

INCIDENT

Aircraft Type and Registration:	Airbus A320-232, HA-LPB	
No & Type of Engines:	2 IAE V2527E-A5 Turbofan engines	
Year of Manufacture:	2001	
Date & Time (UTC):	1 October 2006 at 1947 hrs	
Location:	London (Luton) Airport	
Type of Flight:	Public Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 159
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Abrasion marks on lower fuselage skin and on two adjacent frames	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	40 years	
Commander's Flying Experience:	5,458 hours (of which 3,012 were on type) Last 90 days - 251 hours Last 28 days - 57 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The crew were carrying out a manually flown ILS approach without the use of flight directors or autothrust. At 530 ft agl the aircraft was well above the normal 3° glideslope. The glideslope was not regained until shortly before landing, and by then the speed was below approach speed (V_{APP}) and the descent rate was high. During the flare, full back sidestick was applied and the aircraft bounced after touching down in a high pitch attitude; the second touchdown was also in a high pitch attitude. Post flight inspection confirmed that the aircraft tail had struck the ground on landing.

The commander reported the tailstrike to her company but did not advise ATC of the incident and other aircraft movements took place before the next regular runway

inspection. There was no debris deposited on the runway as a result of the tailstrike.

History of the flight

The crew were operating a flight from Warsaw Airport to London (Luton) Airport with the commander as the handling pilot. Both crew members had previously operated into Luton Airport.

In accordance with normal company procedures, the first officer completed an external check of the aircraft while the commander completed the cockpit checks; the off-going crew met the commander and reported that the aircraft was fully serviceable. Engines start and after-start checks were uneventful and the commander

taxied HA-LPB to Runway 29. Because of the weather conditions, which included local rain and thunderstorms in the area, the commander used TOGA power for the takeoff at 1741 hrs; the rotation appeared normal to both crew members.

The cruise towards the destination was uneventful, and prior to descent the commander briefed the first officer for the approach and landing at Luton. ATIS information 'G' was in effect from 1920 hrs and included the following information: Runway 26 was in use with a surface wind of 210°/ 16 kt, visibility was greater than 10 km, cloud was FEW at 800 ft and SCT at 2,100 ft, air temperature was 14°C with a dew point of 11°C, and the QNH was 1000 mb. ATIS information 'H' issued at 1950 hrs was identical. As the commander was due for a simulator check in the near future and the weather was reasonable, she decided to fly the approach manually and briefed the first officer that she would not use flight directors, autopilot or autothrust.

On arrival in the London area, HA-LPB was held in the hold at 'Abbot' for approximately 15 minutes before ATC began radar vectoring the aircraft for the approach to Runway 26. The commander disconnected the autothrust at around 3,000 ft amsl. Then, as the aircraft turned onto final approach and with the airport and runway clearly in sight, the commander disconnected the autopilot and flight directors. She used 'Managed' speed and selected TRK/FPA (Track/ Flight Path Angle) on the PFDs (Primary Flight Displays). Her primary reference for the approach was the runway PAPIs but she also had ILS displayed.

As the aircraft descended through 1,000 ft agl, both crew members noted that the wind was approximately 40 kt from the south-west and that there was some turbulence. By 750 ft agl, the aircraft was fully configured for

landing with full flap and medium autobrake selected. Around 500 ft, the commander became aware that the aircraft was above the required glide path; the PAPIs were showing four 'whites'¹ and the first officer called that they were high. The commander retarded the thrust levers and applied forward sidestick and considered that she re-established on the glide path. She considered that the approach was then stable at about V_{APP} (140 kt for this approach).

As the automatic height calls activated at 50 ft agl, the commander began to retard the thrust levers and to flare the aircraft. However, she was then aware that the height calls were becoming more frequent than normal and applied more aft sidestick. Touchdown was firm and the aircraft bounced slightly. Her recollection was that she held the sidestick position steady and the aircraft touched down again within about two seconds. The autobrake system applied the wheelbrakes almost immediately and reverse thrust was used on the landing roll. During the subsequent taxi to the allocated stand, the aircraft monitoring system activated with an exceedance report. Fuel on landing was 3,120 kg.

On turnaround, the commander discovered a scrape on the underside of the fuselage and brought it to the attention of a company engineer who was on board the aircraft. He confirmed that the aircraft needed to be checked and, in accordance with the company Operations Manual, the commander contacted the company operations centre to report the event. However, she omitted to contact ATC to advise them of the tailstrike. The incident was reported by the company to the AAIB the following morning and ATC did not become aware of it until the AAIB requested the radio recordings of the event.

Footnote

¹ Four 'whites' indicated that the aircraft was above a 3°35' glideslope.

Recorded information

The aircraft was fitted with a solid-state 25-hour Flight Data Recorder (FDR) and a solid-state two-hour Cockpit Voice Recorder (CVR). Both recorders were downloaded at the AAIB; data and audio recordings were recovered for the incident landing and were time-aligned for analysis.

Additionally, the aircraft was fitted with a Data Management Unit (DMU). It was the DMU which generated the exceedance report which indicated that the vertical load factor on landing was 2.29g and the rate of descent on touchdown was 672 ft/min.

A time history of the relevant parameters during the incident is shown at Figure 1. The data presented starts with the aircraft at 1,300 ft amsl, with both autothrust and autopilot disconnected (at 6,000 ft and 4,300 ft amsl respectively), on the ILS approach to Runway 26 with the commander flying. At this point the aircraft's descent rate was approximately 750 ft/min, the airspeed was reducing through 160 kt, the pitch attitude was just above 2°, and the flaps were at 20°. Throughout the approach the aircraft remained within 1 dot of the localiser; pitch attitude predominantly varied between -1° (nose down) and +5° (nose up).

As the aircraft descended through 1,200 ft amsl, the descent rate slowed and the aircraft started to deviate above the glideslope. At 1,100 ft a small amount of thrust² was applied just as the flaps extended to 40°. At this point the descent rate had slowed to 270 ft/min and the airspeed was 150 kt.

As the aircraft passed through 1 dot above the glideslope, the first officer called "GLIDE". The commander then momentarily reduced the pitch attitude before returning to a pitch of 2.3° nose up. The aircraft's descent rate began to increase but glideslope deviation continued to increase; at 2 dots above the glideslope the first officer called "GLIDE GLIDE". The thrust levers were then pulled back to the flight-idle position (-2.5° TLA) and the commander again momentarily reduced the pitch attitude. However, the aircraft continued to deviate further above the glideslope reaching 3.1 dots³ at 530 ft agl (calculated to be between 130 ft and 144 ft above the 3° glideslope) before stabilising back at 2 dots above as pitch attitude was again reduced and the descent rate increased to 900 ft/min.

At 400 ft agl, the commander started to pitch the aircraft's nose up while applying small amounts of thrust (10° TLA giving 1.05 EPR), allowing the airspeed to slow to 140 kt (the calculated approach speed V_{APP}) while still maintaining the 900 ft/min descent rate. The thrust levers were pulled back to +2.5° TLA as the aircraft passed through 300 ft agl and just as the first officer advised against using any further thrust. At 150 ft agl the airspeed started to reduce, gradually decaying to 130 kt at 50 ft agl.

The commander commenced the flare at 50 ft just as the first officer shouted "PULL". The commander then rapidly applied and held full aft sidestick (-16°) with the aircraft at 30 ft agl and coincident with the first officer shouting "PULL PULL PULL PULL". The descent rate from 75 ft agl to touchdown averaged 975 ft/min. One second before touchdown, at 11 ft agl, the aircraft passed through the glideslope from above.

Footnote

² For clarity, only the EPR for the left-hand engine is shown but is representative of the right-hand engine. Similarly, only the thrust lever angle (TLA) for the right-hand engine is shown.

Footnote

³ The aircraft instruments display a maximum of 2 dots deviation from the glideslope: each dot reflects an angular deviation of 0.36° from the glideslope.

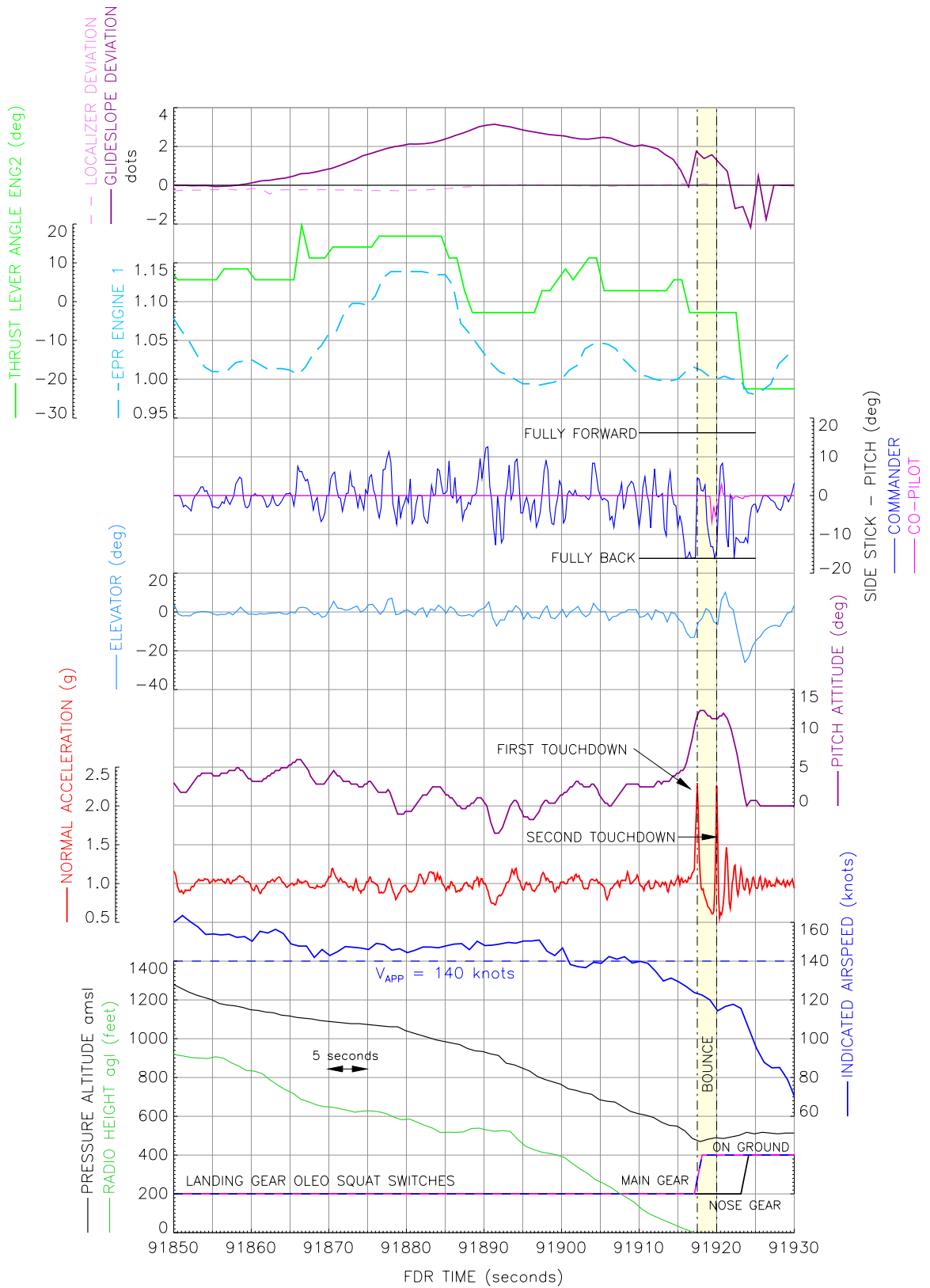


Figure 1
 Salient FDR Parameters
 (Accident to HA-LPB on 1 October 2006)

The aircraft touched down with +2° of roll attitude (right main landing gear first) with a vertical load factor of +2.3g and at an indicated airspeed of 125 kt. The aircraft reached a maximum pitch attitude of 12.3° nose-up. The spoilers deployed just as the aircraft bounced⁴, and the pitch attitude started to reduce. The commander then made a nose-down sidestick input (+4.6° then +2.7°) before again applying full aft sidestick, and just as the first officer applied -7° aft sidestick. As neither of the priority takeover pushbuttons were pressed, the sidestick inputs from both crew would have been additive in effect.

The aircraft then touched down for a second time with a vertical load factor of +2.3g and a pitch attitude of 12° nose up. The nose was then gently lowered and the aircraft was slowed to a taxi speed. No windshear warnings were recorded during the approach and landing.

Engineering information

The damage to the aircraft (manufacturer's serial number 1635) consisted of abrasion marks approximately 70 inches long on the lower fuselage skin in the area of frames 65 to 68. At frames 65 and 66, the skin had worn away and there were light abrasion marks on both frames. There was no other damage to the aircraft structure. The damage indicated that there had been a brief, relatively light contact between the rear of the aircraft and the surface of the runway. Marks on the runway indicated a single ground contact within the normal touchdown zone.

Subsequent engineering checks revealed no further damage to the aircraft.

Footnote

⁴ The bounce was insufficient to cause a change in state of either of the two main landing gear squat switches.

Operational information

Runway inspections

ATC were not informed of the incident and the runway was not inspected until the next routine inspection. This was 44 minutes after the event during which 25 aircraft movements had taken place. Investigation subsequently confirmed that no debris from HA-LPB had been deposited on the runway.

Approach lighting

The PAPIs had last been flight-checked on 10 July 2006, when they were shown to be aligned with the ILS glideslope. Additionally, the routine ground checks of the PAPI light angles showed that they were accurate on 29 September and on 10 October 2006.

Manufacturing company information

Information from the manufacturing company shows that the tailstrike rate for the A320 fleet is 2.7 occurrences per million flight cycles; the fleet has accumulated more than 19 million flight cycles.

The latest Airbus Flight Crew Operating Manual (FCOM) Bulletin giving advice on avoiding tailstrikes was 806/1 issued in June 2004. This states that for an A320 a tailstrike will occur at a pitch attitude of 13.5° with the main landing gear oleos fully extended and at a pitch attitude of 11.7° with the oleos fully compressed. For a normal 3° approach, the speed reduces by 8 kt during the flare and the normal pitch attitude at touchdown is 7.6°, giving a ground clearance angle of 5.9°. When the approach speed is decreased by 5 kt, the ground clearance angle is reduced by approximately 1.3°.

Approximately 70% of tailstrikes occur on landing. Some are associated with external factors such as turbulence and wind gradient but most are due to deviations

from normal landing techniques. The sections of the Bulletin relevant to the incident involving HA-LPB are reproduced below:

'a) Allowing speed to decrease well below Vapp before flare.

Flying at too low speed means a high AOA and high pitch attitude, thus reducing ground clearance. When reaching the flare height, the pilot will have to significantly increase the pitch to reduce the sink rate. This may lead the pitch to go beyond the critical angle.

d) Too high a sink rate, just prior to reaching the flare height.

In case of a too high sink rate close to the ground, the pilot may attempt to avoid a firm touchdown by commanding a high pitch rate. This action will significantly increase the pitch attitude and, as the resulting lift increase may be insufficient to significantly reduce the sink rate, a firm touchdown may occur. In addition, the high pitch rate may be difficult to control after touchdown, particularly in case of bounce.

e) Bouncing at touchdown

In case of bouncing at touchdown, the pilot may be tempted to increase the pitch attitude so as to ensure a smooth second touchdown. If the bounce results from a firm touchdown associated with a high pitch rate, it is important to control the pitch so that it does not further increase beyond the critical pitch angle.

APPROACH AND LANDING TECHNIQUES

A stabilized approach is essential for achieving successful landings. It is imperative that the flare height be reached at the appropriate airspeed and

flight path angle. A/THR and FPV are effective aids to the pilot.

The Vapp should be determined with the wind corrections, given in FCOM/QRH, using FMGS functions.

As a reminder, when close to the ground, the wind intensity tends to decrease and the wind direction to turn (directions in degrees decreasing in northern latitudes).

Both effects may reduce the headwind component close to the ground, and the wind correction to Vapp is there to compensate this effect.

When close to the ground, high sink rates should be avoided, even in an attempt to maintain a close tracking of the glideslope. Priority should be given to attitude and sink rate. If a normal touchdown distance is not possible, a go-around should be performed.

If the aircraft has reached the flare height at Vapp with a stabilized flight path angle, the normal SOP landing technique will lead to repetitive touchdown attitude and airspeed.

Assuming an 8-knots speed decrease during flare, and a -1° flight path angle at touchdown, the pitch attitude will increase by approximately 4.5°.

During flare, the pilot should not concentrate on the airspeed, but only on the attitude with external clues. Note: Airspeed indication during flare is influenced by the static error due to the ground effect.

The PNF should monitor the pitch attitude on the PFD and call "PITCH" whenever the following pitch value is reached: For A320: 10°.

After touchdown, the pilot must fly the nosewheel smoothly, but without delay, on to the runway, remaining prepared to counteract any residual pitch up effect of the ground spoilers. Note: The main part of the spoilers' pitch up effect is compensated by the flight control laws.

BOUNCING AT TOUCHDOWN

In case of a light bounce, maintain the pitch attitude and complete the landing, while keeping thrust at idle.

Do not allow the pitch attitude to increase, particularly following a firm touchdown with a high pitch rate.

In case of a high bounce, maintain the pitch attitude and initiate a go-around.'

'Pitch limit indicator on PFD and "PITCH PITCH" auto-callout devices, that exist on A340-500 and A340-600, have been developed for all fly-by-wire aircraft. The maximum pitch attitude not to be exceeded will be indicated during take-off or landing. The auto-callout will trigger in case of excessive pitch attitude at landing below a given altitude. These improvements require a package EIS (Electronic Instrument System) and FAC (Flight Augmentation Computer) not yet available for in-service aircraft.'

Operating company information

The company Operations Manual Part B dated 1 October 2005 contained the following relevant information:

1. Para 2.3.4: *'No control inputs are to be made by the non-handling pilot.'*
2. Para 2.3.10: *'Use of A/THR is recommended, even when flying manually.' 'FDs are to be used for all instrument approaches until visual. (Raw data approaches are of limited value, but may be flown occasionally in VMC at the captain's discretion.)'*
3. Para 2.5.1: *'Stabilised Approach: Go around is mandatory if an approach is not stabilised by 1000 ft AAL (IMC) or fully stabilised 500 ft AAL (VMC). Stabilised is defined as: On profile (within ½ dot (ILS) or 100 ft (NPA); Gear down and at least Flap 2; Speed no more than V_{app}+20 kts decreasing or GS mini, whichever is higher. Fully stabilised is defined as: On profile (within ½ dot (ILS) or 100 ft (NPA)); Landing config; Approach power; V_{app} or GS mini.'*

During an investigation into a tailstrike to another Airbus A320, C-GTDC on 16 June 2003, the AAIB recommended that:

'Airbus should introduce an aural warning to its fly-by-wire aircraft types to alert pilots of excessive pitch angle or excessive pitch rate during landing.'
(Safety Recommendation 2004-58)

On 2 July 2004, Airbus responded:

'We developed, on the A340-500 and A340-600, a system giving a visual indication on the PFD and an aural warning in case of excessive pitch angle. We are now studying the feasibility of extending this on all other fly-by-wire aircraft types.'

Following the incident involving HA-LPB, Airbus confirmed that:

Discussion

There were no indications of any technical defects with the aircraft. Additionally, the PAPIs were confirmed as serviceable and accurate.

The tailstrike occurred when the aircraft touched down at a high pitch attitude with the airspeed some 15 kt below the computed V_{APP} ; the aircraft then bounced before a second touchdown, again at a high pitch attitude. Indications are that either touchdown could have resulted in a tailstrike but that only one strike occurred. The initial touchdown followed an approach which had been well above the required glideslope at 530 ft agl. From that point, it is considered that the commander would have been working hard to re-acquire the glideslope and also maintain V_{APP} particularly when not using autothrust or flight director. The aircraft remained above the glideslope until 11 ft agl, and by then it was at a high rate of descent and was slow. These conditions are acknowledged in the Airbus Bulletin as being typical conditions for a tailstrike to occur. The position of the aircraft in relation to the glideslope at 530 ft agl was such that a go-around would have been the most appropriate action. The company operations manual required such an action at 500 ft aal if the approach was not fully stabilised. While the Airbus modification to alert the crew to a high pitch attitude on landing is beneficial, the situation should generally be avoided by an early decision to go-around from an unstable approach.

One other aspect that may have been pertinent was that the commander was flying the aircraft without the use of

autopilot, autothrust or flight directors. The aircraft can be safely flown manually and this is authorised by the company Operations Manual under certain conditions. However, it would then require close monitoring by both crew members and would normally only be done during benign weather conditions, to an airfield without any operating difficulties and to one that was familiar to the crew. While the weather report appeared reasonable, it became apparent to the crew that the wind at 1,000 ft was strong and that there was turbulence on approach. At night, and on an approach with undulating terrain, the conditions were such that a manual approach would require maximum concentration and monitoring. It would have been prudent to use all the available aircraft systems for the approach.

During the bounce, after the initial touchdown, the non-handling pilot made an aft sidestick input. While this had no effect on the pitch attitude, since the handling pilot had already applied full aft sidestick, the possible additive effects make dual sidestick inputs highly undesirable; the Operations Manual specifically precludes non-handling pilots from making any inputs.

Following the tailstrike, the commander reported the incident as required to the company operations centre, who then assumed responsibility for onwards reporting. However, during this time ATC were not informed of the tailstrike. During the subsequent investigation, the crew readily acknowledged their responsibility to inform ATC. Additionally, following the incident, the company issued guidance to personnel clarifying the reporting requirements after any accident or incident.