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FEDERATION OF RHODESIA AND NYASALAND

DEPARTMENT OF CIVIL AVIATION

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# REPORT BY THE INVESTIGATING BOARD ON THE ACCIDENT TO DOUGLAS DC6B AIRCRAFT SE-BDY WHICH OCCURRED NEAR NDOLA AIRPORT DURING THE NIGHT OF 17th SEPTEMBER, 1961

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FEDERAL DEPARTMENT OF CIVIL AVIATION

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# C I V I L  A I R C R A F T  A C C I D E N T

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Report by the Investigating Board on the accident to Douglas DC6B aircraft SE-BDY which occurred near Ndola Airport during the night of 17th September, 1961

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## GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

| | |
|---|---|
| ADF | Automatic Direction Finding |
| ATC | Air Traffic Control |
| ATCO | Air Traffic Control Officer |
| ATS | Air Traffic Services Unit |
| C of A | Certificate of Airworthiness |
| C of G | Centre of Gravity |
| DME | Distance Measuring Equipment |
| ETA | Estimated Time of Arrival |
| FAA | Federal Aeronautics Administration |
| FIC | Flight Information Centre |
| FIR | Flight Information Region |
| FL | Flight Level |
| GMT | Greenwich Mean Time |
| H/F R/T | High Frequency Radio Telephony |
| Hg | Inches of Mercury |
| ICAO | International Civil Aviation Organisation |
| IFALPA | International Federation of Airline Pilots Associations |
| ILS | Instrument Landing System |
| ins | Inches |
| kts | Knots |
| kc/s | Kilocycles |
| (M) | Magnetic |
| MAC | Mean Aerodynamic Chord |
| mbs | Millibars |
| mc/s | Megacycles |
| MER | Above Mean Sea Level |
| NDB | Non-directional Radio Beacon |
| QDM | "Q" Code symbol for the bearing to be steered in zero wind to reach the radio station concerned. |
| QFE | "Q" Code symbol for the pressure setting to be set on an altimeter for it to read zero on landing. |
| QNH | "Q" Code symbol for the pressure setting to be set on an altimeter for it to read the aerodrome height MER on landing. |
| RAF | Royal Air Force |
| RRAF | Royal Rhodesian Air Force |
| R/T | Radio Telephony |
| (T) | True |
| TAS | True Air Speed |
| U.N. | United Nations |
| VHF | Very High Frequency Radio Telephony |
| VOR | VHF Omnidirectional Radio Range |
| VSI | Vertical Speed Indicator |

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# REPORT BY THE INVESTIGATING BOARD ON THE ACCIDENT TO SE-BDY

## PART 1 - INTRODUCTION

### 1. ACCIDENT DETAILS

| | | |
|---|---|---|
| 1.1 | Location | From Ndola aerodrome control tower 8.05 nautical miles on a true bearing 279°. Map reference Ndola 1228D3 grid position 652657, geographical position -<br>Latitude 12°58'20"S<br>Longitude 28°31'23"E |
| 1.2 | Date and time (approx.) | 17th September, 1961. 2215 GMT<br>18th September, 1961. 0015 local |
| 1.3 | Operator | Transair Sweden A.B., Malmo, Sweden. |
| 1.4 | Aircraft type and registration | Douglas DC6B SE-BDY |
| 1.5 | Extent of damage | Destroyed |
| 1.6 | Number of crew | Four, all killed. See appendix 3.1 |
| 1.7 | Number of passengers | Twelve, all killed. See appendix 3.2 |
| 1.8 | Type of operation | Public transport - non-scheduled (charter) flight. |
| 1.9 | Phase of operation | Approach preparatory to landing. |
| 1.10 | Type of accident | Insufficient altitude in approach: collision with trees. |

### 2. SUMMARY

2.1 Brief summary of events leading up to the accident.

2.1.1 The aircraft SE-BDY departed from Leopoldville at 1551 hours GMT on 17th September, 1961 with the Flight Plan destination stated to be Luluabourg. After clearing Leopoldville tower frequency, radio silence was apparently maintained until the aircraft called Salisbury FIC at 2002 GMT filing a revised Flight Plan which indicated the aircraft destination to be Ndola, estimated time of arrival 2235 GMT. At 2035 GMT the aircraft reported over Lake Tanganyika, indicating that it was not flying on the direct route from Leopoldville to Ndola. See appendix 1.3

2.1.2 Radio contact was made with Ndola tower at 2135 GMT. During subsequent conversations weather and landing information, and descent clearance from 16,000

to 6,000 feet, were given. The aircraft reported when it was overhead Ndola descending, with airport lights in sight. The altimeter setting was confirmed by the aircraft and at 2210 GMT the aircraft was requested to report reaching 6,000 feet. No such report and no further radio communication was received from the aircraft.

2.1.3 Eye witnesses saw the lights of the aircraft pass over Ndola airport on a Westerly heading and disappear from view. The aircraft failed to report for final landing instructions, and although it was then believed that it had changed its intention and was proceeding elsewhere, overdue action was nevertheless initiated.

2.1.4 The wreckage of the aircraft was located about eight nautical miles from Ndola airport on a bearing of 279° True. Police arrived on the scene of the accident at 1345 GMT. Only one of the occupants was found to be alive and he subsequently died.

2.2 <u>Authority convening inquiry, appointment of accredited representatives, etc.</u>

2.2.1 In view of the importance of the personality involved and the widespread interest in this serious and tragic accident, the Federal Government required the Director of Civil Aviation personally to lead the technical investigation, assisted by Wing Commander Evans, R.A.F., of the British High Commission to the Federation. The investigating board consisted of :-

| | |
|---|---|
| Lt. Col. M.C.H. Barber, D.F.C. | Director of Civil Aviation, Federation of Rhodesia and Nyasaland (Chairman) |
| G/Capt. J. Blanchard-Sims, A.F.R.Ae.S., | Senior Operations Officer, Federal Department of Civil Aviation. |
| Mr. M. Madders, A.F.R.Ae.S., | Chief Inspector of Aircraft, Federal Department of Civil Aviation. |
| W/Cdr. E. Evans, R.A.F. | Air Adviser, British High Commissioner to the Federation. |

2.2.2 Representatives from Sweden - the State of Registry, the International Civil Aviation Organisation on behalf of United Nations, the International Federation of Airline Pilots Associations, and Transair the operators of the aircraft, were invited to participate in the investigation. These persons were:-

Accredited Representatives :

| | |
|---|---|
| Mr. E.A. Landin | Inspector of Civil Aviation, Royal Swedish Board of Civil Aviation. |
| Mr. J.P. Fournier | International Civil Aviation Organisation/United Nations |
| Capt. A.G. McAfee | International Federation of Airline Pilots Associations |

Technical Advisers :

To Mr. Landin:

| | |
|---|---|
| Dr. E. Bratt | Minister for Sweden to the Republic of South Africa. |
| Mr. T. Nylen, LL.M. | Legal Adviser, Royal Swedish Board of Civil Aviation. |
| Mr. N.E.L. Lindman | Temporarily attached to the Royal Swedish Board of Civil Aviation, as Senior Inspector of Aircraft. |
| Mr. O. Danielsson | Superintendent, Swedish Criminal State Police. |
| Mr. N. Landin, M.Sc. | Assistant Director of the Swedish National Institute of Technical Police. |
| Mr. A.W. Jansson | Temporarily attached to the Royal Swedish Board of Civil Aviation, as Inspector of Aircraft. |

To Mr. Fournier:

| | |
|---|---|
| Mr. T.R. Nelson A.F.R.Ae.S. M.C.A.I. | International Civil Aviation Organisation/United Nations |

On behalf of Transair Sweden, A.B., the owners and operators of the aircraft :

| | |
|---|---|
| Capt. S. Persson | Director of Flight Operations, Transair Sweden, A.B. |
| Mr. B. Virving | Chief Engineer, Transair Sweden, A.B. |
| Mr. C.G. Hellberg | Chief Flight Engineer, Transair Sweden, A.B. |

Secretary to the Board :

| | |
|---|---|
| Mr. I.J. Berry | Senior Aerodromes Officer, Federal Department of Civil Aviation. |

## PART 2 - FACTS ASCERTAINED BY INQUIRY

### 3. AIRCRAFT INFORMATION

| | | |
|---|---|---|
| 3.1 | Registration marking | SE-BDY |
| 3.2 | Aircraft type and makers serial number | Douglas DC6B serial number 43559 |
| 3.3 | Engine type, airframe positions and makers serial numbers | Pratt & Whitney R2800-CB-17<br>Posn. No. 1 serial P.35865<br>" " 2 " P.31738<br>" " 3 " P.32147<br>" " 4 " P.35867 |
| 3.4 | Certificate of Registration number and validity | No. 1508 - validity unlimited. |
| 3.5 | Certificate of Airworthiness: number and date of expiry, and Flight Manual number. | The temporary C of A has no number, and is valid until 31st October, 1961. The Flight Manual has no number, it is attached to the temporary C of A. |
| 3.6 | Certificate of Maintenance date and time (GMT) of issue and period of validity | Issued 17th September, 1961, at 1100 GMT and valid for 24 hours. |
| 3.7 | Date of construction of airframe | 1952 |
| 3.8 | Name and address of owners | Transair Sweden, A.B. Malmo, Sweden. |
| 3.9 | Gross weight: maximum permitted by the C of A for this flight, and at time of accident | Maximum authorised take-off weight 107000 lbs.<br>Actual take-off weight 90594 lbs.<br>Maximum authorised landing weight 88200 lbs.<br>Actual weight at time of accident 76762 lbs. |
| 3.10 | Loading - | |
| 3.10.1 | Centre of Gravity limits from Flight Manual | Gross weight up to and including 87500 lbs:<br>Forward limit 11.0% MAC, Aft limit 33% MAC<br>Gross weight up to and including 103800 lbs:<br>Forward limit 14.2% MAC, Aft limit 33% MAC |

Gross weight up to and including 107000 lbs:

| Forward limit | Aft limit |
|---|---|
| 16.0% MAC | 33% MAC |

Landing gear extended.

3.10.2 Actual C of G position at commencement of flight and at time of accident

C of G position at take-off between 20.0 and 26.9% MAC.

C of G position at time of accident between 17.1 and 25.3% MAC

3.11 Airframe history -

3.11.1 Flying time since manufacture — 16340 hours

3.11.2 Flying time since last overhaul — 7210 hours

3.11.3 Flying time since last periodic check — 105 hours

3.11.4 Modifications — All applicable FAA Airworthiness Directives have been complied with

3.12 Engine history

3.12.1 Flying time since manufacture

| | | | |
|---|---|---|---|
| No. 1 | (P.35865) | 5521 | hours |
| " 2 | (P.31738) | 5886 | " |
| " 3 | (P.32147) | 7927 | " |
| " 4 | (P.35867) | 4848 | " |

3.12.2 Flying time since last overhaul

| | | | |
|---|---|---|---|
| No. 1 | (P.35865) | 518 | hours |
| " 2 | (P.31738) | 390 | " |
| " 3 | (P.32147) | 278 | " |
| " 4 | (P.35867) | 1091 | " |

3.12.3 Flying time since last periodic check

| | | | |
|---|---|---|---|
| No. 1 | (P.35865) | 105 | hours |
| " 2 | (P.31738) | 105 | " |
| " 3 | (P.32147) | 105 | " |
| " 4 | (P.35867) | 105 | " |

3.12.4 Modifications — All applicable FAA Airworthiness Directives have been complied with

4. CREW INFORMATION

4.1 Name — Hallonquist, Per-Erik Bo.

Duty — Pilot in Command

| | |
|---|---|
| Age | 35 years |
| Type of licence | Swedish Airline Transport Pilot's licence number D-193. |
| Aircraft class | Single- and multi-engined land aircraft. |
| Type Ratings | Douglas DC-3, Curtiss C-46/ CW20-T, Douglas DC-6. |
| Instrument Rating and date of last check | Included in the licence. 28th June, 1961 |
| Date of last medical examination | 24th April, 1961. |
| Expiry date of licence | 31st October, 1961. |
| Types flown | Bucker Bestmann, Harvard, Focke Wulf, "Stieglitz", Fieseler Storch, Saab B17, Saab J21, Douglas DC-3, Curtiss C-46, Douglas DC-6, Douglas DC-6B. |
| Time on accident type: | DC-6 1266 hours DC-6B 179 hours |
| Time on type in past 90 days | DC6/6B 205 hours |
| Time on type in past 24 hours | 7 hours |
| Grand total | 7841 hours |

Captain Hallonquist started his flight training in the Swedish R.A.F. in 1946 where he remained until 1953. In 1947 he was issued with a Private Pilot's licence. A Commercial Pilot's licence was issued to him in 1953. At about this time he had further flight training for 4 months with Air Service Training Limited, England. He obtained his Airline Transport Pilot's licence in 1955. He was also the holder of a valid Flight Radio Telephony Operator's licence number 4447. He was employed by Transair as a co-pilot on DC-3 in 1954, and was promoted to captain on DC-3 in 1955 and on Curtiss C-46 in 1957. During October-November, 1959, he was given theoretical and practical training on DC-6 aircraft under the supervision of Scandinavian Airlines System. In December, 1959, he commenced flying as a captain on DC-6 for Transair. His total instrument flight time and night flight time was 2669 hours. He had not been involved in any previous flying accidents.

| | | |
|---|---|---|
| 4.2 | Name | Litton, Lars Olof. |
| | Duty | Co-pilot |
| | Age | 29 years |
| | Type of licence | Swedish Airline Transport Pilot's licence number D-360 |
| | Aircraft class | Single- and multi-engined land aircraft |
| | Type Ratings | As a captain, Douglas DC-3, Douglas DC-6. As a co-pilot, Curtiss C-46. |
| | Instrument Rating and date of last check | Included in the licence. 6th April, 1961. |
| | Date of last medical examination | 17th July, 1961 |
| | Expiry date of licence | 31st January, 1962 |
| | Types flown | Cessna 140, Luscombe Silvaire, Piper Cub, Ercoupe, Auster V, D.H. 89, Airspeed Consul, Klemm 35, Douglas DC-3, Curtiss C-46, Douglas DC-6, Douglas DC-6B. |
| | Time on accident type | DC-6 506 hours DC-6B 216 hours |
| | Time on type in past 90 days | DC6/6B 261 hours |
| | Time on type in past 24 hours | 17 hours |
| | Grand total | 2707 hours |

First Officer Litton had his first flight training at a private Swedish flying school, and obtained his Private Pilot's licence in 1953. A Commercial Pilot's licence was issued to him in 1955. He obtained his Airline Transport Pilot's licence in 1961. He was also the holder of a valid Flight Radio Telephony Operator's licence number 4443. He was employed by Transair as a co-pilot on DC-3 and Curtiss C-46 in 1958. During November, 1960, he was given theoretical and practical training on DC-6 aircraft under the supervision of Scandinavian Airlines System. In December, 1960, he commenced flying as a co-pilot on DC-6 for Transair. His total instrument flight time and night flight time was 835 hours. He had not been involved in any previous flying accident.

| | | |
|---|---|---|
| 4.3 | Name | Wilhelmsson, Nils-Goran |
| | Duty | Flight Engineer |
| | Age | 27 years |
| | Type of licence | Swedish Flight Engineer's licence number MF-129 |
| | Type Ratings | Curtiss C-46, Douglas DC-6 |
| | Date of last medical examination | 17th July, 1961 |
| | Expiry date of licence | 31st July, 1962. |
| | Time on accident type | DC-6 1173 hours DC-6B 195 hours |
| | Time on type in past 90 days | DC6/6B 311 hours |
| | Time on type in past 24 hours | 17 hours |
| | Grand total | 2630 hours |

Mr. Wilhelmsson was also the holder of a valid Swedish Aircraft Maintenance Engineer's licence number MM-411. He completed a course at a Swedish Municipal Technical School for ground engineers during the years 1949-1951. During the years 1952-1957 he was employed as a ground engineer with a Swedish civil air carrier, and also with the Swedish R.A.F. He was employed as a ground engineer by Transair in 1957 and started to work as a flight engineer on Curtiss C-46 with Transair in 1958. During March, 1960, he completed theoretical and practical training on DC-6 aircraft under the supervision of Scandinavian Airlines System.

| | | |
|---|---|---|
| 4.4 | Name | Ahreus, Nils-Erik |
| | Duty | Reserve Captain |
| | Age | 32 years |
| | Type of licence | Swedish Airline Transport Pilot's licence number D-199 |
| | Aircraft class | Single- and multi-engined land aircraft |
| | Type Ratings | Douglas DC-3, Curtiss C-46, Douglas DC-6. |
| | Instrument Rating and date of last check | Included in the licence 3rd May, 1961. |

| | |
|---|---|
| Date of last medical examination | 28th April, 1961 |
| Expiry date of licence | 31st October, 1961 |
| Types flown | Tiger Moth, Focke Wulf, "Steiglitz", Fieseler Storch, Klemm 35, Harvard, Bucker Bestmann, Saab Safir, Saab B.17, Vampire, Saab J29, Piper Cub, Luscombe Silvaire, Airspeed Consul, Douglas DC-3, Curtiss C-46, Douglas DC-6, Douglas DC-6B. |
| Time on accident type | DC-6 738 hours DC-6B 122 hours |
| Time on type in past 90 days | DC6/6B 241 hours |
| Time on type in past 24 hours | 10 hours 40 minutes |
| Grand total | 7107 hours |

Captain Ahreus started his flight training in the Swedish R.A.F. in 1947, where he remained until May, 1954. In 1947 he obtained his Private Pilot's licence. A Commercial Pilot's licence was issued to him in 1948. Around June, 1954, he was employed as a pilot with a Swedish air carrier engaged in agricultural flying. In 1955 he obtained a Senior Commercial Pilot's licence. He was given an Airline Transport Pilot's licence in 1956. He was also the holder of a valid Flight Radio Telephony Operator's licence number 4402. He was employed by Transair as a co-pilot on DC-3 in 1955 and was promoted to captain on DC-3 in 1956, and on Curtiss C-46 in 1958. During October and November, 1960, he completed a course of theoretical and practical training on DC-6 aircraft under the supervision of Scandinavian Airlines System. In November, 1960, he commenced flying as a captain on DC-6 aircraft for Transair. His total instrument flight time and total night flight time was 1500 hours. He had not been involved in any previous flying accident.

5. WEATHER INFORMATION

5.1 The last routine weather observation taken prior to the accident was made by the Meteorological Office staff at Ndola at 1900 GMT on 17th September (3½ hours before the accident). This observation was recorded on a Form M.O. 48 (serial

number 17) and passed to the Air Traffic Control Officer. It contained the following information:-

Ndola - 17/9/61 1900 GMT

Surface wind - direction 110°(M) speed 10 knots

Visibility - 5 miles

Present weather - fine, slight haze.

Cloud - nil

QNH - 1019.9 mbs (30.12 ins)

QFE - 875.6 mbs (25.86 ins)

5.2 The following is an extract from the autographic record for 2200Z on 17th September, 1961.

Surface pressure 876.7 mbs i.e. 25.89 ins giving a QNH of 30.15 ins (1021 mbs)

Screen temperature - 70° F.

Surface wind - 120/9 kts (True)

5.3 The following is the weather report transmitted by Ndola Air Traffic Control to the aircraft SE-BDY at 2137 (38 minutes approx. before the accident).

| | |
|---|---|
| Surface wind | 120°(M) 7 knots |
| Visibility | 5 to 10 miles with slight smoke haze |
| Control QNH | 1021 mbs |
| QFE | 877 mbs |

5.4 Moonset - 0024 GMT - 1st Quarter

6. NAVIGATION AIDS

6.1 Aids available on this flight

Leopoldville - NDB and VOR

Ndola - NDB, VDF and DME

6.2 Aids fitted to the aircraft

| | |
|---|---|
| 1 ea | US Army Type BE-16 Magnetic Compass |
| 2 ea | Pioneer Bendix D120 Master Direction Indicator |
| 2 ea | Collins Type 331A-2 Course Line Indicator |
| 2 ea | Pioneer Bendix 36105-1J-15-C1 Magnetic Indicator |
| 2 ea | 51Y-1 ADF Receiver |
| 1 ea | 16002-1-C Flight Path Computor |
| 2 ea | 51 R-NAV Receiver (VOR/ILS) |

2 ea 51 V-2 GS Receiver (ILS)

1 ea MKA-7A Marker Receiver (ILS)

1 ea AVQ-10 Receiver Transmitter (Radar)

6.3 Aids used and their effectiveness.

6.3.1 Navigation was not a significant factor in this accident as the aircraft arrived safely over the destination airport of Ndola. All the aids at 6.1 above were fully serviceable throughout the duration of the flight.

6.4 Maps, radio facility charts, etc.

6.4.1 It was not possible to ascertain what maps were actually used during the flight. However, as the aircraft completed a flight from Leopoldville to Ndola via the Southern end of Lake Tanganyika, the maps used were obviously sufficient for the purpose.

6.4.2 The operators of the aircraft, Messrs. Transair, have stated that all let-down and destination information is obtained from the Jeppesen Route Manual. A copy of this manual was recovered from the wreckage and, although badly burned, it was possible to ascertain that it had been amended by "LL" on 11/9 to include amendment number 34. The approach chart sheet for Ndola was missing, and it is possible that it was removed by the captain and placed in front of him whilst carrying out his approach to the airport. It was ascertained from a complete copy of the manual that the information regarding Ndola was correct. In addition, a copy of the U.S. Air Force publication "Flight Information Publication - Terminal (Low Altitude)" dated July, 1961, was found in the wreckage. There is no mention of Ndola in this publication but Ndolo aerodrome, situated on the outskirts of Leopoldville, is included. Certain notes appear in green on the Ndolo sheet and on the top cover of the publication. These notes may be siginificant in that there is reason to believe that Ndolo was not used by large aircraft at any time after the issue of this particular publication (July, 1961) and in that at least one of the notes on the Ndolo sheet appears to relate to Ndola. The relative approach altitudes, shown on the Ndolo sheet are substantially lower than those applicable to Ndola.

7. COMMUNICATIONS

7.1 Data on communications and their functioning.

7.1.1 The aircraft obtained take-off clearance from Leopoldville tower on VHF and was airborne at 1551 GMT. The Investigating Board has found no evidence to show that this aircraft had any radio communication after leaving Leopoldville until 2002 GMT when contact was made with Salisbury FIC on 5521.5 kc/s. H/F R/T communication with Salisbury FIC was maintained successfully until 2132 GMT when the aircraft was told to contact Ndola Approach. At 2135 GMT the aircraft contacted Ndola on 119.1 mc/s and maintained VHF communication until the last contact at 2210 GMT when it was overhead the airport. Recordings of H/F R/T conversations between the aircraft and Salisbury FIC on 5521.5 kc/s and also between the Salisbury FIC ATCC and Ndola tower ATCC on 6915/3682 kc/s are at appendices 1.4 and 1.5. Extracts from the ATC log at Ndola are at appendix 1.6. There were no tape recording facilities at Ndola for recording radio communications.

8. GROUND INSTALLATIONS

8.1 Condition of aerodrome and installations.

8.1.1 Ndola aerodrome has one bitumen runway 10/28 which is 6650 feet long by 100 feet wide, and is an all-weather aerodrome. The aerodrome is normally manned with ATC, communications, meteorological, and fire fighting staff during the hours 0400-1600 GMT and to cover scheduled movements outside these hours. The aerodrome and all facilities were fully serviceable during the night of 17th/18th September, 1961 and communication staff were on duty throughout the night. ATC and fire fighting personnel remained on duty from 1600 GMT on the 17th until 0115 GMT on the 18th.

9. FIRE FIGHTING EQUIPMENT

Due to the ignition of large quantities of fuel, estimated to be in excess of 1,000 imperial gallons, released by the rupture of the tanks during the crash, the wreckage was largely consumed by fire. The crashed aircraft was not found for some considerable time and therefore no fire fighting activities took place.

## 10. EXAMINATION OF WRECKAGE AND TECHNICAL INVESTIGATION

### 10.1 General Observations

10.1.1 Examination of the site of the accident indicated that the aircraft had first struck the tops of trees when on a heading of about 120°(M) at a shallow angle and a moderate rate of descent. The first point of impact with the tree tops is 66 feet higher than the point of impact of the nose of the aircraft with the ground. The linear distance between the two points is 760 feet, giving an average angle of descent after the first impact of 5°.

10.1.2 The propellers of the aircraft cut through the uppermost branches of the trees, and the severed branches, together with pieces of rubber from the propeller de-icing boots, were the first items to be found along the wreckage trail. The left wing tip was severed from the aircraft at an early stage indicating that the aircraft was probably in a slightly left wing-low attitude and the swath cut by the aircraft through the trees indicated an increasing angle of left bank. As the left outer mainplane of the aircraft collided with the trunks of the trees it was progressively demolished. At the same time the propellers and the fuselage suffered increasing damage by impact with trees and detached pieces were scattered along the wreckage trail.

10.1.3 The nose of the aircraft, with the fuselage, centre section empennage and right wing largely intact, struck a 12 foot-high anthill and the fuselage cartwheeled about the anthill swinging through approximately 180° and suffering complete demolition from further impact with trees and ground. Fire, fed by fuel from the burst tanks, covered the main wreckage and spread 350 feet back along the wreckage trail.

10.1.4 The intensity of the fire melted and fused most of the alluminium alloy of the wing centre section and fuselage. The four engines were broken from their mountings and severely damaged by impact and the subsequent fire. See Wreckage Plan appendix 1.1.

10.1.5 A ground search was organised using more than 160 policemen covering the area indicated on the map at appendix 1.7. The search failed to reveal any parts of the aircraft which had been detached prior to impact with the trees.

10.2 Condition of the wreckage.

10.2.1 The main wreckage was contained in an area approximately 60 feet by 90 feet and its disposition is shown on the wreckage plan at appendices 1.1 and 1.2. With the exception of the empennage, the fuselage aft of the rear pressure dome, and the left hand outer (No. 1) engine, the whole of the concentrated main wreckage was badly damaged by fire. The photographs at appendix 1.9 show the extent of destruction. The wing assembly, comprising left and right inner sections and right hand outer, came to rest correct side uppermost and had been attached to fuselage and power plants prior to impact. The right hand wing and flying control surfaces were badly damaged by impact and this occurred as the wing fell on to the trees in a vertical movement. The empennage was inverted with upper halves of the vertical stabiliser and rudderbroken off, the complete right hand stabiliser and elevator were also detached. The left hand inner (No. 2) and the right hand inner (No. 3) engines, together with their respective propellers and nacelles were extensively incinerated. The fuselage nose section including the cockpit was broken up and scattered in an area centred approximately 100 feet before the nearest part of the main wreckage. The fuselage forward of the rear pressure dome was completely destroyed by impact and subsequent fire, the seats, interior fittings and galley equipment being scattered over a wide area. The landing gear assemblies were located in the main wreckage. The left hand wing tip was recovered some 600 feet from the main wreckage, parts of the left hand outer wing being

located in the flight path between these two positions. Fire had not occurred prior to impact. The detailed technical report on the condition of the wreckage will be found at appendix 1.8.

10.3 Technical Examination of the Wreckage.

10.3.1 The accident site was surveyed by two land surveyors of the office of the Northern Rhodesia Government Divisional Surveyor, Ndola, who prepared a grid reference of the site showing contour lines at one foot intervals, position of large anthills and heights of some trees in the wreckage path which had been cut and damaged. The grid reference was marked out on the site by the surveyors using stakes and string, location of damaged trees referred to on the grid drawing being indicated by indexed pegs. The area covered by the grid was 168,000 square feet (840' x 200').

10.3.2 All items of the wreckage were examined at the site for unusual features, relevant settings were recorded where applicable and the parts marked or labelled with the grid reference in which they had been found. The position of all significant parts of the wreckage are plotted on the Wreckage Plan at appendices 1.1 and 1.2

10.3.3 Various samples of ash, metal and fabric were taken from selected locations in the wreckage by the Chief Research Officer of the Rhodesian Selection Trust, Kalalushi, and subjected to laboratory examination and analysis to check for evidence of explosive agents. A copy of the report prepared following this analysis is contained at appendix 1.10.

10.3.4 A detailed technical report is at appendix 1.8. However, examination of significant wreckage produced the following facts -

10.3.4.1 Landing Gear. The left hand gear assembly was in the "down" position, shown by both pairs of down latch locking lugs in contact and fully engaged with the actuating strut piston at bottom of stroke (fully extended). The right hand gear assembly

actuating strut piston was also fully extended, but the down latch locking lugs were broken; this type of breakage would occur only if the lugs were in the fully locked "down" position. In the case of the nose gear assembly the actuating strut piston rod had fractured at the cylinder with the piston at the top of the stroke, indicating that this assembly was also in the fully down position. The landing gear control lever was recovered spring loaded in the landing gear "down" position. The door operating mechanism was also found in the "open" position. There is no doubt that the landing gear was selected "down" and fully locked "down" at the time of impact.

10.3.4.2 Wing Flap System. The flap operating handle was recovered damaged and burnt, the plunger housing was loose on its quadrant which was bent and indicated that the operating handle plunger was in the 5th slot at the time of impact; this represents the 30° flap down position. The quadrant has eight positions 10°, 15°, 20°, 25°, 30°, 35°, 40° and 50°. The plunger assembly was detached from the operating handle, therefore no positive indication is given by this control, although it is probable that the selector was in fact at the 30° position at the time of impact. The flap position indicator had markings on the dial at the 30° position consistent with the pointer having probably been in this position. All four flap actuating struts were recovered - left hand units loose, right hand units in position. Piston rod extensions were checked but were considered unreliable since the left hand units were wrenched from the wing in the crash and the right hand units were in the full flap "up" position. The right hand wing flaps would be

forced into the "up" position in the crash and since the hydraulic pipes to the actuating struts were broken the pistons would move with the flaps.

10.3.4.3 Flying Controls. It is considered that nothing significant can be deduced from the position of any of the flying controls and surfaces. The only components that might have given some indication were the trim tab actuators. However, these are cable operated and were forced to the extreme in one direction, the direction being dependent on the order of breaking of the operating cables.

10.3.4.4 Engine and Propellers. An examination of the engines and propellers revealed no sign of failure or malfunction prior to impact. Inspection of the propeller stop ring assemblies confirmed that the angular setting of all propellers was in the constant speed range. Therefore, it is considered that the engines and propellers were operating in a normal manner and developing power at the moment of first impact.

10.3.4.5 Altimeters. All three altimeters were set at approximately the correct QNH for Ndola airport at the time of the accident. The controller had given 1021 mb (30.15" Hg) and the altimeter pressure settings were :-

| | |
|---|---|
| 1st Pilot's instrument | 30.14" Hg. |
| 2nd Pilot's instrument | 30.16" Hg. |
| Navigator's instrument | 30.17" Hg. |

The pointers on all altimeters were loose and the readings unreliable. See appendix 1.11 for a report by the United States Civil Aeronautics Board.

10.3.5 During the period 24th to 30th September, the wreckage was transported from the crash site to the hangar at Ndola airport where the major components and

those parts which could be recognised were placed in their relative positions on the hangar floor on a planned layout of the aircraft. See appendix 1.12.

10.3.6 Following removal of the wreckage from the accident site, the area where the wreckage and bodies had lain between grid line 64 and the track (shown on appendix 1.1) was then raked and sifted using ¼" sieves. This operation produced further pieces of the aircraft, cartridges, cartridge cases, bullets, coins and small items of personal property. With the exception of the aircraft parts all items were handed to Northern Rhodesia Government C.I.D. representatives. The raked residue which did not pass through the sieves was collected and moved to the Ndola airport hangar for further investigation.

10.3.7 The large fused blocks of metal salvaged from the fuselage and centre wing area were broken into small pieces and any visible unmelted parts suspended in the blocks removed for identification and examination. The thinner sections of blocks were broken by sledge hammer and chisel, but it was necessary to break up the heavy blocks by steam hammer.

10.3.8 All fused items and burnt rubble still adhering to the wreckage was removed and this, together with the residue from the breaking operation and heaps of debris, shovelled from the crash site, were sifted through ¼" sieves. This second sifting operation produced further pieces of the aircraft, cartridges, cartridge cases, bullets, coins and small items of personal property.

10.3.9 To assist in the detailed technical examination of the wreckage all items removed from the crash site were segregated in the hangar in the following divisions:-

All structural parts of the aircraft that could be identified together with the power plants and propellers were placed in approximate correct positions in the aircraft layout mentioned at 10.3.5 above.

The respective hydraulic, pneumatic, electrical systems, etc.

Small unburnt pieces that could be identified as some part of the wing structure.

Small burnt pieces and pieces embedded in fused blocks that could be identified as parts of the wing structure.

Small unburnt pieces that could be identified as parts of the fuselage structure.

Small burnt pieces and pieces embedded in fused blocks that could be identified as parts of the fuselage structure.

Broken pieces from fused blocks from which all visible unmelted pieces had been removed.

Dust from sifting operations.

Small miscellaneous parts, bolts, nuts, small cabin articles, etc.

10.3.11 Special Technical Investigations and Tests

10.3.11.1 The three altimeters recovered from the first and second pilots and navigator's flight panels were forwarded for detailed specialist examination and report to be carried out under the auspices of the Civil Aeronautics Board, Washington. The relevant report is at appendix 1.11.

10.3.11.2 Samples of ash and burnt wreckage taken from selected positions at the accident site were analysed and checked for the presence of explosive agents, with negative results. The relevant report is at appendix 1.10.

10.3.11.3 All residue from the accident site was raked together and sifted to retrieve all ammunition reported to have been carried in the aircraft, and to search for any bullets or missiles inconsistent with the weapons carried in the aircraft. At the same time a search was made for any foreign objects

or parts of such objects which could have contained explosive agents. The result of these searches was negative.

10.3.11.4 All fire-arms and ammunition recovered from the wreckage were taken by the Northern Rhodesia Police who carried out appropriate investigation. This investigation proved that none of the bullets in the fire-arms had been fired. A report of the ballistics expert is attached at appendix 1.13.

10.3.11.5 All parts of the aircraft were examined for bullet holes or signs of explosion or sabotage. Certain items were segregated and formed the subject of special investigations by the Northern Rhodesia Police and by Swedish Government experts. No bullet holes or evidence of sabotage were found.

10.3.12 At 1430 GMT on 2nd November, 1961, the hangar at Ndola airport, containing the wreckage, was locked and sealed in the presence of two members of the Investigating Board.

## PART 3 COMMENTS AND FINDINGS

### 11. RECONSTRUCTION OF FLIGHT UP TO THE ACCIDENT

11.1 The information available to permit a reasonable reconstruction of the flight is vague and incomplete. The time of departure from Leopoldville was 1551 GMT and the following position reports were made during the flight:-

| | |
|---|---|
| Over reporting point 432B (07°40'S - 30°33'E) | at 2035 GMT |
| Abeam Kasama | at 2106 GMT |
| Abeam Ndola (NDB) | at 2147 GMT |
| Over Ndola airport | at 2210 GMT |

Consequently, there must be some conjecture in any attempt to reconstruct the flight or what should be considered as the most likely route followed by the aircraft. See appendix 1.3. This will be particularly true for the portion of the flight between Leopoldville and the point where the position report was made at

2035 GMT. The flight plan indicates that the initial cruising altitude should have been 13,500 ft (FL 135) but at 2035 GMT the aircraft reported cruising at 17,500 feet (FL 175). Since there is no indication as to when the aircraft climbed from FL 135 to FL 175, this part of the flight has been computed as if the climb to FL 175 was made immediately after take-off from Leopoldville. It has also been assumed the climb was made in still air at a true airspeed of 184 knots. This climb should then have taken about 35 minutes and should have covered about 108 nautical miles over the ground. The only upper wind information available to the Board for FL 175 covers that portion of the probable route from reporting point 432B to Ndola airport. During the period of the flight this wind is believed to have been 070° - 100°(T) at 10 to 15 knots. For computing purposes a wind of 085°(T) at 15 knots has been used for the portion of the flight from 432B to Ndola airport and it has been assumed that for the portion of the flight Leopoldville until reporting time 2035 GMT the wind was weaker and from the East; a wind speed of 5 to 6 knots has been used as the average for this purpose.

11.2 The most likely route followed by SE-BDY between Leopoldville and reporting point 432B was direct to an approximate position 04°35' South, 29°25' East, then down Lake Tanganyika to reporting position 432B.

11.3 The computation for the portion of the route that is most likely to have been followed after 432B has been made in reverse, i.e. starting from the time over Ndola airport at 2210 GMT. At 2147 GMT the aircraft reported abeam Ndola. This was 23 minutes before arriving over Ndola. A VDF bearing (QDM 279) taken at the time of this report indicates that the aircraft was then due East of Ndola airport. Assuming the aircraft travelled at an average ground speed of 255 knots (240 TAS plus 15 knot tail wind component) from where it was at 2147 GMT until it reached Ndola, it would be logical to conclude

that the aircraft was then 98 nautical miles from Ndola over position 13°00'S, 30°19'E. The distance from abeam Kasama to the assumed position when the aircraft reported at 2147 GMT is 170 nautical miles. The elapsed time for this portion of the flight was 41 minutes. This indicates a ground speed of 248 knots which would appear reasonably consistent with known and assumed circumstances. The distance from abeam Kasama to reporting point 432B (on a direct line from 432B to position assumed at 2147 GMT) is 150 nautical miles. This portion of the flight took 31 minutes and indicates that the ground speed would have been 290 knots. This ground speed is not consistent with the other section of the flight and in view of reported wind conditions appears to be unlikely. Since the ground speed South of the point abeam Kasama appears reasonable and consistent, the computed ground speed of 290 knots would appear to suggest that the aircraft covered a shorter distance than 150 nautical miles between 2035 GMT and 2106 GMT, and was probably 22 nautical miles to the South or South East of 432B when it reported as being over this reporting point.

12. DISCUSSION OF THE EVIDENCE

12.1 There is evidence that an intended flight using either OO-RIC or SE-BDY to carry Mr. Hammarskjold to Ndola was proposed on Sunday morning to start at 1600 GMT on Sunday 17th September, 1961. In fact SE-BDY was used and took off 9 minutes early at 1551 GMT.

12.2 Captain Hallonquist apparently did not wish to file a flight plan for this last flight, and the ATCO Leopoldville suggested at 1500 GMT that he should file a departure plan for destination Luluabourg. Hallonquist did so and on it stated his endurance was 13 hours 25 minutes.

12.3 The U.N. Air Commander, Leopoldville, knew only 45 minutes prior to take-off that destination was Ndola. No one except the aircraft crew concerned appeared to have any knowledge of the proposed route and flight level. This route proved to be

entirely different from that followed by OO-RIC, the aircraft carrying Lord Lansdowne, which was to arrive and depart Ndola before the arrival of SE-BDY, the aircraft carrying Mr. Hammarskjold. The route followed by SE-BDY was apparently Leopoldville Lake Tanganyika and then South to abeam Ndola.

12.4 SE-BDY did not contact Nairobi FIC but was in H/F radio contact with Salisbury FIC from 2002 GMT, when it was still outside the Salisbury FIR. During subsequent conversations until it was handed over by FIC to Ndola approach at 2132 GMT, the aircraft passed information comprising an abbreviated flight plan giving flight level, routing and ETAs Ndola.

12.5 From 2135 GMT the aircraft worked Ndola approach on VHF during which time it was cleared to commence its descent at 2157. GMT from 16,000 feet to 6,000 feet, and was asked to report "top of descent". It did not do so but presumably commenced its descent at that time and flew overhead Ndola airport from East to West at approximately 2210 GMT Sunday 17th September at normal circuit altitude or less. The aircraft was asked to report reaching 6,000 feet after stating he was overhead Ndola, but failed to do so.

12.6 When over the airport the aircraft was heard and observed by a number of witnesses none of whom noticed anything unusual in its flight. The flashing red anti-collision light on top of the aircraft fin was operating and the navigation lights were switched on "steady". It had already indicated .. its intention to land at Ndola as it had given an ETA of 2220 GMT. SE-BDY apparently flew overhead Ndola radio beacon 2.5 nautical miles West of the airport and apparently continued on a normal procedure turn and letdown. The aircraft was reported as low over the beacon and very low during the procedure turn. Although it had only been cleared down to 6,000 feet MER (1840 feet above Ndola aerodrome) it did not report as having reached that altitude and, in fact, hit trees and the ground at a shallow angle of 5° or less, at what appears to have been normal approach speed, at an altitude of 4,357 feet MER with its undercarriage locked down, flaps

partially extended, and with all 4 engines developing power and all the propellers in the normal pitch range, heading towards the Ndola radio beacon on a landing approach. The 3 cockpit altimeters were set correctly, within fine limits, to the QNH setting given by Ndola. These altimeters are American instruments and cannot be set to QFE settings at Rhodesian altitudes; in addition, it is normal Transair practice to set all altimeters to QNH. However, had it been possible to set the captain's and first officer's altimeters to QFE, then by setting one at QNH and the other at QFE a simple subtraction of indicated heights would have given the height of the aerodrome as a check of the instruments.

12.7 Smoke from a factory chimney near the airport may have been drifting across the approach to runway 10, but it is considered that this had no bearing on the cause of the accident as the pilot of a DC4 which landed at 2035 GMT saw the smoke but had no difficulty whatever in carrying out a visual approach and landing. As the surface wind speed and direction did not alter appreciably between the time the DC4 landed and the time of the crash, the smoke conditions at the time that SE-BDY was carrying out its approach would be similar to those seen by the pilot of the DC4.

12.8 No. 2 engine of SE-BDY was slightly damaged by one small calibre bullet on the morning of Sunday, 17th September at Elisabethville. It was thoroughly inspected and repaired by the afternoon of the same day at Leopoldville. The Transair maintenance staff carried out a very thorough inspection of the aircraft and no further damage was found. The Investigating Board has no reason to doubt the serviceability of SE-BDY for this flight.

12.9 Although Ahreus and Litton had flown from Leopoldville to Elisabethville and return on the night of Saturday, 16th September, Captain Hallonquist had not flown for over 24 hours prior to the flight to Ndola and appeared rested and

in good spirits before take-off. In fact he was apparently most anxious to make the flight. There were crew bunks and sleeping bags on the aircraft.

12.10 Captain Hallonquist was almost certainly seated in the aircraft captain's seat at the time of the impact and co-pilot Litton was almost certainly in the starboard pilot's seat. The three pilots were well qualified and were experienced on the DC6 and had each flown over 100 hours in the Congo within the 6 weeks prior to the crash.

12.11 SE-BDY may have been carrying two parachute flares and while there is no doubt that the magnesium content of these flares would intensify the fire at the crash there is no evidence to show that they caught fire or were dropped prior to the crash.

12.12 There is no evidence that special security arrangements for this aircraft were made at Leopoldville, therefore the possibility for a saboteur to place an infernal device on board this aircraft prior to take off, or to otherwise interfere with it, cannot be precluded. However, no evidence was found which points to sabotage as the cause of the crash. There is no sign of explosion or fire in the air, and the aircraft appears to have been under full control until it hit the trees, and all remaining control system parts appear to have been in good order at the time of impact.

12.13 No evidence has been found to support the suggestion that SE-BDY was shot down by ground fire or by offensive aircraft. In fact the weight of evidence is all against such actions having taken place. The aircraft indicated that once it crossed into the Salisbury FIR it intended to remain outside Congolese territory. SE-BDY had its normal night flying lights on when in the vicinity of Ndola - these included the anti-collision light which would be visible for miles. It is unlikely that the captain would leave these lights on if he realised he was being shot at or chased,

or even if he was concerned about such action being taken against him. The one Katangese Fouga fighter bomber trainer was examined at its base at Kolwezi by some members of the Board and the calibre of its two machine guns noted. No such calibre bullets (or any bullet holes) were found in the wreckage. In fact no bullets inconsistent with weapons carried in the aircraft were found. Local witnesses at Kolwezi have stated that the Fouga had never been operated at night. After examining information from the aircraft manufacturers, the Board is satisfied that Ndola is beyond the Fouga's combat range from Kolwezi - the only known airfield from which it could operate. The aircraft commander stated that he had never violated the Federal border and that he had never shot down an aircraft. There was no radio transmission from SE-BDY indicating that it was being, or had been, shot at or attacked and there was no evidence of bullet or shell injury to the crew which might have prevented such transmission. Up to approximately 2210 GMT on 17th September the pilot was in contact with Ndola tower and was acting and talking normally and the aircraft was seen and heard to be flying in a normal manner. From that time on, for the remaining 5 minutes or so of the aircraft's flight, it was under observation by many police officers on duty and by three witnesses in particular, except for the last 20 or 30 seconds when SE-BDY apparently went below the line of vision of one of them who was standing on a fourth floor balcony. No strange bullets or anything resembling parts of a shell, grenade or rocket have been found and no bullet holes or damage consistent with offensive action have been found in the wreckage. Neither of the pilots made any transmission which indicated trouble or alarm from the time when it was overhead Ndola to the time of the crash (2215 GMT approx.). The aircraft crashed on track, and the wheels and flaps were down - which again points to a normal descent and approach. If the aircraft had been under attack or if the pilots had been worried about such a possibility, the logical thing would have been for them to retract the wheels

and flaps, increase power to take avoiding action, switch out the lights and warn the aerodrome. The weight of evidence clearly predominates in favour of a situation that was normal and correct, except that SE-BDY was about 1,700 feet lower than it should have been at this point. The Board does not hold the view that the pilot was flying low intentionally.

12.14 The overwhelming weight of reliable evidence is that at the time SE-BDY was the only aircraft in the air in the vicinity of Ndola.

12.15 There is no evidence of any in-flight fire or explosion in SE-BDY. There is no singeing, discolouration or burning of the tree tops prior to the beginning of the ground fire which extended back from the final wreckage point some 120 yards, which is some 200 yards after the aircraft first touched the tree tops. The first pieces of wreckage of the aircraft were found in the direction of flight from the first point of impact with the tree tops. These were pieces of propeller rubber de-icing boots, then the port wing tip, pieces of port outer wing, propeller blade, etc. There was no evidence of fire damage on those pieces which were not in the area of ground fire.

12.16 Medical evidence shows that two bodies were found to have bullets, fragments of exploded cartridge cases and percussion caps in the skin, the subcutaneous tissues or the muscles. These bodies had ammunition in their vicinity in the wreckage, and the orientation of the bullets within the tissues did not support any contention that they had been fired from any consistent direction. The pathologists consider that these injuries resulted from explosion of ammunition in the fire. The bullets found in the bodies have been microscopically examined by ballistics experts and it was ascertained that they had not passed through the barrel of a fire-arm. Three or four other severely burned bodies were found to have pieces of partially melted aircraft metal superficially sited on them. The pathologists considered that this resulted from the incineration of bodies in the presence of aircraft wreckage and in no way suggests fragmentation from an explosion. None of the foreign objects was found in an individual in any way responsible for flying the aircraft. No other bodies were found to have any foreign metal fragments in them. The summary

and conclusions from the medical report are at appendix 3.3.

12.17 The temporary survivor of the crash made several statements during the 5/6 days he was in hospital. Medical evidence regarding this is that those statements made on the 18th September are unreliable because he was delirious at that time and that statements made during the last 24 hours of his life, with regard to sparks in the sky, may also have no significance as he was then uremic and part of the picture of this disease is spots and flashes of light before the eyes.

12.18 The route taken by the pilot of OO-RIC was virtually direct from Leopoldville to Ndola and passed within 60 miles of Kolwezi. The aircraft was in radio communication with both Kamina and Elisabethville and had its anti-collision beacon and navigation lights illuminated. Until a short time before departure it was generally believed that this aircraft would be carrying the U.N. Secretary General. OO-RIC arrived safely at Ndola without any interference en route.

12.19 The possibility that one of the three American DC3 aircraft parked (2 at Ndola and 1 at Elisabethville) might have been in radio contact with SE-BDY and may have instructed it to divert or had knowledge of the intention to do so was investigated. The evidence of the senior American officer and of the other two aircraft captains is that there was no communication by any of these three aircraft with SE-BDY.

12.20 The remains of the aircraft control mechanisms, power plants and systems have been meticulously examined and no evidence was been found of failure or malfunction. This fact, together with the evidence at the crash site and of the mass of the observers' evidence as to the aircraft's behaviour, indicate that there was no technical defect or structural or material failure.

12.21 It was noted that the aircraft captain's altimeter, which was in comparatively good condition, was found disconnected from the static supply. However, had there been a break in the static line as a result of disconnection during flight, the effects would have been immediately apparent as the captain's VSI would have remained stationary, and the airspeed indicator and altimeter would have under-read, i.e. the indicated height would have been lower than the actual height. In other words it would have erred on the safe side. The Board cannot see how this can have any significance as a causal factor in the accident. Additionally, as the co-pilot's and navigator's static instruments were connected to a separate supply any

discrepancy in the readings should have been obvious. The simple misreading of an altimeter, however, cannot be ruled out as a possibility.

12.22 Amounts of up to 7% of carboxyhaemoglobin were found in the two pilots in control, the radio operator and Mr. Serge Barrau as well as 2% in Mr. Hammarskjold's body, while all others which it was possible to test were negative. The pathologists have stated that these amounts are not significant.

12.23 Because the aircraft flew over the airport and away to the West, some of the witnesses thought that it was going elsewhere or was communicating with another station. Similarly, when the aircraft did not land some witnesses thought that Mr. Hammarskjold had changed his mind and had diverted the aircraft back to its starting point or to Elisabethville. However, the investigation has satisfied the Board that the aircraft was almost certainly engaged in some form of procedure turn preparatory to a landing approach.

13. SEARCH AND RESCUE ACTION

13.1 The relevant documents defining Search and Rescue action to be taken in respect of a missing aircraft are:-

13.1.1 "PROCEDURES FOR SEARCH AND RESCUE WITHIN THE SALISBURY SEARCH AND RESCUE AREA" - Reference 334/3 dated 6th October, 1959.

13.1.2 "AIR TRAFFIC CONTROL INSTRUCTIONS" Department of Civil Aviation dated September, 1960.

13.1.3 "STATION STANDING INSTRUCTIONS - NDOLA AIRPORT" dated June, 1961

13.2 The above documents state inter alia in this case that initiating action should have been taken by Ndola ATS Unit thirty minutes after the latest ETA of SE-BDY, i.e. at 2245 GMT. In spite of the fact that the "INCERFA" signal was not originated until 2342 GMT and was not despatched until 0016 GMT, other correct action was taken by Ndola airport staff.

13.3 The ATCC Ndola continued to try and contact SE-BDY on both VHF channels from 2215 GMT onwards and queried Ndola police for reports of an aircraft crash. He also communicated with Salisbury FIC and initiated a "communication search" and checked other aerodromes for news.

13.4 The Ndola and Mufulira police orginated ground search action by sending out Land Rover patrols in the early hours of the morning from both places to investigate a report of a flash in the sky North West of Ndola. These patrols which started at 0145 GMT found nothing significant. The Ndola control tower was closed at 0115 GMT and there was a communicator left on duty who knew how to contact the Airport Manager.

13.5 The RRAF search action which started on Monday morning was finally successful at about the same time as ground reports from Africans reached police and airport authorities.

13.6 If the Africans who witnessed the crash or heard the explosion had reported the fact to any authority they could have led police or rescue vehicles to the scene of the accident before daylight. No such report was made until about 1300 GMT on Monday 18th.

14. SPECIAL TESTS

14.1 In view of the diversity of opinion amongst witnesses as to height above ground and as to what lights were showing from SE-BDY whilst over or in the vicinity of Ndola airport, an experiment was carried out using a DC6 aircraft belonging to Transair, and flown by a Transair crew with one of the Board's observers (who is also the Director of Flight Operations of Transair) acting as second pilot. Two members of the Board were in the aircraft observing the flights.

14.2 During this experiment the aircraft was flown over Ndola airport and out over the crash site on the night of 9th October, 1961, making five different runs at varying heights with different combinations of lights showing, at different power settings and speeds. Full details of these flights are at appendix 1.14.

14.3 During these tests the pilot followed the let-down pattern detailed in the Jeppesen route manual as used by Transair crews, and on each occasion it was noted that the aircraft flew over, or very close to, the crash site and on approximately the same heading as the swath through

the trees. (The crash site in the forest was identified by Police Land Rover vehicles stationed there with their head-lights illuminated).

14.4 Whilst this flying was being carried out all but one of the relevant witnesses were placed in the positions they held on the night of the accident and were accompanied by members or observers of the Board. These witnesses were given forms to complete which requested information regarding height, direction, noise and lights of the aircraft being used in the tests as compared with what they saw and/or heard on the night of the accident.

14.5 An analysis of the results of these flights, together with discussion with the witnesses at the time, shows that the majority of witnesses were emphatic that the aircraft on test was never as low as SE-BDY on the night of the accident. As the lowest flight during the tests was 6,000 feet (1840 feet above ground) over the airport and 5,300 feet (934 feet above the tree tops) over the crash site, it would seem to indicate that SE-BDY was low over the airport and very low during the turn to approach the airport. In fact this points to SE-BDY being below 6,000 feet MER when overhead the airport and certainly much lower than the obstacle clearance limit of 4,660 feet (500 feet above the airport) specified on the Ndola approach chart in the Jeppesen Route Manual, after passing over the airport and during the turn to approach. The majority of the witnesses indicated that SE-BDY was showing its flashing red anti-collision light and navigation lights on "steady", with the power settings and speed consistent with a normal circuit and approach.

14.6 In addition, two special flights were made using DC3 aircraft with members of the Board flying in the aircraft as observers on each occasion. The first flight was made at night, carrying out an instrument procedure let-down to Ndola aerodrome, to investigate whether the town and aerodrome lights may have been confusing to a pilot strange to the area. It was agreed that the lights did not casue confusion. The second flight was made immediately

before dusk to simulate as nearly as possible a DC6 carrying out a procedure approach. The speed was maintained at 140 knots. In each case the test aircraft flew approximately overhead the crash site on approximately the same heading as the crash swath through the trees, and the Board is satisfied that SE-BDY was carrying out a procedure approach when it crashed.

15. CONCLUSIONS

15.1 The aircraft was correctly certificated and had been maintained in accordance with the approved maintenance schedule.

15.2 The aircraft was correctly loaded with the C of G within prescribed limits.

15.3 No evidence could be found to suggest failure or malfunction of the aircraft control mechanisms, power plants or systems. The evidence at the crash site and the mass of observers' evidence as to the aircraft's behaviour indicate that there was no technical defect or structural or material failure.

15.4 The three altimeters installed in the aircraft were recovered and it was possible to determine that the correct QNH for Ndola was set on each instrument.

15.5 The crew held valid licences appropriate to their duties and had not exceeded the prescribed flight time limitations.

15.6 All navigational aids and radio facilities at Ndola were fully serviceable and operating at the time of the accident.

15.7 The weather at the time of the accident was fine with slight smoke haze and the night was dark and there was no cloud. The moon was in its first Quarter and set at 2224 GMT.

15.8 SE-BDY had been cleared by the ATCO Ndola down to 6,000 feet MER after checking the QNH and was asked to report reaching 6,000 feet. The aircraft did not report reaching 6,000 feet but passed overhead Ndola airport and overhead (or nearly so) the Ndola NDB. It had almost completed the procedure turn when it struck the tree tops. Its wheels

were extended and the flaps partially extended at the time. The aircraft first touched the tree tops at a height of 4,357 feet MER. Ndola airport is 4,160 feet MER.

15.9 SE-BDY was showing the correct external lights up to the time of the accident.

15.10 The pathologists have stated that no medical cause for this accident has been found and that there exists no medical evidence of sabotage.

15.11 FIC Salisbury and Ndola Tower had sufficient information regarding SE-BDY's position, destination and ETA for their control purposes.

15.12 The Control Tower was closed down at Ndola airport on the night in question after INCERFA action had been initiated but not resolved. A communicator was on duty throughout the night who could have recalled staff if required.

15.13 Certain African charcoal burners could have reached the crash site by 2245 GMT and led rescuers to the crash before daylight had they so wished.

16. CAUSES.

16.1 The Investigating Board is of the opinion that the evidence available does not enable them to determine a specific or definite cause.

16.2 The following list gives the Board's opinion of the possibilities. The order of listing is not intended to indicate any degree of priority.

16.3 The wilful act of some person or persons unknown which might have forced the aircraft to descend and collide with the trees.

16.3.1 Comment. The Board is of the opinion taking into consideration the extent of the destruction of the aircraft and the lack of survivor's evidence, that this possibility cannot be completely ruled out. The Board is, however, satisfied, on the weight of evidence available to it that it is an unlikely possibility.

16.4 Some undetermined defect in the engines, the airframe, control mechanisms or systems, beyond the power of the crew to remedy in the air that might have induced the forced descent of the aircraft.

16.4.1 Comment. Despite intensive examination of the wreckage no such defect has been discovered. The weight of evidence suggests that the aircraft was airworthy and fully controllable immediately prior to collision with the trees.

16.5 Descent of a fully controllable aircraft into the trees due to (a) some misunderstanding of the aerodrome altitude or (b) some sudden incapacitation of the three pilots on board or (c) some misreading of the aircraft's altimeters or (d) some incorrect altitude indication on at least one of the aircraft's three altimeters, or some combination of (a) to (d).

16.5.1 Comment. In the opinion of the Board the probable cause of the accident lies within this group.

..... Lt. Col. Chairman

..... Senior Operations Officer

..... Chief Inspector of Aircraft

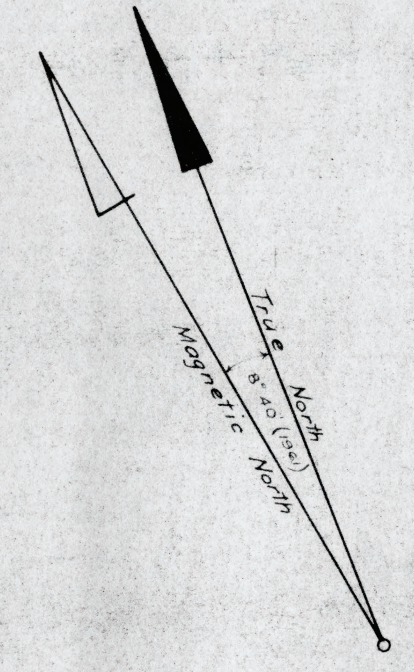
..... W/Cdr. R.A.F.

APP.
1.1

# WRECKAGE PLAN

## ACCIDENT TO DOUGLAS DC-6B SE-BDY

SCALE: 1 INCH TO 20 FEET.




The Magnetic Bearing of the line O0/O84 is 120°.

NOTE

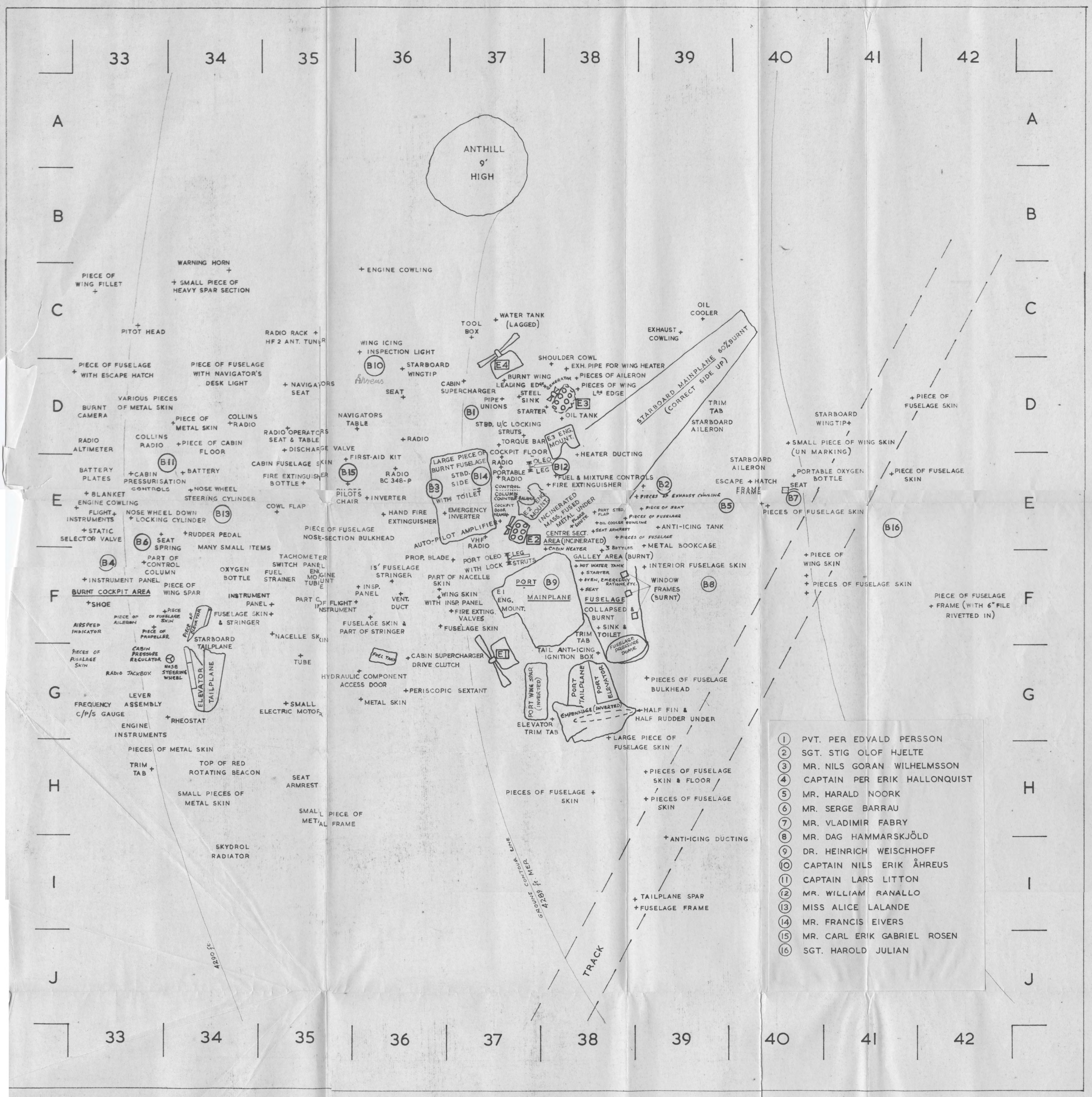
1. Datum ground level at peg u0 adopted as 4300 feet from Federal Trig Survey 1 in 50,000 Series Sheet 1228 $D_3$
2. Ground level contours are indicated thus ——4298——
3. The heights of the highest damaged points of a few selected trees (W1 – W36) are shown thus eg 4346.4 W3

Prepared in the Office of the Divisional Surveyor, Ndola, from a survey made by us in September, 1961.

APP.
1.2

# EXPLODED PLAN OF GRID Nos. 33-42 (APPENDIX 1.1)





APP.
1.3

APPENDIX 1.3

LEOPOLDVILLE FIR
BRAZZAVILLE FIR
NAIROBI FIR
LUANDA FIR
SALISBURY FIR
LOURENCO MARQUES FIR
GULF OF GUINEA
PROBABLE ROUTE FLOWN BY SE-BDY
04°35' S 29°25' E
REPORTING POSITION 432 B
ON AT GMT
ADR 432
CALLED "ABEAM KASAMA" 2106 GMT
13°00' S 30°19' E AT 2147 GMT
SE-BDY REPORTED "OVERHEAD NDOLA" 2210 GMT
ROUTE FLOWN BY OO-RIC
REPUBLIC OF THE CONGO
RHODESIA AND NYASALAND
ANGOLA
MOZAMBIQUE
TANGANYIKA

APP.
1.4

TRANSCRIPTION OF TAPE RECORDED R/T COMMUNICATIONS
BETWEEN SE-BDY AND SALISBURY FIC

Date : 17th September, 1961
Recorded at : Salisbury
Circuit : No. R/T 1. Frequency 5521.5 kc/s
Time : Between 2002 GMT and 2132 GMT.

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| 2002 | SAY | SEBDY | Call |
| | ? | SBY | Aircraft calling Salisbury say again your call sign. |
| | SAY | SEBDY | Good evening. How do you read |
| | ? | SAY | Say again your call sign. |
| | SAY | SEBDY | How do you read |
| | SEBDY | SAY | Roger three to four slight static |
| 2002¼ | SAY | SEBDY | Request ETA CORIC |
| | SEBDY | SAY | Standby one |
| | SEBDY | SAY | Calls |
| | SAY | SEBDY | Go ahead |
| | SEBDY | SAY | What is your destination and aircraft type |
| 2004½ | SAY | SEBDY | Standby one |
| | SAY | SEBDY | Calls |
| | SEBDY | SAY | Go ahead |
| | SAY | SEBDY | Destination Ndola aircraft DC6 ? |
| | SEBDY | SAY | Understand destination Ndola DC6C is that affirmative |
| | SAY | SEBDY | DC ??? |
| | SEBDY | SAY | Understand destination Ndola and aircraft type DC6 is that affirmative |
| | SAY | SEBDY | That is affirmative |
| 2006½ | SEBDY | SAY | Roger what is your ETA Ndola |
| | SAY | SEBDY | Roger standby one |
| | SAY | SEBDY | Calls |
| | SEBDY | SAY | Go ahead |
| | SAY | SEBDY | ETA 2235 approximately standby for ??? ETA |
| | SEBDY | SAY | Roger approximate ETA 2235 what was your place of departure |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| | SAY | SEBDY | Place of departure Leopoldville |
| | SEBDY | SAY | Roger Leopoldville place of departure the ETA OORIC 2017 Ndola |
| | SAY | SEBDY | 2017 is that affirmative |
| | SEBDY | SAY | That is affirmative |
| 2009¼ | SAY | SEBDY | Roger, check, listening out |
| | SAY | SEBDY | Call |
| | SEBDY | SAY | Call |
| | SAY | SEBDY | Request arrival time of OORIC over |
| | SEBDY | SAY | Standby one |
| 2033 | SEBDY | SAY | Go ahead |
| | SAY | SEBDY | Go ahead |
| | SEBDY | SAY | Go ahead go ahead |
| | SAY | SEBDY | Go ahead |
| | SEBDY | SAY | Nothing for you were you calling |
| | SAY | SEBDY | Request arrival time of OORIC |
| 2033½ | SEBDY | SAY | Roger standby one |
| 2040 | SAY | SEBDY | Call |
| | SEBDY | SAY | Go ahead |
| | SAY | SEBDY | Checks 432B at 2035 flight level 175 flying on advisory route 432 to avoid Congolese territory. |
| 2042 | SEBDY | SAY | Confirm position 432B at 2035 flight level 175 and your flying on route 432 is that affirmative |
| | SAY | SEBDY | That is affirmative |
| | SEBDY | SAY | Stand by for arrival time OORIC |
| | SAY | SEBDY | Standing by |
| 2049 | SEBDY | SAY | Arrival time Ndola OORIC 2035 |
| | SAY | SEBDY | Roger 2025 |
| | SEBDY | SAY | Negative 2035 |
| | SAY | SEBDY | Roger thank you 2035 |
| | SEBDY | SAY | That is affirmative |
| 2108 | SAY | SEBDY | Call |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| | SEBDY | SAY | Go ahead |
| | SAY | SEBDY | Check abeam KS 06 estimate abeam ND 47 flight level 175 request flight level 160 |
| | SEBDY | SAY | Say again your position estimate at 47. |
| | SAY | SEBDY | Roger estimate abeam ND at 47 |
| | SEBDY | SAY | Roger abeam KS 06 flight level 175 estimate abeam ND 47 request flight level 160 is that affirmative |
| | SAY | SEBDY | Roger that is affirmative |
| | SEBDY | SAY | Standby one |
| 2111 | SEBDY | SAY | Nil traffic to flight level 160 |
| | SAY | SEBDY | ??? |
| | SEBDY | SAY | Nil traffic to flight level 160 please acknowledge |
| | SAY | SEBDY | Roger check will give you a call reaching 160 |
| | SEBDY | SAY | Roger thanks |
| 2115 | SEBDY | SAY | What are your intentions on arrival Ndola |
| | SAY | SEBDY | Say again |
| | SEBDY | SAY | What are your intentions on arrival Ndola |
| | SAY | SEBDY | Standby |
| | SAY | SEBDY | We are keeping outside Congolese territory proceeding around the border to land at Ndola |
| | SEBDY | SAY | On arrival Ndola are you night stopping or proceeding elsewhere |
| | SAY | SEBDY | I am taking off almost immediately ??????? (unreadable) |
| | SEBDY | SAY | Are you returning Leopoldville tonight |
| | SAY | SEBDY | Negative |
| | SEBDY | SAY | What is your destination on departure Ndola |
| | SAY | SEBDY | Unable to say at present |
| 2115 | SAY | SEBDY | We have reached FL 160 |
| | SEBDY | SAY | Roger understand reached 160 |
| 2132 | SEBDY | SAY | Confirm you estimating abeam ND at 47 |
| | SAY | SEBDY | Affirmative |
| | SEBDY | SAY | Roger contact Ndola VHF 119.1 now |
| | SAY | SEBDY | Roger will do. |

APP.
1.5

APPENDIX 1.5

TRANSCRIPTION OF TAPE RECORDED R/T COMMUNICATION
BETWEEN SALISBURY FIC AND NDOLA TOWER

Date: 17th September, 1961
Recorded at Salisbury
Frequency : 6915/3682 kc/s.
Time : Between 2002 GMT and 1356 GMT 18th

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| | | | 17th September, 1961 |
| 2002½ | SAY | NDOLA | Call |
| 2018 | SAY | NDOLA | Call |
| 2018½ | SAY | NDOLA | Call - do you read |
| 2019 | SAY | LUSAKA | Call - 6915 |
| 2020 | LUSAKA | NDOLA | Our teleprinter is out with SAY will you ask them to see us 5455 |
| | NDOLA | LUSAKA | Roger will do |
| 2036 | NDOLA | SAY | Call |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | You are strength 2 distorted there is a DC6 at FL 175 from Leopoldville estimating Ndola 2235 and we haven't received an arrival signal on OCRIC |
| | SAY | NDOLA | Roger he arrived at 2035 over |
| | NDOLA | SAY | Roger thanks is the arrival signal on its way |
| | SAY | NDOLA | Affirmative our teleprinter is unserviceable will you see us on 5455 |
| | NDOLA | SAY | Roger will do |
| 2036½ | SAY | NDOLA | Thank you |
| 2112 | NDOLA | SAY | Call |
| 2113 | NDOLA | SAY | 6915 do you read |
| 2114 | NDOLA | SAY | 6915 do you read |
| 2114½ | NDOLA | SAY | 69 do you read over |
| 2119½ | SAY | NDOLA | Will you try again now over |
| | NDOLA | SAY | Roger you are now strength 3 |
| | SAY | NDOLA | Roger you are about 2 to 3 now go ahead |
| | NDOLA | SAY | Roger SEBDY now at flight level 160 he gave a position report abeam KS at 2106 and estimated ND at 47 over |
| 2120 | SAY | NDOLA | Roger thanks |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| 2122 | NDOLA | SAY | Call |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | SEBDY to you |
| 2122½ | SAY | NDOLA | Roger thank you |
| 2129 | SAY | NDOLA | Ndola has SEBDY over |
| | NDOLA | SAY | Thank you if you can get any information from him as to his future movements I'd be most grateful |
| | SAY | NDOLA | Sorry would you mind trying again you are fading badly |
| | NDOLA | SAY | Roger I say again if you can get any information from SEBDY as to his future movements after landing Ndola I'd be most grateful |
| 2130 | SAY | NDOLA | Stand by one |
| 2131 | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Reply on the tie line please, I will reply on the tie line ---- correction I will reply on the teleprinter over |
| | NDOLA | SAY | Roger thank you |
| 2135 | SAY | NDOLA | Call |
| 2224 | NDOLA | SAY | Call |
| 2225 | NDOLA | SAY | Call - 6915 over |
| 2229 | NDOLA | SAY | Call - over |
| 2300 | NDOLA | SAY | On 6915 do you read over |
| 2320 | NDOLA | SAY | How do you read |
| 2321 | NDOLA | SAY | Do you read |
| | | | 18th September, 1961 |
| 0436 | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Good morning to you I've nothing ? on 36 I had a message from radio police they are ? informing at 3 o'clock and they reported that a ? man ? at 2300 zulu about seen ? great flash in the sky in direction of Mufulira or locking a ? bit ? out from Ndola will you require a signal |
| | NDOLA | SAY | Affirmative ----- ? confirm by signal and advise any future developments please |
| 0436½ | SAY | NDOLA | Roger |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| 0508 | NDOLA | SAY | Calls |
| | NDOLA | SAY | Calls |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | It may sound a little pedantic but would you check with police and various other organisations are working on this aircraft |
| | SAY | NDOLA | Sorry Salisbury say again |
| | NDOLA | SAY | I say again would you just confirm that the police organisation etc is working on this aircraft this missing aircraft over |
| | SAY | NDOLA | I can't say that they are working or not the APM has been informed he's not here and as far as I know they didn't ----- ? but of course I haven't been ----- ? |
| 0512 | NDOLA | SAY | I thought security was bad but not as bad as that it's a complete blanket is it |
| | | | (No reply by Ndola to this) |
| 0552 | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Can I speak to the SATCO if he's there please |
| | NDOLA | SAY | Roger stand by |
| | NDOLA | SAY | Go ahead Ndola |
| | SAY | NDOLA | Reference your RCC2 what action would you suggest we take. Over. |
| 0553 | NDOLA | SAY | I was just wanting to check that the local Copperbelt police had all been put in the picture over |
| | SAY | NDOLA | We haven't advised any other police stations but presumably since this report came from the police in the first place they have alerted their other Copperbelt police stations general opinion seems to be that he's turned back - I don't think there's probably anything in this report over. |
| 0554 | NDOLA | SAY | Roger I'll keep it short I just sent a signal to you now-now-now replying from Leo with nil contact with them on any point-to-point frequency we just raised them through relay of Luluabourg nil news |
| | SAY | NDOLA | Roger thank you we have of course aircraft available here for search if necessary. |
| 0554½ | NDOLA | SAY | Roger thank you |
| 0606 | NDOLA | SAY | Were you calling |
| | | | (no reply) |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| | NDOLA | SAY | Call |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | Were you calling |
| | SAY | NDOLA | Negative |
| | NDOLA | SAY | Roger a message from RCC would you please check and confirm with us that all the police stations along the Copperbelt have been alerted for this aircraft over |
| 0606½ | SAY | NDOLA | Roger will do |
| 0724½ | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Will you ask CATCC please to confirm his request for RRAF search aircraft by signal over |
| 0725 | NDOLA | SAY | Roger I'll do that I believe it is being done at the moment over |
| | SAY | NDOLA | Sorry come again |
| | NDOLA | SAY | Roger wilco |
| | SAY | NDOLA | They're making the arrangements to carry out the search as requested but they'd like it confirmed in a signal for the record please over |
| 0725½ | NDOLA | SAY | Roger a signal will be arranged |
| 0749 | NDOLA | SAY | Call 69 |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | Reference the aircraft 5 crew 9 pax 5 crew 9 pax signal follows |
| 0749½ | SAY | NDOLA | Roger |
| 0805½ | SAY | NDOLA | Call 69 |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Controller please |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Reference the search aircraft there'll be one Provost and one Canberra the Canberra to the North ---- ? ---- ? 50 miles radius of ---- ? ----- ? Congo border |
| | NDOLA | SAY | Sorry you're fading badly say again please. |
| 0806 | SAY | NDOLA | Stand by one |

| TIME | TO | FROM | REMARKS |
|---|---|---|---|
| | SAY | NDOLA | I say again for SATCC reference the search the aircraft will be one Provost to the South and one Canberra to the North ---- ? ---- ? 50 miles radius ---- ? |
| 0807 | NDOLA | SAY | Understand one Provost to the South and one Canberra to the North all after that I'm afraid was unreadable |
| | SAY | NDOLA | I'll try again ---- ? ---- ? 50 mile radius but ? not ? over ? the Congo border |
| | NDOLA | SAY | I can understand within a 50 mile radius and up to the Congo pedicle is this correct |
| | SAY | LUSAKA | Call |
| | LUSAKA | SAY | Go ahead |
| | SAY | LUSAKA | No he said 50 miles to North and 50 miles to South the other way takes them over the Congo border. |
| 0807½ | LUSAKA | SAY | Roger thank you |
| 0931 | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | Can you confirm Jacko 169 departed Thornhill 0830 elapsed time 57 minutes still nil contact |
| | NDOLA | SAY | Roger he'll probably be quite close in before he contacts you he's descending to I think to about 3000 feet agl to have a look for this queer job |
| 0933 | NDOLA | SAY | 169 passed abeam mine at eight minutes past nine he is down to 3 thousand searching. |
| 1010 | NDOLA | SAY | Calls |
| | SAY | NDOLA | Go ahead |
| | NDOLA | SAY | Confirm that VPE has been requested to look out for this aircraft on the way. |
| | SAY | NDOLA | You are fading say again please |
| | NDOLA | SAY | Roger would you confirm that VPE has been requested to have a look for this missing aircraft en route over. |
| | SAY | NDOLA | He is in the picture but whether he will look out I can't say. |
| 1023 | NDOLA | SAY | Roger |
| 1355½ | SAY | NDOLA | Call |
| | NDOLA | SAY | Go ahead |
| | SAY | NDOLA | The wreckage has been located will advise later. |
| 1356 | NDOLA | SAY | Thank you |

APP.
1.6

## EXTRACTS FROM AIR TRAFFIC CONTROL LOG NDOLA AIRPORT

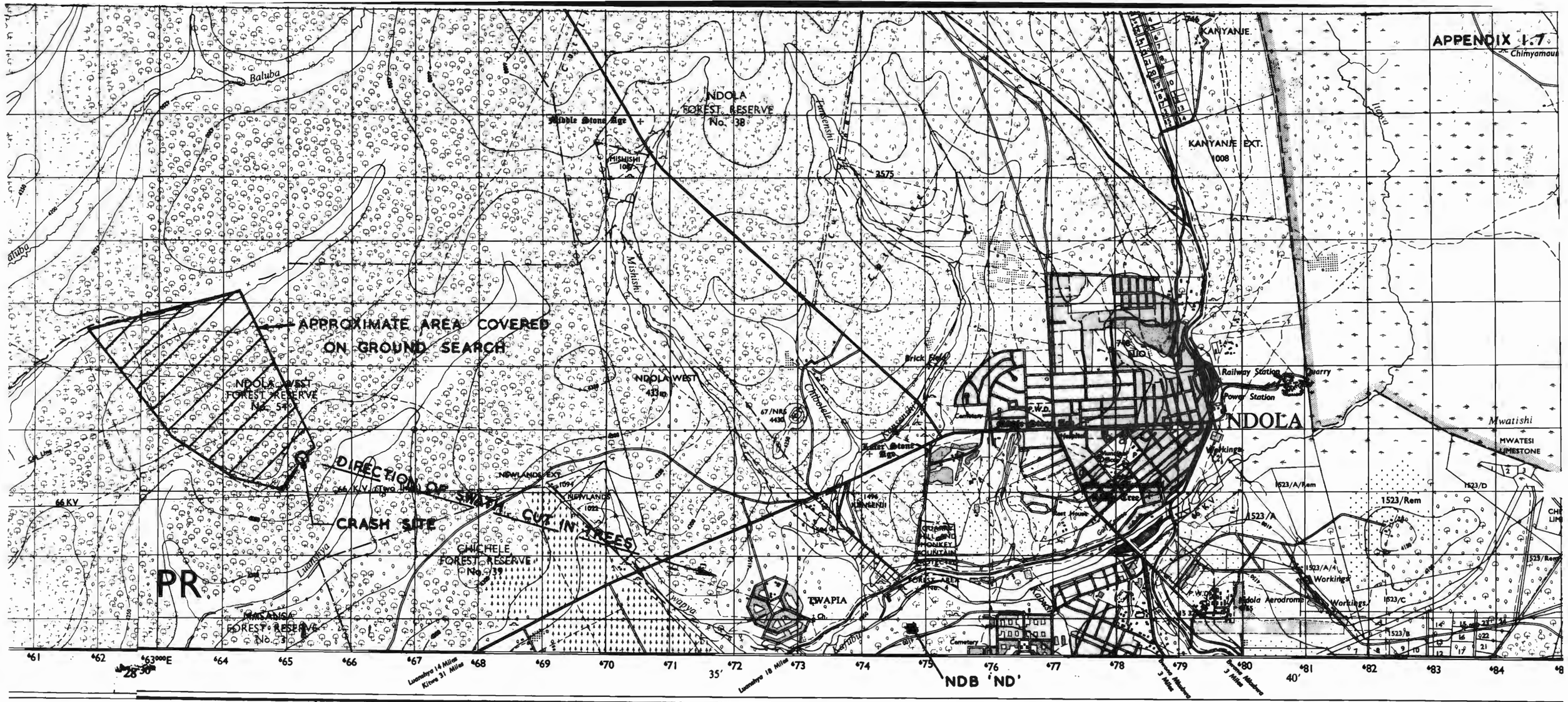
### SUNDAY 17th SEPTEMBER, 1961

| | |
|---|---|
| 0320 GMT | Budrewicz on |
| 0325 GMT | Runway inspection |
| 0335 GMT | Fire bell and stop watch O.K. |
| 0810 GMT | Ndola CTL 5 x 5 |
| 1045 GMT | Budrewicz off. House on. |
| 1053 GMT | Fire bell O.K. stop watch seen and O.K. |
| 1735 GMT | House off Martin on. Stop watch and fire bell O.K. |
| 2135 GMT | First contact with SEEDY estimating abeam ND at 2147 Ndola 2220. |
| 2147 GMT | Reported abeam Ndola (AD200 - 278°) would not divulge further movements. |
| 2210 GMT | Overhead Ndola (visual sighting by RRAF personnel) aircraft checked QNH given 1021 report reaching 6000 feet. No further contact after repeated calls from 2214. Police contacted re any reported crash and overdue action taken. |
| 2345 GMT | Overdue action (QUA) taken on SEEDY DC-6 and INCERFA. |

### MONDAY 18th SEPTEMBER, 1961

| | |
|---|---|
| 0001 GMT | Martin on |
| 0115 GMT | Martin off |

APP.
1.7


APPENDIX 1.7
APPROXIMATE AREA COVERED ON GROUND SEARCH
DIRECTION OF SWATH CUT IN TREES
CRASH SITE
NDOLA WEST FOREST RESERVE No. 54
NDOLA FOREST RESERVE No. 38
CHICHELE FOREST RESERVE No. 39
MASANSA FOREST RESERVE No. 3
NDOLA WEST
NEWLANDS EXT.
NEWLANDS
KANYANJE
KANYANJE EXT.
NDOLA
TWAPIA
Railway Station
Power Station
Quarry
Workings
Ndola Aerodrome
Mwatishi
MWATESI LIMESTONE
Baluba
Mishishi
Chibolele
Luanshya
Kafubu
Kansenshi
Itawa
Chimyamau
Brick Field
Cemetery
Rest House
Middle Stone Age
Later Stone Age
66 KV
1523/A/Rem
1523/Rem
1523/A
1523/A/4
1523/C
1523/B
1523/D
NDB 'ND'
Luanshya 14 Miles
Kitwe 31 Miles
Luanshya 18 Miles
Broma Mazabwa 3 Miles
35'
40'
28°30'

APP.
1.8

## TECHNICAL EXAMINATION OF THE WRECKAGE

The following report was prepared after every piece of wreckage had been examined.

The condition of the items which could be recognised is recorded and no item revealed any damage or selection that could not be attributed to the crash.

The term selection is used to explain the apparent anomalies that might be inferred from the position of the trim control mechanisms, the engine emergency liquid shut-off valves and the fuel valves. All of these are cable operated and their final position would depend entirely on the order of fracturing of the operating cables.

The broken, cut and burnt ends of the control cables were matched using a ten power magnifying glass, but it is still not possible to guarantee that the correct match was made in all cases.

C O N T E N T S.


| Page | | |
|---|---|---|
| 1 | 1. | POWER PLANT AND NACELLES |
| 2 | 2. | ENGINES - compiled by Drew D. Waldron, Pratt & Whitney Representative. |
| 4 | 3. | PROPELLERS - compiled by H.W. Apthorp, Propeller Overhaul and Repair Shop Inspector employed by Central African Airways Corporation. |
| 9 | 4. | FUSELAGE |
| 12 | 5. | WINGS |
| 13 | 6. | EMPENNAGE |
| 13 | 7. | CONTROL SURFACES |
| 21 | 8. | FUEL SYSTEM |
| 22 | 9. | ICE CONTROL SYSTEMS |
| 23 | 10. | FIRE EXTINGUISHER SYSTEM |
| 23 | 11. | OXYGEN SYSTEM |
| 23 | 12. | HYDRAULIC SYSTEM |
| 24 | 13. | LANDING GEAR |
| 25 | 14. | AIR CONDITIONING SYSTEM |
| 25 | 15. | ELECTRICAL SYSTEM |
| 27 | 16. | RADIO EQUIPMENT |
| 33 | 17. | INSTRUMENTS |
| 41 | 18. | PITOT-STATIC SYSTEM |
| 42 | 19. | AUTO-PILOT SYSTEM |

## 1. POWER PLANT AND NACELLES

### No. 1

Nacelle structure partially torn away from wing with fire proof bulkhead slightly damaged and cracked and all four engine mount firewall fittings still attached. The engine itself had torn out of its mountings on the engine mount ring which was broken. Severe burning had taken place around the bulkhead area, but the engine was almost untouched.

The oil tank was slightly burnt, damaged and holed with pipe line unions still attached. One of the pipe lines was missing and the other burnt.

The cabin supercharger drive shaft was in position, but the supercharger pumps and associated pipe lines were torn off, with the regulator piston and cylinder loose.

Some fire extinguisher pipe lines were in position.

The oil cooler was burnt and, together with its by-pass valve, was also badly damaged.

The emergency oil shut-off valve was open, attached to its casing.

The emergency fuel shut-off valve was on the bulkhead, with linkage attached, but in the "closed" position.

Most of the cowl flaps and the anti-drag ring were not in position.

The carburettor cold air intake scoop was recovered, having been torn off.

### No. 2

The nacelle structure had been torn away from the wing with all four engine mount fittings attached to the fireproof bulkhead. The engine had torn out of its mountings and was separate from the nacelle. All the nacelle area and engine had suffered severe damage from fire, the drag ring and cowl flaps being destroyed.

The oil tank was burnt and crushed.

The water/alcohol tank was in position, badly burnt, and two system switches were found loose in the nacelle.

The emergency oil, fuel and hydraulic shut-off valves were recovered and found to be "open", "closed" and "closed" respectively.

The oil cooler was melted.

The generator, starter motor and hydraulic pump were recovered, all being badly burnt.

### No. 3

The nacelle structure had been torn off the wing with all but the lower right engine mount fittings still attached to the fire proof bulkhead. The engine was separate from the nacelle with the engine mount ring missing. Both the nacelle and engine had suffered severe damage from burning; anti-drag ring and cowl flaps were missing.

The oil tank was recovered loose, severely burnt and damaged.

The oil, fuel and hydraulic emergency shut-off valves were recovered and found to be in the "open", "closed" and "closed" positions respectively.

The oil cooler was loose and half demolished by fire.

The generator, part of the starter motor, hydraulic pump and feathering pump and motor were found loose, all badly burnt.

No. 4

The nacelle structure had suffered considerable impact damage and was torn off the wing with all engine mount fittings attached to the fireproof bulkhead. The engine was detached from the nacelle with the engine mounts and mount ring missing.

Both the nacelle and the engine had suffered severe damage from burning, the engine rear section being burnt out with gears scattered. Anti-drag ring and cowl flaps severely damaged by fire.

The oil tank found was loose, badly crushed and burnt.

The oil cooler found badly burnt.

Emergency fuel shut-off valve found half open.

Cabin supercharger drive shaft found loose, pumps, regulator and associated pipe lines also found loose and badly damaged by fire.

The generator, starter motor, feathering pump, and motor, and part of propeller governor found loose, damaged by fire.

Part of propeller governor stop motor found, still attached to electrical conduit.

Magnetos and distributors were still in position on the engine.

2. ENGINES

Examination of the engines removed from DC6B SE-BLY was performed in a hangar at Ndola airport. The Investigating Board and the accredited representatives agreed that complete disassembly to the last detail part was not necessary.

No. 1. R2800-CB17. Engine No. P. 35865

This engine was intact, could be rotated and was not too seriously damaged by impact or ground fire. The propeller hub and dome were firmly attached to the engine propeller shaft and the majority of engine components were intact. The engine front case was cracked from impact and the magneto outer case was destroyed by ground fire; however, the main portions of the magneto and distributors were still attached to the front accessory case. All cylinders were in place and No. 8, No. 10 and No. 14 cylinder cooling fins had considerable wood imbedded. The rear case, intermediate case and blower case were intact and relatively undamaged.

The front case and reduction gear assembly were removed and examination revealed no evidence of failure. The drives of the magnetos, distributors, governor and oil scavenge and booster pump were in good condition. One cylinder from the front crankcase section and one cylinder from the rear crankcase section were removed to permit visual examination of the

crankshaft, master and link rod assemblies. Examination of these assemblies through the cylinder crankcase ports revealed no evidence of failure of the crankshaft, bearings, master rods, link rods, pistons, piston pins or cylinders.

The rear, intermediate and blower cases were in good condition and no evidence of failure was observed. The main oil screen was removed and disassembly revealed no evidence of metal particles or excessive accumulation of carbon. The oil scavenge strainers from the intermediate and rear case were removed and no evidence of failure was found. The low and high clutch selector valve was removed but because it is hydraulically positioned and spring loaded to the low position no information could be obtained. The carburettor was intact and the throttle valves and mixture control were positioned in the closed position. This was drawn to the attention of Mr. M. Madders, Mr. T.R. Nelson, Mr. L. Lindman and Mr. C.G. Hellberg. The position of the throttle and mixture control may be explained as there are two cables to each control pulley. Failure of both cables to each pulley would have to occur at the same instant in order that the position of the throttle and mixture control remain unchanged. If only one cable failed then forces on the other cable could result in a position change of the applicable valve or control.

No. 2. R.2800 CB-17. No. P.31738

The engine in No. 2 position was damaged so extensively by fire after impact that the engine number could not be determined. Mr. Bo Virving, Transair Chief Engineer, supplied the number from maintenance records.

The propeller hub and dome were firmly attached; however, the front case, front accessory case, magneto, ignition distributors, nine cylinder heads, portions of the rear crankcase, blower case, intermediate case, carburettor and rear case were destroyed by ground fire.

Examination of the propeller reduction gear, front cam, front and rear master rods and link rod assemblies, crankshaft and steel gears of the rear section revealed no evidence of failure.

No. 3. R.2800 CB-17. No. P.32147.

The engine in No. 3 position was damaged so extensively by fire after impact that the engine number could not be determined. Mr. Bo Virving, Transair Chief Engineer, supplied the number from maintenance records.

The propeller, hub and dome were firmly attached; however, the front case, front accessory case, magneto, ignition distributors, five cylinder heads, portions of the rear crankcase, blower case, intermediate rear case, rear case and carburettor were destroyed by ground fire.

Examination of the propeller reduction gear, front and rear cams, front and rear master rods and link rod assemblies, crankshaft and remaining portions of the rear cases revealed no evidence of failure.

No. 4. R.2800 CB-17 No. P.35867

The front case, front accessory case, magneto and distributors, crankcase and cylinders were not too severely damaged. The blower case, intermediate rear case, rear case and carburettor were destroyed by fire.

The propeller was firmly attached and removal from the propeller shaft revealed it to be normal. The front case and reduction gear were removed and examination revealed no evidence of failure. The magneto drive, distributor drives and governors were in good condition with no visible distress other than that caused by impact and ground fire. One cylinder was removed from the front and one from the rear crankcase to permit visual inspection of the crankshaft, master and link rod assemblies. Examination of these assemblies through the cylinder crankcase ports revealed no evidence of failure of the crankshaft, bearings, master rods, link rods, pistons, piston pins or cylinders.

General

Visual inspection of those parts disassembled and portions of assemblies which were accessible revealed no evidence of failure or indications that the engines were not operating prior to impact. The No. 1, No. 2, No. 3 and No. 4 propeller blade angles were determined to have been 36, 36, 34 and 45 degrees respectively at impact (by Mr. Harry Apthorp , Central African Airways Propeller Inspector).

As a result of the engine investigation and Mr. Apthorpe's findings on the propellers it is considered that the engines were operating at impact.

3. PROPELLERS

The specified blade angle settings for the propellers are - Feathered angle 96°; Low pitch angle 30°; Reverse pitch angle -8°. This information is extracted from the Douglas Maintenance Manual for DC6B aircraft.

No. 1 Manufacturer: Hamilton Standard. Type: 43E60-9.
Propeller Serial No. 198194.
Blade Serial Nos.: No. 1 blade 669362. No. 2 blade 669363.
No. 3 blade 669364

The propeller was removed from the engine shaft. Due to damage to the dome shell it was not possible to remove the dome assembly from the propeller barrel, therefore the front barrel half was removed with dome assembly attached. The blade assemblies were removed from the spider.

Report on Blade Assemblies

All blade gear segments were fitted with index angle 29° in line with "A" reference line on blade centre bushings.

All blade bush drive pins and retaining screws were found to be sheared, this had permitted rotation of the blades on the blade centre bushes, all blades had turned towards reverse pitch. The approximate rotation of each blade was - No. 1 blade 238°; No. 2 blade 80°; No. 3 blade 29°.

Number 1 blade had been broken off at approximately the 27" station, the section of blade which had been broken off was located in the wreckage. It was established that impact had occurred from the face side of the blade towards the camber side.

*Note The face side of a propeller blade is the side which is rearward facing and the camber side is forward facing in normal flight.

Number 2 blade was complete but badly damaged, particulary at the outer 12" section of the blade. It was established that impact had occurred from the camber side of the blade towards the face side.

Number 3 blade was found to be broken off at approximately the 13" station in the shank area. The break had occurred at an angle across the shank and a large crack extended from the edge of the break to the blade fillet radius. It was established that impact had occurred from the camber side towards the face side of the blade.

All spider shim plates and thrust bearing retainers were found to be badly damaged, this damage being consistent with severe impact.

Report on Dome Assembly

The dome shell was found to be dented and cracked. The crack was approximately 6" in length and was irregular in shape, it extended from the dome retaining nut outwards and around the dome shell. This damage was considered to be due to impact.

Stop Ring Setting

The feather stop ring was fitted with indexed angle 30° to 96° on rotating cam.

The reverse pitch stop ring was fitted with indexed angle 30° to -8° on rotating cam.

Angular Position of Propeller

Calculated from position of stop rings in relation to fixed stops.

Stop face of feather stop ring to stop face of fixed feather stop 60°.

Stop face of reverse pitch stop ring to stop face of fixed reverse pitch stop 44°.

From the above the angular position was calculated as 36°.

Barrel and Spider Assemblies

Visual examination of the barrel and spider assemblies did not reveal any serious major damage or failure.

No. 2

All identification markings of the number 2 propeller had been removed by the severe incineration which had taken place.

Due to the incineration of the assembly, removal of the propeller from the engine shaft was not attempted. The front half of the barrel, complete with dome assembly, was removed from the barrel rear half. The rear section of the barrel was moved back on the engine shaft in order to remove blades from the spider. Attempts to remove the blades from the spider with available equipment were unsuccessful.

As a result of the fire, all identification markings and assembly markings on the blade butt flanges were illegible.

One of the blades had been broken off at approximately the 22" station, the remaining blades were broken in the shank section in the vicinity of the blade centre bushes.

It was noted that the blade which was broken at the 22" station was turned towards the reverse pitch setting, this would indicate that the blade centre bush drive pins and retaining screws had sheared.

Report on Dome Assembly

A large hole in the dome shell, approximately 25% of the surface area in extent, was noted and it was also noted that a portion of the piston had disintegrated and was missing. It was not possible to determine whether this damage had been due to impact or to incineration.

The pitch change mechanism which was visible through the damaged dome shell was noted to have the cam roller assemblies positioned within the constant speed range of the cam slots, the cam rollers were positioned towards the low pitch angle position and approximately .600" from the commencement of the reverse pitch portion of the cam slots.

Stop-Ring Setting

It was noted that all angle index markings on rotating cam gear teeth had been eradicated and it was therefore not possible to check the stop ring settings visually; however, from observation of the position of the stop rings in relation to the fixed stops and also the position of the cam rollers it is considered that the stop rings were correctly fitted.

Angular Position of Propeller

Calculated from position of stop rings in relation to fixed stops.

Stop face of feather stop ring to stop face of fixed feather stop 60°.

Stop face of reverse pitch stop ring to stop face of fixed reverse pitch stop 44°.

From the above the angular position was calculated as 36°.

Barrel and Spider Assemblies

Due to the fact that only limited stripping of the hub assembly was possible, the visual check of the barrel and spider assemblies was restricted.

The appearance of the barrel assembly was consistent with it having been subjected to the action of fire, however no major damage of the assembly was noted.

Examination of the spider assembly revealed no major damage or failure.

No. 3

All identification markings of the number 3 propeller had been removed by the severe incineration which had taken place.

The front half of the barrel was removed with the dome assembly attached. All light alloy components were found to be in an advanced state of incineration and due to this, removal of the spider assembly and barrel rear half from the engine shaft was not attempted.

All blades had been broken off in the shank area and the portions of the blades retained in the barrel had been subjected to severe fire action.

The serial number of No. 1 blade was established as 569699. From the position of the serial number marking in relation to the position of the gear segment it would appear that the blade centre bush drive pins and retaining screws had sheared.

The butt sections of numbers 2 and 3 blades were in an advanced state of incineration and all identifying and assembly marks had been eradicated.

Report on Dome Assembly

The dome shell was almost completely destroyed, only the portion in the dome retaining nut area remaining. The piston assembly was also very badly damaged by the fire.

As a result of the damage to the dome shell and piston assemblies the cam mechanism was visible and it was noted that the cam roller assemblies were positioned within the constant speed range of the cam slots, the cam rollers were positioned towards the low pitch angle position and approximately .500" from the reverse pitch portion of the cam slots.

Stop Ring Settings

It was noted that all angle index markings on the rotating cam gear teeth had been eradicated and therefore it was not possible to visually check the stop ring settings. From observation of the stop rings in relation to the fixed stops and also the position of the cam rollers, it is considered that the stop rings were correctly set.

Angular Position of Propeller

Calculated from position of stop rings in relation to fixed stops.

Stop face of feather stop ring to stop face of fixed feather stop 62°.

Stop face of reverse pitch stop ring to stop face of fixed reverse pitch stop 42°.

From the above the angular position was calculated as 34°.

Report on Barrel and Spider Assemblies

Due to the fact that only partial stripping of the hub assembly was possible, the visual check of the barrel and spider assemblies was limited.

The appearance of the barrel assembly was consistent with it having been subjected to the action of fire, however, no major damage to the barrel assembly was noted.

Examination of the spider assembly revealed no major damage or failure.

No. 4. Manufacturer: Hamilton Standard. Type 43E60-9
Propeller Serial No. 172436
Blade Serial Nos. No. 1 blade 569708: No. 2 blade 569709;
No. 3 blade 569710

The dome assembly was removed from the hub assembly and the propeller was removed from the engine shaft. The hub assembly was dismantled and the blades were removed from the spider.

Examination of Blade Assemblies

All blade gear segments were fitted with index angle 29° in line with "A" reference line on blade centre bushings.

Number 1 blade was complete and it was noted that the blade centre bush drive pins and retaining screws were intact.

The blade was bent from the camber side towards the face side, indicating impact from the camber side towards the face side. The bend had occurred at approximately the 54" station and the angle of bend was not large.

The thrust bearing retainers and spider shim plates had not suffered any major damage.

Number 2 blade was complete and it was noted that the blade centre bush drive pins and retaining screws had sheared and that the blade had turned on the centre bush approximately 100° towards reverse pitch.

The blade was bent from the camber side towards the face side of the blade at approximately the 18" station, a further bend was noted from the face side towards the camber side at approximately the 54" station.

It is considered that the initial impact was sustained by the camber side of the blade and that the bend at the 54" station was secondary. The angles of the bends were not large.

A local bend was noted at the leading edge of the blade approximately 10" from the tip.

The thrust bearing retainers had not suffered any major damage. The spider shim plate was noted to have been slightly damaged by impact.

Number 3 blade was complete and it was noted that the blade centre bush drive pins and retaining screws had sheared and that the blade had turned on the centre bush approximately 10° towards reverse pitch.

The blade was bent from the camber side towards the face side, the angle of the bend was considerable. It was considered that impact had occurred from the camber side towards the face side.

A local bend was noted at the leading edge of the blade approximately 12" from the tip. A small section had been broken off at the tip section of the trailing edge.

The thrust bearing retainers had been damaged and 6 rollers were adrift. The spider shim plate had been broken along a chord approximately 2" in length.

Report on Dome Assembly

Visual examination of the dome assembly showed only superficial damage to the exterior of the dome shell.

Stop Ring Setting.

The feather stop ring was fitted with indexed angle 30° to 96° on rotating cam.

The reverse pitch stop ring was fitted with indexed angle 30° to -8° on rotating cam.

Angular Position of Propeller

Calculated from position of stop rings in relation to fixed stops.

Stop face of feather stop ring to stop face of fixed feather stop 51°.

Stop face of reverse pitch stop ring to stop face of fixed reverse pitch stop 53°.

From the above the angular position of the propeller was calculated as 45°.

Report on Barrel and Spider Assemblies

Visual examination of the barrel and spider assemblies revealed no major damage or failure.

General

Some portions of the broken blades from Nos. 2 and 3 engines were recovered from the wreckage and identified with the portions retained in the hub assemblies.

Prior to removal from the accident site, the number 1 blade of No. 4 propeller was found to be positioned at approximately - 45° angle marking on blade butt face to the barrel reference mark. This information would be borne out by the blade centre bush drive pins and retaining screws being intact.

Conclusions

With the exception of No. 1 blade of No. 4 propeller, it is considered that the angular position of the propeller blades after the aircraft came to rest may be ignored due to the failure of the blade centre bush drive pins and retaining screws and consequent movement of the propeller blades. Whilst no physical check of the drive pins and retaining screws of the number 2 and 3 propellers was possible, it is probable that these items had also failed.

It is also considered that the shearing moment exerted on the centre bush drive pins and retaining screws at the time of the initial impact would not have overcome the hydraulic lock existing in the propeller domes. For this reason, the angular readings obtained from the dome stop rings may be taken as accurate, within the blade angle tolerances laid down by the manufacturer.

The damage sustained by the number 4 propeller was considerably less than that sustained by the other three propellers.

During the investigation no evidence of mal-assembly or mal-functioning of the propellers was apparent and, it is considered that all of the propellers were operating in a normal manner up to the moment of first impact.

4. FUSELAGE

60% of the fuselage structure between stations -46 and +938 had been destroyed by fire, 30% of the remainder was broken into pieces too small to reconstruct to advantage. The pieces making up the remaining 10% were placed in their approximately correct positions in the planned layout of the aircraft. These items included :-

33% of front pressure bulkhead containing brake control valves with operating rods and hydraulic lines attached, but broken.

Windshield wiper motor

40% of the instrument panels

5% of the electrical panels

80% of the cockpit window frames

60% of the control column hand wheels

80% of the rudder pedal assemblies

Nose steering wheel

Broken cockpit rudder torque tubes

Fuel valve selector lever assembly, levers loose giving no indication of position.

Propeller reverse lock lever mechanism.

Gust lock/throttle interlock mechanism.

Gust lock operating handle.

Left hand and right hand throttle levers attached to torque tube push rods which had broken away from the torque tubes. The levers were loose and gave no reliable indication of position.

Throttle lock assembly.

Carburettor preheat control levers indicating a cold air selection.

Mixture control levers with push rods attached. Levers loose giving no reliable indication of position.

Cabin supercharger disconnect handles with emergency release bar in "normal" position.
Left hand handle one third released and right hand handle three quarters released but both unreliable.

Aileron trim indicator but no position indication.

Part of fuselage frame with rudder trim wheel and broken cables attached.

Landing gear selector lever.

Flap selector lever.

Cabin emergency pressure relief valve control handle, one hole from normal position.

Drift meter.

Nose wheel steering control valve.

40% of first and second pilot's chairs.
Seat rails had been ripped out of floor. Four seat belt fittings were bolted to chair pieces but belts were missing.

80% of Flight Engineer's chair with belts and belt attachments missing.

75% of Radio Officer's and Navigator's chairs, each with two seat belt fittings attached but belts missing.

5 crew belt buckles all locked.

3 ft. of steel door frame.

Emergency cabin pressure relief valve, spring loaded to closed position.

Front lower cargo compartment door lock mechanism in closed position.

Hydraulic compartment door.

Various parts of window frames.

Two emergency flare chutes.

Rear cargo door lock mechanism in closed position.

Flight compartment door lock with handle in "closed" position.

Cabin supercharger oil cooler.

Rear toilet.

The section of fuselage from station 938 to station 1008 had been torn away and although badly damaged was unburnt and had attached to it :-

The rear pressure bulkhead.

Empennage anti-icing system heater, ignition coils, accessory container, junction box and associated valves and ducting.

Bank of control cable pulleys at station 985 all free but damaged.

The fuselage tail section aft of station 1008 was unburnt but had suffered impact damage and severe damage to the right hand stabiliser stub where the stabiliser had been torn off. Still attached were:-

Inner section of left hand stabiliser.

Lower section of fin and rudder.

Elevator and rudder gust lock mechanism complete.

Elevator, rudder and control tab mechanisms were complete, but had suffered some impact damage.

Doors

Cargo and flight compartment door locking mechanisms recovered and all in closed position.

Emergency Exits

One external opening emergency exit found closed. One internal emergency exit operating handle found - "closed" position.

Passenger chairs

All destroyed, burnt and broken.
66 seat buckles and 24 seat belt attachment plates found.
1 only chair floor attachment found.

Emergency equipment

72 $CO_2$ life jacket inflation bottles.
18 Life jacket flares all burnt and discharged.
1 Complete life jacket together with the burnt remains of many other jackets.
2 Emergency flare chutes.

4 Life raft $CO_2$ inflation bottles, serial Nos. 11680BP, 11631BP, 11655BP and L-1065, all mainly undamaged but with the contents discharged, two found with operating heads and two with operating heads missing.

Galley equipment

The galley was disintegrated and the following items were amongst those recovered:-

Food containers
Water heater
Water tanks
Knives and forks etc.
Trays
Tinned food, etc.

5. WINGS

Left Hand Outer Panel

This panel was completely disintegrated and, with the exception of the wing tip and some other pieces, had suffered considerable burning; all sections of the wing joint that were found had the joint bolts in position and secure. The major pieces found were:-

Wing tip badly smashed

Section from stations 635 to 675

Section from stations 540 to 600

Section from stations 423 to 525

A large number of small pieces were found and identified and it is considered that 80% of the panel was identifiable.

Left Hand Wing Centre Section

The whole of this section from station 60 to 421 had suffered severe damage from fire. The following sections were recovered and could be identified, the remainder existed as either unrecognisable burnt pieces or fused blocks.

The lower skin structure, between front and rear spars from approximately station 280 to 421, encrusted with burnt debris and with part of No. 1 nacelle still attached.

Section of upper skin structure between station 380 and 421 containing No. 1 alternate fuel tank filler neck with filler cap and part of strainer in position.

Fuselage Wing Centre Section

This section was almost destroyed and reduced to fused blocks with the exception of:-

Top centre spar boom with left hand and right hand fuselage to wing joint at station 60 in position, and secure.

All other top spar joints between fuselage and wing at station 60 with joints still secure and with short sections of boom attached.

Right Hand Wing Centre Section

This part of the wing had suffered severe fire damage and with the exception of the following sections had been reduced to unrecognisable burnt pieces and fused blocks of metal.

Section between centre and rear spars tapering from four feet span at station 130 to one foot at station 421 with top skin structure in position but with 50% of lower skin burnt away, and containing landing lamp, retracted and with glass unbroken.

Section between station 360 and 421 with lower skin badly damaged and burnt. This section was still attached to the outer wing panel and had been severed from the remainder of the centre section by a tree. The unburnt sections of the wing break joint were still secure.

Right Hand Outer Panel

This panel had suffered the least amount of impact damage, but was severely burnt, the following sections only remaining:-

Section forward of trailing edge tapering from 6 feet span at station 421 to trailing edge only at station 630, with lower skin structure severely burnt.

Wing tip badly damaged and blackened.

6. EMPENNAGE

Vertical Stabiliser

95% recovered.

Half of the vertical stabliser was still attached to the fuselage tail section. The other half complete with half of the rudder was broken off on impact. All attachment bolts secure and locked. Right hand skin ripped and badly damaged. The nose section had been ripped away from fuselage and was severely damaged.

Left Hand Horizontal Stabiliser

50% recovered.

Outward to station 129 this component was complete and still attached to the fuselage with the top surface blackened by burning bush. The remainder had disintegrated and pieces were found at I.32, H.24, H.22, I.31, G.32, J.21 and E.26. This unit was removed from the fuselage at the crash site to facilitate its transport to Ndola.

Right Hand Horizontal Stabiliser

90% recovered.

This component had been torn off with most of the elevator attached, just outboard of the joint to the fuselage stub, and had been broken along a line at station 125 at the front spar to station 90 at the rear spar, with damage to tip.

The impact had also damaged the stub front spar, ripping it away from the fuselage.

7. CONTROL SURFACES

Left Hand Aileron. Serial No. 426.

95% recovered.

This component torn off the wing in pieces, was severely damaged but unburnt, the majority of the pieces were recovered and are listed below:-

Inboard section from station 421 to 485 with inner rib pushed in.

Inboard section from station 485 to 585

Outer section from station 585 to 615

Outer section from station 615 to 675

Tip section from station 675 to 697

Aileron operating sector mechanism locked, with full and free movement and cables attached and locked.

Hinges

| | |
|---|---|
| Station 421 | missing |
| Station 485 | hinge bracket torn from aileron but hinge assembly complete in wing, properly secure and locked with control push rod attached and locked to control drive assembly. |
| Station 585 | hinge complete and properly locked but torn away from aileron. |
| Station 675 | hinge bracket torn from aileron but hinge assembly complete on wing, properly secured and locked. |

Spring control tabs

Inner section broken in two at station 450

Outer section complete

Tab Hinges

| | |
|---|---|
| Station 432 | hinge properly secured and locked, attached to tab but torn off aileron. |
| Station 470 | hinge missing but bearing found in position and locked on trim tab bracket. |
| Station 474 | hinge missing but bearing found in position and locked on trim tab bracket. |
| Station 508 | hinge properly secured and locked, attached to tab but torn off aileron. |

Tab operating mechanism in aileron was free and properly locked, with one piece of control cable $2\frac{1}{2}$ feet long attached to bellcrank. Operating rods broken from trim tab at eye ends.

Right Hand Aileron Serial No. 253

This component, torn off the wing in pieces, suffered severe impact damage and some burning. The pieces recognised were:-

Section from stations 421 to 469, compressed like a concertina, into a length of 18".

Section from station 469 to 585 aft of leading edge section, also telescoped.

Leading edge section from station 485 to 585.

Leading edge section from station 585 to 615 burnt.

Outer section from station 610 to 675 complete.

Aileron operating sector with push rod and cables securely attached, torn out of wing.

Hinges

| | |
|---|---|
| Station 421 | hinge missing, broken hinge bracket still on wing. |
| Station 485 | hinge bracket torn from aileron and hinge assembly attached to wing but bent inwards through 45°. Hinge free and properly locked. Aileron control drive assembly and push rod torn out of wing. |
| Station 585 | hinge found loose, but still free with hinge bolt secure. Bracket attachment bolts had sheared on both wing and aileron. |
| Station 675 | hinge found loose, free with hinge bolt secure. Brackets torn off aileron and wing. |

Spring Control Tab

Inner section complete

Outer section badly damaged and burnt.

Tab Hinges

| | |
|---|---|
| Station 432 | intact and attached to aileron and tab |
| Station 470 | hinge bracket broken from aileron but hinge assembly properly secure, but bent and attached to tab. |
| Station 474 | hinge attached to aileron broken from tab at bearing with hinge bolt secure. |
| Station 508 | hinge attached to tab with bolt secure but broken off aileron. |

Tab operating mechanism in aileron, free and properly locked, with cables attached, but bellcrank was broken; inner push rod missing and outer push rod broken off at tab.

Cockpit aileron trim position indicator found, but no indication of position.

Aileron Control Cables

The following control cables were recovered:-

Both cables from control wheels to aileron torque tube, one intact, the other broken from control wheel.

Fuselage left aileron up cable, broken in three places, with both end fittings and a turn buckle in position. Automatic pilot installation end fittings intact but servo and cable torn away.

Fuselage right aileron up cable - section from aileron torque tube with end fitting and locked turnbuckle in position. 93" of the cable between station 132 and 225 cannot be matched. Section from station 225 to aileron cross complete with eye end, bearing and bolt.

Wing left hand aileron down cable. Cable had been cut in two places and broken in two places. One piece removed from left hand sector complete with ball end. 126" of cable could not be matched.

Wing right hand aileron down cable - removed from right hand sector with ball end attached and one turnbuckle in position. 242" of cable could not be matched.

Wing right hand aileron up cable - removed from right hand sector with ball end attached and one turnbuckle in position. 311" of cable could not be matched.

Wing left hand aileron up cable - piece removed from left hand sector with ball end attached. A further section recovered and matched. 318" of cable could not be matched.

The sections of missing cable are presumed to have been incinerated, together with the aileron cross assembly in the intense fire in the centre fuselage area.

Left Hand Elevator

60% recovered.

Outboard to station 152 of this component was complete and still attached to the stabiliser with the top surface blackened by grass fire. Except for the elevator tip the remainder had disintegrated.

Hinges

| | |
|---|---|
| Station 129 | hinge complete, free and secure, attached to elevator and stabiliser. |
| Station 204 | hinge bearing only found with hinge pin properly locked. |
| Station 250 | hinge found loose with pieces of elevator and stabilizer still attached - hinge free and properly locked. |
| Station 279 | hinge bracket torn away from stabliser but hinge properly locked, still attached to elevator tip. |

Left Hand Elevator Spring Control Tab

This component was complete and properly secured and locked to elevator. The operating push rod was in position and attached to the tab link mechanism which was complete, secure and free to operate. The torque tube from the fuselage had been disconnected during salvage operations.

Left Hand Elevator Trim Tab .

Inner tab complete and properly attached to elevator. 8" of operating rod still attached to tab, remainder missing.

Outer tab found loose. Both hinge brackets had torn off elevator, but hinges properly locked and in position on tab. Operating rod missing but rod bearing housing attached to tab bracket.

Trim tab drive drum in position in elevator with cable attached. The drive mechanism was found loose with the screw jack fully extended, i.e. full "nose up" trim position.

Right Hand Elevator

This component was almost completely recovered (98%) but broken into three pieces.

The inner section had been torn off along a line from station 86 at the trailing edge to station 110 at the leading edge.

The torque tube fitting had broken at bolt holes and parts of fitting were still attached to the elevator.

The trailing edge sections between stations 86 and 100 complete.

The remainder from station 110 outboard was complete and still attached to the stabiliser.

Hinges

| | |
|---|---|
| Station 129 | except for the upper arm of the hinge bracket which had been broken, the hinge assembly was complete, properly secure and locked. |
| Station 204 | except for damage to the upper arm of the hinge bracket, the hinge assembly was complete and properly secure and locked. |
| Station 250 | hinge assembly complete, properly secure and locked. |
| Station 279 | hinge bracket torn off stabiliser tip, but hinge properly locked and secure, still attached to elevator. |

Right Hand Elevator Spring Control Tab

Except for a broken hinge bracket at sation 82 this component was complete and properly secured and locked to elevator. The operating push rod was in position and attached to the tab link mechanism which still operated freely. The push rod between the tab torque tube and tab link mechanism was broken off at the fuselage.

Right Hand Elevator Trim Tabs

Except for a broken hinge bracket at station 117 both trim tabs were complete and properly secured and locked to elevator. The trim tab drive mechanism was complete and except for a bent operating rod was undamaged. The cables had been broken at station 30 with the cable drum wound to the extreme "nose down" trim position.

Elevator and Spring Control Tab Mechanism

With the exception of the right hand upper bellcrank, which was broken and the elevator torque tube which was cracked at left hand centre position, the elevator torque tube and spring control tab mechanism was complete and operated freely. The elevator down spring was in position and secure.

Elevator Control Cables

The following control cables were recovered:-

Left hand elevator up cable. This cable had been cut and burnt into six separate pieces, the pieces were matched and the complete cable recovered. The attachments to the control column sector and to the torque tube bellcrank were recovered properly secure and locked. The protection sleeve at the rear pressure bulkhead was in position.

The auto pilot cable end fittings recovered with turnbuckle in position, secure and locked.

Left hand elevator down cable. This cable had been cut and broken into 5 separate pieces, the pieces were matched and the complete cable recovered. The cable was properly secured and locked to control column sector with turnbuckle

in position also secure and locked. The protection sleeve at the pressure seal at station 938 had been burnt off. The attachment to the torque tube bell-crank was recovered properly secure and locked.

Right hand elevator up cable. This cable had been cut, burnt and broken into 12 separate pieces, the pieces were matched and except for 40" the complete cable was recovered. The control column sector was missing but the cable end was still secured and locked to down cable with turnbuckle in position and locked. At the elevator end the cable was securely locked to the torque tube bellcrank.

Right hand elevator down cable. This cable had been cut, burnt and broken into 12 separate pieces and a section 300" long could not be traced. Control column end of cable secured with bolt to up cable. Section of cable aft of pressure bulkhead recovered complete with attachment to torque tube bellcrank, secure and locked.

Rudder (Serial No. APV 43550 (or 9)).

This component, 95% recovered, was broken into two pieces at station 60, the pieces still being attached to the respective parts of the vertical stabiliser.

The lower half was properly secured to the rudder torque tube.

The rudder torque tube control assembly was intact and free, with control cables attached, except for top hinge support bracket which was broken at hinge.

Hinges

| | |
|---|---|
| Station 60 | with the exception of the top rudder hinge support bracket, which had been torn from the rudder, the hinge was complete, properly secure and locked. |
| Station 135 | bolts retaining hinge bracket to vertical stabiliser had sheared and the bracket had broken at hinge position. The rudder attachment was intact with the hinge bolt in position and locked. |

Rudder spring control tab

The tab was badly crushed, but in one piece, bent between the two broken pieces of the rudder.

With the exception of the hinge at station 2, which had broken off the rudder bracket, all hinges were intact, secure and properly locked.

Except for the spring housing which was dented and the left hand leg of the spring tab upper yoke which had broken from bearing, the spring tab and trim tab mechanisms were intact and operated freely. The rudder trim cables were still attached with the cable drum wound to the "full left" trim position corresponding to nose right.

Rudder Control Cables

Left hand. This cable had been cut and burnt into 3 pieces. The rudder torque tube lever end of the cable was secure and locked. Both auto-pilot cable attachment fittings were in position but with turnbuckles burnt off. Aft of the auto-pilot fitting the cable was complete and still secure and locked to walking beam.

Right hand. This cable had been cut, burnt and broken into 6

pieces and a section 388" in length could not be matched. The rudder torque tube lever end of the cable was secure and locked with turnbuckle in position. Section of cable aft of rear bulkhead recovered with attachment to rudder walking beam secure and locked.

Wing Flaps

Left Hand Flap

35% recovered.

The whole of this flap assembly had disintegrated and had suffered considerable damage from burning. The major pieces found and recognised are:-

Section from station 170 - 200.

Section 50" x 24" from station 250 - 300

Section from station 300 - 355

Section from station 355 - 421

Section of trailing edge 36" x 24"

Sections of vane from station 281 - 378 and 378 - 421 both damaged and burnt.

Hinges

| | |
|---|---|
| Station 62 | missing |
| Station 167 | this hinge assembly had disintegrated but the following pieces were recovered and identified.<br><br>Forward link with bearing areas burnt.<br><br>Part of aft link with bearing and bolt in position.<br><br>Flap actuating strut torn from wing and flap link but with attachment bolts still in position on strut. The assembly had been burnt and the piston rod was extended $14\frac{3}{4}$". |

N.B. The synchronising rod at this position was not recovered.

| | |
|---|---|
| Station 281 | this hinge assembly recovered loose with actuating strut fork end, broken at lock nut, still attached with bolt secure and locked.<br>The actuating strut was recovered still attached to wing fitting with bolt in position, secure and locked. The piston rod was extended $2\frac{1}{4}$". |
| Station 378 | hinge found loose still attached to wing support beam and flap fitting. With the exception of the aft link attachment to the support beam, which had broken at the bearing housing, the hinge linkage was complete, secure and locked. |

Right Hand Flap

50% recovered.

Approximately half of this flap was still attached to the

wing by the hinges at stations 167, 281 and station 378, the remainder had disintegrated and had either been destroyed or was not recognisable. The sections recovered, all damaged, were:-

Leading edge section from station 167 - 260

Complete section from station 260 - 378

Trailing edge section from station 378 - 421

The sections of vane from station 167 - 281 and 281 - 378 were complete and still attached to flap, the remainder of the vane could not be found.

Hinges

| | |
|---|---|
| Station 62 | missing |
| Station 167 | the hinge and operating assembly was complete still attached to wing and flap with all bolts properly secure and locked. The actuating strut was in position with the piston rod extended $6\frac{3}{8}$"(gland nut to centreline of bolt). The synchronising rod rear cable attachment was complete, with cable attached, but the front attachment had been burnt away. |
| Station 281 | the hinge and operating assembly with all bolts secure and locked was still attached to the flap and wing support beam which had been torn from the wing. The actuating strut was in position with the piston rod extended $3\frac{7}{8}$" (gland nut to centreline of bolt) |
| Station 378 | hinge recovered loose with all link bolts secure and locked, with broken wing support beam and flap fitting still attached. |

Synchronising system

The right hand synchronising rod and the bus cable system were recovered with 10" of cable missing, and two end fittings and one turnbuckle burnt off.

Control and operating system

The wing flap selector assembly was recovered with the control handle loose but still in position on the quadrant, the spring loaded plunger assembly which locks the handle in any selected position was missing. The quadrant had been bent at the fifth slot indicating that the locking plunger could have been in this position at the moment of impact; this represents the 30° flap down position.

The indications of the flap actuating struts are not considered to be reliable since, as soon as the hydraulic lines were broken the pistons could take up any position.

The control cables, flap control valve and the follow up cables were not recovered.

Flap Indicator

The flap position indicator was recovered with pointer and glass missing, but with markings on the face at the 30° position, which might have been caused by the pointer at the moment of impact.

Control Surface Locks

The rudder and elevator control locks were found in situ in the unlocked position, undamaged with cables attached. The aileron control lock was missing. The control operating handle and the control lock/throttle interlock mechanism were found loose. Except for the pieces attached to the rudder and elevator lock mechanisms none of the control lock cables were identified.

d. FUEL SYSTEM

Tanks

All fuel tanks destroyed by fire.

Pipe lines

Except for short lengths still in position in the remaining wing sections and some small pieces found loose, all the main fuel pipe lines were destroyed.

Engine Tank Selector Valves

Three of these valves were recovered loose, all badly burnt.

No. 1 engine valve identified with main tank selected to engine.

No. 3 or No. 4 engine valve (side only could be determined) partly open to alternate and main tank. This position probably due to severe damage of valve.

The third valve could not be identified in any specific position and had either main or alternate tank selected to the engine.

Crossfeed valves

One only found, so badly burnt that no selection could be identified.

Fuel Tank Drain and Line Shut off valves

Five of these valves were found loose, badly damaged and burnt. Four of them were selected from tank to system, but the fifth was in the "tank off" position.

Fuel dump valves

The dump valves for No. 1 main and No. 4 main tanks only were found. These were both in position in the wing and selected "closed".

Fuel dump chutes

All four dump chutes were recovered, badly burnt. Two with operating levers attached, but rods broken.

Internal vent chambers

Three of these units were recovered, loose.

Submerged electric boost pumps

No. 4 main tank pump was still in position in wing and intact. No. 1 main tank pump loose, badly burnt.

External Electric Boost Pumps

Seven units recovered, five extensively burnt and damaged.

Cockpit selector levers

The engine tank selector and cross feed valve control levers were recovered loose with rods only attached. No indication of positions at time of impact.

Control cables

Except for short pieces in the remaining wing sections no fuel system control cables were identified.

Strainers

One main strainer recovered, badly burnt but element showed no signs of contamination.

Seven filler neck strainers recovered all burnt in varying degrees.

9. ICE CONTROL SYSTEMS

Left Hand Wing Anti-icing system

Heater with intake ducting and heater accessories container, recovered badly burnt still in position in No. 1 nacelle. Some loose ducting was recovered but the remainder of the components were destroyed.

Right Hand Wing Anti-icing system

The heater complete with intake ducting and the accessories container had been torn out and were found loose. Both units were badly burnt and damaged. All other components were destroyed with the exception of some loose heater ducting and some wing ducting, still in position in the remains of the wing leading edge.

Empennage Anti-icing system

With the exception of some of the leading edge anti-icing ducting and the heater exhaust duct which was broken away from the fuselage, the whole of this system was still in position in the rear fuselage and empennage.

Other components were still attached and in good condition. The main items recovered were:-

Tail heater.
Heater junction box.
Accessories container.
Two ignition coils
Ground blower unit.

10. FIRE EXTINGUISHER SYSTEM

With the exception of some of the nacelle discharge tubing and valves and the tail heater fire extinguisher items, the whole of this system had disintegrated. The following components were recovered.

All six main $CO_2$ cylinders:-

| | | | |
|---|---|---|---|
| (i) | No. 449 B.P. | - | discharged through safety seal, control head missing. |
| (ii) | No. 47920 B.R. | - | control head in position with manual release "open", and safety seal still intact. |
| (iii) | No. 48311 B.R. | - | discharged through safety seal, control head missing. |
| (iv) | No. 981 B.P. | - | discharged through safety seal, control head missing. |
| (v) | No. 48134 B.R. | - | discharged through safety seal, control head missing. |
| (vi) | No. 48104 B.R. | - | control head in position with manual release "open" and safety seal still intact. |

$CO_2$ cylinder No. K99505 B.B. for tail heater was found intact mounted in its normal position. The cylinder was discharged by the investigating officers.

$CO_2$ cylinder No. 60598 B.P. for cabin heater was found discharged with operating head missing.

The following five cabin hand fire extinguishers:-

Two $CO_2$ Nos. 45632 B.X. and 45620 B.X. - both discharged with handles attached.

Two water - both burst in fire.

One Pyrene - damaged.

11. OXYGEN SYSTEM.

This system was completely disintegrated. The following components were recovered:-

Crew's oxygen cylinder No. 32972 B.C.

Passenger's oxygen cylinder No. 50867 B.J.

Two portable oxygen bottles Nos. K9413 and V69439 complete with regulators found undamaged.

Two regulators, one undamaged.

12. HYDRAULIC SYSTEM.

Excepting the two right-hand wing flap actuating struts, which were both in position and relatively undamaged, and the following burnt and damaged items, the hydraulic system was destroyed.

Parts of both engine-driven pumps.
Both main accumulators.
Left-hand flap actuating struts.
Flap operating handle, quadrant and plunger assembly.
Two piston and sleeve assemblies from unidentified hydraulic selector valves.
Main and nose landing gear actuating struts.
Landing gear selector lever.
Brake control valves.
Brake accumulator.
Four brake de-booster cylinders.
Main gear wheel brake assemblies.
Emergency brake air cylinder No. 5512 B.R., discharged but undamaged.
Nose wheel steering control valve.
Nose wheel steering actuating struts.
Nose wheel steering accumulator.

13. LANDING GEAR.

All three landing gear assemblies had been torn out at their main attachments and the main gears were also badly damaged by fire.

All structural parts of the assemblies were recovered and the following assessment made:-

Landing Gear.

Port Assembly. Actuating piston at bottom of stroke. Both down lock lugs, two pairs, fully engaged in "down" position. Drag link lower assembly main oleo to lock bent and damaged. Main oleo cylinder expanded due excessive heat and internal pressure. Leg in fully extended position. Both brake drums loosely in position on axle. Upper portions of drag link assembly still attached to 4 feet of front spar. Oleo leg for main leg yoke to centre spar part of one lug only attached. Whole assembly has turned wheel axle approximately 90° outwards. Torque link detached from upper leg fitting, attaching bolt not found. Bungee springs not in position.

Starboard Assembly. Actuating piston rod broken off at piston with piston at bottom of stroke (gear "down" position) - cylinder detached from cylinder head - both locking lugs broken off probably due to fracture of lower drag links at impact - torque links still attached - no deformation of oleo cylinder - axles in position - brake drums in situ on axles - wheel nuts in position and locked - both wheels disintegrated - upper part of oleo cylinder and centre spar extensively burnt but not attached to spar structure - cylinder head of actuating cylinder attached to burnt part of front spar - assembly considered to be in locked "down" position due to shearing of locking lugs and position of actuating piston - door operating assembly also in fully extended position.

Nose Assembly. Actuating piston rod fractured at cylinder with piston at top of stroke indicating nose gear down. Drag link broken at attachment to oleo leg - bungee cylinder found detached from nose gear assembly - no significance since it is spring loaded and found to be in extended position - both upper attachments in nose wheel well wrenched away from well beams - both steering cylinders torn off oleo leg - torque links in position - wheel fractured and scattered - oleo cylinder fully extended - both steering cylinders detached and found in wreckage - only fire damage in assembly in wheel bearings and tyre.

Landing Gear Selector Lever found in main wreckage with control handle positively locked in "down" position.

The nose wheel doors were broken and damaged but unburnt.

The majority of the main wheel doors had been destroyed by fire. Some of the operating mechanism was recovered.

14. AIR CONDITIONING SYSTEM

With the exception of various pieces of ducting and the undermentioned burnt and damaged components, this system was destroyed.

Cabin heater with ducting torn loose but with rubberised fibre joints still in position.

Cabin heater accessories container.

Ignition Units

Cabin after cooler, casing only remained, all tubes destroyed and cooling turbine and axial flow fan missing.

Mixing control valve casing and shaft assembly only, remainder of control mechanism missing.

Left and right hand cabin supercharger drive assemblies badly burnt with following items recognisable: the pumps with pipe lines still attached, one filter housing, drive shafts but with clutch assembly and control missing. Cabin supercharger oil cooler. Cabin supercharger disconnect operating handles with the emergency release bar in the "normal" position. Position of handles unreliable.

Ground blower motor only, the blower had been destroyed by fire.

14A. CABIN PRESSURISATION SYSTEM

Cabin pressure emergency relief valve

Emergency cabin altitude control selector positioned one reference hole from normal position.

Vacuum relief valve

Rate/ratio switch set to "Rate"

Cabin pressure regulator

Cabin pressure change limit control.

15. ELECTRICAL SYSTEM

The following list details the electrical units recovered and identified. Numerous parts of other units were recovered, such as armatures, relays, motor and generator main and end frames, etc., and these showed extensive damage due to the crash and fire:-

Inverter JH 4 Part No. F45-10. Ser. No. 1108

Unit showed slight crash and fire damage. Input cables still connected but insulation badly damaged by fire and heat. Slight pressure was needed to turn the rotor and it is considered that this is possibly due to the unit being subjected to heat. Commutator shows slight deposit on segments due, it is considered, to smoke and heat, otherwise appears to be in a relatively good condition.

Inverter (not complete).

Armature rotor and regulator frame extensively damaged.

Inverter (not complete)

Armature rotor and regulator frame extensively damaged.

Emergency Inverter.

Unit badly damaged by crash and fire.

Edison Fire Detection Relay Panel Type 55S.

Unit slightly damaged by crash but badly damaged by fire.

Overvoltage Protector Type 1623.

Three units were recovered, one of which (Ser. No. R4387) showed little damage both externally and internally. Internal damage consisted of:

Main reset spring contact out of position.
Armature spring disconnected.
Stop bar broken.

One unit does not appear to have suffered from heat, but the other two units had been damaged by fire.

Timers (Timing Units).

Damaged by fire.

Electric Horns.

2 recovered - badly damaged by fire.

Autotransformer CAT 70G178.

Damaged.

Actuator Electromechanical. Ser. No. 275042. Part BYLC 2307-1.

Unit shows little crash damage, but badly damaged by heat.

Emergency Lighting Panel.

Unit damaged by heat. Batteries showed approximately 3 volts.

Cockpit Lights (Instrument).

Slight damage.

Propeller Electric Speed. Ser. No. 251011.

Unit extensively damaged with crash and heat.

Rheostat Unit.

Unit case torn and buckled but components in good condition with very slight signs of damage.

Generators.

Four recovered including one still attached to engine.

Starters.

Four recovered.

Accumulators.

Almost completely destroyed. Remnants of plates and cases only found.

Bus Bars and Cabling.

Cabling generally was badly damaged by fire.

Voltage Regulators.

Four frames only recovered.

Landing lights.

(i) Std. wing light checked and found in full retracted position - confirmed by undamaged glass and glass rim, position of limit switch and undamaged motor drive gear and rack assembly.

(ii) Port wing light - actuating rack only found - impact marks on teeth indicate lamp in extended position but damage could have occurred when being ripped off wing - not considered as reliable as std. wing light indication.

(iii) Three wing light switch levers found but nil switches at rear of panel, therefore nil indications - neither two lamp not two position switch levers are able to assist.

16. RADIO EQUIPMENT.

The equipment salvaged, identified and inspected, is detailed below and is followed by the report on the individual units.

1. H.F. Transceiver Type 618S-1.

Unit extensively damaged by fire. Front part consisting of mechanical drive unit, blower motor and meter unit separated from main unit. *Frequency setting 8930.5 kc/s.

2. H.F. Transceiver Type 618S-1. Ser. No. 1219.

Unit shows little signs of damage - slight dents on main and front dust covers, starboard carrying handle bent, and signs of unit being subjected to heat at rear and rear top. Interior in good condition. *Frequency setting Channel 8A-4220 kc/s.

*Frequency chart found in wreckage.

3. MCW Oscillator.

External - dust cover dented and paint blistered mainly on port side.

Interior - in a relatively good condition, only damage apparent being caused by heat. Circuit diagram on port side almost completely charred away.

4. Automatic Keying Unit. Type 708A.

Unit in good condition - only signs of damage being dents in dust cover and cables running from 5-pin plug and socket at rear of unit showing signs of heat. Coding disc in use shows coding WHMPY. Spare coding disc inside dust cover.

Unit attached to HF2 mounting tray.

5. Antenna Tuner Type 180L-3. Ser. No. 184.

Considerable damage with front cover twisted half off the main unit. Carrying handle on front burnt through, paint blistered on starboard side, back and base. Meter on front panel with glass is complete but smoke blackened - movement appeared serviceable on test.

6. Antenna Tuner Type 180L-3. Ser. No. 231.

Unit badly damaged by fire, only approximately 50% remaining.

7. Power Supply Unit Type 416W-1. Ser. No. 380.

Unit extensively damaged and burnt.

8. Power Supply Unit Type 416. Ser. No. 381.

Unit badly damaged by heat, particularly at rear. Lord mount (shock mounts) rubbers appear to have been completely burnt away. Check with meter on both fuses appears to indicate that fuse elements are both serviceable but solder on end cap of fuses has melted through heat and open-circuited the fuses.

9. VHF Transmitter Type 17L-6. Ser. No. 30.

Extensively damaged by fire.

10. VHF Transmitter Type 17L-6. Ser. No. 33.

Extensively damaged by fire.

11. VHF Receiver Type 51R-3. Ser. No. 3727.

Extensively damaged by fire.

12. VHF Receiver Type 51R-3. Ser. No. 4691.

Extensively damaged by fire.

13. VHF Receiver Type 51R-3. Ser. No. 3676.

Extensively damaged by fire.

14. VHF Receiver Type 51R-3.

Extensively damaged by fire. Approximately $\frac{2}{3}$ of unit left.

15. Glide Slope Receiver Type 51V-2. Ser. No. ??0. Plate below makers' plate with number 345-401
4

Extensively damaged by fire.

16. Glide Slope Receiver Type 51V-2. Ser. No. 786.

Extensively damaged by fire.

17. Marker Receiver Type MKA-7A. Ser. No. 29.

Extensively damaged with only part of unit remaining.

18. ADF Receiver Type 51Y-1. Ser. No. 636.

Unit damaged with extensive fire damage.

19. ADF Loop.

Unit extensively damaged with only approximately one half remaining.

20. ADF Loop.

Unit extensively damaged with only approximately one half remaining.

21. Amplifier Type M1-36A P.A. Ser. No. 1250.

Unit extensively damaged.

22. Isolation Amplifier Type 346A. Ser. No. 121.

Unit almost flattened and extensively damaged by fire.

23. Weather Radar AVQ10. Ser. No. 868. Transmitter Receiver M1-37517-1.

Unit extensively damaged and burnt. Meter switch appears to be in 'OFF' position.

24. Weather Radar AVQ10. Ser. No. 887. Accessory Unit M1-37521-5.

Unit extensively damaged by fire. One fuse salvaged - F.1301. 2.5 amps. Fuse unserviceable but appears to be result of solder on end cap melting.

25. Weather Radar AVQ10. Ser. No. 804. Antenna M1-37513-4.

Unit extensively damaged.

26. Weather Radar AVQ10. Ser. No. 1270. Indicator M1-37524.

Unit badly damaged but no visible sign of heat.

27. Weather Radar AVQ10. Ser. No. 1255. Indicator M1-37524.

Unit badly damaged with paint blistered. Half rubber hood burnt away.

28. Radio Altimeter Model AVQ9. Ser. No. 710. Transmitter Receiver M1-19659.

Unit in a fairly good condition both externally and internally. Two fuses 1/16 amp. and $1\frac{1}{2}$ amp. in serviceable condition. Crystal and 6L6 valve free from holder with locating pin on 6L6 broken.

29. Radio Altimeter Model AVQ9. Ser. No. 824. Indicator M1-19672.

Unit damaged with paint blistered on port side and slightly on bottom. Perspex on indicator blistered. Receiver Gain knob in 'OFF' position. Scale switch in 'TIMES TEN' position.

30. Receiver Indicator R65/APN9.

No visible signs of burning but unit badly damaged and squashed.

31. H.F. Receiver Type BC-348-P. Ser. No. 2906.

Settings: Wavechange Switch - 6 to 9.5 Mc/s.
Tuning Dial - 95.6.
Frequency setting - approximately 6080 kc/s.
C.W. Oscillator switch - 'OFF'.
Crystal Switch - 'OUT'.
Audio Switch - 'OFF'.
'AVC' 'OFF' 'MVC' switch - 'MVC'.
Volume control - within $\frac{1}{4}$" of maximum.
Dial Light Control - within $\frac{1}{8}$" of maximum.

Dial Lamps and 5-amp fuse serviceable. Unit shows signs of heat, particularly in area of shock mounts. Shock mount rubbers burnt in varying degrees with rubber in rear port mount burnt away. Interior of unit shows very little damage. The receiver appears to have been on but frequency setting not considered significant as knob could have moved during the crash. However, unlikely that wave change switch would move.

32. Dinghy Transmitter Type Signal Corp T74/CRT-3. Number 2087.

Unit badly damaged by crash and fire. Aerial reel and handle still in position.

33. Portable Radio (VHF) Battery Operated.

Unit extensively damaged by fire. Batteries almost completely destroyed.

34. ADF Controller 614.

Unit smoke-blackened and burnt, particularly rear of unit.

Dial Setting - 499.

'OFF' 'ADF' 'ANT' 'LOOP' switch - on 'LOOP'.

'L' 'LOOP' 'R' switch - on 'LOOP'.

'BFC' 'ON' 'OFF' switch - Toggle only remains. Switch missing.

Gain control - unable to give position.

35. Control Panel AMR 101B VHF NAV 1 and 2.

Unit badly damaged.

Dial Settings - VHF NAV 1 115.4.
VHF NAV 2 111.5.

Volume control knobs and units missing.

36. Control panel Type AMR 102A. VHF Com 1 and 2 HF Com 1 and 2.

Unit badly damaged and burnt. All dials charred. Reading on VHF Com 1 dial 121.1 Mc/s. Unable to obtain VHF Com 2 dial setting. HF Com 1 dial setting indicated a frequency of 8285 kc/s. HF 1 Transmitter unit showed 8930.5 kc/s. HF Com 2 dial estimated to be set to a frequency between 2 and 3 Mc/s. H.F.2. Transmitter unit showed 4220 kc/s.

37. Selector Box AMR 103 BL.

Unit damaged by crash and fire. Only details remaining on front are unit type and words MASTER LEVEL over control on lower left of unit. Master level control set at mid position.

38. Control Panel AMR 104A HF Com 1 and Com 2.

Unit badly damaged by crash and fire. HF1 dial showed a setting of 21 but unable to decide letter. HF2 unable to give any setting for dial. Selector switch for HF1 and 2 missing. Unable to decide position of 'PHONE' 'STD BY' 'CW' 'MCW' switches.

39. Selector Box.

Unit damaged with part missing. HF Com 1 and 2 and VHF Com 1 and 2 in down position but switches loose so considered not indicative. Selector switch with 5 position marked 'H.F. 1 TRANS' 'HF 2 TRANS' 'INTER' 'VHF TRANS' 'VHF TRANS' set on 'INTER'. Master level control set fully anti-clockwise. Emergency normal switch position damaged.

40. Selector Panel.

Front Plate only retrieved with remains of indicating lights, rotary switch and toggle switches.

41. Remote Magnetic Indicator Switch Panel

VHF NAV 1 VHF NAV 2

ADF 1 ADF 2

Front plate only retrieved with 2 switch toggles but switch bodies missing.

42. Bendix Amspeaker Type M1-51A. Ser. No. A312.

Unit in reasonably good condition both externally and internally.

43. Bendix Amspeaker Type M1-51A. Ser. No. A.209.

Unit smoke blackened and dented. Speaker cone burnt away, otherwise very little damage.

44. Eight Inch Loudspeakers.

Frames only remain.

45. Control Relay Model AMR 110. Ser. No. 1.

Remains of unit attached to rear of 51R-3 VHF Receiver.

46. Control Relay Model AMR 110. Ser. No. 4.

Plate with above details retrieved.

47. 351A Accessory frame.

OMNI Bearing indicator only remaining component in frame. Indicator Type 337A-20B7. Ser. No. 3884.

48. Mounting Tray 351A.

49. Section of 351A VHF Receiver Frame Ser. No. 2265.

50. Remler Handset Type A.255 complete with cord and plug.

In good condition.

51. Carbon Microphone Insert. MC-254-A P/O ANB-H-1.

52. Two Carbon Microphone Inserts.

Possibly from hand-held microphones.

53. Lightweight Headphones. Pat. No. Telex 2386644.

Cord and plug missing but headphones in a reasonable condition.

54. Co-Pilot's Jackbox.

55. Coaxial Feeder 'T' Junction )
) VOR
56. Coaxial Feeder 'T' Junction ) Glide Slope.

57. VOR Aerial (Type 37J-3).

58. VHF Aerial (Type 37R-1) R5851-10.

59. Microphone Jack.

60. Plastic Label with words "VHF REC ACCESSORY UNIT".

61. Circuit Breaker Switch Bank.

Switches recovered:-

1. Marker Rx.
2. Sextant Light.
3. P.A. Amplifier.
4. ADF 2.
5. Glide Slope.
6. VHF Nav.
7. Computor.
8. Not identified.
9. VHF 2 Receiver.
10. VHF 2 Trans.
11. H.F.
12. H.F. 2 Power.
13. Not identified.
14. Glide Slope.
15. VHF Nav.
16. Computor.
17. Not identified.
18. VHF Rec.
19. VHF 1 Trans (Plate only).

The above were retrieved in three sections numbers 1 - 13 inclusive in one bank, 14 - 18 inclusive in another bank and 19 plate only on its own. All switches showed fire damage and all switch operating toggles were either loose or missing.

Inspection of the radio units recovered showed, in the majority of cases, extensive damage which is considered consistent with the crash and the fire which followed.

Internal damage to units which were complete with dust covers was to a large extent due to fire and where dust covers were damaged, components did not show any signs of damage which was considered attributable to causes other than the crash.

Glass fuses and filaments recovered were, in the majority of cases, complete.

Damage to the circuit breakers was considered due to the crash and fire.

Conclusion.

From the examination of the radio equipment no reason can be put forward to indicate that the installation was not operating satisfactorily up until the time of the crash.

17. INSTRUMENTS

Altimeters.

UNIT 'A'. Kollsman Serial No. 671CPX-6-051-20329.

In position on captain's flight instrument panel. Glass unbroken, case undamaged, static line found disconnected. Set to 30.14 inches; set knob broken off. Indicating needles loose also centre spindle. Needles unreliable. 10,000 ft. needle indicating 10,000 ft., 1,000 ft. needle indicating 9,600 ft., 100 ft. needle indicating 60 ft.

UNIT 'B'. Kollsman Serial No. 64990.

Found in cockpit area. Glass cracked, case undamaged, face of instrument burnt, static line connected but rubber line torn off adaptor. Set to 30.16 inches; set knob broken off. 100 ft. and 1,000 ft. needles loose and unreliable but 10,000 ft. needle fixed and indicating approximately 5,000 ft.

UNIT 'C'. Kollsman Serial No. 671CPX-6-051-17753.

Found in cockpit area. Glass missing, case fractured, static line union broken off, face of instrument burnt, needles burnt and bent. 100 ft. and 1,000 ft. needles loose and unreliable. 10,000 ft. needle fixed and indicating approximately 6,000 ft. Set to 30.17 inches; set knob broken off.

UNIT 'D'. Kollsman Serial No. not decipherable until glass is removed.

Found in cockpit area, glass intact but stained, therefore making reading difficult. Set to 29.92 inches; set knob broken off. Case burnt but not cracked. Needles fixed indicating 1,600 ft. Probably spare instrument because tag wire in place through an attaching hole and nil attaching screws fitted. Threads in case for static union appear undamaged.

UNIT 'E'.

Extensively burnt and damaged. Tag wire in place through attaching hole indicating spare instrument. 10,000 ft. needle indicating 20,000 ft. 1,000 ft. needle indicating approximately 4,000 ft., 100 ft. needle missing.

Air Speed Indicators

UNIT 'A'.

Part of rear casing bearing Kollsman identification plate. Type SAE Spec. AS 391. CAA-TSO-C2 found with pitot union and union pipe nut attached. Part of capsule also attached to case. Found in cockpit area.

UNIT 'B'. Kollsman Serial No. 586CK-6-0160-7087.

Found at F.33. Case fractured, glass and indicating needles missing. Identification plate shows SAE Spec. AS 391 CAA-TSO-C2. Pitot and static unions undamaged. Instrument dial calibrated in knots, not seriously damaged.

UNIT 'C'.

Part of instrument mechanism found, thought to be Air Speed Indicator though slightly differing in construction to Units 'A' and 'B' above.

Turn and Bank Indicators.

UNIT 'A'. Pioneer Type 3906-1G-A1 Serial 1809P.

Case damaged, glass broken, indicating needle loose on spindle, bank indicator unbroken. Found at G.32.

UNIT 'B'. Pioneer Type 3906-1G-A1 Serial 335P.

Case damaged, glass broken, indicating turn needle showing full "L", bank indicator missing. Found at F.34.

Rate of Climb Indicator.

Four loose dials found E.33, F.34 and cockpit area, one Pioneer, two Bendix Pioneer, one undecipherable. Three mechanisms less case.

Magnetic Compass.

UNIT 'A'. U.S. Army Type BE-16 Serial No. "FOR E" 43-3826.

No reliable setting - glass broken, case minor damage - made by Kollsman. Found G.32.

Three Axis Trim Indicators.

UNIT 'A'. Bendix PB-10 Automatic Pilot, Serial No. 1681.

Found in position in captain's panel, glass broken, electrical connections broken, indicators loose and unreliable.

UNIT 'B'.

Weston type 822, model 883, glass missing, external and interior burnt extensively unreliable.

Master Direction Indicator.

UNIT 'A'. Pioneer Bendix D12013-2E-L Serial No. ???86E.

Front of instrument removed from captain's flight panel. Glass broken, dial damaged, heading 75°, reciprocal heading approximately 253°. Case badly burnt and damaged also recovered. Conduit nuts missing.

UNIT 'B'. Pioneer Bendix D120-2H.

Glass and dial undamaged. Heading 99°, reciprocal heading 282°. Case and mechanism also recovered at G.33 separated from front of instrument. Conduit nuts, together with instrument back, missing.

UNIT 'C'.

Nil identification - instrument badly damaged - conduit nut fitted to back of instrument.

Flap Position Indicator.

Bendix instrument - type 20003-7A-13-1A Serial No. 2090 -

glass broken - case burnt but complete - needle missing: see remarks under Flap Indicator, page 20.

Course Line Indicator.

UNIT 'A'. Collins Radio Company type 331A-2. Serial No. 244.

Case damaged, electrical wires cut at salvage site - glass broken - heading fixed at index mark (top of case) at 116°, setting needle 104°.

UNIT 'B'. Collins Radio Company 331A-2. Serial No. 243.

Body of instrument separated from dial and face of instrument which was found attached to captain's flight instrument panel. Wires broken at rear of instrument. Glass broken - heading fixed at index mark (top of case) at 124°, setting needle at 112°.

Gyro Horizon.

UNIT 'A'.

Badly burnt nil dial or needle.

UNIT 'B'.

Badly burnt nil dial or needle.

Pacitor Contents Gauges. Simmonds Aerocessories.

UNIT 'A'. Part No. 37415 - 280 Serial No. XX20015 nil dial dial - case only - wires broken - found E.32.

UNIT 'B'.

Case only nil part number etc. - nil dial - burnt.

UNIT 'C'. Part No. 37415-282. Serial No. XX23207.

Case and part internal mechanism only.

UNIT 'D'. Part No. 37415-282. Serial No. XX23210 - burnt found F.34.

Case and part internal mechanism only.

UNIT 'E'. Part No. 37415-238. Serial No. XX19899 found E.32. Wires broken off.

Case and part internal mechanism only.

UNIT 'F'. Part No. 37415-281. Serial No. XX23107, found G.35.

Case and part internal mechanism only.

UNIT 'G'. Part No. 37415-281. Serial No. XX23110.

Removed from fuel quantity panel and is fuel "No. 3 Main". Glass broken, needle fixed indicating 280 lbs.

UNIT 'H'. Part No. 37415-280. Serial No. XX19985.

Removed from fuel quantity panel and is fuel "No. 4 Main." Glass broken - needle indicating contents nil but needle loose and reading unreliable.

UNIT 'I'. Part No. 37415-238, Serial No. XX19881.

Removed from fuel quantity panel and is fuel "No. 4 Alternate". Glass broken - needle missing.

(Note: qty. 3 dials also found).

Fuel Flow Indicator.

UNIT 'A'. (Engines Nos. 3 and 4) Pioneer type No. 21100-30A-128-A2. Serial No. 7350.

Conduit nut attached at rear - needles loose and unreliable.

Manifold Pressure Gauges.

UNIT 'A'. Engines Nos. 1 and 2. Kollsman 728FU-6-04-6129.

Glass cracked - both needles loose and unreliable - case undamaged - disconnect coupling for No. 1 engine in position but similar coupling missing from No. 2 position - found at F.33.

UNIT 'B'. Engines Nos. 3 and 4. Kollsman 728FU-6-05-6598.

Glass smashed - one needle missing, other loose and unreliable - both disconnect couplings still attached - case undamaged.

UNIT 'C'. Engines Nos. 1 and 2. Kollsman 728FU-6-04-6638.

Spare instrument label wire attached to one securing bolt hole - glass smashed.

RPM Indicators.

UNIT 'A'. Engines Nos. 3 and 4. Kollsman 740CK-6-022-4587.

Glass undamaged, case broken - plugs damaged - No. 3 engine needle loose. No. 4 fixed at zero.

UNIT 'B'. Engines Nos. 1 and 2. Kollsman 740CK-6-021-4581.

Glass missing - case damaged - connections broken off - only balance of one needle remaining and this part is burnt to dial indicating that needle was pointing to 900 RPM.

B.M.E.P. Indicators.

UNIT 'A'. No. 1 Engine. Pioneer Type 20003-53L-14-A2. Serial No. 1860-AB.

Pointer fixed underneath broken glass at 165 lbs/sq. in - case burnt but undamaged - conduit nut attached - wires broken. Found at F.32.

UNIT 'B'. No. 2 Engine Bendix Type 20003-14-53L-14-A2. Serial No. 1396.

Pointer moveable unreliable was reading 164 lbs/sq.in. - case undamaged - glass intact - conduit nut attached - wiring broken. Found at F.32.

UNIT 'C'. No. 4 Engine Pioneer Type 20003-53-L-14-A2. Serial No. 1861-AB.

Removed from panel found at E.32. Glass intact - case undamaged slightly burnt - Pointer fixed at 250 lbs/sq.in.

Fuel Pressure Indicators.

UNIT 'A'. Nos. 1 and 2 engines. Type 21000-5D-8-A1. Serial No. 9608 - glass smashed - case undamaged - needles missing - conduit nut attached - wires broken.

UNIT 'B'. Nos. 3 and 4 engines. Type 21000-5A-13-A1. Serial No. 7433-AB recognisable as Nos. 3 and 4 engines indicators by attachment of fuel pressure warning light lamp holder - glass missing - case burnt but undamaged - conduit nut attached, wires broken. Pointers fixed indicating 30 and 27 psi for Nos. 3 and 4 engines respectively.

UNIT 'C'. Port and starboard anti-icing wing heaters. Type 21000-5A-13-A1 Serial No. 13585. Case burnt but undamaged - glass missing - conduit nut attached - wires broken - nil pointers. Found at E.31.

UNIT 'D'. Cabin and tail heater - Type 21000-?-?-A1. Serial No. 9745. Glass smashed - case undamaged - conduit nut, adaptor and wires all missing - needles out of range - cabin below zero, tail above scale. Found at E.33.

UNIT 'E'. Spare gauge indicated by attaching wire for label. Extensively burnt, type and aerial numbers obliterated.

UNIT 'F'. Spare gauge indicated by attaching wire for label. Extensively burnt, type and serial numbers obliterated.

UNIT 'G'. Spare gauge extensively burnt, thought to be carried in similar location to units 'E' and 'F' because of similar condition.

Water Pressure Gauges.

UNIT 'A'. Pioneer Type 21000-5B-13-A1. Serial No. 14842. Glass smashed - case undamaged - left needle below zero - right needle loose, both unreliable. Found G.32.

UNIT 'B'. Pioneer Type 21000-5B-13-A1. Serial No. 7435-AB - glass smashed - case undamaged - left needle loose unreliable - right needle missing. Found at E.33.

Oil Pressure Gauges.

UNIT 'A'. Pioneer Type 21000-4B-13-A1. Serial No. 13986. Glass missing - nil needles - case undamaged - conduit nut in position - wires broken. Found at F.33.

UNIT 'B'. Pioneer Type 21000-4D-8-A1. Serial No. 9756. Glass and needles missing, case unbroken, but union adaptor broken off rear of case.

UNIT 'C'. Pioneer Type 21000-4B-13-A1. Serial No. 17163. Glass missing, extensively burnt - left needle 10 lbs. fixed, right needle below zero.

UNIT 'D'. Pioneer Type 21000-4B-9-A1. Serial No. 12978,

for cabin supercharger - glass smashed - both needles loose and unreliable - case intact - conduit nut in position - wires broken off. Found at Y72A.

UNIT 'E'. Type 21000-4B-13-A1. Serial No. 12273.

Spare unit badly burnt. Tag wire through attaching hole.

Oil Temperature Gauges

UNIT 'A'. Lewis type 77B8 serial 1185.

Glass smashed - case damaged - conduit nut in position - wires broken - left loose and unreliable - right fixed and dial marked at 70°C. Removed from panel found at E.33.

UNIT 'B'. Lewis type 77B8 serial 1189.

Glass missing, case and dial burnt - conduit adaptor torn off rear of case - wires broken - left needle loose and unreliable, right fixed at 25°C. Found at E.33.

UNIT 'C'. Lewis type 77B8 serial 1221 for cabin supercharger.

Glass missing, frame cracked, case damaged - conduit nut disconnected at salvage site. Both needles loose and unreliable. Removed from panel. Found at Y72A.

Carburettor Air Temp. Gauges

UNIT 'A'. Lewis type 77B7 serial 1317.

Glass missing, case intact, conduit nut in position - wires broken - needles loose and unreliable. Found at F.33.

UNIT 'B'. Lewis type 77B7 serial 1007.

Glass dial and needles all missing - instrument extensively burnt - conduit nut in position, wires broken.

Outside Air Temp. Gauges

UNIT 'A'. Lewis type 46B2 serial 793.

Glass broken, needle loose, case damaged, conduit nut uncoupled at site.

UNIT 'B' Lewis type 46B2 serial 797.

Extensively damaged and burnt, nil dial, nil needles.

Cabin Pressure Regulators

UNIT 'A'. Kollsman type 966D-6-03-624.

Dual needle indicator loose and unreliable - start marker set at 800 ft. - glass unbroken - case damaged - conduit nut removed at site - static pressure line attached. Found at G.33.

UNIT 'B'. Kollsman type 966G-6-03-721.

Spare instrument indicated by attaching wire for label. Extensively burnt and damaged.

UNIT 'C'. Kollsman type 966G-6-03-723.

Spare instrument indicated by blanking covers still in position.

Cabin Pressure Change Limit

UNIT 'A'. Kollsman type 967-6-01-584.

Conduit connecting union torn off back of instrument - glass broken - needle missing. Found at E.33.

Oil Contents Gauges

UNIT 'A'. Pioneer type 24201-58A-101-A1. Serial 629.

Case burnt, glass missing, needles found at 2 and 6 gallons but unreliable since both point to right hand scale, conduit nut pulled off. Found at F.38.

UNIT 'B'. Pioneer type 24201-58A-101-A1. Serial ?95.

Case damaged, glass broken, needles loose and unreliable, conduit nut unscrewed at site.

UNIT 'C'. Pioneer type 24201-58A-101-A1. Serial 438.

Case intact, glass broken, conduit nut attached, wires broken. Removed from panel marked for Nos. 1 and 2 tanks. Needles fixed but considered unreliable left needle below scale, right indicating 14 gallons.

UNIT 'D'. Liquidometer type for auxiliary oil tank type EA102AN-651, serial 94147-2.

Case broken, case front missing, glass and needle missing, dial damaged, conduit nut attached, wires broken.

UNIT 'E'. Liquidometer type for auxiliary oil tank type EA102AN-631. Serial 436879-1.

Case burnt, glass missing, needle and dial burnt, needle fixed indicating zero. Conduit nut broken off adaptor.

Anti-icing Fluid Contents Gauge

UNIT 'A'. Liquidometer type EA102AN-44L serial 86217-9.

Case and glass intact, union adaptor broken off rear of case, wires broken, needle loose, unreliable. Removed from panel. Found at E.32.

Hydraulic Reservoir Contents Gauge

UNIT 'A'. Liquidometer type unknown serial 92223-9.

Case broken, union adaptor and wires detached, dial deformed, needle missing.

Water Contents Gauge

UNIT 'A'. Liquidometer type EA148-AN-46 serial 95068-8.

Case undamaged, glass broken, union nut disconnected. Both needles spring loaded to zero reading. Removed from panel, found at E.32.

Hydraulic Pressure Gauges

UNIT 'A'. U.S. Gauge type AW-2¾-34-KF4 serial 1042.

Case and needle missing, dial damaged, hydraulic pipe broken from attaching union nut.

UNIT 'B'. U.S. Gauge type AW-2¾-34-KF5, serial 1368.

Case, dial and needle missing, hydraulic pipe broken from attaching union nut.

UNIT 'C'. U.S. Gauge type AW-2¾-34-KF5, serial no. not shown.

Case, dial and needle missing, hydraulic pipe broken from attaching union nut.

UNIT 'D'. U.S. Gauge type AW-2¾-34-G, serial 3.

Case and needle missing, dial damaged, hydraulic pipe broken from attaching union.

UNIT 'E'. U.S. Gauge type AW-2¾-34-KF5, serial no. not shown.

Spare gauge indicated by label wire through attaching screw hole. Nil union nut or pipe.

Pressure Indicators

UNIT 'A'. U.S. Gauge type AW-1⅞-14-D13F5 serial No. 542.

Case broken, dial and needle missing, union nut unscrewed off rear of case.

UNIT 'B'. U.S. Gauge type and serial No. unknown but similar construction to Unit 'A'.

Case broken, dial and needle missing. Pipe broken from union nut.

UNIT 'C'. U.S. Gauge type AW-1⅞-17-CZ6 serial 138907.

Case and glass undamaged attached to bracket, needle reading zero.

Cabin Supercharger Dual Pressure Indicator

UNIT 'A'. Kollsman type 728FU-6-04-8598.

Case intact, glass missing, pipes broken from adaptor union nuts - needles loose, unreliable.

Cabin Compression Ratio Limit Switch

UNIT 'A'. Spare Unit. Burnt - type 1008-CK-03 serial 581.

Ampmeters

UNIT 'A'. Amps. D.C. Western type 22Z2-840.

Glass missing, instrument burnt, wires attached to case terminals. Dial and needle burnt indicating 400 amps - unreliable. Found at E.33.

UNIT 'B'. Amps. D.C. Western type 22Z2-840.

Glass broken, needle fixed below zero of scale - terminals detached from rear of case. Found at F.32.

UNIT 'C'. Amps. D.C. Western type 22Z2-840.

Glass missing, case broken, one terminal detached and one in position on rear face of instrument. Needle loose and unreliable.

UNIT 'D'. Amps. D.C. Western type 22Z2-840.

Glass missing, case burnt. Needle loose, unreliable, below zero on scale. Found at F.33.

Volt Meters

UNIT 'A'. Volts D.C. Western type 21Z2-840.

Glass cracked, case intact. Terminals and leads still attached to rear of case. Found at E.31.

UNIT 'B'. Volts A.C. Western type unknown but similar in construction to Unit 'A'.

Terminals and leads still attached to rear of case.

Frequency Meter

UNIT 'A'. Hickok Model 59.

Case damaged, glass missing, needle loose unreliable. Found at G.33.

Master Direction Indicator (found subsequently)

UNIT 'D' Pioneer type 12013-2E-L serial 2385E.

Instrument burnt, union nuts and wires burnt off. Heading fixed on "N" north - attaching screws missing probably spare instrument.

Radio Magnetic Indicator

UNIT 'A'. Bendix Pioneer type 36105-1J-15-C1 serial 2971

Face of instrument removed from captain's flight panel; case and mechanism found separately. Heading fixed on 104°.

UNIT 'B'. Bendix Pioneer type unknown but corresponding dial marked E-361-1J.

Dial loose and heading reading 92°. Glass broken, case damaged and burnt. Connecting sockets to rear of instruments burnt, nil conduit nuts.

UNIT 'C'. Bendix Pioneer type unknown.

Dial, case and mechanism badly burnt - conduit nut attached to rear.

NOTE: Three altimeters, units 'A', 'B' and 'C' have been despatched to the Civil Aeronautics Board, Washington, for detailed examination and report.

18. PITOT-STATIC SYSTEM

This system had disintegrated and was severely damaged by fire. The following pieces were recovered:-

2 pitot heads
6 main static vents
7 drain valves
1 static selector valve with bent handle in position half way between normal and neutral.
2 equaliser manifolds
2 distributor manifolds
Various pieces of pipe lines with ten quick disconnect couplings, four of which were disconnected, including the captain's altimeter static connection.

19. AUTO-PILOT SYSTEM.

This system was extensively damaged by fire. The following units were recovered and identified:-

Bendix Controller Type PB10/PB10A. Ser. No. 427.

Unit damaged with 'ON' 'OFF' switch locked in 'ON' position by switch guard being bent over in crash and bearing against operating arm of switch.

Bendix Flight Path Computer Type PB10A. Ser. No. 172-D.

Starboard side of unit badly damaged by fire. Unit smoke blackened and insulation burnt on port side. Three fuses checked - 2 still serviceable and one unserviceable - considered to be due to solder melting on end cap. Front cover on with controls locked.

Bendix Amplifier PB10. Ser. No. 464.

Unit badly damaged by crash and fire.

Fluxgate Amplifier. Ser. No. 399?

Unit badly damaged. Serial Number shown may be incorrect as details of manufacturers' label almost obliterated.

Collins Steering Computer. Ser. No. 25..

Unit extensively damaged and burnt.

Collins Vertical Gyro. Ser. No. 0-6800.

Internal and external damage slight.

Rudder, Aileron, Elevator and elevator trim tab servos, badly burnt and damaged, one Serial No. 1411 recorded.

Master direction indicator, badly burnt and damaged.

Gyro flux gate transmitter.

APP.
1.9

PHOTOGRAPH NO. 1.

APPROACH PATH ILLUSTRATING NARROWING SWATH CUT BY AIRCRAFT AS LEFT WING DOWN ATTITUDE INCREASED.

PHOTOGRAPH NO. 2.

MAIN WRECKAGE AREA SHOWING ANT-HILL STRUCK BY AIRCRAFT NOSE IN CENTRE LEFT OF PHOTOGRAPH AND LAST 300 FEET OF WRECKAGE TRAIL.

PHOTOGRAPH NO. 3.

VIEW FROM THE AIR OF MAIN WRECKAGE AREA ILLUSTRATING ALMOST COMPLETE INCINERATION.

PHOTOGRAPH NO. 4.

VIEW LOOKING BACK ALONG APPROACH PATH SHOWING SWATH CUT BY AIRCRAFT AND THE INITIAL SHALLOW APPROACH ANGLE.

PHOTOGRAPH NO. 5.

PART OF MAIN WRECKAGE AREA FOLLOWING REMOVAL OF ENGINES - RIGHT-HAND WING IN BACKGROUND.

PHOTOGRAPH NO. 6.

GENERAL VIEW OF MAIN WRECKAGE AREA SHOWING FROM LEFT TO RIGHT NOS. 4, 3 AND 2 ENGINES.

APP.
1.10

APPENDIX 1.10

R.S.T. MINE SERVICES LIMITED

RESEARCH LABORATORY

REPORT ON AIR CRASH DEBRIS

Two members of the staff of the R.S.T. Research Laboratory visited the scene of the crash in order to search for materials which could be of possible value in assisting the investigation of the disaster.

An area between the point of the plane's first contact with the tree tops to the position at which the major portion of the wreckage finished up was carefully scrutinised, and a number of samples were taken for further investigation. The samples included burnt vegetation, pillow stuffing, and a number of pieces of shattered metal.

The findings from the above materials proved to be completely negative, being as follows :-

a) Metal Samples

The metal samples, some of which had apparently become molten due to the intense heat of the fire caused by the crash, were sparked on an emission spectograph, the resulting spectrogram being that of pure aluminium, thus merely confirming the purity of the metal, no impurities having been detected. A visual inspection of the samples which had not melted showed evidence of a normal brittle fracture due to the sudden impact of a large mechanical force.

b) Burnt Vegetation

Samples of burnt vegetation were inspected microscopically and compared with specimens of the local vegetation (wood, leaves and grass) which were collected from the vicinity of the crash and later ignited within a laboratory muffle furnace, the ash being identical in both instances.

c) Burnt Pillow Stuffing

Material found in the main section of the crashed plane was thought to be charred pillow stuffing, however, as it had rather a peculiar glistening appearance it was decided to carry out a microscopic examination as for the burnt vegetation. A sample of undamaged pillow stuffing was ignited in a muffle furnace and on examination was found to have an identical texture to the material under test, thus confirming the nature of the charred sample.

Signed. John E. Butler

Kalulushi
25th October, 1961

APP.
1.11

REPORT ON THE EXAMINATION OF THE ALTIMETERS FROM DOUGLAS AIRCRAFT MODEL DC-6B, SWEDISH REGISTRY NUMBER SE-BDY

## I. INTRODUCTION

Three altimeters manufactured by the Kollsman Instrument Corporation; bearing serial numbers 671CPX-6-051-20329, 671CPX-6-051-17753 and 64990 were received by the undersigned on October 31, 1961. A letter accompanying these instruments requested the Board to make checks it normally performs to such instruments recovered from aircraft involved in an accident. To comply with this request arrangements were immediately made with the manufacturer to use his facilities in the examination of these altimeters. On November 1, 1961, a meeting was held at the Kollsman plant in New York City to outline the examinations desired. At this time an examining group was formed and consisted of the following personnel:

Wesley D. Cowan, Civil Aeronautics Board.

Walter Angst, Kollsman Instrument Corporation.

Robert Cooperman, Kollsman Instrument Corporation.

The three altimeters were in the personal custody of the undersigned from the time of receipt until all examinations were completed.

## II INVESTIGATION

To attempt to determine whether a possible malfunction existed in any of the altimeters prior to the accident the examinations were made in three phases; external observations, operational testing and detailed inspection of the internal mechanisms.

The external observations covered the damage due to ground fire or impact forces, the presence of proper mounting attachments, the static hose fitting, the presence of an inspection seal and all pointer positions.

The operational testing phase applied a pressure change to the static port fitting and pointer movement, if any, observed.

The third phase examinations were made to determine if all parts of the assembly were present; if any foreign matter or objects were present; if any corrosion, dents or foreign deposits existed on the bellows surface; and the condition of the various gears, springs,

levers and bearings.

Photographs were taken at appropriate times during the examinations.

The following is a resume of the highlights of the examinations:

Kollsman Altimeter S/N 671CPX-6-051-20329 Unit A

There was light impact damage to the case of this unit but no evidence of exposure to excessive heat. The hose fitting was still intact and the rubber pressurization seal was still in place. The knob shaft was broken off at the bezel and the inspector's lead seal was not present. The instrument did not respond to a pressure change. The bellows still retained a vacuum but were dislodged from the mounting bracket. The rocking arm was loose from its mounts. The damage to the gears, levers and springs was attributed to impact forces. The 100 foot pointer was loose on its shaft but the 1000 foot and 10,000 foot pointers were still attached to their shaft mechanisms. There were no foreign objects found within this instrument. No evidence was found to indicate that this altimeter was malfunctioning prior to ground impact. The following readings were obtained:

100 foot pointer - loose

1000 foot pointer - 9000 feet

10,000 foot pointer - 19,000 feet.

barometer setting - 30.14 inches

outer setting marker - minus 205 feet

inner setting marker - minus 200 feet

Kollsman Altimeter S/N 64990 Unit B

The glass face cover of this instrument was cracked and the knob shaft was broken off. The mounting screws appear to have been broken after exposure to fire. The hose fitting was intact but there was no lead inspector's seal present. The dial and pointers were fire damaged although two pointers remained firmly attached to the shafts. The pressurization seal was in position. Two bellows' sections still retained vacuum but heat exposure apparently softened the solder on various fittings. The diaphragm mounting stud and various levers

and springs were bent or broken by impact forces. A dark liquid or greasy film covered the inside surface of the case and most of the mechanism. Portions of this instrument that were covered by this substance were subsequently taken to the Federal Bureau of Investigation to get their assistance in identifying the unknown substance. Attachment A is a copy of their report which indicates that this substance was a combustion by-product. This is to be expected in an accident of this type. The examination of this altimeter disclosed no evidence to indicate malfunction prior to ground impact. The following readings were obtained:

100 foot pointer - 560 feet

1000 foot pointer - loose

10,000 foot pointer - 4000 feet

barometer setting - 30.16 inches

outer setting marker - minus 220 feet

inner setting marker - minus 200 feet

Kollsman Altimeter S/N 671 CPX-6-051-17753 Unit C

The case of this instrument had a slight indentation near its center. Part of the bezel and knob shaft was broken. The glass cover and hose fitting were missing. The dial, pointers and setting markers were fire damaged. There was no inspector's seal. The pressurization seal was in position. Heat from the ground fire apparently desoldered the bellows construction causing the loss of vacuum. The rear bellows section showed an indentation that matched the deformation in the case due apparently to impact forces. The bending and breaking of gears, pivots and levers was believed to be caused by impact forces. There was no evidence to indicate that this altimeter was malfunctioning prior to ground impact.

100 foot pointer - loose

1000 foot pointer - loose

10,000 foot pointer - 6000 feet

barometer setting - 30.18 inches

outer setting marker - minus 230 feet

inner setting marker - minus 200 feet

The dials of all three altimeters were taken to the Federal Bureau of Investigation and were examined under four different frequencies of ultraviolet light. There were no indications that the pointers had impacted against the dials. (See attachment "B")

Photographs and examination data are included in a report submitted by the Kollsman Instrument Corporation. (See attachment "C").

Signed Wesley D. Cowan
Systems Specialist

Civil Aeronautics Board,
Bureau of Safety,
Washington, D.C.

ATTACHMENT 'A'

FEDERAL BUREAU OF INVESTIGATION

WASHINGTON, D.C.

November 15, 1961

To: Mr. Melvin Gough,
Director,
Bureau of Safety,
Civil Aeronautics Board,
Washington, D.C.

Attention: Mr. Wesley D. Cown.

(signed) J. Edgar Hoover

Re: Crash of the Dag Hammarskjold aircraft; Civil Aeronautics Board Matter.

Your file No.
FBI File No.
Lab No. PG-67845 DE

Examination requested by : Addressee

Reference: Evidence delivered by special messenger on 11/14/61

Examination requested : Chemical Analyses

Specimens:

Q4 Altimeter, Unit - B

Results of examination:

This report confirms and supplements the telephonic report furnished to Mr. Cowan on November 14, 1961.

The foreign material in the altimeter has the typical appearance and odor of a condensate from some kind of burned plastic material. The fact that the altimeter was very close to a fire is shown by the small blisters in the paint near the open end of the unit. It was not possible to identify the pyrolized material in the Unit. Plastics, adhesives, rubbers, and the like could be the source of the material found in the unit.

Specimen Q4 is being retained in the Laboratory until called for by a representative of your office.

Attachment 'B'

FEDERAL BUREAU OF INVESTIGATION

WASHINGTON, D.C.

November 13, 1961

Mr. Melvin Gough,
Director,
Bureau of Safety,
Civil Aeronautics Board,
Washington, D.C.

Attention: Mr. Wesley D. Cowan

(signed) J. Edgar Hoover

Crash of the Dag Hammarskjold aircraft:
Civil Aeronautics Board matter.

Lab No. PG-67803 DE

Examination requested by : Addressee

Reference: Evidence personally delivered by Mr. Wesley D. Cowan on 11/6/61

Examination requested: Miscellaneous

Remarks:

Q1 Envelope marked "Unit A" containing altimeter dials
Q2 Envelope marked "Unit B" containing altimeter dials
Q3 Envelope marked "Unit C" containing altimeter dials

Result of examination:

Specimens Q1, Q2 and Q3 were examined under four different ultraviolet lights. No evidence was found on any of the submitted pieces to indicate that the hands of the altimeters struck the dials.

The evidence is being retained until called for by a representative of your office.

Attachment 'C'

REPORT OF EXAMINATION OF 3 ALTIMETERS

TYPE 671CPX-6-051-20329
TYPE 671CPX-6-051-17753
SER. No. 64990 (Only identification discernible)

The above three altimeters were submitted to Kollsman Instrument Corporation for examination by the Civil Aeronautics Board, Washington, D.C. on November 1st, 1961.

The following persons were present during the examination:

W.L. Cowan - Civil Aeronautics Board, Wash., D.C.

W. Angst - Kollsman Instrument Corp., Engineering Dept.

R.W. Cooperman - Kollsman Instrument Corp., Legal Dept.

The three altimeters were first photographed in their assembled state, as received, and are shown in photographs Nos. 1 and 2 (Note: The pointers on photograph No. 1 are not in the same position as when first observed at Kollsman).

Altimeter 671CPX-6-051-20329 Unit A:-

A. Examination before removal of the mechanism from the case disclosed the following:

1. The lead seal is missing.
2. The barometric pressure setting knob shaft was broken off flush with the bezel.
3. The 100 ft. pointer is loose.
4. The 1000 ft. pointer indicates 9000 ft.
5. The 10,000 ft. pointer indicates 19,000 ft.
6. The barometric setting indicates 30.14 inches.
7. The field pressure outer setting marker indicates -205 ft., the inner setting marker -200 ft.
8. No fire damage is visible.
9. The pointers do not respond to pressure changes.

B. Examination of the mechanism after removal from the case disclosed the following:

1. The 100 ft. pointer is loose on the pointer shaft.
2. The 1,000 ft. and 10,000 ft. pointers are still attached to their respective shafts.
3. Both diaphragm temperature compensating links were loose in the case.

4. Both sector rockingshaft pivots are broken.

5. The diaphragms are free of visible damage.

6. No pointer impact marks could be detected on the dial under ultra violet light.

Altimeter Serial No. 64990 Unit B:

A. Examination before removal of the mechanism from the case disclosed the following:

1. The lead seal is missing.

2. The barometric pressure setting knob shaft is broken off flush with the bezel.

3. The three instrument mounting screws are broken; portions of each screw left in the instrument flange.

4. The cover glass is cracked.

5. Dial and pointers are fire damaged.

6. The 100 ft. pointer indicates 560 ft.

7. The 1000 ft. pointer is loose.

8. The 10,000 ft. pointer indicates 4000 ft.

9. The barometric pressure setting reads 30.16 inches.

10. The field pressure outer setting marker indicates -220 ft.; the inner setting marker -200 ft.

11. Shaking discloses loose pieces inside the case.

12. The pointers do not respond to pressure changes.

B. Examination of the mechanism after removal from the case disclosed the following:

1. The 100 ft. pointer is tight on its shaft.

2. The diaphragm mounting stud is bent in the direction of the impact shock.

3. The solder holding the diaphragm to its stud melted and permitted the diaphragm to move on the stud. The diaphragm centerpiece, to which the link connects, also shifted due to the solder melting.

4. The link broke where it is pinned to the diaphragm centerpiece.

5. Both rockinghsaft pivots are broken.
6. The balance weight spring broke at the mounting stud.
7. The balance weight lever arm on the rockingshaft broke.
8. One intermediate gear shaft pivot broke.
9. Both diaphragm temperature compensating lins were loose in the case.
10. One of the diaphragm capsules lost the vacuum due to the solder melting.
11. The diaphragm and most of the mechanism is covered by a black sticky fluid. Kollsman was not able to identify it by its odor.
12. No pointer impact marks could be detected on the dial by ultra violet light.

C. Altimeter 671CPX-6-051-17753 Unit C

Examination before removal of the mechanism from the case disclosed the following.

1. The knob shaft was sheared off flush with the bezel.
2. The cover glass is missing.
3. Part of the bezel itself is broken off.
4. The three instrument to panel mounting screws are broken; portion of each screw left in the flange.
5. The dial and pointers and the setting markers are fire damaged, the 100 ft. pointer is badly bent.
6. The 100 ft. and the 1000 ft. pointers are loose.
7. The 10,000 ft. pointer indicates 6000 ft.
8. There is no hose fitting screwed to this case.
9. The barometric pressure setting reads 30.18 inches.
10. The field pressure outer setting marker indicates -230 ft.; the inner setting marker indicates -200 ft.

Examination of the mechanism after removal from the case disclosed the following:

1. The handstaff of the 100 ft. pointer broke off with the pointer.
2. Part of the top mechanism casting is bent up (towards the dial) near the inner setting marker drive gear.

3. The solder on the three cells of the diaphragm assembly melted destroying the vacuum, and causing the diaphragm to come off its mounting stud.
4. The two temperature compensating links were loose in the case.
5. The calibrating arm was forced out of its hole in the rockinghshaft either by the impact shock or by the force of the expansion of the diaphragm due to the loss of vacuum noted in "3" above. This caused the link to bend.
6. The balance weight spring broke at the mounting stud.
7. Both rockinghshaft pivots are broken.
8. One pivot of the intermediate gear shaft is broken.
9. The rear part of diaphragms is dented.
10. The case shows impact damage on bottom half of cylindrical portion of case.
11. No pointer impact marks could be detected on the dial by ultra violet light.

Conclusions

Careful examination of all three altimeters and the inspection of the mechanism of each after removal from the case disclosed no abnormal condition not attributed to impact shock and fire resulting from the crash of the aircraft.

Due to the damage caused by the impact of the crash the pointer indications have no significance and do change with the physical movement of the instrument without any relation to pressure changes.

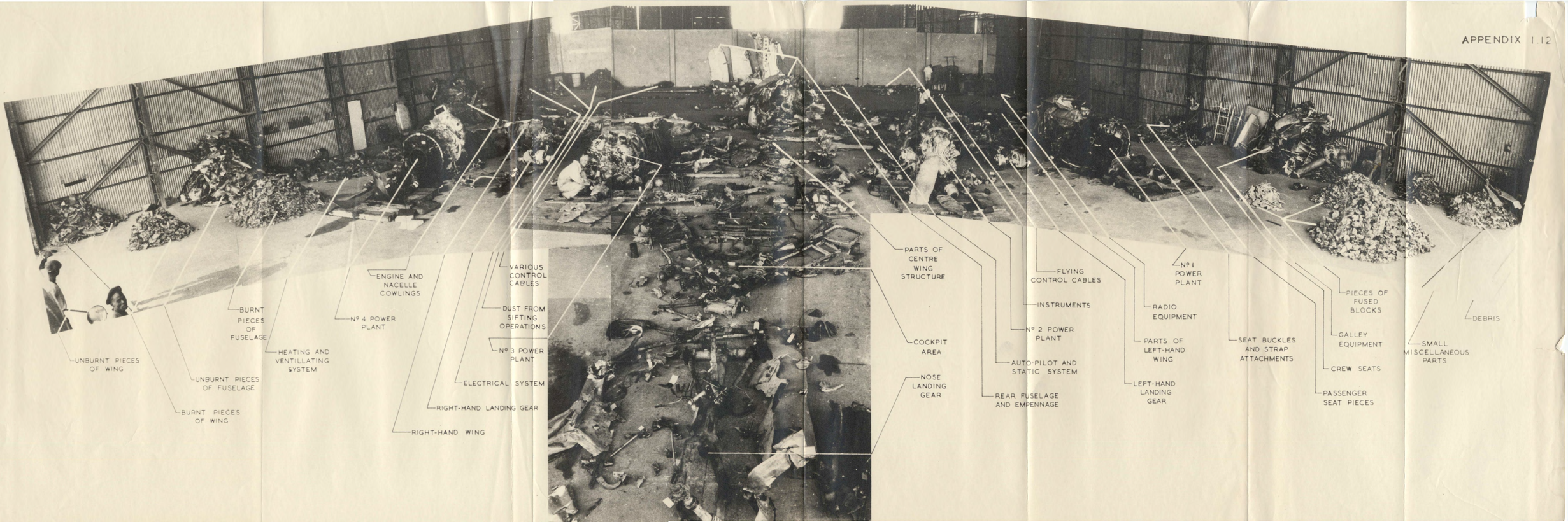
The correlation between the barometric setting dial and the two setting markers was found to be correct. Due to the damage sustained by the mechanism as a result of the impact shock no correlation check between barometric pressure setting and the pointer could be made on any of the three altimeters.

Photographs No. 3, 4 and 5 show the altimeters in their disassembled state.

(signed) Walter Angst
Kollsman Instrument Corporation
Air Data Engineering

November 2, 1961.

APP.
1.12


UNBURNT PIECES OF WING
BURNT PIECES OF WING
UNBURNT PIECES OF FUSELAGE
BURNT PIECES OF FUSELAGE
HEATING AND VENTILLATING SYSTEM
ENGINE AND NACELLE COWLINGS
Nº 4 POWER PLANT
RIGHT-HAND WING
RIGHT-HAND LANDING GEAR
ELECTRICAL SYSTEM
Nº 3 POWER PLANT
DUST FROM SIFTING OPERATIONS
VARIOUS CONTROL CABLES
PARTS OF CENTRE WING STRUCTURE
COCKPIT AREA
NOSE LANDING GEAR
REAR FUSELAGE AND EMPENNAGE
AUTO-PILOT AND STATIC SYSTEM
Nº 2 POWER PLANT
INSTRUMENTS
FLYING CONTROL CABLES
LEFT-HAND LANDING GEAR
PARTS OF LEFT-HAND WING
RADIO EQUIPMENT
Nº 1 POWER PLANT
SEAT BUCKLES AND STRAP ATTACHMENTS
PASSENGER SEAT PIECES
CREW SEATS
GALLEY EQUIPMENT
PIECES OF FUSED BLOCKS
SMALL MISCELLANEOUS PARTS
DEBRIS

APP.
1.13

REPORT ON THE EXAMINATION OF VARIOUS EXHIBITS RECEIVED FROM SQUADRON LEADER BRADSHAW, DETECTIVE INSPECTOR GANGE, SENIOR INSPECTOR APPLETON, SENIOR INSPECTOR ALLAN AND ASSISTANT SUPERINTENDENT CARY.

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The exhibits are listed and described in this report in their order of receipt and are being retained by me at C.I.D. Headquarters, Lusaka, in their respective groups as they were received.

NORTHERN RHODESIA POLICE
- 9 NOV 1961
LUSAKA
C.I.D. HEADQUARTERS

Receipt of three revolvers, two machine pistols and one charged machine pistol magazine (25th September, 1961).

On Monday, 25th September, 1961 at the Lusaka airport, I personally received from Squadron Leader BRADSHAW a package which contained the following:-

(i) A Swedish "KULSPRUTE" machine pistol No. 392524 B (B.36).
(ii) A Swedish "KULSPRUTE" machine pistol No. 111871 B (E.34).
(iii) A "Smith & Wesson" revolver No. 175747 (C.37).
(iv) A "Smith & Wesson" revolver No. 176197 (F.39).
(v) A "Colt" revolver No. 731069 (E.39).
(vi) A machine pistol magazine charged with 24 rounds of 9 m.m. Parabellum ammunition (13 "Separate anvil type" primer and 11 "Berdan" type primer). (E.36).
(vii) An empty holster and four ammunition pouches which contained 24 rounds of .38 Special ammunition (12 Peters, 7 Remington, 3 Western and 2 Winchester). (E.41).

(see section "Examination of Firearms").

Receipt of six machine pistol magazines and two magazine springs (27th September, 1961).

On Wednesday, 27th September, 1961 at Ndola I personally received from Detective Inspector GANGE the following:-

(i) One empty magazine and magazine spring (C.40).
(ii) Five empty magazines and one magazine spring with a lump of fused metal attached to it. (D.37).

All the magazines were damaged and bore unmistakeable evidence of exposure to extreme heat. Two of the magazines were minus their base plates and followers. There is no doubt that the magazines had all contained live rounds, some of which exploded in them from heat (see photograph No. 1).

On the 27th September, 1961 at the scene of the crash, I was shown part of the fibre glass radar nose dome of the crashed aircraft. The outer fibre glass layer had a jagged oblong perforation and the layer immediately below it had a transverse fracture. These, in my opinion, were not consistent with the type of perforation normally caused by a high velocity projectile, but appeared more consistent with damage sustained through impact. The fibre glass was extensively damaged by heat and it was, therefore, extremely difficult, if not impossible, to ascertain with absolute accuracy the cause of the perforation and fracture.

The same day at the site of the crash, I was handed a portion of the cockpit window frame that had through it an irregularly shaped hole approximately 1 cm. in diameter. I subsequently effected a microscopic examination at C.I.D. Headquarters of the edges of the hole and found conclusive indications that the hole had not been caused by a bullet, but most probably by an object with a jagged point. The piece of metal was labelled F.34.

The same day at the hangar at Ndola airport I was shown a number of holes in various parts of the wreckage viz. (a) two holes in the cowl flap of engine No. 1 and (b) three holes in the port cooler support member and one hole in the primary fire wall of engine No. 3, and (c) a hole in the intake pipe for No. 5 cylinder of engine No. 4.

The holes in the components of engines Nos. 1 and 3 were established without doubt as holes caused by rivets that sprang.

The hole in the intake pipe of No. 5 cylinder of engine No. 4 was irregular in shape and appeared to have been caused by the impact. Damage to the cylinder and to the intake pipe itself in the immediate vicinity of the hole manifested this to be the most likely cause.

The same day I was also shown a nick, approximately 1 cm. square, in the leading edge of one of the propeller blades of engine No. 4. The appearance of the metal at the edges of the nick, and its shape, indicated conclusively that it could not have been caused by a bullet. It appeared

consistent with the blade's having struck something whilst in rotation; most likely a part of the disintegrated propeller of the adjacent engine.

RECEIPT OF BULLETS, CARTRIDGE CASES, ONE COLT REVOLVER, NINE BOTTLES WHICH CONTAINED BULLETS AND FRAGMENTS OF BRASS ALLEGEDLY REMOVED FROM BODIES 1 AND 2 AND FIVE CHARGED MACHINE PISTOL MAGAZINES.

On the 28th September, 1961 at Ndola, I personally received from Detective Inspector GANGE a number of envelopes that contained bullets and cartridge cases. These are enumerated and described below in their respective groups.

Group I.

(a) Twelve 9 m.m. bullets, and
(b) Eight 9 m.m. cartridge cases.
(All found near body No. 3).

Most of the bullets revealed distinct signs of the effects of heat, though were completely free from any markings consistent with barrel rifling.

Five of the cartridge cases were split open, two still contained their percussion caps and three were minus their percussion caps. (All these were of the "Separate anvil type" primer). The remaining three cartridge cases were unsplit, two contained their percussion caps ("Separate anvil type") and one was minus its percussion cap ("Berdan" type).

(Photograph No. 2 illustrates the two types of primers).

Group II.

(a) Fourteen 9 m.m. bullets, and
(b) Twenty-four 9 m.m. cartridge cases.
(All found near body No. 9).

All the bullets as well as the cartridge cases showed signs of exposure to intense heat. No rifling markings were discernible on any of the bullets.

The cartridge cases were comprised as follows:-

(a) Fifteen split open and fragmented, of which six contained their percussion caps ("Separate anvil type") and nine were minus their percussion caps (4 "Separate anvil type" and 5 "Berdan" type).

(b) Nine unsplit of which three contained their percussion caps ("Separate anvil type") and six were minus their percussion caps (5 "Berdan" type and 1 "Separate anvil" type).

Group III.

(a) Five 9 m.m. bullets, and

(b) Twelve 9 m.m. cartridge cases.
(All found near body No. 1).

Three of the bullets showed signs of exposure to intense heat. No rifling markings were visible on any of the bullets.

The cartridge cases were comprised as follows:-

(a) Six split and fragmented of which four were minus their percussion caps and two still contained their percussion caps (all "Separate anvil" type).

(b) Six unsplit of which three were minus percussion caps and three still contained their percussion caps (all "Separate anvil" type).

Group IV.

(a) Two Peters .38 special cartridge cases, found near body No. 14.

Both these cartridge cases were split open and fragmented and minus their percussion caps.

(b) A .38 "Smith & Wesson" revolver No. 998723, found near body No. 9.
(See section "Examination of Firearms").

On 28th September, 1961 at Ndola I personally received from Senior Inspector APPLETON a number of bottles that contained objects which had allegedly been removed from bodies 1 and 2.

Group V.

(a) Articles removed from body No. 1.

Bottle No. 1 contained a brass fragment which appeared to be a portion of a cartridge case.

Bottle No. 2 contained a split and fragmented 9 m.m. cartridge case that was minus its percussion cap ("Separate anvil" type).

Bottle No. 3 contained a 9 m.m. bullet of which the lead core had commenced to melt.

Bottle No. 4 contained a 9 m.m. bullet which also showed indications that melting of the lead core had commenced.

Bottle No. 5 contained two pieces of fused alloy.

Bottle No. 6 contained a 9 m.m. bullet and a piece of brass which appeared to be a fragment of a cartridge case. The lead core of the bullet was intact.

Cartridge Case. This was a 9 m.m. cartridge case, split open and fragmented and minus its percussion cap ("Separate anvil" type).

Total number of objects removed from body No. 1:-

(a) Three 9 m.m. bullets.
(b) Two 9 m.m. cartridge cases.
(c) Two fragments of brass.
(d) Two pieces of fused alloy.

The three bullets were completely free from any rifling markings and could not, therefore, have passed through the rifled barrel of a firearm.

The condition of the lead cores of the two bullets indicated conclusively that they had been lodged superficially in the burning body where the temperature was sufficiently high to initiate melting.

Group VI.

Articles recovered from body No. 2.

Bottle No. 1 contained a 9 m.m. bullet that was minus

its lead core.

Bottle No. 2 contained a 9 m.m. bullet of which the lead had commenced to melt.

Bottle No. 3 contained (i) three pieces of brass that appeared to be cartridge case fragments, (ii) a percussion cap, and (iii) a small brass stud or rivet.

Total number of objects removed from body No. 2:-

(a) Two 9 m.m. bullets.
(b) Three fragments of brass.
(c) A small stud or rivet.
(d) A percussion cap.

The two bullets were completely free from any rifling markings and could not, therefore, have passed through the rifled barrel of a firearm, and for the reasons stated in the case of body No. 1, must also have been close to the surface of the body from which they had been removed.

On 28th September, 1961 at Ndola, I personally received from Senior Inspector ALLAN the following:-

Group VII.

Five charged machine pistol magazines, contained in a pouch. (All found near body No. 15). The magazines were charged as follows:-

Magazine No. 1.

| | | | |
|---|---|---|---|
| 25 | 9 m.m. | rounds | ("Separate anvil" type) |
| 10 | " | " | ("Berdan" type) |
| 35 | | | |

Magazine No. 2.

| | | | |
|---|---|---|---|
| 33 | 9 m.m. | rounds | ("Separate anvil" type) |
| 2 | " | " | ("Berdan" type) |
| 35 | | | |

Magazine No. 3.

| | | | |
|---|---|---|---|
| 22 | 9 m.m. | rounds | ("Separate anvil" type) |
| 12 | " | " | ("Berdan" type) |
| 34 | | | |

Magazine No. 4.

| | | |
|---|---|---|
| 25 | 9 m.m. rounds | ("Separate anvil" type) |
| 8 | " " | ("Berdan" type) |
| 33 | | |

Magazine No. 5.

| | | |
|---|---|---|
| 26 | 9 m.m. rounds | ("Separate anvil" type) |
| 10 | " " | ("Berdan" type) |
| 36 | | |

| | |
|---|---|
| "Separate Anvil" type primer | 131 |
| "Berdan" type primer | 42 |
| | 173 |

Receipt of bullets and cartridge cases. (5th October, 1961).

On 5th October, 1961 at C.I.D. Headquarters, Lusaka, I personally received from Detective Inspector GANGE a number of envelopes that contained cartridge cases and bullets. These are enumerated and described below in their respective groups.

Group VIII.

34 bullets all found near body No. 1, comprised as follows:-

(a) One .38 lead bullet. The effects of heat were apparent on the bullet, though no rifling markings were present.
(b) Thirty-three 9 m.m. bullets of which the majority revealed unmistakeable signs of exposure to intense heat. No rifling markings were discernible on any of them.

Group IX.

(a) One live round .38 Peters special.
(b) Seventy-two 9 m.m. bullets, some of which revealed signs of exposure to intense heat. The majority, however, (46) were in an excellent state of preservation and revealed no signs of rifling.
(These were found near body No. 1).

Group X.

(a) Eight 9 m.m. bullets, and
(b) Five 9 m.m. cartridge cases.
(All found near body No. 3).

Six of the bullets revealed distinct signs of exposure to heat and two were in a sound state of preservation. No rifling markings were present on any of them.

Three of the cartridge cases were extensively split and fragmented. The percussion cap of one of these was missing ("Separate anvil" type). The other two cases were more or less intact and one had its percussion cap missing("Berdan" type). Four of the cartridge cases were equipped with the "Separate Anvil" type primers.

Group XI.

(a) 1 Winchester .38 special live round, and
(b) 94 bullets, comprised as follows:-
(Near body No. 3)

(i) Ninety-two 9 m.m. bullets.
(ii) Two .38 lead bullets.

The effects of heat were apparent on most of the bullets, though no rifling markings were visible on any of them.

Group XII.

Forty-six 9 m.m. cartridge cases comprised as follows:-
(Found near body No. 1).

(a) 32 split and fragmented cases. 14 of these contained their percussion caps and were all of the "Separate anvil" type. 18 of these cases were minus their percussion caps and consisted of 11 cases with the "Separate anvil" type primer and 7 cases with the "Berdan" type primer.
(b) 14 cartridge cases that were not split or fragmented. 8 of these contained their percussion caps

and were of the "Separate anvil" type primer. The remaining six were minus their percussion caps and consisted of 4 of the "Separate anvil" type primer and 2 of the "Berdan" type primer.

Group XIII.

Six .38 Special cartridge cases that were found near body No. 2. All these cartridge cases were split and minus their percussion caps, and consisted of the following:-

(a) 4 Peters .38 special.
(b) 1 Western .38 special.
(c) 1 Winchester .38 special.

Group XIV.

(a) Thirty-eight 9 m.m. bullets.
(b) Eleven 9 m.m. cartridge cases.
(5 "Berdan" type and 6 "Separate anvil" type primer).
(All found near body No. 9).

The bullets showed signs of the effects of intense heat, but were completely free from any rifling markings.

The cartridge cases were comprised as follows:-

(a) Five cases that were split open, two still contained their percussion caps and three were minus their percussion caps.
(b) Six cases that were not split of which four were minus their percussion caps ("Berdan" type primer) and two still contained their percussion caps ("Separate anvil" type primer).

Group XV.

(a) Three 9 m.m. cartridge cases, and
(b) One 9 m.m. bullet.
(All found near body No. 1).

The cartridge cases were not split, but were minus their percussion caps (2 "Separate anvil" type and 1 "Berdan" type primer). The bullet bore no rifling markings.

Group XVI.

Three .38 lead bullets, found near body No. 2.

The bullets were free from any rifling markings, but it was evident that they had been exposed to heat.

Group XVII.

One .38 lead bullet; no rifling markings were visible. (Found near body No. 2).

Group XVIII.

(a) Seven .38 Special cartridge cases comprised as follows:-

(i) 5 Peters.
(ii) 2 Remington.

The cartridge cases were split and fragmented, except one "Peters" cartridge case. They were all minus their percussion caps.

(b) Thirty-five 9 m.m. cartridge cases comprised as follows:-

(i) 17 split and fragmented cases of which nine contained their percussion caps ("Separate anvil" type primer) and eight were minus their percussion caps (3 "Berdan" type primer and 5 "Separate anvil" type primer).
(ii) 18 unsplit cases comprised as follows:-

(a) 6 with their percussion caps (1 "Berdan" type and 5 "Separate anvil" type).
(b) 12 minus their percussion caps (7 "Separate anvil" type and 5 "Berdan" type).

All these cases were found near body No. 1.

Group XIX.

(a) Eight 9 m.m. bullets, and
(b) Four 9 m.m. cartridge cases.
(All found near body No. 1).

The effects of heat were evident on most of the bullets, but they were completely free from any rifling markings.

11/.....

The four cartridge cases were comprised as follows:-

(i) Three unsplit cases, of which two contained their percussion caps ("Separate anvil" type primer) and one was minus its percussion cap ("Berdan" type primer).

(ii) One fragmented case minus its percussion cap ("Separate anvil" type primer).

Group XX.

(a) One live round of 9 m.m. ammunition, equipped with a "Separate anvil" type primer. (Found near body No. 3).

(b) Three live rounds of 9 m.m. ammunition of which two were equipped with "Separate anvil" type primers and one with a "Berdan" type primer. (Found in D.35).

Receipt of bullets and cartridge cases and two machine pistol barrel jackets. (13th October, 1961).

On 13th October, 1961 at Ndola, I personally received from Detective Inspector GANGE a number of envelopes that contained bullets and cartridge cases. These are enumerated and described below in their respective groups.

Group XXI.

(a) One .38 lead bullet, and
(b) Two 9 m.m. cartridge case.
(Found at hangar).

The bullet bore no rifling markings whatsoever.

The one 9 m.m. cartridge case was split longitudinally but still contained its percussion cap. The other cartridge case was intact, but minus its percussion cap. Both cases were of the "Separate anvil" type primer.

Item XXII.

One 9 m.m. bullet (found at hangar). The bullet was completely free from any markings consistent with barrel rifling, but bore distinct evidence of exposure to heat.

Group XXIII.

(a) Two Peters .38 special cartridge cases, and
(b) One 9 m.m. cartridge case.
(Found at hangar).

The percussion caps of the three cartridge cases were missing. The effects of heat were apparent on the 9 m.m. case and one .38 special case. The other .38 special cartridge case was damaged on the rim of the base, bent and slightly bulged approximately 4 mm. from its base. These features indicated a strong probability that this cartridge case had been expelled from the cylinder of a revolver when its propellant charge exploded from heat.

Group XXIV.

(a) 32 cartridge cases, and
(b) 43 bullets.
(Found near body No. 9).

The cartridge cases were comprised as follows:-

(i) 4 Peters .38 Special.
(ii) 2 Remington U.M.C. .38 Special.
(iii) 1 W.R.A. .38 Special.
(iv) Twenty-five 9 m.m. cases (14 with "Separate anvil" type primer and 11 with "Berdan" type primer).

All the .38 Special cartridge cases were split and fragmented and minus their percussion caps. Eleven of the 9 m.m. cases were intact, albeit minus their percussion caps. Fourteen of the 9 m.m. cases were split and fragmented; seven contained their percussion caps and seven were minus their percussion caps.

The bullets were comprised as follows:-

(i) 3 .38 lead bullets, and
(ii) Forty 9 m.m. bullets.

The lead bullets revealed signs of exposure to heat, but were completely void of rifling markings.

Some of the 9 m.m. bullets also revealed the effects of exposure to extreme heat. However, no rifling markings were visible on any of them.

Group XXV.

59 cartridge cases comprised as follows:-
(Found near body No. 3).

(a) 3 Peters .38 special cartridge cases, all split, fragmented and minus their percussion caps.

(b) 3 Peters .38 special cartridge cases. These were intact, but minus their percussion caps.

(c) 1 Western .38 special cartridge case, split and fragmented and minus its percussion cap.

(d) 1 Winchester .38 special cartridge case, split and fragmented and minus its percussion cap.

(e) Eight 9 m.m. cartridge cases which were comparatively intact. 3 were minus their percussion caps ("Berdan" type primer); 1 had a split percussion cap; 1 was minus its percussion cap and 3 contained their percussion caps. The last five were of the "Separate anvil" type primer.

(f) Twenty 9 m.m. cartridge cases, split and fragmented and minus their percussion caps.

(g) Twenty-three 9 m.m. cartridge cases that were split and fragmented, but with their percussion caps in place.

All the cartridge cases listed under (f) and (g) were of the "Separate anvil" type primer.

Item XXVI.

On the 13th October, 1961, I personally found at the scene of the crash, at the spot where body No. 2 was found, a 9 m.m. bullet. The bullet was well preserved and revealed no rifling markings whatsoever.

Group XXVII.

The same day at Ndola, I received from Mr. CARY, two machine pistol barrel jackets Nos. 111871 and 392524. The serial numbers of the jackets corresponded with the serial numbers of the two "KULSPRUTE" machine pistols. The two jackets were without bayonet bosses and were obviously intended to replace the bayonet boss jackets on the machine pistols, if necessary, or vice versa.

Group XXVIII.

On Wednesday, 25th October, 1961, I received from Mr. CARY at Ndola:-

(a) One Peters .38 special live round.
(b) One Remington .38 special live round.
(c) One 9 m.m. bullet.
(d) One 9 m.m. cartridge case.

The 9 m.m. bullet revealed the effects of extreme heat, but bore no rifling markings.

The 9 m.m. cartridge case also showed the effects of heat and still contained its percussion cap. It was not split open and was equipped with a "Separate anvil" type primer.

The two .38 special rounds were found near body No. 3 and the 9 m.m. bullet and cartridge case were recovered at the hangar at Ndola airport.

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## SUMMARY AND CONCLUSIONS.

Total number of bullets examined:-

| | | | |
|---|---|---|---|
| (i) | 331 | 9 m.m. | (bullets removed from bodies included) |
| (ii) | 11 | .38 special | |
| | 342 | | |

Total number of cartridge cases examined:-

(a) 230 9 m.m. of which 144 were split open, 86 were unsplit, 99 still contained their percussion caps, and 131 were minus their percussion caps.

(b) 32 .38 special cartridge cases of which 26 were split open and 6 unsplit. These were all minus their percussion caps.

(Cartridge cases contained in the cylinders of the four revolvers are not included).

Of all the bullets examined, including those removed from the two bodies, not one revealed any evidence of having passed through the rifled barrel of a firearm.

Not one of the percussion caps in the cartridge cases that still contained them, bore any indentation consistent with the impact of the firing pin of a firearm. On the contrary, all the cartridge cases and the majority of the bullets bore symptoms which indubitably signified that they were all components of ammunition that had exploded from heat.

All the 9 m.m. cartridge cases were comprised of two types that were identical with the two types of which all the live rounds were comprised viz. "Berdan" type primers and "Separate anvil" type primers. (See photographs 2 and 3).

The .38 special cartridge cases were comprised of the same types as the .38 special live rounds viz. "Peters", "Western", "Winchester" and "Remington".

I, therefore, concluded without doubt that all the exploded rounds of ammunition were part of the supply of ammunition carried on board the aircraft.

16/.....

## EXAMINATION OF FIREARMS.

I. Revolver No. 998723. (F.37)

Smith & Wesson .38 military and police revolver, chambered to accept the .38 Smith & Wesson special cartridges.

| | |
|---|---|
| Capacity of Cylinder: | 6 rounds |
| Cylinder Rotation: | Anti-clockwise |
| Rifling: | 5 lands and 5 grooves with a clockwise twist. |

General Condition:

The revolver was extensively damaged by heat and revealed the following defects:-

(i) finish completely destroyed.
(ii) butt plates burnt away.
(iii) both shields at the rear of the cylinder bent.
(iv) action locked.

The cylinder of the revolver contained six empty cartridge cases, comprised as follows:-

(i) 3 Remington.
(ii) 2 Peters.
(iii) 1 Winchester.

The percussion caps of two of the cartridge cases situated at 7 o'clock and 11 o'clock respectively were missing. The percussion cap of the cartridge case situated at 12 o'clock i.e. aligned with the barrel, had a small perforation in its centre which conformed to the firing pin aperture in the recoil plate. The periphery of the perforation was extruded and not depressed which clearly indicated that the perforation had not been caused by the firing pin, but by combustion pressure from inside the cartridge case against the firing pin cavity.

The other three cartridge cases revealed no identations or other markings on their percussion caps. It was quite obvious that all the cartridges in this revolver exploded from heat and that none of them was discharged by the impact

of the firing pin.

The bullet of the cartridge aligned with the barrel must have passed through the barrel and will have acquired rifling markings. The bullets situated on either side of the frame in the cylinder could have been expelled from the cylinder, although not without a certain amount of distortion or fragmentation.

The bullet situated at 6 o'clock lodged against the frame of the revolver and there were indications that it melted away.

(See photograph No. 4).

II. Revolver No. 175747. (C.37)

Smith & Wesson .38 Special (airweight) chambered to accept five .38 special cartridges.

Cylinder Rotation: Anti-clockwise

Rifling: 5 lands and 5 grooves with a clockwise twist.

General Condition:

(i) Finish damaged by heat.
(ii) Butt plates destroyed by heat.
(iii) Action locked.
(iv) Cylinder locking mechanism damaged.
(v) Left hand shield at the rear of the cylinder blown off.

The cylinder of this revolver contained 4 Remington .38 special cartridge cases. The cases situated in the cylinder at 2 o'clock and 7 o'clock were minus percussion caps. The chamber at 10 o'clock was empty.

The percussion cap of the cartridge case at 12 o'clock bore a small protrusion which conformed to the firing pin aperture in the recoil plate.

All the cartridges in this revolver exploded from heat and the revolver was fully loaded when the explosions occurred.

The cartridge situated at 12 o'clock was approximately 1 mm. misaligned when it exploded, but despite this its bullet must have passed through the barrel.

Damage to the left hand shield at the rear of the cylinder must have been caused by the cartridge which occupied the chamber at 10 o'clock. No striker pin indentations were visible on the caps of the two cartridge cases that still contained them.

(See photograph No. 5).

III. Revolver No. 176197. (F.39)

Smith & Wesson .38 Special (airweight) chambered to accept five .38 special cartridges.

Cylinder Rotation: Anti-clockwise

Rifling: 5 lands and 5 grooves with a clockwise twist.

General Condition:

(i) Butt plates partly damaged by heat.
(ii) Frame bent and fractured.
(iii) Action and cylinder lock completely damaged.
(iv) Both shields at the rear of the cylinder blown off.

The cylinder of this revolver contained 3 cartridge cases viz. two .38 Peters special and one with its base blown off, situated at 5 o'clock.

The chambers situated at 10 o'clock and 2 o'clock were empty. A fragment of brass was lodged under the ejector in the chamber at 2 o'clock.

All the cartridges in this revolver exploded from heat and the revolver was fully loaded when the explosions occurred.

The cartridge situated at 12 o'clock, i.e. opposite the barrel, exploded when it was approximately 4.5 mm. out of alignment. The degree of misalignment was ascertainable from the impressions on the base of the cartridge case caused by the recoil plate. Misalignment was, no doubt, caused by the prior explosion of some of the other cartridges in the cylinder. A fragment or fragments only of the bullet situated at 12 o'clock could have passed through the barrel.

No firing pin indentations were visible on the percussion caps of the two cartridge cases. Damage to the frame of the revolver was caused by the explosion of the cartridges contained in the chambers at 10 o'clock, 2 o'clock and 5 o'clock.

(See photograph No. 6).

IV. Revolver No. 731069. (E.39)

"Colt" official police .38 special, chambered to accept six .38 special cartridges.

| | |
|---|---|
| Cylinder Rotation: | Clockwise |
| Rifling: | 6 lands and 6 grooves with an anti-clockwise twist. |

General Condition:

(i) Finish damaged by heat.
(ii) Butt plates partly destroyed.
(iii) Action damaged.
(iv) Cylinder locking mechanism damaged.
(v) Left hand shield (thumb piece) damaged.

The cylinder of this revolver contained 6 cartridge cases and was, therefore, fully loaded. The cartridge cases consisted of the following:-

4 Peters and 1 Remington (percussion cap missing) and one with its base blown off, which appeared to have been a Remington or a Peters cartridge.

The revolver was covered with a greasy substance which could have issued from a burning body.

All the cartridges in this revolver exploded from heat.

The cartridge situated at 12 o'clock exploded when it was approximately 5 mm. out of alignment with the barrel. The degree of misalignment was ascertainable from the impression of the recoil plate on the base of the cartridge case. The bullet of this cartridge could not have passed through the barrel of the revolver. Damage to the revolver and the extent of misalignment of the cartridge at 12 o'clock were obviously caused by the explosion of the cartridges situated at 10 o'clock and 8 o'clock.

No firing pin indentations were visible on the percussion caps of the 4 cartridge cases which still contained them.

(See photograph No. 7).

Machine Pistol No. 111871 B (E.34) and Machine Pistol No. 392524 B. (B.36).

Both were Swedish "KULSPRUTE" machine pistols, chambered to accept 9 m.m. "Parabellum" ammunition.

The collapsible butts of both the machine pistols were bent and their plastic coverings burnt. The wooden pistol grip of pistol No. 111871 B was fractured.

The magazine housings of both were slightly dented, but their magazine spring clips were intact. It was, therefore, obvious that the machine pistols had been without their magazines when the crash occurred as forcible expulsion of the magazines would inevitably have resulted in damage to the spring clips.

.....

(R.H. ELS)

FORENSIC BALLISTICS DEPARTMENT,
NORTHERN RHODESIA POLICE.

No. 1

No. 2

No. 3

No. 4
SPECIAL
REM-UMC
REM-UMC

No. 5

No. 6

No. 6

No. 7

APP.
1.14

## DETAILS OF SPECIAL FLIGHTTESTS CARRIED OUT WITH A DC6 AT NDOLA ON 9th OCTOBER, 1961

| | FLIGHT No. 1 | FLIGHT No. 2 | FLIGHT No. 3 | FLIGHT No. 4 | FLIGHT No. 5 |
|---|---|---|---|---|---|
| Time started :<br>Time ended : | 1928 GMT<br>1934 GMT | 1939 GMT<br>1945 GMT | 1951 GMT<br>1959 GMT | 2005 GMT<br>2011 GMT | 2017 GMT<br>2023 GMT |
| Lights : | Anti. coll. light : ON<br>Nav. lights : STEADY<br>Cabin lights : ON | ON<br>STEADY<br>OFF | ON<br>FLASH<br>OFF | OFF<br>FLASH<br>ON | ON<br>STEADY<br>OFF |
| Aircraft altitude : | 5 miles East : 150<br>Overhead : 138<br>Proc. turn : 90<br>Crash site : 90 | 80<br>70<br>60<br>53 | 60<br>60<br>60<br>53 | 100<br>80<br>75<br>65 | 80<br>70<br>60<br>55 |
| Direction : | W end of R/W : 290°<br>At abeam ND a shallow turn to 310° | Same as No. 1 | Instrument approach procedure | Same as No. 1 | Same as No. 1 |
| Aircraft attitude : | Steep descent (up to 2000 feet per min.) | Normal descent | Level except just after procedure turn | Steep descent (about 1500 feet per minute) | Normal descent |
| Aircraft speed : | Up to 210 knots indicated. | 5 miles East : 180 kts<br>Overhead : 165 kts<br>Proc. turn : 130 kts<br>Crash site : 130 kts | 160 kts<br>140 kts<br>130 kts<br>130 kts | 205 kts<br>205 kts<br>180 kts<br>160 kts | 180 kts<br>160 kts<br>130 kts<br>130 kts |
| Blower : | Low | Low | Low | Low | High * |
| Remarks : | Impossible approach | | A little too far out | Impossible approach when using normal power and speed limitations | By mistiming brought too far out |

* NOTE : High blower simulated by using 1" manifold pressure.

APPENDIX 1.14

APP.
2.

APPENDIX 2

## LIST OF WITNESSES

1. Flying Officer C. Craxford, RRAF, Pilot.
2. Mr. A.C. Martin, ATCO, Ndola Airport.
3. Captain L. Starck, Transair, Pilot.
4. Mr. K.H. Hammond, R.R.A.F, Fitter.
5. Col. A.M. Matlick, U.S. Air Attache.
6. Mr. Jeki Mubanga, African Charcoal Burner.
7. Flight Lieutenant W.J. Fidlin, R.R.A.F. Navigator.
8. Mr. D.A. Clarke, Fitter, Ndola Municipality.
9. Flying Officer B.J. Green, R.R.A.F. Pilot.
10. Mr. Farie Mazibisa, African Charcoal Burner.
11. Mr. E.A.I. Ikonfela, African Charcoal Burner.
12. Squadron Leader J. Mussell, R.R.A.F. Pilot.
13. Mr. K.A. Phillips, Fuel Plant Superintendent.
14. Mr. D.E. Peover, Architect.
15. Mr. M.U. van Wyk, Assistant Inspector, N. Rhodesia Police.
16. Mr. A.V. Allen, Senior Inspector, N. Rhodesia Police
17. Mr. J.A. Goodbrand, Communicator, Ndola Airport.
18. Mr. J.K. Pennock, Assistant Inspector, N. Rhodesia Police.
19. Mr. T.K. Parkes, Senior ATCO, Ndola Airport.
20. Mr. A.F. Grey, Meteorological Officer, Ndola Airport.
21. Mr. A.E. Begg, Assistant Inspector, N. Rhodesia Police.
22. Mrs. J. Hunkin, Housewife.
23. Mr. R.J. Read, Senior Inspector, N. Rhodesia Police.
24. Mr. Nelson Gondwe, African Charcoal Burner.
25. Mr. Ledison Daya, African Charcoal Burner.
26. Mr. Damson Moyo, African Charcoal Burner.
27. Mrs. Y. Joubert, Housewife.
28. Mrs. W. van Heerden, Housewife.
29. Mr. Amoni Njembwe, Plantation Fire Watcher.
30. Mr. Kapiko, Plantation Fire Watcher.
31. Mr. Bernard Bowa, Plantation Fire Watcher.
32. Mr. Lemon Mwansa, Plantation Fire Watcher.
33. Mr. F.J. Vaughan, Assistant Inspector, N. Rhodesia Police.
34. Mr. J.H. Williams, Airport Manager, Ndola.
35. Mr. V. Freeth, Senior Radio Technician, Ndola Airport.
36. Mr. Davidson Simango, African Charcoal Burner.
37. Mr. D.L. Bermant, Travel Agent.
38. Private M.G. Vosloo, Rhodesian Army.
39. Rt. Hon. Lord Alport.
40. Mr. M.T. Cary, Assistant Superintendent, N. Rhodesia Police.
41. Mr. Posyana Banda, African Charcoal Burner.
42. Mr. L.H. Cock, Valuation Officer, Northern Rhodesia Police Reserve.
43. Mr. R.J. Gange, Detective Senior Inspector, Northern Rhodesia Police.
44. Mr. F.J. Andrews, Headmaster, N. Rhodesia Police Reserve.
45. Mr. D.J.F. Buchanan, Detective Inspector, N. Rhodesia Police.
46. Mr. W.J. Chappell, Caretaker.
47. Mr. J.A. Eade, Chief Inspector, N. Rhodesia Police.
48. Mr. D.L. Lowe, N. Rhodesia Police Reserve.
49. Mr. M.A. Brache, Research Worker.
50. Mr. D.J. Appleton, Senior Inspector, N. Rhodesia Police.
51. Mr. T.C. Olsson, Aircraft Maintenance Engineer, Leopoldville.
52. Mr. S.E. Torp, Aircraft Maintenance Engineer, Leopoldville.
53. Mr. K. Peterzen, Radio Mechanic, Leopoldville.
54. Mr. A. Braham, FIC Controller, Leopoldville.
55. Mr. A. Yeadon, ICAO ATCO Elisabethville.
56. Mr. P. Brichant, ATCO Leopoldville.
57. Mr. A. Deltour, Aviation Fuel Superintendent, Leopoldville.
58. Mr. A. Kroon, U.N. Security Officer, Leopoldville.
59. Mr. F. Bonkuli, Aviation Fuel Supervisor, Leopoldville.
60. Mr. G. Brinkman, U.N.Chief Comm. Officer, Leopoldville.

61. Air Commodore E.L. Morrison, U.N. Air Commander, Leopoldville.
62. Lt/General S. Mac Eoin, Force Commander, U.N. Leopoldville.
63. Dr. S. Linner, Officer-in-Charge, U.N. Congo, Leopoldville.
64. Rt. Hon. Lord Lansdowne.
65. Mr. P. Pratt, Assistant Inspector, N. Rhodesia Police.
66. Mr. J. Spoffirth, Assistant Inspector, N. Rhodesia Police.
67. Lt. Col. D.G. Gaylor, USAF Air Attache.
68. Mr. F.J. Crouch, Communicator FIC, Salisbury.
69. Mr. A.T. Knight, SATCO Salisbury Airport.
70. Mr. C.P. Chilvers, SATCC, Salisbury Airport.
71. Mr. G.R. Owen, ATCC Salisbury Airport.
72. Mr. L.J. Murphy, Airport Manager, Salisbury.
73. Mr. L.E. Thorogood, ATCO Salisbury Airport.
74. Mr. R. Budrewicz, ATCC Ndola Airport.
75. Mrs. A.R. Wright, Farmer's Wife.
76. Flight Lieutenant W.J. Jolley, RRAF.
77. Mrs. C. Anderson, Housewife.
78. Mr. E. Mayne, Assistant Inspector, N. Rhodesia Police.
79. Mr. R. Parmentier, Engineer, Kolwezi.
80. Mr. D. Kambendja, Airport Manager, Kolwezi.
81. Mr. M.V. Forrest, Contractor, Kolwezi.
82. Captain A. Matemi, Katangese Army, Kolwezi.
83. Major J. Lelin, Katanga Air Force, Kolwezi.
84. Mr. Daveson Kasakanisa, African Domestic Servant.
85. Mr. T.J. Kankasa, Secretary Twapia Town Management Board.
86. Miss E. Monks, Matron, Ndola Hospital.
87. Nurse M. Gresty, Ndola Hospital.
88. Nurse R.F. Kendall, Ndola Hospital.
89. Nurse M.E. Molyneaux, Ndola Hospital.
90. Nurse J. Constantine, Ndola Hospital.
91. Nurse P.H. Habgood, Ndola Hospital.
92. Nurse I.M.T. McDonald, Ndola Hospital.
93. Nurse P.I. Gigsworth, Ndola Hospital.
94. Nurse E.P. Johnson, Ndola Hospital.
95. Nurse M.F. Burke, Ndola Hospital.
96. Nurse D. Paice, Ndola Hospital.
97. Nurse M.C. Bradden, Ndola Hospital.
98. Nurse J.L.M. Flint, Ndola Hospital.
99. Nurse A. McGrath, Ndola Hospital.
100. Nurse B.E. Millar, Ndola Hospital.
101. Nurse M.A. Cornish, Ndola Hospital.
102. Nurse P.E. Phillips, Ndola Hospital.
103. Nurse M.C. Hope, Ndola Hospital.
104. Nurse B.M. Sims, Ndola Hospital.
105. Nurse J.M. Jones, Ndola Hospital.
106. Nurse S.J. Dare, Ndola Hospital.
107. Nurse M.D. Brookbanks, Ndola Hospital.
108. Nurse M. Cleasing, Ndola Hospital.
109. Nurse E. Northcote, Ndola Hospital.
110. Nurse E.M. Gardner, Ndola Hospital.
111. Mr. D.M. McNab, Government Surgeon, Ndola Hospital.
112. Mr. H.C. Bridges, Communicator, Salisbury Airport.
113. Mr. G.D.J. Fourie, Airport Manager, Lusaka.
114. Mr. J. Turnbull, Communicator, Salisbury Airport.
115. Air Commodore H. Hawkins, Deputy Chief of Air Staff, RRAF.
116. Mr. G.E. Towlson, Assistant Inspector, N. Rhodesia Police.
117. Mr. A.J. Wenham, Assistant Inspector, N. Rhodesia Police.
118. Mr. S.C. Weitsz, Assistant Inspector, N. Rhodesia Police.
119. Mr. A.H. Cairns, Borehole Driller.
120. Captain R. Deppe, Pilot of OO-RIC
121. Nurse D.M. Kavanagh, Ndola Hospital.
122. Major K.O. Ljungkvist, Air Operations, U.N. Leopoldville.
123. Commander D.L. Ely, U.S. Naval Attache, South Africa.
124. Mr. T.J. Tryggvason, Aircraft Mechanic.
125. Mr. R.E. Mellstrom, Aircraft Mechanic.
126. Nurse E.M. Gardner, Ndola Hospital.
127. Nurse E. Northcote, Ndola Hospital.
128. Mr. K.E.E. Blennow.
129. Mr. N.A. Ohlsson.
130. Mr. O.E. Tjernell.

APP.
3.1

APPENDIX 3.1

CREW LIST

| | |
|---|---|
| Pilot in Command | Captain Per-Erik Bo HALLONQUIST. Killed |
| Co-Pilot | Captain Lars Olof LITTON. Killed. |
| Reserve Pilot | Captain Nils-Erik AHREUS. Killed. |
| Flight Engineer | Nils-Goran WILHELMSON. Killed. |

APP.
3.2

## PASSENGER LIST

Mr. Dag HAMMARSKJOLD. Killed.
Mr. Heinrich WEISCHHOFF. Killed.
Mr. William RANALLO. Killed.
Miss Alice LALANDE. Killed.
Mr. Francis EIVERS. Killed.
Mr. Carl Eric Gabriel ROSEN. Killed.
Mr. Harald NOORK. Killed.
Mr. Serge BARRAU. Killed.
Mr. Vladimir FABRY. Killed.
Sgt. Stig Olof HJELTE. Killed.
Pvt. Per Edvald PERSSON. Killed.
Sgt. Harold JULIAN. Seriously injured, died later.

APP.
3.3

# MEDICAL REPORT

The Report of the Medical Investigation carried out by the three pathologists concerned is a large, technical and comprehensive document covering in detail all aspects relating medically to this accident, and running into 57 foolscap pages and containing 14 full plate X-ray photographs.

The Summary and Conclusions have been extracted and are given below (Appendices and references thereto having been omitted) -

## Summary and Conclusions with Discussion

### Introduction

Post mortem examinations were carried out on sixteen complete or partial bodies recovered from the accident site, including that of the sole initial survivor, who died later in hospital. This figure coincided with the number reported on the passenger and crew list.

Detailed records of all examinations are to be found in the various appendices. These examinations were directed towards the elucidation of such considerations as are indicated in the following numbered headings.

### I. Identification

Confident identification of all bodies was made.

In thirteen instances there was good definite evidence of identity; in three cases conclusions were by exclusion based upon acceptance of the list of occupants of the aircraft which denoted only one female and one coloured male.

### II. Medical Evidence in Relation to Accident Cause

a) State of health of flight crew

No evidence of impaired bodily function which could have a bearing upon the cause of the accident was discovered on the initial post mortem examinations, or the histological examinations of any of the crew. Toxicological examinations of organs taken from the three pilots were negative and an examination of the pilots' medical records revealed no cause for incapacity.

b) The significance of the blood carboxyhaemoglobin Estimations

i) As an accident causative factor: It is not considered that the positive results recorded, the highest of which was 7%, can be implicated in the cause of the accident. Impaired function in a normal adult does not occur at levels less than 20 - 25% and only the mildest symptoms, such as headache, under 30%. Further, the apparent significance of three of the five positive results being in crew members, is considerably reduced by the fact that the other two probable occupants of the flight deck were not affected.

ii) As an indication of in-flight fire: Similar reasoning precludes the possibility that an in-flight fire caused this carbon monoxide absorption, since the five people with positive results were almost certainly distributed among unaffected individuals throughout the length of the plane.

iii) As an indication of individual survival in the post crash fire: Victims of conflagrations frequently show carboxyhaemoglobin levels of over 15%. The levels in the present instance would be consistent with very short periods of survival in the fire but, could equally well be explained by the smoking habit which is well recognised to produce low levels of carboxyhaemoglobin.

c) The Possibility of Sabotage

No evidence of in-flight explosion or firearm injuries was discovered despite exhaustive examination with this possibility in mind. X-rays revealed a number of bullets, cartridge cases and metallic fragments in six of the bodies, the significance of which is assessed as follows:-

i) None of the foreign bodies was found in an individual in any way responsible for flying the aircraft.

ii) Bullets were found in Bodies Nos. 1 and 2. Their orientation within the tissues did not support a contention that they had been fired from any consistent direction. They were relatively superficially situated, and were not associated with any discernible evidence of bleeding. They did not appear to have any rifling marks but were handed to the police for expert examination.

iii) Cartridge cases, whole or in part and percussion caps were found in bodies Nos. 1, 2 and 6. The distorted cartridge cases with separate percussion caps precluded their having been exploded in a breech mechanism. All these fragments were superficially situated either in the skin or in tissues exposed by incineration.

iv) Other metallic fragments consisted of irregular fused or partially fused, aircraft alloy, or of identifiable manufactured objects such as a small toothed wheel and fragments of a zip fastener. These were all lying superficially in or on tissues exposed by incineration.

It is impossible to escape the conclusion that these foreign bodies resulted from the exploding of ammunition in the post crash fire and from the fortuitous contamination of the surface of incinerated bodies by debris from the burning wreckage.

III. Correlation of Medical Evidence with that of Apparent Accident Sequence.

1. The distribution of bodies throughout the wreckage, with an assessment of the type and severity of injuries inflicted on them, is in general agreement with the reconstructed accident sequence and the assumed probable seating positions occupied by the victims during flight.

2. Evidence of fastened seat belts, in respect of Bodies Nos. 1, 3, 5, 6, 7 and 11 lends support to the contention that preparations for landing were being made.

3. The probable occupants of the flight deck (Nos. 3, 4, 11, 15 and 10) were five of the first seven bodies along the flight trail and showed the severest multiple injuries. The presence of Nos. 6 and 13 among those of the crew in the first group of seven bodies is regarded as fortuitous and probably consistent with these individuals being in a forward part of the main compartment.

4. No real inconsitencies arise in the positions of the next eight bodies; from that of No. 5 it may be assumed that the purser, having warned the other occupants to fasten their safety belts, did so himself towards the rear of the fuselage. Nos. 7, 8 and 9 were in positions entirely consistent with these individuals having occupied the rear private compartments. The initial survivor had obviously crawled from a burning area and therefore the plotted position of No. 16 is immaterial to this discussion.

IV. Survivability and Safety Measures

There is no evidence available to suggest that there was a failure to use the seat belts provided, or that the presence of universal rearward facing seats would have substantially altered the survivability in this particular crash.

i) Bodies 1, 3, 5, 6, 7 and 11 showed evidence of fastened seat belts.

ii) Nine bodies, Nos. 3, 4, 5, 6, 7, 8, 10, 11 and 15 suffered such injuries as to preclude survival even had no fire ensued. Of the remaining seven bodies those of 9, 12 and 14 were too badly incinerated to assess this.

iii) In the remaining four bodies Nos. 1, 2, 13 and 16, no lethal injuries apart from burns were found but, except in that of 16 who in fact died of burns, the evidence in the other three is equivocal. None of these showed any carboxyhaemoglobin and, if they were alive at all during the fire, must be considered to have died suddenly and rapidly from shock.

iv) The histological evidence of bone marrow emboli in one casualty classified in paragraph ii) above as having lethal injuries is merely an indication of multiple impact prior to death.

V. Reiteration

No medical cause for this accident has been found and there exists no medical evidence of sabotage.