

**Report on the accident to
Boeing 727 G-BDAN
on Tenerife, Canary Islands,
on 25 April 1980**

Translation of the report produced by
the Spanish Civil Aviation Accident Commission
Released July 1981

LONDON
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IP - REPORT TO ACCIDENT INVESTIGATION

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Aircraft Accident Report No 8/81
Spanish Civil Aviation Accident Commission

Operator: Dan-Air Services Limited

Aircraft: *Type:* Boeing 727
 Model: 46
 Nationality: British
 Registration: G--BDAN

Place of Accident: Tenerife, Canary Islands
Latitude 28° 23' 53" N
Longitude 016° 25' 05" W

Date and Time: 25 April 1980 at 1321 hrs

All times in this report are GMT

Introduction

The Spanish Accident Investigation Commission was informed of the disappearance of the aircraft at 1530 hrs on 25 April 1980. The accident occurred in an uninhabited mountainous zone and in cloud, and it was therefore some hours before the debris was found.

In accordance with ICAO Annex 13 the accident was notified to the countries of registration and manufacture (the UK and the USA respectively).

The accident occurred during a charter flight from Manchester (UK) to Tenerife (Canary Islands, Spain), under instrument flight rules (IFR) with instructions to land on runway 12 of Tenerife Norte Airport.

The aircraft was flying in cloud at the time of the accident and struck the side of a mountain. The aircraft was totally destroyed by the impact and its 146 occupants were killed instantaneously.

Investigation

1.1 History of the flight

Boeing 727 registration G-BDAN, took off from Manchester Airport at 0922 hrs on 25 April bound for Tenerife Norte. The flight was a charter, DA-1008, which was to disembark its passengers at the aforesaid airport and was then to pick-up another set of passengers and return to Manchester on the same day.

The aircraft had taken on 49,800 lbs of fuel and the crew had carried out the normal pre-flight operations and had requested and received the weather information for the flight.

After a flight in which there was no evidence of anything abnormal, and after being notified by the Las Palmas Control Centre that the flight was being transferred to the Tenerife Norte Airport Approach Control (APP), the crew made their first radio contact at 1314.28hrs. (06:50)*, reporting that they were at FL 110 and 14 nautical miles (n.m.) from 'TFN' VOR-DME, to which Tenerife Air Traffic Control APP replied 'DAN-AIR 1008, cleared to the 'FP' beacon via 'TFN' flight level 110, expect runway one two, no delay'. These communications took place between 1314.28hrs. (06:50) and 1314.53hrs. (06:25) approximately, whereupon the aircraft repeated the clearance and requested weather information, which was provided by Tenerife APP at 1315.10: (06:08) 'OK - runway in use 12, the wind 120/05, visibility 6 from 7 kilometres, cloud: 2/8 at 120 metres, plus 4/8 at 250 metres, plus 2/8 at 350 metres, November Hotel 1013, temperature 16, dew point 11, and drizzle'.

Approximately one minute later Tenerife APP instructed the aircraft to descend and maintain FL 60. This was acknowledged by the aircraft, and immediately afterwards APP requested the aircraft to indicate its distance to TFN, the aircraft replying that it was 7 n.m. from the beacon.

At 1318.48. (02:30)hrs the aircraft notified APP that it had just passed 'TFN' and was on course for 'FP'. According to the data obtained from the FDR (Flight Data Recorder) and the CVR (Cockpit Voice Recorder) this notification took place 33 seconds after passing the beacon.

APP immediately notified the aircraft of an unpublished holding pattern at 'FP' as follows: 'Roger, the standard holding pattern over Foxtrot Papa is inbound heading 150, turn to the left, call you back shortly'.

The only reply from the aircraft was 'Roger' and its call sign, without repeating the information it had been given (it was not required to do so under current ICAO rules); just 56 seconds later the aircraft reported 'DAN-AIR 1008, is the Foxtrot Papa, level at 60, taking up the hold'. Tenerife APP replied 'Roger'.

During the exchanges with the DAN-AIR aircraft there was another aircraft in flight, IB-711, with which communications were being carried on in Spanish in accordance with ICAO recommended practice. When this aircraft left 5000 feet it reported to APP, which then cleared the DAN-AIR aircraft to descend to that altitude.

* NOTE: Times in brackets are minutes and seconds to impact.

The last transmission received from the accident aircraft, at 1321.13.5 hrs. (00:04.5) was: 'Er . . . DAN-AIR one zero zero eight, we've had a ground proximity warning'. The accident occurred approximately 2 seconds later.

Investigation later confirmed that the aircraft was fitted with a GPWS (Ground Proximity Warning System) which was activated some 27 seconds before impact and continued to sound for 10 seconds until it re-set itself when the aircraft flew over a deep valley.

The aircraft totally disintegrated, the debris was scattered over a wide area and the 146 occupants died instantly.

1.1.1 Route which the aircraft should have followed

The route which should have been followed is shown in Annex A.

According to standard procedures, the aircraft should have followed the R-010 radial of the 'TFN' VOR-DME, after transfer from Las Palmas Control Centre to Tenerife Norte Approach Control and should have continued along that radial to 'TFN' then turned right along radial R-255 from that beacon until reaching the 'FP' beacon; it should then have made a further right turn on to an outbound track of 330° then turned once more to the right, coming back to 'FP' on an inbound track of 150° and entering the holding pattern.

1.1.2 Route taken by the aircraft

Annex A shows the path actually followed by the aircraft.

According to the reconstruction of the flight path, the aircraft arrived at the 'TFN' VOR-DME on an incorrect radial, passing to the east of 'TFN' with an error of some 0.79 n.m., and reported 33 seconds after passing the beacon.

It initiated a turn to the right but failed to intercept the R-255 radial which it should have followed and at no time did it take up a heading for 'FP'; it passed 1.59 n.m. to the south of that aid and continued on 263° for more than 20 seconds, which took it into an area where the minimum safe altitude (MSA) is 14,500 feet.

It then began a turn to the left which took it further into the area with a MSA of 14,500 feet, until the activation of the Ground Proximity Warning System (GPWS) prompted the commander to initiate a right turn which was maintained until the aircraft struck the mountain 11.5 km. from 'FP'.

Accident site

The point of impact was at 28° 23' 53" N, 16° 25' 05" W, on a bearing of 222° magnetic from the threshold of runway 12 at Tenerife Norte, at an elevation of approximately 5,450 feet (1,662 metres) and 11.5 km. past the turning point.

Date and time

The accident occurred on 25 April 1980 at 1321.18 hrs.

1.2 Injuries to Persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	8	138	—
Non-fatal	—	—	—
None	—	—	—
Total	8	138	—

1.3 Damage to Aircraft

In view of the violence of the impact and the nature of the terrain, the aircraft was totally destroyed, damage being assessed at 100%.

1.4 Other Damage

There was damage to the terrain at the accident site, due to the destruction of trees (mainly pines), to various fires and to the contamination of the area by bodies and fuel.

1.5 Personnel Information

1.5.1 Commander

Name: ARTHUR JOHN WHELAN

Nationality: British

Date and place of birth: 11.10.29, Birmingham (UK)

Licences:

Airline Transport pilot's licence No. 51,676 obtained on 4.10.77

Valid from 28.10.77 until 27.10.87

B-727 Captain's certificate:

Issued by Dan-Air Service Limited dated 5.1.77, valid from 23.12.76

Medical certificate:

Last renewal on 25.3.80

Certificate of route competence:

Obtained on 21.1.75, last renewal 21.1.80, issued by Dan-Air Limited.

Safety and survival certificate:

Obtained 18.10.79

GPWS instruction certificate:

Obtained on 28.4.78

Last renewal of instrument rating:

Dated 18.11.79, expiry 20.11.80

Last renewal of Emergency Manoeuvres on Instruments:

Valid from 29.11.79 until 14.7.80

Annual Line check:

Valid from 6.11.79 to 17.11.80

Private pilot's licence: full licence, 28.10.65.

Type ratings:

- a) As pilot or co-pilot on:
- | | |
|--------------------------------|----------|
| D.H.C. 1 and Dakota C-47 | 28.10.65 |
| Comet Variant | 28. 5.71 |
| Boeing 727 | 6.12.76 |
- b) As co-pilot on:
- | | |
|---------------|----------|
| D.H.114 | 28.10.65 |
| Comet 4 | 26. 3.65 |

Experience:

Flights to Tenerife Norte: total 58

Last visit prior to the accident: 29.1.80

Flying hours: Total	15,299.62 h
Last 30 days	37.03 h
Last 24 hrs	00.00 h
Last flight prior to the accident – 17.4.80	6.98 h
On Boeing 727's	1,912 hours.

Duty hours:

Previous 30 days: 86.49 h

Previous 24 hours: 00.00 h

Last duty period prior to accident—23.4.80—04.99 hours on standby.

1.5.2 Co-pilot

Name: MICHAEL JOHN FIRTH

Nationality: British

Date and place of birth: 20.6.46, Somerset (UK)

Licences:

Commercial pilot's licence: obtained on 21.1.80

No. 95,933, valid from 4.2.80 until 3.2.90

Medical certificate: last renewal 30.10.79

Instrument rating: last renewal 28.2.80, valid for 13 months.

Private pilot's licence: rating for single-engined aircraft of less than 12,500lbs (5,700 kg), 4.2.75.

Rating for multi-engined aircraft of less than 12,500lbs (5,700 kg) obtained on 4.2.75.

Type ratings:

As pilot or co-pilot: Boeing 727, 23.3.79.

Radio operator's licence: 4.2.75.

Experience:

Flights to Tenerife Norte: total 9

Last visit to Tenerife Norte before the accident: 22.12.79.

Flying hours: Total 3,492.92 h

Previous 30 days 38.59 h

Previous 24 hours 00.00 h

Last flight before the accident --

20.4.80 5.23 h

Total on B.727's 618.44 h

Duty hours:

Previous 30 days 82.95 h

Previous 24 hours 00.00 h

Last duty period prior to accident -- 21.4.80 05.00 hours on standby.

1.5.3 *Flight Engineer*

Name: RAYMOND JOHN CAREY

Nationality: British

Date and place of birth: 11.7.46, Dartford (UK)

Licences: No 2, 131

Flight Engineer's licence dated 13.5.76, valid from 13.5.76 to 12.5.86.

Ratings:

Comet 4 and 4C, 13.5.76

Boeing 727, 11.4.78

Medical certificate:

Last renewal 18.1.80

Last annual line check 21.5.79, valid to 21.5.80

Survival certificate valid to 10.4.81

Six-monthly aptitude check: valid to 10.4.81

GPWS instruction certificate obtained on 23.2.78

Experience:

Flying hours: Total 3,340.87 h

Previous 30 days 16.53 h

Previous 24 hours 00.00 h

Duty time:

Previous 30 days 44.25 h

Previous 24 hours 05.00 h

Last duty period before the accident--24.4.80 05.00 hours on standby.

1.5.4. *Approach controller*

Name: JUSTO CAMIN YANES

Nationality: Spanish

Date and place of birth: 22.2.46, Santa Cruz de Tenerife (Spain)

Licences:

Controller's licence No. AOITC-000448, 1.10.73

Ratings:

Tenerife Norte local and ground control - 15.12.78

Tenerife North APP - 17.2.79.

Medical certificate:

Valid in accordance with Spanish requirements.

1.6 Aircraft Information

The aircraft was a Boeing 727-100/46 manufactured in 1966 and certificated for passenger transport. The 727 is a low-wing monoplane with a metal structure and skin, powered by three Pratt and Whitney JT8D-7 engines mounted in the tail. The aircraft has a retractable tricycle landing gear and is pressurized.

Registration: G-BDAN

Manufacturer: The Boeing Company USA

Manufacturer's serial number: 19279

Category: Passenger transport

Date of manufacture: 24.6.66

Certificate of Airworthiness:

No. 6638, issued on 23.12.1975, last renewed on 18.2.1980, valid until 17.2.1981.

Certificate of Registration:

No: R.14428/1, dated 15.8.1974

Owner: Dan-Air Services Limited

Radio Certificate:

No: 9-94-G-BDAN

Date: 30.5.1979

Equipment:	H.F. R.T. Communication:	1 Collins 618T2
	VHF communications:	2 Collins 618M1
	A.D.F:	2 Collins DF 203
	I.L.S.VOR:	2 Collins 51 RV1
	Marker:	1 Bendix MKA 28C
	D.M.E:	1 Collins 860 E2
	Airborne Search Radar:	1 Bendix RDR 1E
	ATC Transponder:	1 Collins 621 A3
	Radio Altimeter:	1 Bendix ALA 51A
	Intercommunication:	Gables G 610-11

The aircraft also carried a VLF Omega' - Cracor 7800 which was in the process of being incorporated in the Certificate.

Noise Certificate:

Number 279, dated 10.1.80

Radio Station Licence:
Dated 15.7.1974, renewable annually.

Certificate of Maintenance :
Latest certificate:
Dated 11.1.80, issued by Dan-Air Engineering Limited, Lasham Airfield,
Hants.
Validity: until 2400 hrs on 9.5.80 or until completion of 900 flying
hours (i.e. 30808 aircraft hours from new).

Maintenance Schedule approved by the UK - CAA
Number: MS/Boeing 727/1, Issue 1 amendment 215

Maintenance System:
All maintenance was based on the Approved Maintenance Schedule which was
based on the manufacturer's maintenance schedule and technical manual.

The following checks were required:
Pre-departure inspection

Daily

A	Not exceeding 100 flying hours
Intermediate	Not exceeding 32 days
B	Not exceeding 900 flying hours or 120 days
C	Not exceeding 1800 flying hours
D	Not exceeding 18,000 flying hours

All maintenance, except that up to Check B and non-scheduled defect
rectification, was performed at Lasham.

Radio checks were as follows:

Ground function check: every intermediate 4 check
Radio air test: every 2 years
Radio ground test: every 2 years, alternating with the radio air tests.
V.S.W.R. (Voltage Standing Wave Ratio) check: every D check.

Radio equipment:

Last radio installation survey: 10.1.80
Last radio air test: 14.1.80.

Maintenance history:

Aircraft time since new at the time of the accident: 30,622 flying hours.
Last aircraft maintenance check:
Type C (Equalised 14)
Date: 11.1.80
Total hours: 29,908.

Engines:

No.	1	2	3
Overhaul every	16,000	16,000	16,000
Time since overhaul	9,064	11,606	3,750
Hot end inspection every	6,000	6,000	6,000
Time since hot end inspection	4,162	1,235	-
Time available to 1st disc limit	1,985	4,394	4,928
Cycles available to 1st disc limit	1,551	2,576	5,455

Other Information

Defects reported repeatedly between 11.1.80 and 24.4.80:

Small discrepancies between captain's and first officer's Machmeter indications

Problems with Omega equipment

Slight rudder trim datum problems

FDR warning lights

Left cabin outflow valve remaining closed.

The records show that no deferred defect which could be considered in any way relevant to the accident was still outstanding at the time of the accident. Only the Omega system remained to be dealt with.

Weight and balance

Maximum authorised take-off weight: 76,657 kg
(168,996 lbs)

Actual take-off weight: 76,156 kg
(167,892 lbs)

Maximum landing weight: 64,637 kg
(141,902 lbs)

Estimated weight at impact: 60,031 kg
(132,343 lbs)

Fuel

Total uplift: 22,604 kg
(49,800 lbs)

Fuel at take-off: 22,339 kg
(49,248 lbs)

Estimate for the journey: 16,125 kg
(35,548 lbs)

Estimated at impact: 6,214 kg
(13,699 lbs)

1.7 Meteorological Information

The meteorological conditions in the accident zone and over the northern part of the island in general were as follows:

Wind at various flight levels:

At 1200 hrs	20,000 ft	230°/30 knots
	10,000 ft	160°/15 knots
	8,000 ft	160°/10 knots
	Surface	140°/04 knots

Significant Meteorological Observations for the Flight:

Fog was recorded at the Izaña Observatory near El Teide Mountain from before 1200 hrs until 1500 hrs. There were no storms or turbulence. The 0°C isotherm was at 11,000 ft.

Pressure

There was a slight depression (between 1012 and 1013 mb at ground level).

Temperature Inversions:

1°C between 6,000 and 9,000 ft

Cloud

Izaña Laboratory, 2,467m (8,094 feet)

– 1200 hrs: fog, visibility 00 metres

Earlier: fog

– 1500 hrs: fog and rain. Visibility 00 metres

Santa Cruz de Tenerife

– 1200 hrs: 6/8 stratocumulus at 600/1,000m.

– 1500 hrs: 8/8 stratocumulus at 600/1,000m. Drizzle.

Los Rodeos Airport

– 1200 hrs: 4/8 cumulus and stratocumulus at 900m; 3/8 altocumulus and altostratus at 10,000m.

Visibility more than 10km.

– 1230 hrs: 4/8 cumulus and stratocumulus at 900m; 3/8 altocumulus at 10,000m.

Visibility more than 10km.

– 1300 hrs: 2/8 stratocumulus at 400m; 3/8 cumulus and stratocumulus at 900m; 3/8 altocumulus and altostratus at 10,000m. Visibility 6km.

– 1330 hrs: 2/8 stratocumulus at 300m; 6/8 cumulus and stratocumulus at 800m.

Visibility 5km.

– 1400 hrs: 7/8 cumulus and stratocumulus at 900m; 8/8 cumulus and stratocumulus at 800m.

Reina Sofía Airport

– 1200 hrs: 4/8 cumulus and stratocumulus at 1,000m; 6/8 stratocumulus at 2,500m. Drizzle.

– 1300 hrs: 6/8 cumulus and stratocumulus at 1,700m.

– 1400 hrs: 2/8 cumulus and stratocumulus at 2,000m; 3/8 cirrus at 20,000m.

– 1500 hrs: 4/8 cumulus and stratocumulus at 2,000m; 2/8 cirrus at 20,000m.

Cloud cover in the area can be estimated at a small layer of approximately 2/8 at 1,000m; a second layer of 4-6/8 with its base at 1,500m or 2,000m and with tops at 10,000m. The second layer was continuous in nature in the mountainous zone. There was a third layer starting above 10,000m with about 5/8 altocumulus and altostratus.

Over the Monte de la Esperanza peak, given the light wind conditions, there was nothing which could have produced a vertical wind component or turbulence which could have affected the flight profile.

Meta notified to the aircraft: 1315.10 hrs (06.08) – Wind 120/05, visibility 6 to 7 km, cloud 2/8 at 120m, 4/8 at 250m and 2/8 at 350m; QNH 1013 mbs; temperature 16°C; dew point 11; drizzle.

Later, at 1317.36 (03:45), the QFE was given as 941 mbs.

1.8 Aids to Navigation

The approach aids for runway 12 at Tenerife Norte Airport are as follows:

VOR – DME

Identification signal	TFN
Emission characteristic (E M)	A9A2
Transmitting on	112.5 MHz
Operating hours	24
Co-ordinates	28°31'43"N 16°15'34"W
Notes	0.2 Kw CH 72x

Locator

Identification signal	FP
EM	A2
Transmitting on	243 KHz
Operating hours	24
Co-ordinates	28°29'00"N 16°21'42"W
Notes	FM, THR, RWY 12, 0.05 Kw

NDB

Identification signal	TX
EM	A2
Transmitting on	410 KHz
Operating hours	24
Co-ordinates	28°26'45"N 16°14'47"W
Notes	FM, THR, RWY 30, 0.05 Kw

There are two published holding procedures for the approach to runway 12:

- a) The holding procedure at TFN.
- b) The holding procedure for a missed approach over TX.

There is no approach control radar available.

Runway 12/30 is equipped for instrument approaches, with ILS equipment to the following specification:

ILS/LLZ

Identification signal	ITF
EM	A9/A2
Transmitting on	110.3 MHz
Hours	24
Co-ordinates	28°28'52"N 16°21'06"W
Notes	FM THR-12, 0.025 Kw Coverage 25 NM Elevation of ILS reference point 22m.

1.9 Communications

The Tenerife Norte tower has the following ground-air communications equipment:

Approach (APP)	
Call sign	Tenerife Approach
E M	A3
Transmitting and receiving on	3023.5 KHz/119.7 MHz
Hours	24
Tower (TWR)	
Call sign	Tenerife
Transmitting and receiving on	118.7 MHz (emergency 121.5MHz) (Ground control 121.7 MHz)
Hours	24

The tower also has 16-channel communications recording equipment, which is used as follows:

- Channel 1 – Clock (time signal)
- Channel 2 – Telephony, ground controller
- Channel 3 – Telephony, assistant controller
- Channel 4 – Telephony, APP/TWR controller
- Channel 7 – Radio, ground controller
- Channel 8 – Radio, assistant controller
- Channel 9 – Radio, APP/TWR controller
- Channel 12 – Radio, general

The other channels are not in use.

There were various exchanges between DAN-1008 and APP, and these conversations together with the conversations in the Tower were recorded from the time of transfer to APP until after the crash.

1.10 Aerodrome information

Tenerife Norte is situated 8 km from the town of Santa Cruz de Tenerife, on the island of Tenerife, Canary Islands, Spain.

It is 630m above sea level and the co-ordinates of the runway mid-point are 28°28'30"N. and 16°19'50"W. The runway is asphalt, 3,400 metres long and 45 metres wide, with thresholds 12/30.

1.11 Flight Recorders

The aircraft was fitted with a flight data recorder (FDR) which was recovered in good condition on 26.4.80, and a cockpit voice recorder (CVR) which was recovered, also in good condition, on 27.4.80.

The F D R was taken to Madrid for read-out and interpretation, and it provided the flight path from a few minutes before the aircraft's first communication with approach control until the time of impact.

The C V R was sent to England for analysis by the UK Accidents Investigation Branch. Three 'masters' of the tape were made together with several copies for use by the Commission and for transcription purposes.

Flight Data Recorder:

Make and model – Sundstrand FEB-542
Manufacturer – Sundstrand Data Control Inc.
Redmond, Washington 98052

Part No – 100550-2

Serial No – 5520

This model records the following parameters:

Side 1 – Time, heading (magnetic), speed (IAS), altitude (feet) and vertical accelerations (g);

Side 2 – Bank angle, pitch, EPR (engine pressure ratio), flap position (degrees), GPWS (event marker) and time.

Cockpit Voice Recorder

Make and model – Fairchild A-100 UK-HOTMIKE Mk1

Manufacturer – Fairchild Equipment Corporation

Part No – A100-4

This installation was modified to comply with UK requirements. It provides four recording channels which were used to record conversations as follows:

Channel 1 – Recording of what was heard by the captain through his headset

Channel 2 – Conversations of the captain, first officer and flight engineer via the microphones

Channel 3 – Cockpit area recordings

Channel 4 – Recording of what was heard by the first officer through his headset.

By combining the information from these two flight recorders it is possible to reconstruct, in relation to the flight path of the aircraft, the conversations which take place, which facilitates analysis of the nature and sequence of events.

1.12 Wreckage and crash site

The site of the initial impact was 28°23'53"N and 16°25'05"W, 11.5 km on a bearing of 222° magnetic from the threshold of runway 12 at Tenerife Norte, according to the Military Map of Spain No 20/20. This initial impact was at 1,662 m (5,450 feet) amsl, approximately 38 metres below the summit of the mountain, which has an elevation of 1,690m on a track of 250° – 260° magnetic and a maximum elevation of 1,752m (5,748 feet) – Pico del Chiriguel.

The aircraft struck obliquely on a slope of the mountain that faces 033° and inclines 30° to the horizontal; in relation to the flight path the effective upward slope was 20°.

The impact slope forms one side of a valley whose floor, approximately 1,310 m (4,300 feet) above sea level, runs from northwest to southeast. The northeast side of the valley is formed by another peak which rises to approximately 1,464 m (4,800 feet).

The aircraft impacted in a relatively broad clear zone, immediately before a densely wooded area. A few small trees were struck immediately before ground impact and the right wing tip grazed a rock. The marks produced on the ground were obliterated by an earth fall caused by the crash.

The wreckage distribution indicated that much of the aircraft broke up at initial impact but there were signs that a large section of cabin aft of the wings, possibly with the empennage attached, remained relatively intact and travelled several hundred metres before breaking up and starting a secondary wreckage trail which included passenger seats and occupants.

The main wreckage trail was approximately 350 m long, across the slope, rising some 60 m above the initial impact. The maximum width was some 200 m, a large number of fragments of the wreckage having rolled a considerable distance downhill from their initial impact point.

In general, the early part of the main trail included a high proportion of wing structure and engines, the left-hand main landing gear, the tips of the horizontal stabilisers and elevators and some flight deck components. The trail continued with additional flight deck components, passenger baggage, the nose landing gear, small fuselage, wing and engine portions, a large portion of wing centre section and the relatively intact empennage, minus horizontal surface tips. The final part of the main trail consisted of a large number of fragments of the mid and rear sections of the fuselage, and electronics bay components.

The secondary trail continued for a further 250 m, climbing 15 m to the top of the ridge then descending 45 m on the other side and crossing the road.

A considerable number of small, light fragments of burnt material were found in the vicinity of Las Lagunetas, a village at 1,440 m (4,700 feet) above sea level and 2 km on a bearing of 039° from the crash site. A few similar fragments were recovered from the woods between Las Lagunetas and the crash site. At the point of impact and in the immediate vicinity the ground below the surface was heavily saturated with fuel. In addition, a large part of the surrounding vegetation showed traces of small fires caused by the fuel released on impact.

Structural Integrity

Parts of the wings, tailplane and fuselage were found in the wreckage zone.

Engines

Major portions of all three engines were identified. Damage to rotating assemblies and the nature of the fractures in those components indicated that all engines were at high power at impact. All three thrust reverser assemblies were located and were found to be in the forward thrust position.

Control Surfaces

It was not possible to determine the position of the primary controls with any certainty. The wreckage revealed the spoilers to be in the retracted position.

It was determined by means of the jack that the tail plane incidence corresponded to 5 units of nose-up trim. It was not possible to establish whether the setting had been altered as a result of impact damage.

Lift Control Devices

Although determination of their positions at impact was not possible, the available evidence indicated that trailing edge flaps, leading edge slats and Kruger flaps were in the retracted position at impact.

Landing Gear

The evidence indicated that the landing gear was retracted.

Flight deck

The flight deck broke up on impact. A small proportion of the controls and instruments were located and recovered, including the following with impact readings where available:

VHF COMM 1 CU (Control Unit) Portion — Not including frequency selection and display system

VHF COMM 2 CU (Control Unit) Portion — Not including frequency selection and display system

ATC Transponder CU

Airborne Search Radar CU

Flight Director CU — Relatively intact. As found: mode selector at INOP, Pitch Command Selector at neutral.

Flight Director CU — Relatively intact. As found: mode selector at INOP, Pitch Command Selector 1 division up from neutral.

VHF NAV 1 CU — portion: marks on parts of the frequency display and selector showed that the frequency setting was 112.45 when the unit suffered the major impact.

VHF NAV 2 CU — marks on the mechanism showed that the selected frequency was 110.30.

Servo altimeter:

Subscale — Set to 29.915 in of mercury (1012.5 millibars)

Altitude — Marks on the digital selector drum indicated more than 5,300 feet.

Artificial horizon (2 off) — both horizons were found at a 5° nose-up pitch setting. One showed 35° of bank, the other 33°, both to the right.

Parts of the following instruments were also found:

Outboard flap position indicator

Inboard flap position indicator

EPR Gauge

No 2 Engine fuel flowmeter

No 3 Engine fuel flowmeter

Fuel quantity gauge

Total quantity gauge

Generator drive oil temperature gauge

Cabin pressure controller

FDR CU

Pusher pneumatic pressure gauge.

Flight data recorder

The Sundstrand metallic tape FDR, P/N 100550-2, which was fitted to the aircraft was recovered in a usable condition, with its protective casing slightly damaged.

Cockpit voice recorder

Fairchild A100 four-track, recovered with casing and tape both intact.

Seat Belts

Approximately 50% of the passenger seat belts located on site were found fastened and others showed signs of having been fastened at impact. It was reported that a number of belts were unfastened by rescue personnel.

Configuration

The evidence found indicated that at the time of impact the landing gear was retracted and the trailing edge flaps, leading edge flaps and slats and the spoilers were retracted. The position of the tail plane trim was 5 units nose-up. It was also established that the three engines were at high forward thrust and there was a large quantity of fuel on board.

Impact Parameters

Ground and vegetation markings, wreckage distribution and wreckage break-up characteristics in relation to the terrain indicated aircraft impact on a track of 250–260°M, with 2° or 3° descent and speed estimated at 250–300 kt. Impact was with a small degree of right slide-slip and an estimated 30–40° right bank. Pitch attitude was 5° nose-up at impact.

1.13 Medical and pathological information

In view of the nature of the impact there were no survivors of this accident, and since the aircraft was totally destroyed and the wreckage and remains were widely scattered, identification of the victims was extremely difficult.

Few bodies showed signs of burns, but all were severely mutilated. Identification was based on fingerprints and dental charts.

Although it was not possible to identify the flight crew, there is nothing in their medical records to suggest that they were not medically fit.

1.14 Fire

Localized fires broke out when parts of the aircraft and the ground which were heated to a high temperature came in contact with fuel, and some cabin seats were also burned, which appeared to be consistent with the seat cushions having absorbed fuel at impact.

These fires extinguished themselves, possibly due to the low temperatures and high humidity in the area on the day of the accident.

There was no evidence to suggest pre-impact fire.

1.15 Survival and Rescue Aspects

When the alert was given after contact between approach control and the aircraft had been lost, a standard search procedure was carried out by the Spanish Aerial Rescue Service, assisted by the Guardia Civil on the ground.

Because the aircraft was not on the course it should have followed and because of the fog prevailing in the area, the search lasted several hours. A number of people using the road which runs from La Laguna to el Teide peak found pieces of aircraft wreckage which they could not at first identify and to which they did not pay much attention; they only reported the fact when they heard the news of the aircraft's disappearance on the radio.

The aircraft was located at 20.00 hrs local time by members of the Guardia Civil and after an initial inspection the area was immediately cordoned off. Some bodies were recovered but due to the location and the nature of the terrain, and the arrival of nightfall, this task had to be abandoned until the following morning.

During the night various groups were organised and co-ordinated for recovery of the bodies. Work began at 07.00 hrs local time on the 26th and continued throughout the 26th and 27th.

Members of the Guardia Civil, police, army, Spanish Red Cross, volunteers from mountaineering groups, airport personnel and others took part in the search and recovery operations, and were co-ordinated and directed by the representative of the Civil Governor of Tenerife during the three days of the operation to recover the bodies. The Guardia Civil maintained a watch on the remains of the aircraft while the investigation was carried out.

1.16 Tests and research

The radio aids, the 'TFN' VOR, the ILS localiser and the 'FP' and 'TX' beacons were checked and found to be operating satisfactorily.

The possibility of amateur radio operators in the area causing interference in the radio aids was investigated. The results were negative.

Tests also showed that overhead electrical cables in the accident zone could not have caused any interference in the aircraft's navigation equipment or in the radio aids.

Tests conducted by Marconi on the GPWS warnings indicated that they were consistent with the terrain profile obtained from the FDR and with the warnings which were given in the aircraft and recorded on the FDR and the CVR.

Aerial inspection of the area did not reveal anything which could have been relevant in the causation of the accident and the meteorological information discounts any possibility of turbulence, downdraughts or mountain waves in the vicinity.

None of the research carried out in relation to the condition of the aircraft or its crew has provided any evidence which could be significant in this accident.

1.17 Other Information

1.17.1 GPWS (Ground Proximity Warning System)

A GPWS of Litton design, manufactured under licence by Marconi Avionics, was installed.

The GPWS used the output from a Bendix T/R radio altimeter, part number ALA 51A, serial number 3319.

The system is intended to provide warnings in five modes:

- 1 Excessive rate of descent with respect to terrain (envelope of radio height above terrain vs barometric altitude sink rate).
- 2 Excessive closure rate to terrain (envelope of radio height above terrain vs terrain closure rate).
- 2A Flaps not in landing configuration (landing gear up or down).
- 2B Landing configuration.
- 3 Accumulated altitude loss before acquiring 700 ft terrain clearance after take-off or missed approach.
- 4 Flight into terrain with less than 500 ft terrain clearance and not in landing configuration.
- 5 Excessive glide slope deviation.

The system has built-in time delays which make the exact point at which a warning is given to some extent dependent upon the rate of change of the parameters and the time for which the condition is sustained. The warning initiation point is also affected by the radio altimeter update rate and the GPWS resetting period.

A single GPWS warning was registered by both the CVR and the FDR between approximately 27 secs. and 17 secs. before impact (FDR time). Using the flight path recorded by the FDR for a wind or 160/09 a cross-section of the terrain was established with the aid of a military map of Spain (No 20/20, scale 1:100,000).

The indications are that the warning was initiated at approximately 1,500 feet above the terrain following a 5-second period of 6,000 feet/min. terrain closure rate.

Tests carried out by Marconi Electronics indicated that warnings would occur as follows:

1st part of the warning : 27 secs. — 22 secs. before impact.

2nd part of the warning : 22 secs. — 17 secs. (approximately) before impact.

The evidence shows that the GPWS operated approximately as predicted.

The circumstances which triggered the warning were altered by the aircraft passing over the ridge and the valley immediately preceding the impact zone.

Terrain closure rates did not reach excessive values until a few seconds before impact.

2. Analysis

Due to the nature of the accident, material evidence was hard to come by and too much reliance cannot be placed on such evidence as was found, given the violence of the impact and the large number of persons who had to be mobilised to recover the bodies because of the area over which they were scattered and the nature of the terrain. Although the rescue teams were instructed not to move or tamper with parts of the aircraft during the rescue operation, it was very difficult to recover the remains without moving some parts of the wreckage. The flight data recorder and the cockpit voice recorder, together with the recordings of APP communications, were of vital importance in studying this accident.

Since there is no evidence of any functional abnormality in the aircraft itself, this analysis will concentrate mainly on the communications with Tenerife Norte approach control (APP) from the time it was first contacted by the aircraft, and in particular the communications and conversations taken from the CVR for the last five minutes before the accident, i.e. from the point when the aircraft was approximately 7 n.m. from the 'TFN' VOR-DME.

Between 1245.39hrs. (35:39) and 1246.52hrs. (34:26) control of DA-1008 was transferred from the Las Palmas Control Centre to Tenerife Norte APP.

From the first communication by DA-1008 at 1314.28hrs. (06:50) until 1317.39hrs. (03:39), APP was in contact only with this aircraft and IB-711; thereafter until the time of the accident, apart from these two aircraft, it was also in contact with Hapag-Lloyd 542 which took off from runway 12 at the airport.

At 1314.28hrs. (06:50) DA-1008 contacted APP:

'Tenerife, good morning, Dan-Air one zero zero eight'.

At 1314.33hrs (06:45) APP replied: 'Dan-Air one zero Tenerife, go ahead'.

At 1314.36hrs. (06:42) DA-1008 reported:

'Good morning sir, levelled at one one zero, fourteen miles to Tango Fox November'.

At that moment the aircraft was between 14 and 16 miles from the 'TFN' VOR-DME and was approaching FL 110 with an indicated airspeed (IAS) of approximately 280 knots.

At 1314.45hrs (06:33) APP called:

'Dan-Air one zero zero eight, cleared to the Fox Trot Papa beacon via Tango Fox Trot November, flight level one one zero, expect runway one two, no delay'.

This message, with its closing words 'no delay' probably fixed in the commander's mind the idea that they would be making the shortest possible approach, judging by the following reply from the aircraft:

1314.55hrs. (06:23):

'Roger, cleared to the Fox Papa via Tango Fox November, runway one two. Can we copy the weather?'

APP immediately asked:

'Confirm, did you copy the weather?'

DA-1008 replied:

'I would like to copy the weather and the pressure, please'.

APP passed on the following information:

'O.K. Runway in use one two, the wind one two zero, zero five visibility six from seven kilometres, cloud two oktas at one two zero metres, plus four oktas at two five zero metres, plus two oktas at three five zero metres, November Hotel one zero one three, temperature one six, dew point one one and drizzle'.

The aircraft acknowledged the message and requested the QFE for runway 12.

'Roger, can we have the Fox Echo, please, for runway one two'.

At this moment APP asked IB-711:

'Iberia seven one one, level?'

IB 711 replied:

'Iberia seven one one we are past the VOR and have left six, we are now five thousand, five thousand, maintaining'.

This allowed APP to clear DAN-1008 to descend, and the following communications took place between APP and the aircraft.

'Received. Break. Dan-Air one zero zero eight descend and maintain flight level six zero'.

'Roger, leaving one one zero for six zero'.

'Report your DME reading, please'.

The aircraft replied:

'Er, we're reading seven DME Tango Fox November and requesting the QFE, please'.

According to the reconstruction of the path followed by the aircraft, taken in conjunction with the information from the flight data recorder and the cockpit voice recorder, at the time of this message the aircraft was between 7.5 and 9 nm. from the 'TFN' VOR-DME and was descending from FL 110 to 60.

APP supplied the information on the QFE which had been requested by the aircraft:

'Nine four three'.

'One zero zero eight, nine four three many thanks'.

Later APP corrected the QFE.

'One zero zero eight, for your information QFE for runway one two is nine four one'.

'Roger, nine four one for one two, thanks'.

In the cockpit, the commander asked to co-pilot to tune in the ILS on his side, to use the back beam for guidance, at 1317.18hrs (04:00).

'You can put the ILS on your side we might get it on a back beam for a lead in'.

There were no further messages between DAN-1008 and APP until the aircraft reported that it had just passed the 'TFN' VOR-DME, but according to the CVR, the crew noted passing the radio aid approximately 33 seconds before reporting the fact, and this delay in reporting might have influenced subsequent events. The cause of the delay cannot be determined, since no other conversation took place in the cockpit and communications during this period were scanty, there being only a 10-second exchange between the Hapag-Lloyd flight and APP.

From the time it reported its position as 7 n.m. on the DME, approximately 4:50 before impact, the aircraft's speed continued to increase.

Data from the CVR:

NOTES: P 1 Commander
 P 2 Co-pilot
 FE Flight Engineer
 APP Approach Control
 DAN Dan-Air 1008
 HP Hapag-Lloyd
 IB IB-711

Radio Communications

Cockpit

		FE 'That's what I reckoned it should be by calculation'.
		P1 'I won't go out the full procedure if you know because it takes you way out to sea on this'.
APP	'IB-711 report on completing procedure turn'.	
IB	'Roger IB-711'.	Morse Code ITF ILS audio ident.
		P2 'ITF three oh five is in my box'.
		P2 'Three oh two I'm sorry excuse me'.
		P1 'Just about to go overhead going for'.
		P2 'Two five five out of here'.
		(Humming)
HP	'Tenerife good afternoon – Hapag-Lloyd five four two'.	
APP	'Five four two, good afternoon report ready'.	
HP	'Wilco'.	
DAN	'Dan-Air one zero zero eight has just passed the Tango Fox November heading to the er, Fox Papa'.	1318.48 (02:30)

While the above exchange was going on, the aircraft commenced a wide turn to the right, taking it on to 263° magnetic which placed it to the south of the 255° radial of the 'TFN' VOR-DME, which was the radial it ought to have followed in order to pass over the FP beacon, according to the clearance it had at the time.

At 1318.54hrs. (02:24) APP, in view of the information on the aircraft's position, notified the aircraft that the holding pattern at 'FP' was as follows:

'Roger, the standard holding over Fox Papa is inbound heading one five zero, turn to the left, call you back shortly'.

This transmission ended at 1319.00hrs. (2:18).

The aircraft immediately acknowledged the information.

'Roger DAN-AIR one zero zero eight'.

For the next 56 seconds there were no transmissions between the aircraft and APP, or between APP and any other traffic, but there ensued a series of comments amongst the crew on the information they had received and these need to be analysed because they reveal doubts, due to the phrase 'no delay' in their first exchange with APP, the lack of clarity in the information received, which began with 'standard holding' and ended with 'turn to the left', and the idea which had formed in the commander's mind one minute and twelve seconds earlier, and these may enable us to formulate a hypothesis on the motives which led the crew to direct the aircraft to the accident site.

Information from the CVR:

Radio Communications

Nothing during this period

Cockpit

- P1 'Inbound one five zero to your left'
P2 'One five zero left yeh'
P1 'That's an odd sort of one the runway. . .'
P1 'One to go'
P2 'One to go'
FE 'One to go'
P2 'No I'm not er suppose it's alright'
P1 'I'll just turn straight round left on to one five zero when I go overhead then'
P2 'Yes'
P1 'The only thing is we're hmm we're just about to miss it ah ah it's too close'
P2 'Would you like the other one on the Fox Papa as well for this?'
P1 'If you put them both on as we're going to hold yeh'
P1 'That's er that's the Foxtrot Papa now'
P2 'Yeh'.

After the information about the hold had been acknowledged, given the expansive and extroverted nature of the co-pilot it is possible that he made some gesture of surprise; the commander confirmed 'Inbound one five zero to your left', which created a mental image of an inbound heading of 150° towards some unknown point which we have been unable to determine, given that the aircraft was on a heading of 263° magnetic at the time. A further difficulty is that the commander apparently understood that the 150° inbound heading was a course to be taken up at 'FP'.

The co-pilot accepted what the commander said, but the latter still appeared to have doubts when he said 'That's an odd sort of one the runway . . .'

The crew then repeated the commander's words 'one to go'. Subsequently the co-pilot still appeared to have doubts about the information they had received and the action which the commander had apparently decided to take.

The commander's response was: 'I'll just turn straight round left on to one five zero when I go overhead then'.

This appears to imply that he would make a turn to the left immediately on passing over 'FP', on a heading of one five zero, which again reinforces the idea which he had already formed when he said 'Inbound one five zero to your left'.

Once again the co-pilot, in spite of his uncertainty, confirmed what the commander had said, rather than voice his doubts which might have led to the crew calling APP.

Nevertheless the commander, who was still maintaining his aircraft at a high speed considering his proximity to 'FP', remarked: 'The only thing is we're just about to miss it ah ah it's too close'.

This appears to refer to the 'FP' beacon and possibly the difficulty in performing a manoeuvre to get from his heading of 263° on to 150°, which appears to be the picture he had in his mind.

The co-pilot suggested:

'Would you like the other one on the Fox Papa as well for this?'

We cannot say whether this suggestion was an attempt to draw the commander's attention to the fact that the information they had received referred to 'FP'.

The commander replied:

'If you put them both on as we're going to hold, yeh'.

He appears to have been convinced that they had to hold, and believed he knew how the hold should be performed.

A moment later the commander remarked:

'That's er that's the Foxtrot Papa now'.

The co-pilot answered: 'Yep'.

It is notable that at a time when instrument monitoring was most needed, the co-pilot's attention was mainly focussed on selecting and identifying the 'FP' beacon on his ADF.

The crew were probably engaged in checking their charts for the hold, therefore they did not anticipate their arrival at 'FP' at that moment.

The co-pilot immediately reported to APP:

'Dan Air one zero zero eight is the Foxtrot Papa level at six zero taking up the hold'.

APP replied: 'Roger'.

However, according to the reconstruction of the flight path, the aircraft continued on heading 263° for approximately 20 seconds, during which time it covered about 2 n.m. (this action is difficult to comprehend since the commander had already stated previously that he would commence a turn immediately after passing 'FP'). At this time the aircraft was flying in a sector with a minimum safe altitude of 14,500 ft.

Following a comment by the flight engineer 'that's the fuel', which appeared to relate to his own specific duties, the co-pilot apparently continued expressing vague doubts to the commander, when he said: 'Bloody strange hold isn't it'.

The commander replied:

'Yes, doesn't isn't parallel with the runway or anything'.

But he continued the manoeuvre he had initiated.

A few seconds later the co-pilot expressed further doubts and the flight engineer joined in:

P2 'It's that way isn't it?'

FE 'That is a three isn't it?'

P2 'HMM'.

FE 'That is a three isn't it?'

P2 'Yes, well the hold's going to be here isn't it?'

The co-pilot's comments are an indication of the uncertainty he felt about the manoeuvre which was being performed, but the meaning of the flight engineer's comments and precisely what he was referring to, is not clear.

While this conversation was going on in the cockpit, APP received the following transmission from IB-711:

'Free five thousand now, we are in the procedure turn'.

APP immediately contacted DAN-1008:

'Dan-Air one zero zero eight recleared to five thousand on the Quebec Foxtrot Echo and the Quebec November Hotel'.

This clearance should not have been given in this form, which could lead to an error if the crew did not choose the correct datum for interpreting altitude. However, the crew acknowledged the message, read back the information and used the QNH as the datum.

This information was given by APP at a time when, as far as APP knew, the aircraft was entering the hold, according to the transmission received 35 seconds earlier.

The crew, bearing in mind the zone in which they were flying (assuming they had determined where they were), should have notified APP of their position and of the risks involved in descending to the assigned altitude.

A few seconds after reading back the information, the commander, who was quiet and not particularly vocal by nature and who appears to have been thinking about the manoeuvre, exclaimed:

P1 'Hey, did he say it was one five zero inbound?'

It would appear that at this moment the commander's mind went back over the information he had received on the hold, and he realised that his manoeuvre was taking him on a heading of 150° magnetic away from 'FP', whereas the information he had been given referred to an inbound heading of 150° to 'FP' for the hold.

This question led to the following dialogue:

P2 'Inbound yeh'.

P1 'That's'

P1 'I don't like that'

P2 'They want us to keep going more round don't they?'

The conversation broke off at that moment because the Ground Proximity Warning System (GPWS) sounded.

The commander broke off the turn to the left, ordered an overshoot and remarked:

P1 'He's taking us round to the high ground'.

He initiated a turn to the right and because this happened to take the aircraft over a valley the GPWS was deactivated.

This manoeuvre alerted the co-pilot, who said to the commander:

'I suggest a heading of one two two actually and er take us through the overshoot, ah'.

But the commander continued the turn to the right, being convinced that the left hand turn he had been making was taking the aircraft towards the mountains.

'He's taking us round to high ground'.

The co-pilot did not repeat his previous suggestion, and simply acknowledged the comment.

The commander made a call to APP approximately 4 seconds before impact: 'Er, Dan-Air one zero zero eight we've had ground proximity warning'.

At the same time as the commander was completing his message, the flight engineer exclaimed:

'Bank angle'.

'Bank angle'.

The impact then followed.

Company procedures require the flight engineer to alert the pilots whenever the bank angle exceeds 30°, and although the aircraft had been exceeding that angle for fifteen seconds, the reason he did not give a warning was probably that he was adjusting the engine settings, in accordance with the commander's instructions.

APP, in view of the traffic being handled, should have kept the Dan-Air flight in the hold at 'TFN' but, possibly not wishing to delay the flight and being convinced he knew the position of the two aircraft, he kept them at a separation of 1,000 feet.

The controller did not determine correctly the position of the Dan-Air aircraft. This is evident from his failure to appreciate that it was overhauling IB-711. Thus, when DA-1008 reported passing 'TFN', perhaps earlier than he had calculated, he found himself in an unexpected situation and therefore passed information about a hold at 'FP', revising his calculations and estimating that at the theoretical speed for the sector, the aircraft would take nearly two minutes to reach 'FP'; but it reported passing 'FP' and taking up the hold just 63 seconds later.

He authorised a descent to 5,000 feet, in the belief that the aircraft would be on the entry segment to the hold, i.e. on a heading of 330° outbound from 'FP' in accordance with the procedure for entering the holding pattern. APP began the information on the hold with the words 'The standard holding . . .', which according to ICAO Doc. 8168-OPS, Part II, Chapter 1, Section 1.1.1.3, indicates turns to the right unless otherwise specified. Although what APP meant to say was '. . . turns to the left . . .', what was actually heard was '. . . turn to the left . . .', and this, if the information was not read back, could give rise to incorrect interpretation.

It proved possible to determine, by reconstruction of the flight path, that after passing 'TFN' the aircraft flew at an average speed of approximately 250 knots, higher than that advisable for this part of the approach. At the same time, the navigation was very imprecise, and more specifically the aircraft passed to the east of the 'TFN' VOR-DME at a distance of approximately 0.79 n.m. and at no time did it intercept the 255 radial of 'TFN', which would have brought it to 'FP'; it therefore passed to the south of 'FP' at a distance of 1.59 n.m. The crew reported passing over 'TFN' some 33 seconds after actually passing it;

APP immediately issued instructions for a hold at 'FP', which was accepted without read-back or any request for clarification.

The crew were never certain what action to take on reaching 'FP'. The following hypotheses can be put forward:

If they had only interpreted the first part 'the standard holding over Fox Papa is inbound heading 150 . . .', they should have turned to the right on passing 'FP' in order to take up the 'standard' hold at 'FP' with an inbound heading of 150.

If they had only taken the second part of the message '. . . turn to the left' as mandatory, one would assume that they should have turned left as soon as they received the message, or commenced the turn over 'FP', instead of continuing on 263° for a further 20 seconds before commencing their turn to the left.

It appears that the commander's intention as soon as he received the information (and in spite of his having said 'Inbound 150 . . .') was to make a left turn to take up the 'standard' hold at 'FP', approaching the radio aid on a heading of 330°, or simply to follow a magnetic bearing of 150°, because he thought that was the information he had been given.

With all the accumulated navigational errors, the activation of the GPWS led the commander to alter his flight path because he did not know his position. The deactivation of the GPWS led him to believe that his avoiding action had been correct.

Standard operating procedure for an avoidance manoeuvre requires the aircraft attitude to be adjusted to achieve the best rate of climb and it must be said that the commander made a mistake in not levelling the wings, with the result that instead of starting to climb, the aircraft simply reduced its rate of descent.

The combination of events led to the accident.

The confusion in the information and its acceptance by the crew lead us to examine the existing ICAO rules on holding instructions; it is apparent that they are not sufficiently clear and can give rise to errors of interpretation, since some documents such as Doc. 8168, Part II, Chapter 1 referred to earlier and Annex 4, Chapter 8, section 8.2.1 are ambiguous and contradictory and require clarification.

3. Conclusions

3.1 Findings

- a) The commander and his crew were properly qualified, experienced and medically fit.
- b) The air traffic controller was properly qualified and experienced and medically fit.
- c) The aircraft had a valid Certificate of Airworthiness, Certificate of Registration and Certificate of Maintenance. The records show that it had been maintained in accordance with the approved Maintenance Schedule.
- d) The commander did not follow the correct flight path after passing 'TFN' and did not know his exact position, particularly after he reported passing 'FP'.
- e) APP should have instructed the aircraft to hold at 'TFN'.
- f) Since the hold at 'FP' was unpublished, the information furnished by APP was incomplete.
- g) The crew had little time to assimilate the information on the hold at 'FP' and although they did not understand it, they did not ask for clarification.
- h) The commander should have paid more attention to his navigation, in order to maintain a proper safe altitude in relation to the terrain, particularly as he was not being monitored by radar.
- i) The co-pilot did not check or query the operations being carried out by the commander, as required by the Company Operations Manual, with the result that the required co-operation between the crew did not occur.

3.2 Causes

The cause of the accident was that the commander, without taking account of the altitude at which he was flying, took the aircraft into an area of high terrain and thereby failed to maintain a safe height above the terrain as he was required to do.

The following were contributory factors:

- a) Carrying out a manoeuvre without having it clearly defined.
- b) Imprecise navigation by the commander which reveals that he was disorientated.
- c) Lack of teamwork between pilot and co-pilot.
- d) The short time between the information on the hold being given and the aircraft passing 'FP'.
- e) The fact that the hold was unpublished.

4. Recommendations

- a) Flight crew should be reminded that precise navigation and adequate vertical terrain clearance are of vital importance.
- b) When there are any doubts about the instructions provided by APP, crews must request clarification before carrying out any manoeuvre based on the information received.
- c) ICAO should clarify some ambiguities in its documents, and more specifically in relation to the need to publish all holding circuits and to clarify the 'standard' hold.

ADDENDUM BY THE UNITED KINGDOM TO THE REPORT OF THE SPANISH
ACCIDENT COMMISSION ON THE ACCIDENT TO BOEING 727 G-BDAN AT
TENERIFE ON 25 APRIL 1980

As the United Kingdom Accredited Representative I am, in general, in agreement with the contents of the report made by the Spanish Accident Commission on the accident to Boeing 727 G-BDAN, but consider that the following comments are necessary in order to give a proper balance to the report.

- 1 The information concerning the holding pattern at FP, which was transmitted by Air Traffic Control (ATC), was ambiguous and contributed directly to the disorientation of the crew. The transmission by the commander that the aircraft was taking up the hold at FP was acknowledged by ATC but not queried. In the absence of an instruction to hold this amounted to a tacit approval of the action proposed by the commander and implied that it was what ATC required.

- 2 The United Kingdom interpretation of the criteria detailed in ICAO document 8168 results in a minimum safe altitude for the procedural entry into the unpublished holding pattern at FP of 7000 feet and for the pattern itself of 6000 feet. Neither of these two figures includes the recommended extra 1000 feet applicable because of the wind effects in hilly terrain. No evidence came to light during the investigation that, prior to the accident, any minimum safe altitude calculations had been carried out by a competent authority for this entry and holding pattern. In the absence of a published holding pattern at FP it is reasonable to suppose that the crew of G-BDAN would accept an ATC clearance to descend to an altitude of 5000 feet on the assumption that these calculations had been made. It is further evident that if ATC had not cleared the aircraft below 7000 feet during its attempted entry into the holding pattern, this accident would not have occurred.

3 The 'ideal' track portrayed in Annex A/1 is not practicable, as it is not possible for an aircraft to fly around the sharp angles drawn. A more realistic track over-flying FP would inevitably take the aircraft towards the area of high ground to the south west of the airfield, this factor must be taken into account when calculating minimum safe altitudes. TFN is only 6 miles from FP and there is little time in which to intercept the TFN 255 radial before reaching FP. As TFN is equipped with a DME and as no delay was expected it would be quite understandable if the commander decided to fly a flight path which would bring the aircraft overhead FP on a heading of $302^{\circ}(M)$, in a good position to carry out the published procedure for landing on runway 12. There is some evidence that this was his intention up to the time ATC passed him the information regarding the hold at FP.

It is considered that if the substance of these comments had been reflected in the Findings and Causes, the report would have been acceptable to the United Kingdom.

R G MATTHEW
United Kingdom Accredited Representative

July 1981