

# Embraer EMB-145EP, G-ERJE

AAIB Bulletin No: 5/2003

Ref: EW/C2002/07/02

Category: 1.1

## INCIDENT

<b>Aircraft Type and Registration:</b>	Embraer EMB-145EP, G-ERJE	
<b>No &amp; Type of Engines:</b>	2 Allison AE 3007/A1/1 turbofan engines	
<b>Year of Manufacture:</b>	2000	
<b>Date &amp; Time (UTC):</b>	5 July 2002 at 1000 hrs	
<b>Location:</b>	7 nm east of Bristol International Airport	
<b>Type of Flight:</b>	Public Transport	
<b>Persons on Board:</b>	Crew - 5	Passengers - 47
<b>Injuries:</b>	Crew - None	Passengers - None
<b>Nature of Damage:</b>	None	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence	
<b>Commander's Age:</b>	56 years	
<b>Commander's Flying Experience:</b>	9,810 hours (of which 600 were on type)	
	Last 90 days - 110 hours	
	Last 28 days - 31 hours	
<b>Information Source:</b>	AAIB Field Investigation	

## Summary

The aircraft was operating a scheduled service flight between Charles de Gaulle (CDG) Airport, Paris and Bristol International Airport. While attempting to establish on the localiser prior to conducting the Runway 27 Instrument Landing System approach (R27 ILS) at Bristol, the aircraft descended below its cleared altitude of 2,500 feet. A rate of descent of about 5,000 feet per minute was observed at around 1,600 feet amsl (1,000 feet above aerodrome level), while the aircraft was still 9 nm from touchdown. The descent was arrested and the aircraft climbed back up to 2,400 feet amsl before completing the approach to land.

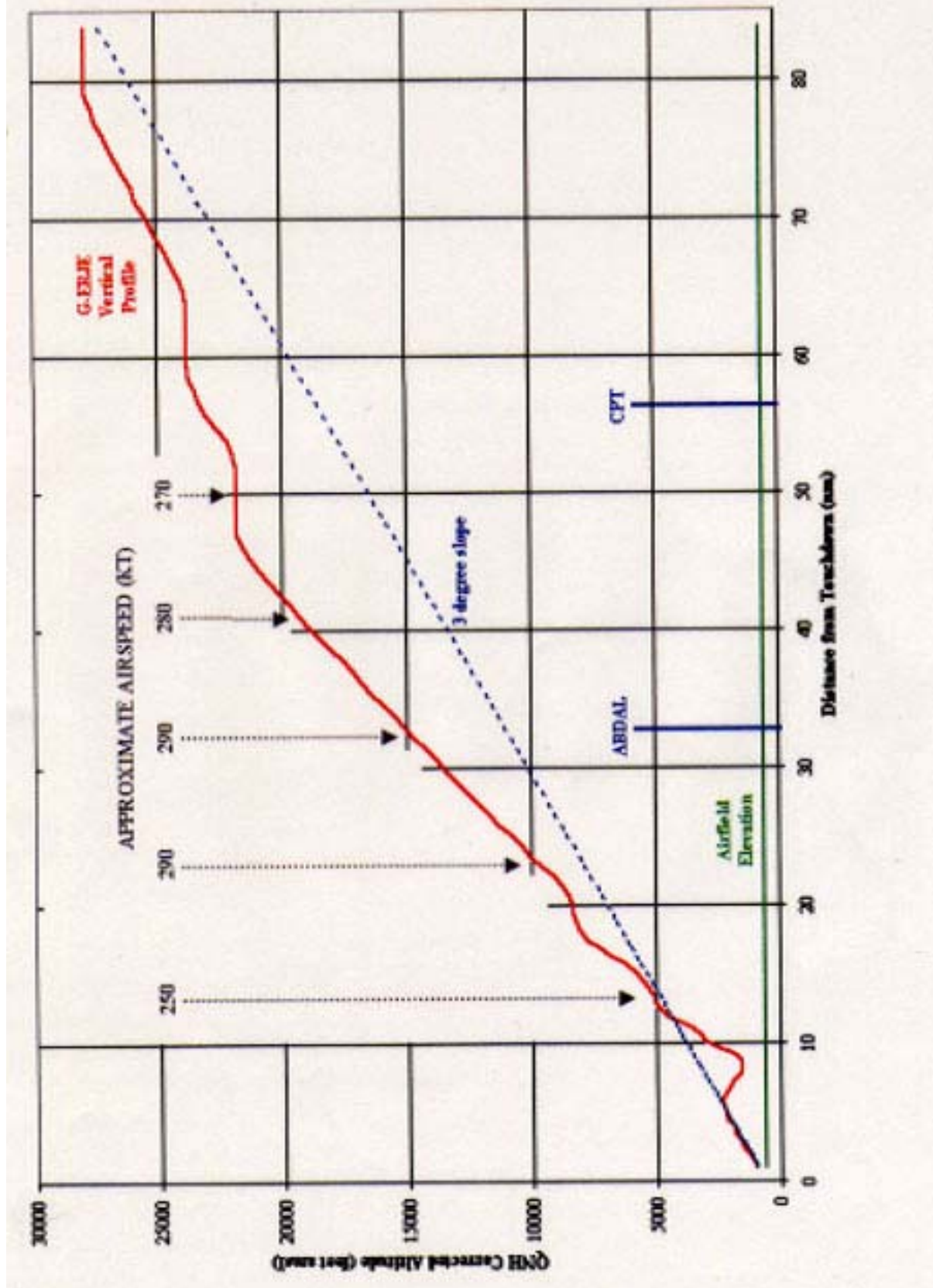
## History of the flight

There were three crew members present on the flight deck. The commander was the pilot flying for the sector, the right hand seat was occupied by the operating first officer (PNF) and another first officer (observer) occupied the jump seat for the purpose of familiarisation with the Flight Management System (FMS).

The descent from cruise altitude was carried out with the Autopilot engaged, using Flight Level Change (FLC) mode initially. The expected routing was via Compton (CPT) VOR (located 56 nm east of the airport), then to waypoint ABDAL (located 32 nm east), followed by self positioning for a

straight-in ILS approach on Runway 27. The aircraft passed CPT at FL230 and descended shortly after to FL220. Further descent clearance to FL110 was obtained and the aircraft vacated FL220 when it was 8 nm west of CPT, tracking towards ABDAL. The aircraft was now above the ideal vertical profile for a straight-in approach (Figure 1), so to increase the rate of descent the commander selected Vertical Speed (VS) mode, with a 3,000 feet per minute rate of descent. A subsequent clearance was given for the aircraft to self-position to establish on the Localiser for the R27 ILS approach, and a handover to Bristol Approach control followed.

Figure 1  
G-ERJE Descent Profile



Further descent clearance was given to the aircraft by Bristol Approach, initially to FL45 and then to altitude 2,500 feet referenced to the QNH of 1007 mb. At a distance of 30 nm from the airport, the aircraft passed through FL140. Speedbrakes were deployed when passing FL100. When the aircraft was below FL100, there was a "HIGH SPEED" audio overspeed warning and the commander responded by selecting 'Speed' mode with a target of 240 kt. The rate of descent reduced to zero at FL80 for a short time and then, at a distance of 20 nm from touchdown, descent continued.

The Approach mode was 'Armed' and the crew received an indication of Localiser capture at a distance of about 21 nm. The PNF reported "LOCALISER ESTABLISHED" to ATC, who in reply advised the crew that they were "ABOUT HALF A MILE TO THE SOUTH AT THE MOMENT". The PNF acknowledged this and replied "JUST INTERCEPTING IT AND TO COME BACK ONTO IT SHORTLY". The controller responded by clearing the aircraft for further descent with the glidepath. Meanwhile, the commander had selected 'Heading' mode to turn the aircraft back towards the centreline. He also retracted the Speedbrakes, but shortly afterwards the "HIGH SPEED" audio warning sounded again. In an attempt to control the speed, the commander disconnected the Autopilot and flew the aircraft manually.

The commander called for, and the PNF carried out, the Approach Checklist. As he was conducting these checks, the aircraft crossed through to the north side of the Localiser. The PNF recalled the commander asking for the Landing Gear to be selected 'Down'. He checked the speed, which was less than the limiting speed of 250 kt, and then selected the Landing Gear before continuing with the Approach Checklist. Later, the commander could not recall having requested the landing gear selection. ATC advised the crew that the aircraft was now the other side of the localiser and queried whether they wished to continue. The PNF then recalled noticing that the aircraft was below its cleared altitude, with a rate of descent of 5,000 feet per minute and a Ground Proximity Warning System (GPWS) amber caution on the EICAS, so he called out a warning to the commander. At about the same time, ATC advised the crew that the aircraft was at 1,400 feet, that this was too low and emphasised the instruction "CLIMB". The PNF remembered the aircraft breaking out below cloud briefly as the commander put the aircraft into a climb. The observer on the jump seat heard the GPWS caution "SINK RATE" and checked the rate of descent, which he recalled was 5,500 feet per minute at that time. Neither of the two operating pilots could recall hearing a "SINK RATE" caution.

The aircraft climbed back up to 2,400 feet amsl and was cleared to carry out the ILS approach. The recovery to the climb was carried out smoothly and steadily. Neither the cabin crew nor the passengers were aware of any unusual manoeuvre during the flight. A normal approach and landing ensued.

Following the landing, there was a brief discussion amongst the flight crew about the problems experienced on the approach. The observer left the aircraft at this time and the remaining two pilots prepared the aircraft for their next sector, a return to Paris CDG. The commander, when asked by the first officer, told him that he would be filing a company Air Safety Report (ASR). The commander filed an ASR regarding the overspeed event and poor ILS capture and tracking performance, both at Bristol and on the previous sector into Paris CDG. The ASR did not include information about the descent below ILS glidepath nor the 'SINK RATE' GPWS alert.

## **Meteorological conditions**

At the time of the incident, the Bristol area was subject to an unstable westerly airflow, behind a cold front, which had passed through earlier during the morning. A Met Office aftercast showed that the wind at 2,000 feet amsl was from 250° at 15 kt. At 5,000 feet amsl it was from 280° at 15 kt and at 24,000 feet amsl it was from 230° at 20 kt. The aftercast indicated that there was scattered/broken stratus cloud, base 500 to 1,200 feet amsl, with cloud tops to 1,500 feet and further layers of broken strato-cumulus cloud, base 2,000 to 3,000 feet.

The 0950 hrs METAR recorded at Bristol International Airport was as follows: Surface wind from 230° at 8 kt, visibility greater than 10 km, few clouds at 600 feet, broken cloud at 1,000 feet, temperature +14°C, dewpoint +13°C and the mean sea level pressure (QNH) was 1007 mb.

## **Flight crew experience**

The commander had been employed by the company for a number of years as a Captain on the DHC-8 (Dash 8) turboprop aircraft. In March 2000, he underwent a conversion training course onto the Embraer 145 as a Captain. He was unsuccessful on this course, but repeated the conversion course in

the right hand seat as a first officer and completed his training on the type in October 2000. In June 2001, he qualified as a Captain on the type and had then flown a further 400 hours as a commander up to the time of the incident.

The first officer had been employed by the company for about two years and was just completing his first year on this aircraft type. The two operating crew members were both based at Bristol and had flown together previously on a number of occasions. The observer, who was new to the company, recently qualified on type and, being based elsewhere, was not previously known to either crew member.

## Incident reporting

In the United Kingdom (UK), there is an established Mandatory Occurrence Reporting (MOR) system, whereby individuals are required to submit reports on certain events under the terms of Article 117 of the Air Navigation Order. Further information and guidance is published in Civil Aviation Publication (CAP) 382, The Mandatory Occurrence Reporting Scheme. The following events are listed in CAP 382 as items that should be reported by flight crew:

*'Unintentional significant deviation from intended track or altitude (more than 300'), caused by a procedural, systems or equipment defect or human factor.'*

*'GPWS alert when: Flight at a level, or on a route, different from that allocated'*

*'Operation of any primary warning system associated with manoeuvring of the aircraft e.g. overspeed warning'*

## Recorded data

Both flight recorders were overwritten by the time this incident came to the attention of the AAIB. Recorded radar and ATC data however were available for the investigation. Radar data was obtained from a radar head located at Clee Hill, position N5223:51.90 W00235:53.90, elevation 1,760 feet amsl, located some 60 nm north of Bristol Airport. From this data, horizontal and vertical flight profiles could be constructed. The horizontal profile showed that the aircraft intercepted the Localiser course at an angle of between 5° and 10° and subsequently passed through the centreline. The second attempt to establish was made at a track intercept angle of 35° and the aircraft again passed through the centreline. The derived vertical approach profile is reproduced at Figure 1. The terrain below the lowest point of the glidepath deviation was some 100 feet amsl, with local terrain up to about 330 feet amsl.

## Operating procedures

The operator's aircraft fleet is fitted with two different types of FMS. There are significant differences in the operation of these two systems. The operator has established a training programme which comprises a course of ground training and two observational flight sectors on an aircraft fitted with the other type of FMS from that on which initial conversion training was conducted. The flight familiarisation can be carried out during two normal line sectors. On this occasion, the operating crew were not made aware before they reported for their flight that it was to be used for this purpose.

For enhanced system efficiency and traffic capacity reasons, London Area Control Centre procedures for traffic inbound to Bristol Airport restrict descent below FL220 until after the aircraft has passed CPT VOR. Routing is then generally towards ABDAL, with descent clearance down to FL110, after which the handover to Bristol Approach control is made. Further descent and approach clearances are managed by Bristol ATC. The company standard operating procedure was to carry out the Approach checklist once the aircraft had been given a descent clearance to an altitude (ie when cleared to descend below the Transition Altitude). At Bristol the Transition Altitude is 3,000 feet.

The Transition Altitude in the UK varies between 3,000 and 6,000 feet, depending on location, which is relatively low compared to many other countries. The UK forms part of the ICAO European Region. The following text is published in ICAO document 'Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS)';

*'As far as possible a common transition altitude should be established:*

*a) for groups of aerodromes of a state*

*b) on the basis of an agreement, for aerodromes of adjacent states, states of the same flight information region, of two or more adjacent flight information regions or one ICAO region*

*c) for aerodromes of two or more ICAO regions when agreement can be obtained between these regions.'*

There have been several study groups investigating the possibility of a harmonised Transition Altitude throughout Europe, but to date no firm proposals have been considered.

## **Aircraft information**

The aircraft has a  $V_{MO}$  of 320 kt between 26,000 and 10,000 feet, which then reduces linearly to 250 kt at 8,000 feet. To avoid 'nuisance' overspeed warnings during descent, the aircraft manufacturer recommends operating the aircraft at speeds of 20 kt below  $V_{MO}$  until at 10,000 feet, then at 240 kt or less thereafter. The Operations Manual also contains the following instruction:

*'Flight idle must be selected passing FL120 in order to reduce speed to 240 kt by FL80. This will prevent an overspeed.'*

In the event of an overspeed occurring, the speedtape of the Primary Flight Display (PFD) indicates the present speed in red, there is an audio warning tone and an audio voice warning "HIGH SPEED". The Quick Reference Handbook (QRH) procedure for this condition is to adjust airspeed to  $V_{MO}/M_{MO}$  Max.

The Embraer 145 (E145) aircraft type first entered service in the UK in August 1997. A review of the UK MOR database highlighted 12 events in which the E145 has reportedly either failed to capture or adequately maintain a Localiser course. There have also been a significant number of reports within UK operators' own company safety reporting schemes. It does not appear however that the E135 (a similar type but with a shorter fuselage length), has experienced the same problem. As a result of problems experienced with Localiser capture, the operator had previously issued an Operations Manual Amendment Notice to advise crews of Localiser intercept and tracking problems experienced with the type, but this had been withdrawn by the time of this incident.

## **Discussion**

The ATC altitude requirement of FL220 at CPT (56 nm east of Bristol) means that an aircraft will need to carry out a higher than usual rate of descent in order to be able to carry out a straight in approach. Recognising this, the commander selected a rate of descent of 3,000 feet per minute once descent clearance had been obtained. However, during the descent below FL100, the aircraft was not slowed down sufficiently for it to stay within the required airspeed limitation. Other options, if an increased rate of descent cannot be sustained and the aircraft is still too high above the desired profile, are either to request to route overhead the airfield and carry out a procedural approach from there, or to request a longer routing with more track miles from ATC.

Although the presence of three crew members on the flight deck should allow for extra flight progress monitoring, this may not always be the case in practice. On this flight, the presence of the extra crew member may have increased the workload for both pilots during both sectors as they passed on information about the functioning of the FMS.

During the descent, it appears that some flight progress monitoring Standard Operating Procedures (SOP) calls were missed. There are a number of possible reasons why this occurred. The descent was rushed because of the high rate required and the high speed of the aircraft. The "HIGH SPEED" warning led the commander to disconnect the Autopilot earlier than usual, thereby increasing his workload. The Approach checklist was carried out late in the approach sequence because it was the standard practice to action it once the aircraft was cleared to an altitude, and the Transition Altitude at Bristol is relatively low. The Landing Gear was selected down, which increased the aircraft drag and consequently resulted in a greatly increased rate of descent. It is also likely that the "SINK RATE" caution occurred at the same time as the '1,000 to go' altitude alert audio tone and it therefore overrode the alert tone.

Once the descent below the cleared altitude had occurred, it was soon detected through a number of different means. Visual ground contact was acquired, the GPWS alert activated, the PNF called out that the aircraft was too low and ATC advised the crew that the aircraft was too low. Prompt recovery action was then taken by the commander.

### **Safety action**

As a result of the in-service problems with Localiser capture and tracking, the aircraft manufacturer has issued a number of Service Bulletins (SBs). The newest software standard, which was fitted to the aircraft at the time of this incident, was EICAS System Version 17. The manufacturer issued SB 145-31-033 (EICAS System - Upgrade to Version 18.5 (Phase 8.5)) during the summer of 2002, which addressed reported instances of Localiser capture difficulties by E145 aircraft. In view of the continued poor VOR/LOC performance on this aircraft type, the CAA has recommended to the Joint Aviation Authorities (JAA) that this SB should be made mandatory. Another bulletin, SB 145-34-0050, requires replacement of the entire VOR/LOC antenna system. It is understood that this is to reduce signal strength losses along the feeder cables. The longer fuselage of the E145 may account for the apparently poorer in-service performance when compared with the otherwise similar installation in the E135 model. The CAA is urging the JAA to make this SB mandatory. Although neither of the above mentioned SB's are mandatory at present, it is understood that the CAA is monitoring the effectiveness of these SB's through the JAA.