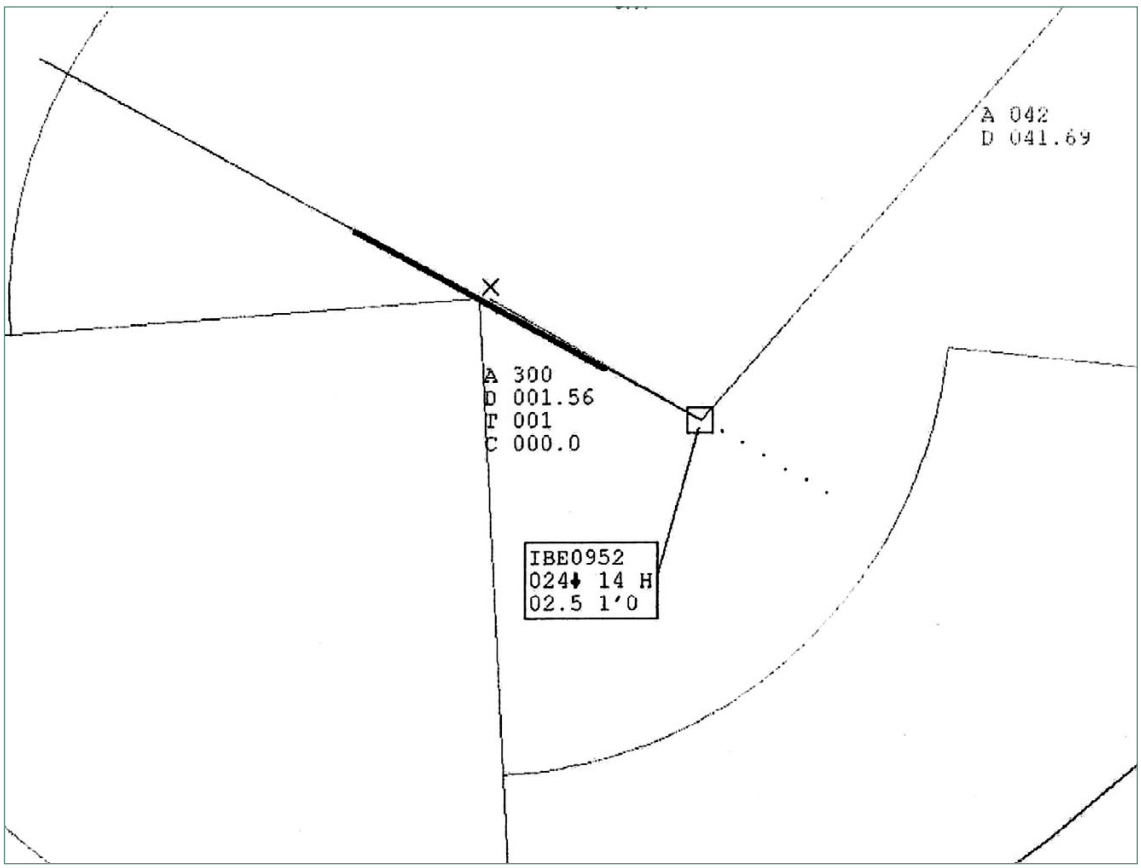
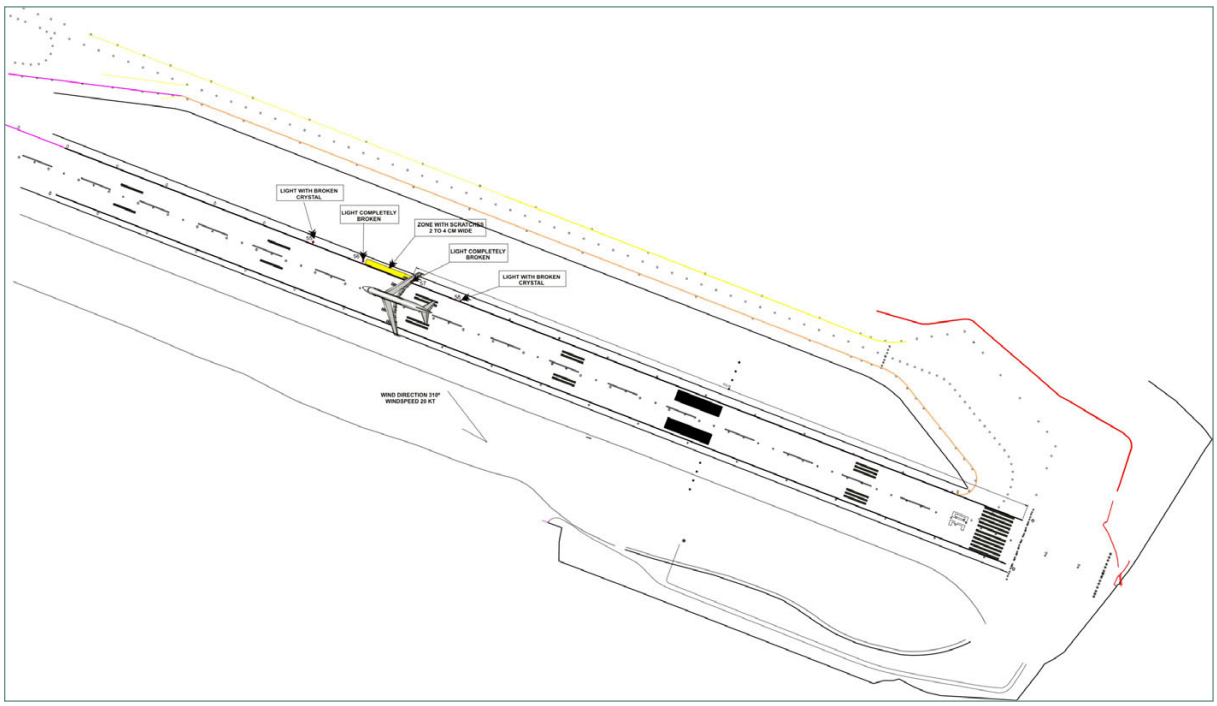


Figure 1. Radar Track image showing the aircraft aligned with the runway extended centreline on short final, descending through 2,400 ft and around 140 kt of groundspeed, at 10:04 h radar time



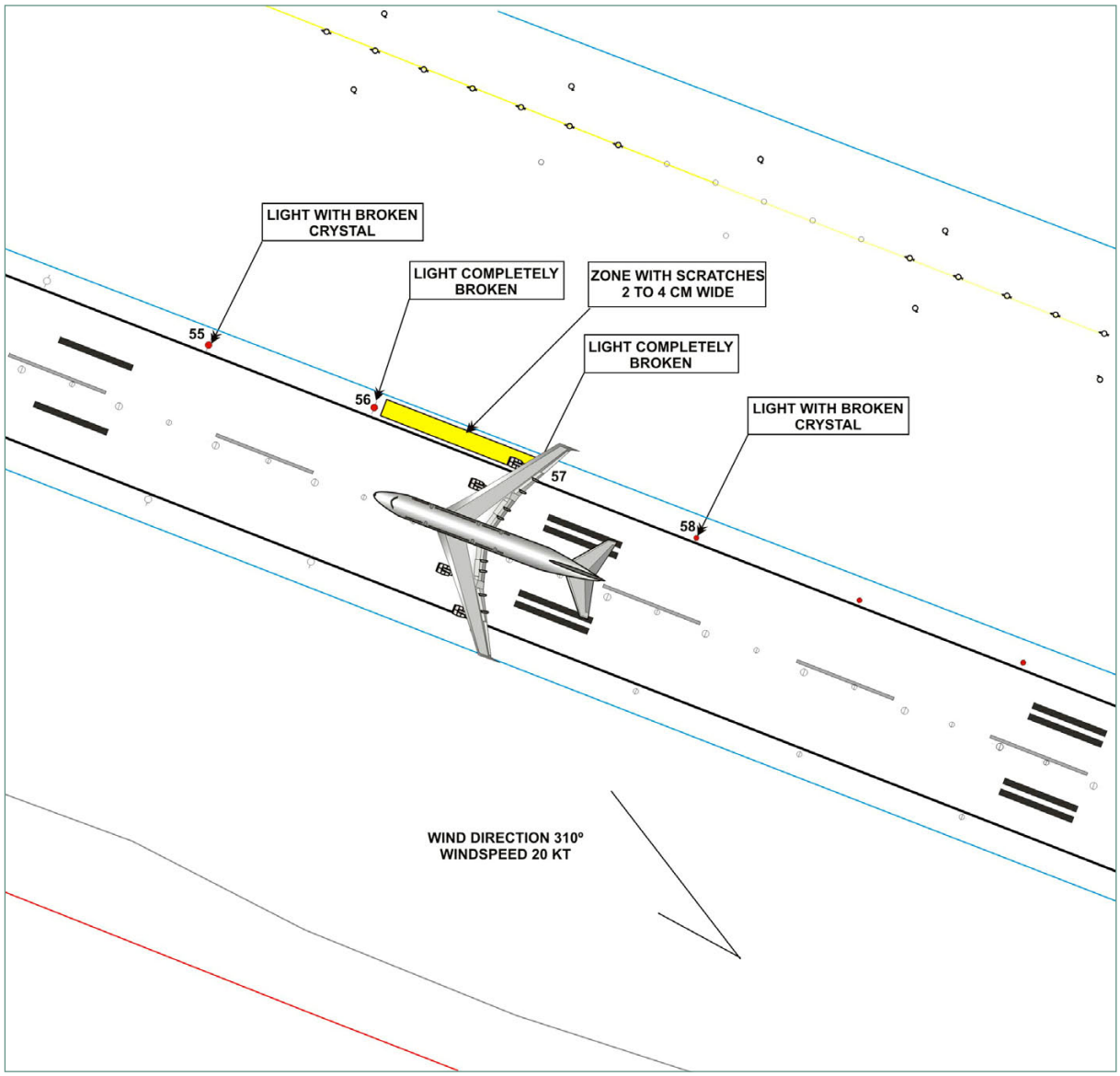


Figure 2. Drawing prepared by airport personnel after the runway inspection. Runway width is 45 m. Distance between lines of runway edge lights is 48 m. Distance from the longitudinal axis of the B747 to the outboard part of nacelle 4 is around 23 m

1.2. Personnel information

1.2.1. *Pilot in command (CM-1)*

Nationality: Spanish. ATPL issued by the CAA of United Kingdom, 44 years old, with type ratings B747 100-300, B737 300-900, F27, BAe 146, B757/767, A318/319/329/321 and D228. Last type rating, skill test: 12-2-2005. Last line check: 27-5-2005. Last medical check: 6-4-2005. Total flight time: 9,515 h. Flight hours on the type: 529. His cur-

rent duty period had started at 5:40 h that day, with more than 24 h of rest the previous day.

The CM-1 had flown 229 h during the last 12 months, and 64 h during May 2005.

The CM-1 had been in line training since 21-4-2005 to 22-5-2005. The records of this training showed that he was considered to have demonstrated good performance, with nice control even in a flight to JFK in gusty conditions. It was stated that his extensive experience was evident. On 27 May he passed the final line check with satisfactory results.

1.2.2. *First officer (CM-2)*

Nationality: U.S.A. ATPL issued by the FAA and validated by the CAA of Iceland, 49 years old with type ratings of B747, B737 and DHC-7. Last type proficiency test: 18-3-2005. Last line check: 17-2-2005. Last medical check: 4-11-2004. According to the information provided, the expiry date of his medical certificate was 12-5-2005 (19 days before the date of the incident). Total flight time: 9258 h. Flight hours on the type: 1321. His current duty period had started at 5:40 h that day, with more than 24 h of rest the previous day.

The co-pilot had flown 719 h during the last 12 months, and 39 h during May 2005.

The CM-2 passed his line check on 17 February 2005 with satisfactory results. On 18 and 19 March 2005 he had passed a flight simulator proficiency test also with satisfactory results and no remarks were noted in the training form.

1.2.3. *Flight engineer (CM-3)*

Nationality: U.S.A. Flight engineer licence issued by the FAA and validated by the CAA of Iceland. 56 years old. Last proficiency check: 6-12-2004. Last medical check: 7-8-2004.

1.3. Aircraft information

The Boeing 747-300 has a length of 70.4 m and a width of 59.6 m. The approximate ground clearance angles are as follows:

— Tail cone and body gear pitch angle clearance: 10° (shock-absorbers compressed)
12.5° (shock-absorbers extended)

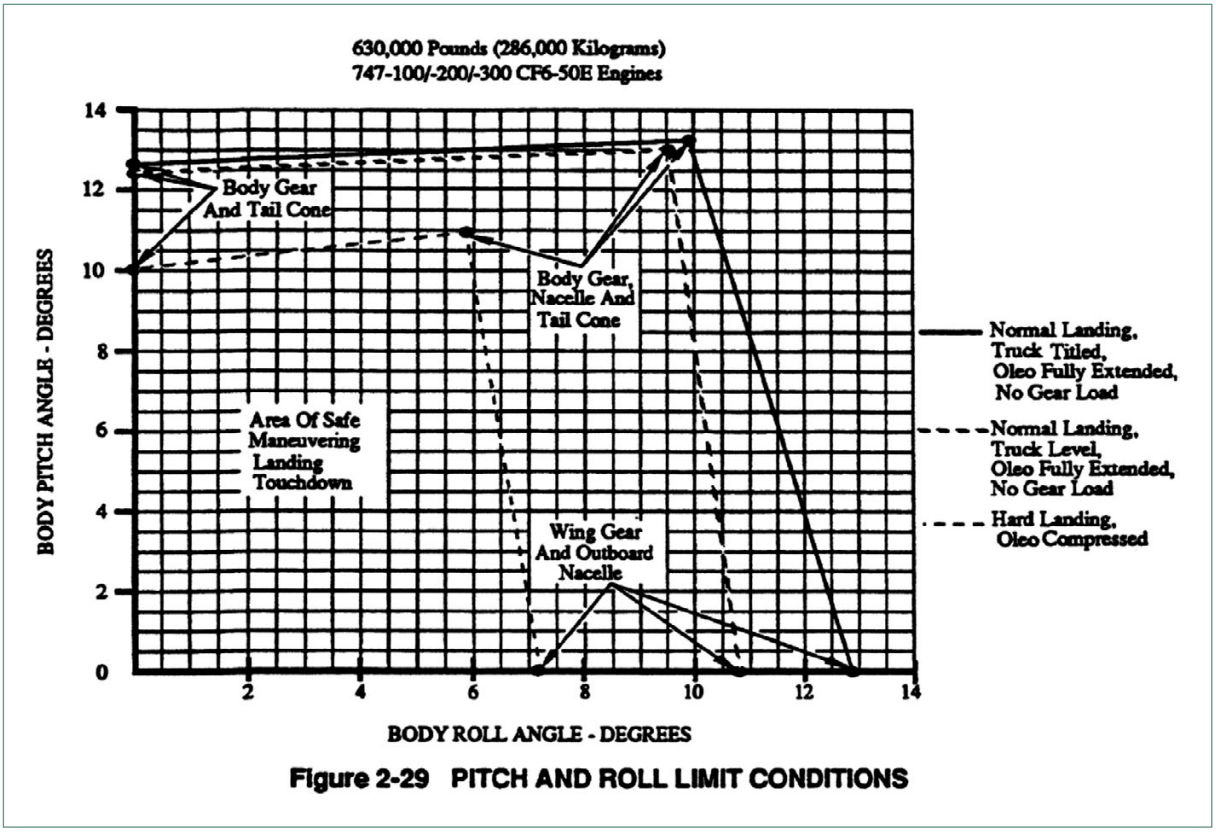


Figure 3. Pitch and roll limits conditions from the Boeing B747 Flight Crew Training Manual, page 2-52, 16 August 1993

— Outboard nacelle and wing gear roll angle clearance: 7.2° (shock-absorbers compressed)
10.8° (shock-absorbers extended)

1.4. Flight recorders

1.4.1. *Cockpit voice recorder (CVR)*

The aircraft had a CVR L-3 Communications, P/N 93A100-30, s/n 6381. This CVR records the sounds in the cockpit during the last 30 minutes. It had last been overhauled by a maintenance center in USA and a FAA Form 8130-3 to release it back to service had been issued on 1-2-2000.

The CVR was installed on the aircraft by Iberia, which carried out the maintenance of the aircraft under a contract with Air Atlanta, on 16 October 2002 (it had been in storage until that moment). The scheduled maintenance check of the CVR was required to

be carried out in every A4 check. The last A4 check was carried out on 1 December 2004, when the aircraft had 67,310 flight hours.

On 31 May 2005 the aircraft had logged more that 69,000 flight hours and 11,966 flight cycles.

The recorder was downloaded by the Air Accidents Investigation Branch (AAIB) of the United Kingdom.

The tape mechanism was inspected and about two inches of tape was found in a damaged condition in the tape drive capstan area. Upon disassembly the tape was found to have been worn through by the drive capstan as the tape had stopped moving due to a concertina effect. The tape join was adjacent to the damaged area and it was likely that the tape may have become momentarily bonded to the drive wheel which would have been sufficient to have caused this type of fault.

The replay of the tape showed that it appeared that the CVR stopped recording (when the tape jammed around the tape capstan area) while the aircraft was in a cruise phase, probably during a flight previous to the incident flight. It was not possible to determine the date of that recording. The Cockpit Area Microphone channel was badly distorted.

The CVR was then taken to an authorized maintenance centre to be inspected in detail. During this inspection, it was noted that the water jacket, which provides fire insulation, was dated 1989. This part of the unit has a ten year life and if the unit was repaired/overhauled in 2000 it should have been changed in accordance with the component maintenance manual.

The most likely cause of the tape fouling around the capstan area was due to ageing of the capstan drive wheel. Over time the rubber wheel degrades and the tape can momentarily adhere to the wheel, which results in the tape being damaged in the way found when the unit was inspected by the AAIB.

In summary, the condition of the unit was typical of one that had not been overhauled for some time and the lack of maintenance most likely resulted in the damage to the tape and loss of recording capability.

The manufacturer of the CVR device, L-3 Communications Aviation Recorders, was then consulted regarding the possibility of that kind of malfunction not being detected during the pre-flight inspection carried out by the flight crew (see paragraph 1.5 below). They answered that «if the tape motion had been arrested due to the tape winding on the capstan roller, then the unit would not pass the "push-to-test" operation. For the

push-to-test operation to complete successfully, the tape must be moving past the write head and the read head. The push to test is based on confirmation of a test tone that is first written and then read back from the tape».

They also provided the Component Maintenance Manual (CMM) pages in which it is stated that for this model of CVR, an overhaul period is defined as «not more than 4,000 operating hours (non-flight Hours)». According to the information gathered, this period had been exceeded in service since the CVR was installed on TF-ATJ on 16 October 2002 because the aircraft had flown 10,133 h since that moment until the day of the incident.

The CMM also mentions that «At the time of overhaul the thermal assemblies [...] must be brought up to proper weight, and any thermal assembly more than 10 years old must be replaced. The manufacturing date can be found on the thermal assembly».

Several other parts of the CVR must also be replaced during overhaul, including the reel and tape assembly, bearing-capstan, belt drive, roller-tape guide, etc.

1.4.2. *Flight data recorder (FDR)*

The aircraft had a FDR Sundstrand, P/N 980-4100DXUS. The data was downloaded and provided to the operator and to the manufacturer for analysis.

The following parameters were not recorded in this aircraft: ground speed, drift angle, air/ground tilt switch, control surface deflections, glideslope deviations, localizer deviations, and speed brake handle. The winds could not be calculated from the FDR data.

Additionally, the rudder pedal data appeared to have sensor errors, leading to dropouts near the zero position.

The available data showed that there had been an unstable approach. During the last 1,000 ft of altitude, the airspeed varied between 150 and 175 kt. Airspeed was higher than Vref (142 kt) plus 20 kt (i.e. a total of 162 kt) from 700 ft to about 350 ft AGL. Below 200 ft, airspeed was around Vref plus 12 kt. The recorded values of some parameters for the last seconds of the approach appear on Tables 1 and 2.

Figure 4 shows the variation of indicated airspeed with the altitude from 1,500 ft AGL.

UTC (hh:mm:ss)	Altitude above the ground (ft AGL)	Altitude of the aircraft (ft)	Indicated airspeed (kt)	Magnetic heading (deg)	Pitch angle (deg)	Control column deflexion (deg)	Roll angle (deg)	Control wheel position (deg)	Revolutions N2 of engine n.° 4 (%)
10:04:04	118	1,912	154.9	301	3.1	–3.71	–1.5	–18	91.1
10:04:05	108	1,902	149.9	300	2.7	–2.95	0.3	–3	91.8
10:04:06	91	1,885	147.2	299	2.7	–2.41	–1.2	–31	90.2
10:04:07	83	1,877	149.3	298	2.2	–1.81	–0.9	–43	89.6
10:04:08	70	1,864	148.5	298	3.1	2.44	–0.4	–40	90.7
10:04:09	49	1,843	148.3	297	5.8	4.41	1.1	–7	87.9
10:04:10	24	1,818	144.2	297	9.3	6.09	1.8	–5	85.0
10:04:11	10	1,804	142.5	298	8.9	–2.54	2.8	–28	83.0
10:04:12	8	1,802	150.2	299	4.9	2.41	7.2	1	81.3
10:04:13	18	1,812	146.6	299	3.6	4.00	5.7	3	79.5
10:04:14	20	1,814	144.8	299	4.9	3.46	1.8	–29	78.0
10:04:15	10	1,804	139.9	298	8.0	4.31	3.5	–55	76.5
10:04:16	0	1,794	135.4	297	6.7	1.33	7.6	–39	75.2
10:04:17	0	1,791	132.2	296	4.0	–1.94	9.0	–33	74.2
10:04:18	0	1,790	132.1	295	1.8	–1.52	5.7	–32	73.2
10:04:19	0	1,807	129.7	296	0.0	–4.19	1.5	–34	72.5
10:04:20	0	1,810	128.1	297	–0.4	–6.98	2.5	–17	73.6
10:04:21	0	1,808	124.9	297	–0.4	–10.91	1.3	–16	78.5
10:04:22	0	1,808	117.5	296	–0.4	–10.91	0.8	–15	84.8
10:04:23	0	1,803	120.5	296	–0.4	–10.72	1.9	–14	91.8
10:04:24	0	1,801	118.6	297	–0.9	–10.76	2.2	–13	97.2

TABLE 1. Values of some parameters. Touchdown happened at 10:04:16

At approximately 70 ft there was a flare and the pitch was quickly increased to 9.3°, then was reduced and again increased to 8° at touchdown, with noticeable movements of the control column. At around 50 ft above the runway the engines' thrust started to reduce. There were two important roll oscillations during the flare, as well as large control wheel inputs to the right. Touchdown happened at around 10:04:16

UTC (hh:mm:ss)	VERA (g)	VERC (g)	VERE (g)	VERG (g)	LATA (g)	LATC (g)	LATG (g)	LONA (g)	LONC (g)
10:04:04	1.09	1.01	0.93	0.98	0.037	–0.003	–0.013	0.055	0.037
10:04:05	0.98	0.95	0.96	0.99	0.004	–0.019	–0.030	0.061	0.055
10:04:06	0.98	0.99	0.97	0.94	0.018	0.013	–0.066	0.076	0.054
10:04:07	1.01	1.01	0.97	0.91	0.037	0.021	–0.044	0.047	0.039
10:04:08	0.92	0.99	0.96	0.91	0.004	–0.027	–0.027	0.039	0.053
10:04:09	0.97	1.09	1.12	1.09	–0.012	–0.015	–0.044	0.071	0.084
10:04:10	1.15	1.19	1.25	1.21	0.022	0.013	–0.058	0.107	0.119
10:04:11	1.24	1.20	1.17	1.15	0.014	–0.007	–0.025	0.096	0.061
10:04:12	1.09	0.98	0.99	0.90	0.016	0.007	–0.021	0.017	–0.014
10:04:13	0.83	0.82	0.86	0.88	0.008	0.003	–0.038	–0.016	–0.012
10:04:14	0.90	0.87	0.91	0.99	0.010	–0.027	–0.013	–0.006	0.001
10:04:15	0.99	1.01	1.01	1.02	–0.028	–0.076	–0.005	0.025	–0.019
10:04:16	1.40	1.35	1.06	1.05	–0.144	–0.166	–0.121	0.054	–0.009
10:04:17	0.88	0.79	0.90	1.01	–0.138	–0.156	–0.152	–0.026	–0.028
10:04:18	1.04	1.04	1.08	1.01	–0.124	–0.095	–0.154	–0.046	–0.090
10:04:19	0.99	1.02	1.07	1.08	–0.016	–0.007	–0.084	–0.103	–0.158
10:04:20	0.93	0.93	0.96	0.92	0.004	–0.058	–0.003	–0.171	–0.157
10:04:21	1.05	1.01	0.96	0.94	–0.024	–0.048	–0.027	–0.162	–0.153
10:04:22	1.01	0.98	1.03	0.93	–0.031	0.009	–0.040	–0.160	–0.152
10:04:23	0.94	1.09	1.02	1.04	0.035	–0.003	0.005	–0.150	–0.160
10:04:24	0.93	0.93	1.00	0.96	–0.004	0.001	–0.032	–0.192	–0.175

TABLE 2. Values of accelerations before and after the touchdown. Only 4 out of 8 vertical accelerations, 3 out 4 lateral accelerations, and 2 out of 4 longitudinal accelerations are shown

h, and maximum recorded vertical acceleration was 1.40 g with a roll of around 7.6° that exceeded the aircraft's ground contact envelope and caused the number 4 nacelle strike (see Figure 5). The lateral accelerations in the three seconds around touchdown were always negative (to the left) and were between –0.005 g and –0.176 g.

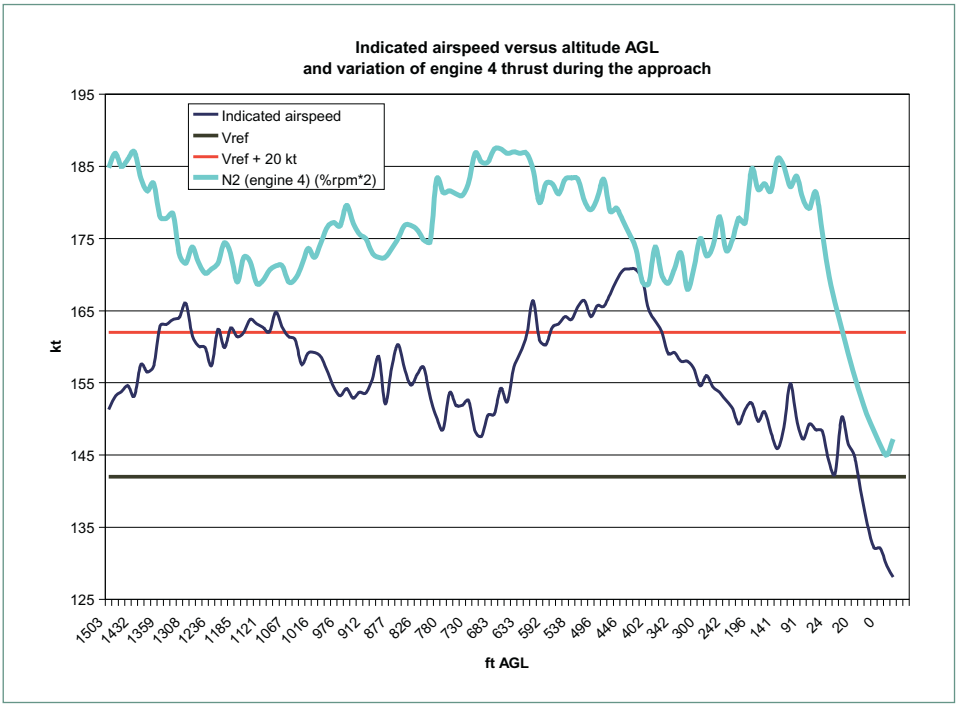


Figure 4. Vref was 142 kt. The rotational speed N2 is multiplied by two for better readibility (i.e. 95% RPM in reality is represented as 190 in the graph)

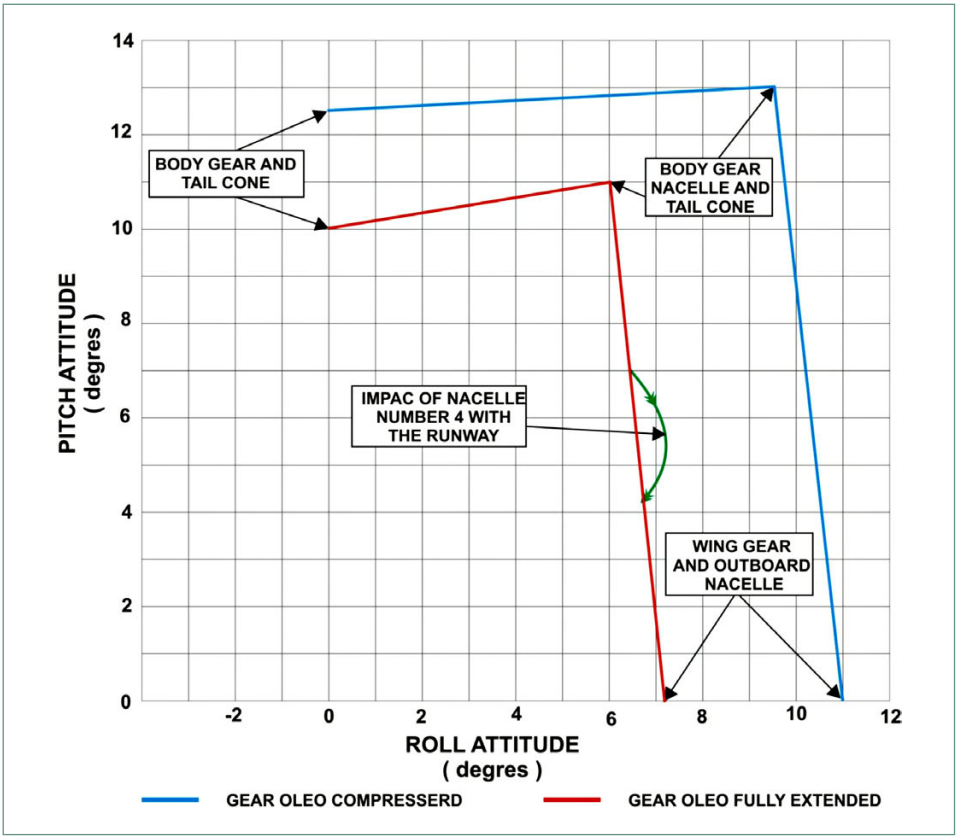


Figure 5. Exceedance of the geometric limits according to the FDR data

1.5. Meteorological information

The METAR current at the time of touchdown was GCXO 311000Z 32023KT 9999 SCT014 17/10 Q1021 NOSIG.

The record of the measured wind values at threshold 30° was obtained. Between 9:45 h and 10:15 h UTC wind direction was within 300° and 330° and speed was within 28 and 31 kt; no gust above 31 kt was observed within that period. The last wind check provided to the crew by the ATCO was 330/24.

The airport recorded 10:09 h as the landing time of TF-ATJ (IB0952). An ATR72 had landed on the same runway at 09:24 h and another landed at 10:20 h. Meanwhile there were two takeoffs at 09:57 h and 10:02 h.

1.6. Operational information

The operator provided the relevant parts of their operations manual. Tenerife Norte was classified as a «category B» aerodrome with the remarks «Circling. Terrain».

The Boeing OM, Normal Procedures, Pre-flight, Cockpit Preparation (Jun 01/97) included a test of the CVR to be made by the CM-3: «Press TEST switch; check that meter needle fluctuates in the white band».

The Boeing OM, 04.27.02 (Jun 21/93) stated that it is recommended to add an approach speed wind correction of 1/2 the steady headwind component plus all of the gust value, based on tower-reported winds. The maximum wind correction should not exceed 20 kt. In all cases the gust correction should be maintained to the touchdown while the steady wind correction should be bled off as the airplane approaches touchdown.

The maximum demonstrated crosswind speed is 30 kt.

The Standard Operating Procedures (SOP) dated Jul 10/2003 covered the duties and responsibilities of each B747 operating flight crew member along with work sharing details. The pilot not flying (PNF) must closely monitor the approach and make the standard callouts. During final approach, strict monitoring by the PNF is imperative. He is responsible for calling to the attention of the PF any significant deviation from normal conditions. In turbulence and/or strong crosswinds when the aircraft is being flown by visual reference the PNF should be alert to the fact that additional calls, particularly of airspeeds are required during alignment manoeuvres and flare.

The SOP contained several stabilized approach conditions, mostly in accordance with the recommendations of the Flight Safety Foundation ALAR (Document 8168 of ICAO «Air-

craft operations», Volume 1, III-4-3-1). Below 500 ft in VMC «all approaches SHOULD be stabilized», including speed being not greater than Vref plus 20 kt. There was no mandatory requirement that a go-around otherwise be initiated. There were no standard callouts to be made by the PNF in the event specific values of pitch and roll were exceeded during the landing.

2. ANALYSIS

The available information shows that the CM-2 was the pilot flying, while the CM-1, who had passed his final line check with the operator four days before, was the PNF or monitoring pilot. The total experience on the type was 529 h for the captain and 1321 h for the co-pilot.

The aircraft arrived to the terminal area of Tenerife Norte with a speed higher than that desired by the crew. They asked for assistance from the ATC to have more time to bleed off the excess speed as well as to have radar vectors to intercept the localizer.

The crew recalled that there was turbulence below 1,500 ft, which is relatively usual at TFN airport. This turbulence has an orographic origin and may be present even below 500 ft, which may make it difficult in practice to comply with the general recommendations of the operations manual regarding stabilized approach in VMC.

The METAR current at 10:00 h mentioned a wind of 320° 23 kt, with no gusty conditions reported. Wind conditions recorded in the minutes immediately previous and subsequent to the touchdown were between 300° and 330° and speed was between 28 and 31 kt. In an approach to runway 30, this means that the crosswind component would have always been below 15 kt, although with sudden simultaneous changes in speed and direction that would hinder controllability.

This factor probably caused an unstable initial approach regarding airspeed.

Later on, when descending through 1,000 ft, the flight crew remembered a shift in the wind direction that caused a sudden increase of indicated airspeed (IAS) and they took action to rectify conditions and adjust speed again. However, the FDR shows that airspeed was above 162 kt (Vref + 20 kt) from 700 ft to about 350 ft AGL, with a peak of 171 kt for three seconds at around 400 ft AGL.

Since the airspeed was above Vref + 20 when the aircraft was below 500 ft in VMC, the strict application of the usual ALAR doctrine would have implied an immediate go-around to start a new approach. The airspace around TFN was not congested at the time and there were no other conditions that would have discouraged a go-around. However, the flight crew did not recall the approach as being especially challenging or very unstable, and it seems they never considered the possibility of a go-around.

Even though the airspeed was outside the SOP limits below 500 ft, it seems other parameters were relatively stable. In particular, the aircraft was relatively aligned with the runway centreline and the recorded altitude shows it was relatively stabilized on the glideslope.

Additionally, below 200 ft the airspeed was more or less stable at around Vref + 13, considering that the crew stated they added 10 kt to Vref because of the gusty conditions. This added value would roughly be in accordance with the Boeing recommended procedure (half of the steady headwind component), because the headwind would have been around 21 kt (total wind 23 kt at 320° in the METAR, or 24 kt at 330° in the last wind check). The measured wind limits/gusts in the relevant period of time would have resulted in instantaneous values of headwinds between 31 kt and 28 kt.

The SOP of the operator did not clearly stipulate the point at which a go-around must be carried out due to unstable conditions. It was stated that the approach «should be stable». No guidance was provided regarding the application of these criteria to airports that often show turbulent conditions. However, the manual mentioned that a close monitoring by the PNF is required during the approach, especially under turbulent conditions, to provide appropriate callouts.

It seems the crew did not perceive any clear instructions warranting a decision to discontinue their approach, and under all these conditions, they continued with the landing.

At 10:04:07 h, nine seconds before touchdown, the flare was initiated and it seems that it was at that point when the actual circumstances arose that directly led to the incident, with large control column and control wheel inputs that caused important pitch and roll angle variations that eventually (at around 10:04:16 h) exceeded the ground contact envelope for the outboard nacelle of the aircraft with the gear oleo compressed. The combination pitch/roll that caused the strike was between 6.7°/7.6° and 4.0°/9.0° respectively. The roll inputs were attributed by the crew to the wind conditions. However, the reasons for the large pitch changes during the flare are unclear. The analysis of the last seconds of the landing shows that it is possible that both the decrab and the flare were made somewhat prematurely (i.e. at a height above the runway higher than the optimum) given the unstable wind conditions being faced by the airplane at that moment.

It seems no occupant of the aircraft (neither crew members or passengers) noticed the strike. The passengers disembarked normally and one of them, an employee of the airport used to turbulent, gusty approaches to the airport, stated that nothing strange was noted in the cabin. The pilots did not realize or suspect that the angles achieved had exceeded the envelope until they were advised by ground personnel. This suggests that it would be advisable to provide more data to flight crews to increase awareness of the combined pitch/roll geometrical limits of the aircraft. Additionally, the SOP should include standard callouts of the PNF to advise early enough of pitch and roll combinations that could exceed those limits with the shock absorber compressed.

It could be argued that during those final nine seconds of the approach a go-around should have been executed, since the landing became clearly unstable due to the pronounced changes in pitch and roll that were adopted in an attempt to keep the aircraft under control. The need to discontinue the approach earlier, during the initial approach, is more doubtful, because the only parameter that exceeded the established threshold for any substantial period of time was airspeed, and this went back to within limits below 400 ft. However, the policy of the ICAO «Approach and Landing Accident Reduction» (ALAR) says that special approaches or approaches in abnormal conditions which demand deviations from the general criteria for stabilized approaches below 500 ft in VMC require a special briefing. This would apply to special circumstances at airports with a lot of orographic turbulence that exists even down to low altitudes.

The lack of recorded CVR data precluded a more detailed analysis of the whole operation in the cockpit, including callouts, task sharing, etc.

The above combination of circumstances resulted in this serious incident. Although nobody initially noticed the impact, and the visible damage to the aircraft was relatively minor, it had to be subjected to detailed inspections and ferried back to base.

3. CONCLUSION

The incident probably happened because the turbulent wind conditions at the airport caused the pilot flying to use large control inputs which resulted in the aircraft exceeding its geometrical ground contact envelope.

The lack of a CVR recording covering the period of the incident prevented the investigation of callouts and monitoring by the PNF.

4. SAFETY RECOMMENDATIONS

After the incident, the operator grounded the crew for a time and analyzed with them the whole event to derive safety lessons from it.

Due to the defects noted in the FDR's recording of data regarding the rudder pedal, and in the CVR maintenance status, which precluded a more detailed analysis of the operational aspects of this incident, the following recommendations are issued:

REC 12/07. It is recommended that Air Atlanta analyze the downloaded FDR data of their B747 fleet to determine the need to replace the rudder pedal sensors as required to assure full consistency among recorded values.

REC 13/07. It is recommended that Air Atlanta analyze the actual cockpit voice recordings of their B747 fleet to assure that sound recorded by the cockpit area microphone is of adequate quality.

REC 14/07. It is recommended that Air Atlanta inspect their CVR devices to assure that they have the required maintenance status regarding overhaul periods.

REC 15/07. It is recommended that Air Atlanta review the pre-flight procedures to assure that defective CVR devices with jammed tapes are detected by the corresponding test.

Due to the destabilization during the final phase of the landing, and to the fact that the impact with the nacelle was not noted, the following safety recommendations are issued:

REC 16/07. It is recommended that Air Atlanta consider the possibility of providing the ground geometrical envelope of the Boeing B747-300 to the flight crews in an easily useable format, to increase their awareness of the danger of large control inputs during flare.

REC 17/07. It is recommended that Air Atlanta includes in the SOP of the aircraft standard callouts to be made by the PNF during the landing in the event the pitch or roll ground geometrical envelope limits of the aircraft are exceeded to avoid an impact of the wingtip, tail or nacelle with the runway surface.

REC 18/07. It is recommended that Air Atlanta consider the possibility of including the requirement to carry out a mandatory go-around under certain, well defined, unstable conditions during approach below certain altitudes. These conditions and the associated altitudes should be adapted to the orographic and meteorological characteristics of every airport if so required, including the need for a weather briefing if it is a significant factor.