AIRCRAFT ACCIDENT REPORT 10/77

Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Boeing 747 G-AWNC
Report on the accident near Subang International Airport, Kuala Lumpur, Malaysia on 11 May 1976

LONDON

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Department of Trade
Accidents Investigation Branch
Kingsgate House
66-74 Victoria Street
London SW1E 6SJ

2 November 1977

The Rt Honourable Edmund Dell MP
Secretary of State for Trade

Sir,

I have the honour to submit the report by Mr G C Wilkinson an Inspector of Accidents, on the circumstances of the accident to Boeing 747 G-AWNC which occurred near Subang International Airport, Kuala Lumpur, Malaysia on 11 May 1976.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

Accidents Investigation Branch
Aircraft Accident Report No. 10/77
(EW/A262)

Operator:		British Airways (Overseas Division)
Aircraft:	*Type:*	Boeing 747
	Model:	Series 136
	Nationality:	United Kingdom
	Registration:	G-AWNC
Place of Accident:		Near Subang International Airport, Kuala Lumpur, Malaysia
Date of Accident:		11 May 1976

All times in this report are GMT

Synopsis

The accident was reported by British Airways to the Accidents Investigation Branch of the Department of Trade, and notification was received from the Malaysian Civil Aviation Authority that they had initiated an investigation. A United Kingdom Accredited Representative participated in the initial stages of the investigation in Kuala Lumpur, after which the Malaysian authorities elected to delegate the inquiry to the United Kingdom in accordance with paragraph 5.1 of Annex 13 to the ICAO Convention.

The accident occurred during a manually flown approach to Runway 15, at night, and in good weather. The commander had elected to follow an approach procedure using the VOR and MF beacons. The aircraft descended substantially below the normal flight path and hit trees 2.2 nm before the runway threshold. Following a successful overshoot the aircraft landed on Runway 33 without further incident and without injury to passengers or crew.

It is concluded that the accident was caused by insufficient monitoring of the aircraft flight path by the crew during the transition from a let down procedure to the visual phase of a landing approach at night. Inadequate planning and a poor execution of the approach by the commander coupled with an approach procedure which did not allow a stabilised approach. A prolonged audio warning and possibly tiredness were contributory factors.

1. Factual Information

1.1 History of the flight

The aircraft was operating as British Airways (Overseas Division) (BAOD) scheduled passenger service BA 888 from London to Melbourne via Bahrain, Bangkok and Kuala Lumpur. The flight crew, consisting of the commander, co-pilot and flight engineer had taken the aircraft over at Bahrain after a 24 hours lay-over from the previous day's service. (In BAOD Terminology the flight engineer is called the engineer officer). The aircraft had departed Bangkok at 1040 hrs and after an uneventful flight at flight level (FL) 330 made an approach to land on Runway 15 at Kuala Lumpur International Airport, it being flown manually by the commander.

The approach was being made in visual meteorological conditions but the commander had elected to carry out the instrument approach procedure based on the Very High Frequency, omni-directional radio range (VOR). The relevant approach procedure plate, as used by BAOD is at Appendix 1. Before descent from cruising altitude the commander had briefed the co-pilot and flight engineer on the procedure.

The VOR (call sign VBA) is 12.4 nm from the threshold of Runway 15 and is offset about 1 nm to the north of the extended centre-line of the runway. The approved procedure requires the aircraft to cross VBA at or above 2,000 feet (QNH) and then to track out on the 158° radial descending towards the NM medium frequency locator beacon, which is on the runway centre-line approximately 4 nm from the threshold. If visual contact with the ground is established at the decision height of 860 feet (QNH) over NM then 860 feet is maintained in level flight until intercepting the nominal glide path, as defined by VASI or by visual estimation. If not visual at 860 feet over NM the aircraft overshoots and proceeds according to its ATC clearance.

Approaching VBA in descent from cruising level both pilots set the Kuala Lumpur QNH of 1012 mbs on their pressure altimeters and also set the indices on the pressure altimeters to the decision height of 860 feet in accordance with BAOD procedures. They also set the indices on their radio altimeters to 791 feet, this value is derived by subtracting the runway threshold elevation of 69 feet from the decision height of 860 feet. With this setting the radio altimeter audio warning should have started approximately 75 feet above 791 feet and continued with an increasing amplitude down to 791 feet which, over level terrain, would coincide with 860 feet on the pressure altimeters.

As the aircraft crossed VBA at 2,000 feet tracking out on 158° (M) the runway lights were clearly visible to the flight crew, and about this time the commander called for the landing checks. Wing flaps were extended progressively to 1, 5 and finally to 10 and when the aircraft had descended to about 1,000 feet the flight engineer made a warning call of 'no flags, 10 flap set'.

The aircraft levelled off at about this time and almost simultaneously the radio altimeter decision height audio warning began and was apparently much louder and persisted for much longer than the crew had anticipated. During the period that the audio warning was operating the commander stated that he called for landing gear down and 20 flaps. The landing gear lever was selected down but one of the landing gear warning lights became dislodged from its holder. This caused an interruption of the flight engineer's drills whilst he verified the door status from the systems panel.

Neither the co-pilot nor flight engineer heard the call for 20 flap and consequently it was not selected; the commander was not aware of this but he did not query why the actioning response was not repeated back to him. Airspeed had been excessive throughout the approach. The failure to extend 20 flaps exacerbated the situation so that as the aircraft approached NM the commander was faced with the necessity of aligning the aircraft with the runway, maintaining height, and reducing airspeed.

From this point, about two miles before NM, the crew's recollection of events is fragmentary and confused. The commander stated that he was flying the aircraft by reference to attitude, speed and rate of descent but he could not recall any power settings. Despite the requirement to hold decision height until intercepting the visual glide path, descent restarted before NM but neither the commander nor the other two flight crew members, appear to have been aware of the premature loss of height or of a significant rate of descent. Just after passing NM at a speed of about 170 knots the commander called for 25 flaps. This was twice queried by the co-pilot as '25 from 10?' because of the missing intermediate 20 flap call and also because the airspeed was close to the limiting speed for 25 flap. There was, however, no response from the commander. During this period of time the flight engineer was completing the landing check list, the co-pilot was operating the radio and both were monitoring the 25 flap extension.

The commander recalled that on looking up after an instrument scan the runway lights had disappeared; at about this same time the co-pilot noticed that his radio altimeter was reading about 150 feet and called urgently '100 feet above ground level'. As this call was made the commander advanced the thrust levers and rotated the aircraft into a climbing attitude. As the thrust levers were being advanced the commander heard a noise like an engine surge. No. 1 engine indications were seen to falter then recover; the aircraft yawed and banked to the left and the commander applied corrective control. Overshoot drill was carried out using less than maximum go-around thrust and, during this period, the flight engineer told the commander that he thought they had struck the ground; the commander however was not convinced that they had done so.

Following the overshoot the aircraft entered the holding pattern over the KL beacon to the south of the airport. Aircraft systems, flying controls and handling characteristics were checked. All indications were normal but as a precautionary measure the airport fire and rescue services were requested to stand by. The commander then elected to land on Runway 33 and asked for the Standard VASI to be switched on. He carried out the KL NDB let-down procedure and made an uneventful landing on Runway 33 with the airport emergency services in close attendance. Inspection of the aircraft after landing showed evidence of engine and landing gear damage consistent with the aircraft having hit the tops of trees.

The accident occurred at night at approximately 1220 hrs at a position latitude 03° 10'N, longitude 101° 31' E at an elevation of approximately 170 feet above mean sea level (amsl) and 2.2 nm from the threshold of Runway 15.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	–	–	–
Serious	–	–	–
None	18	104	

1.3 Damage to aircraft

The airframe and engines sustained superficial damage and ingestion contamination.

1.4 Other damage

The aircraft flew through tops of mature rubber trees on an estate knocking down two complete trees and felling several large boughs. The area affected was approximately 200 metres long and 30 metres wide.

1.5 Personnel information

1.5.1 Flight crew

Commander — Male, aged 48

(i) Licence — Airline Transport Pilot's Licence valid until 1 December 1978 subject to continued medical fitness, recency requirements, and instrument rating renewal. A class 1 medical certificate, issued in January 1976, required spectacles to be carried for distant vision. Spectacles were being worn at the time of the accident. Aircraft ratings: Boeing 747 and VC10.

(ii) Mandatory — Last periodic competency check was on 2 April 1976 in 747 Flight Simulator. This included an instrument rating renewal.

Last route check (on the New York - London sector) was completed on 1 March 1976. Last safety equipment and procedures check: 8 March 1976.

(iii) Flying experience — Total hours all types: 12,169
Total hours in command, all types: 2,743
Total hours on B747: 904 (as pilot in command).
Total hours on B747 during last 6 months: 182.
Total hours on B747 during last 30 days: 48 hours 48 minutes.

(iv) Duty time — The commander had been on duty for 9 hours 50 minutes at the time of the accident, including a period of approximately one hour before take-off from Bahrain.

Co-pilot — Male, aged 29

(i) Licence — Airline Transport Pilot's Licence, valid until October 1980, subject to continued medical fitness, recency requirements and instrument rating renewal. Last medical examination was in January 1976. Aircraft ratings: co-pilot on Boeing 747 and VC-10.

(ii) Mandatory checks — Last periodic competency check was on 19 March 1976 on a 747 Flight Simulator. Instrument rating renewal, also on a 747 Flight Simulator was done on 25 September 1975. Route training completed on 6 October 1975. Safety equipment and procedure check on 10 October 1975.

(iii) Flying experience	Total hours all types: 3,930 Total as co-pilot on Boeing 747: 252 Total hours during last 6 months: 192 Total hours during last 30 days: 57
(iv) Duty time	10 hours 40 minutes up to the time of the accident.
Flight engineer	Male, aged 41
(i) Licence	Flight Engineer's Licence, valid until March 1978 subject to continued medical fitness and recency requirements. Last medical examination was in September 1975. Type rating: Boeing 747 and VC-10.
(ii) Mandatory checks	Last periodic competency check: 11 March 1976. Safety equipment and procedure check: 10 November 1975.
(iii) Flying experience	Total hours all types: 5,577. Total hours on B747: 1,952 Total hours in last 6 months: 272 Total hours in last 30
(iv) Duty time	10 hours 40 minutes up to the time of the accident.

General

The three flight crew members had not previously flown together as an operating crew. The commander had previously landed at Kuala Lumpur on 14 March 1976 and 13 December 1974, both occasions being in daylight on to Runway 33. The co-pilot had last operated into Kuala Lumpur as a VC10 co-pilot in June 1973 and the flight engineer, had operated into Kuala Lumpur once in the previous 12 months; neither pilot had experience of the VOR procedure to Runway 15 at night. On 14 March 1976 the commander had made an unsuccessful VOR approach to Runway 15 in daylight and in poor weather followed by an overshoot.

All three flight crew members reported that although they were not conscious of tiredness at the time of making the approach they felt very tired after the subsequent landing. They reported varying degrees of dissatisfaction with their 24 hours rest period at Bahrain and felt that the timing of the flight and the hotel facilities provided did not result in them obtaining adequate rest before the flight to Kuala Lumpur.

1.6 Aircraft information - Boeing 747-136 G-AWNC

1.6.1 General information

(i) Manufacturer	The Boeing Company, Seattle, USA
(ii) Year of manufacture	1970 Serial No. 19763
(iii) Name of registered owner	British Airways Board, registered 1 April 1975

(iv)	Certificate of Airworthiness	Transport Category (Passengers) first issued 30 June 1970, last renewed 16 November 1973 valid until 15 November 1976
(v)	Total hours since last C of A renewal	10,192
(vi)	Certificate of Maintenance	11 November 1975, valid for 2,400 hours
(vii)	Hours flown since last inspection	2,201
(viii)	Total hours since new	18,407
(ix)	Weight at time of accident	207,100 kg
(x)	Centre of Gravity	Within limits as shown on Company load sheet
(xi)	Fuel remaining at time of accident	20,900 kg
(xii)	Type of fuel	Jet A1
(xiii)	Defects	There were no defects pertinent to the accident

The aircraft flight instrumentation was fully serviceable and provided an adequate presentation of heading, height, attitude and airspeed information for each pilot.

1.7 Meteorological information

The accident occurred in darkness at 1220 hours, 62 minutes after local sunset. The following weather condition existed at Kuala Lumpur between 1200 hours and 1230 hours:

Surface wind	Calm
Visibility	15 km
Cloud	1 Okta cumulo-nimbus to the SE, base 1,700 feet
	4 Oktas 14,000 feet, 7 Oktas at 28,000 feet
Weather	Nil
Surface temperature	+ 25°, Dewpoint + 22°
Surface humidity	85%
QNH	1012 (changed to 1013 at 1230 hrs)
QFE (Runway 15)	1010
Runway conditions	Wet

1.8 Aids to navigation

1.8.1 In the aircraft

The aircraft's navigation equipment was serviceable and consisted of two VOR receivers, two automatic direction finding (ADF) receivers, two Distance Measuring Equipment (DME), two transponders, two weather radars and three Inertial Navigation Systems (INS). Although the INS can be used to provide track guidance, distance to run to or from a selected way point, drift and groundspeed, none of these INS facilities was used to monitor the aircraft's progress from VBA towards NM, nor was the DME equipment used to monitor continuously the distance run from VBA.

1.8.2 On the ground - radio aids

As noted in 1.1 and at Appendix 1 the relevant radio aids consist of the VOR/DME beacon VBA and the M/F locator beacon NM, both these facilities were fully serviceable. The locator beacon has a nominal power of 80 watts although it is understood that its actual output is somewhat greater. It is about 1.4 nm from overhead high tension power cables which are closer to the runway and cross the extended centre line at right angles. The power cables carry pulse signalling for switchgear in the form of an audio tone system of less than 300 cps; this is used in bursts of no longer than 5 seconds duration, possibly once per hour. There were no recent reports of unsatisfactory performance or poor reception in respect of the beacon itself.

1.8.3 On the ground - visual aids

Runway 15 is equipped with a single white line and two crossbar approach lighting, high intensity edge lights, wing bars and threshold lights. All runway and approach lights were switched on and serviceable and the crew stated that the runway lights were 'crystal clear' from 12 miles distance. There are two types of Visual Approach Slope Indicators (VASI), the ICAO Standard red/white indicators and the Australian 'T-bar' system available on Runway 15. The 'T-bar' was the primary VASI system in use at Kuala Lumpur and the switching controls for the standard VASI were taped over on the control console in the Tower to prevent inadvertent use when the 'T-bars' were active. The procedure at Kuala Lumpur is to switch on the 'T-bars' when an aircraft is handed over to Approach Control from Airways Control and to switch them off after the aircraft has landed. The approach of G-AWNC was preceded by a Boeing 707 (9 MMCR) which landed 16 minutes earlier on Runway 15 and its commander stated that the 'T-bars' were switched on. It is not known if they were switched off after 9 MMCR landed but the Approach Controller stated that before G-AWNC commenced its approach he checked and saw that the green light on the control console was illuminated, thus indicating that the 'T-bars' were switched on for Runway 15. From the available evidence it is concluded that the 'T-bar' VASI were probably switched on at the time of the accident.

After the accident the commander said that he had not seen either approach lights or VASI and maintained that the latter were not switched on; the co-pilot was unable to recall whether or not they were switched on, the flight engineer said he had not seen any red lights. The commander also said he had not asked for the VASI to be switched on because he assumed they were unserviceable. A Class 1 Notam (Notices to Airmen) No. 4/76 published on 5 May by the Malaysian Aeronautical Information Service contained the following information:

'Kuala Lumpur ..... T-VASIS ..... with immediate effect T-VASIS on a 3 degree glide slope available to aircraft 5 minutes before ETA. Red/White VASIS will be available only on specific request'. This information was on a briefing sheet which the crew of G-AWNC obtained before leaving Bangkok.

1.8.4 Post accident flight checks

A post-accident flight check was carried out on 15 May by an aircraft of the Malaysian CAA Calibration Unit. The accuracy of the VOR/DME installation and the glide-slope settings of the VASI were checked; the VOR radial of 158° coincided with the overhead indication of the north marker NDB (NM) and the 'on glide slope' setting of both sets of VASI was found to be 3°. In the case of the 'T-Bar' system the top of its red sector lights coincided with an angle of 2° which was within permitted tolerances.

Flight checks were made to measure the height of the 3° 'T-bar' glide slope at NM and the height above the impact point where the VASI and runway lights would be masked by the intervening topography or trees. It was established that:

(a) the 'on glide slope' indication intersected overhead NM at 1310 feet QNH;

(b) the red 'T' full gross undershoot indication and all runway lights were visible at 400 feet QNH when overhead the point of impact, and;

(c) the 'T-bars' and the first 600 feet of runway lighting were obscured at 300 feet QNH when overhead the point of impact.

The above measurements were taken at dusk.

1.9 Communications

Communications were normal throughout the relevant period. Continuous speech recording equipment was in operation in Kuala Lumpur Tower and a satisfactory transcript of the messages exchanged between the aircraft and ground facilities was subsequently derived. There was no evidence of the radio altimeter audio warning noise in the recording of the RTF transmissions from the aircraft when it was passing the NM beacon.

1.10 Aerodrome information

Runway 15 is 3,475 metres long and has a touch-down elevation of 69 feet amsl with an obstruction free approach slope of 1:50. For the final 1½ nm of the approach centre line the terrain undulates between 50 feet and 80 feet amsl with isolated spot heights up to 200 feet amsl. From 1½ nm out to 2.2 nm (where the aircraft struck trees) the ground elevation varies between 100 and 150 feet amsl with spot heights up to 260 feet amsl to the left of centre line. The area is primarily rubber tree plantation with the tops of trees to an average height of about 60 feet above ground.

The approach area to Runway 15 is completely devoid of any form of lighting from housing, roadways etc.

1.11 Flight recorders

1.11.1 Flight Data Recorder

(a) The aircraft was equipped with a Plessey PV740 digital flight data recording system.

The installation included both a crash-protected mandatory recorder with steel wire as the recording medium and an expanded AIDS recorder with steel tape as the recording medium.

A playback of both recorders was obtained and tabulated data for the accident flight was produced. Additionally, decimal dump listings were produced to enable checks on raw data to be carried out.

All mandatory parameters had been recorded but pressure altitude had been subject to intermittent errors and pitch attitude failed to register in excess of 12.8 degrees nose-up.

(b) Sufficient valid data were available to enable a detailed analysis of the incident to be made.

The evidence obtained from the FDR does not differ significantly with other evidence, ie crew statements, site investigation, etc.

A number of plots were produced of which the following are included in this report:

(i) Relevant parameters against time (Appendix 2)

(ii) Track plot (Appendix 3)

(iii) Approach profile (Appendix 4)

(iv) Terrain and obstruction clearance (Appendix 5)

1.11.2 Cockpit Voice Recorder

A Fairchild A100 Cockpit Voice Recorder was fitted but provided no evidence to assist the investigation because the recorder continued to run for more than 30 minutes after the accident occurred in a system in which the duration of the continuous loop recording was 30 minutes. In any case the flight engineer erased the cockpit voice recorded tape record in the course of the normal post-landing shut down drills.

1.11.3 Recorded data

The flight recorder data shows that as the aircraft approached the VBA VOR beacon it was descending on a heading varying between 140° (M) and 142° (M), with the thrust levers retarded and the indicated airspeed (IAS) reducing to 230 knots overhead VBA. After crossing the beacon at 2,000 feet QNH, the aircraft turned on to 165° (M), flaps were extended to 1, and a descent towards NM was started at about 500 feet per minute (fpm). Flaps were then progressively extended to 5 and then to 10 whilst the descent continued steadily on the heading of about 165° (M) and by approximately 1,100 feet QNH the IAS had reduced to 194 knots.

The descent was checked at about 1,000 feet QNH, 100 seconds after leaving VBA and approximately 2 nm before NM. The thrust levers were advanced slightly, increasing the engine pressure ratios (EPR) from about 0.955 to about 1.025. Level flight was maintained for about 20 seconds at 980 feet QNH during which time the IAS decayed to about 180 knots, and also during this 20 second period there was an alteration of heading to the left on to 153° (M).

120 seconds after leaving VBA and approximately 18 seconds before reaching NM the aircraft began to descend again, initially with about the same thrust setting used in the period of level flight. At 123 seconds the landing gear was indicating down and locked, thus it may be deduced that it had been selected 'down' about 23 seconds earlier, coincident with the aircraft being levelled out. The aircraft passed a little to the east of NM at 138 seconds and almost immediately turned right on to 166° (M). It was then at about 760 feet QNH descending at an average rate of about 500 fpm with the IAS reducing from 177 knots to 172 knots. At 162 seconds, ie about 40 seconds after renewing the descent, the thrust levers were fully retarded and a left turn towards a heading of 152° (M) simultaneously initiated. About 8 seconds later, as the aircraft was passing 380 feet QNH, flaps were selected to 25°. This selection was made at about 160 knots, and was accompanied by a nose-down change in pitch attitude from +2.9° to +1.5°; the rate of

descent then increased to about 900 fpm until the thrust levers were advanced about 4 seconds prior to impact. At a speed of 152 knots 180 seconds after leaving VBA the aircraft struck the trees; at that time the pitch attitude had increased to +3.6° and the thrust levers were moving forward.

The remainder of the relevant recorded data indicates a normal overshoot followed by a period in the holding pattern and a landing on Runway 33.

1.12 Wreckage information

1.12.1 Accident site

The position at which the aircraft had struck the trees was identified from the air by lines of discoloration in the tops of rubber trees on a low hummock about two miles short of the runway and about 400 metres to the right of the runway extended centre line. The ground elevation at this point is about 140 feet amsl and the tops of trees are about 60 feet above ground level. The main impact mark was a 200 metres long swathe of defoliated branches heading directly towards the airfield; the width of this swathe corresponded to the width of the main landing gear and to the left of this swathe were two deep straight 'trenches' in the tree tops at a spacing appropriate to the aircraft's left side engines. To the right of the swathe there was a faint trough at the correct spacing for the number 3 engine.

On the ground there were small fragments of flap structure and along the line of the main swathe two complete trees and several large boughs had been felled by the passage of the aircraft. Witness marks on the trees indicated that the aircraft had penetrated the foliage down to a depth of about 15 feet from the tree tops. The length of the trail of broken branches was measured at about 200 metres with some traces of freshly broken foliage extending a further 100 metres.

1.12.2 Damage to aircraft

Examination of the aircraft after the landing on Runway 33 showed that there had been some damage to the hydraulic and electrical systems on all the main landing gear legs. From strike marks on the fuselage, landing gear and engine intakes it was evident that the aircraft had been immersed in foliage to a depth corresponding to the height of the main wing landing gear legs, the left side of the aircraft having penetrated deeper into the foliage than the right. The longitudinal distribution of strike marks indicate that the aircraft had been in a slight nose-up attitude. Numbers 1 and 2 engines, although undamaged were found to be deficient to thrust because of ingestion contamination.

1.13 Medical and pathological information

Not applicable

1.14 Fire

There was no fire

1.15 Survival aspects

The passengers were all seated with their safety belts fastened for landing when the aircraft struck the trees. When power was applied for the overshoot some of the cabin crew heard an unusual noise, felt a bump and a lurch, and sparks were seen coming from No. 1 engine. The Cabin Services Officer (CSO) went to the flight deck and reported to the flight engineer that sparks had been seen from No. 1 engine. At this time the flight crew were preoccupied in checking the aircraft's system and the CSO was informed by the EO to the effect that 'there was a serious problem and to make sure everyone was strapped in'. The CSO then advised the cabin staff to be extra vigilant and to ensure that all door areas were cleared of loose articles. There was no PA announcement but the CSO's instructions

were relayed verbally to each door position and the cabin staff were alerted to the possibility of an emergency evacuation after landing. The CSO reported back to the flight deck that everything was secure for the landing. Passengers were not aware, nor were they made aware, that anything unusual had occurred.

1.16 Tests and research

None

1.17 Other information

1.17.1 BAOD operating procedures

The relevant BAOD Boeing 747 crew manuals contain appropriate instructions to flight crew members. Items of particular relevance to this accident are as follows:

'In respect of crew co-ordination:-

"Cross-checking, monitoring and call outs.

Safety demands that the 747 is operated strictly in accordance with recommended procedures and techniques, varied only as dictated by commonsense and airmanship, having regard to all the circumstances prevailing. The occupants of the Pilot's and E/O's seats must operate as an integrated crew, monitoring and cross-checking each other's actions in so far as is practical ....."

"The navigation and flight progress indications must be cross-checked and monitored continuously; any crew member must advise the Captain immediately if:-

(a) it appears that the aircraft is departing significantly from its intended flight path OR

(b) any abnormal instrument indications, comparator, annuciator flag or light warnings are observed.

(c) any hazardous situation is developing".

During the take-off, climb and approach to land phrases of flight, the non-handling Pilot who will be responsible for monitoring and cross-checking instruments should call out appropriate information; On final approach it is vitally important that the non-handling Pilot continues to monitor the aircraft flight path by references to instruments even after becoming visual, until the threshold has been crossed.

Flap retraction and extension procedure.
When making a flap selection the Co-pilot should check the airspeed and keep his hand on the selector until the flaps have stopped at the desired position before reporting the selection complete e.g.

Captain ..... "Flap 20 set".

Co-pilot ..... "Speed OK, Flap 20"

E/O checks Co-pilot makes correct selection and monitors. Co-pilot keeps hand on flap lever and watches indicators to check the flaps operate symmetrically and stop in correct position.

Co-pilot reports ..... "Flap 20 set".

General - Flight handling

The sheer mass and inertia of the 747 will naturally tend to make for stability of flight path and speed thus accentuating the necessity for forward planning and, for example, for early establishment of "slot" conditions during the approach for landing'.

1.17.2 BAOD Boeing 747 operations and route checking

Most BAOD Boeing 747 operations are into airports equipped with modern approach aids, and involving either automatic approaches or, if manual, then at least approaches in which the aircraft is stabilised in speed and rate of descent at an early stage. Up to the time of the accident BAOD Boeing 747 route checking was confined mainly to this environment. The airline structure is such that the training of pilots and the routine route checking of pilots is carried out by two different departments. It is not BA policy, once a pilot has successfully completed his training, for its route checking organisation to be alerted to any possible weaknesses exhibited by pilots during their training. This is in line with the provisions of CAP 360.

1.17.3 BAOD use of radio altimeter indices

At the time of this accident BAOD procedures called for the setting of a height related to Decision Height on the radio altimeter indices regardless of the type of approach or the terrain in the approach area. With a low decision height, a stable rate of descent and a flat area before the threshold, the related audio warning period is necessarily brief and pertinent. However, in a case such as Runway 15 at Kuala Lumpur, with a high decision height, rising terrain before the threshold and a requirement for extended level flight at about decision height the warning period will be prolonged with the aircraft still at a significant height. The noise level is high and produces a considerable degree of distraction, also a serious interference to voice communication between crew members particularly when, as is generally the case with the Boeing 747, noise excluding headsets for radio and intercommunication are not used on the flight deck.

1.17.4 Commander's training and subsequent checks

The commander began his conversion training on the Boeing 747 in February 1974; he experienced difficulty in assimilating operational procedures applicable to the aircraft type and also that his airmanship was at times demonstrably weak. Towards the end of the simulator phase of his training his progress gave rise to concern in BAOD training management when he failed his instrument rating renewal. However, when re-tested after a refresher detail the following day his standard was adjudged satisfactory and he was considered fit to progress to base flying training. He then received 12 hours 44 minutes dual instruction and 38 landings on the aircraft itself before progressing to route training, where he flew 6 North Atlantic sectors under supervision. On the completion of his route supervision he was issued with an Operations Certificate as Captain on Boeing 747 aircraft for Category I Weather Minima.

On 30 July 1974, three months after qualifying as captain on type, he failed the initial competency check in the flight simulator. In particular an ADF procedure was incorrectly flown with RMI tracking below standard. This poor showing was attributed to lack of recent route flying practice (2 hours during the preceding calendar month): he was re-tested the next day and his performance deemed satisfactory.

On 25 February 1975 he underwent a six-monthly competency check in the flight simulator and was required to be re-tested for: Renewal of Instrument Rating; Category II renewal check; All requirements for a Periodic Base Check. He satisfactorily completed the check when subsequently re-tested on 2 March 1975.

On 13 May 1975 after completing the appropriate training syllabus and the requisite number of autolands in service he was certificated to operate Category III Weather Minima. His last two periodic base checks were satisfactorily completed in January and April 1976.

2. Analysis

The commander's decision to carry out a practice cloud break procedure followed by a straight-in approach from a decision height of 860 feet was in accordance with BAOD policy and was sound in principle since it did not entail delay or hazard to the service. The weather was fine and the runway lights were clearly visible when the descent was started from 2,000 feet. There was no fault in the aircraft's flight instrumentation or radio navigational equipment to account for the accident nor was there any fault in the ground radio installations or airport runway lighting systems.

Over VBA the airspeed was above that recommended in the BAOD 747 Flying Manual for the distance from touch-down (12.4 nm) but not so high as to have prevented a reduction to the recommended value of 156 knots by the time the aircraft reached 8 miles from touch-down, provided that appropriate action was taken in good time. Delay in extending the flaps to 10 reduced the rate of airspeed decay and prevented attainment of the recommended approach airspeed during the period of level flight before NM and the subsequent failure to deploy flaps to 20 exacerbated this airspeed problem.

Approaching NM the aircraft began to diverge from the approved procedure. It has not been possible to establish whether this was intentional or unnoticed but, if intentional, certainly no indication of a change in plan was communicated to the co-pilot or flight engineer nor was there any reason for such a divergence. It is therefore considered more probable that the divergence was unintentional.

It is apparent that the commander was unaware that 20 flap had not been selected. His expectation that the speed would reduce and the pitch attitude would change following the selection of 20 flap was therefore not fulfilled. It may be that whilst he was attempting to resolve this apparent disparity in the aircraft's behaviour that he relaxed his scan of the instruments and allowed the aircraft to descend inadvertently.

As he took no action to correct this premature descent it must be presumed that he did not notice it and since neither the co-pilot nor the flight engineer drew his attention to it, it must also be assumed that they were not aware of it. In particular the co-pilot appears not to have been continuously monitoring the radio altimeter below 2,500 feet agl as required by the company's operating manual. This requirement was introduced following an incident at Nairobi.

After passing NM the commander appears to have become completely absorbed in making a heading change for runway alignment and in trying to reduce his airspeed. Descent continued apparently unnoticed and unchecked so that eventually, when he fully retarded the thrust levers, turned left towards 152° M, and called for 25 flap, the situation was already critical. The aircraft was then at 500 feet QNH with a rate of descent of about 900 feet per minute.

It is evident that from the time of starting the premature descent before reaching NM the commander did not pay sufficient attention to the attainment of a safe approach path nor did he monitor the descent by reference to his flight instruments. It is also evident that neither the co-pilot nor the flight engineer monitored the aircraft's progress properly or if they did they failed to give appropriate warnings when they were necessary. These scanning and monitoring deficiencies must have persisted over a period of more than 50 seconds and a failure of this order is indicative of a break-down in monitoring at a time when the crew were not particularly pressed.

On their own evidence the crew were not particularly tired and indeed, had they been so the commander is unlikely to have committed this crew to the additional effort the procedure entailed. Although the schedule did involve a change from their established UK work/sleep cycle, this was nothing more than is a normal part of airline activity. It would be illogical to attribute a significant proportion of the accident cause to this factor when a great number of more difficult work/sleep routines occur daily in airline operations without any such deterioration in professional standards. None the less crew tiredness may, possibly, have been a factor affecting the way in which the approach was conducted.

The prolonged noise level of the radio altimeter warning could have provided a significant distraction in the period of level flight before NM and was possibly a cause of the failure to achieve 20 flap. However the audio warning had certainly stopped by the time the aircraft passed NM, probably 10 to 15 seconds beforehand. There remains therefore some 40 to 45 seconds of unmonitored descent leading up to the accident which was not subject to this distracting element and cannot be directly attributed to it.

Taking into account the marginally acceptable performance standards displayed by the commander during and after his Boeing 747 conversion training, it is perhaps not surprising that he found difficulty with and became totally engrossed in the procedure and aircraft handling.

The VOR/ADF procedure for Runway 15 at Kuala Lumpur International Airport was evolved before the advent of large jet aircraft and was, as a consequence, not ideally suited to such aircraft as the Boeing 747. However, it is considered that such a procedure should not have presented a competent pilot with any problems.

In instances where individual pilots have experienced difficulties with their conversion training, as was the case with the commander of G-AWNC, it would seem prudent for the airline training department to advise the route checking organisation, within the same company, of the individual's problems so that particular attention could be given to the appropriate aspects of line operations.

Both the accident under review and an earlier incident involving another BAOD Boeing 747 at Nairobi (see Aircraft Accident Report 14/75) revealed inadequacies in BAOD flight deck management and crew co-ordination procedures. In both cases the commander became engrossed with his own activities to the detriment of his overall supervision of the progress of the flight and BAOD integrated crew procedures were inadequate as a safeguard.

It is the responsibility of airline management to ensure that adequate procedures are adopted for the safe operation of their aircraft and that the flight crews are trained in their use. Whilst it is relatively straightforward to write instructions urging flight crew members to operate as an integrated crew and to monitor the performance of other crew members, it is quite another matter to ensure that the training and education of the flight crews results in safe and effective monitoring being achieved.

The two Boeing 747 investigations discussed both serve to highlight the soundness of the principle that the most effective monitoring is achieved when the person with the most authority, namely the commander, is the monitor.

3. Conclusions

(a) Findings

(i) The aircraft had been properly maintained and its documentation was in order.

(ii) The crew were appropriately licenced and experienced. They had carried out all the necessary periodic checks.

(iii) There were no defects in the radio navigational aids on the ground or in the aircraft.

(iv) The commander elected to carry out an approved practice instrument let down procedure to Kuala Lumpur in weather conditions which permitted a visual approach to land.

(v) The let down procedure flown by the commander was not well planned and the published profile was not correctly followed. The operators recommended handling techniques, recommended speeds and flap configurations for this procedure were not observed.

(vi) A request by the commander for the selection of 20 flap was not heard by the co-pilot possibly due to a loud and prolonged audio warning from the radio altimeters; this resulted in an excessive airspeed at a late stage in the landing procedure.

(vii) The use of the radio altimeters related to a high QNH decision height presented the crew with a significant distraction without providing them with useful information.

(viii) The extension of 25 flap and the reduction of thrust at a late stage in the approach in an attempt to reduce airspeed caused a nose-down pitch which was either unnoticed by or uncompensated for by the commander.

(ix) The flight crew failed to notice a dangerous excursion below the safe approach path to the runway.

(x) Both pilots were concentrating on airspeed to the detriment of other flight instruments. There was a breakdown of overall monitoring of the flight instruments and of the visual flight path during the last 30 seconds before overshoot action was taken.

(xi) The published let-down procedure for Runway 15, at the time of the accident, was not compatible with a stabilised final approach from above 1,000 feet in the landing configuration.

(xii) The commander had experienced difficulty in his conversion training on 747 aircraft. His performance during type conversion and subsequent competency checks warranted a more critical scrutiny by the operator.

(xiii) It is not clear whether the T-bar VASI's on Runway 15 were switched on; however the commander did not request that they should be, nor did he request the standard VASI to be illuminated.

(xiv) There is a possibility that tiredness of the crew contributed to the manner in which the approach was conducted.

(b) Cause

The accident was caused by insufficient monitoring of the aircraft flight path by the crew during the transition from a let-down procedure to the visual phase of a landing approach at night. Inadequate planning and a poor execution of the approach by the commander coupled with an approach procedure which did not allow a stabilised approach, and possibly tiredness were contributory factors.

4. Safety Recommendations

It is recommended that:

(1) British Airways should re-examine their Boeing 747 flight deck procedures to establish whether a reallocation of crew duties and monitoring responsibilities during the landing approach would permit a greater degree of supervision.

(2) The VOR/ADF let-down procedures for Runway 15 at Kuala Lumpur should be reviewed with a view to making them more compatible with a stabilised final approach from above 1,000 feet in the landing configuration.

(3) Consideration should be given to the provision of ILS equipment for Runway 15 at Kuala Lumpur.

(4) The procedure for the use of the radio altimeter decision height warning for non precision approaches should be reviewed.

(5) Operating crews should be required to take positive steps to preserve the CVR record following an incident or accident and the Air Navigation Order be amended accordingly.

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