No. 2

Polskie Linie Lotnicze LOT (Polish Airlines), Vickers Viscount 804, SP-LVA, accident near Liège, Belgium on 20 August 1965. Report undated released by the Department of Civil Aviation, Ministry of Communications, Belgium.

1.- Investigation

1.1 History of the flight

The flight was a non-scheduled international IFR flight from Lille, France to Wroclaw, Poland. The aircraft took off from Lille, at 1240 hours GMT and was cleared to climb to FL 160 on a heading to "Silly". At 1242 hours the pilot contacted Brussels ACC and reported he was at 3 000 ft, still climbing and estimating "Silly" at 1249 hours. At 1253 hours he reported over "Silly" at FL 120, and was cleared to climb and maintain FL 130. At 1254 hours the pilot called Brussels and reported he was at FL 130 and estimating "Gatta" at 1300 hours. Five minutes later he reported over "Silly" at FL 130 and estimating "Olno" at 1310 hours. As this was the second time the pilot mentioned "Silly" the radar controller checked his position and confirmed that the aircraft was in fact over "Gatta". At 1300 hours the radar controller directed his attention to Caravelle F-BJTQ which, after passing "Gatta" at 1256 hours on airway "Green One" was cleared to make a right turn on Luxembourg but requested permission to make a detour to avoid an area of intense storm activity. At 1311 hours Brussels ACC has no news of the Viscount which by then should have reported reaching "Olno". Attempts to make radio contact with the aircraft were unsuccessful, and no echo appeared on the radar scope in the vicinity of "Olno". No distress signal was recorded. While in cruising flight the aircraft had entered an area of bad weather, lost altitude and disintegrated in flight before crashing to the ground at 1308 hours GMT. The location of the crash site was 50°44'N 05°13'E, in the village of Jeuk.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	4		
Non-fatal			
None			

1.3 Damage to aircraft

The aircraft was completely destroyed.

1.4 Other damage

There was no other damage.

1.5 Crew information

The pilot-in-command, aged 37, held an airline transport pilot's licence valid until 7 September 1965 with various type ratings including the Viscount 804. He also held a navigator's licence and a radio telephone operator's certificate. His last instrument flying proficiency check was given on 4 June 1965 and the rating obtained at that time was very good. His last medical check was on 8 March 1965.

He had flown a total of 9 816 hours of which 3 454 were as co-pilot and 6 362 were as pilot-in-command. He had flown 1 564 hours on Viscounts of which 1 340 hours were as co-pilot and 225 hours were as pilot-in-command. Within the 90 days preceding the accident he had flown 166 hours on Viscount 804 aircraft as pilot-in-command. His total duty time on the ground and in flight was 365 hours. During the week preceding the accident he had flown 16 hours as pilot-in-command on the Viscount 804. Two days before the accident he had had one day of rest time. The pilot-in-command had never had an accident.

The co-pilot, aged 38, held an airline transport pilot's licence valid until 31 August 1965 with a rating as pilot-in-command of LI-2 and IL-14 aircraft. He also held a navigator's licence and a radio telephone operator's certificate. His last instrument flying proficiency check was on 13 June 1965 and his last medical examination was on 2 March 1965.

He had flown a total of 11 623 hours of which 5 251 hours were as co-pilot and 6 372 hours were as pilot-in-command. He had flown a total of 1 815 hours on Viscount as co-pilot. Within the three months preceding the accident he had flown a total of 198 hours including 161 hours on Viscount 804 aircraft. During the week preceding the accident he had flown 17 hours including 12 hours on Viscount 804 aircraft. He had never had an accident.

Also aboard were two hostesses.

1.6 Aircraft information

On 15 August 1965 a check 2 was carried out at the BEA maintenance shop in London and the certificate of airworthiness of the aircraft was validated until 15 August 1966.

Maintenance work had been carried out on the aircraft in accordance with the BEA Viscount maintenance schedule, approved by the Air Registration Board and the Department of Civil Aeronautics of Poland including a check A on 18 August 1965 by BEA. No major defect had been reported by pilots since 15 August 1965.

On take-off the all-up weight was 23 815 kg which was less than the maximum authorized weight of 29 257 kg and the centre of gravity was within the authorized limits.

The aircraft carried no cargo.

The type of fuel being used was not stated in the report.

1.7 Meteorological information

The weather forecast for Belgium on the day of the accident was as follows:

1. General weather situation:

   A weak cold front located southeast of the British Isles was moving slowly eastward and was to move across Belgium during the day and in the evening.

2. Wind:

   (a) surface: southwest, gradually turning west; 5 to 10 kt

   (b) at 1 000 m: 230°/10 kt, gradually turning 280°/15 kt

3. Weather: cloudy to overcast

   Overcast in frontal region with showers and local thunderstorms during the afternoon and the night; mist and fog during morning, improving rapidly.

4. Visibility:

   locally 500 - 1 500 m during morning, improving gradually to 5 - 10 km; decreasing to 2 - 4 km in the stormshowers.

5. Cloud:

   Cirrus and altocumulus broken, base 3 000 m; in frontal region 6 to 8/8 stratocumulus and cumulus 600 to 1 000 m; local cumulonimbus.

6. Freezing level at 3 500 m, falling to 2 800 m behind the front.

7. Light icing; moderate to heavy in the frontal region.

Before the flight the crew received from the Lille meteorological centre the latest forecasts for Lille, East Berlin, Poznan and Warsaw together with three charts (700, 500 and 300 mbs) prepared at 1200 hours giving the winds and temperatures at those altitudes but without indicating any particular phenomenon.

The 700 mbs chart indicated westerly winds 20 - 25 kt with temperatures of +5°C to 0°C in the region of northern France, Belgium and Germany.

The 500 mbs chart indicated westerly winds 50 - 60 kt and temperatures of -10°C to -15°C in the same region.

At 1200 hours the cold front mentioned in the general forecast was located over eastern Belgium and was moving towards Germany. At 1500 hours it was located between Cologne and Frankfurt.

The study of the weather conditions on 20 August indicated that there was, following the passage of the cold front, a squall line (well-defined turbulence).

At approximately 1300 hours this line crossed the Beauvechain-Tirlemont area as confirmed by the statements of several pilots of other aircraft including the pilot-in-command of Caravelle F-BJTQ which, after taking-off from Brussels and after crossing "Gatta" at 1256 hours observed a very active formation of cumulonimbus in the entire area extending from approximately 15 NM southeast of "Gatta" which led it to alter its route.

The accident site was crossed by this active bank between 1230 hours and 1330 approximately; this was confirmed by the meteorological observations of the Brustem aerodrome, located 6 km north of the accident site and by various statements of witnesses who were close to the scene of the accident.

It was thus ascertained that the weather conditions at the time of the disaster were bad in the area.

It was not possible, however, to determine exactly the magnitude of the hazard factors which may have been responsible for the aircraft's loss of stability at the time the Viscount left FL 130.

In view of the conditions described above, it is possible that a particularly turbulent storm cell lay on the flight path of the aircraft. However, this cannot be definitely affirmed because at the time the Viscount left FL 130, a scheduled transport aircraft - a SABENA Convair 440 - entered "Green one" in the opposite direction at FL 70. The pilot-in-command of the Convair was interrogated at length in an effort to obtain all possible information that might have enabled the Investigation Commission to gain a first-hand impression of conditions on the airway at the time of the accident. However, nothing abnormal was noticed by this pilot who stated that his flight had been routine and without any turbulence.

1.8 Aids to navigation

The following aids to navigation were available:

Lille	NDB	
Cambrai	NDB	VOR
Silly	NDB	VOR
Gatta	NDB	
Olno	NDB	VOR
Novenich	NDB	VOR

The aircraft was equipped with VOR, radio compass and ILS. Its position was reported over the Silly and Gatta radio beacons. Brussels ACC surveillance radar checked and confirmed these positions.

1.9 Communications

Communications were normal until 1259 hours when the last communication from the aircraft was received.

1.10 Aerodrome and ground facilities

Not relevant to this accident.

1.11 Flight recorders

Not mentioned in the report.

1.12 Wreckage

The crash occurred on arable land, and a crater about 20 m wide and 2 m deep was formed. The aircraft was inverted along magnetic heading 040°.

The pattern of distribution of the wreckage on the ground indicated that the aircraft disintegrated in flight at a fairly low altitude, estimated at between 2 000 and 3 000 ft, while proceeding on a heading of approximately 200°.

At the time of impact it had a high forward speed and a rapid rate of descent.

The fact that many of the fragments lay in wheat fields and cultivated plots rendered the search for wreckage extremely difficult. However, practically all the structural parts and fragments shed by the aircraft at the time of disintegration were recovered near the site of the crash. This excluded any possibility of failure and loss of components at the cruise altitude such as might provoke loss of control of the aircraft.

Inspection of broken components revealed that the failures were caused by excessive aerodynamic loads on the structure.

No sign of fatigue or corrosion under strain was discovered which might have caused local weakening of the structure.

1.13 Fire

Not mentioned in the report.

1.14 Survival aspects

Inspection of the remains of the cockpit seats showed that the pilots had fastened their safety belts.

1.15 Tests and research

None mentioned in the report.

2.- Analysis and Conclusions

2.1 Analysis

Engines 1, 2 and 3 were found deeply embedded in the ground and evidence revealed that No. 4 engine was torn off in flight by upward momentum. The engines were badly damaged but although they were not completely dismantled, nothing in their condition

or that of the propellers which were carefully examined suggested defective functioning prior to the accident.

The pitch settings of the propeller blades at the time of impact were:

No. 1 propeller	52 1/2°
No. 2 propeller	50°
No. 3 propeller	49°
No. 4 propeller	24°

From the damage found on the propellers it was concluded that:

- the aircraft had a high rate of descent at the time of impact and its longitudinal axis was more or less horizontal;

- the engines were developing reduced power at impact;

- no failure was due to fatigue;

- the whole of the damage can be attributed to impact loads.

The flight controls system disintegrated on impact. Examination of the parts recovered did not reveal any failure or defect other than those due to impact.

The pilot's cockpit and its equipment disintegrated on impact. Some airborne instruments were identified, but no readings could be taken from them.

Examination of the electrical system led to the conclusion that:

- the main distributor bar was receiving direct current;

- the alternating current necessary for the airborne instruments was available.

No trace of any lightning strike was discovered.

The hot air anti-icing system was operating at impact.

No trace of hail damage could be found.

It was concluded from the distribution of debris on the ground that the aircraft disintegrated in flight at a relatively low height, estimated at about 2 500 ft.

All the failures were studied and proved to be static ruptures due to overload. The broken sections were sound and showed no sign of weakness due to fatigue or corrosion.

At 2 500 ft the aircraft was still in cloud (the ceiling at Jeuk at the time of the accident was 1 000 to 1 200 ft), and none of the eye witnesses saw the aircraft disintegrate or perform a manoeuvre at this height.

It may be assumed that, in order to reach the height of 2 500 ft from its cruising level, the aircraft must have entered a dive at high speed and that the pilot, on recovering control, attempted to level out, but exceeded the design limits of the airframe during this manoeuvre.

Data were obtained from the manufacturer concerning the gust and manoeuvre loads for an aircraft weight of 51 000 lb with the centre of gravity at 13 per cent of the mean aerodynamic chord, which were the conditions prevailing at the time of the accident. A detailed analysis of the various possibilities of failure of the aircraft in terms of speed was made and indicated the following:

At the moment of downward failure of the stabilizers under the maximum load attained during the manoeuvre, the aircraft is subjected to a dive moment which is no longer compensated and undergoes a rotation round the pitch axis which imposes tremendous aerodynamic and inertia loads on the structure.

The angle of attack of the wings becomes negative and the aerodynamic loads cause a downward flexion of the wings. The inertia loads and gyroscopic torques provoke an upward wrench of No. 4 engine. The rotation movement carries the aircraft into an inverted position. The disintegration consequent upon this pattern of forces can account for all the failures and the distribution of the debris on the ground.

Inspection of the propellers showed that the blades were in coarse pitch on impact. The angles noted were approximately 50° for Nos. 1, 2 and 3 propellers. In view of the flight conditions prevailing, it may be assumed that the pilot reduced throttle in order to brake the aircraft as much as possible. With the throttle levers closed, a blade angle of 50° corresponds to an aircraft speed of approximately 300 kt, or roughly the dive speed of the Viscount (Vd = 293 kt). At this speed a deflection angle of -10° applied suddenly to the elevator is sufficient to produce a downward break in the tailplane; the corresponding stick load is of the order of 100 lb.

These conditions are not exceptional in regard to either the speed attained or the loads involved, and are likely to provoke a sequence of failures in accordance with the pattern described above. It was, therefore, considered likely that these were the conditions actually experienced.

The design calculations of the Viscount are adapted to the British Civil Airworthiness Requirements in force in 1956. These requirements were revised in 1962 for the purpose of introducing new calculation criteria for manoeuvre loads. Aero-loading Note 629 issued by the manufacturer on 7 January 1966 established the conformity of the structural resistance of the Viscount to the new regulations, provided that modification No. F 172 was carried out.

Modification F 172 had been carried out on the subject aircraft, therefore it was concluded that the failures resulted only from exceeding the design limits, without any structural weakness being implicated.

No evidence explaining why the aircraft left its cruising level and entered a high velocity dive was found. The hypothesis of failure at FL 130, in particular, does not seem to merit retention.

In view of the adverse weather conditions prevailing in the area it was assumed that the pilot lost control of the aircraft as a result of severe turbulence encountered in a storm cell which had reached the stage of maturity and was therefore particularly active. The turbulence seemed to have been very local and therefore probably intense. There was no reference in the meteorological information, the departure forecast or the en-route communications of the possibility that storms or turbulence might be encountered. As the pilot had no weather radar at his disposal he was probably unaware of the presence of a cumulonimbus on his route and was taken by surprise by severe and sudden turbulence which put the aircraft in a difficult position.

The symmetry of the failure suggests that the aircraft was in symmetric flight at the time of disintegration.

2.2 Conclusions

Findings

The crew were satisfactorily certificated.

The certificate of airworthiness of the aircraft was valid until 15 August 1966. The aircraft had been properly maintained, and no major defect had been reported since the last major check.

On take-off the all-up weight and the position of the Centre of Gravity were within permissible limits.

The study of the weather conditions on 20 August indicated that there was, following the passage of a cold front, a squall line (well-defined turbulence) in the area of the accident.

No evidence of engine/propeller malfunction or failure was found. The aircraft disintegrated in flight at a height of approximately 2 500 ft under load factors exceeding the stress limits of the aircraft.

Cause or
Probable cause(s)

No evidence was found to explain why the aircraft left its cruising level.

The overall atmospheric conditions in the vicinity of Jeuk and the circumstances of the accident were such that it was assumed that the pilot lost control of the aircraft when entering a cumulonimbus. It is possible - and even highly probable - that turbulence was a determining factor in the accident.

3.- Recommendations

In the light of this accident the Commission considers it desirable:

1. that public transport aircraft be equipped with airborne weather radar;

2. that information concerning meteorological phenomena hazardous to aviation should be transmitted to aircrews with the greatest possible precision.

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