No. 35

Asociación Interamericana de Aviación, (AIDA), Ltda., PBY-5A, HK-133, crashed on the side of Quetame Hill, Vereda de "Cubia", Bojacá, Cundinamarca Department, Colombia on 8 December 1956, Report released by Department of Civil Aviation, Colombia.

Circumstances

The aircraft departed Santa Cecilia Airport, Bogotá at 0647 hours local time bound for Medellín and Quibdó, carrying a crew of 5 and 11 passengers. Take-off was made at a time when the airport was closed due to poor visibility. While flying on instruments a few moments after take-off, the starboard engine failed. The aircraft continued its flight over the Sabana de Bogotá for approximately 23 minutes, following which, while flying on a magnetic heading of approximately 280 degrees, it crashed violently (at approximately 0705 hours) against Quetame Hill, 25 km. northwest of Santa Cecilia airport at an elevation of 2 790 metres (9 170 feet). With the exception of the flight engineer and one of the passengers, all the occupants of the aircraft were killed.

Investigation and Evidence

At the time when the accident occurred, the aircraft had flown 48 minutes since its last 100-hour inspection and 7 891 hours 58 minutes since its last general overhaul. It was last inspected by the Colombian Civil Aviation Authorities on 30 November 1956 and was found airworthy by the inspector. It was given a temporary 10-day certificate of airworthiness valid until 9 December 1956.

The starboard engine had flown 184 hours, 51 minutes since its last general overhaul. On 14 November this engine was installed in HK-133 following its removal from aircraft HK-1001, another PBY-5A, belonging to the same company, which was undergoing repairs. Following the flights made by HK-133 on 6 December the aircraft log book carried an entry by the pilot who noted that this engine was losing power. In order to remedy the defect noted by the pilot, the maintenance service did the following work on the engine on 6 December:

> Corrected the basic adjustment of both carburetors; corrected an air leak into the line to the supercharger pressure indicator; adjusted the inlet tubes and checked the adjustment of the carburetor air intake.

When this work was completed, the engine was tested on the ground. The turbine was found to be still making a noise and the same loss of power reported by the pilot was observed. On the same day, the carburetor was dismantled in order to inspect the turbine. It was found that the latter had been displaced to the rear part, which caused rubbing against the jet section. The mechanics therefore removed the engine in order to dismantle the turbine section.

On 7 December another turbine was installed. This work was done under the supervision of the owner and manager of the Tadecol Workshops and of AIDA's Chief of Maintenance. The technical assistance given by the manager of the Tadecol Workshops was limited to checking that the mechanical distribution of the engine was correct. After verifying this, he withdrew and the AIDA mechanics continued the work. When installation of the turbine was completed, the engine was reinstalled on the starboard side of the aircraft, following replacement of the starboard magneto and an oil change. The engine was ground tested by the captain of the aircraft and the flight engineer for approximately 20 minutes. The aircraft was declared to be in satisfactory working order by the personnel who repaired it but the necessary test flight was not made before commencement of the scheduled passenger flight, 4 hours and 47 minutes later.

Only the following facts are known concerning the accessories of the the starboard engine:

> Before flights on 14 November, the fuel pump had been replaced and the carburetor support adjusted. Also before flights on 15 November the thermo-couple had been adjusted. On 5 December, the nuts fastening the carburetor to the engine were adjusted and an air leak into the boost pressure gauge line was corrected.

The weather conditions at Santa Cecilia field at the time when HK-133 took off were as follows:

"Horizontal visibility reduced to 300 metres in all directions owing to low cloud. The ceiling was at approximately 400 feet above the airport, with 3/8 stratocumulus". The dispatcher stated emphatically that the airport was closed and that he said to the captain before the take-off that he should wait for better visibility and ceiling conditions since Techo airport was also closed owing to low visibility - he had called Techo Flight Control at 0610 and they had communicated the conditions at that airport. Another captain, a pilot of Pato Gold Mine, who flew over the Sabana de Bogotá approximately 10 minutes after the accident, stated that that area was completely covered by cloud up to approximately 9 000 feet. He stated that Madrid, Techo and Santa Cecilia airports were closed owing to low visibility but that Guaymaral Airport, where he landed a few minutes later at 0725 hours, was open. He also stated that from Guaymaral northwards the visibility was unlimited and that the summits of El Tablazo, El Yunque and of the Andes were clear of cloud. From the communications log of Techo Control Tower it was also noted that the airport was closed owing to low visibility at 0545 hours local time and that it was reopened at 0820 hours.

HK-133's radio equipment was inspected by the Civil Aviation Department on 30 November (8 days before the accident) and all the equipment was found to be in satisfactory operating condition. At 0604 hours local time the pilot established control on the route control frequency of 6589.5 kc/s, requested information concerning the weather at Medellín and tested his radio equipment. This was the only radio contact made by the pilot prior to and during the flight.

It is noted that the pilot failed to make the required radio contacts with Techo Control Tower. As regards the ADF equipment, both radio compasses were found to have been functioning, as the readings of the left-hand and right-hand instruments were respectively 175° and 185°. All the switches of the HF transmitters and receivers were in the "on" position. It was noted, moreover, that the radio equipment of the Techo Control Tower was functioning normally as borne out by the reports of flights which preceded and followed that of HK-133, and the communications log of that station.

It was found that fire did not threaten either during the flight or on impact and that the fire extinguishing equipment carried was not used. However, it was noted that the selector valve of the CO_2 bottles for extinction of engine fires was set for discharge of the bottles on to the starboard engine.

A witness who was 3 kilometres from the point of impact states that the crash occurred at approximately 0700 hours local time when there was cloud in all directions and the visibility was estimated to be 20 metres. He heard the aircraft pass overhead at low altitude and presumed that it was going to crash.

A statement was also obtained from another aircraft captain, a pilot (previously mentioned) of Pato Gold Mine, who took off from El Bagre for Bogotá at 0555 hours local time on the day of the accident and began to fly over the Sabana de Bogotá at 0715 hours at an altitude of 11 500 feet. He states that the station at Techo informed him that that airport was closed with ceiling and visibility zero. He noted that the Sabana was covered with cloud to an altitude of approximately 9 000 feet. He was able to see the peaks of the hill parallel to Madrid landing field, but the latter was completely closed. This captain flew above the ceiling and arrived over the city of Bogotá hoping to land at Santa Cecilia airfield. However, there was no visibility at Santa Cecilia and he proceeded to Guaymaral. He also states that from Suba to the north of the Sabana the ceiling and visibility were unlimited, furthermore, there was no high cloud over the Sabana but only low lying cloud. He states that the hills El Tablazo, El Yunque and Los Andes were clear of cloud but that he was unable to see Quetame Hill or the other hills in the vicinity of Bojacá. When asked if there was sufficient visibility over La Sabana to make an emergency landing owing to the low visibility, the captain replied: "It was impossible to make an emergency landing owing to the low visibility". It is therefore concluded that, ten minutes after HK-133 crashed into Quetame Hill, the Sabana de Bogotá was completely covered by cloud up to an altitude of approximately 9 000 feet or that a blanket 340 feet thick covered the Sabana level. Furthermore, according to the statements of the aircraft captain and the witness, Quetame Hill and the range adjacent thereto were completely covered by cloud. According to these statements, it is presumed that the Sabana de Bogotá was completely covered by thick cloud at the time of the accident and that HK-133 was flying in IFR conditions immediately after take-off.

Upon arrival at the scene of the accident the Investigating Commission found the wreckage of HK-133 lying on one of the slopes of Quetame Hill at an elevation of 2 790 metres, its magnetic heading being 235°.

On examination of the aircraft the following facts were noted:

1) All the wing panels had detached themselves from the hull and were found lying 8 metres away. Examination of the starboard wing indicated that the wing had not been subjected to any excessive loads in flight. The port wing was broken at two points: at the level of station 24 and at the level of station 19. According to the tracks found on the ground, at the level of the port wing float and 15 metres away on the left, it is assumed that the first impact of the aircraft on the surface was taken on this wing, which pressed upon the float, causing the breakage of the wing at the two points mentioned. By force of impact and the centrifugal force of a slight turn (about 5° bank) to port, the aircraft revolved about 30° to port round its vertical axis. Careful examination of the structural elements of this wing shows that it had not been submitted to overloading in flight.

2) On examination of all control surfaces no evidence was found of structural breakage in flight. It was considered that had a structural failure occurred in flight, the broken portion or an adjacent part of the structure would probably have detached itself from the aircraft before the crash and would have been found at some distance from the accident site.

3) The control surface tabs were found in the following positions -

a) the rudder control tab was about 6 to 8° to starboard;
b) the elevator tabs were down;
c) the aileron tabs (port aileron) were about 3° to the rear;

4) The aircraft hull was completely destroyed up to station 367.

5) The hull section from station 388 to the tail was found in apparently good condition, with evidence of rearward bending stress between stations 546 and 576 and stations 367 and 388.

6) The starboard engine was found practically detached from the nacelle and twisted about 30° to the left. Inspection of this engine revealed the following:-

The propeller was detached with part of the nose housing and the entire reduction system, the whole being found behind the engine and level with the trailing edge of the central section. Examination of the teeth of the reduction gear showed that this area had been submitted to temperatures much higher than normal. The propeller blades were bent at a 19° angle and their folding back and the traces of impact on the ground indicated that the engine was idling or turning at a very low rpm at the time of the crash. The cooling vanes were found in the open position. All the steel tubes of the engine mounting were found broken close to the support of the former with the nacelle. All the connections between the oil tank, the radiator and the engine pump were found broken, and it was impossible to determine whether any of the pipes were broken or had come loose before the crash. Unsuccessful attempts were made to find the oil valve. The fuel valve was found in the closed position, yet it is doubted whether it was in that position before the crash, as the twist of the motor to port side could have closed it. On the outside, the crank cases of the power and accessory sections showed signs of having been subjected to high temperatures, judging by the scorched and cracked paint. Cylinders Nos. 1, 3, 12, 13 and 14 were dismantled at the site of the accident, and the following details were noted: Cylinder No. 12 had a completely melted-down piston, and broken piston rings; the connecting rod was broken at the point of juncture with the piston, and showed signs of having been subjected to excessively high temperatures. The piston of Cylinder No. 11 was also melted down to a large extent and seemed to have supported temperatures above normal. The remaining pistons were melted to a lesser degree and had some broken piston rings. Owing to seizure it proved impossible to dismantle cylinders and pistons Nos. 2, 4, 5, 6, 7, 8, 9 and 10. The oil filter was removed and numerous metal particles were found (tin, aluminium, brass and steel). The oil pan was dismantled, and inside were found a large number of piston, piston ring and rod fragments. All the spark plugs were dismounted, and it was noted that they were all of the type recommended for the engine and appeared to have been operating normally, although some of them seemed too tightly compressed owing to the high temperatures they had undergone. Nothing was found

to indicate a malfunctioning of the ignition system. The turbine and accessory sections were dismantled a few days after the accident, and it was found that the gears, the shafts and the hubs underwent temperatures well above normal, owing to lack of lubrication. On the starboard side of the tail unit, a large quantity of oil was observed; it had escaped from the starboard engine, which could have been due to filtration into the turbine section through misalignment, to failure of the internal return system, or to a break in one of the connections of the external oil line. The accessories of this engine showed no evidence of failure. The engine's feathering system was examined, particularly the electric motor and the pump; none showed evidence of failure. The electric circuit of this system could not be examined as it had been totally destroyed.

7) The port engine was in satisfactory working order.

8) It is presumed that the landing gear was extended by the violent crash of the aircraft against the hill, which loosened the gear from its retracted position.

The starboard leg was found unlocked in the "down" position, which shows that at the time of the crash the gear must have been retracted.

9) The cabin and instrument controls -

Cockpit - the master magneto switch was in the "on" position.
Starboard engine - both on. Port engine - both on.
The clock showed 0729 hours. The pilot's airspeed indicator - 72 knots. The pilot's radio compass - 175°. Co-pilot's - 185°. It proved impossible to determine the readings of the other instruments or the position of the other controls, all of which had been completely destroyed. Flight Engineer's station. Starboard engine tachometer, 2 600 rpm. Precision indicator of the supercharger: 26.5" Hg. fuel mixture controls: "full rich"; altimeter: 12 240 feet and 29.92" Hg.

Analysis of Evidence

The aircraft took off from Santa Cecilia airport with an overload of 525 kgs over the maximum gross weight permitted by the Colombian Civil Aeronautics Authority for take-off at sea level, and with an overload of 1 505 kgs over the operational maximum gross weight recommended for Bogotá. According to the graphs on take-off weight limitations shown in CAA Manual No. 42, at a standard altitude of 8 260 feet and with a runway of 5 414 feet (Santa Cecilia) the maximum operating gross take-off weight is 11 339 kgs. According to the load and trim computations the aircraft took off from Santa Cecilia with 12 845 kgs, and the maximum gross weight at sea level authorized by the Colombian Civil Aeronautics was 12 320 kgs.

The company had not established an adequate technical system for aircraft loading, and it was therefore impossible to determine the point of the aircraft's centre of gravity at take-off and at the moment of the accident.

The aircraft dispatcher showed that he lacked the technical knowledge necessary for the proper discharge of his functions, since he had not even known either the empty weight of aircraft HK-133 or the maximum gross operating weight for Bogotá. Moreover, he was working without a technical system for loading or for determining the aircraft's centre of gravity.

The failure of the starboard engine was conclusively proved; it was caused by serious damage to the lubricating system, due to either of the following causes:

a) the severance of a connection in the external oil line to the engine;
b) the misalignment of the turbine section, which might have produced an obstruction in the internal lubricating passages of the engine.

It proved impossible to determine the condition of the connections of the oil line serving the starboard engine, owing to the considerable damage suffered by the radiator, the pipes and the hoses.

It was impossible to determine exactly why the pilot did not feather the damaged engine. However, it is assumed that this may have been due to either

a) exhaustion of the oil supply for the pitch control system; or
b) failure of electrical system of the feathering circuit.

The weather conditions at Techo and Santa Cecilia Airports were completely adverse at the time of HK-133's take-off, for which reason the take-off was effected under IFR conditions as shown by the Meteorological Report and the Route Control and Techo Approach Control logs.

On establishing radio contact with Techo Control Tower, the pilot merely tested his radio equipment and enquired about weather conditions at Medellín, which would suggest that his take-off was deliberately undertaken in spite of unfavourable weather and the prohibition of Techo Control Tower. Apart from this radio contact the pilot did not contact any ground station, notwithstanding the relatively long flight time and the satisfactory working order of the aircraft's radio equipment.

Santa Cecilia Airport was approved by the Civil Aeronautics Authority, for operational use, subject, however, to control by Techo Tower.

The journey log book was not kept in conformity with the recommendations of the Colombian Civil Aeronautics Authority.

The Company forms covering ground testing of the engines do not include a specific item relating to the checking of the pitch control system. It is, therefore, not known whether the testing of the starboard engine, accomplished some hours before the accident, included this check, and, consequently, whether the aircraft took off with the system in good working order.

The aircraft did not undergo the necessary flight test after the replacement of the turbine section of its starboard engine. This appears to have been the Company's practice in its maintenance work on HK-133, as it was found moreover that the proper test flight was not performed after the replacement of the port engine.

The facts which follow give evidence of serious shortcomings in the Company's maintenance Service as well as in its Operations Section:

a) The pilot discharged the functions of Maintenance Superintendent, and was in charge of some technical aspects of the work entailed by such functions without being duly licensed for this by the Colombian Civil Aeronautics Authority;

b) There was no responsible Maintenance Department to plan and take decisions on the various kinds of work to be performed on the aircraft as these functions were assigned to the Chief of Operations;

c) The chief maintenance officer was unable to perform his duties successfully as he did not have sufficient experience with PBY-5A equipment and as part of his functions were being discharged by the pilot.

The role of the owner and manager of the Tadecol Workshops in the installation of the starboard engine's turbine was limited to seeing that the engine's mechanical distribution was correct; he did not, however, assume total responsibility for this work.

AIDA was operating without taking the precaution of having available a spare engine in good working order, which would have ensured maximum safety. In its absence, the starboard engine of HK-133 was repaired hastily and without conforming to technical standards, a few hours before the accident. This is further borne out by the fact that the Company had to ask the Colombian Air Force for the loan of the port engine used on the aircraft at the time of the accident. Previously this engine was installed on a PBY-5A that had not been in service for some time.

The fact that the Company did not have an aircraft available that could have replaced HK-133, led to the excessive haste with which this aircraft was reconditioned to enable it to perform the flight of 8 December, carrying passengers.

Two mechanics were on board the aircraft to advance their flight mechanic's training course. They were flying as additional crew without holding the appropriate licences. The Civil Aeronautics Authority had not been informed of this training being given by the Company to the mechanics.

The pilot reported at Santa Cecilia Airport on 7 December at 0630 hours local time to assist in getting HK-133 ready for flight. He remained at work all day, the night of the 7th and part of the early morning hours of the 8th (until 0230 hours local time) when he retired, only to return for the flight at 0545 on the same day. This suggests that, at the time of the accident, the pilot was tired owing to the continuous work he had performed on the 7th and 8th. The same may be said of the

flight engineer, who had worked to service the aircraft before as well as during the flight.

Reconstruction of the flight until the time of the accident

On 6 December at 1350 hours local time HK-133 landed at Santa Cecilia Airport from Miraflores, Comisaria del Vaupes, piloted by a captain who was also Chief of Operations and Maintenance Superintendent of the Company (AIDA). After this flight the pilot stated in the aircraft log that the starboard engine was losing power. The Company's maintenance service proceeded, on the same day, to determine what was wrong with the engine. The fault was found in the turbine section and consisted of an inadequate tolerance between the turbine and the distribution section, which produced appreciable friction between the two parts. The starboard engine was taken down, the turbine section was removed and replaced by another one in working order. The work on the starboard engine continued throughout the whole of 7 December and part of the morning of the 8th until, at about 0150 hours, the engine was tested on the ground for some 30 minutes. The aircraft was declared airworthy and ready for the start of the scheduled passenger flight a few hours later.

At 0604 hours the captain called Techo Route Control Centre from the aircraft in order to test the aircraft radio equipment and to inquire about the weather conditions at Medellín. Route Control informed him that the radio signal was fairly good and very clear but did not give him the Medellín weather information. There were no further contacts from the aircraft with any ground station. At 0610 the dispatcher called Techo Control Tower to inquire about weather conditions both at Techo and at Medellín airports. He was told that Techo airport was completely closed due to poor visibility. This information was passed on to the pilot of HK-133. Ignoring the weather conditions prevailing at the time at Techo airport and at Santa Cecilia, the captain gave orders for passengers to board HK-133 at 0630 hours local time. Take-off was started at 0647 hours local time. At take-off Santa Cecilia airport was still completely covered by thick, low fog and, therefore, as soon as the aircraft became airborne it was under IFR conditions. A few minutes after the aircraft had begun to climb, the starboard engine became damaged following complete failure of the lubricating system. As the aircraft was overloaded and the engine was not feathered it was impossible to maintain the rate of climb required to break through the 340 foot thick fog blanket covering most of the Sabana de Bogotá. This circumstance forced the aircraft to continue flying under IFR conditions. It is thought that the pilot was trying to find a way to Magdalena Valley in order to be able to fly at a lower altitude and obtain better performance from the engine still functioning as well as better visibility, but that

1) he tried to do so at an inadequate height (due to failure of the engine which prevented his climbing to a higher altitude) or,

2) thinking he was on the border of the Sabana he started descent too early.

The Chief, Technical Control and Investigation Branch also believes that the aircraft was not turning at the moment of impact (opinion of Chief, Technical Section, Investigator). He believes that owing to the slope of the hill and the heading of the aircraft, the latter was struck on the port wing float which made it turn to the same side. It may be, however, that there was a slight bank to the left due to the fact that the only engine functioning was on that side and that a twin-engined plane when it is stabilized for flight with only one engine leans on the latter.

Probable Cause

The probable cause of the accident was complete failure of the starboard engine due to the breakdown of the lubricating system.

Contributory causes included:

1. Recklessness of the pilot in taking off from a closed airport while aware of the poor weather conditions prevailing throughout the Sabana - a circumstance which prevented returning to the airport of departure when complete breakdown of the starboard engine occurred;

2. The 1 506 kilograms overload of the aircraft above the maximum gross operating weight for Bogotá according to the performance curves of the aircraft;

3. The adverse weather conditions prevailing from the moment of take-off until the moment of the accident;

4. An error of judgment on the part of the Operations and Maintenance Sections of the Company in failing to provide for a test flight of the aircraft after the turbine section had been changed and in finding aircraft HK-133 airworthy for the purpose of a scheduled flight with passengers under such conditions;

5. The lack of competent air traffic and weather authorities at Santa Cecilia airport in a position to check civil aviation regulations and to prohibit take off from a closed airport;

6. Faulty internal organization within AIDA which should have defined exactly the duties of the Maintenance Superintendent, of the Maintenance Chief and of the Dispatcher;

7. The failure of the Company to have available a spare engine which would have avoided carrying out such delicate repair work in a hasty manner.

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