Avro 146-RJ85, EI-CNJ

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Aircraft Type and Registration:	Avro 146-RJ85, EI-CNJ
No & Type of Engines:	4 Allied Signal LF-507-1F turbofan engines
Year of Manufacture:	1997
Date & Time (UTC):	7 January 1998 at 1251 hrs
Location:	London City Airport
Type of Flight:	Scheduled Public Transport
Persons on Board:	Crew - 4 - Passengers - 28
Injuries:	Crew - None - Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	16,500 hours (of which 700 were on type)
	Last 90 days - Unknown
	Last 28 days - Unknown
Information Source:	AAIB Field Investigation

History of Flight

The aircraft was operating a scheduled service between Turin and London on a windy day. The 1250 hrs ATIS was Runway 28 in use, wind 240°/17 kt maximum 28 kt and varying in direction between 200° and 290°. Visibility was greater than 10 km and there were a few towering cumulus clouds base 3,000 feet. There was no rain and the runway was dry but pilot reports of windshear on short finals had been received in the ATC Tower and a warning of windshear was passed to the crew of EI-CNJ when they were approximately 4 nm from touchdown. During the latter stages of the approach the controller passed wind reports to the crew of 230°/18 kt maximum 28 kt and 240°/18 kt maximum 28 kt. Because of the windy conditions ATC had increased the Airport's fire and rescue service readiness state to 'weather standby'.

The commander was handling during the autopilot coupled ILS/DME approach to Runway 28 which has a 5.5° glideslope. The Tower controller watched the aircraft land on Runway 28 which has a published landing distance available of 1,199 metres. He reported that the aircraft touched down nosewheel first and continued along the runway at speed with the mainwheels clear of the ground. At a point about two thirds along the runway the mainwheels touched down and shortly afterwards the lift spoilers deployed. Heavy wheel braking and smoke from the mainwheels was noticed; the smoke became more noticeable after the aircraft had crossed over the 'piano key' threshold markings. The aircraft overran the published landing distance available and entered the 75 metre starter extension of Runway 10 but it remained on the hard surface and was able to turn off at Hold Alpha without assistance. The fire and rescue service were despatched by ATC to inspect the aircraft's landing gear but no damage was evident. The aircraft then continued with a normal turn-around and departed for Turin.

Examination of the end of Runway 28 revealed main gear tyre marks made by EI-CNJ. These could be traced back towards the mid point before becoming lost in the mass of marks made by other aircraft. The tyre marks were discontinuous, consistent with normal operation of the anti-skid system, and became heavier towards the end of the landing roll. Beyond the piano keys, ie in the runway extension area, the marks were continuous for 5 to 6 metres, indicating locked wheels following deactivation of the anti-skid system at low speed. These marks terminated 31 metres from the end of the paved area. The skid had been severe enough to leave a quantity of loose rubber on the runway surface and had generated locally high temperatures on the tyre, with 'footprints' of partly melted rubber being made by the left wheels as the aircraft taxied following brake release.

Recommended approach and landing technique

The RJ85 has a maximum demonstrated crosswind component of 33 kt. With flaps at 33, Vref at the landing weight was 108 KIAS. For steep approaches the aircraft manufacturer offers the following advice: "When gusts are reported, increase approach and threshold speeds by the gust factor up to a maximum increment of 10 kt." On the subject of windshear, the same manual advises: "If windshear or turbulence is expected on final approach, increase the approach and threshold speeds by the gust factor up to a maximum of 10 kt. The speed over the threshold must not be more than Vref+10 kt for RLW data to remain valid; therefore, the maximum approach speed that can be set is Vref+15 kt." (Notes: RLW means regulated landing weight which relates to scheduled landing performance and the aircraft is expected to lose at least 7 kt airspeed in the flare). The manufacturer's advice regarding the landing rollout technique is: "Confirm idle power and lower the nosewheel to the runway. Commence wheel braking and confirm positively that the lift spoilers have automatically deployed, following up immediately with manual selection if deployment is in any doubt or if LIFT SPLR glareshield caption illuminates".

Flight recorders

The Flight Data Recorder (FDR) was replayed by the operator once the aircraft had returned to Turin and the data was passed to the AAIB. The Cockpit Voice Recorder (CVR) would have recorded over the period of the incident during the subsequent flight and so was not replayed.

Recorded data showed that the approach was flown with flap 33 selected and the autopilot ILS/DME coupled down to a height of 440 feet agl. At that altitude typical values of wind direction and speed were recorded as 240°/26 kt. Over the next 6 seconds the airspeed initially reduced from 121 kt to 115 kt, with very little change in the ground speed of 96 kt. The nose of the aircraft was lowered to 5° nose down and airspeed increased to a peak value of 131 kt but with a momentary fluctuation down to 112 kt. During the period following autopilot disconnect the aircraft had progressively fallen below the prescribed glide path of 5.5° culminating in the activation of a GPWS warning for four seconds. The thrust levers were advanced briefly and the nose raised to regain the correct profile before the flare was initiated at a height of 50 feet agl. At no stage during the approach or landing was the windshear warning activated.

At an airspeed of 121 kt the nose gear contacted the ground first, near the centreline and just past the two inset touchdown lights which are 336 metres beyond the threshold of Runway 28. The vertically mounted accelerometer registered 1.23 g at this initial touchdown. After nose gear oleo compression, the elevator trailing edges, which had been raised to zero degrees incidence during the flare, were lowered to 20° down, which indicates full forward control position, and remained in that position for the duration of the landing roll. The aircraft travelled for a further 10 seconds down the runway on the nose gear during which time both left and right brakes were applied and the pitch attitude remained between 2.0°and 2.5° nose down. Main gear oleo compression and yellow hydraulic system spoiler deployment did not occur until the end of this 10 second period when the airspeed had reduced to 105 kt and the aircraft had travelled 560 metres down the runway from the touchdown point. After a further 130 metres, at an airspeed of 88 kt and within two seconds of the yellow spoiler deployment, the green hydraulic system spoilers deployed. The aircraft braked rapidly, achieving a peak deceleration of -0.56 g in the remaining 200 metres that it travelled. After the aircraft had slowed to less than 20 kt, it departed the end of the runway and ran onto the starter extension with left rudder applied. The right wheel brakes only were released, the aircraft turned left and came to rest on a heading of 138°M.

Examination of aircraft

Following the incident the aircraft flew three more sectors, ending the day at its Turin base. The operator reported that despite the heavy rubber deposits left by the main gear tyres in the runway extension area at London City, a visual inspection of the landing gear, including the tyres, revealed no defects. Checks were also made on the hydraulic contents, the brake accumulator and the brake system, including the anti-skid system, all of which were satisfactory.

Runway markings

A number of aspects of the airport design and marking at London City Airport are based on recommendations in the ICAO Stolport Manual. The inset thresholds are conventionally marked but the touchdown zones have only one pair of fixed distance markers with centres approximately 123 metres from the thresholds; these coincide with the glidepath origin and the PAPIs. The end of each touchdown zone is marked by a pair of white lights inset into the runway surface 336 metres from the threshold. The lights are visible during approach but they tend to disappear below the aircraft's nose in the landing flare. This can sometimes make it difficult for pilots to judge whether or not they will touch down before or after the lights. The Manufacturers Training Manual for the aircraft states that unless it is anticipated that the aircraft will be on the ground by the end of the touchdown zone then a go-around must be initiated. However, in an 'All Operator Message' issued by the aircraft manufacturer's customer support organisation on 21 November 1997 entitled 'OPERATIONS INTO LONDON CITY AIRPORT', these lights were incorrectly described as *'the ideal touchdown point lights'*. Other slightly confusing features are the 'starter extensions' at each end of the runway which may be used for take-off but not for landing (see AAIB Bulletin 4/98 page 28). These extensions have a surface colour similar to the main runway and it is not obvious from a distance where the runway stops and the starter extension begins. Consequently, during the early stages of the landing roll the runway distance remaining can appear to be longer than is actually the case.

Analysis

In the prevailing wind conditions, and having received a warning of windshear on short finals, the commander was justified in carrying extra speed on final approach. For this approach, half the gust factor would have been 5 kt [(28-18)/2] but this increment would be for gust protection only . In view of the reported wind shear, the commander was justified in adding the maximum increment of 15 kt to Vref for the approach with the expectation of losing 5 kt in the flare thereby touching down at Vref+10 kt. He succeeded in achieving an average airspeed of Vref+15 kt on finals until just before the flare when the airspeed started to rise. The commander reduced engine power to compensate but in the flare the airspeed started to reduce rapidly so he increased power to stabilise the airspeed. The aircraft floated and the nose wheel touched down just beyond the lights which mark the end of the touchdown zone.

After touchdown the control column was pushed fully forward. This action was contrary to advice contained in the aircraft manufacturer's training manual which contains the caution warning *"After nosewheel touchdown, do not move the control column significantly forward of neutral"*. The warning was issued because if significant forward pressure is applied and held, lift generated by the elevators can reduce the load on the mainwheels to the extent that the 'weight on ground' sensors remain open . Without weight on the mainwheels the wheel brakes are ineffective, the ground

spoilers cannot be deployed and the engines generate flight idle thrust instead of ground idle thrust. Consequently the landing ground roll distance increases markedly and heavy braking may be needed when the weight on wheels sensors eventually sense that the aircraft is on the ground and allow the ground spoilers to deploy. This problem appears to have occurred on the incident landing and it was made worse by the excess speed on touchdown. Nevertheless, there was still a 10 kt headwind component on the runway and having touched down at a ground speed of 111 kt (airspeed 121 kt = Vref+13) , the aircraft should have stopped without the need for fierce braking had the commander not held the control column fully forward.

The UK AIP entry for London City had a textual reference to the end of touchdown zone lights in section 2.14 but the lights were not shown or mentioned on the Aerodrome Chart. The AERAD aerodrome chart also mentioned the lights and their significance but the Jeppesen chart did not. The operator used Jeppesen charts. Nevertheless, the commander should have learned of the significance of the lights during his training to operate into London City Airport. He was not trained by the aircraft manufacturer's flight training organisation.

Safety actions

As a result of this and other landing incidents at London City Airport, the CAA reviewed the information and guidance available to operators; as a consequence, the AIP entry and aerodrome chart for London City will be amended at the next cycle to clarify certain items of information. The operator's pilots have been re-briefed on the significance of the touchdown zone lights and the correct position of the control column after touchdown. The aircraft manufacturer undertook to clarify minor discrepancies in its Aircraft Flight and Operations Manuals concerning approach speeds and its customer support organisation was invited to amend the All Operators Message describing the significance of the touchdown zone lights. The Jeppesen company was informed of the purpose of these lights and the absence of any mention or illustration of the lights on its aerodrome chart.