BAe 146, G-ZAPK, 18 November 1996

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INCIDENT

Aircraft Type and Registration:	BAe 146, G-ZAPK
No & Type of Engines:	4 ALF502 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	18 November 1996 at 1347 hrs
Location:	London City Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 5 - Passengers - 47
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	13,545 hours (of which 4,700 were on type)
	Last 90 days - 190 hours
	Last 28 days - 39 hours
Information Source:	AAIB Field Investigation

History of flight

Flight recorder data was not available because it had been overwrittenon subsequent flights. The history of this flight has thereforebeen derived from crew statements, witness accounts and recordedradar data.

The aircraft was being operated on a sector from Dublin to LondonCity; the commander was the handling pilot. Just after 1344 hrs,the aircraft began a coupled ILS approach, from 3,000 feet, toRunway 28; the weather was CAVOK, the surface wind was 325°/10kt and the runway was dry.

The configuration for the approach was:

Landing gear down

Flap 33°

Airbrake open

The crew could not recall what VREF they hadused, however, as the landing weight was about 31,260 kgthe correct value would have been 109 kt. The command speed pointer(bug) on the ASI was set to VREF+5 kt, therecommended approach speed. The first officer recalled that thespeed during the initial part of the approach was "bug+10kt" (VREF+15 kt). He drew the commander'sattention to this and received an acknowledgement. He noted that,as the aircraft crossed the threshold, the speed was about "bug+7kt" (VREF+12 kt).

It was not clear where the aircraft touched down, but when itdid it appeared to both pilots to be normal and the commanderselected the engines to ground idle. He then selected the liftspoilers and applied the brakes but there was little retardationand he felt that the aircraft was "skating on glass". He said that he called "no brakes" and shortly afterwardsthe first officer called "no spoilers". The first officernoticed that there were no spoiler captions on the annunciatorpanel and the 'Lift Spoiler' warning on the glareshield was notilluminated.

When the commander recycled the spoiler lever the lift spoilersdeployed. Almost immediately, he felt normal braking and theaircraft started to decelerate rapidly; the first officer wasby now also applying pressure to the brake pedals.

The ATC controller had not noticed the initial part of the landingbut he reported that the aircraft finally touched down between1/3 and 1/2 way alongthe runway, nose wheel first. There was a considerable amountof "smoke" evident from the area where the main wheelstouched. The controller, anticipating an overrun, pressed thecrash alarm.

At about 1347 hrs, the aircraft came to a halt at the end of thestarter extension to Runway 10. The controller told the AFS thathe suspected a burst tyre and asked them to investigate and report. Shortly afterwards the crew asked the controller if there wasany sign of fire. At the request of the AFS, the commander shutdown the engines and awaited an inspection.

At 1400 hrs, in the absence of any evidence of fire or tyre damage,the decision was made to restart the engines and to taxi to thestand. The commander checked the spoilers and they deployed normallyconsequently, after consulting the ground engineer, he decidedthat it was probably a "one off" problem and the aircraftand crew continued with their schedule.

Aircraft operator

The aircraft and crew were on lease to an Irish based companywhich operates a regular schedule between Dublin and London CityAirport. The crew had not flown regularly into London City andwere relatively inexperienced in this sphere of operation. However,they were properly trained and licensed to operate the flight;the training was carried out by another company which operatesregularly into London City Airport.

London City Airport

The airport is situated in the docklands area of the city; ithas a single runway which is designated 10/28. The landing distanceavailable (LDA) in either direction is 1199 metres; the pavedarea beyond the western end of the runway is 75 metres long andis a starter extension for aircraft

departing from Runway 10;it is not part of the LDA. The limit of the touchdown zone onRunway 28 is marked by white lights set into the runway surface;these are 336 metres in from the threshold.

At the time of the incident, the airport had about 114 movementsa day; the main aircraft types were BAe 146/RJ, De Havilland DHC8and the Fokker 50. There were 11 main operators, although a total72 operators had been given approval to operate at London CityAirport using a large range of aircraft types. Because of theunusual characteristics of the Airport and the steeper than normalapproach path of 5.5°, the airport authority lays down severalconditions with which an operator must comply before this approvalis given.

BAe 146 normal approach procedure

The normal approach procedure for the BAe 146 aircraft is largelystandard across the range of operators. Prior to localiser capture18° flap is selected with a minimum speed of VREF+30kt. Once established on the localiser, 24° flap is selectedand the speed reduced to VREF+20 kt. At 1 1/2dots below the glideslope, the landing gear is selected down,the flap is selected to 33° and the speed is reduced to VREF+5kt, which is bugged on the command speed pointer. At glideslopeintercept, the airbrakes are selected out. The approach is flownin this configuration aiming to cross the threshold at VREF. The landing flare is started and the power is reduced to flightidle; the flare should not be prolonged and, after the main wheelstouchdown, the thrust levers are retarded to ground idle and thenose wheel is lowered onto the runway. The lift spoilers arethen selected by the Commander and braking commences. After touchdownthe non handling pilot confirms "SPOILERS YELLOW/GREEN -BRAKE PRESSURE" or warns of a spoiler or brake failure. If it appears that the touchdown point will be beyond the touchdownzone limit a go-around must be initiated before the aircraft touchesdown.

Description of pertinent systems

Compression of both main oleos removes the flight idle (60% N_2)baulk allowing the selection of Ground idle (50% N_2)by the handling pilot.

The YELLOW (No 2 engine) hydraulic system powers the inboard liftspoilers and the roll spoilers. The GREEN (No 3 engine) hydraulicsystem powers the four outboard lift spoilers. The inboard spoilersdeploy immediately they are selected provided either the noseoleo is compressed and either main oleo has been compressed inthe previous 10 seconds or both main oleos are compressed. Theoutboard spoilers deploy 1.5 seconds after both main oleos arecompressed. When the spoilers deploy green 'SPLR Y' and 'SPLRG' captions illuminate on the annunciator panel.

Should the spoilers not deploy there will be no 'SPLR Y' and 'SPLRG' captions on the annunciator panel. A 'Lift Spoiler' warningon the glareshield will illuminate subject to the following conditions:

1. If the spoilers are selected but do not deploy, the warningilluminates after 3 seconds and stays on until the spoilers dodeploy or are deselected.

2. If any oleo is compressed and the spoilers are not selected,the warning illuminates after 6 seconds and stays on for14 seconds or until cancelled.

Probable sequence of events

No technical defects were found at the time of the incident andnone was reported subsequently which could be related to the event. In the absence of any evidence of a technical problem, and withno Flight Recorder data available, a probable sequence of eventswas derived from crew statements, witness accounts and the wayin which the pertinent systems function.

With little or no headwind component it is difficult to lose excessspeed once established on the 5.5° glideslope because thepower setting is already very low (40 to 50% N1)and all the drag producing devices have been selected. If theapproach, as in this case, starts at a higher than ideal airspeed,it is likely that a large part of this excess speed will be maintainedthroughout the approach. The first officer noted that the speedwas about "bug+7 kt" at the threshold.

If the aircraft touched down firmly enough to compress the mainoleos and withdraw the flight idle baulk but then became airborneagain before the commander had transferred his right hand to thespoiler lever and moved it rearwards, the spoilers would not deploy. The 'Lift Spoiler' warning would normally have illuminated after3 seconds, however, it is possible that the system was reset beforethe end of the period when the commander momentarily recycledthe spoiler lever.

If the aircraft floated and the required combination of weighton wheels switches was not made, the spoilers would remain stowedand the wheel brakes would be only marginally effective, givingthe commander the impression that the aircraft was "skatingon glass"; this pilot impression has been identified in otheraccidents/incidents where lift spoilers have not deployed andthe initial diagnosis is invariably a brake rather than a spoilerfailure.

The commander's recycling of the lever was probably coincidentwith the aircraft having slowed sufficiently to settle onto theground and make the conditions required for the spoilers to deploy. From this point the aircraft decelerated as would be expectedwith full braking applied.

Manufacturer's performance data

The aircraft manufacturer produced landing performance data forthe BAe 146-200 at London City Airport under the following conditions:

Runway 28

Pressure altitude 144 feet (QNH - 1009 mb)

Temperature +6°C (ISA - 8.7°C)

Surface wind 320°/9 kt

Landing weight 31,261 kg

Runway surface Dry

The distance is based on the aircraft flying a 5.5° steepapproach and crossing the runway threshold at 35 feet, at VREF. With all retardation devices serviceable the unfactored landingdistance is 487 metres. If the lift spoilers fail but normalbraking is still available, the unfactored landing distance becomes679 metres.

The unfactored distance is measured during certification flyingand uses flight test methods; it would not be expected that normalin-service landing techniques would routinely achieve this distance. A safety factor designed to compensate for the variables inherentin normal airline operation is applied to this distance to producethe Flight Manual standard landing performance. For dry runwayperformance this figure is 1.67; this includes an allowance fora threshold overspeed of up to 15 kt.

With all retardation devices serviceable the factored landingdistance is 812 metres. If the same safety factor is appliedin the case where the lift spoilers have failed but normal brakingis still available the factored distance is 1,134 metres.

It should be noted that all the above figures apply to the conditionspertaining at the time of the incident when the aircraft was significantlybelow maximum landing weight (36,740 kg) and the runway was dry;a further factor of 1.15 would apply if the runway was wet.

Discussion of incident

If the aircraft crosses the threshold at 35 feet at VREF+15kt and touches down normally, it should stop inside the LDA evenwithout the deployment of lift spoilers. However, when the elementswhich make up the safety factor move towards their limiting valuesthe situation becomes more critical even in the relatively benignconditions of the incident flight.

If it appears that the touchdown point will be beyond the touchdownzone limit, the procedure is clear, a go-around must be initiatedbefore touchdown; during this procedure the main wheels may wellmake ground contact.

If the landing continues and the aircraft touches down in thecorrect place and then becomes airborne again, or simply floatsbeyond the touch down zone limit the problem becomes more complex. It appears that there are situations when the pilot is unawarethat the aircraft is not on the ground.

The manufacturer has given considerable thought to the conceptof initiating a go-around after touchdown at London City Airportor any other similarly limiting airfield. The company feels thatthere are so many variables to be considered that it would beimpossible to lay down a procedure which would totally precludean even more serious incident developing. Because of this, theycould not endorse any initiative that would encourage a crew toinitiate a go around after the aircraft has touched down.

The situation of London City Airport is such that there is a limitedamount of land in the overrun area of either runway and the consequencesof a high speed overrun are potentially very serious. The basicdefence against such an event lies in the formulation and applicationof suitable procedures to ensure that the aircraft arrives atthe threshold in the correct configuration at the correct heightand speed, and that the landing is positive and within the limitof the touchdown area. However, it would be prudent to considersome form of runway end and safety area enhancement which wouldcompensate for the lack of a clear overrun area and would be capableof bringing an aircraft to a stop in the event of a misjudgedtouchdown and/or the failure of retardation devices. The feasibilityof installing some form of soft ground arresting device in underconsideration by the airport authority: this, in its basic formis a pit which gets progressive deeper with distance from therunway end and is filled with a soft retarding substance suchas sintered ash.

Study of landings at London City Airport

In 1991/1992 the CAA undertook a project at London City Airportthe aims of which were:

1. To provide a statistical usage definition of a typical DHC-7operation in the verification and formulation of existing andproposed design and operational requirements.

2. To develop a prototype operational exceedence programme fora commuter aircraft.

3. To examine the specialist area of steep approaches and STOLoperations.

4. To enable the operator to establish the relevance and usefulnessof a FDR programme to his operation.

5. To encourage other operators to start similar programmes.

The project provided a useful insight into the operation of theDHC-7 aircraft in a steep approach environment. As the BAe 146has become a major type at the Airport, it could prove equallyuseful to undertake a similar study related to this aircraft. The manufacturer has already suggested that a working group shouldbe formed to discuss BAe 146 operations at London City Airport;it could prove an ideal forum for initial discussions on the levelof co-operation and the methods of the study.

Safety Recommendation:

97-27: It is therefore recommended that the CAA, in conjunctionwith the manufacturer, airport authority and operators, carryout a project to determine the scatter of significant landingparameters for the BAe 146 aircraft operating into London CityAirport.