

No. 28

Cunard Eagle Airways Ltd., Vickers Viking 3B, G-AHPM, accident near Stavanger Airport, Sola, Norway, on 9 August 1961. Report of the Royal Norwegian Commission for the Investigation of Civil Aircraft Accidents, dated 28 May 1962. Also released by the Ministry of Aviation (United Kingdom) as C.A.P. 182.

Circumstances

The aircraft departed London at 1329 hours GMT on an (estimated) two and a half hour charter flight to Stavanger Airport. That same day, between the hours of 1624 and 1630 GMT, it crashed about 18 NM northeast of the airport on Holteheia, a steep mountainside running in a north-south direction. The accident site was at an altitude of 1 600 ft. All persons aboard the aircraft (i.e. 3 crew and 36 passengers) were killed. The aircraft was destroyed. An intense fuel and oil fire followed the impact.

Investigation and EvidenceThe Aircraft

Its certificate of airworthiness, last renewed on 3 February 1961, was valid for a period of one year. The aircraft had flown a total of 20 885 hours.

The aircraft's certificate of maintenance dated 29 July 1961 was valid until 19 August 1961 or for 100 flying hours. On the day of the accident a preflight inspection 'B' was carried out and certified on a pre-flight inspection record.

The port engine was last overhauled completely on 3 October 1956. Since that time it had run about 1 293 hours. Immediately prior to the departure of the aircraft on its last flight an ignition rpm drop was experienced on the right-hand magneto of this engine. The fault was rectified.

The starboard engine had run a total of 1 156 hours since last overhaul.

At take-off the aircraft weighed 15 084 kg, i.e. 338 kg below the maximum permitted. It was estimated that at 1622 hours on 9 August, the time of the last radio contact with the aircraft, the all-up weight would have been about 614 kg below the maximum permitted for landing. The aircraft's centre of gravity was within the prescribed limits.

The aircraft carried enough fuel for 5 hours 15 minutes of flight.

Crew information

The captain held a valid airline transport pilot's licence endorsed in Group 1 for Viking aircraft. At the time of the accident his total flying hours were approximately 8 000, of which 3 730 hours 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 before the accident he had completed 114 flying hours.

Cunard Eagle Airways considers Stavanger Airport as a "Category A" airport, i.e. one with standard approach aids which present no hazard due to terrain difficulties. Although the captain had not been to Sola before, he had considerable experience as a Viking captain on European routes and had completed 21 instrument approaches in Europe during the preceding twelve months. The operator considered that he had shown his competency and familiarity with approach aids similar to those at Stavanger and that the ILS procedure there presented no difficulty to normal approach or departure procedures. He was authorized to operate as a pilot-in-command to all Category A airfields on route within the European region.

No specific briefing for the flight was carried out, but the captain had access to all relevant information contained in the flight guide and topographical maps carried on the aircraft and to information available at the Ministry of Aviation Briefing Room at London Airport, which included the hours of operation and availability of the Stavanger GCA.

The co-pilot, at the time of the accident, held a valid senior commercial pilot's licence endorsed in Group II for Vikings. His total flying hours amounted to 1 744, of which 262 were on Vikings as first officer. Inspection of the records showed that on 30 May 1961 he 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 18 January and his last competency check was on 22 May 1961. His 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 of flying.

The air hostess had completed 163 flying hours and was considered to be an above average hostess.

All crew members had sufficient rest prior to the flight.

Weather - landing forecast for Stavanger Airport, Sola

0600 - 1500 hours

surface wind	120°/20 kt, gusty
visibility	3 NM
cloud	3/8 stratus at 1 000 ft 8/8 stratus at 1 500 ft

becoming between 0900 - 1200 hours

wind	210°/20kt, gusty
visibility	11 NM
cloud	6/8 cumulus at 1 800 ft

temporarily between 0900 - 1500 hours

visibility	4 NM in heavy showers 5/8 cumulonimbus at 1 200 ft
------------	---

Actual weather at Stavanger

On the day of the accident a low pressure system reached southwest Norway. A trough passed the Sola area some time between 1200 and 1500 hours, following which the surface winds veered from south-southeast to southwest, occasioning rain and showers but without significant change in the cloud base. Most likely the wind at 1 500 ft came from a direction of 230°, with an average velocity of 50 kt. At times it may have reached 60 kt. Cloud formations were variable.

The freezing level at Sola was about 7 500 ft. Carburettor icing is hardly likely to have occurred.

Atmospheric pressure given in the actual reports from Sola was correct. The pressure was rising. This, occurring after the sub-scale of the aircraft's 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 reported thunderstorms on 9 August. Aircraft reported no special atmospheric disturbances in the area. The relatively large amounts of precipitation indicated that static may have occurred for short periods.

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 southeasterly direction, with an average wind speed of 20 to 25 kt, with gusts up to 45 kt. The wind veered to the southwest around 1400 hours, 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.

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

Wind velocity at 1 500 ft at Stavanger

At the time G-AHPM was near Sola, an SAS flight was holding at Rennesy LII NDB at 6 000 ft awaiting its turn to land. The SAS pilot said that 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 true airspeed of 150 kt.

At 1850 on the same day a Viking landed at Sola after making an approach by GCA. This aircraft experienced 25° port drift on final approach at a true airspeed of 115 kt.

It was established that the (mean) wind direction at the time of the accident was about 050° M. From this and the drift angles experienced by the two aircraft mentioned, the wind at 1 600 ft at about the time of the accident probably was 230° M at approximately 60 kt.

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. If so requested, a revised flight forecast issued by the meteorological office at London as late as 1155 hours would have been made available to the crew. Considering that the flight's departure from London was postponed about 5 hours,* it is surprising that the captain did not seek to obtain a revised forecast prior to leaving, 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.

Stavanger Airport, Sola

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 MF locator on 352 kc/s, is positioned 3.8 NM from the runway threshold. When approaching from the south the prescribed procedure is to cross the outer marker at 2 000 ft on the QNH and fly north for 2.5 NM, descending to 1 500 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 localizer beam. The 45 seconds timing may be increased or decreased according to the wind conditions. On re-joining the localizer the aircraft descends to 1 300 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 2 500 ft.

Monitoring of radio equipment

No failure occurred in the monitoring equipment for the locator and the ILS during the time the aircraft was making its approach.

Test of ground radio aids

Flight tests were carried out on the radio navigation aids which may have been used by the aircraft while in the Stavanger area. Particular attention was given to the ZO locator and the ILS.

ZO locator (at outer marker of the ILS to runway 18 at Stavanger)

It was found that if the aircraft radio compass was tuned to a frequency slightly above 352 kc/s, interference from

* This delay had no bearing on the accident.

the Danish radio beacon at Billum was experienced. This NDB (OZR) is 216 NM 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 NM whilst that of the ZO locator is 25 NM. 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 mistuned 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 mistuned towards the frequency of Billum it was possible to hear the call sign of ZO as well as that of Billum.

Ground-controlled approach

Civil aircraft are permitted to use Air Force-operated GCA's. An international Class 1 Notam, dated 12 June 1961, announced that the GCA at Stavanger Airport, Sola, during the period from 1 July to 14 August 1961, was closed to all operations from Saturdays at 1100 hours to Mondays at 0600 hours.

On 9 August, 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.

Reconstruction of the flight up to the accident

Evidence showed that the aircraft 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 the flight the aircraft was in radio contact initially with Preston

Airways; later with Stavanger Control. There were 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.

At 1611 hours the pilot reported just coming up to LEC (Stravanger/Varhaug) 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 4 000 to 2 000 ft, the aircraft, at 1613 hours, confirmed that it was descending and had passed 3 500 ft. From the evidence of the air traffic control officer at Sola it appears likely that the aircraft passed overhead the airfield, northbound, at approximately 1618 hours. At 1620 hours a QDM of 180° (corrected 184°) was obtained by Sola Tower. It is estimated that the aircraft was then almost on the centreline of the ILS and to the north of the outer marker.

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 (Rennesy) 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 was 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 kt. However, evidence indicates that at this time a considerably stronger wind existed at the 1 600 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.

Nothing indicated the occurrence during flight of abnormal technical or operational circumstances or incidents, which may have contributed to the accident. In so far as it could be ascertained the flight proceeded normally up to a certain position north of the outer marker or ZO locator on the ILS beam to runway 18 at Stavanger Airport, Sola.

From the position at 1620 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 witnesses the aircraft flew in from the west and crossed the coastline at a position approximately 9 NM to the east of the ILS centreline, whence it made good a track of about 105° M for the last 4 NM to the position of the crash. Statements from two ground witnesses, however, could 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 localizer. This would mean that the planned ILS approach had been discontinued. The Commission was of the opinion that an evaluation of all other available evidence made this unlikely.

The Commission was of the opinion that the weather conditions at Sola, i.e. strong and gusty winds, must be considered 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. Also, 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 eight other aircraft landed at Sola without any problems of note.

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

Air traffic control

The services rendered were in accordance with the procedures and regulations in force at the time.

Information transmitted to G-AHPM appears to have been correct. The ATC officer checked the flight three times on his VHF automatic direction finder. The control officer acted correctly by checking the ETA of the aircraft over LEC and in correcting the pilot when, at 1618 hours, he reported estimating the LII beacon in approximately two minutes. The Commission noted that the crew was not precise in reporting times overhead the LEC and ZO beacons.

The ATC officer called the aircraft at 1629 hours without getting a reply. Normal time for procedure turn manoeuvring 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 1629 hours appears to have been within the 3 minute limit prescribed in ATC procedures.

No request for GCA service was made either by the captain of the aircraft or by the ATC officer at Sola. The non-use of this equipment was not, in the opinion of the Commission, a contributory cause of the accident, but the Commission believed that the accident to G-AHPM might have been avoided if the GCA station had been utilized either in its primary function or for surveillance. The latter utilization 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.

Technical aspects

It was established that electrical power was available on the aircraft. 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, cannot be entirely discounted.

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. The engines were under power, and the propellers were in the constant speed range. There were no signs of a pre-crash fire.

Possible reasons for the aircraft's departure from the instrument let-down pattern

The most likely one is associated with the very strong southwesterly 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 1 600 ft was about 230°/60 kt 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 kt. 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 localizer 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 localizer 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 localizer 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 outboard 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 localizer by the time he had completed the final part of the procedure turn.

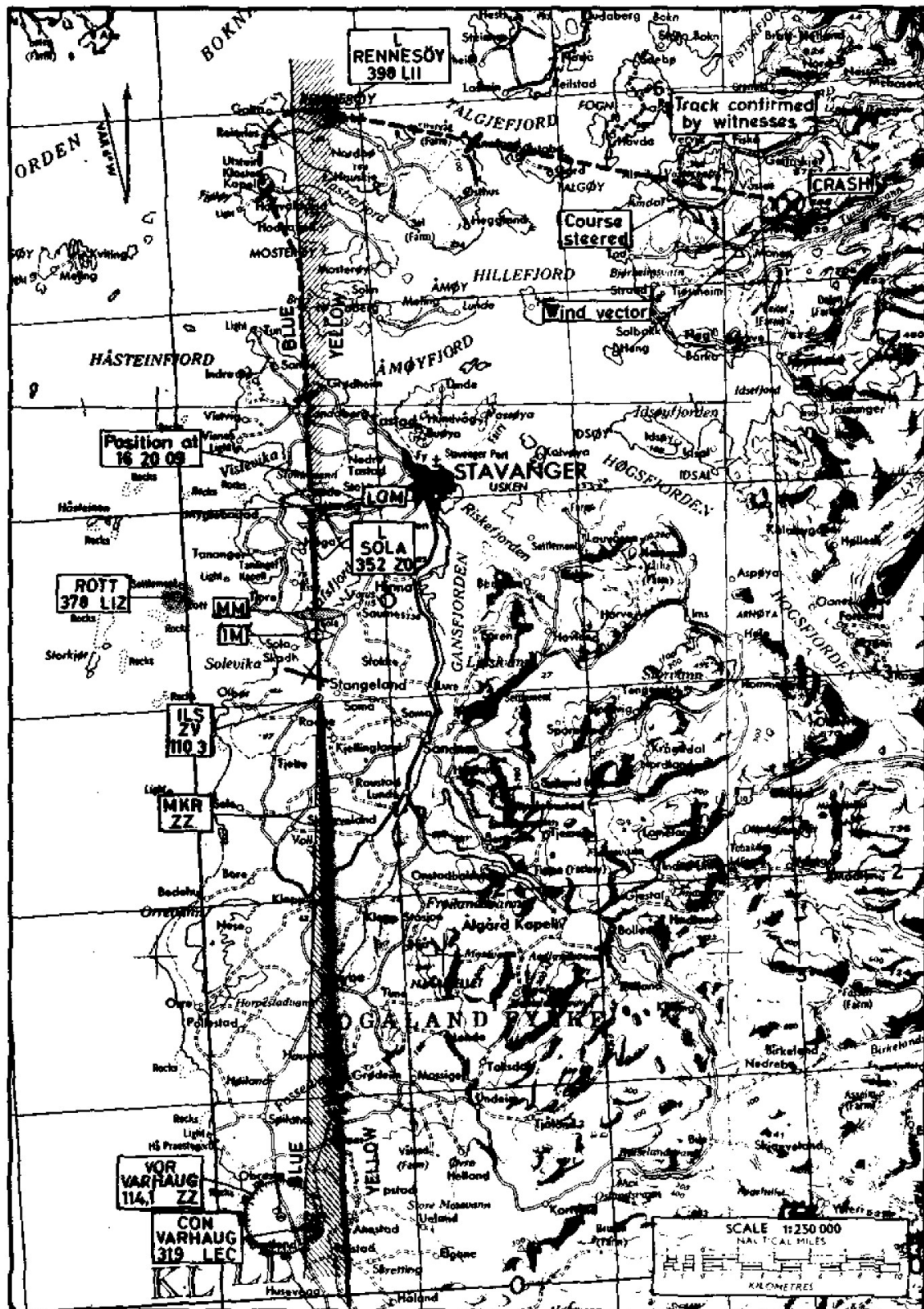
After completing the procedure turn there is little doubt the crew expected still to be on the western side of the localizer beam and they may have missed the movement of the localizer needle that resulted from crossing the beam. If the crew misinterpreted the indications of the localizer needle this 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 localizer beam. The Commission was 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 misinterpreting the ILS indicator readings.

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 localizer. Nevertheless, this should not have prevented them from correctly interpreting the indications of the localizer needle.

Probable Cause

For reasons unknown, the aircraft deviated from the prescribed flight path.

RECONSTRUCTION OF LAST PART OF FLIGHT



Unbroken line: Aircrafts initial approach
Dotted " : Possible flight path last minutes

Viking 3B, G-AHPM
9/8/61

FIGURE 14