No. 13

SABENA, Boeing 707-329C, OO-SJK, accident 8 miles north of Lagos/Ikeja Airport, Nigeria on 13 July 1968. Report dated 20 August 1969, released by the Federal Ministry of Transport, Nigeria

## 1.- Investigation

### 1.1 History of the flight

Flight C 712 was a non-scheduled international cargo flight from Brussels direct to Lagos on behalf of the Federal Government of Nigeria with 34 994 kg of cargo on board. No passengers were being carried.

A flight plan was filed for a flight of 6 hours 9 minutes and the total endurance of the aircraft was stated as 8 hours 20 minutes. The designated alternate was Kano.

The aircraft took off from Brussels at 2152 hours GMT on 12 July 1968 and routine radio reports were received during the en route phase of the flight. At 0325 hours R/T contact was made with Lagos approach control. The R/T transmissions with the aircraft have been identified as being almost certainly the voice of the co-pilot indicating that he was doing the R/T while the pilot-in-command was flying the aircraft. The aircraft gave an ETA at Lagos of 0355 hours and reported that it was at Flight Level (FL) 330. A request was then made for the latest Lagos weather and the reply included the following information:

> wind: 210°/3kt; visiblity: 16 km; cloud: 5/8 stratocumulus 270 m, 7/8 altostratus 2 400 m, temporary thunderstorms, 1/8 cumulonimbus 2 000 ft; QNH: 1012 mb; temperature 24°C

At 0327 hours the aircraft reported an ETA overhead Ibadan NDB of 0344 hours in response to a request for this information from Lagos. One minute later it reported that the Ibadan NDB did not appear to be operating. At 0336 the aircraft requested descent clearance. It was cleared to Lagos at FL 60 and commenced the descent from FL 330 at that time. Three minutes later the aircraft reported passing Ibadan and descending through FL 275 but since it had reported earlier that the Ibadan NDB seemed not to be radiating it is not known how the position was determined. In reply Lagos approach stated that there was no delay in the approach and that the runway in use was 19. At 0341 hours, when the aircraft was about 50 miles north of Lagos, it was recleared to 2 200 ft on a QNH of 1012 mb and told to report field in sight. (See Figure 13-1.)

The flight recorder readout shows that shortly after this interchange the descent was interrupted while the speed decreased to a figure corresponding to the recommended maximum for landing gear extension and this speed was not exceeded for the remainder of the flight. Close study of the flight recording shows subsequent irregularity indicating that the automatic pilot was most probably disengaged at this stage of the flight. Subsequent to the speed reduction the rate of descent was re-established to approximately 2 000 ft/min and at 0350 hours the aircraft passed one mile to the east of Lagos airport

whilst on a southerly heading at an altitude of 15 000 ft. The aircraft was heard flying over the airport at this time. The flight recorder indicates that a procedure turn was made to the south of the airport in the vicinity of the city of Lagos and at its conclusion there was a second interruption in the descent following which the airspeed remained below the maximum for 25° of flap. At 0354 hours the aircraft passed over the airport northbound at an altitude of 9 000 ft maintaining the average rate of descent of 2 000 ft/min for a further 2-½ minutes. At 0356 hours a procedure turn was commenced at an altitude of about 5 000 ft during which the rate of descent was reduced to 1 500 ft/min. The track of the aircraft between its passage over the airport northbound and the commencement of the final procedure turn is almost coincident with the outbound track of the published VOR approach procedure. At 0357 hours Lagos approach control was informed by the aircraft that it was in the procedure turn and requested to give the wind conditions. In reply control stated that the wind was calm and this was acknowledged. Shortly afterwards approach control instructed the aircraft to report runway in sight and this was also acknowledged. On completion of the procedure turn at an altitude of 1 400 ft (a height above the airport of 1 268 ft) the airspeed was reduced from 190 kt to a little less than 160 kt and the rate of descent was reduced to 900 ft/min. The heading was stabilized on 197°M and at 0359 hours the aircraft asked for the runway lights to be put on maximum brightness. Approach control replied that the runway lights were on low intensity non-variable. A transmitter switch was then heard but there was no subsequent message from the aircraft before it crashed about 8-½ miles north of the airport approximately on the extended centre line of the runway. All the occupants were killed and the aircraft caught fire immediately and was burnt out. The accident occurred at 0400 hours.

1.2 Injuries to persons

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | 5 | 2* | |
| Non-fatal | | | |
| None | | | |

1.3 Damage to aircraft

The aircraft was totally destroyed by impact and the subsequent fire.

1.4 Other damage

None.

1.5 Crew information

The pilot-in-command, aged 45, held a valid airline transport pilot's licence endorsed for Boeing 707 aircraft in command. He had flown a total of 13 706 hours of which 6 000 hours were at night. He had completed 5 416 hours in the Boeing 707 including several similar flights to Lagos, the last one being on 4 May 1968. His last medical examination took place on 14 March 1968. On 4 November 1967 he had satisfactorily completed

* Two supernumerary ground crew: one ground mechanic and one loadmaster.

a proficiency check on the aircraft which was valid until 4 July 1968. Due to an administrative error this validation had expired by 9 days at the time of the accident but he had been detailed for another proficiency check on 18 July 1968. Operational technique while flying the line is checked periodically by the Chief Pilot. The pilot-in-command had passed such a check on 29 April 1968 when he demonstrated his familiarity with Company policy and adherence to laid down procedures. He had previously spent a period on detachment flying in West Africa. During the 30 days preceding this accident he had flown a total of 50 hours. His rest period immediately prior to this flight was 75 hours.

The co-pilot, aged 37, held a valid senior commercial pilot's licence endorsed for 2nd Pilot on Boeing 707 aircraft. He had completed 6 292 hours flying of which 705 hours had been on this type. He had passed a proficiency check on 11 July 1968 and his last medical examination took place on 25 June 1968. During the 30 days preceding this accident he had flown a total of 44 hours. His rest period immediately prior to this flight was 28 hours.

The flight navigator, aged 45, held a valid flight navigator's licence. He had completed 9 298 hours flying, of which 282 hours had been on this type. His last proficiency check took place on 18 March 1968 and his last medical examination was passed on 9 July 1968. During the 30 days preceding this accident he had flown a total of 39 hours. His rest period immediately prior to this flight was 20 hours.

The flight engineer, aged 42, held a valid flight engineer's licence, endorsed for Boeing 707 aircraft. He had completed 12 322 hours flying, of which 2 725 had been on this type. His last proficiency check took place on 13 June 1968 and his last medical examination was passed on 29 January 1968. He had flown a total of 50 hours during the 30 days preceding this accident and his rest period immediately prior to this flight was 68 hours.

The flight radio operator, aged 56, was the holder of a valid flight radio operator's licence and had completed 23 508 hours flying. His last medical examination was passed on 30 January 1968. During the 30 days preceding this accident he had flown a total of 38 hours. His rest period immediately prior to this flight was 24 hours.

The two supernumerary crew members were both ground staff having no connexion with the in-flight operation. They were seated in the passenger cabin of the aircraft.

It was several days after the accident before any post mortem examination of the victims took place and it was not possible to establish whether there was any cardiac failure or pre-crash collapse of any sort affecting either of the pilots or any of the other crew members that could have contributed to the accident. It was not possible to find any evidence of intoxication, carbon monoxide or other poisoning or effect of drugs that might have been contributory.

## 1.6 Aircraft information

The aircraft was a Boeing 707-329C serial number 19211, registered in Belgium. It was constructed in July 1966 and had flown 6 048 hours since new. The Certificate of Airworthiness was last renewed on 14 May 1968 and was valid at the time of the accident. The weight of the aircraft at take-off was 148 628 kg and the centre of gravity was 22.85 per cent MAC. The aircraft was correctly loaded within the prescribed limits.

Four Pratt and Whitney JT-3-D engines were installed with numbers and histories as follows:

| Position | Serial Number | Hours since last overhaul |
|---|---|---|
| 1 | 644829 | 376 |
| 2 | 645566 | 4 419 |
| 3 | 645564 | 5 354 |
| 4 | 644817 | 2 432 |

The normal overhaul period of the engines is 5 000 hours but the engine in No. 3 position had been granted an extension to 5 500 hours by the Belgian airworthiness authorities. The last inspection of the airframe and engines was carried out on 6 July 1968 when the total airframe hours were 5 965. A station check was completed in New York at 0900 hours on 12 July 1968 and a daily inspection was carried out on the same day when all reported defects were recorded as having been rectified.

All appropriate FAA airworthiness directives had been complied with.

1.7 Meteorological information

A forecast issued by the Service Météorologique at Brussels National Airport for this flight gives no significant weather over the entire route. Landing forecasts for terminal and alternate aerodromes were as follows:

| Station | Period of validity | Surface wind | Visibility | Weather | Cloud |
|---|---|---|---|---|---|
| Lagos | 21-03 | Vrbl/03 | 9 km | - | 3/8 450 m<br>1/8 Cb. 600 m<br>6/8 3900 m |
| | 03-21 | Vrbl/03 | 9 km | - | 6/8 3900 m |
| | Gradu 03-05 | 340/05 | 8 km | - | 3/8 360 m<br>5/8 3600 m |
| | Mar | | | | 1/8 Cb. 540 m |
| Kano | 21-03 | 220/05 | 9 km | - | - |
| | Tempo | - | - | - | 1/8 Cb. 1200 m<br>4/8 9000 m |
| | Gradu 00-03 | - | - | - | 5/8 4200 m |
| | 03-21 | 220/05 G.15 | 9 km | - | 5/8 4200 m |

An appreciation of the weather conditions at the time and scene of the accident prepared by the Senior Meteorological Officer at Lagos Airport gives the following:

surface wind 300/02 kt; visibility 16 km; cloud 4/8 SCu 270 m, 1/8 Cb 450 m, 7/8 ACu ASt 2400 m; weather nil; temperature 24°, dewpoint 23°; QFE 1007 mb; QNH 1012 mb.

There was no reported turbulence or icing.

The upper winds at the relevant time are estimated as follows:

| | |
|---|---|
| 2 000 ft | southwesterly 15/20 kt |
| 3 000 ft | southwesterly 15/20 kt |
| 5 000 ft | southwesterly 05/10 kt |
| 8 000 ft | southwesterly 03/08 kt |
| 10 000 ft | northeasterly 10/15 kt |
| 20 000 ft | easterly 10/20 kt |

Eye witness reports indicate that there were no thunderstorms and it was not raining in the vicinity of the accident site at the time although thunderstorms had been noticed to the north and northwest earlier and rain commenced at Lagos Airport soon after the accident. At the time of the accident it was dark; the three-quarters full moon was above the horizon and the sun rose at 0550 hours.

1.8 Aids to navigation

The ground navigation aids available on this flight which could have been significant were as follows:

| Description | Location | Frequency | Call Sign | Power Output | Service-ability |
|---|---|---|---|---|---|
| Ibadan M.F. Beacon | 07.26N 03.54E | 400 Kcs. | IB | 750 Watts | Not known |
| Lagos M.F. Beacon | 2.5 N.Mls. on a bearing of 145°M from Lagos Airport Control Tower | 265 Kcs. | LS | 2 Kilowatts | Serviceable |
| Lagos M.F. Locator Beacon | 06.36.21N 03.19.47E | 336 Kcs. | LA | 80 Watts | Serviceable |
| Lagos VOR | 06.35.46N 03.19.40E | 113.7 Mcs. | LA | 200 Watts | Serviceable |
| Nigerian National Broadcasting Station | 06.34N 03.21E | 1088 Kcs. | - | 5 Kilowatts | Serviceable 05-23hrs |
| DME | 06.36.21N 03.19.47E | 223/228 Mcs. | - | Not Known | Serviceable |

ILS equipment was not installed at Lagos Airport at the time of the accident.

The navigation aids fitted to the aircraft were as follows:

| | |
|---|---|
| ADF | (Dual installation) |
| VOR/ILS | (Dual installation) |
| Compasses | (Triple installation) |
| Radar | |
| Loran | |
| DME | |
| Doppler | |
| Sextant | |

Maps and charts

The requisite maps, radio facility charts, navigation logs, flight plans, navigation manuals, operations manuals, flight briefing, NOTAMs, flight pro-formas and stationery are all prepared for every service departure from Brussels by the operators and were prepared in this case. Among the charts provided were airways and aerodrome approach charts for the Lagos area produced for their own use by the operators. On all the aerodrome approach charts the safe height for the Lagos area within 25 NM radius of the airport is given as 2 000 ft. During the final approach all procedures should be commenced overhead the facility being used at a height not below 2 200 ft QNH. A two minute race track pattern to the south of the field provides facilities for holding aircraft or for losing excessive height.

The ADF procedure using the 'LA' beacon and the VOR procedure are similar in that they provide for a timed run northbound from the facility for 2-$\frac{1}{2}$ minutes followed by a procedure turn to the east. At the completion of the procedure turn the aircraft should stabilize on its inbound heading and have descended to an altitude of 1 200 ft QNH on the VOR (1 232 ft QNH on the ADF), which should be maintained until the aircraft has reached the point at which the procedure turn was commenced. Thereafter it may descend to the break off height of 732 ft QNH (600 ft QFE).

On the final approach to runway 19 an obstruction is marked at an elevation of 216 ft (84 ft above field elevation) approximately 1 000 m from and in direct line with the threshold of the runway.

1.9 Communications

En route communications were maintained by use of VHF and HF radio telephony and wireless telegraphy throughout the flight. VHF contact had been maintained with the Air Traffic Control Centre at Kano until the aircraft had been handed over to Lagos local area control approaching Ibadan. The recording device at Kano was unserviceable and there is no recording of the communications prior to entering Lagos area. Thereafter communications of good quality were established and maintained with Lagos approach on frequency 124.3 Mcs until the accident. Timed recordings of the communications were kept by ATC Lagos. The timings on the tape are inserted by a coded signal from an automatic master timing device in the recording circuit and will appear at one minute intervals when the tape is moving. The tape recorder itself is put into motion by a transmission from either the ground or an aircraft station. Once started it will continue to run until a period of

70 seconds has elapsed since any transmission from any source, and then the movement of the tape is automatically stopped. On occasion it may be set in motion inadvertently by electrical disturbances such as lightning flashes, etc. The tape has two recording tracks one for the Approach frequency of 124.3 Mcs and one for the Tower frequency of 118.1 Mcs and transmissions on either of these frequencies, from any source, are sufficient to set the tape in motion.

The radio failure procedures applicable within the Lagos area are the basic procedures as laid down in ICAO Rules of the Air.

1.10 Aerodrome and ground facilities

The approach lights, the airport runway lights, VASIS and aerodrome flashing beacon were switched on and serviceable and eye witness reports indicate that they were functioning. The aerodrome flashing beacon was observed by an eye witness from Iju waterworks which is in the vicinity of the accident site.

Two airport fire vehicles with 12 men in attendance were alerted at 0506 hours and proceeded to the accident scene. They were joined by three appliances of the Lagos Fire Brigade who were alerted at 0735 hours.

1.11 Flight recorder

The SFIM film type flight recorder recovered from the wreckage was in good condition and was dispatched to the Administration de l'Aéronautique Service Technique, Brussels (with a copy to the Boeing Company), for transcription. The equipment records the vertical acceleration, indicated airspeed, pressure altitude and magnetic heading against a time base.

The recording (see Figure 13-2) indicates that the trace ceased at 0359:30 hours on 13 July 1968 at which time the approximate readings were:

| | |
|---|---|
| Vertical Acceleration | 1 g (normal flight loading) |
| Indicated Airspeed | 160 kt |
| Pressure Altitude | 300 ft |
| Magnetic Heading | 194° |

1.12 Wreckage

The wreckage was located in sparsely inhabited, tree-covered terrain approximately 8-½ miles north of Lagos aerodrome. At the time the aircraft collided with the tops of the trees it was right way up, laterally level and descending at an angle of approximately 6°. The height of the ground in the vicinity of the crash is approximately 230 ft (98 ft above aerodrome elevation) with the trees extending upwards another 70 or 80 ft. Structural disintegration was progressive as the aircraft crashed through the vegetation and the wreckage trail extended for almost 1 500 ft. The direction of the initial trail was found to be approximately 195°M, almost directly in line with the extended centreline of runway 19 at Lagos.

It was established that the landing gear was down and locked at the time of the crash. The wing flaps were extended to 40°; the flap selector was at full flap setting (50°). The leading edge flaps were extended as were both extensible landing lamps; the spoilers were retracted. There was no evidence of lightning strike or explosion in the vicinity of the fuel surge tank vents or wing tips.

Flying controls

The rudder showed no evidence of pre-crash malfunction. So far as can be ascertained the rudder trim was neutral. The horizontal stabilizer, elevators and trim tabs were badly damaged when examined, the damage being consistent with the passage of the aircraft through the trees of the crash site, followed by the ground fire. The setting of the horizontal stabilizer has been established to be 4.5 units aircraft nose up. This setting was consistent with that required for the estimated weight of the aircraft (110,658 kg) and estimated C of G (23 per cent MAC) at the time of the crash. The actuator screw jack was free to rotate and its primary brake assembly showed no evidence of malfunction. The elevator and trim tab hinge points and control details which remained have been examined and no evidence has been found of pre-crash jamming or fouling. Except where jamming had occurred as a result of the crash impact, all were found free in operation. The auto-pilot trim servo, the manual/electric trim servo and the stabilizer actuator were subjected to a post-crash workshop examination. No defects were found in any of the units.

There was considerable damage to the wing structures, the majority of which had become separated from the aircraft. So far as can be ascertained the lateral control integrity of the aircraft was unimpaired up to the point of impact.

Control pedestal

The following control settings were recorded during the examination:

| | | |
|---|---|---|
| Thrust levers | | No. 1 fully forward |
| | | No. 2 fully forward |
| | | No. 3 fully forward |
| | | No. 4 $1\frac{1}{2}$ ins. from fully forward |
| Speed brake lever | | Fully forward in detent (retracted) |
| Flap selector lever | | 50° |
| Rudder trim | | Zero |
| Weather radar | Range | 50 miles |
| | Contour/normal Sw. | Normal |
| | Stab. On/Off | Off |
| | Lo/Hi | 1 division to Hi |
| | Tilt | 2° up |

The automatic pilot controller was not found in the wreckage; the condition of the control pedestal was consistent with the destruction of this unit in the crash and subsequent fire.

The power plants

All four power plants had broken away from their mountings in the crash impacts. The fan section of every engine had suffered impact and severe damage to the fan blading but there was no evidence of centrifuging turbine material or turbine failure.

All engines were in forward thrust. Following examination of the engines on the site and detailed examination of blades by the engine manufacturers, it was established that the engines were all rotating on impact. The amount of engine power being produced has not been determined.

Although all engines were affected by ground fire, no evidence was found of an in-flight fire.

Fuel system

There was no indication of any malfunction in the fuel system and the recommended pattern of fuel usage and tank selection appears to have been followed.

Fire protection system

Escape of fuel following impact with the trees resulted in a flash fire and local ground fires consumed much of the inner wings and fuselage. No evidence was found of an in-flight fire. The engine fire extinguishers were discharged thermally by overheating in the ground fires.

Instruments

The following instruments and items of equipment were recovered from the wreckage with the indication as given:

| | | |
|---|---|---|
| Pilot-in-command's altimeter | Barometric setting | 1010.5 mbs |
| | Pointer reading | 300 ft |
| | Drum reading | 4-5 000 ft |

(Instrument damaged, drum free to rotate and possibly disturbed)

| | | |
|---|---|---|
| Co-pilot's altimeter | Barometric setting | 1012 mbs |
| | Pointer reading | 300 ft |
| | Drum reading | 0-1 000 ft |

(Instrument jammed. Possible readings as at impact)

| | | |
|---|---|---|
| Navigator's altimeter | Barometric setting | 1012 mbs |
| (3 pointer type) | Height reading either | 80 000 ft |
| | or | minus 10 000 ft |

(Instrument badly damaged)

The above-mentioned pressure altimeters were subjected to detailed examination by the manufacturers following the accident. In the case of the pilot-in-command's altimeter the damage was such that it was not possible to ascertain either the altitude indication or the barometric setting at impact. There was no evidence indicating a pre-crash failure.

In the case of the co-pilot's altimeter the damage was also such that it was not possible to establish the altitude indication at impact. There was no evidence indicating that the barometric setting was other than that at the moment of impact. There was no evidence indicating a pre-crash failure.

The navigator's altimeter was also damaged to such an extent that it was not possible to establish the altitude indication at the moment of impact. No evidence was found indicating that the barometric setting was other than that at impact. There was no evidence indicating pre-crash failure.

| | |
|---|---|
| Pilot's Kollsman airspeed indicator | Red pointer 352 Knots<br>White pointer below 0 |
| Course deviation indicator | Compass card 194°<br>Heading cursor 180° |
| Compass warning flag showing | |

This unit was subjected to a detailed examination after the accident. Although the instrument was badly damaged and the driving gear to the compass card was disengaged, the compass reading has been estimated to be 193°.

The selected heading curser was positioned at 184° and the VOR selected course (veeder counter) appears to have been set at 184° also. The VOR deviation needle carriage was found blocked on a course of approximately 50° which does not correspond with either the selected course or the heading. This unit is free to move to any position when the differential assembly is removed or disengaged as was found in this instrument. The glide slope needle and both the 'TO/FROM' and 'GS/NAV' flags were destroyed in the crash. No evidence of pre-crash defect was found.

Flight director mode switch: Knob broken

Despite examination it was not possible to establish the position of this switch prior to impact although, when examined, the electrical connexions corresponded to the 'approach' (G/S) mode, possibly as a result of the impact.

Pilot's horizon director indicator: Dial missing

Technical examination revealed that all parts of the instrument forward of the mechanism plate were missing. Details of the display to the pilot prior to the impact were therefore not available. Although the autosyn control transformers and transmitters were affected by sand and corrosion, the electrical circuits were not damaged. At the time of the examination these were as follows:

a) Roll Attitude Control Transformer
Output signal gives an angle of $4\frac{1}{2}$ degrees in relation to the electrical zero.

b) Roll Command Control Transformer
Output signal gives an angle of 3 degrees in relation to the electrical zero.

c) Roll Attitude Transmitter
Output signal gives an angle of $4\frac{1}{2}$ degrees in relation to the electrical zero.

d) Pitch Command Control Transformer
Output signal gives an angle of $\frac{1}{2}$ degree in relation to the electrical zero.

After cleaning, the mechanical functions of these four items were found to be free of defect as were the associated generators. The direction of the deviation of the control transformers is not known: the wiring was partially destroyed and the polarity of the current is undetermined.

| | |
|---|---|
| Pilot's radio magnetic indicator | Compass card 184° |
| | No. 1 pointer Detached |
| | No. 2 pointer Free to rotate |

The indication of No. 1 pointer prior to impact could not be established No. 2 pointer was found over a reading of 096° giving a relative bearing to the aircraft's heading of 280°. No evidence was found of pre-crash defect.

| | |
|---|---|
| Navigator's Radio magnetic indicator | Face of instrument missing |
| No information could be obtained from this instrument | |
| Doppler indicators (position unknown) | Drift dials and Pointers missing |
| | Ground speed counters 189.5 knot |
| Wakman aircraft clock (Position unknown) | Stopped at 04 hrs 09 min 08 secs. |

Inspection indicated that the clock stopped at crash impact as both balance staffs were broken and the train was locked solid. However the hands were free to move and may have been moved by some external force.

Radio Navigation Aids

The following settings and indications were observed during examination of the wreckage:

| | |
|---|---|
| VHF/VOR 1 Controller | |
| Nav. Frequency | 113.70 Mcs. |
| VOL/ON/OFF | 'ON' Full volume |
| DME.T.Sw. | 'Standby' |
| O'RIDE Sw. | 'O'RIDE' |
| VHF/VOR 2 Controller | |
| Nav. Frequency | 113.70 Mcs. |
| VOL/ON/OFF | 'ON' Half volume |
| DME.T.Sw. | 'Standby' |
| O'RIDE Sw. | 'O'RIDE' |
| ADF No. 1 Controller | |
| Mode Switch | ADF |
| Frequency | 267 Kcs. |
| Gain Switch | Half turn from zero |
| Other settings appropriate | |
| ADF No. 2 Controller | |
| Mode Switch | ADF |
| Frequency | Either 1088 or 1083 Kcs. |
| Gain Switch | Undetermined |
| Other settings (where determined) appropriate | |

All instruments and accessories were badly damaged by the crash and subsequent fire. The information given above has been obtained from subsequent examination carried out by the Belgian Administration de l'Aéronautique and/or the manufacturers.

1.13 Fire

No evidence was found of in-flight fire. The aircraft caught fire on impact and, because of the inaccessibility of the crash site, it was burnt out.

1.14 Survival Aspects

The violence of the impact, the subsequent disintegration of the aircraft and the ensuing fire rendered the crash non-survivable.

1.15 Tests and Research

None.

1.16 Altimeters and altimeter setting requirements

Three pressure sensitive altimeters were fitted to the aircraft. Two of these (the pilot-in-command's and co-pilot's) were of the Kollsman drum-pointer type while the navigator's instrument gave its indication by means of three pointers. In the drum-pointer type of altimeters, the increments of hundreds of feet are indicated by the pointer and the increments of thousands of feet are displayed on a drum revolving behind a cut-away portion of the instrument face.

Associated with these instruments is a correction system which forms part of the Kollsman Integrated Flight Instrument System (KIFIS). In the case of the altimeters the correction system corrects the indicated reading for temperature and compressibility at altitude. This system is normally switched 'off' during the approach check (below 6 000 ft above airfield elevation).

Two sections of the General Policy Manual deal with the question of setting of altimeters. The first section is of a general character and covers definitions, en route procedures etc. In this section there is a reference to altimeter settings during the approach and landing phase of flight: "on descending below the transition level the altimeter setting shall be changed to the QNH of the aerodrome and thereafter the vertical position of the aircraft shall be controlled with reference to altitude." However, under the heading General Information about the various altimeter settings, there is a reference to the use of a QFE altimeter setting which states: "In the event that a pilot prefers that his altimeter indicates the actual height of his aeroplane above the runway during the final approach for a landing: he will use a QFE altimeter setting. This setting is obtainable on request from the aerodrome and is intended to be used only when he has been cleared to commence his final approach."

In the Operating Procedures section of the manual under the heading Approaches to Airports it is stated: "for approach and landing the following altimeter settings will be used:

a) QFE: whenever available for all aerodromes with a field elevation below or equal to 1 000 ft

b) QNH: for all aerodromes with a field elevation above 1 000 ft or whenever QFE is not available."

(It is to be noted that all break-off heights stipulated in Sabena documents are based on QFE references. When using QNH for let down and landing, pilots will make a note of all relative altitudes, including the break-off height, in relation to the QNH setting and keep the note handy for reference during the entire approach.)

Use of the QFE is conditional upon its availability from the tower and its use is restricted to final approach and landing because, whereas instrument approach charts indicate both the elevations and heights of obstacles, en route charts indicate only the elevations. Aerodrome meteorological minima for both the ADF and VOR approaches are stated in the operations manual. No descent exceeding fifty feet below break-off height is permitted until the landing runway is clearly in sight.

In the matter of cockpit drills for the setting and checking of altimeters the procedure is covered by reference to the Company's operating manuals for the aircraft. In the manual for the 707-329 there is a reference to the Approach Check and the relative reference to the altimeters is covered under the item "Radio, Instruments and Radar" to which the answer is "SET". Later on in the same check list a reference is made to "KIFIS, ALT/CORRECTION" to which the answer is "OFF, FLAG DOWN." There is no specific reference to either the setting or cross-checking of the altimeters in either the approach check or landing check in this manual.

In the 707-329C Manual which is supplementary to the 329 Manual there is no reference to an approach check or a landing check. However, a check list for use in the cockpit of the 707-329C (a copy of which was found amongst the wreckage) refers to the altimeters during the approach check when they are required to be "SET AND CHECKED." There is no reference to the altimeters during the landing check. No instructions are given in this case as to the altimeter setting to be used on the co-pilot's altimeter neither is there a requirement to check that the difference between an altimeter set at the QFE and one set at the QNH indicates a difference in height corresponding to the aerodrome elevation.

The Boeing Company's Operations Manual (which is not carried in the aircraft) has particular reference to 'Altitude awareness' in special revisions circulated by the company in March 1966. Among other provisions under the title Descent they specify the following additions:

"During descent from en route flight, the pilot not flying will call out:

1. Approaching 20 000 ft AMSL (or 18 000 ft) as a reminder to re-set altimeter.
2. 1 000 ft above assigned altitude.
3. Approaching 10 000 ft AMSL.
4. Approaching 5 000 ft AMSL (if appropriate).
5. 1 000 ft above initial approach altitude, or 1 000 ft above field elevation (in the case of visual approaches)."

Under the title Approach Boeing recommends the following should be added:

"On final approach, upon reaching a designated altitude (not less than 500 ft above field elevation) the pilot not flying will call out altitude, airspeed and rate of descent. Thereafter he will call out significant deviations from programmed airspeed and desired descent rates."

In the same manual, under General Descent, the recommendation is made that "it is desirable to arrive within the airport control zone at low altitude and with the check lists almost completed for landing.

.....Descent should be initiated at the proper distance from the destination and pilots should plan descent, select speed schedule and calculate the vertical speed in feet per minute and time to start descent.

.....The rate of descent suggested in the 'approach' stage of the flight is 600 - 800 ft/min."

## 2.- Analysis and Conclusions

### 2.1 Analysis

The circumstances of the aircraft's departure from Brussels and the en route phase of the flight at cruising altitude were routine but the descent from cruising altitude and the approach to Lagos airport were characterized by a sustained high rate of descent which was continued until the aircraft collided with the ground. It is therefore necessary to consider why the descent was continued below a safe altitude. The possibilities fall under three main headings:

i) It was unavoidable because of a defect in the aircraft or its instruments or equipment.

ii) It was deliberate descent because the pilots had, in error, assessed their position to be close to the touchdown point of the runway in use; or

iii) It was a mistaken descent because of an error in establishing the aircraft's height above the ground.

So far as point (i) is concerned, examination of all the evidence indicates that there was no failure of the aircraft or its components and that they were capable of responding to the actions of the crew until the moment of impact. Careful examination of all the instruments salvaged from the wreckage has not revealed any evidence of malfunction or incorrect display of information. Although the possibility cannot be completely disregarded, no evidence was found that aircraft or instrument malfunction could have been a contributory factor.

Point (ii) was given careful consideration. The approach was made at night over a sparsely populated area. There would have been an almost total absence of lights or other visual clues. The pilot-in-command had been stationed in West Africa and was familiar with the area. He had flown into Lagos on a similar flight approximately 2 months earlier. On the subject flight he had correctly announced his position on a procedure turn shortly before the impact and he would have been aware that he was at least 3 minutes flying time from the runway threshold. For a pilot to be misled to the extent of descending to 350 ft, a very convincing pattern of lighting would be necessary. The evidence indicates that this was not the case, therefore the possibility of a deliberate descent for this reason appears unlikely.

Considering point (iii), the evidence indicates that the descent was commenced without the pilot being able to fix his distance accurately from Lagos. Although he had reported passing Ibadan, he had also reported that he was unable to receive the NDB and there is some doubt as to whether it was operating at the time. Although he may have obtained some indication of his position by the use of his radar on "mapping" the assessment of his position from this information may not have been very accurate. He was unable to use the Lagos DME as the aircraft was not equipped with the appropriate frequency. Therefore it seems likely that there was no accurate fix available until the aircraft passed overhead the Lagos NDB although the fact that the landing gear was extended 4 minutes before arriving over Lagos indicates that the pilot was aware of the necessity to increase his rate of descent.

When the aircraft passed overhead Lagos for the first time its height was 15 000 ft; this was 12 800 ft higher than the height given on the approach chart for the commencement of the approach procedure. At this point the pilot had two alternatives. He could have descended in the holding pattern to the south of the airport; or continued a high rate of descent during the procedure turn to the south and, if necessary, during the subsequent part of the approach. In the event he chose the latter and it is significant that he had not only to lose height but also surplus airspeed before he could extend his flaps and complete his approach and landing checks.

Five minutes after its first passage over the airport, the aircraft passed overhead again heading north on the outbound part of its procedure. The pilot had now to establish himself on a horizontal pattern for the final approach and the evidence indicates that this was done by reference to the Lagos VOR. At this time the aircraft was at 8 900 ft and had 7 700 ft to lose during the 2-$\frac{1}{2}$ minute northbound run plus the final procedure turn; a rate of descent of 2 000 ft/min was therefore maintained.

No call had been made by either the aircraft or the tower since the call acknowledging the clearance shortly after leaving Ibadan at F/L 275. It may have been that, due to the state of emergency existing at the time in Nigeria, the pilot considered that radio calls should be kept to the minimum and that he had been told to call when he had the field in sight with that object in mind. Nevertheless he had received and acknowledged the QNH and at least two of the altimeters found in the wreckage indicated that this had been correctly set.

As the aircraft lost height its rate of descent was decreased to approximately 1 000 ft/min and, when the pilot called on procedure turn, he was only 1 000 ft above the correct height for this position. The request from the aircraft at this point for the wind is considered to be normal bearing in mind the aircraft's weight and the length and state of the runway.

As the aircraft was established on the final heading it descended through the check height of 1 200 ft QNH. According to the flight recorder there is a momentary break in the descent at about this point but immediately afterwards the aircraft resumed its descent and continued to lose height at approximately 850 ft/min. As the airfield is less than 1 000 ft AMSL and a QFE was available, the pilot should have asked for and set the QFE at this stage but he did not do so. The request for runway lights on "maximum bright" made at this time may have been made because the pilot would have been aware that with the approach lights, they were the only final approach aid available to him and he wished to obtain the maximum assistance that they could provide. It is considered very doubtful that the pilot could have seen the lights from his position at the time of the request.

There was no break in the aircraft's descent as it passed through its break off height of 732 ft QNH. The General Policy Manual states that, during an instrument approach, descent greater than 50 ft below the break-off height is not authorized unless the pilot has the landing runway clearly in sight. Although Sabena's minimum landing techniques using the ILS call for a height check during the final stages of the descent by the pilot not flying the aircraft, there is no such requirement on a normal ADF or VOR approach. It is significant to note that, even if the pilot had mistakenly assumed that his altimeter was set on the QFE it would have had little effect on the sequence of events as there was only 5 millibars difference (corresponding to approximately 150 ft) between the two settings.

From the examination of the wreckage it was possible to establish that the flaps were selected to 50° (which is the final item of the landing check) but they did not have time to extend before the aircraft crashed. The flight manual calls for this action to be done upon intercepting the final approach course which could indicate that is where the pilot considered himself to be. It is also the point where the accident occurred.

Colleagues of the pilots have identified the voice using the R/T as that of the co-pilot. In this case, in accordance with the company's standard practice, the pilot-in-command would have been flying the aircraft and the co-pilot may well have been concentrating more on looking out of the cockpit windows to see if he could see the aerodrome lights than on monitoring the altitude. The absence of an outer marker beacon or an ILS to provide Glide slope guidance made this action necessary. The ability of the pilot to make his approach and land the aircraft safely depended upon his making a visual approach by means of the approach lights, runway lights and the VASI's.

The airline's operating and general policy manuals provide for the setting of the altimeters during the approach check and the setting of a QFE (on the occasion when it should be set) during the final approach. In the General Policy manual it is stressed that constant attention should be paid at all times to the altimeters. Nevertheless specific instructions do not appear as to which of the two pilots' altimeters should be set on to the QFE if this is to be used, nor to the setting that should appear on the other altimeter. There is no requirement for the cross checking of the altimeters against each other, no requirement that the approach to pre-determined altitudes shall be monitored and called out by the pilot not handling the controls and no check list item during the landing check concerning the altimeters. The purpose of the Boeing Directive on Altitude Awareness, extracts from which appear in section 1.16 of this report, was to draw attention to the importance of monitoring the altitude during the approach stage of flight.

The aircraft was cleared to descend to 2 200 ft or field in sight. There was no requirement for the pilot to call reaching this altitude or at any intermediate altitude and he did not do so. Had the pilot made such a call it might have drawn his attention to the height of the aircraft at the time.

## 2.2 Conclusions

### (a) Findings

The aircraft's documentation was in order and it was correctly loaded for the flight.

Examination of the aircraft wreckage and salvaged equipment has revealed no evidence of pre-crash failure or malfunction.

The crew was properly licensed and adequately experienced on the aircraft and the route.

The aircraft made an almost continuous descent from FL 275 to the point of impact without an intermediate report being made of either its height or position between "passing IB Beacon" and a point "on procedure turn" north of Lagos airport.

The approach to land was made at night without ILS glide slope or marker beacon guidance.

There was an absence of instructions regarding the monitoring of the altitude by the pilot not flying the aircraft and the cross checking of altimeters during an approach.

(b) Cause or
Probable cause(s)

The accident was caused by the aircraft descending below its minimum safe altitude for reasons that have not been determined.

Non-scheduled international
Landing
Collision - ground
Undetermined

ICAO Ref: AIG/035/68

ACCIDENT TO BOEING 707-329C, OO-SJK, OF SABENA, 8 MILES NORTH OF LAGOS/IKEJA AIRPORT, NIGERIA, ON 13 JULY 1968

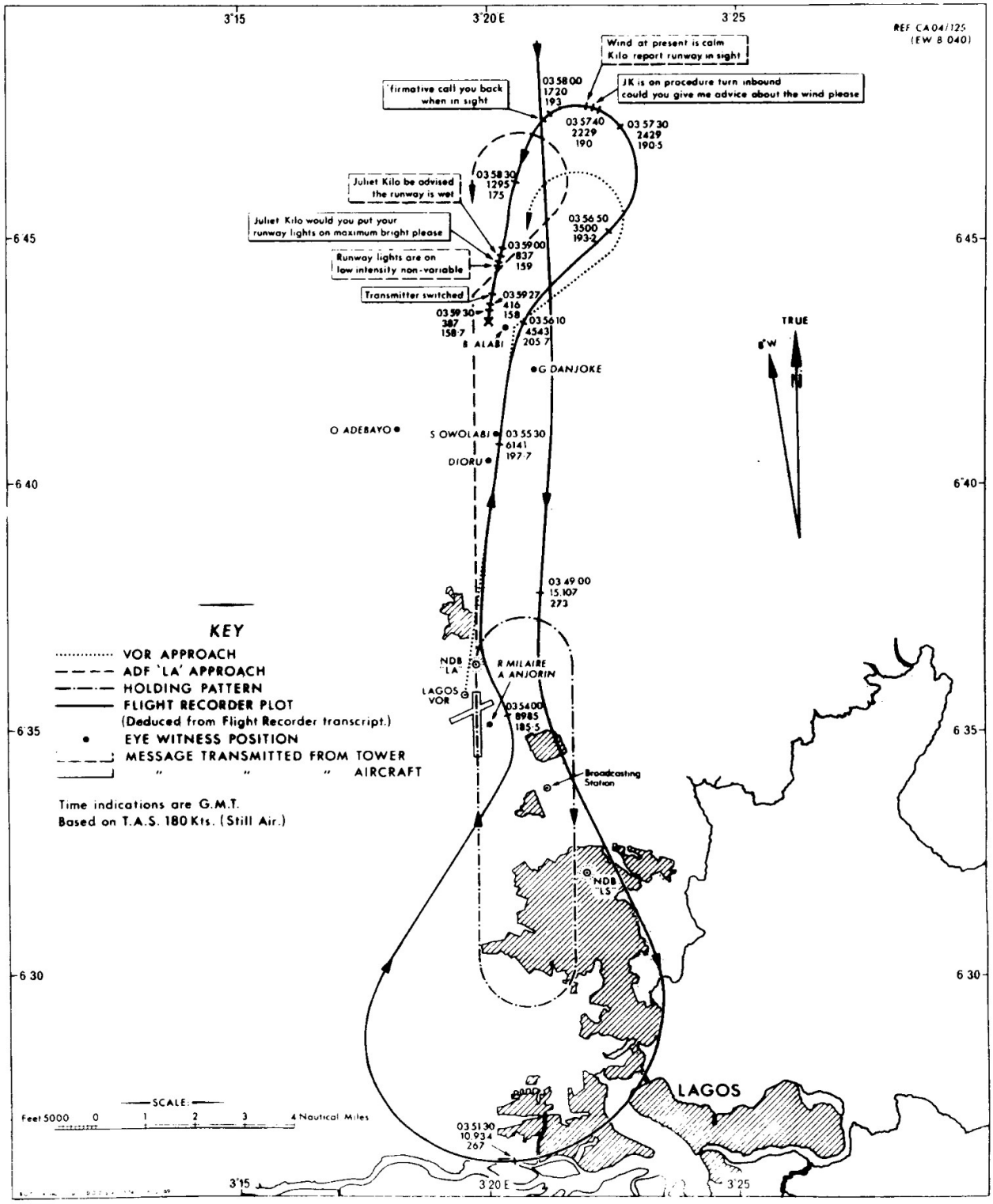


Fig. 13-1

ACCIDENT TO BOEING 707-329C, OO-SJK, OF SABENA, 8 MILES NORTH OF LAGOS/IKEJA AIRPORT, NIGERIA, ON 13 JULY 1968

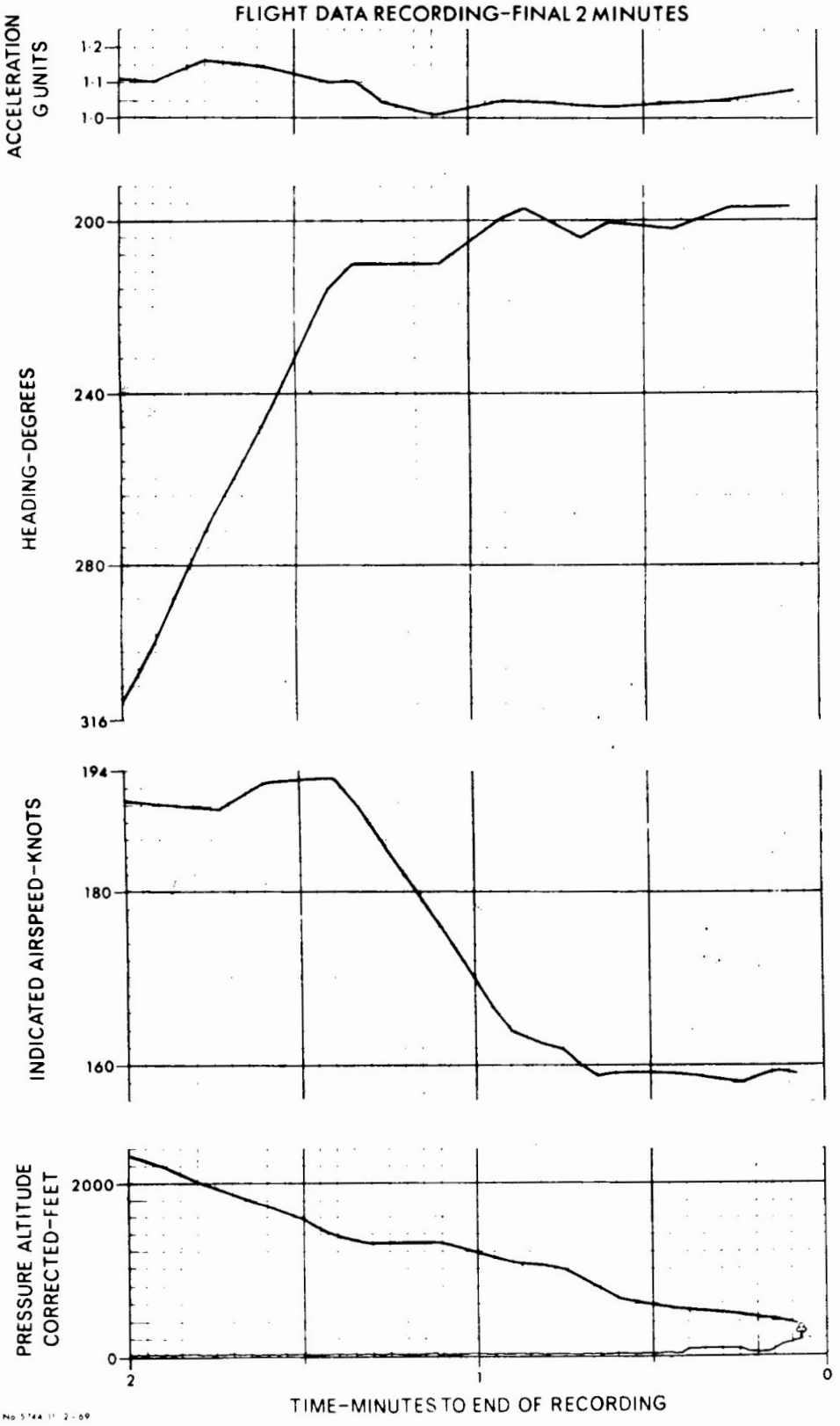


Fig. 13-2