Part One of the Spanish Report

KLM, B-747, PH-BUF and Pan Am B-747 N736 collision at Tenerife Airport Spain on 27 March 1977

Report dated October 1978 released by the Subsecretaria de Aviacion Civil, Spain, in both Spanish and English

1.1 History of the flight

The KLM Boeing 747, registration PH-BUF, took off from Schiphol Airport (Amsterdam) at 0900 hours on 27 March 1977, en route to Las Palmas de Gran Canaria. This flight was part of the Charter Series KL 4805/4806 Amsterdam-Las Palmas (Canary Islands)-Amsterdam operated by KLM on behalf of the Holland International Travel Group (H.I.N.T.), Rijswijk-Z.H.

The Boeing 747 registration N736PA, flight number 1736, left Los Angeles International Airport, California, United States, on 26 March 1977, local date, at 0129Z hours, arriving at John F. Kennedy International Airport at 0617Z hours. After the aeroplane was refuelled and a crew change effected, it took off for Las Palmas de Gran Canaria (Spain) at 0742Z.

While the aeroplanes were en route to Las Palmas, a bomb exploded in the airport passenger terminal. On account of this incident and of a warning regarding a possible second bomb, the airport was closed. Therefore, KLM 4805 was diverted to Los Rodeos (Tenerife) Airport, arriving at 1338Z on 27 March 1977. For the same reason, PAA 1736 proceeded to the same airport, which was its alternate, landing at 1415.

At first the KLM passengers were not allowed to leave the aeroplane, but after about twenty minutes they were all transported to the terminal building by bus. On alighting from the bus, they received cards identifying them as passengers in transit on Flight KL 4805. Later, all the passengers bearded KLM 4805 expect the H.I.N.T. Company guide, who remained in Tenerife.

When Las Palmas Airport was opened to traffic once more, the PAA 1736 crew prepared to proceed to Las Palmas, which was the flight's planned destination.

When they attempted to taxi on the taxiway leading to runway 12, where they had been parked with four other aeroplanes on account of the congestion caused by the number of flights diverted to Tenerife, they discovered that it was blocked by KLM Boeing 747, Flight 4805, which was located between PAA 1736 and the entrance to the active runway. The first officer and the flight engineer left the aeroplane and measured the clearance left by the KLM aircraft, reaching the conclusion that it was insufficient to allow PAA 1736 to pass by, obliging them to writ until the former had started to taxi.

The passengers of PAA 1736 did not leave the aeroplane during the whole time that it remained in the airport.

KLM 4805 called the tower at 1656 requesting permission to taxi. It was authorized to do so and at 1658 requested to backtrack on runway 12 for take-off on runway 30. The tower

controller first cleared the KLM flight to taxi in the holding Position for runway 30 by taxiing down the main runway and leaving it by the (third) taxiway to its left. KLM 4805 acknowledged receipt of this message from the tower, stating that it was at that moment taxiing on the runway, which it would leave by the first taxiway in order to proceed to the approach end of runway 30. The tower controller immediately issued an amended clearance, instructing it to continue to taxi to the end of the runway, where it should proceed to backtrack. The KLM flight confirmed that it had received the message, that it would backtrack, and that it was taxiing down the main runway. The tower signalled its approval, whereupon KLM 4805 immediately asked the tower again if what they had asked it to do was to turn left on taxiway one. The tower replied in the negative and repeated that it should continue on to the end of the runway and there backtrack.

Finally, at 1659, KLM 4805 replied, "O.K., sir." At 1702, the PAA aeroplane called the tower to request confirmation that it should taxi down the runway. The tower controller confirmed this, also adding that they should leave the runway by the third taxiway to their left. At 1703:00, in reply to the tower controller's query to KLM 4805 as to how many runway exits they had passed, the latter confirmed that at that moment they were passing by taxiway C-4. The tower controller told KLM 4805, "O.K., at the end of the runway make one eighty and report ready for ATC clearance."

In response to a query from KLM 4805, the tower controller advised both aeroplanes KLM 4805 and PAA 1736 that the runway centre line lights were out of service. The controller also reiterated to PAA 1736 that they were to leave the main runway via the third taxiway to their left and that they should report leaving the runway. At the times indicated, the following conversations took place between the tower and the KLM 4805 and PAA 1736 aeroplanes.

Times taken from KLM CVR.

1705:44.6	KLM	The KLM ... four eight zero five is now ready for take-off ... uh and we're waiting for our ATC clearance.
1705:53.41	Tower	KLM eight seven zero five you are cleared to the Papa Beacon climb to and maintain flight level nine zero right turn after take-off proceed with heading zero four zero until intercepting the three two five radial from Las Palmas VOR. (1706:08.09)
1706:09.61	KLM	Ah roger, sir, we're cleared to the Papa Beacon flight level nine zero, right turn out zero four zero until intercepting the three two five and we're now (at take-off). (1706:17.9)
1706:18.19	Tower	Stand by for take-off, I will call you.
1706:19.39		A squeal is heard (1706:22.06)
1706:21.92	PanAm	Clipper one seven three six.
1706:25.47	Tower	Ah Papa Alpha one seven three six report when runway clear (1706:28.89)
1706:29.59	PanAm	OK, will report when we're clear. (1706:30.69)
1706:31.69	Tower	Thank you

Subsequently, KLM 4805, which had released its brakes to start take-off. run 20 seconds before this communication took place, collided with the PAA aeroplane.

The control tower received no further communications from PAA 1736, nor from KLM 4805.

There were no eyewitnesses to the collision. Place of accident The accident took place on the runway of Tenerife Airport (Los Rodeos) at latitude 28° 28' 30" N and longitude 16° 19' 50" W. The field elevation is 2 073 ft (632 m).

Date The accident occurred on 27 March 1977, at 17 hours 06 minutes 50 seconds GMT.

1.2 Injuries to persons

1.2.1 KLM 4805

Injuries	*Crew*	*Passengers*	*Others*
Fatal	14	234	-
Non-fatal	-	-	-
None	-	-	

1.2.2 PAA 1736

Injuries	*Crew*	*Passengers*	*Others*
Fatal	9	317	-
Non-fatal	7	61 *)	2 **)
Minor/none	-	-	

*) 9 of these passengers subsequently died as a result of injuries received.

**) Company employees, sitting on the cockpit jumpseats, who had bearded the aeroplane in Tenerife.

1.3 Damage to aircraft

Damage to the aeroplanes was 100 per cent due to the impact and post-impact fire.

1.4 Other damage

The runway was damaged in the area of impact by the impact itself and by the subsequent fire. Cost of repairs thereto amounted to 16 005 464,22 pesetas.

1.5 Crew information

1.5.1 KLM crew

a. Captain

Nationality: Dutch
Date and place of birth: 5 February 1927, in Lisse, Netherlands

Licences:
Private Pilot's Licence issued 21.6.1947
Commercial Pilot's Licence issued 18.4.1950
Flight Navigator's Licence issued 6.8.1963
Airline Transport Pilot's Licence issued 19.10.1956 and valid until 16.6.1977
Flight Radio Telephone Operator's Licence issued 22.9.1952 and valid until 2.10.1980

Douglas DC-3	28.9.1951	until	20.6.1962
Convair CV 240/340	23.8.1952		20.6.1962
Lockheed L749/1049	1.10.1952		20.6.1962
Douglas DC-6	12.2.1957		20.6.1962
Douglas DC-7C	6.6.1957		20.6.1962
V. Viscount 803	11.6.1959		21.7.1967
Douglas DC-9	16.3.1967		9.6.1971
Boeing 747	23.1.1971		16.6.1977

Flying experience:
Total flying time as of 27.3.1977: 11 700 hours
Flying time on Boeing 747 as of 27.3.1977: 1 545 hours
Last medical examination:
29.12.1976. Result: fit for ATPL
Last proficiency check:
25.1.1977: O.K.

b. Co-pilot (First Officer)
Nationality: Dutch
Date and place of birth: 12.2.1935 in Opperdoes, Netherlands

Licences:
Private Pilot's Licence issued 31.5.1958
Commercial Pilot's Licence issued 2.3.1960
Flight Navigator's Licence issued 20.4.1966 and valid until 26.6.1977
Flight Radio Telephone Operator's Licence issued 30.12.1957 and valid until 2.6.1981
Airline Transport Pilot's Licence issued 5.6.1970 and valid until 29.6.1977

Type ratings:

Beechcraft D18S	2.3.1960	until	11.7.1961
Fokker F-27	26.8.1966		2.7.1970

Douglas DC-8	13.12.1970		29.6.1977
Boeing 747	19.1.1971		29.6.1977

Flying experience:
Total flying time as of 27.3.1977: 9 200 hours
Flying time on Boeing 747: 95 hours

Last medical examination:
29.12.1967. Result: fit for ATPL

Last proficiency check:
17.1.1967. Result: O.K.

c. Flight Engineer

Nationality: Dutch
Date and place of birth: 30.8.1928 in Amsterdam, Netherlands

Licences:
Flight Engineer's Licence issued 12.5.1950 and valid until 3.9.1977
Flight Radio Telephone Operator's Licence issued 10.6.1970 and valid until 3.9.1977
Private Pilot's Licence issued 6.9.1973 and valid until 3.9.1977

Type ratings:

Douglas DC-3	12.5.1950	until	28.3.1958
Douglas DC-6	28.3.1958		24.10.1960
Douglas DC-7C	28.3.1958		24.10.1960
Douglas DC-8	24.10.1960		3.9.1976
Boeing 747	22.4.1976		3.9.1977

Flying experience:
Total flying time: 17 031 hours
Flying time on Boeing 747: 543 hours

Last medical examination:
16.8.1976. Result: fit for Flight Engineer

1.5.2 PAA crew

a. Captain

Nationality:	American
Date of birth:	18 May 1920
Total flying time:	21 043 hours
Total 747 hours:	564

Total last 30 days:	63:43
Total last 24 hours:	6:33
Total this flight:	0
Last medical examination:	23 March 1977:
Certificates and ratings:	ATP, 747 and 707 ratings
Last proficiency check:	15.11.1976

b. Co-pilot (First Officer)

Date of birth:	14-sep-38
Total flying time:	10 800 hours
Total 747 hours:	2 796
Total last 30 days:	42:39
Total last 25 hours:	6:33
Total this flight:	0:00
Last medical examination:	13.1.1977
Certificates and ratings:	ATP, 747 and 707 ratings
Last proficiency check:	17.1.1977

c. Flight Engineer

Date of birth:	12-dec-30
Total flying time:	15 210 hours
Total 747 hours:	559
Total last 30 days:	52:01
Total last 24 hours:	6:33
Total this flight:	0:00
Last medical examination:	25 June 1976
Certificates and ratings:	Flight Engineer, Turbojet rating

1.6 Aircraft information

1.6.1 KLM 4805

Aircraft type:	Boeing 747-206B
Registration:	PH-BUF
Serial No.:	20400
Year of manufacture:	47304:00:00
Manufacturer:	The Boeing Company, Seattle, Washington, U.S.A.
Airworthiness Certificate:	No. L1877
Date of first issue:	19 October 1971 (as Certificate of Validation, valid for three months) issued by the Department of Civil Aviation, Aeronautical Inspection Directorate

Date of definitive first issue:	13.12.1971
Date of last renewal:	15.11.1976
Date of expiry:	13.2.1977

Maintenance record

Total airframe hours as of 27.3.1977:	21 195
Total number of landings:	5 202
Last major overhaul/inspection:	January 1975, at 13 200 hours total aircraft time
Last periodical inspection:	18 March 1977 D-11 check at 20 898 hours total aircraft time
Maintenance Release:	No. 6076 of 18 March 1977

Engines

Number of engines: four (4) Engine type: Pratt and Whitney JT-9 D-7

Engine position	Serial No.
Position	1 663056
	2 685641
	3 662694
	4 662800

On the day of the accident, engine no. 1 had accumulated 15 080 total flying hours; no. 2 had accumulated a total of 16 677 hours; no. 3, 6 716 hours; and no. 4, 13 692 hours. The corresponding number of cycles was as follows: no. 1: 3 340 cycles; no.2: 3 337 cycles; no.3: 1 637 cycles; and no. 4: 3 399 cycles. 1.6.2 PAA 1736

Aircraft type:	Boeing 747-121
Registration:	N736PA
Serial No.:	19643, manufactured in January 1970 under a Standard Airworthiness Certificate, Transportation Category
Total hours:	TT: 25 725
	TC: 7 195 (These hours and cycles go up to 27.3.1977 in JFK Airport)
Owner:	Pan American (PAA)
Flight number:	1736

Maintenance record

The aeroplane was equipped with an instrument flying panel in accordance with airline requirements under CFR 14, U.S. Code Far 121

On 17 March 1977, at 25 726 hours total aircraft time, the aircraft received a Pre-flight Inspection in accordance with the PAA FAA-Approved Maintenance Programme.

Engines

Engines: Pratt and Whitney JT 9 D-7CN

No. 1- Serial no. P 662403 CN:	total hours:	14 364
	total cycles:	4 234
No. 2 - Serial no. P 662996 CN:	total hours:	13 350
	total cycles:	2 824
No. 3 - Serial no. p 662256 CN:	total hours:	18 511
	total cycles:	6 666
No. 4 - Serial no. P 662307 CN:	total hours:	16 281
	total cycles:	4 838

Note.- Not included are the flying hours from JFK (JohnF. Kennedy Airport in New York to Tenerife, i.e., 6:33 hours).

1.7 Meteorological information

At Los Rodeos Airport, this is provided by:

1. A weather observation tower located at about 400 m southwest of the approach end of runway 30.
2. Another tower located at about 200 m northeast of the approach end of runway 12.
3. A visibility transmissometer located at about 70 m south of the runway 30 approach.
4. A ceilometer located in the same place.
5. Barometric pressure, temperature and dew point recording equipment.
6. Teletype for route weather information.
7. Visibility is reported by the tower controller when the approach to the runway in service is in sight. Otherwise, this is done by an observer in the weather observation tower.
8. Runway visual range (RVR) is not reported.
9. The following visibility values are given:
   - Horizontal and slant approach
   - Runway
   - Taxiway

QAM at approach end of runway 30 at 1630 hours

Approach horizontal visibility:	10 km
Runway visibility:	3 km
Approach slant visibility:	7 to 8 m
Present weather:	intermittent light rain and fog at distance
Cloud coverage:	1/8 at 0 m, 2/8 at 30 m, 2/8 at 120 m, 2/8 at 180 m

Field altimeter setting (QNH):	1023 mb (30.21 Hg)
Sea level barometric pressure (QFE) Runway 30 approach end:	949 mb
Temperature:	14°C
Dew point:	13°C.

QAM at approach end of runway 30 at 1645 hours

Approach horizontal visibility:	8 to 10 km
Runway visibility:	2 to 3 km
Approach slant visibility:	7 to 8 km
Present weather:	Intermittent light rain and fog patches
Cloud coverage:	2/8 at 0 m. 2/8 at 30 m, 2/8 at 90 m, 2/8 at 150 m
Field altimeter setting (QNH):	1023 mb (30.21 Hg)
Sea level barometric pressure (QFE)	
Runway 30 approach end:	951 mb
A.D.:	948 mb
Runway 12 approach end:	949 mb
Temperature:	14°C
Dew point:	13°C

QAM at approach end of runway 30 at 1650 hours

Approach horizontal visibility:	2 to 3 km, intermittent 8 km
Runway visibility:	2 to 3 km
Approach slant visibility:	2 km, intermittent to 7 km
Present weather:	Light rain and fog patches
Cloud coverage:	4/8 at 0 m, 2/8 at 30 m, 2/8 at 60 m

QAM at approach end of runway 30 at 1702 hours

Approach horizontal visibility:	500 m, intermittent to 5 km
Runway visibility:	300 m
Approach slant visibility:	500 m, intermittent to 5 km
Present weather:	Light rain and fog patches
Field altimeter setting (QNH):	1023 mb (30.21 Hg)
Sea level barometric pressure	
(QFE) Runway 30 approach end:	951 mb
A.D.:	948 mb.
Runway 12 approach end:	949 mb
Temperature:	14°C
Dew point:	13°C

QAM at approach end of runway 30 at 1710 hours

Approach horizontal visibility:	4 to 5 km, intermittent 7 km
Runway visibility:	1 km

Approach slant visibility:	4 to 5 km, intermittent to 6 km
Present weather:	Intermittent light rain and fog patches
Cloud coverage:	5/8 at 0 m, 2/8 at 30 m, 2/8 at 90 m

QAM at approach end of runway 30 at 1725 hours

Approach horizontal visibility:	1 km, intermittent 3 km
Runway visibility:	300 m
Approach slant visibility:	1 km, intermittent 3 km
Present weather:	Light rain and fog patches
Cloud coverage:	7/8 at 0 m, 1/8 at 30 m

QAM at approach end of runway 30 at 1925 hours

Approach horizontal visibility:	100 m
Runway visibility:	100 m
Approach slant visibility:	100 m
Present weather:	Light rain and fog patches
Cloud coverage:	8/8 at 0 m
Field altimeter setting (QNH):	1022 mb (30.19 Hg)
Sea level barometric pressure	
(QFE) Runway 30 approach end:	950 mb
A.D.:	948 mb
Runway 12 approach end:	948 mb
Temperature:	13°C
Dew point:	13°C

1.8 Aids to navigation

1.8.1 KLM 4805

The aircraft was equipped with the following aids to navigation:

VOR/ILS:		
Bendix RNA-26C	108-117, 95 MHz	3 systems
Marker Beacon:		
Bendix MKA-28C	75 MHz	1 system
ADF :		
Collins 51Y-7	190-1750 kHz	2 systems
DME:		
Collins 860 e-3	1000 MHz	2 systems

ATC Radar Beacon:

Collins 621A-3	1030-1090 MHz	2 Systems
Weather Radar:		
Bendix RDR-1F	9375 MHz	2 systems
Radio Altimeter:		
Collins 860F-1	4300 MHz	3 systems
Inertial Navigation System:		
Delco Carousel IV		3 systems
Emergency Radio Beacon:		
Garret Rescue-99	121.5/243 MHz	4 systems

1.8.2 PAA 1736

The aircraft was equipped with the following aids to navigation:

Description	Make	Model	No. of systems
ADF	Collins	51Y4	2 systems
DME	Collins	621A-3	2 systems
VOR/ILS	Collins	51RV2B	2 systems
Radar	(AVQ-30X) RCA	MI-592041	2 systems
Radio Altimeter	Bendix	ALA-51A	2 systems
Radar Beacon	Collins	621A-3	2 systems
Inertial Navigation System	Delco Elect	7883450-041	3 systems

1.9 Communications

1.9.1 KLM 4805

The aircraft was equipped with the following communication instruments:

HF COM:		
Collins 61 8T-2	2-30 MHz	2 systems
VHF COM:		
Collins 618M-2B	118-135.97 MHz	3 systems
Selcal:		
Motorola	NA-135 1 Dual Decoder	
Cockpit Voice Recorder (CVR):		
Sundstrand AV-557B		1 system

1.9.2 PAA 1736
The aircraft was equipped with the following communication instruments:

Description	Make	Model	No. of systems
VHF	King	KTR-9100A	2 systems
HF	Collins	61182	2systems
Audio-Interphone	Ford	1-X00-185-3	1 system
Selcal	Motorola	NA-126AV	1 system

1.10 Aerodrome and ground facilities

Los Rodeos (Tenerife) Airport is located at an elevation of 632 m (2 073 ft). The 12/30 runway is 3 400 m (11 155 ft) long, and has two stopways of 60 m. It is 45 m wide. The elevation at the approach end of runway 30 is 2 001 ft and that of runway 12 is 2 064 ft. The highest point of the airport is near the intersection of taxiway 3.

Because of its altitude and location in a sort of hollow between mountains, the airport has distinctive weather conditions, with frequent presence of low-lying clouds.

The Los Rodeos Airport was equipped with the following radio aids to navigation at the time of the accident:

VOR/DME, TFN 112.5 Mc	Normal operation
ILS 110.3 Mc	Normal operation
FP Beacon, 243 kc	Normal operation
NDB, TX, 410 kc	Normal operation
NDB, LD, 370 kc	Out of service (NOTAM II 573/76)

Los Rodeos Airport was equipped with the following visual approach aids at the time of the accident:

Approach lights	In service
VASIS	In service(that of runway 12 was being tested)
Flashers on runway 30	In service
Precision approach lighting	In service
Runway centre line indicated	In service

The airport was equipped with the following beacon marking system at the time of the accident:

Lighting of the flight runway	in service
Lighting of the taxiway	in service

The runway centre line lights were out of service (NOTAM II 92/77).

The air-ground communication radio frequencies in service at the time of the accident were as follows:

- 119.7 Mc for Approach
- 118.7 Mc for Taxiing

The following NOTAMs were in force at the time of the accident, with regard to the Los Rodeos Airport radio aids and air-ground visual and communication aids:

1. On 15.3.1977, NOTAM I, National no. 643, International No. 382, contained the following text: "Runway 12/30 centre line lights out of order until further notice." (This NOTAM was changed to NOTAM II-A, no. 92/77 on 15.3.1977.)
2. On 19.3.1977, NOTAM I,· National no. 791, International no. 463, contained the following text: "Frequencies 121.7 and 118.7 MHz being tested." (On 25.311977, this NOTAM was changed to NOTAM II-A, no. 108/77).

1.10.1 Magnetophone recording points in the Tenerife control tower equipment

Radio

a. Radio channels recording

   The radio channels recording is performed by operator posts in the following manner.

   The reception signals heard over the loudspeaker are recorded immediately after the loudspeaker line amplifier at the point indicated in the "Rx loudspeaker record" diagram.

   The reception signals heard by earphones are recorded immediately after the earphone line amplifier at the point indicated in the "Rx earphone" diagram.

   The transmission signals are recorded immediately before the transmission line amplifier at the point indicated in the "Tx record" diagram.

   All these signals are appropriately mixed in order to be fed into the magnetophone recording channels in the following manner:

   Operator Post A Channel 7
   Operator Post B Channel 8
   Operator Post C Channel 9
   Operator Post D Channel 10
   Operator Post E Channel 11

b. General radio recording

   All the signals received by the Tower receivers, whether coming from aircraft or from the airport's own ground transmitters, are recorded at a point immediately before the radio control system, indicated in the "Rx lines record" diagram.

   These signals coming from all the receivers are conveniently mixed and fed into Channel 12 of the magnetophone.

Telephony

Telephone transmissions and messages received are also recorded by operator posts and taken from the points indicated on the diagram as "telephone record" and "L.C.

loudspeaker record", being conveniently mixed and fed into the magnetophone the following manner:

Operator Post A Channel 2
Operator Post B Channel 3
Operator Post C Channel 4
Operator Post D Channel 5
Operator Post E Channel 6

Channel 1 of the magnetophone records the time signals.

1.11 Flight recorders

1.11.1 KLM 4805

KLM Boeing 747, registration PH-BUF, flight number 4805, was equipped with a digital flight data recorder (DFDR) and a cockpit voice recorder (CVR).

Digital flight data recorder (DFDR)

This was a Sundstrand model 573 A with 41 parameters. The box was considerably damaged by the impact and fire. The front aluminium panel was missing, so that the tape covering could be seen. Therefore, no serial number was immediately available, and this was obtained from the KLM records.

1.11.2 PAA 1736

Boeing 747, registration N736PA, belonging to Pan American World Airways Company, flight number 1736, was equipped with a digital flight data recorder (DFDR) by Lockheed Aircraft Service Co. (LAS), Model 209-E, serial number 375. The DFDR was not damaged by fire and suffered only sight damage due to the impact.

It was also equipped with a cockpit voice recorder (CVR), model Fairchild A-100, serial number 504.

Both recorders were transported, duly sealed, by the Spanish Civil Aviation Authorities to the N.T.S.B. in Washington for transcription.

1.12 Aircraft wreckage

A 1:2 000 scale plan showing the position of the wreckage of the KLM aeroplane, PH-BUF, and of the Pan Am aeroplane, N736PA, is herewith attached.

1.13 Medical and pathological information

On account of the magnitude of the disaster, the Spanish, Dutch and American medical authorities, as well as the Spanish Judicial Authority, agreed that the pathological teams should work together on the tasks of identification, embalming and possible autopsies.

It was not possible to perform autopsies on the members of the KLM crew on account of the state of the bodies.

1.14 Fire

1.14.1 Alarm and mobilization of the firefighting team

The weather conditions, with fog patches at 0 m, prevented the accident from being immediately and directly visible from the control tower, where they only heard one explosion followed by another, without being able to localize them or ascertain their cause.

Moments later, an aircraft located on the parking apron advised the tower that it had seen a fire, without specifying the exact place nor its cause.

The tower immediately sounded the fire alarm for the fire service, informing them that there was a fire and that they should be prepared for an urgent departure. The tower had not yet been able to locate the fire.'

Subsequently, a member of the CEPSA Co. arrived at the fire station parking lot, where the firemen were all ready and prepared, and told them that there was a fire "to the left to the parking area"

This was the first, though vague, indication regarding the location of the fire. The firemen immediately communicated this information to the tower, and set out at the greatest possible speed, which nevertheless was very low because the weather conditions resulted in a serious risk of collision with persons, vehicles and aeroplanes, in view of the fact that they had to cross the very congested parking apron diagonally.

Finally, they saw a bright light through the fog and when they came closer, although they were as yet unable to see the flames, they suffered the effects of strong heat radiation.

When there was a slight clearing, they saw for the first time that there was a aeroplane totally envelopped in flames, its only visible part being the rudder.

After they began to fight the fire, a greater clearing opened in the fog and they saw a bright light further away, which they thought at first was a part of the same aeroplane that had broken off and was also burning.

They divided up the fire trucks and, on approaching what they thought was only a second focal point of the same fire, they discovered a second aeroplane on fire. They immediately concentrated their main efforts on this second aeroplane because the first was already totally irrecoverable.

As a result of this action, they were able - in spite of the tremendous range of the fire in this second aeroplane - to save the left side, from which between fifteen and twenty thousand kg of fuel were subsequently removed.

Meanwhile, because of the dense clouds surrounding it, the tower was still unaware of the exact location of the fire and whether one or two aeroplanes had been involved in the accident.

1.14.2 The impact, start of and extinguishing of the fire

There is no indication of any failure prior to the impact. The distance from the approach end of runway 30 to the Pan Am wreckage was about 1 385 m. From here to the main KLM wreckage there was a distance of about 450 m.

The Pan Am aeroplane was at an angle of about 45 degrees relative to the centre of the runway, i.e.,.at about 75 degrees magnetic. It is possible that it continued to move after the impact.

Apparently, the KLM no. 1 engine only grazed the tip of the Pan Am aeroplane's right side; the nose and front landing gear overshot the latter aeroplane and the main landing gear smashed against it in the area of its no. 3 engine, (See Appendix 4 showing the position of the two aeroplanes at the moment of impact).

The KLM aeroplane was already entirely airborne when the impact took place. Its tail drag had scraped the runway in an excessive rotation for a distance of 65 ft; the tracks on the runway began about 300 ft before the place of impact.

Some sections of the right side of the Pan Am aeroplane were found near the KLM one, indicating that there was indeed an impact there.

The KLM fuselage skidded over the Pan Am aft fuselage, destroying it and Shearing off the empennage. The KLM aeroplane continued in flight, hitting the ground about 150 m further on and sliding another 300 m on the runway. It caught fire suddenly and violently.

The four available turret trucks, with their corresponding crews, were initially used for extinguishing the fire. Later, all the airport Fire Service vehicles, except one which was out of service and the two first-aid Land Rovers, were added. likewise, within a few minutes, fire fighting units from La Laguna and Tenerife joined in, with three tank trucks. The fire was not totally extinguished until 0330 on March 28.

Five thousand kilograms of foam (Tutogene) and about 500 000 L of water were used in order to put out the fire.

1.14.3 Fire fighting equipment

a) The Tenerife Airport Fire Fighting Unit had the following equipment available at the time of the accident:

- 2 Walter Yankee 4 200 L water and 840 kg foam Turret Trucks
- 2 Walter Yankee 4 200L water and 800 kg foam Turret Trucks
- 1 Walter Yankee 3 550L water and 660 kg foam Turret Truck
- 1 Walter Yankee 12 000 L water truck
- 1 International 5 886 L water and 600 kg foam truck
- 1 International 750 kg foam truck (dry chemical)
- 2 Land Rover 250 kg powder first-aid vehicles

One Walter Yankee turret truck was out of service, as indicated in the NOTAM.

b) Training of fire fighting team

Theoretical training takes place practically every day, in the form of classes and explanations regarding deployment, using the wall-mounted visual displays in the fire station.

All equipment is tested and personnel are drilled three times a month with fire-pit exercises and dry runs, with a constant view to achieving optimum readiness as well as maximum efficiency and rapidity of response.

Eight men are regularly kept partially suited during peak airport traffic periods. In practice, two men are ready at all times and all the fire station trucks are ready to roll within 30 to 45 seconds after the alarm sounds.

1.14.4 Rescue and survival

There were no survivors in the RLM aircraft, even though the impact both against the Pan Am aeroplane and against the ground could not have been excessively violent. However, an immediate and raging fire must have prevented adequate emergency Operations because all the aircraft's evacuation doors remained shut even though the fuselage was not significantly deformed.

In the Pan Am aircraft, the first-class lounge disappeared as a result of the impact, as well as nearly the whole of the top of the fuselage. The lounge floor gave way, which meant that the crew had to jump to the first-class section and get out through a hole in the left wall; behind the L.1 exit. This hole was the main escape route for the passengers located in the forward part of the aircraft. None of those in the first-class lounge survived.

According to the survivors, the shock of impact was not excessively violent leading them to believe that the cause was an explosion. They jumped to the ground through openings in the left side, or through door L.2 which was duly opened, from a height of 20 ft (6 m). The left engines were still turning and there was a fire under the wing on this side. A large number of passengers escaped off this wing, jumping from it to the grass. Explosions were already taking place, and the ambulances appeared almost immediately.

At the centre and aft of the aeroplane, the accumulation of wreckage and twisting of metal sheets of the fuselage must have been such that, apart from the fire which suddenly broke out, it formed a kind of trap, preventing forward exit of the passengers.

Total evacuation time is estimated to have been about one minute. The crew and "extra crew" helped effectively in the evacuation. Subsequently, airport personnel and even private individuals who happened to be there also provided effective help. There were five ambulances in the airport at the time of the accident.

The general plan of evacuation worked very much in accordance with what had been planned in case of emergency. In general, it was carried out very rapidly and there was a free traffic flow between the airport and the hospitals. This operation was directed by the Civil Guard for Traffic.

Local radio transmitters requested that anyone who could help should go to the airport. This appeal, which undoubtedly was made with the best of intentions, nevertheless had negative consequences because, when most of the people arrived, the PAA injured had

already been evacuated, and a traffic jam occurred which could have made the providing of further help more difficult.

There were large-scale blood donations. All the injured were promptly and duly taken care of in the Santa Cruz hospitals, so that it was not necessary to make use of the three surgical teams and 89 hospital beds made available in Puerto de la Cruz.

1.15 Tests and investigations

1.15.1 In the investigation of this accident, the following tapes play a very important role: the two digital flight recorders (DFDR), one belonging to the Pan American Boeing 747, N736PA, and the other to the KLM Boeing 747, PH-BUF; the two cockpit voice recorders (CVR), one of which also belonged to each aeroplane; and the Tenerife Control Tower transmission tapes. The KLM DFDR and CVR were located in the aeroplane's tail section. The Pan Am DFDR was located in the tail section and the CVR in the cockpit.

1.15.2 KLM DFDR

The KLM DFDR box was considerably damaged by the impact and fire. The front aluminium panel was missing, so that the tape cover was visible. Therefore, no serial numbers were immediately available, and these had to be obtained from the KLM Company records. The unit's stainless steel cover was deformed and it could not be taken out of the structure. It had to be removed by opening the welded joint by means of a hammer and chisel. At first large scissors were used to try and .cut the casing in order to open it, but this attempt failed. Once the casing had been removed, the shock-proof cover was separated from the electronic section by means of an iron lever (the cover was attached to the electronic section with an anti-shock mounting). The lid bolts were removed from the shock-proof cover, and it was taken off. The DFDR heat insulation material had been singed and separated from the lid.

The teflon sheaths of the magnetic recording wire connectors were not burned and had kept their original colours. These would probably have been discoloured by temperatures above their MST temperatures of 4000 to 4780F. The nylon cord used to tie the wire reels was discoloured. The MST for the nylon used is 2500 to 3000F. There was no proof of melted welding, which indicates that the temperature did not reach 3600F. Therefore, it is probable that the temperature to which the cover was subjected was between 2500 and 3600F.

Burn marks were found on the steel disc covering the upper reel, as well as on the reading head and on the reels themselves. The aluminium reels had a slightly golden colour. This shade of colour could have been caused by some material which gave off gases inside the cover during the fire.

The tape was found intact, without breakages. It was smudged and discoloured in the places where it was revolving around the reels and the heads at the moment that the recorder stopped working.

The mechanism had a burned area at its point of contact with the tape. It was possible to remove the heaviest bits from the tape by using alcohol, cotton and cotton tips. It was possible to read all the data on the tape after adequate cleaning.

The whole of the tape except for the last six meters was on the bottom reel. The accident data were on track 1.

DFDR tapes are made of a material called Vicalloy. They are 0.64 cm wide and 247 m long. Four tracks are recorded - two forward and two backward. Only one track records at a time and each track lasts approximately 6.25 hours, making a total time of 25 hours. There are two recording heads - one going forward and the other backward - as well as two playback and two eraser heads. The tape recording speed is 1.09 cm/sec and the playback speed is 14.2 cm/sec.

1.15.3 The Pan American DFDR

The PAA aircraft DFDR was not damaged by fire, and only slightly damaged by the impact. The inner and outer seals (dated 22 March 1977) were intact, as were the four screw seals for the box (S/N 1413).

The DFDR box is a shock-proof casing. The heat indicator is outside the tape cover. A temperature indicator (TEM PLATE) outside the tape cover showed a temperature of between 1100 and 1200F, indicating that this was the highest temperature to which the box had been exposed.

When the tape covering was opened up, the tape was found to be intact, without any breakages and in excellent condition. On account of the strong impact to which this unit was subjected, the tape had come off the reel and two revolutions had fallen off the lower reel. The tape was handled carefully and replaced on the reels. Most of it was on the lover reel, with approximately 28 m remaining on the upper reel.

There was no problem with playback; The data were found between 105-113 m on track 3.

The DFDR LAS tape is based on Mylar, with an instrumentation grade 1.0 mm thick, 0.64 cm wide and approximately 145 m long (of which about 142 m are used for recording). Six tracks are registered, three forward and three backward. Only one track is recorded at a time and each one lasts approximately 4.2 hours, making a total recording time of 25 hours. There are two recording heads (one going forward and the other backward) and two playback heads. There are no eraser heads. The tape's recording speed is 0.94 cm/sec and the playback speed is 30 cm/sec.

1.15.4 Boeing 747, N736PA, cockpit voice recorder

As previously stated, the Pan American aeroplane's CVR was an A-100, with its identification plate missing. Pan American records show that the serial number was 504. This Fairchild CVR was only blackened. The tape was removed, copied and transcribed in accordance with normal procedures.

This CVR has four channels, which are recorded simultaneously. Recording is continuous, but only the last 30 minutes are kept. On one of the channels, that corresponding to the cockpit microphone area, all the latter's sounds are recorded. On the other three channels are recorded the communications from the Captain, First Officer and Flight Engineer, respectively.

Transcription of this flight recorder was carried out in the N.T.S.B. laboratories in Washington.

1.15.5 KLM Company Boeing 747,'registration PH-BUF, cockpit voice recorder

It was not possible to transcribe this aeroplane's CVR at the N.T.S.B. because there was no reading equipment for this recorder in the N.T.S.B. laboratories, as the U.S. airline companies had not acquired this type of CVR. It was taken by a representative of the Spanish Civil Aviation Authorities to the Sundstrand equipment manufacturers in Seattle (U.S.A.) on 5 April 1977. Members of the N.T.S.B. and KLM accompanied this representative. When copies of the CVR were taken to the N.T.S.B., it was observed that there were noises and echoes, and for this reason the said representative returned to Sundstrand on April 7. New copies were made, partially suppressing the noises and echoes and obtaining recordings of satisfactory quality.

Like the Pan Am CVR, this CVR has four channels, which are:

- Channel 1: Flight engineer's communications.
- Channel 2: Co-pilot's communications
- Channel 3: Captain's communications
- Channel 4: Sounds in cockpit area.

The transcription of the said tapes on paper was carried out in the N.T.S.B. laboratories.

1.15.6 Tape of Tenerife Control Tower's communications

The Spanish authorities made a cassette copy of the Tenerife Control Tower tape available. The original is in the, hands and under the custody of said Authorities. A problem arose when an attempt was made to correlate the times of the tower tape with those of the Pan Am and KLM CVRs. The codified signal and the conversation in the tower were recorded simultaneously on the cassette and it was difficult t, read the time signal. Moreover, the tape apparently changed speeds, making it difficult to correlate the time elapsed. Therefore, the Pan Am CVR was used as a basic time reference, being in perfect agreement with this aircraft's DFDR.

The GMT time was determined by means of a transcription of the tower tape, whose chronology it was possible to ascertain with an acceptable degree of accuracy. This technique proved to be satisfactory as it was in agreement with the Pan Am and KLM CVR times. The PAA and KLM speeds were adjusted in such a way that the aeroplanes' 400 Hz energy was synchronized with the audio laboratory clock and, therefore, with the real time. The Pan Am CVR times were the most accurate during the initial period, on account of the Sundstrand B 557 B recording method. The degree of error is negligible. The Sundstrand tape is not continuous, but rather reverses its direction every 15 minutes.

The tape's basic time reference was determined by simultaneously recording the CVR and a digital watch on a video tape.

Subsequently the Spanish Authorities made copies of the control tower tape available; these did not give rise to time correlation problems.

1.16 Human factors

There is no evidence of contributory medical causes.

Socio-psychological causes

1. Limits on duty time of Dutch crews

   Until a few years ago, the Flight Captain was able, at his own discretion, to extend the limit on his crew's activity in order to complete the service. However, this was recently changed in the sense of imposing absolute rigidity with regard to the limit of activity. The captain is forbidden to exceed it and, in case he should do so, may be prosecuted under the law.

   Moreover, until December 1976, it was very easy to fix the said limit of activity by taking only a few factors into account, but this calculation has now been made enormously complicated and in practice it is not possible to determine it in the cockpit. For this reason it is strongly recommended that the Company be contacted in order to determine it.

   This was the situation in Tenerife, and for this reason the captain spoke by HF to his company's operations office in Amsterdam. There they told him that if he was able to take off before a certain time it would seem that there would be no problems, but that if there was any risk of exceeding the limit they would send a telex to Las Palmas.

   This uncertainty of the crew, who were not able to determine their time limit exactly, must have constituted an important psychological factor.

2. Those who serviced the KLM aeroplane in Tenerife stated that the crew appeared calm and friendly. Nevertheless, they perhaps felt a certain subconscious - though exteriorly repressed - irritation caused by the fact that the service was turning out so badly, with the possible suspension of the Las Palmas-Amsterdam flight and the resulting alteration of each person's plans, which would be aggravated by the existence of other possible sources of lateness such as ATC delays, traffic congestion in Las Palmas, etc.
3. Behaviour

   3.1 *Care*. This can be divided into voluntary and involuntary, or subconscious. The increase in one brings with it a decrease in the other.

   Visibility both before and during the accident was very variable. It changed from 1 500 to 300 m or less in very short periods of time. This undoubtedly caused an increase in subconscious care to the detriment of conscious care, part of which was already directed toward take-off preparation (completing of check-lists, taxiing with reduced visibility, decision to take off or to leave the runway clear and execute a difficult 180 degree turn with a 747 on a 45 m runway, in fog).

   3.2 *Fixtion.* Two kinds: a fixation on what is seen, with a consequently diminished capacity to assimilate what is heard, and another fixation on trying to overcome the threat posed by a further reduction of the already precarious visibility. Fated with this threat, the way to meet it was either by taking off as soon as possible, or by testing the visibility once again and possibly refraining from taking off (a possibility which certainly must have been considered by the KLM captain).

   3.3 *Relaxation.* After having executed the difficult 180 degree turn, which must have coincided with a momentary improvement in the visibility (as proved by the CVR, because shortly before arriving at the runway approach they turned off the wind- screen wipers), the crew must have felt a sudden feeling of relief which

increased their desire to finally overcome the ground problems: the desire to be airborne.

4. Possible biometrical factors

4.1 *Fatigue.* Although within reasonable limits, fatigue began to be felt.

4.2*Overload.* Problems were accumulating for the captain to a degree far greater than that of a normal flight. Likewise for the co-pilot, who did not have much experience in 747s.

4.3 *Low-frequency electromagnetic waves.* According to certain studies, these have a deleterious effect on man's intellectual performance (e.g., 400-cycle alternative current waves in an aircraft).

4.4 *Noise and vibration.* Their level is quite high in a 747 cockpit.

5. Other possible causes

5.1 *Route and pilot-instruction experience.* Although the captain had flown for many years on European and intercontinental routes, he had been an instructor for more than ten years, which relatively diminished his familiarity with route flying. Moreover, on simulated flights, which are customary in flight instruction, the training pilot normally assumes the role of controller - that is, he issues take-off clearances. In many cases no communications whatsoever are used in simulated flights, and for this reason take-off takes place without clearance.

5.2 *Authority in the cockpit.* Although nothing abnormal can be deduced from the CVR, the fact exists that a co-pilot not very experienced with 747s was flying with one of the pilots of greatest prestige in the company who was, moreover, KLM's chief flying instructor and who had certified him fit to be a crew member for this type of aeroplane. in case of doubt. these circumstances could have induced the co-pilot not to ask any questions and to assume that this captain was always right.