C.A.P. 182

MINISTRY OF AVIATION

CIVIL AIRCRAFT ACCIDENT

Report of the Royal Norwegian Commission for the Investigation of Civil Aircraft Accidents on the Accident to Viking G-AHPM near Stavanger, Norway on 9th August, 1961

LONDON: HER MAJESTY'S STATIONERY OFFICE

1962

Price 3s. 6d. net

THE ROYAL NORWEGIAN COMMISSION
for the
INVESTIGATION OF CIVIL AIRCRAFT ACCIDENTS

Report on the Investigation

of

The Accident to Cunard Eagle Airways Ltd.

Viking Aircraft G-AHPM

near

Stavanger Airport, Sola, Norway

on 9th August, 1961.

All times are G.M.T.

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ANNEXES.

I.

INTRODUCTION

1. On Wednesday the 9th of August 1961 at 1329 hours Cunard Eagle Airways Ltd. Vickers Viking G-AHPM took off from London Airport on a charter flight bound for Stavanger Airport, Sola. That same day, between the hours of 1624 and 1630, the aircraft crashed on Holteheia about 18 nautical miles North East of the Airport into a steep mountainside running lengthwise in a North South direction. All on board were killed. On the basis of investigations and measurements made at the site, the plane's heading at the moment of impact is presumed to have been towards the South East.

   On 10th August at about 1200 hours the Commission arrived at Sola, and after a short briefing proceeded by Royal Norwegian Air Force helicopter to the site of the crash. The following day the Commission was joined by the United Kingdom Accredited Representative, Mr. N. S. Head and his adviser, Mr. R. G. Feltham, both members of the British Accidents Investigation Branch. The same day two pathologists from the R.A.F. Institute of Pathology and Tropical Medicine started work with the Identification Commission appointed by the Chief Constable of Rogaland. No unauthorised interference with the remains of the aircraft is known to have taken place.

2. The Commission also has had the services of Mr. R. C. Warren, Principal Inspector of the British Accidents Investigation Branch.

A.

ACCIDENT DETAILS

3. Location.

   59° 05' 30" N., 6° 01' 00" E., i.e. 045° T., 18 n.m. from Stavanger Airport, Sola.

4. Date and Time.

   9th August 1961 between the hours of 1624 and 1630.

5. Operator.

   Cunard Eagle Airways Ltd. of London Airport, Hounslow, Middlesex, U.K.

   Registered address of Owner: Marble Arch House, 40 Edgware Road, London W.2.

6. Aircraft Type and Registration - Extent of Damage.
Vickers-Armstrongs Ltd., Viking 3B, Serial No. 152.
Certificate of Registration No. R.1847/5.
Totally destroyed.

7. Number of Crew.
3. Captain [redacted], First Officer [redacted], Air Hostess [redacted]
All killed.

8. Number of Passengers.
34 pupils and 2 masters of the Lanfranc Secondary Modern School, Croydon.
All killed.

9. Phase of Operation.
Intermediate approach.

10. Type of Operation.
International public transport, non schedule.

11. Type of Accident.
Collision with rising terrain.

12. Rescue Operation.
The Stavanger Air Traffic Control Search- and Rescue Centre was informed by Sola Control Tower at 1630 hours that the flight was 3 - 4 minutes overdue on an ILS approach, and search and rescue was immediately initiated.

The local Police Authority carried out a telephone search for witnesses who might have seen or heard the aircraft. At the same time a search within the approach sector and the areas adjacent to that sector, was carried out by 3 aircraft and 7 surface vessels. The search continued, without results, during the whole afternoon and evening until 2345 hours, when it was discontinued due to darkness and weather conditions.

During the early evening the Norwegian Broadcasting Company was requested to notify the public that a British Viking aircraft, bound for Sola, was overdue. Prior to this The Norwegian Aircraft Accident Investigation Commission had been notified that an accident was to be feared. Consequently the Members and the Secretary of the Commission immediately prepared to proceed to the scene of accident at the shortest possible notice.

The search and rescue operation was resumed at 0333 hours on the following

day, and the missing aircraft was found by a Safir light training aircraft of the RNoAF at approximately 0515 hours, 1.1/2 miles East of Holta farm, N.W. of Bjørgheimsbygda in Tau, where it had crashed at the top of Holteheia.

Immediately upon discovery of the crashed aircraft orders were given for guards to be posted at the site in order that nothing be touched, removed or photographed until proper release had been authorised by the Commission.

13. Pathology Report.

The forces involved, the extent of the injuries and destruction of the aircraft and its contents make it clear that the accident was not survivable. No personnel safety equipment could have helped and, in particular, rearward facing seats would not have increased the chances of survival.

All bodies were satisfactorily identified by means of personal documents and property, including clothing, and by dental examination.

The circumstances of the accident were not such that sudden and unexpected incapacity of the crew would be a likely factor, and nothing in the past medical histories was found to make such incapacity probable. Tissue alcohol screening and tissue carboxyhaemoglobin estimations exclude the possibility of the crew having been affected either by alcohol or carbon monoxide.

The severity of the injuries were such that all occupants must be assumed to have been killed instantaneously.

B.

HISTORY OF THE FLIGHT

14. On the day prior to the accident Captain [redacted] was off duty. He spent the day at home and with his wife carried out some work in his garden. He retired to bed at about 2200 hours.

On this day, First Officer [redacted] was on flying duties. He left London Airport at about 1950 hours after a duty day of 10 hours 25 minutes and arrived at his home about 1 hour later. After a meal, he prepared the navigational flight plan for the following day's flight and went to bed at about 2230 hours. When he reported for duty the next day at London Airport, at 0705 hours, his rest period had been slightly in excess of the minimum required under the British Air Navigation Order, 1960.

15. Captain [redacted] also reported for duty at 0705 hours and together they went to the Operator's Movement Control Office where the First Officer collected a Navigation Bag containing the maps and Navigational data relevant to the route to Stavanger. After checking the contents of this bag he attended a briefing at the Meteorological Office and obtained a Flight Forecast Folder. Captain [redacted] did not attend this briefing but remained in the Movement Control Office where he checked the aircraft documents including the load and trim sheets.

16. At about 0745 hours the First Officer filed an ATC Flight Plan giving the aircraft's route via Watford and Clacton and then off airways to Stavanger. Estimated flight time was 2 hours 30 minutes; sufficient fuel was carried for an endurance of about 5 hours 15 minutes.

17. The aircraft taxied out for take-off at 0835 hours but about 10 minutes later it returned to the Central Area and the passengers disembarked. The Captain reported that a pre-take-off check of the port engine had revealed a drop of over 100 r.p.m. on the right hand magneto. This fault was eventually traced to a defective plug lead and remedied. The necessary work was carried out by a properly licensed aircraft engineer who, after a test run, certified in the aircraft's Technical Log that the engine was serviceable.

18. While work on the engine was in progress the crew and passengers had a meal at one of the airport restaurants. The First Officer paid one further visit to the Meteorological Office at 0945 hours and obtained an additional briefing regarding the actual weather conditions at Stavanger. These were taken from either the 0850 hours or the 0920 hours Aero Report and gave surface winds of 150° 30 kts. gusting to 49 kts., and 150° 32 kts. gusting to 46 kts., respectively. He did not obtain another Flight Forecast Folder prior to departure although one would have been prepared for him had he requested it.

19. As soon as the aircraft became serviceable, the passengers were embarked and at 1329 hours G-AHPM took off. Under control of the London Radar it was routed out of London via Burnham and Watford, initially maintaining 4000 ft. but climbing to cruising flight level 90 shortly before reaching Clacton.

20. At 1356 hours the aircraft reported that it had passed Clacton at 1354 hours and was estimating crossing ADR 522 at 1414 hours. This estimate must have

been a mistake as a reconstruction of the flight shows that at this time the aircraft was crossing from the Chatham to the Humber ASR. At 1422 hours the aircraft reported that it was clear of ADR 522 and this confirms that it was proceeding on a direct track from Clacton to the Stavanger Consol Station. This was the aircraft's last direct radio contact with U.K. Air Traffic Control. A message at 1455 hours that it estimated 57° North at 1536 hours was relayed to Preston by another aircraft. At 1504 hours Copenhagen Control heard the aircraft call on frequency 4657.5 Kc/s and although they answered "Go ahead" no reply was received.

21. The first contact with Stavanger Control was made at 1543 hours when the aircraft reported that it estimated ZZ at 1608 hours and Sola at 1615 hours. This message was acknowledged by Stavanger Control who cleared it to cross LEC or ZZ at 4000 ft. on the Stavanger altimeter setting of 1000 millibars. ZZ is the callsign of a VOR Station situated 15 n.m. South of Sola. The Consol Station LEC is in approximately the same position.

22. At 1554 hours the aircraft requested the latest Stavanger weather and the following actual for Sola was passed: Wind 210° 25 kts., visibility 10 Km., cloud 4/8th at 500 ft., 5/8th at 2500 ft. This was acknowledged, and at 1603 hours the aircraft called Sola Tower and reported that it now estimated the field at 1618 hours. During this transmission a bearing was taken by the ATC Officer with the automatic VHF direction finder. The QDM, i.e. magnetic bearing from the aircraft to Sola, was 010°. The Tower then informed the aircraft that runway in use at Sola was 18, the surface wind 200° at 25 kts., gusty, and the QNH 1000 millibars.

23. At 1611 hours, as the aircraft had not reported over LEC or ZZ, Sola Tower asked for a revised estimate and was told by the aircraft "We are just coming up to Lima Echo Charlie at this time". The Tower then cleared it for further descent to 2000 ft. at the ZO Locator Beacon for an ILS approach. The aircraft acknowledged "Zulu Oscar beacon for ILS approach, Papa Mike, Roger". A QDM obtained by the ATC Officer at this time was 360°, plus or minus 2°.

24. At 1618 hours the Tower called the aircraft again requesting an estimate for the ZO beacon and the aircraft reported "We estimate the Lima India beacon in approximately 2 minutes". To this the Tower replied "Understand you estimate Zulu Oscar in about 2 minutes". Emphasis was put on the "Zulu Oscar" in the form of a query. The aircraft simply answered "Roger",

instead of indicating clearly which of the two beacons it was actually estimating. From the evidence of the ATC Officer it appears likely that at about this time the aircraft passed over or in the vicinity of the Airport.

25. At 162009 hours, in response to an enquiry from the Tower, "Are you at 2000 ft. ?", the aircraft reported "Eagle Papa Mike passed the Zulu Oscar beacon, will call you on approach". In acknowledging this message the Tower requested "Check Outer Marker on final for landing runway 18" and this was acknowledged by the aircraft. During this transmission the ATC Officer noticed a QDM reading of 180° on the automatic VHF direction finder. The aircraft then requested a QFE and the setting of 999 millibars was passed. At 162244 hours a revised QFE of 1000 millibars was passed, and this was acknowledged "1000 millibars Papa Mike, thank you". This was the last radio contact with the aircraft. At 162938 hours, because it had not checked inbound at the Outer Marker, the aircraft was repeatedly called by the Tower, but did not reply.

26. The following day a RNoAF training aircraft sighted the wreckage about 18 n.m. NE of Stavanger Airport, Sola, at an altitude of about 1600 ft. The terrain in this area is rugged and difficult of access.

II.

FACTS ASCERTAINED

C.

AIRCRAFT INFORMATION

27. Airframe History.

Viking G-AHPM was built by Vickers-Armstrongs Ltd. at Weybridge in 1946, was registered and acquired that same year by British European Airways at 5 hours 15 minutes total flying time. The aircraft was put into service in the middle of May 1947. On 15th February 1955 it was sold to Eagle Aircraft Services Ltd., when it had accumulated 11132 hours 45 minutes flying. The name of the Owner was later changed to Eagle Aviation Ltd. and subsequently to Cunard Eagle Airways Ltd. The aircraft had flown a recorded total of 20.884 hours 46 minutes up to the commencement of its last flight. The last major servicing check carried out was a Check III

at 20.791 hours 47 minutes flying time; this check being completed on 29th July 1961, on which day a Certificate of Maintenance was signed. On the day of the accident a preflight inspection 'B' was carried out and certified on a Pre-flight Inspection Record.

28. Certificate of Airworthiness.

No. A 1847, last renewed on 3rd February 1961 and valid until 2nd February 1962.

Classification of aircraft: Transport Category (Passenger).

29. Certificate of Maintenance. Date of Issue and Period of Validity.

29th July 1961, valid until 19th August 1961 or for 100 flying hours.

30. History of Power Units.

The aircraft was fitted with 2 Bristol Hercules type 674 engines.

Engine Serial No. 133127 was fitted to the port position and had run a total of 1292 hours 46 minutes between the last complete overhaul and commencement of last flight. This overhaul was completed by Bristol Aero Engines Ltd. on 3rd October 1956; the engine was fitted to G-AHPM at the last Check III.

Immediately prior to the departure of the aircraft on its last flight an ignition r.p.m. drop was experienced on the right hand magneto of this engine, and the fault was rectified by changing the front set of sparking plugs and rectifying No. 2 righthand ignition lead which had failed an insulation check. This was recorded and certified on an 'Additional Item' sheet which, with a Certificate of Compliance, was attached to the Technical Records.

Engine Serial No. 133529 was fitted to the starboard position and up to departure on the last flight had run a total of 1155 hours 39 minutes since last overhaul. This overhaul was carried out by Bristol Siddeley Engines Ltd. and the engine was then fitted to G-AHPM on 9th September 1960 with nil hours run.

31. History of Propellers.

Two de Havilland 4 bladed, hydromatic, fully feathering, constant speed type PD/97/446/2 propellers were fitted to the aircraft.

The port propeller, Serial No. 420474, was fitted to G-AHPM at the last aircraft Check III and had run a total of 327 hours 27 minutes since last

complete overhaul. Its log book shows that this last overhaul was carried out by de Havilland Propellers Ltd., Walkden, Lancs., on 13th April 1961.

The starboard propeller, Serial No. 420567, was fitted to G-AHPM after its last overhaul which was completed by de Havilland Propellers Ltd., Walkden, Lancs., on 1st November 1960. It had run a total of 622 hours 28 minutes between that overhaul and the last flight of the aircraft.

32. Loading.

The load sheet shows that the weight of the aircraft at take-off was 15.084 Kgs. This is 338 Kgs. below the maximum permitted. It is estimated that at 1622 hours on 9th August, the time of last radio contact with the aircraft, the all up weight would have been approximately 614 Kgs. below the maximum permitted for landing. The aircraft balance chart for the last flight shows a load index of minus 1.2, corresponding to a centre of gravity position of 71.2 inches aft of datum. The limits are 61.4 to 75.7 inches aft of the datum, and the centre of gravity of the aircraft was thus clearly within the prescribed limits.

33. Accessory History.

No failure of accessory equipment was recorded which could have had a bearing on the accident.

34. Defects.

The Technical Logs show the usual number of small defects, but nothing which is likely to have had a bearing on the accident.

D.

CREW INFORMATION

35. The Captain.

Captain [redacted], aged 40, held a valid Airline Transport Pilot's Licence, endorsed in Group I for Viking aircraft. After serving with the Royal Air Force during the last war, he joined Lancashire Aircraft Corporation Ltd. as a First Officer. He left this company in April 1949 and joined Air Enterprises Ltd. as a Captain, and apart from a short time as a Staff Pilot with Air Service Training, remained with the former until March 1953. He joined Cunard Eagle Airways Ltd. on 26th April 1954 and was promoted to Captain on 1st May 1957. He was mainly engaged in flying

Viking aircraft. His records for the last 4 years show that he had achieved a consistently high standard on all competency checks and was regarded by the Operator as a very capable Viking Captain with considerable experience of flying on European routes. His last Competency Check was carried out on 15th March 1961. During this check Captain [redacted] executed an ILS approach and overshoot with the starboard engine inoperative. His last Instrument Rating Examination was carried out on 15th June 1961.

There is nothing in the medical history of Captain [redacted] which, in the opinion of the Commission, has any bearing on the accident. His last Medical Examination was on 9th June 1961 and was satisfactory.

At the time of the accident his total flying hours were approximately 8000, of which 3730 were in command of Vikings. During the 90 days preceding the accident he had completed 283 flying hours, of which 169 were on Vikings. During the 30 days preceding the accident he had completed 114 flying hours.

36. The First Officer.

First Officer [redacted], aged 29, learned to fly with the Royal Air Force. After leaving the Service in 1953, he worked for 4 years in commercial undertakings not connected with aviation although he joined the Royal Auxiliary Air Force. In April 1957 he entered commercial aviation as a Staff Pilot at a Flying School. This appointment terminated in August 1957. In December 1957 he joined British European Airways as a trainee pilot but left in February 1958 before obtaining the necessary licences.

He obtained a Commercial Pilot's Licence on 13th October 1960 while working for Short Brothers and Harland Ltd. as a Staff Pilot and, on 9th February 1961, passed the additional examination for a Senior Commercial Licence.

On 15th March 1961 he entered the employment of Cunard Eagle Airways Ltd. as a Second Officer. His total flying hours at that time were approximately 1422.

At the time of the accident he held a valid Senior Commercial Pilot's Licence endorsed in Group II for Vikings. His total flying hours were 1744, of which 262 were on Vikings as First Officer. Inspection of the Operator's training records show that on 30th May 1961 First Officer [redacted] satisfactorily completed a comprehensive training course and had satisfied the Operator of his competence to act as a First Officer on

Viking aircraft.

His last Instrument Rating Check was on 18th January and his last Competency Check on 22nd May 1961.

A check of his routine medical examinations from 1957 to 1961 reveals no past medical history of note. His last Medical Examination was on 16th June 1961 when he was assessed 'fit'.

First Officer [redacted] total flying time for the 90 days preceding the accident was 255 hours, all on Vikings. During the 30 days preceding the accident he had completed 94 flying hours. On the day prior to the accident he had completed 7 hours 00 minutes flying.

37. The Air Hostess.

[redacted], aged 23, joined Cunard Eagle Airways Ltd. on 17th April 1961. After approximately one month ground training and some 8 international flights under supervision, she commenced her duties as an air hostess.

At the time of the accident she had completed about 163 flying hours.

[redacted] was considered by Cunard Eagle Airways Ltd. to be an above average air hostess.

38. Flight Crew Qualifications.

The regulations regarding the experience required in the United Kingdom by an aircraft Commander of the routes he is to fly are contained in the Tenth Schedule of the British Air Navigation Order, 1960. This states that the pilot designated as Commander of the aircraft for a flight shall have demonstrated to the operator that he has adequate knowledge of the route to be taken, the aerodromes of take-off and landing and any alternate aerodromes. Particular reference is made to a number of factors including knowledge of the terrain and navigational facilities. This is also in accordance with the requirements of ICAO, Annex 6, Chapter 9, "Aeroplane Flight Crew Qualifications".

Inspection of the Training Manual of Cunard Eagle Airways Ltd. shows that they have divided the world into regions approximately corresponding to the ICAO Air Navigation Regions. Airfields in these regions are divided into three categories:

Catagory A airfields are those with standard approach aids which present no hazard due to terrain difficulties.

Category B and C airfields are those with non-standard approach aids or characteristics that are unusual or present special difficulties.

Cunard Eagle Airways Ltd. have placed the Stavanger Airport, Sola, in Category A in the European Region. Although Captain [redacted] had not been to Sola before, when determining whether he could be considered competent to carry out this flight in accordance with the 1960 Air Navigation Order, they took into account his experience with them as a Viking Captain on European routes. This was very considerable and their records show that he had completed 21 instrument approaches in Europe during the preceding 12 months. They considered that he had demonstrated his competency and familiarity with approach aids similar to those at Stavanger, and that the ILS procedure there presents no difficulty to normal approach or departure procedures.

On the 30th March, 1961, Cunard Eagle Airways Ltd. issued a Route and Airfield Clearance Certificate. This certified that Captain [redacted] had satisfied them that he had adequate knowledge of the European Region and authorized him to operate as a Pilot-in-Command on routes within the region to all Category A airfields.

No specific briefing for the flight was carried out but Captain [redacted] had access to all the relevant information contained in the Flight Guide and topographical maps carried on the aircraft. In addition, information was available to him at the Ministry of Aviation Briefing Room at London Airport. This information included the hours of operation and availability of the Stavanger GCA. Accordingly it appears that the Captain as a responsible person had ample opportunity to study all the necessary data.

Before Cunard Eagle Airways Ltd. clear a pilot to operate in command to airfields placed in Category B it is necessary for him to have had actual flight experience, received appropriately simulated flight instruction, or received a special briefing by means of films or slides. For clearance to Category C airfields actual flight experience is essential.

E.

WEATHER INFORMATION

39. Details of the Landing Forecast given to the Aircraft.

The following aerodrome forecast for Stavanger Airport, Sola, was prepared by the London Airport, Heathrow, Meteorological Office and contained in the

Flight Forecast Folder given to the First Officer:

Period of validity 0600 hours to 1500 hours on 9th August 1961.

Surface wind	120° 20 kts. Gusty.
Visibility	3 n.m.
Cloud	3/8th Stratus at 1000 ft.
	8/8th " " 1500 "

Becoming between 0900 hours and 1200 hours:

Wind	210° 20 kts. Gusty
Visibility	11 n.m.
Cloud	6/8th Cumulus at 1800 ft.

Temporarily between 0900 hours and 1500 hours.

Visibility	4 n.m. in heavy showers,
	5/8th Cumulonimbus at 1200 ft.

40. An Appreciation of the actual Weather at Stavanger.

On 9th August 1961 a low pressure system reached South West Norway. A trough passed the Sola area some time between 1200 and 1500 hours. After the passage of the trough the surface winds veered from SSE to SW, occasioning rain and rain showers but without significant change in the cloud-base. Both the surface wind and the upper winds remained fairly strong. According to the isobaric pattern of the weather maps, the wind at 1500 - 2000 ft. was from 230° at 40 - 50 kts. The surface observations from Sola showed very gusty wind, with wind velocities varying between 15 and 40 kts. Under the existing conditions of air stability, the wind speed at 1500 - 2000 ft. (the geostrophic wind) is usually in fairly good conformity with the maximum gusts.

It is most likely that the wind at 1500 ft. came from a direction of 230°, with an average velocity of 50 kts. For some periods, however, the wind velocity may have reached 60 kts.

The gusts and the vertical currents which the aircraft encountered over Sola should not have been of such intensity as to cause hazards to flight.

With respect to cloud formations in the area between 1500 and 1700 hours, these were undoubtedly somewhat variable. The broken low layer of stratus extended mainly to the North and East of the airfield and covered the high ground in these areas. Above this lower layer was another layer, base 1500 - 2000 ft.

The freezing level at Sola was about 7500 ft., thus eliminating common aircraft icing below that altitude. Carburettor icing with intensity of any significance to flying conditions is hardly likely to have occurred.

The atmospheric pressure, both QNH and QFE, given in the actual reports from Sola, were correct. The pressure was rising. This, occurring after the sub-scale of the aircraft altimeter was set, would result in too low an altimeter indication, and the aircraft would be flying at a higher altitude than indicated.

None of the meteorological stations in the Sola area or the Western part of Norway have reported thunderstorms on the day in question. Nor did the Lightning Counter at Sola register any atmospheric electrical discharges. Aircraft reports from the same day also indicate that no special atmospheric disturbances occurred in the area. However, the relatively large amounts of precipitation - measured by the meteorological stations in the area - indicate that static may have occurred for short periods. In particular, one would believe that any static that did, in fact, occur would have been connected with the trough which passed Sola before 1400 hours.

The actual weather observations from Sola for the period between 0830 and 1745 hours are quite representative for the weather in the area. The half-hourly routine weather observations show a fairly strong and gusty surface wind from a Southerly to South-Easterly direction,with an average wind speed of 20 to 25 kts. (calculated over a period of 10 minutes) with gusts up to 45 kts. The wind veered to SW around 1400 hours, after the trough had passed, with only small changes in velocities.

The visibility at Sola was about 10 km before the passage of the trough, during which the visibility dropped to 2 km. and increased again to 10 km. after passage. Afterwards the visibility remained at that value, apart from a temporary deterioration for a half-hour period just after 1700 hours.

The observations of clouds show that there was a well-broken layer of stratus at about 500 ft., apart from the above-mentioned short period after 1700 hours when the stratus clouds covered nearly all the sky. Above these lower clouds a layer of strato-cumulus was reported, with base varying from 1500 to 2500 ft.

41. Wind Velocity at 1500 ft. at Stavanger.

At the time G-AHPM was in the vicinity of Sola, SAS Flight No. 385 was holding at Rennesøy LII NDB at 6000 ft. awaiting turn to land. From the evidence of the pilot of this aircraft a strong wind affected the Stavanger

area and whilst on final approach to land on runway 18 at 1709 hours he experienced 17° port drift at a TAS of 150 kts.

At 1850 hours on the same day Cunard Eagle Airways' Viking G-AMNX landed at Sola after making an approach by GCA. This aircraft experienced 25° port drift on final approach at a TAS of 115 kts.

The wind direction at the time of the accident was established by taking bearings of paper and other light articles blown from the aircraft at the position of impact and caught in pools of water or rock crevices. The mean direction was approximately 050° M. From this and the drift angles experienced by the two aircraft mentioned, the wind at 1600 ft. at about the time of the accident probably was 230° M. at approximately 60 kts. This corresponds closely with an Appreciation made by the U.K. Meteorological Office and with reports from aircraft other than those mentioned above.

F.

NAVIGATIONAL AIDS AND COMMUNICATIONS

42. Airborne Navigational Aids.

a. Two Standard STR-12D VHF sets.
b. Standard SR 14A/SR 15A ILS set.
c. Standard SR 31 VOR set.
d. Bendix SCR 269G ADF set.
e. Collins 18S-4 HF R/T set.
f. Murphy R19 MF Receiver.

43. Ground Aids Available.

a.	Consol	LEC	Frequency	319 Kc/s.
b.	VOR	ZZ	"	114.1 Mc/s.
c.	Locator	ZO	"	352 Kc/s.
d.	VDF	Sola Tower	"	119.7 Mc/s.
e.	NDB	LII	"	398 Kc/s.
f.	ILS	ZV	"	110.3 Mc/s.
g.	GCA	Sola GCA	"	118.1 "
	Available on 45		"	119.7 "
	minutes notice.		"	121.5 "

44. Stavanger Airport, Sola.

a. ILS Procedure.

The ILS runway at Sola has a Magnetic Bearing of 185°. The Outer Marker, incorporating a 75 Mc/s Fan Marker and a M.F. Locator on 352 Kc/s, is positioned 3.8 n.m. from the runway threshold. When approaching from the South the prescribed procedure is to cross the Outer Marker at 2000 ft. on the QNH and fly North for 2.5 n.m., descending to 1500 ft. on the QFE. A 45° procedure turn is then made to the left and after 45 seconds this is followed by a turn to the right to rejoin the Localiser beam. The 45 seconds timing may be increased or decreased according to the wind conditions. On re-joining the Localiser the aircraft descends to 1300 ft. and, after crossing the Outer Marker, descent is continued on the glide slope to the approach minimum. If, for any reason, the final stage of the approach must be abandoned, the aircraft should turn on to a heading of 270° M. and climb to 2500 ft.

b. Monitoring of Radio Equipment.

In accordance with the requirements of ICAO, Annex 10, there is installed at Sola equipment for monitoring the ZO Locator and the ILS. No failure occurred during the time G-AHPM was making its approach.

c. Flight Test of Ground Radio Aids.

On 15th August and 7th September, 1961, flight checks were carried out on the radio navigation aids which may have been used by G-AHPM while it was in the Stavanger area. Particular attention was given to the ZO Locator and the ILS.

With regard to the ZO Locator, it was found that if the aircraft radio compass was tuned to a frequency slightly above 352 Kc/s interference from the Danish radio beacon at Billum was experienced. This NDB (call sign OZR) is 216 n.m. from ZO on a bearing of 157° T, and transmits on a frequency of 355 Kc/s. The nominal range of this transmitter is 200 n.m. whilst that of the ZO Locator is 25 n.m. The degree of interference depended upon how much the receiver was out of tune towards the frequency of 355 Kc/s. Generally there was no difficulty in tuning ZO and excluding the interference, but if the tuning was done when the aircraft was close to the Beacon there was a greater possibility of mistuning being undetected. Near the Beacon the field strength of ZO was high enough to overcome the interference and give correct radio compass indications even if it was mis-tuned as far as 355 Kc/s. However, when the aircraft left the vicinity of the Beacon, due to the decrease in

its field strength, the interference became effective and incorrect indications resulted. With the receiver mis-tuned towards the frequency of Billum it was possible to hear the callsign of ZO as well as that of Billum.

d. GCA.

Warranted by an agreement, dated 26th October 1959, between the Royal Norwegian Air Force and the Directorate of Civil Aviation, civil aircraft are permitted to use Air Force operated GCA's.

The utilization, by civil aircraft, of Norwegian military GCA stations was promulgated internationally in "Civil Aviation Information Circular, serial number A/1/1960", issued by Directorate of Civil Aviation on 5th January 1960. The Information Circular in question clearly defines the responsibility of the GCA service and further describes in detail the procedures to be applied, the phraseology to be used, and finally lists the aerodromes at which GCA services are available to civil air traffic. One of the aerodromes listed is Stavanger Airport, Sola, where the availability of the GCA services is given as: "Monday to Friday 0700 - 1600 and on request on 45 minutes notice".

The GCA is also listed in AIP Norway, page COM 1 - 5.

As a consequence of the introduction of Norwegian summer time with effect from 12th March 1961, the above hours of service was amended by Class 2 NOTAM, serial number 4, dated 9th March 1961, and given international distribution, to read: "Monday to Friday 0600 - 1500 and on request on 45 minutes notice".

An international Class 1 NOTAM, serial number 378, dated 12th June 1961, announced that the GCA at Stavanger Airport, Sola, in the period from 1st July to 14th August 1961, was closed to all operations from Saturdays at 1100 hours to Mondays at 0600 hours.

e. On the day in question the GCA was available to G-AHPM on 45 minutes notice but no request for this service was made by either the Pilot or the Sola Tower.

G.

GROUND INSTALLATIONS

45. The condition of the Aerodrome and its installations, other than those above mentioned, the length of the runway etc. are deemed to have no bearing on the accident.

H.

MISCELLANEOUS

46. Two witnesses in the U.K., who were present at London Airport and had opportunity to observe the passengers, have stated that they did not see or hear used radios of any sort. Neither was any such equipment, other than that belonging to the aircraft, discovered at the site of the crash.

47. The use of safety equipment, lifebelts, dinghies etc., was not applicable to this accident.

48. Insignificant damage to third party property was caused by the crash and subsequent brush fire. No damage to property was caused during salvage of the essential items required for investigation.

I.

EXAMINATION OF WRECKAGE AND TECHNICAL INVESTIGATION

49. General Observations.

Inspection of the accident site revealed that the aircraft had struck the face of a mountain and had disintegrated instantaneously, the wreckage being widely spread over the surrounding rock surface above and below the point of impact. The face of the rock wall at the point of impact is near vertical and lies on a plane running approximately 010° - 190° M. Approximately 10 ft. above this point and to the East there is a small plateau, beyond which lies a valley. It was on this plateau and in this valley that most of the disintegrated wreckage finally came to rest. The maximum distance of the wreckage throw was in the order of 180 yards. A diagram showing the disposition of the major items is appended as Annex 5.

Detailed examination of the impact area revealed certain points where positive impact identifications could be made - notably the port wing navigation light glass, the port wing leading edge de-icer strips and items from the port and starboard power units. Angular measurements of these points, obtained by a theodolite, enabled the lateral attitude of the aircraft at impact to be ascertained. Further study of the relative bearings and distances of these points permitted the heading of the aircraft at the time of impact to be established with reasonable accuracy. The angular measurements showed that the aircraft was probably in a slightly left wing

low attitude on impact, but an angular displacement of this small magnitude, i.e. less than 10°, could be attributed to either a local gust or to a low-rate turn. The relative bearings and distances showed that the aircraft was on a heading of approximately 135° to 140° M. The inclination of the longitudinal axis of the aircraft at the time could not be accurately determined, but no indications were found to suggest it was far from the horizontal. A trail of loose papers from the aircraft was found on a bearing of approximately 050° M. from the point of impact and indicates the relative wind direction at the time.

50. Fuselage.

The fuselage became completely disintegrated on impact, and the majority of its structure came to rest in various positions on the plateau where the main wreckage trail was formed. The largest piece to remain was the portion forming the tail cone, to which the fin, rudder, tailplane and elevators remained partially attached. The fuselage in general was severely affected by flash fire, and the forward section, which remained on the rock face, was involved in an intense local fire. The passenger seats were, without exception, displaced from their attachments, severely disrupted, and spread on a general heading of approximately 120° M. It was established that a large number of passenger lap straps were fastened at the time. No evidence of an attempt to use any emergency exit was found, the main cabin door and window exits having been disrupted and in some cases disintegrated.

51. Centreplane.

The centre-section was completely disrupted, the starboard side falling in a disintegrated condition from the rock face at the point of impact. The port half of the centre-section was thrown forwards on a heading of approximately 104° M. and came to rest in the general wreckage trail. Both sections had been considerably affected by the impact forces and the flash fire.

52. Port Mainplane.

The port mainplane was found to be one of the first components to strike the mountain, at about the same time as the nose section. The outer portion of the wing made initial contact followed by the leading edge of the wing at points further inboard. Sections of the port wing tip navigation light glass and the leading edge de-icer strips, found embedded in the rock, supply some of the evidence to confirm the attitude and heading of the aircraft at the time of impact.

53. Starboard Mainplane.

This mainplane made some contact with the rock but the momentum of the aircraft and the slope of the rock at this position caused the mainplane to break away from the centre-section as a relatively large item. The major structure of its outer section finally came to rest at a point about 165 yards and on a bearing of approximately 054° M. from the main impact.

54. Ailerons.

The port aileron was badly disrupted but sections of it remained attached to the port outer wing section below the cliff face. The starboard aileron was thrown clear of the rock face and came to rest, as two major items, about 140 yards from the main wreckage. Examination of the remains of both ailerons revealed no evidence of pre-crash mal-functioning.

55. Aileron Tabs.

No pre-crash defect was found on examination of the remains of the aileron tabs. Owing to the disintegration of the controls, the position of the controllable tab on the port aileron could not be established.

56. Flaps.

The flap surfaces were severely damaged at impact and some portions were affected by fire. The post-crash condition of the flap operating jacks indicate that the flaps were in the fully retracted position at the time of the crash.

57. Fin.

The fin received considerable damage and was affected by the flash fire. It remained attached to the fuselage tail cone and came to rest at the top of the ridge above the impact point.

58. Rudder.

The rudder was also found with the fuselage rear cone and the remainder of the tail unit at the top of the ridge near the point of impact. It suffered impact and fire damage. Examination of the remains revealed no evidence of pre-crash defects.

59. Rudder Tab.

Owing to the displacement of all trimmer control cables during the disruption of the fuselage, the position of the tab prior to impact could not be established. No evidence of pre-crash defect of the tab was found.

60. Tailplane.

The port and starboard tailplane sections remained with the rear portion of the fuselage and were found in severely damaged condition. They had also to a large degree been affected by fire. No pre-crash abnormality was evident.

61. Elevator.

The port and starboard elevator sections remained attached to the respective halves of the tailplane. Fire and impact damage was sustained also by these components. Examination of the remains produced no evidence to suggest that malfunctioning occurred prior to impact.

62. Elevator Tabs.

No pre-crash defect was found on examination of the port elevator trim tab and the starboard elevator balance tab. Owing to the disturbance of the control cables at impact, the position of the trim tab could not be determined.

63. Flying Controls.

The flying control system was completely disrupted during the break-up of the aircraft. The individual components were severely damaged and many, including all those in the cockpit area, were seriously affected by the fire. Examination of all the remains revealed nothing to suggest that pre-crash failure, restriction or other defects had occured. No evidence was found to suggest that the automatic pilot was engaged at the time.

64. Undercarriage.

The position of both mainwheel and tailwheel hydraulic operating jacks showed that all three units were fully retracted at the time of impact.

65. Crew Compartment.

The crew compartment was almost entirely destroyed through impact with the rock face and in the subsequent severe fire. The instrumentation and controls situated in the forward part of the compartment were likewise almost entirely destroyed, few instruments surviving as whole units. No useful information was gained from the examination of the remains of the engine or the basic electrical instrumentation and no associated control settings could be established. The vacuum system gauge was found to be locked at a setting of 5.8 inches of Mercury, suggesting that suction was available for the operation of the air-driven gyroscopic instruments.

Examination of filaments from instrument lighting bulbs and other components showed that electrical power was being supplied to them at the time of the crash.

The pilots' seats were almost completely destroyed by impact and the ensuing fire. It was not possible to establish with certainty whether the Captain and First Officer were strapped to their seats at the time, but this would appear to be probable.

66. Cabin Heater and De-Icing Equipment.

Examination of the remains of these systems revealed no useful information.

67. Power Units.

Both power units suffered severe impact damage. The port engine did not disintegrate entirely but lost a number of cylinders and its reduction gear before finally coming to rest in the main wreckage trail. The starboard engine received a greater deceleration than the port engine due to local characteristics of the rock face and became completely disintegrated, its components being scattered along an individual line towards the right-hand side of the general wreckage area. The propellers also disintegrated on impact. All blades except 2, left their hubs, due to centrifugal deceleration and impact forces and became widely scattered. The propeller hubs were severely damaged and their domes were not recovered, being probably destroyed in the fire which broke out in the immediate area of initial strike.

Examination of the remains of the engines produced limited information concerning their operating condition at the time of crash. Both injector carburettors were found with a quadrant setting of 62° and the idle Cut-off control on the port injection carburettor was found in the "Run" position. However, the disruption of the engines and their controls must be considered when assessing the validity of these settings. The disruption of the related controls and the damage sustained by the engine air intake units also prevented their selected positions from being established. Examination of the propeller components on the site indicated that considerable centrifugal and lateral inertia forces were present at the time of break-up and suggest that both propellers were present and rotating at a considerable speed immediately prior to that time. All salvaged portions of the propellers were returned to the Manufacturer in an attempt to determine the blade pitch by reassembly and examination of root attachment components. The results of the examination indicate that both propellers were operating at a pitch setting of between 45° and 50° at the time of the crash.

68. Aircraft Fire Extinguishing Equipment.

No evidence was found of pre-crash fire. However, an intense fire occurred in the immediate crash area after impact, due mainly to release of fuel and oil. Examination showed that the engine fire extinguisher bottles had not been electrically operated.

69. Fuel and Oil Installation.

Owing to the extreme disintegration of components it was not possible to determine with certainty the pre-crash position of the fuel and oil system cocks. Nothing, however, was found to suggest that either of the engine main fuel cocks had been in the closed position immediately prior to the crash.

Fuel and oil contents could not be determined from examination of the wreckage.

70. Radio Equipment.

All this equipment was severely damaged and the components were found scattered over a wide area. Equipment which could be salvaged was given a preliminary inspection in Norway and later forwarded to the United Kingdom for more detailed laboratory examination. Due to the extent of the damage findings could only be based on visual examination.

It was found that at the moment of impact electrical power was being supplied to the radio equipment on the aircraft. The VHF, ILS and ADF sets were switched on and energised. The VOR receiver was not found.

The radio compass tuning dial showed a reading at or slightly above the frequency of 352 Kc/s. ADF tuning on the aircraft is carried out by a remote mechanical control. Therefore, due to a small amount of lost motion between the control and the tuning condenser in the receiver it is not possible to state with certainty the exact frequency to which the set was actually tuned. The ILS control box was not found. However, a radio station box was found selected to ILS, VHF and ADF which shows that the crew might have listened to the ILS and ADF callsigns as well as the VHF. The VOR control box was found set to either 112.1 or 112.2 Mc/s.

J.

EXAMINATION OF WITNESSES

71. In the period 14th August - 5th October ten ground witnesses who had

reported seeing or hearing the aircraft, were further examined by the Police upon request from the Commission.

III

COMMENTS AND FINDINGS

K.

RECONSTRUCTION OF FLIGHT UP TO ACCIDENT

72. Evidence shows that G-AHPM left Clacton at 1354 hours and proceeded, at cruising flight level 90, on a direct track to the Stavanger Consol Station. During this part of its flight the aircraft was in radio contact initially with Preston Airways; later with Stavanger Control. There are indications that the VOR set in the aircraft was tuned to the frequency of Kristiansand S; this facility may have been used by the crew to obtain ground speed checks on the latter part of the flight.

73. At 1611 hours the pilot reported just coming up to LEC Consol Beacon and it is estimated that the time overhead the beacon was between 1612 and 1613 hours. Having previously been cleared to descend from 4000 to 2000 ft. the aircraft, at 161323 hours, confirmed that it was descending and had passed 3500 ft. From the evidence of the ATC Officer at Sola it appears likely that the aircraft passed overhead the airfield, Northbound, at approximately 1618 hours. At 162009 hours a QDM of 180° (corrected 184°) was obtained by Sola Tower. It is estimated that the aircraft was then almost on the centre line of the ILS and to the North of the Outer Marker.

74. From the radio telephony conversation between Sola Tower and the aircraft it appears possible that some confusion existed regarding the radio beacon used when approaching Sola from LEC. Initially, the LII NDB may have been tuned in on the radio compass and the change to ZO only made when the aircraft had passed over the aerodrome Northbound. Reference to the type of route chart used by the First Officer shows the LII NDB and not ZO. This is because the chart is mainly concerned with route facilities and not landing aids. The voice on the radio has been identified as that of the First Officer and normally he would be concerned with the tuning of the various navigation aids. The last surface wind given to the aircraft was

200° 25 kts. However, evidence indicates that at this time a considerably stronger wind existed at the 1600 ft. level and the aircraft's maximum angle of drift, while on the procedure turn, may have been as high as 26°. Although the Captain had ample opportunity to assess the drift as he flew Northbound from LEC, the drift on his procedure turn may have been greater than he expected.

L.

DISCUSSION OF THE EVIDENCE

75. Time of Crash.

The Commission have attempted to fix the exact time of the crash, and have decided that it must have occurred just before 1629 hours. This result has been based on the times and positions taken from the tape recordings of the Sola Control Tower, combined with the distance of the crash site from the last known position of the aircraft. It is also supported by evidence given by witnesses and by an examination of the wrist watches of the casualties found at the crash site.

76. Flight Plan.

In accordance with the flight plan received at Sola at 1400 hours on 9th August 1961, the aircraft, at take-off, had sufficient fuel for å flying time of about 5.1/4 hours. Thus, if conditions had not been suitable for landing at Sola the aircraft carried sufficient fuel to fly on to Kristiansand Airport, Kjevik, which was its specified alternate landing field, or to another airfield in Norway or Denmark.

77. The Weather.

Neither the Flight Forecast nor the verbal briefing received by the crew prior to departure from London Airport, nor the surface wind transmitted to the aircraft by Sola ATC indicated that the wind velocity in the area at the altitude and time of the approach was as high as subsequently determined by an evaluation of the meteorological situation and by reports from pilots that had operated in the Sola area during the critical period. It is shown by evidence that a revised Flight Forecast issued by the Meteorological Office at London as late as 1155 hours would have been made available to the crew if so requested. Considering the fact that the departure of the flight from London Airport was postponed approximately 5 hours it is surprising that the Captain did not seek to obtain such a revised forecast prior

to leaving, particularly as the period of validity of the forecast in his possession would expire before his estimated time of arrival at Stavanger. However, the revised forecast would not materially have changed the information already in the possession of the crew.

78. In the opinion of the Commission the weather conditions at Sola - with rather strong and gusty winds - must be considered to have been unusual for the season. The instability of the air at the time, causing turbulence near the ground, probably made landing and take-off more difficult than normal. It is also the opinion of the Commission that the gusts and vertical currents which the aircraft encountered in the air over the Stavanger area should not have been of such intensity as to cause hazards to flight. During the same afternoon and evening 8 other aircraft - amongst them another Viking operated by Cunard Eagle Airways Ltd. - landed at Sola without any problems of note.

The Commission are satisfied that at the time of the accident the weather conditions at Stavanger Airport, Sola,were above the operator's weather minima for Sola ILS approach and landing.

79. Air Traffic Control.

The Commission are of the opinion that the Air Traffic Control services rendered were in accordance with the procedures and regulations in force at the time.

80. No risk of collision appears to have been present. The traffic was well distributed and separated. Information transmitted to G-AHPM appears to have been correct. The ATC Officer checked the flight 3 times on his VHF Automatic Direction Finder; the first time to ensure lateral separation between the approaching G-AHPM and another flight climbing out on track for Newcastle; the other 2 times as a matter of routine procedure. Further the Control Officer acted correctly by checking the ETA of G-AHPM over LEC and in correcting the pilot when, at 1618 hours, he reported estimating the LII beacon in approximately two minutes.

The Commission note that the crew was not precise in reporting times overhead the LEC and ZO beacons.

81. The ATC Officer called the aircraft at 162938 hours without getting a reply. Normal time for procedure turn manoeuvering had then been exceeded but the duty ATC Officer, because of prevailing wind conditions, expected that this approach would take longer. The normal time for an aircraft to

complete the procedure turn and arrive back over the Outer Marker, inbound, is about 6 minutes. Therefore the ATC Officer's call at 162938 hours appears to have been within the 3 minutes limit prescribed in ATC procedures.

82. No request for GCA service was made either by the Captain of G-AHPM or by the ATC Officer at Sola, presumably because it was not considered that the circumstances were such as to warrant this action.

83. According to the regulations hitherto and at present governing the use of Norwegian GCA stations, these stations are intended to be utilised as radio navigational aids during the last phase of instrument let down to airfields. Notification from the Norwegian Directorate of Civil Aviation of January 5th 1961 refers. On 9th August, the existing weather conditions taken into account, the other flight and navigational aids available at Sola are deemed to have been adequate to ensure normal and safe approach and landing. The validity of this opinion is borne out by the fact that at a great number of the world's international airports, under the most divers climatic and meteorological conditions, ILS represents the principal and accepted basic approach and landing aid system. The Commission are of the opinion that it was completely responsible, under the circumstances, not to have employed the services of the Sola GCA. The non-employment of this equipment can, in the opinion of the Commission, not be termed a contributory cause of the accident.

84. Nevertheless the general standard of flight safety at airfields would, of course, be enhanced by the use of radar surveillance at all times. Thus the Commission is inclined to believe that the accident to G-AHPM on 9th August 1961 might have been avoided if the GCA station had been utilised either in its primary function or for surveillance. The latter utilisation of the equipment would have enabled the ATC Officer to initiate corrective action as soon as the radar scope information showed that the aircraft was astray.

85. Technical Aspects.

From laboratory examinations of the radio components it has been established that electrical power was available on the aircraft and that certain of the radio and navigational aids were in use, including the VHF, the Radio Compass and the ILS equipment. Although the Radio Compass tuning indicator was found at a setting of, or slightly above, 352 Kc/s, the possibility that the set was receiving signals other than those from the ZO Locator, e.g. Billum in Denmark, can not be entirely discounted.

86. No evidence was found of pre-crash mechanical or structural failures, and at the moment of impact the aircraft was in level or nearly level flight with wheels and flaps retracted. There is evidence that the engines were under power and that the propellers were in the constant speed range.

87. The Flight.

Nothing in a detailed analysis of the history of this flight indicates the occurrence during flight of abnormal technical or operational circumstances or incidents, which may have contributed to the accident. On the contrary it would seem as if the flight, in so far as can be ascertained, proceeded in accordance with normal routine up to a certain position North of the Outer Marker or ZO Locator on the ILS beam to runway 18 at Stavanger Airport, Sola.

88. From the position at 162009 hours, when the aircraft was just North of the Outer Marker, until it was seen by witnesses on the ground, little is known with certainty of its track, but it is reasonable to assume that the Captain, at least initially, intended to carry out the ILS procedure laid down in his Aerad Flight Guide. According to evidence of witnesses the aircraft flew in from the West and crossed the coastline at a position approximately 9 n.m. to the East of the ILS centreline, whence it made good a track of about 105° M. for the last 4 n.m. to the position of the crash. Statements from a couple of ground witnesses could, however, be understood to indicate that the aircraft, at around 1630 hours, may have made an approximately 315° port turn on the Eastern side of the Localiser. This would mean that the planned ILS approach had been discontinued. The Commission are of the opinion that an evaluation of all other available evidence makes this unlikely.

89. Observations.

When examining the possible reasons for the aircraft's departure from the instrument let-down pattern the most likely one is associated with the very strong south-westerly wind. It was established that the aircraft passed the vicinity of Sola northbound and it is reasonable to assume that the Captain was attempting to follow the prescribed ILS procedure. It is likely that the wind at 1600 ft. was about 230°/60 kts. and the maximum drift the aircraft would experience on the procedure turn would have been about 26°, and during part of the turn the ground speed may have been as high as 195 kts. If insufficient allowance was made for the drift, it can be shown that by the time the aircraft had completed the turn to rejoin the localiser

beam the wind effect would have taken it close to or even through the centreline. After completing this turn the aircraft should still have had a short distance to run before reaching the beam and at this point the localiser needle on the instrument in the cockpit should be giving a "fly left" indication. When this needle starts to move towards the "on course" position the turn on to the final approach is made. However if the aircraft had passed through the centreline whilst still making the turn, the crew ought to have been aware of this from the "fly right" indications even if they had missed the actual movement of the localiser needle. In addition, the radio compass indicator would have made this apparent if it was correctly tuned to the ZO locator. With the wind speed and direction at the time, even if the Captain had allowed for sufficient drift to make good the required outbound procedure turn track, it would still have been necessary for him to extend the "still air" timing of 45 seconds by approximately 1 minute 15 seconds to ensure that he was still on the western side of the localiser by the time he had completed the final part of the procedure turn.

90. After completing the procedure turn there is little doubt the crew expected still to be on the Western side of the Localiser Beam and they may have missed the movement of the Localiser Needle that resulted from crossing the beam. If the crew misinterpreted the indications of the Localiser Needle this would help to explain why the heading of 135° - 140° M. was maintained to the position of the crash. However, if the ILS equipment in the aircraft was working satisfactorily the crew must, for at least 4 - 5 minutes, have had a continuous indication that they were on the Eastern side of the Localiser beam. The Commission is unable to explain how the crew in a situation of this nature could continue on the heading indicated for the time stated unless they either did not note or were mis-interpreting the ILS Indicator readings.

91. The possibility of interference from the Billum NDB affecting the indications of the aircraft's radio compass cannot be discounted, particularly as the evidence indicates that the crew may have tuned in ZO while the aircraft was close to it. The effect of such interference would be to deflect the radio compass needle in such a way as to strengthen the crew's impression that they were on the Western side of the Localiser. Nevertheless, this should not have prevented them from correctly interpreting the indications of the localiser needle.

M.

CONCLUSIONS

92. The aircraft had valid Certificates of Airworthiness and Maintenance.

93. The aircraft had been maintained in accordance with an Approved Maintenance Schedule. All documents were in order and properly signed.

94. The Crew was properly licensed and within prescribed limits in respect of maximum flying time and minimum rest period. The possibility has been excluded of the crew having been affected either by alcohol or carbon monoxide.

95. The aircraft weight at take-off was below the maximum allowed; the centre of gravity was within the prescribed limits.

96. In the opinion of the Ministry of Aviation in London the Operator's Standard of Compliance with the relevant Regulations of the British Air Navigation Order, 1960, is satisfactory, and was adequate in respect of this particular flight. The Commission have found no reason to take issue with this opinion.

97. The delay to the aircraft prior to departure from London Airport has no bearing on the accident.

98. The instrument approach procedures at Stavanger Airport, Sola, are similar to those with which the Captain was familiar.

99. On the basis of the Flight Forecast the estimates given by the pilot on radio telephony to the ground services must be considered to have been accurate.

100. During the flight from the LEC Consol Beacon to the Outer Marker beacon the crew had the opportunity to assess the angle of drift.

101. There is no reason to suspect electronic interference with the aircraft's navigation aids by portable transistor radios.

102. The Captain attempted to carry out an ILS approach to runway 18 at Sola.

103. The Air Traffic Control Organisation functioned properly, as did all ground navigation and communication aids.

104. The wind speed at the 1600 ft. level in the Sola area was considerably greater than indicated by the Meteorological Information given to the pilot.

105. The weather, although somewhat unusual for the season, was not of a nature to cause serious difficulties to a pilot of Captain [redacted] experience. Other aircraft landed before and after the accident.

106. At the accident site it was established that the aircraft struck the mountain ridge on a heading of approximately 135° to 140° M. With the wind speed and direction at that time its track made good would have been about 111° M.

107. No evidence was found of pre-crash mechanical or structural failures or defects in the aircraft or its equipment. Findings indicate that the engines were under power and the propellers in the constant speed range. Wheels and flaps were retracted.

108. At the moment of impact the aircraft was flying nearly level or slightly port wing down and was probably in a horizontal or slightly climbing flight, but the evidence for the latter is inconclusive.

109. It is significant that the heading of the aircraft at the time of impact is one that would be steered by a pilot who, for some reason, thought he was on the Western side of the Localiser beam.

N.

CAUSE

110. The cause of this accident was a deviation from the prescribed flight path for reasons unknown.

Oslo, the 28th May, 1962.

J.K. Christie
President

Gullbrand Nyhus

Nils K. Jørstad

List of Abbreviations and Codes used in Text.

ADF	- Automatic direction-finding equipment
ADR	- Advisory Route
AIP	- Aeronautical Information Publication
ASR	- Altimeter Setting Region
ATC	- Air Traffic Control
E	- East
E.g.	- Exempli gratia
ft	- Feet
GCA	- Ground Controlled Approach
GMT	- Greenwich mean time
HF	- High frequency
ICAO	- International Civil Aviation Organisation
ILS	- Instrument Landing System
Kc/s	- Kilocycles per second
Kgs	- Kilos
km	- Kilometres
kts	- Knots (Nautical miles per hour)
LEC	- Identification signal of Stavanger/Varhaug Consol Beacon
LII	- Identification signal of Rennesøy non-directional radio beacon
M	- Magnetic
Mc/s	- Megacycles per second
MF	- Medium frequency
N	- North
NDB	- Non-directional radio beacon
NE	- North-east
NW	- North-west
n.m.	- Nautical miles
QDM	- The magnetic heading (expressed in degrees) for an aircraft to steer, with no wind, to reach the direction finding station.
QFE	- Atmospheric pressure at official aerodrome elevation
QNH	- Subscale setting on the altimeter of an aircraft which makes the altimeter indicate aircraft elevation when the aircraft is on the ground at the aerodrome.
R.A.F.	- Royal Air Force

RNoAF - Royal Norwegian Air Force

r.p.m. - Revolutions per minute

R/T - Radio telephony

SAS - Scandinavian Airlines System

SE - South-east

SSE - South-south-east

SW - South-west

T - True

TAS - True airspeed

VHF - Very high frequency

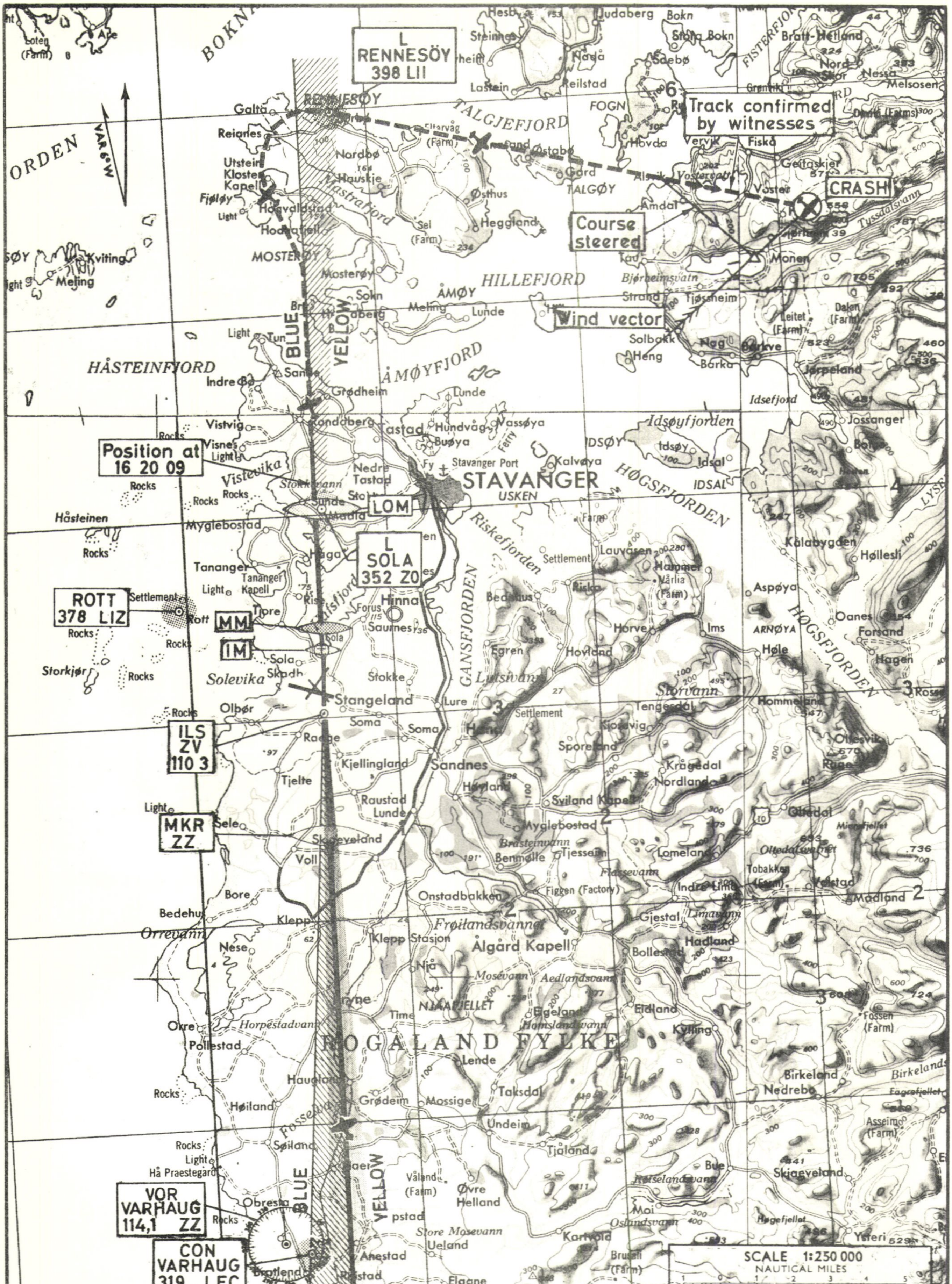
VOR - Very high frequency omnidirectional radio range

ZO - Identification signal of the locator positioned at the Outer Marker of the ILS to runway 18 of Stavanger Airport, Sola.

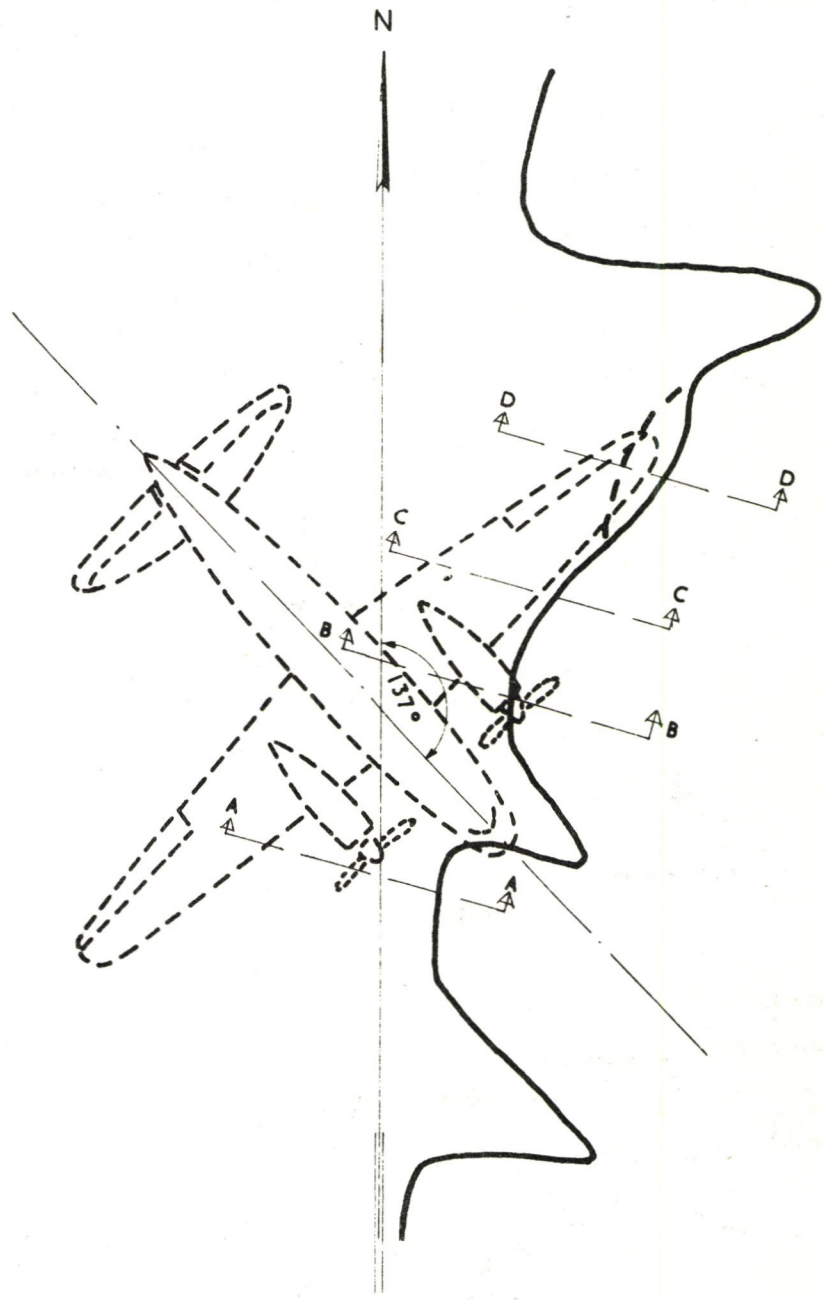
ZZ - Identification signal of Stavanger/Varhaug VOR station.

List of Principal Experts consulted

1) Mr. Truls Dahl	Chief, Airworthiness Section, Norwegian Directorate of Civil Aviation.
2) Mr. John Eriksen	Inspector, Aeronautical Meteorological Services, Norwegian Directorate of Civil Aviation.
3) Mr. John Michelsen	Air Traffic Control Inspector, Norwegian Directorate of Civil Aviation.
4) Mr. Norvald Omberg	Radio Engineer, Norwegian Directorate of Civil Aviation.
5) Mr. Finn Thorsager	Captain, Scandinavian Airlines System.



Unbroken line: Aircrafts initial approach
Dotted " : Possible flight path last minutes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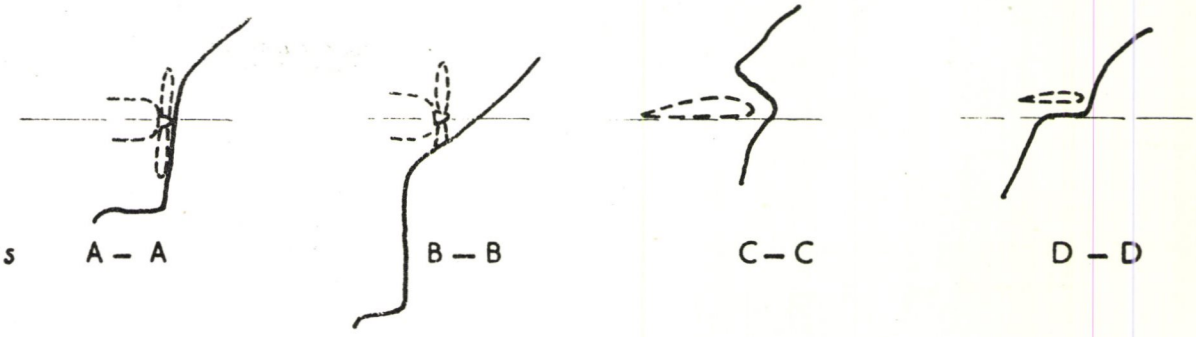
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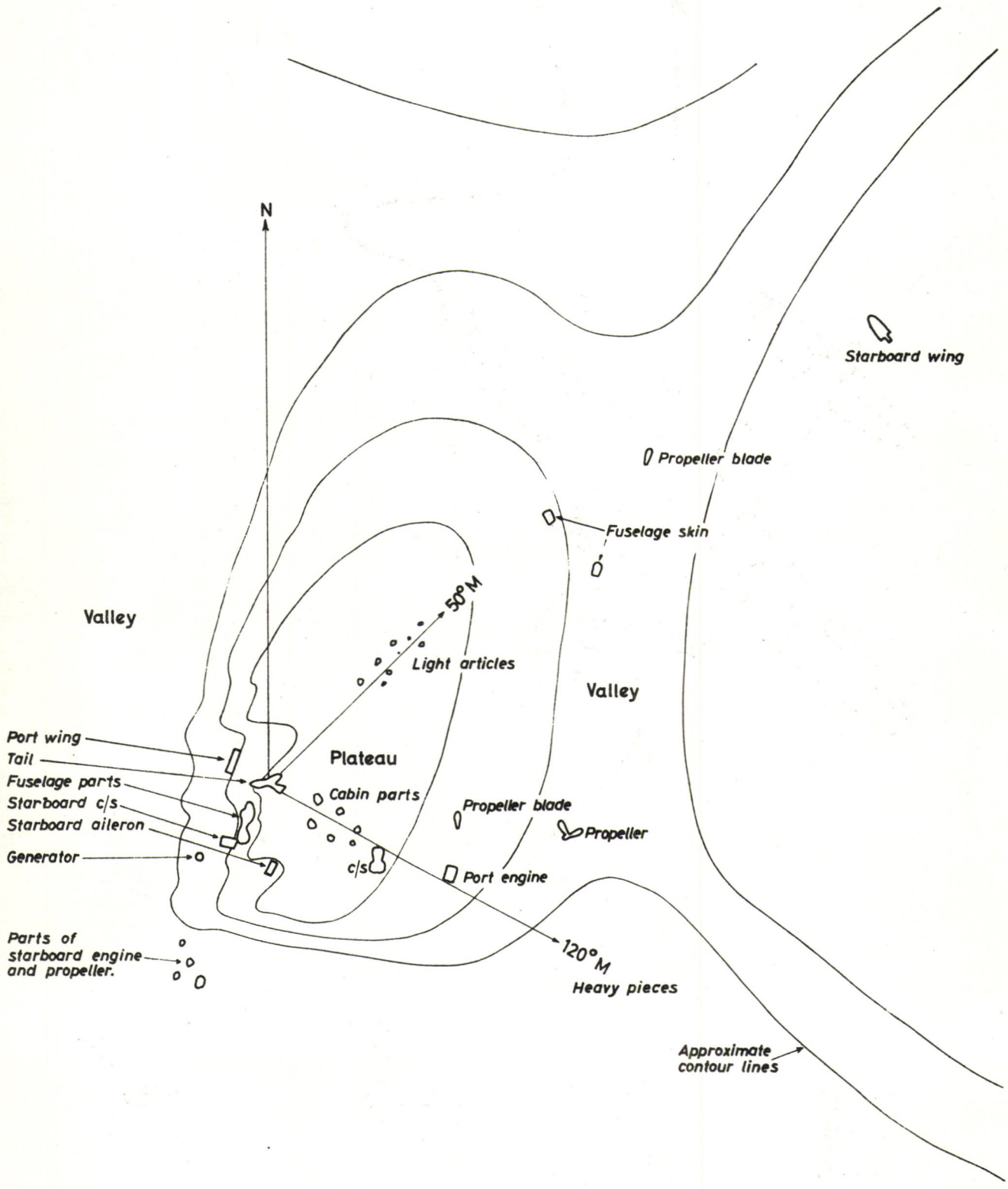
DIAGRAM SHOWING DISPOSITION OF MAJOR WRECKAGE ITEMS

ANNEX 5



Scale 1:1000 approximately

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Accident Site from West

DS 65088/1/Wt.2991 K9 8/62 XL & CL

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